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Emulation of Equal Open Access and Competition Creation in the Wireline Telecommunications Local and Last Mile Market Segments

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Emulation of Equal Open Access and Competition Creation
in the Wireline Telecommunications Local and Last Mile Market Segments

Daniel L. Van Epps

A Dissertation Submitted to
The Department of Technology, Learning & Culture
The College of Education and Human Services
West Virginia University
Morgantown, West Virginia, USA

In Partial Fulfillment of the Requirements for
The Degree of Doctor of Education
Technology Education

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2013

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ABSTRACT

Equal Open Access and Competition Creation in the Wireline Telecommunications Local and Last Mile Market Segments

Daniel L. Van Epps

Expanded telecommunications was deemed a serious need for end users. The “Local Market” and “Last Mile” market segments have largely consolidated into “natural utilities”. Competition and access problems occur if new providers enter the local market and desire competitive access and service to end users. Local and last mile telecommunications market structures are believed to be significantly responsible for inhibiting achievement of a more perfect marketplace. The purpose of this study was to examine potential solutions from laboratory network emulation results addressing the research question “Can equal open access and competition for all users be created in the telecommunications local and last mile segments?” Emulations for 63 local and last mile models were designed and grouped into 16 scenarios. An observation questionnaire was designed to provide further qualitative data regarding the models. The experiment was constructed and attempted to be operated, but the SOHO routers representing telecommunications marketplace participants could not be properly configured to successfully network with each other to provide Traceroute data for validity and verification purposes. Observation data was obtained and was classified into groups and used to create model “filters” regarding optimal local market competition, provider interconnectivity, and four types of last mile provision. All of the models were filtered and scored. Those with the lowest scores (best attributes) were considered to be the leading candidates to address the research question. Further discussion involved opportunities for continued research, application of the findings in real telecommunication markets, and possibilities of why the emulation failed.
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CHAPTER 1: INTRODUCTION

Background

More government agencies tasked with economic retention and development mandates have identified telecommunications as a serious need for their end users (Benkler, 2009, p.21) and have become increasingly involved in their telecommunications markets. Some agencies, quasi-public private partnerships, cooperatives, non-profit corporations, and end users themselves have also tried entering various telecommunication market segments and jurisdictions on their own hoping to provide services, lower costs, increase competition, and in certain cases possibly profit from provision.

The “Local Market” telecommunications market segment is where providers establish their market presence, house their switching equipment, and administer their services. The “Last Mile” telecommunications market segment is where providers’ networks link to their end users’ facilities. The two segments have largely consolidated over time into “natural utilities” sanctioned by local governments as monopoly franchises per infrastructure mode to relieve “unnecessary” and “costly” duplication of wireline-type infrastructure provision previously experienced when multiple providers competed in the same market areas each with their own systems.

The local and last mile market segments combined can be referred to in telephony as the “Local Exchange” and in data networking as a Metropolitan Area Network (“MAN”). The junction of middle mile and last mile market segments involves the local providers “bridging” the two (or more) systems with their network equipment within a facility, and using written agreements to determine each of those other providers’ and end users’ access and use terms and
conditions. Most MANs are inherently configured for technically efficient enterprise service emulating private end users’ Local Area Network (“LAN”) architectures, where the LAN provider totally controls their infrastructure and service provision to their own equipment, and in the case of businesses to their staff end users.

Problems occur however if new providers enter the local market and desire competitive access and service to those MAN end users. The incumbent provider(s) can virtually monopolize the MAN market by controlling the access to and use of their systems, and those competitors gaining access and use will likely encounter unfair competition disadvantages including assessed prices above the incumbents’ costs, restricted throughputs and services, etc. (van Schewick, 2010, p.266). Competitive providers not agreeing to the incumbent’s terms, rates, etc., must additionally construct their own last mile systems to provide end users with service under their own administration and favorable terms, or may elect not to enter that local market at all. The reduced competition affects end users with potentially higher costs and more limited service, while incumbent providers’ local and last mile market shares are increased to between 75% - 95% (Elliott & Settles, 2010).

Another model featuring a government enterprise providing similar last mile rights of way, infrastructure, facilities, network equipment, and carriage service to end users within its jurisdiction is a “Public MAN”. The government likewise can contract with middle mile providers for its end users to gain upstream network connectivity. Such public telecommunications provision may again be implemented to create competition in the local and last mile markets (van Schewick, 2010, p.370), but Public MANs similarly structured to the usually private sector ISPs can also compete unfairly vs. private incumbent and other competitive providers, and possibly constitute a public monopoly.
Problem Statement

The local and last mile telecommunications market segment structures are believed to be significantly responsible for inhibiting the achievement of a more perfect telecommunications marketplace.

Purpose of the Study

The purpose of this study was to examine potential solutions from experimental network emulation results within a laboratory setting regarding equal open access and competition in the local and last mile telecommunication market segments.

Research Questions

The following research question was answered by this study.

• Can equal open access and competition for all users be created in the telecommunications local and last mile segments?

Assumptions

The assumptions for this report were as follows.

• Appropriately and accurately scaled down networks constructed and researched within laboratories can model, simulate, and emulate larger networks situated in the real world.

• In reality a truly perfect telecommunications market can never be achieved. Such markets can approach perfectly competitive status but remain at best imperfectly competitive.
Limitations

The limitations of this study were as follows.

• The results of the study were limited by the validity and reliability of the experiment’s instrument developed and used to gather and report data.

• The experiment relied upon emulations of Internet service providers and Municipal Area Networks within the laboratory, as actual in-service ISPs and MANs were not feasibly available for testing purposes.

• Theoretical perfectly competitive markets permit an infinite number of providers and end users to transact their business, and in reality evolving technology is handling ever-increasing numbers of market participants. However for the purpose of this study only a limited number of providers and end users could be feasibly emulated and tested for the experiment.

• The experiment and its results are not necessarily applicable to various wireless modes of telecommunications.
CHAPTER 2: REVIEW OF RELATED LITERATURE

This chapter of related literature reviewed the economics, politics, technologies, and social aspects and issues involving the distribution sector and telecommunications industry, the evolution and current state of the industry’s wireline technologies, and the telecommunication industry market.

Production-Distribution-Consumption Market Overview

This section examined the Production-Distribution-Consumption market model, technology uses by market participants, the politics and philosophies of trade, government involvement in markets, and the importance of the distribution sector in the market.

Production-Distribution-Consumption Market Models

Although the term “Market” has numerous definitions and may be sub-grouped by locale, demographics, and other interests and aspects, it can also be defined as a collective of producers, distributors, market and exchange places, and consumers serving in respective market segment roles of Production, Distribution, Marketplace Provision, and Consumption. Usually the flow of goods and services starts with a Producer intending to provide them for consumption by a consumer. Intermediary parties are necessary including Distributors utilizing mobility, transportation, communications, and telecommunications means to convey products and services among parties, and providers of actual and virtual sites for marketplaces and exchanges. Sometimes Producers are Consumers as the products and services are reconfigured into other types of products and services and are further conveyed to other Consumer=Producers until they
are finally consumed by end user Consumers. Consumers to can then be Producers, as in the case of producing garbage that is conveyed to a trash collector consumer.

Figure 2.11 details a similar multi-dimensional model “… composed of many interdependent sectors, subsectors, and players,” with a supply chain goal of “an all-encompassing end-to-end solution … optimized by material, information, and money, flowing simultaneously, in real time, and without paper.” (Battelle Memorial Institute, 2007, p.xi). Suppliers, wholesalers, and retailers are broken out from manufacturers, with private sector-provided Transportation; Information and Related Technologies; and Warehousing and Distribution, and public sector-provided Transportation Infrastructure and Regulations and Tariffs, both spanning an entire Supplier-Consumer “Goods, Information and Money” spectrum.

Figure 2.1. Battelle economic model. (Battelle Memorial Institute, 2007, p.xi).
Market Technology

Providers and consumers can incorporate technology as a tool and/or technique to help create new and better products and services, solve production and use problems, devise new uses and applications for products and services, develop improved technologies, etc. Distribution providers can incorporate mechanization to automate natural mobility and communication into transportation and telecommunication respectively. Providers that did not incorporate or upgrade their technologies were at the potential mercy of other providers that did. Distributors were increasingly more important, as other participants in the P-D-C economic model have become more automated and technology-reliant. The U.S. Federal Communication Commission’s National Broadband Plan (U.S. Federal Communications Commission, 2009) noted the developments and benefits of technology when utilized by market participants in their production and distribution of information vs. previous controls imposed by the lack of such technologies.

The conduct of key business activities such as communication, collaboration, process enhancements, and transactions is made easier by use of broadband applications such as online conferencing, social networking, cloud-based business software, and e-commerce. Perhaps chief among the benefits of broadband for business is that it allows small businesses to achieve operational scale more quickly. Broadband and associated information and communication technologies can help lower company start-up costs through faster business registration and improved access to customers and suppliers. Broadband also gives small and medium enterprises (“SMEs”) access to new markets and opportunities by lowering the barriers of physical scale and allowing them to compete for customers who previously turned exclusively to larger suppliers. E-commerce solutions
eliminate geographic barriers to getting a business’s message and product out to a broad audience.

However, small businesses are not fully capitalizing on these opportunities. An estimated 60M Americans go online every day to find a product or service; but only 24% of small businesses use e-commerce applications to sell online. The large majority of small businesses are missing an opportunity to level the playing field versus their larger rivals.

The benefits described above are most compelling when broadband is supported with significant investment in information technology (“IT”) hardware, software, and services and material improvement in business processes. Even technologically lagging firms in the small and midsize space recognize that broadband is a key part of a firm’s basic IT infrastructure. Yet IDC, a research firm, indicates that roughly half of small and midsize firms say that they are cautious when it comes to investing in new IT. Other small businesses voice skepticism about select broadband applications either because of a perceived lack of applicability or uncertain profitability (U.S. Federal Communications Commission, 2009, pp. 266-267).

Anderson noted how consumers used technologies and the benefits of them doing so.

We, the users, will figure out what to do with (technology), because each of us is different: different needs, different ideas, different knowledge, and different ways of interacting with the world. The engineers brought us the technical infrastructure of the Internet and Web - TCP/IP and http:// - but we were the ones who figured out what to do with it. Because the technology was free and open to all, we, the users, experimented
with it and together we populated it with our content, our ideas, and ourselves. The technologists invented the pot, but we filled it (C. Anderson, 2009, p.88).

van Schewick discussed the benefits of systems to the economy and society, depending upon how they were structured.

The architecture of a system influences economic structures and behaviors regarding the development and evolution of the system, and affects the amount and kind of innovation that might occur. In particular, architectural features influence which actors may develop and change a complex system, the incentives under which they act, and the governance structures through which their activity is organized. Conversely, innovation may change existing architectures or create new ones (van Schewick, 2010, p.29). Furthermore, since economic considerations shape actors’ (users’) decisions, system architects (providers) will tend to favor architectures that support their own economic interests. At least in part, then, architectural designs hinge on the choices of economic actors, all of whom pursue their own interests under their particular constraints. Thus, the evolution of architectures is partly endogenous (van Schewick, p.32).

The economic system in which the network is used consists of the actors who use and operate the network, the relationships among them, and the governance structures through which they interact. By providing the context in which innovations are to be deployed, this economic system may constrain the evolution of certain parts of an architecture more than simply considering the dependencies within an architecture would suggest. The economic system in which the network is used influences who controls the components that must be altered and what incentives these actors may have to make these changes (van Schewick, 2010, p.152).
van Schewick then discussed technology’s contributions to economies and societies.

Technological progress is the most important engine of growth for modern economies. Economists have estimated that as much as 70% of the growth in output per hour in the U.S. between 1950 and 1993 can be attributed to technological growth. Exactly how and to what degree specific technological advancements contribute to economic growth, however, is less clear.

Research in economics indicates that technological inventions do not contribute equally to economic growth. Instead, over extended periods of time, technical progress and economic growth seem to be driven by a few general-purpose technologies; some examples are the steam engine, the electric motor, semiconductors, and information technology. General-purpose technologies offer generic functionality that can potentially be applied in a large number of sectors within the economy. As the use of a general-purpose technology spreads throughout the economy, use of the technology increases productivity in the sectors in which the technology is applied. At the same time, new applications of the technology or adoption of the technology in additional sectors of the economy increase the returns to innovation in the general purpose technology, triggering new advances in the general-purpose technology itself. These advances, in turn, may spawn the adoption of the general-purpose technology in additional sectors of the economy, or may lead to new or improved applications in sectors that already use the technology. Thus, the adoption of general-purpose technologies exhibits increasing returns to scale. The ongoing dynamic interactions among new or improved uses of the technology, adoption of the technology in additional sectors of the economy and advances in the general purpose technology can create enormous increases in economic
growth.

Owing to the general nature of a general-purpose technology, and the mere existence of such a technology is not sufficient to have a positive effect on economic growth. A general-purpose technology's effects on growth stem from its adoption in more and more sectors of the economy and from the resulting increases in productivity. Owing to the general nature of the technology, however, its potential applications and uses are not immediately obvious. Instead, realizing a general-purpose technology's inherent promises in a specific sector of the economy requires a considerable amount of innovative activity in order to identify and realize potential uses. Thus, adoption of a general-purpose technology in a specific area is an important innovative activity in its own right; for this reason, such activity is often called co-invention.

As a result, the rate at which a general-purpose technology can affect economic growth depends on the rate of co-invention, not primarily on the rate of technological innovation in the general-purpose technology itself. Thus, the cost of co-invention is an important determinant of the speed with which the social benefits of the general-purpose technology can be realized. In fact, the empirically found delay with which firms' investments in information technology lead to increases in economic growth is usually explained by the high costs of co-invention - that is, by the costs of finding the best ways to apply the new technology in a firm's daily operations, the costs of developing the appropriate software, and the costs of changing organizational structures and processes in response to the new opportunities.

Thus, on the one hand, general-purpose technologies have the potential to contribute disproportionately to economic growth - that is their promise. On the other
hand, the rate at which a general-purpose technology can contribute to this growth is limited by the rate at which new uses of the technology can be identified and realized.

These insights help us think about the importance of application innovation for economic growth. As a general-purpose technology, the Internet has the potential to contribute disproportionately to economic growth. The ability to communicate cheaply and cost-effectively with computers all over the world may be usefully applied in a large number of contexts. The higher the number of uses, the higher the aggregated increases in productivity and the higher the effect of the Internet on economic growth. The rate at which the Internet can contribute to economic growth, however, depends on the rate of co-invention - that is, the rate at which potential uses for the Internet are identified and applications that enable or support these uses are developed, deployed, and used. Measures that increase the cost of co-invention or otherwise reduce the amount of co-invention can harm social welfare significantly. Specifically, increasing application-level innovation increases economic growth; in contrast, limiting application-level innovation may significantly limit the Internet's ability to contribute to economic growth.

The importance of innovation in applications goes beyond its role in fostering economic growth. The Internet, as a general-purpose technology, does not create value through its existence alone. It creates value by enabling users to do the things they want or need to do. Applications are the tools that let users realize this value. For example, the Internet's political, social, or cultural potential - its potential to improve democratic discourse, to facilitate political organization and action, or to provide a decentralized environment for social and cultural interaction in which anyone can participate - is tightly linked to applications that help individuals, groups, or organizations do more things or do
them more efficiently, and not just in economic contexts but also in social, cultural, or political contexts (van Schewick, 2010, pp.357-359).

Shirky noted technology improvements were assisting end user-provided sharing, cooperation, and collaborative efforts.

For the last hundred years the big organizational question has been whether any given task was best taken on by the state, directing the effort in a planned way, or by businesses competing in a market. This debate was based on the universal and unspoken supposition that people couldn't simply self-assemble; the choice between markets and managed effort assumed that there was no third alternative. Now there is. Our electronic networks are enabling novel forms of collective action, enabling the creation of collaborative groups that are larger and more distributed than any other time in history. The scope of work that can be done by non-institutional groups is a profound challenge to the status quo. The collapse of transaction costs makes it easier for people to get together - so much easier, in fact, that it is changing the world (Shirky, 2008, pp.47-48).

Ridiculously easy group-forming matters because the desire to be part of a group that shares, cooperates, or acts in concert is a basic human instinct that has always been constrained by transaction costs. Now that group-forming has gone from hard to ridiculously easy, we're seeing an explosion of experiments with new groups and new kinds of groups (Shirky, p.54).

Political Philosophy of Trade

As discussed, a market hosts participants that may potentially trade products and services. Ideally trading would be “perfect” – fair and free from malice, fraud, outside coercive influence,
and other intentional or unintended biases. Trading can theoretically function without competition by its participants. Such non-profit trading involves sharing or donations of products and services among producers and consumers for a potential collective public good and for non-material needs. "Communitarianism", "Primitive Communism", and the similar “Cooperatism” movements tend to consider trade more as a basic utility. All producers and consumers are "winners", and there are no "losers" or sufferers as a result of trades in those models. Some religious-based societies tend to view products and services and their trade as being subservient to higher personal beliefs. Shirky further elaborated upon these cooperative types.

Sharing creates the fewest demands on the participants. Many sharing platforms operate in a largely take-it-or-leave-it fashion, which allows for the maximum freedom of the individual to participate while creating the fewest complications of group life. Knowingly sharing your work with others is the simplest way to take advantage of the new social tools (referring to the digital photograph sharing website Flickr) (Shirky, 2008, p.49). Cooperating is harder than simply sharing, because it involves changing your behavior to synchronize with people who are changing their behavior to synchronize with you. Unlike sharing, where the group is mainly an aggregate of participants, cooperating creates group identity - you know who you are cooperating with (Shirky, pp.49-50). Collaborative production is a more involved form of cooperation, as it increases the tension between individual and group goals. The litmus test for collaborative production is simple: no one person can take credit for what gets created, and the project could not come into being without the participation of many (Shirky, p.50). Collective action is the hardest kind of group effort, as it requires a group of
people to commit themselves to undertaking a particular effort together, and to do so in a way that makes the decision of the group binding on the individual members. A union or a government engages in collective action, action that is undertaken in the name of the members meant to change something out in the world, often in opposition to other groups committed to different outcomes (Shirky, p.51).

Anderson discussed “Free” trading among end users.

Free can mean many things, and that meaning has changed over the years. It raises suspicions, it has the power to grab attention like almost nothing else. It is almost never as simple as it seems, yet it is the most natural transaction of all. If we are now building an economy around Free, we should start by understanding what it is and how it works (C. Anderson, 2009, p.17). Even after most cultures established monetary economies, day-to-day transactions within close-knit social groups, from families to tribes, was still mostly without price. The currencies of generosity, trust, goodwill, reputation, and equitable exchange still dominate the goods and services of the family, the neighborhood, and even within the workplace. In general, no cash is required among friends. But for transactions between strangers, where social bonds are not the primary scoring system, money provided a common agreed-upon metric of value, and barter gave way to payment. But even then was a place for Free, in everything from patronage to civil services (C. Anderson, pp.36-37). In giving something away, (Peter Kropotkin, 1902) argued, the trade-off is not money, but satisfaction. This satisfaction was rooted in community, mutual aid, and support. The self-reinforcing qualities of that aid would, in turn, prompt others to give equally to you. “Primitive societies” worked that way, he
argued, so such gift economies were closer to the natural state of human affairs than market capitalism (C. Anderson, p.40).

In reality, trading is imperfect and politics are usually introduced into the trading process due to human nature. For-profit trade creates a more materialistic valuation of products and services when they are traded for other products and services, representative currency, or financing. Adam Smith posed when a party makes a (for-profit-type) trade they are valuing the desired products and services more so than what they are exchanging for them; if in a for-profit-type trade a party does not value the product or service at a greater value than what they desire to trade for it, then the party has the option of not trading and is free to retain their product or service or solicit offers from other parties (Smith, 1776).

“Capitalism” can be defined as private entrepreneurial producers and consumers seeking to trade products and services in an attempt to increase or at the least maintain their corporate or personal worths. In pure Capitalism, producers must demonstrate certain returns on investments. Revenues are used to offset expenses, and excess revenues are available for use as profits, dividends, positive investment ratings (resulting in lower borrowing rates), and reinvestment means. Conversely, any lack of producer revenues could increase debts, ultimately risking bankruptcy and potential liquidation, with further complications to raise future capital. Shareholders may also encounter losses, and other lawsuits, legal fines, and similar punishments are also possible. In the capitalistic trading contest there are winners and losers, where winners may remain in the market and possibly acquire more assets, market share, and pricing power, while losers may find competing and remaining in the market more problematic. Skewed gamesmanship may enter into for-profit Capitalistic trading, including advertising and marketing techniques used by a producer to coerce a consumer into purchase choices, and bartering
techniques employed by both producers and consumers to shift trade values in their favors. In both cases where further wealth and fewer losses are desired, there may be increased risks of trading and/or marketplace irregularities to accomplish those goals.

Ideally a “Perfect Market” would exist where producers, consumers, distributors, the market, and trade are all perfect in their functions. In reality only “Imperfect Markets” exist, possibly resulting in various irregularities that affect market participants. A “Cornered Market” can be defined as a market where a provider or consumer has attained significant market share over other competitors through unfair techniques that adversely affect other competitors. An “Oligopoly” results when a small group of providers corners a market, a “Duopoly” results when two providers corner a market, and a “Monopoly” results when one provider dominates or completely captivates a market. Conversely, an “Oligopsony” results when a small group of consumers corner a market, a “Duopsony” results when two consumers corner a market, and a “Monopsony” results when one consumer dominates or completely captivates a market. A “Cartel” and “Collusion” are attempts by market participants to cooperatively and usually covertly corner a market. A market where both providers and consumers are present - a basic necessity for markets to exist – can be defined as a “Served Market”. A market lacking providers, consumers, or both can be defined as an “Unserved Market”. In theory a market lacking a distributor is not necessarily an unserved market if the producer and consumer are situated immediately adjacent to each other, but in reality distribution is naturally part of the P-D-C model and if the provider is absent then the market is unserved.
Government Involvement in Markets

Markets under both Cooperatistic and Capitalistic model types can theoretically exist without government involvement and its oversight. A government can nonetheless be a significant consumer for wares and may be quite welcomed by producers, distributors, and other consumers to participate in a market in that respect. Market participants are typically willing to subsidize their government for it to provide functions they do not desire to provide on their own such as emergency services, sovereign defense against internal and abroad threats, promoting and assisting their growth and security, currency standardization, a legal system to enforce private property rights, binding agreements, etc.

If markets experience problems including those previously addressed and cannot fairly or conveniently rectify the situations themselves, then they may invite participant litigation or require the government to play an arbitrating regulatory role to reduce irregularities and prevent potential market-wide and participant failures. One opinion during the 2010 Wall St. financial crisis supported the regulatory option. “Ultimately … litigation is a poor substitute for regulation.” (Sorkin, 2010). As one mission of governments is to retain and expand their economies, functional markets are desired and even dysfunctional markets are tolerated, but market failures are distinct threats to a country's economy, society, sovereignty, and must be avoided at all costs to ensure its long-term success and survival.

Mixed Economies

Any government intervention in a market can be defined as a “Mixed Economy” and is usually undertaken to achieve certain desirable goals for the market or enforce political ideologies. In one definition of a "Mixed Economy", an issue can be located as a midpoint
somewhere within a range of extreme economic philosophies, with multiple issues having varying positions on the range. MSNBC commentator Lawrence O'Donnell said, “As any introductory economics course can tell you, there’s no capitalist economy anywhere in the world and there is no socialist economy anywhere in the world, not even Cuba. We are all mixed economies, that is, mixes of capitalism and socialism, and we all vary that mix in different ways. That’s why we have a mixed economy, an economy in which we’re trying to use the best, most efficient forms of capitalism, and the best, most efficient forms of socialism where necessary.” (Povich, 2011).

A mixed economy can also result when a government uses a number of solutions in an attempt to correct market problems. U.S. federal government agencies including the former Interstate Commerce Commission and its successor Surface Transportation Board, the Federal Communications Commission, the Federal Trade Commission, and numerous others have regulatory oversight regarding distribution markets. Likewise states' public service/public utility commissions are responsible for certain intrastate distribution market regulations. Some regulations are reserved for county, district, municipal, and other local government agencies. The amount and degree of regulation these government agencies have over market participants varies per the powers granted by their legislatures and the will of their executive branch leaders. Of course the executive and legislative branches are also influenced by voters, lobbyists, higher level executive and legislative governmental branches, and other parties with particular interests in market regulation. A government agency can control markets as both a consumer and a producer. For example the U.S. federal government can purchase gasoline for strategic national security reserves, and in a producer role release ("resell") it, with both actions most likely affecting the gasoline market. Similarly the federal government can sell some of its assets (i.e.,
mineral rights, forests) to other producers, which may affect market prices for similar assets and final prices to consumers.

In theory, a government is non-profit with its revenues adequately covering expenses while maintaining a reserve fund. Most of the government's revenues are obtained from taxes and fees, with some revenues and royalties acquired from product and service conveyances. But in reality the government is usually willing to forego equilibrium by providing tax breaks, grants, sub-market rate loans, tariffs on international wares, and other incentives to subsidize market participants. Obviously there will be resulting shortfalls in its near term revenues, but the government hopes the thus-stimulated economy will provide sufficient revenues to eventually offset its investments and cover borrowing debts.

Ongoing mixed economy debates include what degree of government involvement is necessary to achieve desired market goals, what market goals are addressed with government involvement, what are the effects upon market participants, and what are the costs to the government for intervention. von Mises argued that there is no such thing as a mixed economy. "The market economy or capitalism, as it is usually called, and the socialist [mixed] economy preclude one another. There is no mixture of the two systems possible or thinkable; there is no such thing as a mixed economy, a system that would be in part capitalist and in part socialist." (von Mises, 1949). Former astronaut and Eastern Airlines CEO Frank F. Borman, II once said, “Capitalism without bankruptcy is like Christianity without hell,” (Taylor, 1982) which in a strict interpretation of Capitalism is correct but competes against many governments’ mixed economy goals where all market segment participants are advocated as winners to benefit and expand their economies.
Other possible mixed economic models include “Statism” that can be defined as where government market intervention is significant. Conversely, “Laissez-faire” can be defined as where government market intervention is more limited, sometimes to the extent of permitting the market to function by and regulate itself. “Corporatism” can be defined as where private providers have greater influence over any government market intervention. “Socialism” can be defined as where consumers have greater influence over government market intervention. However von Mises considered government provision not to be Socialism, "It is a step on the way toward socialism, but not in itself socialism." (von Mises, 1949). “Autocratic”, “Authoritarian”, “Totalitarian”, and similar government regime types can be defined as where those governments usually being controlled by one party or an individual have significant if not complete control over their sovereign markets in the express interest of the government. “Anarchy” can be defined as the absence of government, which like total dictatorial control may be equally less desirable.

Market segment participants may try to counter government intervention to protect their investments and other interests by contributing to politicians’ election campaigns, and seeking legislative deregulation and favorable court rulings if those options are available or permissible in the particular governance model.

*Government-Assigned Markets*

The most invasive and pronounced solutions to market problems a government could incorporate are when it assigns a market or market segment to one or more select participants, provides a market or market segment itself, or creates a hybrid public-private partnership, all of which can be considered a "sanctioned market". Such assignments can be achieved through
techniques including urban planning, territorial sovereignty, eminent domain, market restructuring, nationalization, and privatization. A “Natural Monopoly”, “Natural Utility”, or “Public Utility” can be defined as when a market served by a single participant is considered to be more efficient than having multiple participants competing against each other, or when provision by multiple participants in the market is thought to be technically, physically, or practically inefficient, unwieldy, or “redundant”. Certain distribution system and carriage service providers for electricity, railroads, pipelines, telephony, and cable TV have often been designated natural monopolies or “Government Sanctioned Monopolies”.

*Government-Provided Markets*

Early in U.S. history many transportation market segments were privately provided. However such roadways, turnpikes, canals, interurban, and streetcar lines often succumbed to bankruptcy and overall market failures, leaving other market participants with more limited choices for distribution modes. Even the U.S. federal government, which had nationalized many private roadways such as the National Road, assigned their control to state governments. U.S. government agencies now generally provide distribution transportation market segments including highways, secondary roadways, and streets; trails; waterways on rivers and canals with some requiring dams and locks; seaways; and airways (airspace over sovereign territory, airports, and air traffic control). A few exceptions to those examples include private drives and completely privatized or public-private partnerships for bridges, highways, turnpikes, ports, and other infrastructures and facilities. While government agencies provide these systems, they tend not to engage with other transportation service providers for competitive carriage.
In some markets and market segments, government agencies constitute public monopolies. Public transit systems with buses, commuter trains, and other variants of vehicles (again with a few exceptions) are generally government agency-provided, with their own system ownership, maintenance, control, security, monitoring, liability, and additional responsibilities. The government agency in those cases is the sole carriage provider/operator. Many government agencies, particularly at the municipal level, provide their citizens with distribution transportation pipeline-based water and sewer systems and service. Their systems (the distribution market segment), products (water from the government producer, sewage from consumers as producers) and carriage (the service) are combined into one agency.

**Quasi-Public/Private Markets/Market Segments**

In other instances, U.S.-based government agencies along with private providers jointly own and/or administer distribution systems using various hybrids of public-private partnership (“PPP”) models as the sole market or market segment providers, a sample of which are detailed in the following cases.

**U.S. Postal Service.**

The U.S. Postal Service was created in 1775 with the U.S. Constitution empowering Congress "To establish Post Offices and post Roads" as an "independent establishment of the executive branch of the Government of the United States". In 1971, the Post Office Department was reorganized as a quasi-independent agency of the federal government - wholly owned by the government and controlled indirectly by the U.S. President. USPS had a government sanctioned monopoly on most first class mail and standard formerly "third class" mail. USPS said
monopolization provided "for an economically sound postal system that could afford to deliver letters between any two locations, however remote" (http://about.usps.com/publications/pub542/pub542_ch1_002.htm 2013), ensuring rural delivery service (a.k.a. “Universal Service”) immune from network rationalization and creamskimming risks usually found in private business models. In effect, producers mailing letters to a consumer located nearby were subsidizing producers mailing letters to distant consumers’ locations, with the charges built into postage costs. USPS was tax exempt, non-profit, and was “self-funded and does not receive any Congressional appropriations to support its operations, (although) some funding is provided to cover the costs of certain statutorily mandated services”.

(http://www.usps.com/financials/anrpt08/pg43.htm 2011) USPS competed against private parcel carriers, including DHL that was once owned by the Government of Germany's Deutsche Post until its privatization in 2000. Although USPS was a carrier and subcontracted other modal carriers to assist with parcel carriage service, it was not a distribution market provider, i.e., it did not own its own highways.

_U.S. Railroad Administration/U.S. Railway Administration._

During WW I, German submarines patrolling off the U.S.'s east coast were sinking ships destined and arriving from Europe. The panic resulted in transoceanic ships refusing to depart and railroads' east coast port-bound trains backing up in some cases west to Pittsburgh. Thus in 1917 as an emergency wartime measure to address the gridlocking and other rail industry problems of the era, the U.S. Interstate Commerce Commission recommended the U.S. government create the U.S. Railroad Administration to nationalize and administer all of the railroads for the duration of the war. USRA as a government agency was the sole provider of
both the distribution system and carriage service nationally. The lines were re-privatized to their respective owners and USRA was dissolved after the war until its re-incarnation as the U.S. Railway Administration to address the Penn Central Transportation Co.’s bankruptcy and conversion into Conrail. USRA version 2.0 was government intervention in the market that determined what rights of way, infrastructure, and service providers would continue to exist and operate in specific markets. Had the government not taken over the railroads during WW I and the PCTC crisis, the nation’s security, economy, and distribution systems risked market failure and during WW I hostile takeover by foreign governments.

*National Railroad Passenger Corporation (Amtrak).*

The quasi-public/private National Railroad Passenger Corporation (Amtrak) was created by the Rail Passenger Service Act in 1971 to assume intercity passenger service spun off by private railroads that preferred freight carriage service. Those railroads that under their traditional monopolized distribution + carriage service business models had been losing money for decades providing rail passenger service were then freed to concentrate solely upon freight carriage service in an attempt to stabilize their finances and better compete against other transportation modes using more advantageous business, governance, and market models. Amtrak, an independent for-profit corporation, with all preferred stock owned by the U.S. government and common stock owned by railroads and their successors, leased rail line access ("trackage rights") from private rail carriers for some of its trains, and owned other rights of way and infrastructure segments elsewhere. In addition to providing intercity and some commuter passenger services, it has carried mail and some intermodal freight traffic. Amtrak constantly faced calls for reorganization, privatization, spinoffs of some services, discontinuance of certain long distance train routes, and even liquidation as it continued to have budget problems, but
EQUAL OPEN ACCESS AND COMPETITION

interestingly it has increased its patronage, popular support, and received federal American Recovery and Reinvestment Act of 2009 stimulus funding to increase service provision. In some markets Amtrak owns its distribution market segment and provides carriage service as a monopoly, while in most other cases it has government mandated access to private railroads’ lines. Former Amtrak President David Gunn (having previous public transit agency experience) resisted calls for separating Amtrak’s own systems from its service provision, advocating instead that Amtrak be operated essentially as a public transit agency without competition assuming that other companies were not interested in rail passenger service provision. After his departure there were calls by the former G.W. Bush Administration for Amtrak’s restructuring, including renewed investigations of the distribution-carriage separation option using a PPP model variant.

*Consolidated Rail Corporation (Conrail).*

As the result of Penn Central Transportation Co.’s and other regional rail carriers’ Ch. 77 bankruptcies, Congress re-established U.S. Railway Administration to reorganize and consolidate those carriers on 4-1-1976 into the U.S. government-subsidized private Consolidated Rail Corporation for continued freight and some passenger services in the U.S. Northeast and Midwest and Southern Canada regions. Conrail as a government-assigned system provider + carriage service provider competed against more solvent and other government-subsidized private system + service providers often in the same market areas until its eventual privatization on 10-21-1986. The government reportedly subsidized Conrail with $7B in 1983 dollars (Sumcad, 2007).
**Conrail Shared Assets.**

On 6-1-1999 Conrail was jointly acquired by competitors CSX and Norfolk Southern, which then split up most of its distribution and carriage assets amongst themselves. However in certain market areas, fairly equal splits could not be accomplished without giving one company an advantage over the other. To solve the problem and gain buyout approval from the U.S. Surface Transportation Board, the companies created Conrail Shared Assets to control the Detroit, South Jersey/Philadelphia, and North Jersey areas consisting of 1,202 miles of Conrail’s former network (http://www.conrail.com/freight.htm 2010). CSA conducts local carriage and train car switching for consumers in those markets, who then have a choice of using CSX’s or Norfolk Southern’s networks for carriage service beyond the CSA local market areas.

**Ohio Rail Development Commission.**

The Ohio Rail Development Commission was an independent state agency created under the Ohio Department of Transportation, and controlled by ODOT and the Ohio Department of Development with oversight by the Governor’s Office and the State Legislature. ORDC was authorized by to acquire and operate rail lines, generally those that were unwanted by private railroad companies and/or were in danger of being abandoned or liquidated. ORDC could also construct new and restore abandoned rail lines. Its preferred business and governance model as proclaimed by former Executive Director James Seney was to “rescue, rehabilitate, and reprivatize” rail lines back to private railroad companies, and forgo “running a railroad” (personal communication, 7-2003) itself.

ORDC had public-private partnerships with two railroad companies for the operation of two rail lines it owned and/or controlled. In one case, ORDC purchased an unwanted line from
Conrail between Minerva, OH-Hopedale, OH, and has long term net leased it to the Ohi-Rail Corp. The private railroad was responsible for its operation, maintenance, improvement, liability, taxes, etc., including lease payments. In a larger second case, Conrail sold a main line from near Mingo Jct., OH to Columbus to an investment firm that had no interest in operating it. Instead it net leased-to-own the line to ORDC, which likewise was not interested in operating it. ORDC franchised the small Columbus & Ohio River Railroad Company to net operate it, and later after the lease period concluded, took possession of the line and long term (and no-bid) net leased it to the railroad. However ORDC continued to subsidize the railroad even though it was merged into the $B+-valued Genesee & Wyoming Railroad Company’s worldwide conglomerate of similar small railroads. ORDC also authorized C&OR to sublet the line’s right of way adjacent to the tracks to telecommunications providers, and the railroad received those lease payments instead of ORDC or the State of Ohio.

*Alameda Corridor Transportation Authority.*

To expedite rail service between the Port of Los Angeles and the Port of Long Beach, the Alameda Corridor Transportation Authority was created in 2002 to acquire, construct, and administer a 20-mile rail line and other transportation facilities that were provided equally to the Union Pacific Railroad Co. and BNSF Railroad Co. The project acquired the existing rail line between the ports, removed it, and constructed a concrete-lined trench with new tracks below the above street level to replace hundreds of grade crossings with overpasses spanning the trenches. This separation eliminated noisy train horns blowing and accident-prone grade crossings while permitting faster train speeds and greater throughput. Use and operating agreements addressed responsibilities among the ACTA and its users including operation, maintenance, taxes, liability,
security, debris removal, monitoring, etc. Line maintenance expenses were pro-rated based on each railroad’s gross tons-mile. ACTA contracted out for maintenance, and the railroads were responsible for the segment’s dispatching and security. Project revenues including use fees and container charges offset construction debt and administration expenses. ACTA was assessing the railroads $15.79 per 20’ loaded container, $4.21 per empty container, and $8.42 per other rail cars (Alameda Corridor Transportation Authority, 2005, p.22). Theoretically other railroads and qualified users had access to and use of the line segment, whereupon all use fees and container charges might have been re-assessed proportionately based upon the new traffic.

_Akron Metro Regional Transit Authority._

After the Erie Lackawanna Railroad Co., Conrail, Penn Central Corp., et al. abandoned certain rail line segments in the Summit County, OH area, the Akron Metro Regional Transit Authority purchased some of those segments to railbank and rehabilitate them for future uses. In 2000 CSX Transportation sold Metro the 24.42 mile Akron-Canton segment of its former subsidiary Valley Railway Co.’s Cleveland-Zoarville/Valley Jct. main line. Many government agencies in Ohio also owned rail lines though typically net leased them or net franchised line administration and carriage service to private railroads. Metro likewise chose not to engage in freight carriage service and franchised the Wheeling & Lake Erie Railway Co. to provide the service to local users. However Metro open accessed the Akron-Canton line segment for the non-profit Cuyahoga Valley Scenic Railroad to provide passenger rail services on weekends (U.S. Surface Transportation Board, 2003), and reserved for itself providing future rail commuter service. A “Track Coordination Agreement” designated dispatching of trains by Metro, W&LE, and CVSR, a formula and percentage determined the charge base revenue per car rates and
maintenance fee paid by the railroads, and other agreements dictated line maintenance, liability responsibilities, etc.

*Consolidated Facilities Corporation (ConFac).*

USRA during its mission to reform PCTC and other affected railroad companies did analyze creating both Conrail and a “Consolidated Facilities Corporation”. Under one scenario ConFac was to own and operate the affected railroads’ rights of way, infrastructures, and certain facilities while leaving Conrail to provide only carriage service. In theory the option could have permitted open access on ConFac’s system to all railroads. In both cases, system users would have paid access and use charges to help defray the PCTC reformation and other government costs involved over time (U.S. Railway Association, 1975, p.49). However railroad companies with their own systems in PCTC’s service area opposed the model presumably because the ConFac model might have been more efficient than their own private monopolized distribution + carriage service models. Some opponents also argued that ConFac might have encouraged efforts by other solvent railroad companies to likewise “nationalize” their systems (if ConFac was to be a government agency or quasi-government agency) (U.S. Railway Association, 1975, p.50). The private railroads were paying property taxes and were subject to U.S. ICC market regulations that ConFac and its users might have been exempt from due to its open access model, yet those railroads could also have accessed ConFac’s system to equally compete for service and lineside customers without being subject to those taxes, regulations, and other responsibilities and costs incurred from owning their own systems too. The ConFac option was ultimately dropped in favor of a traditional distribution system + carriage service model for Conrail similar to the other railroad companies’ models, although Conrail required significant subsidization to
return it to profitability. Conrail later rationalized and abandoned unwanted line segments that might have been preserved under ConFac so that more intercity routes could have been available for routing choices and network redundancy, and local communities could have retained their network rail access to serve their freight and passenger customers. ConFac critics incorrectly portrayed the separation of the distribution system from carriage service model as “nationalization”, where true nationalization involves government ownership and operation of in this case a railroad.

Ohio Turnpike Commission Adjacent Rights of Way.

In addition to providing its tolled highway, the Ohio Turnpike Commission obtained additional revenues from leasing its right of way adjacent to the highway infrastructure to various telecommunication system providers. Qwest, MCI, AT&T, and IXC were some of the known providers that had marked fiber lines located adjacent to the highway lane, and system construction company Gudenkauf Corp. of Columbus, OH workers once said they had installed conduits and fiber for Marconi and other providers embedded within concrete median barriers that had since been abandoned. OTC easement fees assessed to MCI as of 7-1-1988 were $1925 per mile annually (Ohio Turnpike Commission, 1988), although its annual rates c.2009 had increased to $3K-$4K (J. Disantis, personal communication, July 15, 2009).

Government-Sponsored End User Aggregation.

Some local and state government agency programs “aggregate" or pool private utilities' consumers together amicably with agreements and then purchase those services on their behalf in virtual bulk quantities from select utility providers at prices hopefully closer to wholesale than
regular retail prices. Aggregation supposedly reduces subscriber costs associated with multiple individual accounts, and is in effect a quasi public-private partnership where the government agency performs some of the private provider’s services for them (Ohio Consumers' Counsel, 2009). The concept could theoretically be used by government agencies to acquire wholesale speed telecommunication services for local market end users, and has been advocated by consultants as a solution to assist rolling out faster speeds to rural areas.

While aggregation is a method of trying to create market competition and might eliminate the monopolies utility providers may have over local service markets, it does so by increasingly concentrating a competitive consumer market into a concentrated, perhaps monopsonistic end user market. Should multiple government agencies collaborate in the aggregation program with their respective end users, the end user market becomes more concentrated for the utility service provider to contend with. To be more fair, the government agency aggregator should authorize its end users to pool together in groups and contract with the service provider of their choices from multiple providers instead of the aggregator selecting only one provider for the end users.

Proponents say aggregation programs save the selected provider on costs such as end user billing. Yet in one model the billing function was merely transferred to the government agency and consolidated with their other enterprise service billings. The provider in effect was being subsidized by the government agency or being cross-subsidized by the government agency’s other services. The government agency might also pass along the aggregation program’s costs to end users not enrolled in the program who are subscribed to another competitive service provider, or to end users not using the particular service at all from any provider in the form of various taxes, unless the aggregation program’s costs are required to remain captive to the enterprise.
The contracts between the government agency aggregator and the provider are typically for multiple years in exchange for locked-in rates vs. paying the current going market service prices. Each party believes the locked-in price will benefit their interests depending upon commodity exchange price fluctuations. Yet for example Hurricane Katrina wiping out (then constrained) natural gas capacities would have bankrupted numerous aggregation providers had they not been permitted to break the lock-ins to raise rates or cease service provision. The long term contracts could also be pointless since oftentimes each party by agreement can break the contract prematurely, and end users can also drop out at their convenience and select other service providers, thereby proportionally minimizing the aggregation savings.

Aggregation program providers claim to enable end user leverage against incumbent service providers, but it actually introduces more market intermediaries - the government agency "represents" the end users as an agent, and possibly becomes involved as another intermediary in the market. Some distribution mode utilities have been merged and acquired by others, and thereafter rationalized portions of their networks. Others have spun off the portions of their vertically integrated systems such as “last miles” that deliver services to end users so they can concentrate more exclusively upon for example energy exploration, generation, and wholesale distribution to third parties taking over as retail distributors. It is these distributors that government agency aggregators in some markets must now contract with and not with the more insulated wholesalers, and the distributors are increasingly challenged by pricing power by both the wholesale provider and the aggregator.
Provider Financing and Subsidies

Private providers usually fund their own functions to gain entry into a market. Government agencies too are required to be funded if they intend to gain similar market entry. But if government agencies subsidize private providers for assistance with market entry ability, or if the government cross-subsidizes its agencies to enter the market, the market could become unfairly skewed against those providers not being likewise subsidized. Governments typically advocate economic retention and development, and therefore advocate providers' fiscal successes. At what point does and/or should a government intervene financially to balance providers' returns on investments, market shares, fiscal responsibilities, investment ratings, etc.? Worldwide, many governments unabashedly engage in subsidy practices to its private or quasi-public/private providers, or provide products and services themselves against private providers. When those various mixed economic market types then compete against each other in the global market, conflicts usually arise from the degree of unfair subsidies, currency exchange rates, sovereign government policies and regulations, and other market distortions.

Distribution Market Segment Importance

End user access to and use of distribution services is increasingly important to the point of becoming an inherent right. “Indeed, today the Internet is largely recognized as a general purpose technology, and broadband is regarded as a basic infrastructure, in the same way as electricity, water or roads. Many citizens even consider the Internet as a ‘fundamental human right,’ and some countries have started to put in place legislation stipulating that access to the Internet is a human right for their citizens.” (International Telecommunication Union, 2010, pp.4-5). “(Based on a survey of 27,000 adults in 26 countries carried out by the British
Broadcasting Corporation in 2010, around three-quarters of interviewees considered Internet access as a human right. Countries that have ruled that access to Internet is a human right for their citizens include Finland, France and Estonia.) The U.S. National Broadband Plan reads as follows: ‘Broadband, … is a modern necessity of life, not a luxury. It ought to be found in every village, in every home and on every farm in every part of the United States’ [FCC, 2010]”.

Wireline Telecommunications

Telecommunications can be divided into Wireline and Wireless means, where wireline can be defined as telecommunications provision using physical infrastructure such as copper wire, coaxial cable, fiber optics, etc. to discretely channel electrons or photons between transmitter and receiver equipment. Wireless can be defined as telecommunications provision using the electromagnetic spectrum to transceive electrons or photons without the need for physical wireline infrastructure. Wireline and wireless networks are often commingled with each other to provide service over both mediums. However as mentioned in the Limitations section, this study will focus largely upon wireline telecommunication technologies since the results cannot be similarly conveyed to wireless telecommunications due to certain physical and characteristic differences.

Information began being conveyed amongst living beings by natural communication means, and was further assisted by emerging technologies becoming formal telecommunication systems. Information has since become one of the world’s most valuable commodities. “In multiple sectors - including finance, retail and advertising - free-flowing and interoperable data have increased competition, improved customer understanding, driven innovation and improved
decision-making. Fortune 500 companies such as Google and Amazon have based their business models on the importance of unlocking data and using them in ways that produce far-reaching changes.” (U.S. Federal Communications Commission, 2009, p.207). Thus the systems for transporting information have become equally as important, and the goal of a communications network is to make it possible for applications to interact through a network (van Schewick, 2010, p.50).

The telephone system was developed to transceive analog signals containing voice data via wire infrastructures, and the system was eventually adapted to deliver signatures, text, images and other variants. The early telephony market featured numerous individual service providers establishing their own infrastructures and providing equipment to customers. “After telephone patents held by AT&T’s parent company expired in 1894, more than 6,000 independent phone companies sprouted up.” (Anderson & Wolff, 2010). Those “end users” subscribed to a particular provider, which entitled them access to and service from that carrier to its other end user subscribers. If a customer desired access to other end users not subscribing to that network, they had to additionally subscribe to that provider’s network, or be able to interexchange to it via each users’ cooperating carriers linking their networks together. Telephone pole heights skyrocketed laden with subscriber line circuits, again with some customers subscribing to more than one provider requiring another set of line circuits. Other end users who were well-financed could construct and operate their own private networks separate from telephone system providers’ networks.

After numerous market shakeouts, bankruptcies, mergers, acquisitions, and consolidations in the telephony market, and marketplace interexchange difficulties and conflicts among providers reminiscent of rail interchange problems and occasional violence among
railroad carriers that resulted in the creation of the U.S. Interstate Commerce Commission and numerous state railroad regulatory agencies, telecommunication regulators determined that local market telephony provision was more efficient (using the state of the art technology at the time) under the provision of a sole "common" carrier vs. having an openly accessible marketplace of multiple competing carriers utilizing their own separate networks.

The American Telephone & Telegraph Company formed an early vertical monopoly by combining its local market exchanges with longer distance interexchange service and network equipment manufacturing and provision. AT&T then horizontally integrated most of the U.S. telephony service market, with a few independent carriers remaining in other market areas including the former General Telephone and Electronics Corporation. “By 1939, AT&T controlled nearly all of the US’s long-distance lines and some four-fifths of its telephones.” (Anderson & Wolff, 2010). This structure continued until independent startup company Microwave Communications, Inc., began using microwave relay stations to provide competitive interexchange service via both wireline and wireless means. AT&T legally challenged their marketplace entry and interexchange ability, but instead a number of court cases broke up AT&T’s vertical monopoly. AT&T was stripped of its “local exchange carrier” function and was subdivided into regional LEC Bell operating companies, but was permitted to keep its long distance interexchange carriage service. More providers including Sprint and Qwest then entered the interexchange market by acquiring easements for fiber optic-based infrastructures buried on railroad rights of way in the mid 1990s, similar to the former telegraph companies utilizing aerial easements on poles constructed on railroad rights of way.

Thus end users desiring telephony access and service had to subscribe to a sole government-franchised LEC common carrier provider in their market area, but had a choice for
their preferred long distance “for-hire carrier” and “private carrier” provider their LECs interchanged with. End users were charged tolls for any calls that went outside of their local exchange and certain adjacent exchanges that constituted “local” service.

Computers, which are essentially machines to process, transceive, and store data, evolved from simple abacuses to mechanical clock-like devices to large mainframe units, digital microprocessor desktop units, portable laptop and mobile device units, and infinite variations thereof depending upon their intended (and in cases unintended) applications. Early mainframes were capable of simultaneously hosting multiple end user data entry terminal units, and monitors, printers, and other peripherals to output data at local or off-site locations. Those systems required Local Area Networks (“LANs”) or Wide Area Networks (“WANs”) depending upon the distances between the mainframes and end user equipment. Mainframe operators often had to lease private dedicated data-grade telephony circuits from LECs and/or interexchange carriers (“IXCs”) to scale their networks remotely. But the LEC’s and/or IXC’s networks and networking and interfacing equipment were often bottlenecks in mainframes-end users data throughput capacities, the disproportionate spread increasingly due to end users upgrading their computers with processing capabilities that doubled every few years and carriers unable (or unwilling) to keep up an equal pace of newer and more powerful equipment implementation.

The U.S. Dept. of Defense’s Advanced Research Projects Agency in a quest to interconnect its various computers throughout the U.S. developed a WAN dubbed the “Internet”, although it was disruptive to the traditional phone system.

[RAND Corporation researcher Paul] Baran's main motivation was to design a system that could not be taken out by the Soviet nuclear arsenal. Yet the topological change advocated by Baran was not the reason everyone from the military to industry
vehemently opposed his design. The objection was to his proposal to break the (network traffic) messages into small packets of uniform size capable of traveling independently of one another along the network. This could not be achieved with the existing analog communications system. Thus he advocated a switch to a digital system. This step was too difficult for AT&T, the communications monopoly of his time, to absorb. Therefore, AT&T's Jack Osterman quashed Baran's provision when he declared, "First, it can't possibly work, and if it did it, damned if we're going to allow the creation of a competition to ourselves." Baran's ideas, defeated at every step by industry in the military, were rediscovered only years later, when the Advanced Research Projects Agency, not aware of his results, independently constructed the same vision. By that time, however, the Internet was well along its course of development (Barabási, 2002, pp.144-147).

Soon thereafter other government agencies, universities, etc. interfaced their LANs and WANs to this network, thereby increasing its worth with every newly accessible end user and their IT equipment. Email and File Transfer Protocol were initial Internet services were used to distribute messages and files amongst users. “The Internet is the first big communications network to make group communication a native part of its repertoire. The basic logic of the Internet, called ‘end-to-end communication’, says that the Internet itself is just a vehicle for moving information back and forth – it’s up to the computers sending and receiving information to make sense of it. While the telephone network was engineered for transmission of voice (and the phone company fought bitter legal battles to keep it from being used for any other purpose), the Internet does not know what it is being used for.” (Shirky, 2008, p.157).
The early Internet's routers and sub-networks were interconnected via distribution providers' dedicated wholesale long distance lines and/or retail LEC lines, and their traffic shared via “peering”. “Peering allows two providers exchanging large volumes of traffic to save money by connecting directly, rather than routing traffic across their paid Internet connections. Peering is often free as long as the amount of traffic exchanged is not out of balance, providing substantial cost savings for bandwidth for high-traffic sites and networks.” (Miller, 2009b). The Internet later shifted from a more U.S. government-provided enterprise to greater administration by private providers. “In the U.S., this (privatization) model translated into efforts to shift telecommunications from the regulated monopoly model it followed throughout most of the twentieth century to a competitive market, and to shift Internet development from being primarily a government-funded exercise, as it had been from the late-1960s to the mid-1990s, to being purely private property, market based. This model was declared in the Clinton administration’s 1993 National Information Infrastructure: Agenda for Action, which pushed for privatization of Internet deployment and development.” (Benkler, 2006, p.152). “It was the policy of the U.S. to ‘let the private sector lead’ in deployment of the Internet. To a greater or lesser degree, this commitment to private provisioning was adopted in most other advanced economies in the world. In the first few years, this meant that investment in the backbone of the Internet was private, and heavily funded by the stock bubble of the late 1990s. It also meant that the last distribution bottleneck - the “last mile” - was privately owned. Until the end of the 1990s, the last mile was made mostly of dial-up connections over the copper wires of the incumbent local exchange carriers. This meant that the physical layer was not only proprietary, but that it was, for all practical purposes, monopolistically owned.” (Benkler, 2006, pp.398-399).
Benkler noted the difference between networks for “dumb” equipment (i.e., televisions) vs. “smart” equipment (i.e., computers). “In the broadcast and telephone era, devices were starkly differentiated. Consumers owned dumb terminals. Providers owned sophisticated networks and equipment: transmitters and switches. Consumers could therefore consume whatever providers could produce most efficiently that the providers believed consumers would pay for. Central to the emergence of the freedom of users in the networked environment is an erosion of the differentiation between consumer and provider equipment. Consumers came to use general-purpose computers that could do whatever their owners wanted, instead of special-purpose terminals that could only do what their vendors designed them to do. These devices were initially connected over a transmission network - the public phone system - that was regulated as a common carrier. Common carriage required the network owners to carry all communications without differentiating by type or content. The network was neutral as among communications.” (Benkler, 2006, pp.396-397). In the early-to-mid 1980s, AT&T laid some of the first generation fiber optic lines along various rights of way to better handle the volume and improve transmission quality of interexchanged network data, and to increase the capacity of its remaining analog voice circuits.

By the mid-to-later 1990s the costs of network equipment were dropping and its speed and capacity capabilities were improving significantly. The 1996 Telecommunications Act encouraged further market entry of third parties to provide IXC, IXC and Internet Protocol (“IP”), and IP-only service to compete against the incumbent LECs and IXCs. Williams, Level 3, and others then constructed $B+ nationwide and international networks, some with greatly excess capacities for future expansion and needs. Even non-telecommunication distributors such as Dominion, Enron, American Electric Power, and Norfolk Southern Railway created
subsidiaries to operate their own for-hire and private telecommunication networks along their core distribution market rights of way and even physically within some of their infrastructures. Some market segment providers leased or sold excess unused “dark” fibers and other infrastructure to third party providers and end users without actually providing service themselves upon it. Distribution market incumbents and later market entrants were forced to upgrade their decade or so old systems to increasingly newer technologies to remain competitive in speeds, capacities, and other services, all the while being saddled with past SB infrastructure buildout debts. AT&T for example acquired smaller network equipment providers and telecommunication providers utilizing more advanced networking equipment as an alternative to investing in their own network upgrades.

To recoup their network buildout expenditures, wholesale IXC and IP providers primarily targeted high-end end users, some of which could afford to connect directly into their networks to receive wholesale service thus disintermediating retail service providers. Residential and small business customers were left to retail service providers, who received service from wholesale providers. However the high-end end user marketplace was extremely competitive for a relatively scarce number of those users, forcing intense competition among providers and service discounts to gain and retain accounts, which did not assist in paying down their debts. Enron as a quasi-wholesale provider believed there would be a shortage of bandwidth service at the time, and attempted to establish a bandwidth exchange market where various providers could trade capacities akin to regular commodity exchange markets.

In the later 1990s the industry became fraught with finance and accounting scandals, blatant fraud, and dubious revenue generation techniques. Some wholesalers engaged in a lease/leaseback program with network equipment providers where the carriers would provide
equipment to end users; however when some carriers could not repay the equipment providers they went into default, and in one case the equipment provider acquired the wholesale carrier and began providing wholesale service itself.

Wholesalers under their growing $B buildout debts then sought revenues in the LEC markets by providing voice and retail Internet service. Some wholesalers merged with and/or acquired LECs and Regional Bell Operating Companies ("RBOCs" – the seven LECs in different jurisdictions formed after AT&T was divested of its LEC function) as a means to immediately gain access to the local market vs. constructing their own competitive local exchange networks (i.e., Qwest acquiring RBOC US West). Other wholesalers including AT&T attempted to gain access by using the 1996 Telecommunications Act provisions to force access onto LEC and cable networks capable of IP and telephony service at rates lower than the LEC's or cable provider’s own provision costs. Other IXCs courted independent private MAN ("Municipal/Metropolitan Area Network") providers with fiber optic ring topology infrastructures as alternative intermediaries to LECs to enter local markets.

In 2004 a U.S. Supreme Court ruling declared local networks to be private property, accessible by third parties at the discretion by their owners (akin to railroad trackage rights) without any federal or state-regulated discounted access rates. The USSC then authorized cable companies engaging in ISP to control outside access by LECs and ISPs onto their networks to provide competitive Internet service, similar to incumbent LECs arguing for equivalent restrictions regarding network access by third parties for DSL ISP.

Yet LECs were authorized to enter the IXC market to essentially rebuild vertical LEC + IXC networks. The incumbent IXCs protested to regulators and courts to no avail, which while being locked out of additionally serving the LEC market seriously affected the going concern
status of a few of their business units. Empowered LECs then merged with and acquired a number of the financially strapped and market entry restricted IXCs, including for example SBC purchasing AT&T (SBC then renamed to AT&T), and Verizon buying MCI WorldCom. Those and similar consolidations resurrected the LEC + IXC vertical near-monopoly model AT&T once enjoyed on a national scale, but the model became more monopolistic regionally and oligopolistic nationally (also akin to the railroad market that is oligopolistic nationally but monopolistic or duopolistic regionally and locally). The SBC and Verizon buyouts did contain some conditions to protect high-end end users who would have been re-intermediated with their former LECs to obtain wholesale IXC and/or IP service. Combined LEC + IXC providers then invested more $Bs in installing fiber optic infrastructures from the local central switching offices to customers’ curbs or premises in more profit-promising metropolitan markets to provide “bundled” (multiple packaged services) LEC, IXC, IP, rebroadcast television, and other telecommunication services. In certain cases individual “naked” services were still offered.

The cable television industry started as community area towers located at high geographic elevations with antennas to capture broadcast television and FM radio signals that were distributed to customers over coaxial cable infrastructure networks in lieu of customers constructing their own tall towers and big antennas. Cable companies then started distributing television signals from satellite-based networks, and as those networks and terrestrial broadcasters were converted to digital transmission formats, cable providers also converted their systems to digital and upgraded their networks to fiber optics and hybrid coaxial-fiber optics. With the upgrades and relatively similar network equipment technology, cable providers then offered bundled and in certain cases naked ISP, LEC, IXC, and other telecommunication services to their customers. Cable providers had their share of scandal and fraud, with the former
Adelphia broken up and acquired by other providers as the market continues to consolidate and regularly faces market re-regulation. Time Warner cable was a formal IXC, an advantage over other cable companies that must contract with LECs or IXCs for retail/wholesale telecommunication service access. Benkler discussed both the cable and LEC providers’ system rollouts. “The end of the 1990s saw the emergence of broadband networks. In the U.S., cable systems, using hybrid fiber-coaxial systems, moved first, and became the primary providers. The incumbent local telephone carriers have been playing catch-up ever since, using digital subscriber line (DSL) techniques to squeeze sufficient speed out of their copper infrastructure to remain competitive, while slowly rolling out fiber infrastructure closer to the home. As of 2003, the incumbent cable carriers and the incumbent local telephone companies accounted for roughly 96% of all broadband access to homes and small offices.” (Benkler, 2006, p.399).

Some public utilities that had entered the wholesale telecommunications market later spun off those business units, citing too little revenue from too much competition for too few end users, or are leasing their infrastructures to third party operators. Enron, which entered the telecommunications market by leasing fiber lines from other providers to form a national network, dissolved the unit after its bankruptcy, and that unit’s officials have since appeared in courts on various fraud charges. Some electric power utilities were trying to offer IP service again with new “Broadband over Power Lines” technology using their existing electric transmission lines and end user premise electric wiring networks.

Mid- and higher-end end users were exploring the glut of providers’ extra fiber lines and capacities by leasing and buying their own fiber strands and channels for their own WAN use and connection to retail or wholesale Internet providers. Google in particular leased and/or purchased dark Williams Communications fibers to potentially provide WAN, ISP, or other
expedited access from its databases to end users. More non-incumbent non-profit corporations and government agencies were installing their own infrastructures and networks to provide service to other non-profits, government agencies, for-profits, and residential consumers in competition with existing market providers.

*Rights of Way*

While wireless telecommunications take advantage of transceiving signals through the air, wireline signals constrained physical channels require real property to host those support infrastructures. Depending upon the required route of the network segment, rights of way may be required through virgin lands and/or developed lands already hosting one or more uses. If routed through developed lands, the installation may have to cross or share the same or adjacent rights of way already assigned to other existing infrastructures. Rights of way can be “Private Ways” if the land is privately owned, or “Public Ways” if they are owned by a government agency or similar organization. Usually the infrastructure provider secures easements on the right of way vs. purchasing the right of way outright from the private or public landowner. The landowner may require annual fees and certain access and use terms and conditions from the infrastructure provider in exchange for an easement agreement, and likewise the provider enjoys certain access and use with restricted interference from the landowner and other third parties. Thus ownership of the rights of way is critical for determining infrastructure provision.

Infrastructures may require surface, aerial, or subsurface right of way easements. Generally the larger the infrastructure the more expensive the rights of way acquisition and easement costs will be, though telecommunication lines, particularly fiber cables, tend to require less space than other distribution infrastructures. Generally, telecommunications lines are
mounted aerially or buried for increased security, less conflicts with other infrastructures and their users, etc. Aerial infrastructure installations require rights of way for support structures such as poles, electric transmission line towers, buildings, and other means. Subsurface infrastructure installations require rights of way for cables or to host conduits, pipelines, and other channels to protect internal cables.

Sometimes telecommunication infrastructures share rights of way with third party infrastructures, available space permitting, while at other times providers prefer secure separate, independent easements. Independent burials may be feasible in rural or more open areas, but in urban and highly developed locales available space may be at a premium. Usually government agencies that have developed their rights of way with streets, sidewalks, water/sewer pipelines, and with other utilities’ infrastructures loathe having them torn up and reconstructed every time a telecommunication infrastructure provider requests using a portion of the rights of way as part of their network routes. Apparently once asphalt streets are excavated for say a water/sewer line project, the refilling and asphalt patch is rarely the same quality or physical characteristics as the original paving, and consequently the patched trench tends to fail faster than the surrounding asphalt on the street. The reported cure is to remove all the asphalt from the whole street, properly fill and tamp any washouts given the opportunity, and repave the street, which if oil prices are high and asphalt in short supply can incur great costs. Thus some government agencies have begun insisting upon coordinated infrastructure burials so that only one trench in the right of way is dug for all (or similar) distribution providers at one time to better coordinate disrupting the existing surface, subsurface, and sometimes aerial infrastructures and their users. The technique may be cost effective if multiple providers can be coordinated simultaneously for
the project, but it carries a risk of other infrastructures directly interfering with the telecommunications installation in the same trench.

Even if the telecommunications system is not buried in the same trench as other utilities and infrastructures, failure of say a water/sewer, gas, or steam line can potentially disrupt not only its host right of way but those of other installations tens to sometimes hundreds of feet away. Directional boring techniques are available in place of trenching and filling for some challenging or congested segment locations so that installations can be converted from surface or near surface to deeper underground, such as a line being bracketed to a bridge to jointly cross a river can be bored deeply under the river. Higher costs to bore at such depths are offset by less risk to the infrastructure and disruption of high value network traffic.

**Infrastructure**

The following sections generally concentrate upon wirelines and networking equipment utilized with buried infrastructures. Similarly as was stated in the previous section, infrastructure ownership is also critical for determining service provision.

**Wirelines**

Some type of wireline technology is required to connect or network two or more telecommunication devices together if they are desired to communicate with each other, or if a substitute wireless connection means is not available. The type of wireline utilized must match or adapt to the interfacing ports on the devices, else a network cannot be formed and the devices may remain stranded from communicating with each other. If the devices transceive electronic signals, the wirelines must be able to conduct those signals; likewise if the devices are photonic,
a wireline constructed of light-conducting material must be utilized. Some network equipment can be hybrids containing a mix of electronic and photonic transceiving equipment, subsequently requiring a mix of electronic and photonic conducive wirelines. To fulfill the goals of telecommunications, wirelines must be designed, produced, and installed to convey information from one source to another as quickly and with as near exactness to the original transmission construct as possible, minimizing any resistance and noise that might interfere with the signals, and reducing the need for additional re-amplification or regeneration equipment if possible.

Early wirelines were bracketed to poles and other structures with ceramic, glass, and other non-conducting materials used as insulators in-between the brackets and the support structures. Later lines jacketed with insulation were attached directly to supports and pulled through passageways, pipelines, and conduits. Newer conduit types featured “innerducts”-divided channels and subconduits within conduits - to help separate and organize different internal cables. An advantage of burying conduits containing cables vs. burying cables alone was that the cables could be pulled out of the conduits and replaced with new and upgraded cables instead of abandoning and trenching in new lines, having saved up to 80% or more in construction costs.

Later wireline technology featured wires covered with insulation and strand sets twisted together to reduce interference. More shielding and grounding were featured in some types of “twisted pair” wiring per particular networking applications. Twisted pair wirelines used almost exclusively in end-to-end networks (i.e., end user premise-last mile-middle mile-long haul-middle mile-last mile-user premise) were later being phased out by providers in their long haul and middle mile network segments in favor of coaxial and fiber optic cables that required less regeneration equipment, although they were being replaced more slowly in last mile network
segments due to costs and competition from wireless and other means of distributing information.

Coaxial cable conveyed different types of signals than twisted pair, and was designed somewhat differently than twisted pair wirelines featuring a center wire core, a layer of insulation, an outer layer of shielding wire, and another layer of outer insulation. Due to its low signal loss and better shielding design, signals distributed via coaxial traveled further distances than those upon twisted pair cables. Early mainframe computers used a type of coaxial cable to network with other devices, and cable modem telecommunication service used the same coaxial cable that distributed cable television signals. Some providers used coaxial cable to upgrade from twisted pair in their long haul and middle mile network segments, though fiber optics eventually replaced most coaxial lines. Cable operators used various types and sizes of coaxial cables end-to-end in their network infrastructures, though they too were upgrading more head end-to-neighborhood “miles” with fiber optics and using converters to interface with neighborhood-to-premise coaxial runs.

Fiber optic strands were developed from glass and plastics technologies and adapted to transmit optical telecommunication signals. Plastic fiber was originally cost effective for short distance connections and low throughput applications, but glass fiber with its higher throughput capacities, smaller strand sizes, and greater transmission distances superseded both plastic fiber and coaxial cables. Fiber cables could host a few strands to hundreds of strands each. Fiber optics, first deployed commercially by AT&T and GTE in 1977 (Stix, 2001), were increasingly used in long haul and middle mile network segments, and were gradually being utilized in more last mile segments and premise networks. As of 2010, copper wirelines were the most common way of carrying wireline telecommunications with a share of about 65%, compared to 20% for
coaxial and 12% for fiber (Ricknäs, 2010). Signal regeneration equipment was required at certain intervals to extend reliable transceiving distances, although with improvements in glass purity and other network equipment, distribution distances kept increasing with consequent reduced regeneration costs.

*Networking*

Communication devices were usually produced to network together with other devices. Such networking required interfacing ports and communication standards that matched or adapted to those in each device to properly transceive data amongst them. Generally end-to-end networking using the same interface technologies and standards provides faster performances compared to devices with different standards requiring intermediary converters and adapters to network successfully. If only two devices were to be networked, they could be directly connected to each other if each device had at least one interfacing port. If a device had two or more ports, it could be “daisy-chain” networked to the addition devices. However having the devices provide multiple ports to interconnect multiple devices became somewhat inefficient when the number of potential networked devices was scaled upward, so dedicated networking equipment was created to handle the networking responsibilities instead.

*Facilities*

“Facilities” were locations with structures to house telecommunications equipment, staff, users, etc. by providers, end users, or shared by both. Providers typically used facilities called Network Operation Centers (“NOCs”) that served as headquarters/control centers for the main networking equipment. NOCs could connect to regional offices serving major cities or multiple
states, central offices serving smaller towns, and field facilities including shelters, cabinets, vaults, boxes, etc. serving neighborhoods and end users’ facilities. Some providers built new facilities, leased rooms and whole floors in office buildings and high-rises, and repurposed other buildings to host various equipment and administrative functions.

End users and third parties providing networking services to end users could use their production facilities to house networking infrastructure, their uses, and users, in addition to some of the aforementioned facility types used by providers. Some end user facilities featured specialized application setups such as automated machinery, robotics, telecommuting, telework, videoconferencing, distance learning, point-to-multipoint (i.e., digital projectors in theaters), 3-D and interactive telepresence rooms, etc. Other facilities housed various sized server farms, supercomputers, etc., while those functions were increasingly integrated into cargo shipping containers able to be transported where needed if adequate network connections were available. Providers sometimes leased available facility spaces to end users, known as “Co-Location”, where end user equipment could be directly connected to providers’ backbones.

Facility types ranged from security protection levels shared with the rest of the production or end user activities to buildings designed and constructed to be practically bomb-proof (although the 9-11-2001 World Trade Center collapse affecting Verizon’s New York City NOC likely caused rethinking of locations being in or next to potential targets without adequate redundancy) and other facilities setup in underground tunnels, mines, and similar relatively inaccessible locations.
Neutral Central Offices and Carrier Hotels

A facility owned by a provider and used as their control center without being shared with other providers and users was usually considered to be their private NOC. However other facilities owned by providers and third parties and shared with other providers and/or high end users were variously called “Neutral Central Offices” and “Carrier Hotels”. Those facilities offered tenants access to multiple providers, co-location, regeneration, regional and network-wide NOCs, among other functions. Facilities ranged among regular repurposed office buildings, specialized constructs, and hardened nuclear bomb shelters/national defense control centers deeply embedded within the Earth that offered the utmost in protection for mission critical functions (Buckley, 2000).

The more successful shared facilities were located in close proximities to multiple fiber backbone lines. Switch & Data Facilities marketing VP Leslie Bateman said, “It is important that the facility is strategically located close to where the fiber is. This is typically near the central office of the incumbent carrier and never a big physical distance away.” (Colocation chain stores, 2000). There was no guarantee a backbone provider would connect to the facility. John Payne [sic - more likely Telseon CEO and president John Kane] said, “Just because I have fiber in the street near your facility does not mean I can or will connect to you. You could be misleading my customers, saying we are somehow going to work together.” FIBERWORKS CEO and president Scott Burkholder said, “One of the greatest challenges is that neutral [facility] providers are making choices based on the close proximity of fiber backbone facilities. The fact that they are close does not mean they can gain access to these facilities.” Shared facilities also had to ensure that their tenant providers had good peering agreements, or else an
affected provider’s traffic throughput rates could be slowed if it had to use less indirect routing over the public network (Buckley, 2000).

The primary concern for high end end users such as application service providers, LECs, CLECs, and emerging throughput traders was service, and constructing their own network backbones often was not a feasible option so such neutral colocation sites became more attractive to them (Buckley, 2000). Payne [sic] said, “Having the ability to go to a central point and peer with whomever you want is a major value-add.” Equinix CTO Jay Adelson said, “From a content perspective, performance is significantly enhanced by being right next to a backbone provider. It’s not subject to points of failure present in the current model of doing business over the Web.” Yipes Communications CMO Ron Young said, “Why wouldn’t you want to connect to all these other sources of bandwidth?” (Buckley, 2000). Bateman said the major appeal of a neutral colocation facility was provider choice and the ability to interconnect with a wide range of suppliers. “The selling point is not so much the neutrality but the choice. They want to be able to choose to get connectivity from any carrier. They don’t want to be forced into using the capacity of the colocation facility owner.” (Colocation Chain Stores, 2000).

In one facility type case, Switch Communications acquired what was once Enron’s Las Vegas multiple-provider high speed service trading hub cheaply, giving them direct access to more than 20 primary backbone providers in a single location. Switch then tied this vast network to existing data center hosting facilities, which attracted numerous high end end users. Switch CEO Rob Roy said, “Enron wanted to expand from trading energy. They wanted to use the same type of conceptual algorithm and go trade bandwidth.” Enron spent $Ms creating a single facility that would serve as a hub for all the major U.S. carriers. Those providers’ lines would connect into the Enron building, and Enron would move their throughput around like a
commodity. Roy said, “I don’t think that was ever going to be real, but they thought it was.” Enron had already built most of the infrastructure for the facility and had interested major providers in accessing it, though just as the rest of its business started to collapse into eventual bankruptcy. Thereafter the facility was placed up for sale. Roy said, “We were the only ones that bid on it. It should have been the $200B companies that owned it. We got it for a Cinderella story type of figure.”

Roy said the 407K square foot “SuperNAP” facility was the most energy efficient, tightly packed data center on the planet, and expected it to serve Fortune 100 companies, almost every technology firm, and major media conglomerates. The facility had screens dedicated to tracking weather across the globe, 15 more that monitored hundreds of security cameras, another one that tracked power and networking grids, and “global terrorist activity”. Switch offered users direct access to Verizon, AT&T, Sprint, Cox, XO, Qwest, Time Warner, Global Crossing, and Level 3 among others, offering throughput rates that rivaled major hubs in New York and Los Angeles. Roy said this gave Switch unique pricing and capacity advantages by underbidding other more expensive facilities and creating more competition among the providers.

We built this huge valve system, and we plug all the carriers - 10Gb/sec and 40Gb/sec - into our big gateway. Our biggest customers are saying we are selling space to them at 44% less than all of their connections. And my agreements are not just about [Las] Vegas. I can order a link in Germany cheaper than anyone else can. I can do this because we have some of the world’s biggest companies looking to get into the SuperNAP. And the carriers are hearing about this and seeing the volume of bandwidth these customers want. And I can go and price out that bandwidth with a bunch of different carriers. So, Carrier X comes and says, “Okay, we’ll play ball.” You know,
you can take wholesale, and we’re 30% below that. We are just alone in a very unique spot in the world because of the Enron building. We have clients that come in and save more on connectivity than they pay for the entire data center in a month. So, it almost makes their data center free.

Roy’s SuperNAP model was possibly just the starting point for Switch, as its investors urged him to build ten more similar centers worldwide (Vance, 2008).

In a similar model, major end user Google purchased a carrier hotel that afforded it with direct access to the multiple providers located within the facility.

Originally known as the Inland Freight Terminal, the 2.3M square foot 111 Eighth Avenue building in New York City was designed to relieve congestion around West Side piers by serving as a “post office for freight,” as Gov. Franklin D. Roosevelt said when he broke ground for the project in 1931. Atop this terminal, the Port of New York Authority, as it was then known, built offices and industrial lofts. When the Port Authority of NY and NJ moved its headquarters to the World Trade Center in 1973, the subsequent owners leased space to various commercial ventures (Dunlap, 1997).

The structure sits almost directly on top of where the Hudson Street/Ninth Avenue fiber highway makes a dog-leg to the right before heading north-east toward the Upper West Side. The building’s previous owners, a consortium led by Taconic Investment Partners, knew that proximity to the fiber lines would be attractive to companies, so they tricked out the building with something called a network-neutral “Meet-Me” room, which is literally a room filled with networking equipment that allows the tenants to connect (peer) with each other - and the fiber-line. Thus, 111 Eighth Avenue has become known as one of the most important so-called telecom carrier hotels on the Eastern seaboard, if
not the entire U.S. Google, which had upgraded its NYC presence from its first office at a Starbucks on 86th Street, was leasing space in the facility, but in late 2010 purchased it outright for ~$1.9B, and had Taconic continue the leasing and management operations of the building (Gustin, 2010).

_End User Devices and Uses_

End users were utilizing an increasing number of devices, device types, and applications. IMS Research, which tracked the installed base of equipment that could access the Internet, reported “Sometime this month, the 5Bth device will plug into the Internet. And in 10 years, that number will grow by more than a factor of four. Today, there are over 1B computers that regularly connect to the Internet.” (Cox, 2010). The following were some examples of devices and applications with ever improving technologies, more features, more powers, more throughput, and more storage requirements that continued to test end users’ and providers’ network capabilities when interconnecting and networking them, especially for interactive and symmetric throughput operations. Access and service to these more technologically sophisticated end users was therefore of increased importance moreso than to previous telephone- and/or television-only users.

Computers and servers were becoming faster to process more information, and were being equipped with an increasing number of CPU “cores” in each unit. Optically-based CPUs promised greater processing powers and throughputs than electronic CPUs particularly if such units could be networked optically end-to-end. Individual computers could be connected together and controlled with custom software to create clustered supercomputers with capabilities on par if not exceeding traditional supercomputers. High end end users had
estimated server counts including Google with 450K units (although that number was at least three years old dating from 5-14-2009), Microsoft with 218K c.mid-2008, eBay with likely more than 50K due to its 8.5PB data load, Hewlett Packard with 380K (Miller, 2009), and Facebook at 180K c.8-15-2012 (Miller, 2012).

Digitizing scanners and digital cameras produced digital still images from object views. Consumer models over time featured improved resolutions to equal or surpass 35mm photography at 13.3-20 megapixels per photo with faster digitizing times while dropping in price. Both means required users to manage increasingly large file sizes and the increasing number of images easily being produced. Other emerging digital camera technology featured multiple lenses per device, multiple simultaneous view focuses, and multi-gigapixel file sizes.

Digital video cameras were likewise developed to mimic motion picture cameras. Initially used for broadcast television productions, they evolved into more portable units and incorporated recording live video streams to various media types in analog and digital formats. Technological improvements included higher resolutions, faster frame/second rates, more individual recorded colors, and connectivity to data networks where video was available as a file, played from the file source upon demand, or able to be viewed live. Digital video was displayed in devices including large screen displays, multiple individual displays forming one screen, video projectors, videoconferencing, videocameras, and video streaming.

End users were recording and sharing more events in their lives using various multimedia digital devices, and increasingly doing so 24/7/365. Microsoft researcher Gordon Bell conducted a MyLifeBits project to scan, capture, and log all personal data he generated in his daily life since 2001, including websites he visited, photos and videos taken, documents written and read,
telephone conversations, automatic photos taken with a SenseCam strung around his neck, and music listened to (Leckart, 2009).

More data was being created by end users and their devices, with increasing amounts requiring longer term storage particularly by commercial users for legal and regulatory reasons. A 2010 IDC report (financed in part by storage systems provider EMC Corp.) said in 2010 the volume of digital information created and duplicated in a year would reach 1.2ZB, and estimated that the number of files to be managed would grow by a factor of 67 between 2009 and 2020. IDC’s 2007 report predicted that the volume would reach 988EB by 2010, indicating that the growth had exceeded their projections (Miller, 2010).

Google added new information to its estimated 900K servers c.2010 (Koomey, 2011) at the rate of hundreds of thousands of GBs daily, and was increasing its capacity to index on the order of 100PBs (Gohring, 2010). Google’s YouTube video sharing website expanded its capability to host 4096x2304 pixel resolution (“4K”) videos, although users were warned that to watch those videos they would require “ultra-fast high-speed broadband connections.” (Sarukkai, 2010). In 2010 the European Laboratory for Nuclear Research’s Large Hadron Collider particle accelerator generated 1.25GB of data per second that was collected and distributed to researchers worldwide through the LHC Computing Grid composed of more than 100K processors at 130 organizations in 34 countries (Ohio Supercomputer Center, 2010).

Videogame systems were utilizing custom hardware consoles essentially as powerful as regular computers. Videogame titles were featuring increasingly sophisticated software to generate extensive virtual worlds and simulations that required higher display resolutions, multiple viewing dimensions, and faster rendering engines for better performances and to more closely imitate reality.
Social Networks evolved from the early CompuServe and former market leader MySpace to current favorites Facebook and Google+ with hundreds of millions of users. The sites also offered digital photo and video sharing services that required vast data storage and throughput needs.

"Telepresence" can be defined as a virtual environment for users to experience being fully present at a live real world location remote from one's own physical location, which could further reduce the need for actual travel to those locations. Variants included advanced videoconferencing with some systems using holographic 3-D displays and multipoint-to-multipoint connectivity, telecommuting, and telemedicine applications such as video consultations between doctors and patients and remote surgery. Educational providers including preschool-12, adult and higher education, and R&D efforts were likely to benefit from using telepresence technologies.

As sophisticated systems get better and less expensive, the movement of high-quality telepresence into the mainstream of education could have social, economic, and pedagogical impact on students, faculty, and administrators. It promises to open new kinds of shared instruction, as niche courses can be offered at associated institutions or at main and satellite campuses simultaneously. Decreased costs and increased access to facilities by various academic disciplines and campus groups have the potential to open up new uses and new audiences.

Telepresence (could) merge with virtual worlds, resulting in a robust hybrid system that can support avatars, mobile media, simulated environments, and other augmented reality. Broader course offerings will be enabled as mobile telepresence comes online. Students in criminology could join detectives at crime scenes, for
example, without the risk of contaminating the area. Botany students might join curators at botanical gardens in distant cities. Artists-in-virtual residence might demonstrate their craft for students in their fields. The technology could see increased use in research, perhaps incorporating teleoperation so that researchers at remote locations can manipulate items in live-lab scenarios.

If only a few students in a department want to study an obscure language or uncommon dialect, they might be able to join classes at partner colleges or universities via telepresence or, where feasible, join native speakers. Similarly, the technology holds promise for demonstrations in areas such as dance, drawing, and design, as well as presentations in laboratories and kitchens. Mobile options could extend the audiences for field studies, allowing those on-site in remote rainforests, botanical gardens, or archeological digs to examine specimens and artifacts. Telepresence can be blended with virtual or augmented reality in building and architecture courses where demonstrations of techniques or explanations of the tensile strength of materials might take place in high-definition virtual construction labs that accommodate both on-campus and remote viewers.

Costs, particularly for high-end systems, can be an obstacle … institutions must (also) ensure that adequate bandwidth is available. When lower-cost, high-performance suites emerge that put telepresence systems in the hands of new types of users, experimentation should yield novel uses and reveal even more vivid and compelling learning engagements. (7 things you should know about … Telepresence, 2009).

The amount of throughput for some telepresence functions could require Tb/sec to Pb/sec rates.
Direct Neural Interconnection technology is progressing in connecting living organisms’ brains and nervous systems together and/or to computers via wireline networking. Although in its infancy, the amount of eventual throughput required will be enormous as larger brains are successfully interconnected.

The developing fields of Quantum Computing will create new computers based upon quantum physics using “qubits” instead of “1” and “0” bits for greatly improved processing powers. The related field of Teleportation could enable remote “reproduction” of products. Already the networking and routing needs for those applications were being anticipated.

**Upstream Networks**

End users were most likely interested in connecting their own devices and premise networks to other nearby and remote end users possessing similar devices and networks to access and share information and communications to (except in particular cases) avoid being “islands” not networked to other end users. To do so, end users could acquire, construct, operate, and maintain their own rights of way, infrastructure, and facilities, or they could subscribe to telecommunication providers that specialized in distributing those services to end users. Outsourcing various telecommunication functions to providers and third parties usually saved end users in costs, expertise, responsibilities, etc., and did not require separate individual networks connecting each end user desiring access to another select end user. Numerous types of networks have since evolved and scaled to connect up to multitudes of end users with various uses. Some of the high end academic, research, and governmental networks included National Research And Education Networks, the Internet, Internet2, National LambdaRail, TeraGrid, U.S. Unified Community Anchor Network. Such high capacity networks were considered to be
strategic infrastructure, intended to contribute to high and sustainable economic growth and to core aspects of human development (N. Anderson, 2009).

Although the Internet was increasingly multi-purposed, other networks were dedicated more to entertainment services. Disney/ESPN began streaming live and stored content online, which then evolved into a model where it requested ISPs to subsidize select “value added” online programming provision from ISP subscription fees whether the ISPs’ subscribers viewed the programming or not, else the ISPs were blocked from accessing those feeds. ESPN also provided Microsoft’s video game console Xbox 360 with a free ESPN3 stream to Xbox users that also subscribed to its value added membership service Xbox Live (Stetler, 2010). The model was similar to the cable and satellite television models where a portion of subscribers’ fees went to each channel carried by the distributor, with some content providers demanding higher fees than others. Netflix also distributed various information via physical media, downloading, and online streaming to end users available for viewing on a multitude of device types.

Videogame consoles and computers running videogames were increasingly reliant upon faster speed Internet and networking with fewer delays to interconnect game servers and other game players. Some game providers’ facilities required server farms to keep up with the increasingly fast processing and throughput demands with minimal delays to achieve seamless, life-like play. In addition to playing games, Sony also contracted with Major League Baseball’s live video streaming service viewable on its PlayStation 3 console (Stetler, 2010).
Telecommunication Market Issues

U.S.-based telephony and cable systems started with numerous providers that eventually consolidated into fewer providers per market while being granted sanctions by governments as natural utilities. Although the AT&T breakup resulted in new entrants into the long distance market segment, the local exchange market monopolies were essentially preserved with local system and service provision continued by regional Bell Operating Companies. Those RBOCs eventually reconsolidated horizontally and vertically by acquiring certain distressed long distance providers in that market. The market effects of consolidation then re-emerged. “At the physical layer, the transition to broadband has been accompanied by a more concentrated market structure for physical wires and connections, and less regulation of the degree to which owners can control the flow of information on their networks.” (Benkler, 2006, pp.24-25). The following issues briefly examined in this section were considered to be significant problems in the local and last mile telecommunications markets, some of which can be attributed directly to those markets’ reconsolidation.

Wireline Telecommunication Market Goals

Maslow proposed a personal needs hierarchy (Maslow, 1943). The needs to manually move and communicate should qualify as “Physiological Needs - Other Physical Activities”, and immediately thereafter should also be required the needs of technology-assisted mobility (transportation) and technology-assisted communications (telecommunications). Any lack of the more basic needs would require attention moreso than the other needs such as telecommunications, except that technology and technology-enhanced distribution is increasingly aiding the other basic needs. Contemporary economies, governments, and societies
would most likely cease to function without the availability of distribution systems, thereby greatly affecting personal needs. Distribution services (in particular access to the Internet) were being increasingly regarded as end users’ inherent rights. If individuals, businesses, governments, organizations, etc., sought to continue their existences and advance their positions in respective market sectors, their basic needs must be attained and their growth continued.

Establishing goals could assist with those needs and desires.

A primary goal should be perfect competition. “The textbook case of perfect competition is an ideal model of a competitive market.” (International Telecommunication Union, 2011).

Mathiessen stated, “The (perfect market economy model) demonstrates that what is good for providers and consumers is also good for society.” (Mathiessen, 2011). However, perfect markets and perfect competition in reality are obviously not achievable. “Perfect competition rarely (if ever) occurs in practice. It is more an ideal than a market reality, and so is not useful as a standard for analyzing the performance of real world markets.” (International Telecommunication Union, 2011) However, can the necessary conditions to achieve a perfect market also be used as the basis to achieve a more perfect telecommunications market or more closely approximate one?

MIT researcher and onetime Internet chief protocol architect David D. Clark said if a new Internet architecture is desired, the job must start with the setting of goals. "My goal in calling for a fresh design is to free our minds from the current constraints, so we can envision a different future. The reason I stress this is that the Internet is so big, and so successful, that it seems like a fool's errand to send someone off to invent a different one." He said whether the end result would be a whole new architecture - or just an effective set of changes to the existing one - may not matter in the end. Given how entrenched the Internet (structure) was, the effort would have
succeeded if it at least got the research community working toward common goals and helped "impose creep in the right direction." (Talbot, 2005). Thus to help achieve a perfect market, restructuring the market and its participants may be a solution.

Economic and Financial Issues

A number of significant economic and financial issues were involved in the provision of telecommunication systems and services in the local and last mile markets.

Subsidized Business Models

Some providers competed in markets against other providers that were using cross-subsidized, advertising, loss-leader, and similar business models to absorb service provision costs and shift them to their other provided products and services. A typical example included free wireless Internet provided by restaurants, airports, and other establishments as a public, value-added service for the customers of their core business. Such competition was not “standardized” – fair and equally head-to-head per service – and involved the virtual bundling of two or more services by combining the prices. Other for-profit providers in the same market were thus placed at significant competitive disadvantages against those subsidized models, particularly when the competitor was better financed or more diversified to handle loss leaders, unless they too engaged in similar practices.

Anderson posed that government taxation was a type of subsidization that resulted in a “Free” business model. “As the nation-state emerged in the 17th century, so the notion of progressive taxation, by which the rich gave more so the poor could pay less and receive services for free. This establishment of government institutions to serve the people created a special kind
of Free: You may not pay for government services yourself, but society at large does, and you
may never know exactly which of your own tax dollars come back to you directly." (C.
Anderson, 2009, p.37). He then noted such subsidization techniques could reduce product and
service prices significantly if not to zero, while those costs could be transferred and assessed
elsewhere. “The most common of the economies built around Free is the three-party system.
Here a third party pays to participate in a market created by a free exchange between the first two
parties.” (C. Anderson, p.24). “Economists call such models ‘two-sided markets,’ because there
are two distinct user groups who synergistically support each other: Advertisers pay for media to
reach consumers, who in turn support advertisers. Consumers ultimately pay, but only indirectly
through the higher prices on products due to their marketing costs.” (C. Anderson, p.25). “From
the point of view of the monetary economy it all looks free - indeed, it looks like unfair
competition - but that says more about our short-sighted ways of measuring value than it does
about the worth of what's created.” (C. Anderson, p.27). “Today, we know that the most
disruptive way to enter a market is to vaporize the economics of existing business models.
Charge nothing for a product that the incumbents depend on for their profits. The world will
beat a path to your door and you can then sell them something else. Just look at free long-
distance calling with mobile phones, which decimated the fixed line long-distance business, or
think what free classifieds do to newspapers.” (C. Anderson, p.43). He then advised providers
that “Sooner or later you will compete with free. Whether through cross-subsidies or software,
somebody in your business is going to find a way to give away what you charge for. It may not
be exactly the same thing, but the price discount of 100% may matter more.” (C. Anderson,
p.242).
Other subsidization models included service and content providers injecting advertising and similar techniques into data traffic, resulting in increased throughput on networks and requiring more network equipment to adequately handle loads. Likewise some providers were analyzing traffic (i.e., deep packet inspection) for advertising and subsidization purposes, creating privacy concerns especially when such observations were unbeknownst to end users.

End User Creamskimming

Wholesale providers' strategies had been to concentrate service provision primarily for more highly capitalized, high-end end users vs. lower capitalized middle- and smaller-end end users, thus "creamskimming" customers. According to Metcalfe's Law, providers should want as many end user subscribers (connections) as possible to increase the overall value of the network. In reality it seems those providers adhered to Odlyzko and Tilly’s strategy (Odlyzko & Tilly, 2005), and instead wanted as many higher-end end user subscribers as possible so as to charge them premium rates, thus skewing the overall network value and usefulness away from lower-end end users. Commercialized urban, populated, and wealthy areas were also more likely to have access and service prioritization than did depressed urban, rural, sparsely populated, and marginal areas had, again to reduce the risk of uncertain revenue returns. These access and service redlining decisions in turn hindered rural areas' economic retention and development efforts vs. local, regional, and global competition in other market segments, cost of living improvements, and their potential long-term survival.
Barriers to Entry

Traditionally the arguments against more perfect competition centered on barriers to market entry including the significant costs for competitors constructing their own local and last mile systems from scratch. “Building (wireline) networks … requires large fixed and sunk investments. Consequently, the industry will probably always have a relatively small number of facilities-based competitors. Bringing down the cost of entry for facilities-based wireline services may encourage new competitors to enter in a few areas, but it is unlikely to create several new facilities-based entrants competing across broad geographic areas.” (U.S. Federal Communications Commission, 2009, p.36). If every (provider) has to dig its own holes, the price of entry is too high and competition falters; over time, innovation lags, and the goal of broader and better access suffers (Benkler, 2010). The idea is that the cost of replicating the underlying physical plant: digging trenches, laying ducts, pulling copper/cable/fiber to each and every home is enormous; it therefore deters competitors from entering the market in broadband services (Benkler, 2009, pp.11-12). However a competitor better capitalized to absorb the initial losses or using a cross-subsidization model could potentially implement a system and successfully compete in an established market.

Multiple Telecommunication Markets Provision

If a provider has an advantage in or has cornered one market segment, a possibility exists for it to take advantage of or corner another market segment, with increasing potential effects to end users. Level 3 Communications was a competitive provider in the long distance, Tier I ISP, and city-wide fiber networking markets. Its CEO James Q. Crowe hinted though that Level 3 could look to acquire providers with large urban area local networks. "Our feeling is we're a
logical consolidator. If you own just long distance and you don't own local you're going to have trouble managing your costs." (Verma, 2010). Conversely as mentioned, some local providers have acquired upstream providers (such as Verizon buying MCI Inc.) for increased vertical integration.

Identifying Telecommunication Market Type Problems

As discussed, telecommunication markets may have providers (i.e., Served Markets) or may not (i.e., Unserved Markets). Served Markets may be considered Under-Served, Partially- or Quasi-Served, or Fully-Served based upon the number of active providers in a market. Under-Served and Quasi-Served Markets may be restricted due to oligopolies, duopolies, or monopolies per the provided modes and/or services (i.e., an LEC and cable provider both offering high speed Internet service). Fully-Served Markets may exist if there are competitive providers for all available modes and services.

Provision Taxation

Real and personal property taxation regulations and assessments upon providers’ systems varied in each of the U.S. states and often by local governments for system and service provision. A taxation issue arose when local governments decided to provide systems and services in competition to private sector providers. Normally government infrastructure providers were exempt from taxes, such as for streets. Some legislation was being proposed and enacted to force local governments to likewise be liable for telecommunication provision taxes. However would those governments also have to pay taxes if they provided only ROW, infrastructure, and certain facilities, but opened up their systems to one or more providers to
offer service competitively without competing against them for service provision? In a related railroad industry model, some rail lines were publicly owned, but their government owners did not desire to provide carriage service on them, so they franchised the service provision to private railroad companies. Often the agreements were “net leases”, where the railroad companies also assumed all taxes, liability, maintenance, and other rail line responsibilities. Note that even though the rail line was public, taxes were still being assessed against it. Was this because the line was franchised (quasi-privatized) to a sole private carrier – in essence a government-sanctioned monopoly for a public utility common carrier? Alternatively if the rail line was self-administered by the government for equal access to and use by all railroad companies and other qualified users, should all users instead be considered competitive “private carriers” or “for-hire carriers” without the government provider nor the line users being assessed taxes, just like private- and for-hire truck carriers did not pay public utility real and personal property taxes for using public roads? Although the business and governance model of a local and last mile telecommunications system could be changed to one where a government provided the system and multiple providers (but not the government) offered competitive service over the system to end users, taxation authorities (and their respective legislative bodies) might first have to revise the tax codes to eliminate real and personal taxes on such a system construct to ensure similar modal taxation equality.

Provision Pricing

Service pricing depended largely upon the amount of competition in the telecommunications markets, with those markets being more competitive likely to have lower prices than those that were less competitive. “Competition” was also dependent upon the
amount of competition in competing telecommunication modes (i.e., cable vs. DSL) vs. competition in the same mode (i.e., multiple providers equally using a shared fiber optic system). Who owned the system in either case – be it a private sector provider, government provider, PPP, etc., and whether they assessed third party providers access leases that ranged among for-profit, non-profit, or subsidized models ultimately resulted in varying pricing to end users. Governments subsidized some system provision and/or service provision also creating pricing inequalities particularly if select providers received the subsidies vs. all providers in a market. Even then the true price for provision would have been shadowed and cross-subsidized by other government enterprises, funds, taxes, etc., and potentially could have been hard to “de-bundle” and account for especially if those other budgets became tight.

**Telecommunications Market Competition**

The FCC believed “competition is crucial for promoting consumer welfare and spurring innovation and investment in broadband access networks. Competition provides consumers the benefits of choice, better service and lower prices.” (U.S. Federal Communications Commission, 2009, p.36) Benkler discussed the evolving philosophy of telecommunications market competition.

In the U.S., AT&T became a de facto monopoly in the second decade of the century. The theory throughout this period was one of natural monopoly. Because the fixed investments necessary to create a telecommunications network were so high, while the marginal costs to serve each subscriber over time relatively lower, and because it was valuable to subscribers to be connected to all other subscribers, it was thought to be most efficient to have a single network connect everyone, and then subject the carrier to
regulation to assure that it would not abuse this monopoly by charging high prices for poor service.

By the end of the twentieth century this model was globally seen as a failure. The state-run telecommunications carriers were seen as inefficient and bloated. In the U.S., the Bell System repeatedly outwitted the FCC and the Department of Justice, preventing competitors from entering into competitive lines of business that depended on the core, hard-to-replicate facilities of the local copper loop, and continued to capture rents that, in theory, should have been regulated away (Benkler, 2009, pp. 80-81).

Regarding international competition, the ITU noted “In a number of countries, the Internet market, and particularly the backbone infrastructure and international gateway, remain under the monopoly of the incumbent telecommunication operator. Limited competition and scarce international Internet bandwidth tend to keep prices for Internet access high and often unaffordable in the area of fixed broadband access.” (International Telecommunication Union, 2010, p.201). Domestically, the FCC reported “The U.S. market structure is relatively unique in that (end users) in most parts of the country have been able to choose from two wireline, facilities-based broadband platforms. Approximately 4% of residential end users units were in areas with three wireline providers, 78% had access to two wireline providers, about 13% had access to a single wireline provider, and 5% had no wireline provider, although rural areas were less likely to have access to more than one wireline broadband provider than other areas. In general, broadband subscribers appear to have benefited from the presence of multiple providers.” (U.S. Federal Communications Commission, 2009, p.37). However Benkler responded, “(High speed service) affordability is the hard part - because there is no competition pushing down prices.” (Benkler, 2010).
Telecommunication Service Issues

“The delirious chaos of the open Web was an adolescent phase subsidized by industrial giants groping their way in a new world. Now they’re doing what industrialists do best - finding choke points. And by the looks of it, we’re loving it.” (Anderson & Wolff, 2010). A number of these real and arbitrary “choke points” often resulted in significant service issues.

Provider Control Over Systems and Services

The U.S. Supreme Court once ruled that providers’ networks are private property, and as such those providers were entitled to control over their systems and services. Benkler noted, “Existing local (incumbent providers) argue that they deserve control over a market because they’ve sunk enormous amounts of money into digging trenches and laying cables for their telecommunications network. And to be fair, it is expensive.” (Benkler, 2010). Government regulation of sanctioned natural utilities was thus required as a primary means to control market prices in lieu of competitors providing their own separate equivalent mode systems and services.

Out-of-Routing

One potential practice of provider control was indirect traffic “out-of-routing”, which could cost end users more for the additional route mileages, additional equipment utilization, potentially more delays, and increased contingency risks. Sometimes ISPs did not exchange traffic directly with their competitors because of tariffs, pricing anomalies, or corporate politics, etc., and instead interchanged traffic with other ISPs in “Tromboning” routing arrangements where traffic between two cites in one country flowed (often out-of-route) through other nations’ routers (Rerouting the web, 2008).
Similarly, railroads found that controlling traffic routing could be used for network and equipment rationalization, prioritization of certain services, and increased pricing power. In the case of the former Pittsburgh-St. Louis “Panhandle” main rail line, Conrail c.1983 decided to consolidate its various main rail lines west of Pittsburgh and Buffalo onto only a few remaining routes, excluding the Panhandle’s route. Direct Pittsburgh-Mingo Jct., OH Panhandle traffic was first re-routed to Pittsburgh-Rochester, PA-Mingo Jct., and the bypassed former main line segment from near Pittsburgh-Weirton, WV was later liquidated. Conrail diminished and eliminated 99.8% of the Panhandle’s remaining traffic between Pittsburgh-Columbus by re-routing it to its Pittsburgh-Rochester-Crestline, OH-Columbus line, or allowing truckers to carry it via adjacent roads and highways (including the now congested I-70) to help them justify abandonment to the U.S. ICC. Conrail also considered abandoning that Alliance, OH-Chicago “Ft. Wayne Line” route, and tried shifting the Panhandle’s and Ft. Wayne Line’s traffic to the even longer Pittsburgh-Cleveland-Columbus and Pittsburgh-Cleveland-Chicago routes. The direct Pittsburgh-St. Louis route was ultimately replaced with the much less efficient Pittsburgh-Cleveland-Indianapolis-St. Louis route, leaving the Pittsburgh-Columbus-Indianapolis corridors largely unserved by intercity rail for the first time since the U.S. Reconstruction era. Conrail officials apparently admitted later their rationalizations and abandonments were mistakes, but the damage to the rail network and the high costs to replace it lingered on even after Conrail was split up and acquired by CSX and Norfolk Southern.

Telecommunication System Technical Issues

A number of technical issues were involved with the provision of ROWs, infrastructure, and certain facilities for local and last mile telecommunications systems.
Peering Interconnections

Although numerous networks, particularly the Internet, consisted of interconnected networks, the terms and conditions for interconnections were not always equivalent. Larger providers could discriminate against smaller providers, forcing them to seek other networks and routes for their traffic. The FCC recognized the problem, but had little authority to regulate peering.

The FCC should clarify interconnection rights and obligations and encourage the shift to IP-to-IP interconnection where efficient. For consumers to have a choice of service providers, competitive carriers need to be able to interconnect their networks with incumbent providers. Basic interconnection regulations, which ensure that a consumer is able to make and receive calls to virtually anyone else with a telephone, regardless of service provider, network configuration or location, have been a central tenet of telecommunications regulatory policy for over a century. For competition to thrive, the principle of interconnection - in which customers of one service provider can communicate with customers of another—needs to be maintained. There is evidence that some rural incumbent carriers are resisting interconnection with competitive telecommunications carriers, claiming that they have no basic obligation to negotiate interconnection agreements. In particular, the FCC should confirm that all telecommunications carriers, including rural carriers, have a duty to interconnect their networks (U.S. Federal Communications Commission, 2009, p.49).
Last Mile Segments

The “last mile” - typically the network segment from a provider’s central network office in the local market to an end user’s premise - was an example of necessary provider intermediation because in most cases end users were not located immediately adjacent to the other intended end user or to the provider’s main network switching equipment. Thus an additional link was required to “remotely” connect end users to a provider on one end of a route, and from a provider to the intended end user on the other end of the route.

In some cases the last mile segment could become a “bottleneck” in end users’ supply chains, WANs, etc., especially if the provider’s network equipment was inferior or inefficient compared to the end users’ own equipment. Larger end users were increasingly concerned with those bottlenecks that restricted last mile throughputs to their connecting end users. “Google is also concerned about the speed limitations imposed by wires that run to the home … that would deliver Internet content to residential subscribers at speeds of 1Gb/sec.” (Heinrich, 2010). The consensus of opinions has discouraged multiple competitive intra-modal systems in a market as being duplicative and inefficient vs. a single system owned and operated by a natural utility sanctioned monopoly provider. Somewhat better-served markets had separate multi-modal last mile systems such as for both telephony and cable. However each of these modes were often still monopolized, and although those markets may have had multi-modal duopolistic competition for say Internet, it was usually not enough to persuade the providers to continuously upgrade their network equipment to help eliminate the throughput bottlenecks. Competitors with potentially better network technologies seeking access to incumbent providers’ local market systems for last mile access to end users (without building their own last mile systems) may have
also experienced bottlenecks if the providers’ systems were not able to properly accommodate the better equipment.

System Rationalization

System Rationalization was a strategy where a provider abandoned, spun off, or liquidated various unwanted or inefficient portions of its system such as rights of way, infrastructure, and/or certain facilities. Providers often eliminated select duplicated and overlapping elements especially after mergers and acquisitions with other providers to increase their overall efficiencies and reduce overhead, labor, costs, etc. System liquidations could eliminate potential future competition from the provider’s former service area thus affecting end users' choices of providers, reducing or restricting services, or losing all access to any area systems. End users could then face workarounds including the need to redefine their business models, relocate to served areas with more competitive markets and sufficient services, construct and administer their own systems to network traffic with other remaining providers, or cease business altogether.

End User Use Empowerment

Some end users were installing their own miniature wireline systems and last miles to other adjacent end users, just as some higher end end users were constructing whole end-to-end WANs independent from existing private providers’ systems. Benkler noted the impetus.

The combination of observations regarding market concentration and an understanding of the importance of a networked public sphere to democratic societies suggests that a policy intervention is possible and desirable. The relevant intervention is
to permit substantial segments of the core common infrastructure - the basic physical transport layer of wireless or fiber and the software and standards that run communications - to be produced and provisioned by users and managed as a commons (Benkler, 2006, p.241).

My point here … is to highlight the implications of the emergence of a last mile that is owned by no one in particular, and is the product of cooperation among neighbors in the form of, “I’ll carry your bits if you carry mine.” At the simplest level, neighbors could access locally relevant information directly, over a wide-area network. More significant, the fact that users in a locality co-produced their own last-mile infrastructure would allow commercial Internet providers to set up Internet points of presence anywhere within the “cloud” of the locale. The last mile would be provided not by these competing Internet service providers, but by the cooperative efforts of the residents of local neighborhoods. Competitors in providing the middle mile could emerge, in a way that they cannot if they must first lay their own last mile all the way to each home. The users, rather than the middle-mile providers, shall have paid the capital cost of producing the local transmission system - their own cooperative radios. The presence of a commons-based, co-produced last mile alongside the proprietary broadband network eliminates the last mile as a bottleneck for control over who speaks, with what degree of ease, and with what types of production values and interactivity (Benkler, 2006, p.404).

*Government Involvement in Telecommunication Markets*

The ITU once called for greater government involvement in telecommunications markets, “In order to make services more affordable and increase the spread of the Internet and
broadband, governments need to encourage greater market liberalization in the Internet market, and ensure particularly facilities-based competition.” (International Telecommunication Union, 2010, p.25). Government involvement evolved and occurred in various forms.

**Government Agency WANs**

Most government agencies and institutions as end users created and utilized their own WANs for internal MIS/IT needs, and found that their proper utilization could assist with additional missions, including economic development, societal well being, education, and helping to address the other needs listed in Maslow's needs chart. Such WANs were typically dedicated to production and services (in this case government administration functions), and if so desired could interface with public end users at certain designated points via websites and other portals, while keeping general and unauthorized end users out of certain designated areas. In many cases, Internet service was also provided on the same WANs.

Thus with telecommunications technology being utilized by other end users for various purposes, with certain economic and societal problems being traced to issues within the local and last mile telecommunications markets, and with prodding from networking and equipment producers to multi-purpose their products beyond in-house MIS/IT (and in return increasing those producers' profits), governments were not surprisingly tempted to additionally provide external telecommunication systems and services as competitive providers. For example, most municipalities owned and administered their own rights of way to provide government enterprises including streets and sidewalks. Some of those municipalities providing electric power additionally owned electric poles located upon their rights of way, and public power providers were increasingly encouraged to offer MAN provision using those poles to co-host
aerial MAN lines. “As of October 2009, there were 57 fiber-to-the-premises (FTTP) municipal deployments, either in operation or actively being built, in 85 towns and cities in the U.S. These deployments collectively serve 3.4% of the FTTP subscribers in North America.” (U.S. Federal Communications Commission, 2009, p.153). In those situations, private telecommunication providers desiring to serve the municipal markets had to lease public right of way easements to host their infrastructures upon, and if they did not construct their own poles they had to lease access upon the municipality’s poles. Issues occurred if the municipalities charged private providers higher pole access rates than they charged their own telecommunication provision enterprises, with the advantage that providers were more willing to pay those lease rates than construct and administer their own new support infrastructures. Some municipalities bundled and cross-subsidized their electric and telecommunication enterprises (and possibly the street enterprises that were responsible for maintaining the rights of way), which likely resulted in unfair competition vs. private providers.

However after the Nixon, Attorney General Of Missouri v. Missouri Municipal League, et al. (Nixon v. Missouri Municipal League, 2004) case, numerous states restricted or prohibited political subdivisions from provision (U.S. Federal Communications Commission, 2009, p.153). The FCC thus recommended that Congress should authorize political subdivisions to provide systems and services, particularly if “local entities … decide to offer services when no providers exist that meet local needs. These local entities do so only after trying to work with established carriers to meet local needs. In the absence of (government subsidies to private providers), they should have the right to move forward and build networks that serve their constituents as they deem appropriate.” (U.S. Federal Communications Commission, p.153).
University of Wisconsin Internet Provision.

A number of universities utilizing Internet services were also ISPs to their users, other state and local agencies, and in certain cases to the public, where they might have competed against private providers. WiscNet was a non-profit state-level spinoff from CSNET - an affordable IP-based infrastructure that linked to computer science departments across the U.S. - and contracted with UW's Division of Informational Technology to administer its system. WiscNet received additional NSF grants to extend Internet provision to all WI colleges, universities, 75% of all state school districts, 95% of all state libraries, and to local governments. Like CSNET, WiscNet became a model for other educational systems across the country, for example in Ohio where Ohio State University’s Ohio Supercomputer Center was similarly a WAN provider and ISP for state and local agencies, with the potential to offer ISP to the public.

In 10-2010, the Wisconsin State Telecommunications Association denounced a UW plan to use federal stimulus funds to expand WiscNet's presence in four WI communities as competitors to the incumbent private sector providers. WSTA Executive Director William Esbeck said, “A duplicate network will increase costs for everyone and impact the ability of local telecommunications providers to invest in their communities. With scarce state resources, do we really need UW using government money to stifle private sector investment and threaten local jobs and businesses? UW does not belong in the telecommunications business.” WI Statute §16.972(2)(a) (2011) required that no state agency:

… may offer, resell, or provide telecommunications services, including data and voice over Internet services, that are available from a private telecommunications carrier to the general public or to any other public or private entity.

However §16.972(2)(b) (2011) was an exception to (a) as departments could:
... provide such computer services and telecommunications services to local
governmental units and the broadcasting corporation and provide such
telecommunications services to qualified private schools, tribal schools, postsecondary
institutions, museums, and zoos, as the department considers to be appropriate and as the
department can efficiently and economically provide.

WSTA advocated proposed WI state legislation containing the following positions.

• Required that WiscNet separate itself from the UW Division of Information Technology.
• Barred WiscNet from accepting any funds from UW, including $1.4M for FY 2012-13.
• Prohibited UW from accepting National Telecommunications Information Agency service
  provision stimulus grants.
• Prohibited UW from joining with any entity that offered service to the general public.
• Prevented the WI Board of Regents or UW System from providing telecommunications
  services “that are available from a private telecommunications carrier to the general public or
to any other private entity” to anyone except the UW system itself.
• Prohibited the UW System from “becoming or remaining a member, shareholder, or partner”
  with any entity that “offers, resells, or provides telecommunications services to members of
  the general public.”
• Forced WiscNet clients to instead use Badgernet - WI's state WAN primarily provided by
  AT&T.

State Superintendent of Public Instruction Tony Evers said, “If our schools and libraries
must use other Internet providers, most will pay at least 2-3 times more than what WiscNet now
charges.” UW responded to the "duplication-of-services" charge by stating that 100Mb/sec
BadgerNet service was $6K per month, and 1Gb/sec was $49.5K per month – “still … too high.”
Unlike WiscNet, clients would have been charged for their throughput use under BadgerNet.

UW Chief Information Officer Ed Meachen said WiscNet cost the UW system $2M annually vs. BadgerNet’s comparative $8M. In addition, the higher service charges would have made UW’s access to Internet2 unaffordable (Lasar, 2011).

*Government System Provision*

van Schewick said an alternative solution (vs. waiting for providers to roll out advanced telecommunication networks) may be to think about public provision of infrastructure (van Schewick, 2010, p.370). Wyckoff elaborated on a similar public infrastructure provision proposal for U.S. rail lines during the Penn Central bankruptcy crisis - decoupling track ownership (the predominantly fixed-cost portion of railroading) from operating companies (Wyckoff, 1976, p.128) – that could possibly be emulated for certain telecommunications systems and services.

I propose that the federal government undertake the project to purchase major segments of railroad track and right of way for the purpose of developing a modern, high-speed railroad track system for public use. This would mean the purchase of some of the existing track and right of way, although that is not mandatory. The railroad would be allowed to continue to own and operate as a private right of way any of its track. Similarly, the federal system would not be obligated to buy undesirable track. The railroads would be responsible for development of classification yards and track connecting their own roads [rail networks] with the federal track system. Traffic control through signaling systems would be provided by federal traffic controllers in a role similar to that of the air traffic controllers of the FAA (Wyckoff, 1976, p.130). What I
am considering under this alternative is not simply the old proposition of the passive purchase of the roadbed [sic, Wyckoff here refers to roadbed collectively being the right of way and track vs. the industry’s technical term for a certain portion of the earthwork supporting the tracks] as a means of creating a capital infusion for sick railroads. (The public tracks) would be made available to private carriers, as well as authorized for-hire carriers as alternative routes of convenience (Wyckoff, p.129).

Wyckoff compared the required investments in rail rights of way and infrastructure vs. those for carriage operations.

The greatest concern to me in examining the nature of the railroad management task is the massive fixed cost associated with track ownership and maintenance. In many respects, it is the ownership, construction, and maintenance of private rights of way by railroads that make them natural monopolies and drive them towards increasingly larger, but less manageable, enterprises (Wyckoff, 1976, p.130). It is relatively easier for railroads to attract capital for rolling stock [i.e., rail vehicles] than for improvement of roadbed. Given the present financial conditions of many railroads that most need track improvement, a lender is wise to demand the security of the pledge of easily retrieved property. The minimum security might be something that the lender can physically take possession of and make alternative use of in case of the failure of the lendee. Rolling stock certainly meets this requirement much better than improvements in roadbed. It is questionable whether a prudent private lender would consider track improvement as a reasonable risk at any interest rate without adequate guarantees from the federal government (Wyckoff, p.129).
He then discussed the market advantages of separation vs. right of way and infrastructure + carriage provision.

Once the ownership of the right of way is separated from the operations, it appears that many markets can support several competitors because of the reduced fixed costs. The best way to reduce the variable costs of a short-haul carrier are to reduce its volume of transactions. The best way to reduce the costs of the long-haul carrier is to increase its freight density. Both are possible once railroading is shifted from a fixed-cost-oriented to a variable-cost-oriented business. Charges for the use of this track system would be made on a user-tax basis, again shifting fixed costs of railroading into variable costs, more like the costs structure of the motor [commercial trucking] carriers. As it would be a government-provided facility, it makes sense for several operators to use it jointly. In fact, there are several instances in which railroads are already exchanging trackage rights to each other [i.e., line and facilities leasing in telecommunications] (Wyckoff, 1976, p.130).

By creating a public track system, there is the opportunity to salvage the concept of private enterprise in the operation of for-hire transportation. Certainly many railroads do need cash inflow to supply working capital, rolling stock, and improvement of classification and assembly yards. The purchase of some portions of the track to re-supply it to the railroads in an improved condition on a pay-as-you-go basis would generate necessary cash flow. This will also secure assets for the government in the event the railroads do eventually fail (Wyckoff, p.131).
Such railroad company failures often saw the abandonment of their rights of way and tracks, resulting in constricting the scale of the overall rail network. Wyckoff then compared transportation business and governance models.

Such a system would mirror the concept of the well-designed, safe, high-speed, super-highway system (Wyckoff, 1976, p.129). This proposal of nationalization of tracks is certainly preferable to nationalization of railroads, including tracks and operating companies. The federal government has demonstrated greater competence as a developer and provider of facilities than as a manager of operating organizations (Wyckoff, p.130). Also, the government has had success in such development projects that were too large an undertaking for any single firm or group of firms in the private sector. The Federal Highway System is a good case in point. Other examples of the skill of the federal government in providing transportation facilities that are then used by firms in the private sector and providing private and for-hire transportation are the federal airways and inland waterways. The record of the government acting as cashier for and developer of large transportation facilities has been excellent (Wyckoff, p.131).

Wyckoff concluded noting the proposal’s increased potential for competition.

With the separation of the track ownership and operating company ownership, the barriers of entry for the protection of the existing natural monopolies are no longer as justified. So this may only be a disadvantage to the existing business entities that certainly would like to perpetuate themselves (Wyckoff, 1976, pp.132-133).
Mixed Economies

As listed previously, government agencies had already engaged in other distribution enterprises. Contentions occurred when government agencies used their WANs and network equipment to likewise enter telecommunication markets and provide various services as "enterprises", thereby creating mixed economies. Government agencies could not tolerate unserved markets, which invited their intervention and provision. Market deficiencies in earlier U.S. history were addressed with government agency-sponsored rural electrical and “good roads” programs. For under-served and quasi-served markets affected by market cornering, oligopolies, duopolies, or monopolies, government agencies could decide to compete against incumbent providers for telecommunication service provision, even if those providers were franchised. A quasi-served market competition scenario might have involved a government public MAN offering high speed Internet vs. an ISP offering dial-up speed Internet via an LEC's telephone system. Fully-served markets ideally would not have required government intervention, yet their market entry was always a reserved option with certain inherent advantages governments. Those advantages would most likely have achieved governments’ missions and market goals, albeit enjoying unfair market competition. While governments could enter a telecommunications market to provide a sole service to achieve their missions and goals, they risked becoming more Socialistic when they additionally expanded into multiple markets and offered converged service packages.

Government Enterprise Cross-Subsidization

Some governments providing their own telecommunication systems financed them with cross-subsidizations from other enterprises. Dover, OH and Provo, UT as to be discussed later in
further detail bundled their telecommunication systems into their electrical power system enterprises to cross-subsidize their construction, financing, debt ratings, and risks. Electric power systems and telecommunication systems were technically distinct modes of distribution, as much as say municipal water/sewer departments were from municipal street departments. Dover and Provo end users subscribing to private telecommunication providers nonetheless subsidized the public MANs with their public power subscriptions, and public power users not subscribing to any telecommunication services were still subsidizing the MANs. In Dover since only select commercial end users were being offered MAN service, all other electric end users were subsidizing them. When Provo's telecommunication enterprise bonds were scheduled for retirement, the excess revenues thereafter were to be transferred to their general fund vs. being dedicated to system cost reductions, system upgrades, contingency funds, redundant routes, etc. The general fund was used to cross-subsidize other municipal enterprises, services, and entitlement programs, thereby increasing their reliance upon the MAN enterprise's success and revenue generation. Dover's contingency plan in case of catastrophic systemwide line breaks was to ask for technical assistance from the City of Wadsworth, located 43 miles away with a minimum 75 minute drive time (pending good weather conditions including through secondary back roads). Their plan could be considered another type of cross-subsidization with another municipality, as both were members of AMP-Ohio, an organization acting as a cooperative/wholesaler/lobbyist for member public power municipalities.

If governments that desired becoming competitive providers in their local telecommunications markets had established them as separate independent enterprises, bond counsels may have recommended against those projects if incumbent private providers were already present in and serving local markets; thus bundling the systems under the public power
or other existing municipal enterprises was most likely necessary to avoid counsels’ negative opinions and credit ratings. Further risks were possible with the U.S. Supreme Court’s Nixon v. Missouri Municipal League ruling (Nixon v. Missouri Municipal League, 2004) that authorized states to prohibit their political subdivisions from public provision, which if enacted by states and enforced upon municipalities with existing MANs might force those enterprises to cease provision. Further effects could include the municipality privatizing their systems, retiring any remaining system construction debts from other enterprises, default risks, state and/or federal bailouts, etc. An opinion requested from the State of Ohio Auditor by this author regarding their recognition of municipal electric power and telecommunication systems being considered distinct enterprises with separate independent funds has to date gone unanswered.

**Government Oversight of Telecommunications Markets**

U.S. Congressional, FCC, and state telecommunications policies were in a constant flux of being enacted, revised, and overturned by courts ad nauseam. van Schewick noted how the U.S. legal system affected technological development and implementation, and often did not maintain equal pace with technological developments with subsequent effects upon market participants.

Technical systems may effectively displace laws, and changes in technology can undercut a law's effectiveness even if the law's text remains unchanged (van Schewick, 2010, p.26). Laws can affect the technical environment by regulating technical systems, or by encouraging the development of specific technologies by letting public entities participate in standard setting, funding the development of desired technologies, or restricting public procurement to the technologies the state wants to foster. By imposing
constraints, the architecture of a complex system affects the economic system for its development, production, and use - that is, the actors who will develop, produce, or use the system, the relationships among them, the governance structures they use to interact with one another, and the behavior of these actors. And by changing existing architectures or creating new ones, economic actors can change the constraints that architecture imposes (van Schewick, p.28).

Benkler opined upon the telecommunications market regulation mindset c.2006.

Much of the formal regulatory drive has been to increase the degree to which private, commercial parties can gain and assert exclusivity in core resources necessary for information production and exchange. At the physical layer, the shift to broadband Internet has been accompanied by less competitive pressure and greater legal freedom for providers to exclude competitors from, and shape the use of, their networks (Benkler, 2006, p.384).

The critique of concentration in this form therefore does not undermine the claim that the networked information economy, if permitted to flourish, will improve the democratic public sphere. It underscores the threat of excessive monopoly in infrastructure to the sustainability of the networked public sphere. The combination of observations regarding market concentration and an understanding of the importance of a networked public sphere to democratic societies suggests that a policy intervention is possible and desirable (Benkler, p.241).

Harvard University’s Berkman Center for Internet & Society discussed portions of the Telecommunications Act of 1996 that sought to create and increase market competition using “forced open access”, and the subsequent legal challenges against those provisions.

The most innovative idea at the core of the 1996 Act was that in order to enable competition to develop, incumbents would have to open up access to components of their networks to competitors. The Act introduced unbundling, interconnection, collocation, and wholesale access as elements of open access. Unbundling in the 1996 Act initially had little to do with Internet access. It dealt mostly with letting new entrants enter telephone markets.

By the fall of 2001 (under the G.W. Bush Administration) a new FCC had changed course. The FCC passed a series of decisions that abandoned the effort to implement open access, and shifted the focus … from the idea of regulated competition within each wire - competition over the copper plant of the telephone company and over the coaxial cable of the cable company - to competition between the owners of the two wires. The theory was that two competitors with a strong base in a technology they own were enough to discipline each other, and much preferable to the uncertainties of unbundling and the price regulation and continuous monitoring of anticompetitive abuses that it entailed. The two facilities-based competitors would drive each other to invest, would discipline any monopoly pricing, and would not suffer the negative incentives of knowing that some of their investments in upgraded networks would go to subsidize their competitors. The model of inter-modal competition (competition between firms, each of
which uses a different technological mode to provide its service) seemed to work well
(Benkler, 2009, pp.82-83).

If a provider was required by say a government to open its network for access to and use
by third party providers, the incumbent provider could potentially ration certain services and
impose restrictions to discourage, inhibit, and possibly eliminate the competition. The USSC’s
Brand X ruling however restricted the U.S. federal government from mandating such forced
open access, although left the decision to each state whether to impose such access requirements
or not.

Benkler also discussed the various back-and-forth rulings regarding the 1996 Act’s
authorization of municipal telecommunications provision.

The incumbent broadband providers have not taken kindly to the municipal
assault on their monopoly (or oligopoly) profits. When the City of Abilene, TX, tried to
offer municipal broadband service in the late-1990s, Southwestern Bell persuaded the
Texas legislature to pass a law that prohibited local governments from providing high-
speed Internet access. The town appealed to the FCC and the Federal Court of Appeals
in Washington, D.C. Both bodies held that when Congress passed the 1996
Telecommunications Act, and said that, “no state … regulation … may prohibit … the
ability of any entity to provide … telecommunications service,” municipalities were not
included in the term “any entity.” As the D.C. Circuit put it, “any” might have some
significance “depending on the speaker’s tone of voice,” but here it did not really mean
“any entity,” only some. And states could certainly regulate the actions of municipalities,
which are treated in U.S. law as merely their subdivisions or organs. Bristol, VA, had to
fight off similar efforts to prohibit its plans through state law before it was able to roll out
its network. In early 2004, the U.S. Supreme Court was presented with the practice of state preemption of municipal broadband efforts and chose to leave the municipalities to fend for themselves. A coalition of Missouri municipalities challenged a Missouri law that, like the Texas law, prohibited them from stepping in to offer their citizens broadband service. The Court of the Appeals for the Eighth Circuit agreed with the municipalities. The 1996 Act, after all, was intended precisely to allow anyone to compete with the incumbents. The section that prohibited states from regulating the ability of “any entity” to enter the telecommunications service market precisely anticipated that the local incumbents would use their clout in state legislatures to thwart the federal policy of introducing competition into the local loop. Here, the incumbents were doing just that, but the Supreme Court reversed the Eighth Circuit decision. Without dwelling too much on the wisdom of allowing citizens of municipalities to decide for themselves whether they want a municipal system, the court issued an opinion that was technically defensible in terms of statutory interpretation, but effectively invited the incumbent broadband providers to put their lobbying efforts into persuading state legislators to prohibit municipal efforts. After Philadelphia rolled out its wireless plan, it was not long before the Pennsylvania legislature passed a similar law prohibiting municipalities from offering broadband. While Philadelphia’s plan itself was grandfathered, future expansion from a series of wireless “hot spots” in open area [sic] to a genuine municipal network will likely be challenged under the new state law. Other municipalities in Pennsylvania are entirely foreclosed from pursuing this option. In this domain, at least as of 2005, the incumbents seem to have had some substantial success in
containing the emergence of municipal broadband networks as a significant approach to
eliminating the bottleneck in local network infrastructure (Benkler, 2006, pp.407-408).

Government Provision Opposition

A government’s active provision of telecommunications systems and/or services in a
market may have elicited opposition to their involvement for various reasons. Models that
featured a government being the sole provider of both systems and services were essentially
public monopolies, and while likely welcomed by participants in markets that were unserved by
private sector providers, incumbent providers in other served markets usually opposed them.
Such government provision was also opposed by providers in competitive markets, while similar
provision in more uncompetitive markets as an attempt to break up cornering, monopolies, etc.,
was also opposed by the market leading providers. Private providers generally argued that
government provision was unfair competition and unnecessary market intrusion, citing their own
usually for-profit return on investment requirements, taxable corporation statuses, usually worse
debt ratings with higher borrowing costs, and their sunk costs in constructing their own systems.
Providers inherently wanted to protect their market shares, subscriber bases, system values, and
merger and acquisition value potentials from unnecessary competition. End users in unserved
markets or affected by uncompetitive provision likely supported government provision, though
objections were possible particularly if users were forced to use the government service or a
government’s select provider vs. other private providers they had used previously, particularly if
bundled service packages were involved.
Benkler discussed a number of political subdivisions that went beyond provision of their own MIS/IT systems and entered local telecommunications markets as competitive providers of systems and/or services.

One alternative path for the emergence of basic physical information transport infrastructure on a non-market model is the drive to establish municipal systems. These proposed systems would not be commons-based in the sense that they would not be created by the cooperative actions of individuals without formal structure. They would be public, like highways, sidewalks, parks, and sewage systems. The basic thesis underlying municipal broadband initiatives is similar to that which has led some municipalities to create municipal utilities or transportation hubs. Connectivity has strong positive externalities. It makes a city’s residents more available for the information economy and the city itself a more attractive locale for businesses. The initial drive has been the creation of municipal fiber-to-the-home networks. The town of Bristol, VA, is an example - … the residents of the town, fed up with waiting for the local telephone and cable companies, built their own, municipally owned network. The idea in Chicago is that basic “dark fiber” - that is, the physical fiber going to the home, but without the electronics that would determine what kinds of uses the connectivity could be put to - would be built by the city. Access to use this entirely neutral, high-capacity platform would then be open to anyone - commercial and noncommercial alike (Benkler, 2006, pp.405-406).

Benkler then noted the opposition to those and other projects mounted by incumbent providers as previously discussed U.S. Telecommunications Act of 1996 section (Benkler, 2006, pp. 407-408).
Of interest in those cases (and in general) was exactly what provision from the government the private providers opposed - rights of way, infrastructure, facilities, services, or any market entry at all. A question is would providers oppose an alternative model where a government provided rights of way, infrastructure, facilities, and open access to all providers equally, together with public last miles to municipal end users who could choose among providers, similar to say a municipality’s street enterprise that was openly accessible for use by all qualified vehicle operators? If a municipality were unserved, or was technologically deficient (i.e., a provider’s system in the market was unable to provide high speed Internet) and the municipality’s system was technologically superior and could provide high speeds, the provider might be somewhat open to the government buying out its existing system if it could use the government’s system too since it would not have to build a newer, higher-tech system solely by itself. The loss of customers to the new competition might still be a pricing power issue, and the loss of its system plus its captive customers would reduce its merger and acquisition value potential too. However if a market were already served with a high speed service provider and a government chose to provide a high speed openly accessible system, the incumbent provider would likely oppose the government’s system and any new competitors that used it to provide their services. The incumbent might relent though only if the government bought out its system at a certain price that could be at market rates depending upon how advanced its technology utilization was, the subscriber base count, and other valuation factors.

Some school districts and other local government agencies reliant upon public utility common carrier real and personal property taxation assessments as part of their general operating budgets could oppose the decrease or loss of those taxes if a telecommunications market reorganization was implemented. Any resulting shortfalls would have to be compensated for in
other ways, including government enterprise cross-subsidies, various tax increases, decreased government services provision, reliance upon more state and federal subsidies, etc. In a similar example the West Virginia Turnpike once compensated counties that were supposedly denied the benefits of displaced local traffic re-routed onto its interstate. The benefits of market reorganization therefore had to offset tax loses, perhaps in reduced governments-as-end users’ telecommunication costs and their greater utilization of online services.

*Telecommunications Market Provision Privatization*

Most telecommunication provision in the U.S. has traditionally been by private providers. Benkler argued that privatization of public system and service provision led to market consolidation by private providers.

The result of the push toward private provisioning and deregulation has led to the emergence of a near-monopolistic market structure for wired physical broadband services. By the end of 2003, more than 96% of homes and small offices in the U.S. that had any kind of “high-speed” Internet services received their service from either their incumbent cable operator or their incumbent local telephone company. Less than 2% of homes and small offices receive their broadband connectivity from someone other than their cable carrier or incumbent telephone carrier. More than 83% of these users get their access from their cable operator. Moreover, the growth rate in adoption of cable broadband and local telephone DSL has been high and positive, whereas the growth rate of the few competing platforms, like satellite broadband, has been stagnant or shrinking. The proprietary wired environment is gravitating toward a high-speed connectivity
platform that will be either a lopsided duopoly, or eventually resolve into a monopoly platform (Benkler, 2006, pp.152-153).

However when those services were publicly provided, the government agency was essentially a public monopoly, as it was unusual for multiple government agencies to offer competing systems and/or services against each other.

*Government Apathy*

While there were issues with various government solutions, some problems may have been caused or continued by government officials reluctant to have their offices explore telecommunication market solutions. As explained by an anonymous regional government official (who conferred with local government officials on a daily basis) to this author, those officials acted more as politicians who hesitated to make what they perceived to be risky decisions for fear those solutions could fail and would reflect negatively upon them come a future election day. The official also stated their academic and/or business backgrounds often did not include beyond a basic knowledge or appreciation of distribution market technologies, nor related issues of the day. Some however were willing to learn, but others were not or did not have time to do so and instead relied upon incumbent providers and hired consultants who could shoulder the blame should a solution fail even though they were still paid (often with government funds) for their efforts. Industry lobbyists also influenced government officials as witnessed by the author at numerous public meetings, hearings, and conventions sometimes sponsored in part by telecommunication providers. Verizon recommended government subsidization of existing wireless market providers (where those markets often lacked robust competition) vs. increased regulation (and by inference government market provision) since
numerous studies showed the benefits of deregulation in other countries (U.S. Federal Communications Commission, 2009). Large providers could follow-up their recommendations with lobbying of key legislators and judges for sympathetic legislation and rulings that could further help entrench their market positions. Lesser-capitalized competitors were often not in similar positions of power to lobby effectively for government-mandated market competition.

Some progressive communities were actively interested in the telecommunications market, while others were catching up after hearing about the benefits that advanced telecommunications provided. However the non-adopters risked being uncompetitive much less remaining relevant and potentially dying out much like ghost towns when their minerals and other area natural resources ran out, particularly in the face of significant international competition for faster throughputs at cheaper rates. In another case, one former mayor proclaimed telecommunication provision was the sole responsibility of the incumbent LEC and as such he had no interest in municipal involvement in the local market. Meanwhile the neighboring municipality was busy establishing its own MAN and hoping to provide competitive telecommunication services to its business and residential end users. Many communities, including Lorain County, OH as evidenced in their 2002 Digital Economy Task Force broadband report, and in personal discussions with officials from the Ohio cities of Steubenville and Zanesville and the villages of Bratenahl and Sugarcreek had no idea their jurisdictions hosted or were immediately adjacent to major Tier I intercity backbone lines. This was akin to them not knowing say the Autobahn was located in or nearby their towns, even though the fiber lines were buried and marked with numerous small “Do-not-dig-here” warning signs with the providers’ names along their routes. The political subdivisions could be excused as the Tier I providers did
not actively wholesale market access of and service to lower-end end users and left that market to retail ISPs.

Governments have claimed to dislike dysfunctional markets, yet rarely have they proposed substantive, alternative, potentially more optimal solutions to achieve supposedly desirable market goals. They seemed to tolerate if not advocate or sanction monopolization just short of market cornering vs. more perfect competition, accepting it as merely natural or as a necessary evil. The laissez-faire attitude may favor what Hayek termed a "catallaxy" - a market where "spontaneous order" emerged when no centralized control source (government) overrode decisions of individuals pursuing their own ends (von Hayek, 1989). Perhaps the ideologies of the political parties in control of governing agencies at the time eschewed market involvement much less oversight, with some extremists questioning the need for governments at all.

The FCC seemed complacent with the market structure and competition.

The lack of a large number of wireline, facilities-based providers does not necessarily mean competition among broadband providers is inadequate. While older economic models of competition emphasized the danger of tacit collusion with a small number of rivals, economists today recognize that coordination is possible but not inevitable under such circumstances. Moreover, modern analyses find that markets with a small number of participants can perform competitively; however, those analyses do not tell us what degree of competition to expect in a market with a small number of wireline broadband providers. Given that approximately 96% of the population has at most two wireline providers, there are reasons to be concerned about wireline broadband competition in the U.S. Whether sufficient competition exists is unclear and, even if such
competition presently exists, it is surely fragile (U.S. Federal Communications Commission, 2009, p.37).

Benkler critiqued the FCC’s stance with the following excerpts.

It does not address the source of the access problem: without a major policy shift to increase competition, broadband service in the U.S. will continue to lag far behind the rest of the developed world. The plan acknowledges that only 15% of homes will have a choice in providers, and then only between Verizon’s FiOS fiber optic network and the local cable company. (AT&T’s “fiber” offering is merely souped-up DSL transmitted partly over its old copper wires, which can’t compete at these higher speeds.) The remaining 85% will have no choice at all.

The FCC gave in, deciding that competition between one telephone incumbent and one cable incumbent was enough. Senior FCC staff members have essentially conceded that lobbying pressure from the monopolies is too strong even to begin exploring (an alternative solution of) open access right now (Benkler, 2010).

Governments not continuously advancing their telecommunication markets risked falling behind competitively to others that were making such investments. Australian Prime Minister Julia Gillard said her country could not sit back and let others build infrastructure similar to its proposed National Broadband Network to achieve an advantage. She said, "Singapore, Korea, and Japan have the benefits of this technology," Opposition Leader Tony Abbott "wants to shun the technology", that he did not understand the NBN, and that his thinking was limited to only that of downloading music and movies. “It showed how little he understands modern health care and education.” PM Gillard said how foolish it would have been to say typewriters and fixed
line phones were good enough, and those advocates were “condemning Australia”. (LeMay, 2010).

Various studies indicate the U.S. lagged among developed nations in high speed provision. Google CEO Eric E. Schmidt and other technology and government leaders pointed to the trailing high speed performance as a danger to American competitiveness that threatened to saddle the nation with an “innovation deficit” compared with other countries (Lohr, 2010). Regardless, when presented with projects where such advancements had been made, some critics doubted whether those improvements were too much too soon. Higher-speed Internet service, experts agreed, was an important national goal, but it was less clear whether moving quickly to very-high-speed service was worth the cost. Much of the economic gain could be achieved and consumer demand met by moving on a “more measured path”. Some experts said the demand for 1Gb/sec service could be minuscule. Nonpartisan research group Information Technology and Innovation Foundation president Robert D. Atkinson said, “I can’t imagine a for-profit company doing what they are doing in Chattanooga (offering symmetrical 1Gb/sec for $350/month), because it’s so far ahead of where the market is.” (Lohr).

Select Telecommunication Projects

A sample of numerous recent telecommunication system projects provided under various domestic and international governance and business models were analyzed in terms of local and last mile market competition goals.
ACCESS/Columbiana County (OH) Port Authority System

In Ohio, 26 Columbiana and Mahoning County school districts, two educational service centers, 20 non-public schools, and two Special Education Regional Resource Centers coordinated to form the Area Cooperative Computerized Educational Service System (“ACCESS”). (http://www.access-k12.org 2010). ACCESS was one of 23 governmental computer service organizations serving more than 900 educational entities and 1.4M students in the state. Information Technology Centers (ITCs) provided IT services to school districts, community (charter) schools, joint vocational, career and technical schools, educational service centers, and parochial schools. The ITCs, service organizations, and their users formed the Ohio Education Computer Network. Such sites in conjunction with the Ohio Department of Education comprised a statewide system to provide comprehensive, cost-efficient accounting and other administrative and instructional computer services for participating state entities (State of Ohio Auditor, 2010).

ACCESS constructed a 344-mile SONET-based WAN to serve its member schools and institutions (Columbiana County (OH) Port Authority, 2004), which was later upgraded to a four loop, 10Gb/sec Ethernet WAN with 1Gb/sec interconnecting each members’ facilities. (http://www.access-k12.org/15681092714358197/site/default.asp 2010) A 2004 proposal by the Columbiana County (OH) Port Authority sought to lease for $1.2M with an option to purchase two strands of ACCESS’s fibers made available for commercial use containing at the time 360Gb/sec of capacity. CCPA was to construct a new or retrofit one of their existing facilities for use as a NOC for $3M available for other end users to co-locate their network equipment to, and as a potential new business incubator with direct connection access to on-premise providers utilizing the ACCESS network (Columbiana County (OH) Port Authority, 2004) CCPA later
acquired two more ACCESS strands for free as part of the lease, which were then used by a NOC provider that had located into the port authority's industrial park for increased connectivity to its end users (Giambroni, 2011).

**Municipal Electric Enterprise-Subsidized MANs**

The following cases were examples of municipalities that provided their own public electric power and additionally entered the local and last mile telecommunications markets by establishing cross-subsidized public MANs.

**Dover (OH) MAN.**

The City of Dover, OH which generated and distributed its own electric power to municipal businesses and residents, added Supervisory Control And Data Acquisition (“SCADA”) telemetry services to its grid for improved system monitoring and reliability. The city's electrical consultants recommended using new fiber optic cables for the SCADA network to also remotely monitor and control a secondary substation located across town from the power plant’s NOC. SCADA signals had low bit rates easily handled by copper lines or dialup ISP service to control and monitor relatively few electrical equipment units. The consultants though further recommended Dover consider acquiring and installing cables containing many more fiber optic strands than required to host SCADA for potential use as a future public telecommunications MAN. Dover City Council agreed and approved a municipal bond issuance for both projects to be repaid by electrical and MAN subscriptions (Mizer, 2002). Dover's MAN infrastructure was based upon a design recommended by the same consultants for the City of Wadsworth, OH and other municipalities featuring aerially-mounted multi-strand fiber optic
cables bracketed to power poles arranged in various looped routes around the city, with hybrid fiber-coaxial cable network equipment to serve end users, similar to cable operators’ cable modem service. Dover’s electric enterprise owned and operated the power poles and pole rights of way that hosted the power grid and street traffic control signal infrastructures. Extra pole and right of way space was available for lease to other providers and end users for their system infrastructures. The MAN infrastructure was to be owned and operated by the electric enterprise utilizing their rights of way and poles.

Dover’s MAN provided WAN, dark fibers, and retail ISP to the city’s various departments for their MIS/IT and Internet needs, to the Dover City School district’s facilities, and to select lineside industrial and commercial end users within the jurisdiction. In a State of the City review, Dover Mayor Richard Homrighausen discussed the MAN project.

One of the more major accomplishments during my term has been the installation of Dover’s fiber optics system. The city has over 3.1 miles of 48-strand fiber optic cable and an additional 7+ miles of 96-strand fiber optic cable. At present, the city is using the fiber to power our telecommunications infrastructure, as well as about a dozen businesses within the community. For over eight years, the Dover City Schools have had the benefit of being connected to our fiber optic system, at no charge, for their telecommunications services as well as for the use in their distance learning lab. This past year the city of Dover, in conjunction with the Tuscarawas County Community Improvement Corporation, consummated a high-speed connectivity agreement with the State of Ohio and their Ohio Supercomputer Network. This connection makes Dover the only municipality in the State of Ohio to have such a connection. This also gives Dover a competitive edge over other communities in our area in the way of attracting business and
industry, since we are the only community that can meet the ultra high-speed telecommunications demands of today at tomorrow’s high speeds. Additionally, this connection is allowing Dover to serve as the telecommunications “head-end” for the CIC’s tech park project in [adjacent city] New Philadelphia – and any other business, industry, and educational institutions along the way that are able to connect to the fiber the county is installing to the park.

Q. What do you consider to be the major disappointments of your administration over the past 16 years?

A. While Dover’s fiber optics initiative is listed above as a major accomplishment, at the same time it is a major disappointment in that we have not moved forward with deploying the fiber throughout the city for all residents, business, and industry to take advantage of. I had thought that by this time we would have available a “triple play” fiber program where residents, business, and industry would have voice, video, and data services available over our fiber optic cable. Even though it is disappointing that we are not yet able to provide these services city-wide, our plans are to move in that direction. We are fortunate to be in the position to even offer these services and I would rather take the slow approach to get everything right than to forge ahead and do something that we will be sorry for in the long run.

Q. What are your forecasts and predictions for 2008?

A. We plan on requesting proposals and bidding the engineering services for the full deployment of Dover’s fiber optics system with the intent to service the entire community with this cutting edge technology (Q&A with Dover Mayor Richard Homrighausen, 2008).
The Dover MAN was reportedly connected to only a T1 backhaul service, as no private wholesale providers were available locally (or possibly willing) to provide faster services and network interconnections. Dover City Schools were subscribing to six LEC T1 circuits at the time, which would have taxed the MAN’s capacity if they switched entirely over to service from the MAN. However as Homrighausen discussed, OARnet later branched from their neighboring New Philadelphia POP a few miles southwest of Dover to provide the city’s MAN and its end users with state agency WAN connectivity and faster Internet service.

Dover’s MAN competed against previously established LEC Verizon, cable operator Adelphia, and local wireless providers Tusco.Net, Wilkshire.Net, and Lightspeed Wireless in the same municipal market, offering much the same telecommunication services and speeds, WAN, and in the wireline cases dark fiber availability. Why bond counsel recommended the city construct the new system and provide similar services in a rather well-served market, potentially hampering repayments of their bonds thus requiring cross-subsidizations from other municipal enterprises if not additional taxes and privatization of city assets, was unknown. Homrighausen prohibited WISP Lightspeed Wireless from collocating antennas for its regional network on city infrastructures, as they represented market competition to their MAN. This restriction hampered Lightspeed and other WISPs from utilizing the MAN as a potential backhaul for their system to other upstream providers. Dover tried using proposed zoning changes to force residents and businesses building new homes and facilities to construct and finance their own connections to Dover’s MAN, even if those end users planned to subscribe to services with other providers, or did not desire accessing such services at all. The measure was later tabled by council if not dropped entirely.
As noted, Dover used their public power business and governance model as being the sole producers and distribution providers of power to its businesses and residents to help justify their MAN project. The State of Ohio General Assembly once proposed an anti-competitive telecommunications law to prohibit public MANs from competing vs. private providers, but continued to authorize public power providers to lock out private power providers from accessing and serving the same markets.

_Provo (UT) iProvo MAN._

The City of Provo, UT’s Energy Department - Telecommunication Division constructed and owned a public MAN initially intended for SCADA and WAN for municipal department MIS/IT needs, though it was expanded into a FTTP/FTTH MAN that afforded open access for various competitive providers for WAN and IP services to end users. Retail provider Veracity offered MAN end users symmetrical 10Mb/sec and 100Mb/sec system-wide, bundled service packages only, and required end users use custom network equipment. Another retail provider Mstar Metro offered end users $40/month symmetrical 10Mb/sec and also required end users use custom network equipment. LEC/IXC Qwest and cable operator Comcast were still providing Provo end users services via their own independent systems, but both were invited by the city to access and use the MAN as part of their network for competitive service provision.

To construct the system, Provo issued a type of municipal bonds.

Zion’s Bank, the City’s financial advisor on the project, recommend that the City issue Sales Tax Revenue Bonds to finance iProvo because it obtains the highest possible bond rating, the lowest premium for bond insurance, and possibly eliminates the need for a funded debt service reserve, which if waived by the rating agency would lower the
amount of bonds to be issued. They also examined other financial instruments and
determined these other options would leave the City with the same level of responsibility
for the bonds while adding to the overall cost of the project. The total bonding amount is
expected to be $39.5M (http://www.provo.org/util.iprovofaq.html 2010).

The Energy Department cross-subsidized the MAN enterprise. After the bonds were to be
retired, MAN revenues received from leasing capacity to competitive providers were then
earmarked for the City’s general fund (http://provo.org/util.iprovofaq.html 2010) where they
would theoretically be used to subsidize other municipal enterprises and services.

**Chattanooga (TN) MAN.**

In 1935 the City of Chattanooga, TN established the non-profit municipal utility and
enterprise fund Electric Power Board for the sole purpose of providing electric power. In 1938
EPB received its first power transmitted by the federal government-owned independent
corporation Tennessee Valley Authority, and shortly thereafter began reselling that electricity to
169K customers in the surrounding 600 square-mile area (http://epbfi.com 2011). The TVA
when created restructured a portion of the U.S. electric power market in the Tennessee River
valley region. As a power supplier (power generator + distributor), regulatory agency, and
economic development agency, the TVA forced a number of private power providers (power
generators + distributors) that had previously controlled nearly all of the production +
distribution markets out of business. In 2009 EPB residential electric rates were $0.0947 per
kWh, 18.5% less than the national average, with the TVA setting the wholesale electric rates.
Those low electric rates likely encouraged EPB to further expand into telecommunications
provision (Electric Power Board, 2009).
In 1999, EPB received approval from the Tennessee Regulatory Authority to provide telecommunications services, in 2002 it received approval from the State of Tennessee to provide Internet services, and in 2007 the Chattanooga City Council authorized EPB to provide telephone, Internet, and video services to users via its MAN (http://epbfi.com 2011). EPB via its MAN offered naked symmetrical 1Gb/sec service for $350/month (https://epbfi.com/enroll/packages/# 2011), in addition to bundles including a digital television package with 300+ channels, a digital recording unit, 55 digital music channels, 60 HDTV channels, and on demand channels among other features, and digital telephony service with local and long distance (the premium package included free unlimited long distance) and other add-on services (http://epbfi.com 2011). Business service rates were slightly higher than residential rates due to potentially higher throughputs, and were determined by EPB representatives on a per-case basis. EPB assessed no throughput caps, issued end users static IPs, and permitted end user hosting. AT&T, Level 3, and Sprint supplied the MAN with upstream service. The EPB system was constructed in a served market, and cable provider Comcast did protest their entry. None of the incumbents were using the EPB system as part of their own system, and were still assessing their users higher rates than EPB was for similar IP services (K. Mena personal communication, 2011, December 20).

EPB CEO Harold DePriest did not expect immediate demand for the 1Gb/sec service, and when asked why EPB offered it he replied, “The simple answer is because we can.” DePriest added the higher speed service could be provided at minimal additional expense once the fiber optic MAN was installed and the network equipment was functional. “We don’t know how to price a gig. We’re experimenting. We’ll learn. The overriding consideration is that this
is a real tool for economic development for our community. It is the basis for creating the products and services of the Internet of the future. And it’s in Chattanooga today.” (Lohr, 2010).

EPB’s telecommunication enterprise was bundled with its electric power enterprise, which was a retailer/reseller of TVA-generated power. The telecommunications service was piggybacked on top of the EPB electric grid’s SCATA network, which was the initial reason for installing the fiber optic cable to users. EPB was awarded a $111M U.S. Energy Department grant thereby accelerating its “smart-grid” plan, but DePriest said the federal funds did not subsidize the high-speed Internet service (Lohr, 2010). The two services likely did cross-subsidize each other, as neither were structured as stand alone independent enterprises (http://epbfi.com 2011).

_Dublin (OH) DubLink_

In 1996, the City of Dublin, OH appropriated $96M for street and right-of-way improvement and beautification projects to help resolve traffic problems created by increased sprawl, but hesitated in seeing their finished work torn up by future utility installations, potentially numerous times by multiple telecommunication providers. Telecommunications systems provision therefore factored significantly into their planning process (Intelligent Community Forum, 2011). Dublin thus assembled a team comprised of a telecommunications attorney, a telecommunications engineer, and the city service director to develop a business and governance model for the project, and they suggested a number of options.

• A publicly-owned utility that would provide telecommunications services.
• No government regulation whatsoever.
• A PPP model to provide telecommunications services.
• A PPP model to provide conduit infrastructure but not telecommunications services.

The publicly-owned utility option was dismissed as Dublin lacked the expertise to provide complex telecommunication services. The city, while willing to take some risks, was not willing to assume the financial and managerial risks of owning (i.e., owning ROW, infrastructure, and facilities) and operating a telecommunications company (i.e., administering the system and assumedly providing carriage services). The “No Regulation” option was dismissed because it would not help achieve the goal of preserving the city’s expensive right-of-way improvements, even though the option could encourage more rapid deployment of telecommunications services (Dunn & McDaniel, 2011). The team considered establishing a competitive provider to deliver all telecommunications services, but the city was unwilling to bear the risks of building and operating a company, among other complexities. The legal counsel advised it might also run counter to the 1996 Telecommunications Act by stifling provision competition (Intelligent Community Forum, 2011). It was also difficult for them to devise a regulatory scheme that prevented private providers from constructing infrastructure in the city’s rights-of-way that did not violate the 1996 Act or antitrust laws.

The team therefore decided that creating a conduit system was the best choice. The plan conceptualized that the city or some private entity would build a conduit system throughout the high-density business district where virtually all the initial demand for competitive services would initially occur. The system would feature conveniently placed manholes, a ring design, and redundant building entrances extending from the manholes. Providers would not be permitted to cut into streets or build in city rights-of-way, and would be required to lease space from the conduit system. Lease rates would have to be low enough so that no provider could complain that the rates were a barrier to entry, as prohibited by the 1996 Act (Dunn & McDaniel,
Dublin contracted with the Fishel Company to construct the DubLink buried conduit system within its business district, and franchised them as the conduit provider for 25 years with an additional 25 year renewal option. Fishel leased the municipal right of way and owned the conduit system, which they made openly accessible for providers and other users that included SBC/AT&T, Teleport Communications Group, Time Warner Communications, ICG, and NextLink Ohio. Fishel self-financed construction of the $10M system, and assessed users $7.27 to $9.80 per foot annually ($38,385.60 to $51,744.00 per mile respectively), with those rates regulated by the City. The 30.5 mile system featured 1.25” and 4” buried conduits, with the larger ducts containing innerducts within them, and reportedly 12 1.25” conduits installed per trench.

The network saved users time and money by providing an existing infrastructure within the business district so that users could lease rather than construct their own lines and systems (DataCenter.BZ, LLC, 2009). A few competitive providers opposed the DubLink system ordinances claiming the lease rates were too high and that they could build their own systems cheaper and more efficiently as demand warranted. Dublin City Council was not convinced, as they were essentially proposing to do what Dublin wanted to prevent - haphazardly cutting expensive streets and rights-of-way with considerably short planning horizons and self-serving fiscal concerns (Dunn & McDaniel, 2011). Incumbent LEC SBC Ameritech required two policy positions: its existing systems needed to be “grandfathered” in place rather than be forced to join with the conduit system, and that it retained the right to build systems anywhere and whenever it wanted. Dublin Council then passed a right-of-way control ordinance that established a “DubLink District” encompassing the entire business district of the city. All new telecommunications infrastructure construction within the district was banned, and providers
desiring to deploy systems were required to use the DubLink conduit system. Dublin agreed to “grandfather” Ameritech’s existing facilities and exempt them from the DubLink regulations, giving them various advantages over Fishel and competitors forced to use DubLink. It also authorized any provider to build its own systems if there was no DubLink conduit in that location, provided that it also allowed DubLink conduit to use the same trench (Intelligent Community Forum, 2011). Dublin waived Fishel’s franchise and other fees in exchange for free conduit access. The city itself offered no services to end users except access to certain governmental services for public use. For other services, it leased either conduit space or used its own dark fiber to providers serving the local market (The invisible bridges of Dublin, 2011).

Dublin partnered with the Ohio Supercomputer Network in the Central Ohio Research Network to provide advanced computing power and robust fiber infrastructure that connected area governments, schools, and businesses to Ohio colleges, universities, major research institutes, and Federal laboratories. It also provided capacity to the Online Computer Library Center, which supported more than 69K libraries in 112 countries, and had partners with two carrier hotels in Columbus to give DubLink users low-cost access to Tier I and other providers (Intelligent Community Forum, 2011). Dublin was further considering deployment of a “DubLink II” network for high-speed services to its residential areas situated outside of the DubLink area (Dunn & McDaniel, 2011). Dublin provided transit to the Columbus Fibernet and received capacity on that network in return (Intelligent Community Forum, 2011). The CFN duct system consisted of 70 miles of 20 1.5” innerducts connecting the downtown commercial business district with high-speed users outside of I-270 and high tech business parks in the Columbus suburbs of Dublin, Easton, Gahanna, Hilliard, Polaris, Westerville, and Worthington (http://www.columbusfiber.net 2011). In 2009 DataCenter.BZ, a Tier IV data center located in
Columbus, agreed to bring DubLink’s dark fiber to its facility located in nearby Worthington. The benefit was direct fiber connectivity to the data center, enabling DataCenter.BZ users to cross-connect to the provider of their choice, and utilize the data center’s other services that included collocation, physical security for IT equipment, Tier IV power, 24 x 7 managed services, virtualization, and cloud computing. DataCenter.BZ president Gordon Scherer said, “Not only is this an economical way for companies to privately connect to IT and telecommunication solutions, it eliminates the restriction of bandwidth that is often created by telecom carriers, or any solution that isn’t operated over dark fiber. Utilizing dark fiber, businesses have complete control over their bandwidth and can increase or decrease their speeds based solely on the equipment they choose to operate. Companies will be able to access the best pricing available from the carrier(s) of their choice, forcing the providers to compete in order to win the business.” (DataCenter.BZ, LLC, 2009).

Butler County (OH) Fiber Network

The Butler County, OH Fiber Optic Initiative was a project to provide the county and Miami University with a fiber optic network, and was thereafter expected to connect with and serve most of the county’s other communities. The network featured 100 miles of 96-strand fiber cables routing throughout the county. Butler County originally owned 12 of the strands, Miami University leased 12 strands, provider iFiber of Middletown, OH leased two strands for five years, and a Columbus, OH-based investor owned the balance. Six more strands worth approximately $1M were purchased and donated to Miami University, giving them connectivity to the State of Ohio’s OARnet/Third Frontier Network. iFiber open accessed and sublet their leased strands to competitive third party providers including DONet, Nuvox, and Inter-Tel. The
project was jointly financed by Butler County, Miami University, and Cincinnati Bell, with one source stating the project cost $10M, while another listed the county’s investment at $2.75M with $100K annual costs for operation and maintenance services provided by Cincinnati Bell (http://www.butlercounty.biz/Fiber.htm, http://www.ifiber.net 2006).

A 2010 update on the network reported Butler County paid $5.7M for the system. Of the 96 strands, the county owned 34 and leased 12 of them to Miami University. Butler used 16 of its strands to provide high-speed Internet connections to 38 county government sites, while its remaining six strands were not used. Other network owners included iFiber (30 strands); Cincinnati Bell Telephone (12 strands); NI Solutions (12 strands); Miami University (6 strands); and the City of Hamilton, OH (2 strands). MU’s network connected its main Oxford, OH campus with its branch campuses in Hamilton, Middletown, and West Chester Township, OH. Butler County IT director Greg Sullivan said Butler County’s WAN improved communications between county government offices as well as between county offices and state offices in Columbus, and allowed the county to provide connections to its emergency communications center and Emergency Management Agency. “It has raised the quality of life in Butler County. There are still a lot of advantages for us to use this network.” The county had explored providing connections to residential users but found the cost was prohibitive, according to County Commissioner Chuck Furman.

Butler County financial director Bob Lowery said the network cost the county $274K a year, and its debt for the system c.2010 was about $4M. The county received $300K annually in lease payments from MU, but those only partially offset the $214K a year the county paid Cincinnati Bell to maintain the network and the $350K a year required for debt payments. Lowery pointed out that if the county didn't have its own network, it would be paying Cincinnati
Bell or another provider for similar service, and he didn't know how much that service would cost but it probably would be less than $274K. The financial challenges raised questions about what the county should do with its one-third ownership of the system. Commissioner Furmon said, “We need to know if we should keep the system and expand it. Or should we cut our losses and sell it for what we can get out of it and move on?” County Commissioner Don Dixon said, “There's no way for taxpayers to get their money back. We need to deal with this issue, because it's a constant financial drain.” He also said there was no interest from the private sector in buying any of the 34 county-owned strands. Further complicating matters, Dynus Corp., which was trying to acquire a contract to improve the network, took out $6.5M in loans in the county's name without the county commissioners' knowledge. Over the past 2.5 years, the subsequent scandal resulted in the criminal convictions of three Dynus officials, former Butler County Auditor Kay Rogers, and the indictment of former Butler County Commissioner Mike Fox (Kemme, 2010).

**North Georgia Network**

The American Recovery and Reinvestment Act of 2009 allocated $7.2B for expanding high speed telecommunications access, with the first $4.7B directed to the U.S. Department of Commerce’s Broadband Technology Opportunities Program (BTOP) to provide high speed access to underserved communities and public institutions, and stimulate demand for high speed services in general. Local groups could apply for BTOP funding for “last mile projects” to bring high speed Internet service to census blocks where a majority of users were not served by higher-speed service or had less than 3Mb/sec speeds. Much like the U.S. Rural Electrification Administration, the goal of the government’s programs was to subsidize infrastructure in
underserved and rural regions and create jobs during the economic downturn then. At the time, the programs distributed approximately $200M in grants and loans for infrastructure buildouts including a “$33.5M grant with an additional $8.8M in matching funds to deploy a 260-mile regional fiber-optic ring to deliver gigabit broadband speeds, reliability, affordability, and abundant interconnection points for last mile service in the North Georgia foothills.” (Chettiar & Holladay, 2010, p.36). In 2009 the North Georgia Network Cooperative, Inc. was the first applicant to receive a stimulus grant for an 80% match to their 20% investment in the “North Georgia Network” to help develop a new technology-based economy for GA’s 12 northern counties. The project proposed to build 135 miles of new fiber connecting to 125 miles of existing fiber to create a middle mile ring. NGN was a member-owned cooperative, with part owners including the Habersham Electric Membership Corp. and the Blue Ridge Mountain Electric Membership Corp. Both electric utilities had already constructed locally-based fiber infrastructures and were to be further involved in the NGN (North Georgia Network Cooperative, Inc., 2009).

The NGN featured dual-route redundancy and supported last mile fiber to the home. “NGN is an open network that will feature approximately 2,600 interconnection points along the route, where independent service providers will be encouraged, on a non-discriminatory basis, to interconnect with the system in order to build out their own fiber services to end users. Interconnection for independent service providers will be enabled through an access company that will be a member and owner of NGN. The plentiful interconnection opportunities will result in an abundance of broadband capacity, give consumers a choice of providers, and bring pricing in the region down to the more affordable levels typically enjoyed in non-rural areas” (North Georgia Network Cooperative, Inc., 2009). NGN was fully symmetrical
(http://northgeorgianetwork.com/technology/ 2011) and provided a minimum 1Gb/sec at the connection points (NGN Trailwave Technology Overview, 2011).

**Australia’s National Broadband Network**

Australia had slower and more expensive telecommunications access than many other developed countries c.2008, and officials warned the country might have become less competitive without faster, nationwide coverage. About 64% of homes had high speed service, although Australia’s vast distances and its inhospitable terrain made full penetration difficult. The Australian government then proposed a A$9.4B (US$8.8B) high-speed fiber optic-based network with minimum speeds of 12Mb/sec to access 98% of Australian homes. The network architecture for the last mile would have either delivered fiber to neighborhood "nodes" in each street or directly to end users’ premises (Thieberger, 2008).

In 2009, Minister for Broadband, Communications, and the Digital Economy Sen. Stephen Conroy announced sweeping reforms to Australia’s existing telecommunications regulations as the government also rolled out its upgraded $43B National Broadband Network to bypass incumbent Telstra's existing copper system and go straight to end users’ premises, and moved Telstra towards becoming part of the NBN. The following was paraphrased from the official announcement.

The reforms would drive future growth, productivity and innovation across all sectors of the economy by:

- Addressing Telstra’s high level of integration to promote greater competition and consumer benefits.
• Streamlining and simplifying the competition regime to provide more certain and quicker outcomes for telecommunications companies.

• Strengthening consumer safeguards to ensure services standards are maintained at a high level.

• Removing redundant and inefficient regulatory red-tape.

Telstra was one of the most highly integrated telecommunications companies in the world across the fixed-line copper, cable, and mobile platforms. Sen. Conroy said, “The reforms address the structure of the telecommunications market and provide Telstra with the flexibility to choose its future path. It is the Government’s clear desire for Telstra to structurally separate on a voluntary and cooperative basis.” The reforms would also promote competition and strengthen consumer safeguards. Sen. Conroy continued, “The existing telecommunications anti-competitive conduct and access regimes have been widely criticized as being cumbersome, open to gaming and abuse, and provide insufficient certainty for investment.” Since the commencement of the regime in 1997 there have been more than 150 telecommunications access disputes compared to only three access disputes in other regulated sectors, including airports and energy sectors.

The legislation addressed Telstra’s vertical integration by allowing the provider to voluntarily … structurally separate. If Telstra chose not to structurally separate, the Government could impose a strong functional separation framework on Telstra. The legislation required Telstra conduct its network operations and wholesale functions at arm’s length from the rest of Telstra; provide equivalent price and non-price terms to its retail business and non-Telstra wholesale customers; and such equal treatment be made transparent to the regulator and competitors. The legislation addressed Telstra’s
horizontal integration by promoting competition across telecommunications platforms.

Telstra would be prevented from acquiring additional spectrum for advanced wireless broadband while it remained vertically integrated and owned a hybrid fiber coaxial cable network and maintained interest in provider Foxtel. The legislation authorized the Minister to remove either or both of the second and third requirements if Telstra structurally separated. The legislation also reformed the Australian Competition and Consumer Commission (“ACCC”) so it could address breaches of competition law and conduct damaging to the telecommunications market. Failure by Telstra to meet the minimum performance benchmark requirements would expose Telstra to a civil penalties of up to $10M (Conroy, 2009).

Sen. Conroy added, “These historic fundamental reforms address the long-standing inadequacies of the existing telecommunications regulatory regime," and said Telstra had been too highly integrated for too long, and previous governments from both sides of politics had failed to reform the telecommunications sector (Rodgers, 2009).

The proposed A$43B NBN would provide service to approximately 93% of the population. NBN would give competitors an even platform to compete over, with many of the smaller, more nimble companies backing themselves to be able to outmaneuver Telstra if its dominance of the infrastructure was ended (Bathgate, 2010). NBN was c.2013 providing 100Mb/sec downstream and 40Mb/sec upstream, with prices ranging from A$40 to A$164.95 per month and data limits on all plans. As more end users subscribed to NBN over time, those prices were projected to decrease, with wholesale prices in regional and metropolitan Australia set at the same rate. NBN’s initial pricing objective was to pay off the network and to gain a 7% return on investment for the government (Taylor, 2012). Mike Quigley, CEO of NBN Co. - the
company building the NBN - said NBN would eventually launch 1Gb/sec services in the future. "We will have one consistent set of products across the whole national footprint. And that means consistent ubiquitous service up to 1Gb/sec. Everyone keeps talking about 100Mb/sec. But that's obviously when we're talking about residents. For business, we are allowing for a certain percentage in our dimensioning to structure point-to-point services up to 1Gb/sec." (Taylor) Quigley said increasing the speed would not add to the $43B construction price tag and the fiber could be upgraded to provide even faster speeds in coming years. The faster capability was already built into the equipment, which the company was installing in homes, and Quigley said he decided to enable it after discussions with ISPs and the competition watchdog. NBN Co. would offer unlimited download capacity at 1Gb/sec wholesale rates to retail ISPs, but provider Internode said it was not reasonable to give consumers unlimited downloads (Battersby & Sharp, 2010). Minister Conroy also stated that when a consumer purchased speeds of 50Mb/sec or 100Mb/sec that is what they would get consistently - those speeds represented a consistent rate and not peak speeds (LeMay, 2010).

The NBN proposal implementation was affirmed after the Labor Party took control of the Australian government in 2010. Member of Parliament Tony Windsor said, “In relation to the NBN there will also be equity in terms of wholesale pricing across country areas.” MP Rob Oakeshott added, “And it will be a roll-in, not roll-out – it’s now a broadband roll-in,” referring to a system buildout strategy where rural areas would receive NBN fiber services first vs. metropolitan areas. Ovum research director David Kennedy added, “Under Labor's policy, where we’re clearly heading is a structurally separated industry. While both of them agree on the need to tighten competition rules on Telstra, they don’t agree about whether - Telstra in particular and the industry in general - should be structurally separated. Labor would take us
strongly in that direction.” Quigley retorted to opponents of the government network, “NBN can provide an acceptable return for the government. Taxpayers will get their $27B investment back with interest and they will get a network they can use for decades. This is, I believe, a much better option for the Australian public than giving billions of dollars of taxpayer funding to subsidize commercial companies to marginally improve today’s broadband networks.” (Pitcher, 2010).

The Alliance for Affordable Broadband, comprised of a group of providers and other interested parties, proposed an alternative "NBN Version 3" model and denoted a number of principles upon which the Australian Government should structure its NBN policy. AAB’s numbered issues that differed from the Government’s policies were paraphrased as follows.

1. The Australian government’s primary role should be setting policy frameworks that incentivize providers to build systems themselves. Governments should assist or directly invest in universal service as private providers typically could not provide 100% service coverage.

2. Providers were better managers of capital and technology risk than governments were (a direct contradiction to the Australian Labor Party's policy that its country’s telecommunications market had failed). Infrastructure-based competition - not infrastructure monopolies with retail competition - was the preferred business and governance model. Existing infrastructure competition should be preserved - such as metropolitan hybrid fiber-coaxial networks - and stranding or crowding out such infrastructure assets by the NBN was opposed.

3. A national fiber-only network was unnecessary. For the short to medium term, globally, there was no demonstrated mass requirement for “up to 1Gb/sec” speeds to
homes and small offices/home offices. The greatest priority instead should be serving markets, not faster service to those markets that were already served.

9. A market based approach would be the best solution. An alternative national broadband network called “NBNv3” could include fiber-based network segments for areas of demonstrated need provided there was a commercial return on investment, or where there was a demonstrated and justifiable improvement in productivity and/or social equality to justify taxpayer contributions.

10. A public/private business and governance model should be explored for NBNv3, which, where practical or endeavored to include and recognize competitive providers’ existing network investments and incentivized providers to upgrade their networks and rollout services.

14. Any substantial investment by taxpayers for any national network(s) must be subject to serious investigation and independent cost estimations, cost-benefit analysis, genuine industry and public consultation, as well as a review of its impact on the Australian competitive telecommunications landscape (Ashton, et al., 2010).

Critiques of AAB’s proposal included its exclusion of FTTH, significantly limiting its capacity to deliver speeds of 100Mb/sec or higher. Telecommunications analyst Paul Budde said, “The future as everybody around the world agrees is FTTH and so you need to develop a plan that in the end will lead you to FTTH. It will be a backwards step.” Optus spokesman Maha Krishnapillai warned there were questions over whether AAB’s plan would limit competition and entrench Telstra's market dominance. “What it doesn't do is fundamentally reshape the game, which is the ability for Telstra to continue to control access to that last mile.” (Coalition broadband plan causing concern, 2010).
In August 2011, ACCC said Telstra's separation plan could not progress in its current form and called for certain changes, though analysts said only minor delays to the restructuring effort were expected. Arnhem Investment Management fund manager Theo Maas said ACCC's concerns focused mainly on the transition period during which Telstra would convey its fixed-line assets to NBN. "With NBN being a 10-year process, Telstra will have reasonable power to disadvantage competitors from access to their old copper network during the roll-out period."

(Bendeich, Somasundaram, Paul & Thieberger, 2011) Telstra then advised its shareholders ahead of an October 2011 vote on its plan to convey its fixed-line assets to NBN that it would be $5B better off in working with NBN than competing against it. Independent investment and advisory group Grant Samuel & Associates Pty Ltd. said, "Overall, the advantages of the proposal outweigh the disadvantages. Accordingly … the proposal is in the best interests of Telstra and its shareholders.” The endorsement came after ACCC called for changes in the terms of Telstra's plan. Shareholders were waiting to vote for the company's plan to separate its fixed-line assets, looking to end two years of uncertainty that sent its shares to record lows sparked by the Labor government's shake-up of the industry. Tyndall Investment Management analyst Michael Maughan said, "The majority of the market seems to be in favor of the deal. In fact, you could argue the share price has performed better the more certain the deal has become.” Telstra CEO David Thodey said the board was unanimous in advising shareholders to back the plan.

"We think it is the better overall financial outcome. It does give us a more stable regulatory environment and greater strategic flexibility going forward.” Grant Samuel valued the payments Telstra would receive from the government for its infrastructure assets at A$12.8B (US$13.7B). The only alternative for Telstra would have been to compete against NBN, which would have required it to increase investment in its own networks and face losing access to newer
government network technologies. Grant Samuel estimated Telstra would save A$3.5B by not having to invest in its own networks, while it would lose A$11.6B in cashflows. Altogether, the company would be A$4.7B better off by cooperating with NBN Co. than competing against it. Grant Samuel considered the implications of the network failing or being abandoned, and concluded that Telstra would also be better off under this scenario than one where it chose to compete with a successful network (Paul, 2011).

Canada

In December 2008 the Canadian Radio-Television and Telecommunications Commission issued an order that gave wholesale ISPs access to the faster networks of major providers including Bell and Telus, but in 2009 the Canadian government ordered CRTC to reconsider the decision by Industry Minister Tony Clement (CRTC approves usage-based internet billing, 2010). The government relented to lobbying from the large providers and ordered the review on the grounds that CRTC had failed to consider a number of issues including how the matching speeds would diminish the large providers’ incentives to invest in new infrastructure, and whether there was sufficient competition to protect end users without the requirement of matching speeds. Smaller ISPs including Teksavvy and Execulink had argued that without requirements to offer matching speeds, the large providers would put them out of business. Bell and Telus were offering connections of up to 25Mb/sec and 15Mb/sec respectively over newer fiber-based networks, but smaller providers could typically offer speeds of no more than 5Mb/sec over older copper-based infrastructures. In August 2010, CRTC confirmed that Bell and Telus must offer smaller wholesale ISPs that rented portions of their networks whatever speeds the big providers themselves sold to their own retail customers, despite the previous
disagreement from the government. CRTC said the requirement was necessary to maintain
competition and reasonable prices for high speed services. CRTC also authorized large
providers to charge smaller ISPs an extra 10% mark-up to use their newer infrastructures to help
recoup the costs of their investments. CRTC chairman Konrad von Finckenstein stated, “Access
to broadband Internet services is a key foundation for the digital economy. The large telephone
and cable companies are bringing their fiber networks closer to Canadian homes and businesses,
which allows for faster Internet connections. Requiring these companies to provide access to
their networks will lead to more opportunities for competition in retail Internet services and
better serve consumers.” Teksavvy CTO Marc Gaudrault said regarding the additional provision
preventing ISPs from circumventing download limits or throttling imposed on uses such as P2P
by large providers, "The CRTC's approach will entrench the duopolistic nature of the
communications wireline services industry in many important markets and stifle the ability of
competitors to provide new and innovative services. In this environment, it will be very difficult
for competitors to attract the capital necessary to innovate, grow, and contribute to the greatest
extent possible to the competitive landscape and increase consumer choice." Bell Senior VP of
regulatory and government affairs Mirko Bibic said the decision discouraged investment in its
networks and showed there was a lack of clarity in public policy. The allowed 10% mark-up "is
mere tinkering and does not create an environment which allows us to maximize the returns on
our very significant fiber network investments. We need to know, which is it? Do we want as
much network investment in Canada as possible, or not? Last year, (the Canadian Government)
Cabinet sent this issue back to the CRTC for reconsideration. Clearly, this isn't the decision
Cabinet was looking for.” CRTC also said it would consider the phase-out of mandated Internet
access when alternatives such as wireless and satellite became more accepted as substitutes (Nowak, 2010), which could risk reversion back to modal monopolies or duopolies.

In May 2010 CRTC approved Bell Canada's request for usage-based billing vs. unlimited downloading on both its wholesale users that rented its lines and retail end users based upon how much they download each month. Bell however was required to usage-base bill all of its retail end users before it could usage bill its wholesale users. The CRTC also required Bell to make any "usage insurance plans," which gave its own retail customers extra monthly usage for a small fee, available to wholesale ISPs. Bell was to then charge wholesale ISPs a flat fee for connecting to its network and for a set monthly usage limit per end user. Beyond those set limits, users would be charged per GB, depending on their connection speeds. It argued that usage-based billing was necessary to control the congestion caused on its network by heavy downloaders. CRTC commissioner Candice Molnar dissented on the ruling saying the requirement on Bell to move all of its customers off unlimited downloading plans was unnecessary because a vast majority were already on usage-based services. Small ISPs regarded the CRTC's approval of Bell's plan as inevitable, but opposed it saying it would make them indistinguishable from Bell. ISPs including Teksavvy offered plans with hundreds of GBs of usage, whereas Bell's most popular services limited users to 50GB or 75GB. Teksavvy president Rocky Gaudrault said, "The rates are absolutely atrocious. How the hell are we doing above one dollar for extra usage? It's in the thousands of multiples beyond what the costs are," and added that Bell also continued to have an advantage over smaller ISPs as it was able to offer superior speeds (CRTC approves usage-based internet billing, 2010).
Sweden

A 2004 updated Swedish IT policy bill noted three central objectives.

• IT must contribute to a better quality of life and help improve and simplify everyday life for people and companies.
• IT must be used to promote sustainable growth.
• An effective and secure physical infrastructure for IT, with high transmission capacity, must be available in all parts of the country so as to give people access to, among other things, interactive public e-services.

The plan called for the government to take responsibility in organizational, logistical, and technical issues in order to meet the coordination objective (Benkler, 2009, p.217). Increasing demands for more robust telecommunication systems were driven by the need for greater capacity, which was a result of end user demands for telecommunication services. High speed service was required by nearly every household, business, and public sector service (http://www.stokab.se 2011). Certain provider-owned networks or markets where the traditional telephone network was the only alternative were utilized to their maximum capacities and could not cope with additional end users, which in certain innercity areas caused a shortage of services that previously had only been a problem in sparsely populated areas (http://www.stokab.se 2011).

In 1999 the Swedish government committed over EU600M for the installation of a national backbone (Benkler, 2009, p.218), and in 2000 Sweden’s IT Bill 1999/2000:86 set the goal of “an information society for all.” (Atkinson, Correa, & Hedlund, 2008, p.20) The National Rural Development Agency led an effort to eventually rollout advanced services via provider-neutral networks to rural areas and small towns, and required state-owned corporations
including the government-owned power company Svenska Kraftnät to build a fiber optic backbone infrastructure to 289 municipalities comprising about 70% of the country’s population. Government program grants were limited to communities with no existing providers, the procurement process had to be open and provider-neutral, and municipalities had to provide at least 10% of the cost of building the network (Atkinson, et al., pp.29-30). Tax break subsidies were also used to incentivize buildouts (Benkler, p.218), and other government subsidies to municipalities guaranteed municipal investments in case no private providers wanted to offer services (Benkler, p.121).

In February 2007 the Swedish telecommunications regulator Post och Telestyrelsen (“PTS”) announced a “Proposal for Swedish Broadband Strategy” for all Swedish customers to have high speed access of at least 2Mb/sec by 2010, and for most if not all end users to have a choice of several providers. To achieve this, PTS proposed minimum service requirements for infrastructure supported by government funds, imposed regulations to ensure networks were open to competition, encouraged municipalities to work together to provide networks, and treated Internet access as a universal service (Atkinson, Correa, & Hedlund, 2008, p.G2). Municipalities also helped reduce difficulties in obtaining permits to site equipment and duct access (Benkler, 2009, p.165). However the Swedish IT Policy and Strategy Group questioned whether it was economically feasible for government-supported providers to create parallel high-speed broadband infrastructure in rural areas (Atkinson, et al., p.30).

Sweden’s broadband regulatory policy was influenced by its government-sanctioned fixed telephony monopoly Telia (later TeliaSonera) (Atkinson, Correa, & Hedlund, 2008, p.G2), which in 1996 had a 71% share of the telecommunications market after the Swedish market for local, long-distance, and international telephony was liberalized in 1993 opening the
telecommunications markets to competition (Benkler, 2009, p.215). Because the Swedish government also controlled other communications infrastructures such as power, railroads, and broadcasting, it had a precedent to involve itself in administering distribution networks. However, Sweden had since deregulated these markets but did retain ownership of some infrastructures remaining subject to competition through access regulations or parallel privately-owned infrastructures (Atkinson, et al., p.G2).

In 2000 PTS required TeliaSonera to unbundle its local loop to allow non-discriminatory access to competing service providers (Atkinson, Correa, & Hedlund, 2008, p.34, p.G3). In 2002 the Swedish government owned 45.3% of TeliaSonera and Finland owned 13.7% (Atkinson, et al., p.G2), and in 2003 the government owned 78% of the country’s high speed network infrastructure (Atkinson, et al., p.G2). Since incumbent provider TeliaSonera owned the majority of Sweden’s telecommunications infrastructure, it had the advantage of being able to bid low for rollout projects as it could simply upgrade its existing network, and thus won 65% of the bids. Other providers were government-owned energy and broadcasting companies, allowing them to offer lower service prices since they did not have to meet the revenue expectations of TeliaSonera being a publicly-traded company (Atkinson, et al., p.G2). Government ownership of TeliaSonera was a key consideration in Sweden’s high speed strategy because increased competition required competing DSL providers to be able to access TeliaSonera’s network at the local loop. Thus, the Swedish government’s strategy included policies to ensure that TeliaSonera’s competitors were afforded access to its network on terms that didn’t favor TeliaSonera’s retail operations and were available at reasonable interconnection rates (Atkinson, et al. p.G3).
The 2003 Electronic Communications Act further strengthened and expanded the regulatory authority of PTS to intervene when providers with significant market power were hindering competition for high speed services, and it essentially sought to open markets primarily controlled by TeliaSonera (Benkler, 2009, p.216). In 2003 PTS required TeliaSonera to lower its prices for competitors to access its local loops because the company had been using discriminatory pricing practices, for example favoring some providers over others. In 2004, PTS determined that TeliaSonera had significant market power and required it to meet all reasonable requests from competing operators for access. TeliaSonera appealed the decision in court, but in 2007 the Supreme Administrative Court ruled for PTS. In 2005, PTS determined that TeliaSonera must also offer naked DSL, allowing end users to access fixed telephony and Internet services from different providers (Atkinson, Correa, & Hedlund, 2008, p.G3). PTS then forced TeliaSonera to accept functional separation in 2007 (Benkler, p.213).

The market that currently deals predominantly with access to TeliaSonera's metallic loop is not a functioning marketplace … the authority can conclude that there is neither sufficient transparency nor equal treatment in the market. The current situation falls far short of the goals of effective and competition-neutral access, nor does it establish adequate conditions to gradually loosen the regulation to promote competition on the route to more sustainable competition. [PTS proposed as a remedy] that the ability of the public authority to impose functional separation on a dominant stakeholder should be introduced, meaning that the parts of the operation representing bottleneck resources should be separated from the rest of the organization (Benkler, p.219).
In 2008, TeliaSonera formed TeliaSonera Skanova Access to provide wholesale services, and during the same year the government empowered PTS to require functional separation (Benkler, 2009, p.92).

As a result of the Swedish government’s strong regulatory policies, the country had one of the most active unbundled local loop markets. The first major competitor to TeliaSonera was Bredbandsbolaget (“B2”). A strategic partnership with the National Swedish Rail Administration gave it an advantage as it could use the railway’s communications infrastructure. B2 concentrated mainly on providing Ethernet and DSL services, beginning with 10Mb/sec and later offering 100Mb/sec (Atkinson, Correa, & Hedlund, 2008, p.G3), but it used little of its own network infrastructure and focused largely on urban apartment dwellings where it served more end users at lower costs (Atkinson, et al., p.35). In 2003 the other major competitor Bostream leased TeliaSonera’s network to provide DSL services, though in 2004 B2 acquired Bostream, giving B2 23% of the market. By 2007, TeliaSonera’s market share shrank to 38%, B2 had 18%, Com Hem had 17%, and Glocalnet had 7% (Atkinson, et al., p.G3). Telenor became the second largest broadband provider at 21.5%, competing with TeliaSonera throughout the country by buying several other providers, some of whom relied exclusively on unbundling to startup and build their customer bases (Benkler, 2009, p.91). However some competitive providers that appeared to be facilities-based competitors were mostly using the incumbent’s or municipality’s networks (Atkinson, et al., p.34). As reflected in the prices and service options, the level of competition in Swedish markets was strong, and the rise in high speed users coincided with a continued increase in the number of independent ISPs competing for residential and business end users, which cut into the incumbent’s market share (Benkler, p.213).
A more popular business and governance model was the requirement that large providers provide services on a wholesale basis to multiple retailers. Most municipal networks such as (the State of) Utah Telecommunications Open Infrastructure Agency and the (Province of) Alberta SuperNet operated on a wholesale basis and allowed competitors to resell the network to end users. Sweden followed this model in encouraging their municipalities to construct fiber networks (Windhausen, 2008, p.52). Municipalities, housing associations, and local utility providers built many of the country’s fiber networks and then opened them up to providers including ISPs, cable, and telephone companies (Atkinson, Correa, & Hedlund, 2008, p.G3). Those networks created more competition in local markets and lowered service prices, while end users received access to “future-proofed” fiber optic platforms, greater service choices, and competitive prices (Windhausen, p.50). The City of Stockholm created the municipally-owned corporation Stokab after Telia refused to offer fiber capacity (Benkler, 2009, p.218), and hoped the new provider would more rapidly introduce advanced telecommunications services to its end users (Windhausen, p.50). Stokab was tasked with developing a competition-neutral infrastructure able to meet future communications needs, stimulate competition, promote diversity, offer end users freedom of provider choice, and minimize the need for infrastructure excavations (http://www.stokab.se 2011). The project started in 1999 and grew to 1.2M kms of dark fiber (Press, 2009a) installed in commercial districts and large industrial areas (Atkinson, et al., p.G3) that reached every block in the city (Press, 2009b). Stockholm did not serve end users — ISPs leased access to the network on a competition-neutral basis.

Municipal networks can play an important role in enhancing competition in fiber networks. If these develop, governments should encourage them to be open networks, that is providing dark fiber to service providers rather than becoming themselves service
providers. Nor should the existence of a municipal network providing dark fiber mean that investment in other fiber networks in that municipality should be prevented (Press). Stokab leased its dark fibers to various providers and users including telecommunication providers, ISPs, cable TV companies, mobile telephony providers, network capacity providers, banks, insurance companies, retailers, media companies, universities, urban networks, property owners, and computer and IT companies (Windhausen, p.50). ISPs, including the incumbent telephone and cable companies, owned and operated relatively cheap network equipment that was frequently upgraded as the technologies improved (Press, 2009b). Stokab CEO Jörgen Kleist said regarding their system, “Because new players on the market need neither to invest in new infrastructure nor to lease it from their competitors, the barriers to establishing themselves in Stockholm become low. With a fiber connection, residents are not only given access to a long-term viable connection with high transfer capacity, but, even more importantly, to an increasing range of options when it comes to service suppliers. In order to provide residents with the greatest possible freedom of choice, it is important that property owners also build fiber networks within their properties that make possible direct connection between the operator and the household via fiber.” (http://www.stokab.se 3-2011).

Some Swedish end users received 100Mb/sec service in locations that switched to fiber optic networks (Windhausen, 2008, p.16). However 75 year old Karlstad, Sweden resident Sigbritt Löthberg received the world's fastest Internet connection at 40Gb/sec - the first time ever then that a home user accessed such a high speed. Karlstad Stadsnät network official Hafsteinn Jonsson said, “This is more than just a demonstration. As a network owner we're trying to persuade Internet operators to invest in faster connections. And [Ms. Löthberg’s renowned son and Cisco technician] Peter Löthberg wanted to show how you can build a low price, high
capacity line over long distances." (Sigbritt, 75, has world's fastest broadband, 2007).

Interestingly, many Swedish end users still kept their dial up account – which was very cheap if not free – even when they subscribed to higher speed services (Atkinson, Correa, & Hedlund, 2008, p.G3).

Regarding Sweden’s models, Press concluded, “Many factors determined the cost of Internet connectivity, but the ownership model was significant, and it seemed the Stockholm model was superior to those in the U.S.” (Press, 2009b). Benkler et al. noted, “In … Sweden, unbundling and open access worked exactly as they ‘should’ have, according to the underlying theory that supported unbundling. Innovative entrants opened up markets; some continued to operate; others were bought out by pan-European or pan-Nordic players and became the basis for entry by those players. The risks - that incumbents would disinvest, that entrants would never graduate to independent competitors - did not materialize.” (Benkler, 2009, p.90). Atkinson, Correa, and Hedlund added, “One reason Sweden and certain other European nations adopted this model was because providers were prohibited from attaching their cables aerially onto poles. The cost of laying cables underground was quite high and in many cases borne by the governments. The inherent costs in deploying telecommunications infrastructure, including high speed networks, reinforced the argument that telecommunications providers had natural monopoly characteristics, thus encouraging multiple independent deployments could lead to a waste of resources (Atkinson, Correa, & Hedlund, 2008, p.28).

Amsterdam’s CityNet

Amsterdam's CityNet project sought to connect 37K households throughout the city, with long term plans to pass all 400K households. The network was to be point-to-point FTTH,
where about 10K households would each be connected directly by its own fiber to each Internet points of presence (POP). The system was designed to operate in three distinct layers. The first layer was the “passive network infrastructure” that included ducts, fiber, and street cabinets. The second layer was the active wholesale layer that included network management, control, and maintenance systems such as switches, routers, and optical splitters, all managed and maintained by a wholesale network operator contracted by the city. The third layer was the retail layer that consisted of providers who would buy capacity on a non-discriminatory basis from the two lower layers and provide retail services to end users. Each provider invested in their own service platform - equipment, services, and billing/customer care.

The passive layer was owned by the Glasvezelnet Amsterdam partnership (“GNA”), whose members included the City of Amsterdam with a one-third share; five social housing corporations (being a non-profit model for housing ownership of apartment buildings and owned about one-third of the apartments in the covered area) with a one-third share; and two one-sixth shares were split between two for-profit investors ING real estate and Dutch open fiber networks provider Reggefiber. The shares reflected the actual share of investments made by each of the parties in the €18M project. GNA bid out construction to bury the ducts and pull the fibers, and bid for a concessionaire to operate the wholesale layer. Telcom Italia’s subsidiary BBned was awarded the contract, and was to invest in the active wholesale layer components that it would then own and operate while also operating, but not owning, the passive layer. BBned was required to pay fees per connected household to GNA, and to sell wholesale access services to third party service providers on an open access, nondiscriminatory basis. The retail providers would then sell services to end users and pay fees to GNA. BBned also had retail affiliates that would sell services too (Benkler, 2009, p.166).
CityNet managing director Herman Wagter said, “In the switch house [central office] or interconnection point, we provide for different racks for different operators, because on a line by line basis customers could sign up for different combinations of offerings.” (Slater & Wu, 2008, p.7). In a 2010 interview, Wagter further elaborated upon CityNet’s technology that provided for open access.

Unlike in the U.S. and Japan, stringing fiber along poles is not an option in European capitals. Every fiber cable must be buried below the pavement, then distributed inside a building to apartments; no wires can be exposed on the outside. The density of these old cities is quite high, and real estate is expensive, leaving little room for cabinets with active equipment on the street level. The majority of the housing consists of multi-dwelling-units (“MDUs”) with up to 500 individual apartments per building.

When the design of the Amsterdam fiber network started in 2005, it became clear that there was little experience in the market with this type of deployment. Contractors were used to either putting copper wires or coax lines in new buildings, or digging long stretches of big high density polyethylene (“HDPE”) tubes for backhaul purposes. Most fiber packaging was optimized for backhaul and for metro networks; few products were specifically designed for fiber-to-the-home in these conditions. The experience in Amsterdam and other European cities has resulted over the years in products like miniature direct burial cables, special high-rise cables with break-out windows to allow very fast builds inside MDUs, fibers that can bend sharply, easy-install Fiber Termination Units (“FTUs”) inside apartments, and so on.
Deploying buried cables to every apartment in a dense city is a disruptive process. A point-to-point fiber topology runs individual fibers from each apartment back to the local aggregation point (think of the phone system model); it's the most flexible and future-proof topology. Point-to-point will support all known technologies (GPON, active Ethernet, lambda, RF video overlay, and others) by patching individual fibers in the aggregation point. It allows for easy unbundling of individual lines.

So [GNA] decided to go for point-to-point in Amsterdam: it did (and does) not make sense to be “penny wise and pound foolish,” by saving on fiber upfront but running the risk of having to redo the outside fiber plant in a decade or two. Paying a slightly higher cost (estimated at 5% or less of the total CAPEX budget for the project) for more fiber length and more connectors/patches was considered an acceptable insurance premium against potential premature technical obsolescence.

The second decision was to build an open access, passive fiber plant that would support multiple ISPs in competition. In practice this translates to:

- Unbundled dark fiber access lines, which can be rented individually by an ISP who wants to serve that particular customer.
- ISPs can get access to APOPs to install their line cards and related equipment, patch in their customer access line, and connect to their own backhaul network (Wagter, 2010).

The E.C. sanctioned Amsterdam’s investment in GNA determining that the municipality’s investment was similar to what a private company might have invested in the project. E.C. Competition Commissioner Neelie Kroes commented, “Business activities of public authorities in the liberalized electronic communications sector have to be analyzed
carefully because of the potentially distortive effect of any state aid on the business of private operators, especially in metropolitan areas. However, in this particular case, our investigation found that the municipality of Amsterdam invests on market terms and that several private parties make significant investments in the project." (http://www.citynet.nl 2011) The E.C. reviewed the following issues.

- The co-investment by two private companies, on equal terms, one a real-estate development firm that had plausible reason to invest in improving the broadband infrastructure of its real estate holdings, and the other a company specializing in open fiber infrastructure.
- The fact that the investment was in passive elements, which were expected to last for thirty years and therefore could be sustained with the relatively lower rates of return expected by GNA.
- The fact that the City of Amsterdam was to be reimbursed all of its pre-project investments, with interest, as part of the project costs, all of which were intended to be paid from user fees paid by the wholesale users, and ultimately by the retail subscribers.
- A close review of the business plan: the E.C. submitted the GNA business plans to one independent review by PriceWaterhouseCoopers, and the Dutch authorities submitted a report from a consulting firm and Delft University, both of which confirmed that the GNA business plan was sound, that the internal rate of return for the project was “within the market expectations for companies active in the telecommunications market,” and that it was robust to a wide range of sensitivity tests based on penetration rates, cost evaluations, and other market contingencies (Benkler, 2009, p.167).

The public-private model however became more private than public (Benkler, 2009, p.121) when Reggefiber, as part of its joint venture with incumbent KPN, bought out most of the shares of the
city and the social housing corporations, raising its ownership stake to 70% in 2009. By then the project was planning to roll out to 100K more homes beginning in the summer of 2009 (Benkler, p.167).

Mexico

In early 2013, Mexico was undertaking rapid restructuring of its telecommunications markets. America Movil owned by Mexican telecomm tycoon Carlos Slim had market shares of 70% of mobile phone subscribers and 80% of landlines (Cattan & Martin, 2013). Rival Televisa had about 60% of the broadcast TV market (Graham & Gutierrez, 2013). Mexican President Enrique Pena Nieto said the lack of competition “reduces productivity in Mexico, limiting its capacity to grow and generate better-paying jobs.” Communications and Transportation Minister Gerardo Ruiz Esparza said the proposed Federal Telecommunications Institute would be able to regulate competition and “will be able to mandate the divestiture of assets of market participants to the extent necessary to eliminate anticompetitive effects.” (Cattan & Martin). Congressman and member of the leftist Party of the Democratic Revolution Julio Cesar Moreno said, "In our country there is just one territory and it is not the territory or property of any one telephone company. Neither can we continue being held hostage to monopolists.” (Graham & Gutierrez).

The goal of the legislation was to create more competition in the country’s telecommunications industry (Cattan & Martin, 2013). The bill sought to boost foreign competition and give regulators the power to force firms to sell assets if they had more than 50% of the market (Alper, 2013). In the lower house, PRI lawmakers sought to amend the bill ensuring that Mexico followed a reciprocal approach to opening up its market to foreign investment. The size of holdings foreign firms could take in Mexico would not be allowed to
exceed the share Mexican firms could hold in that country’s market. The bill also proposed allowing foreign investors to take up to 49% ownership of TV or radio broadcasters, pending a review by a foreign investment commission. Some major economies did not allow foreign firms such a large holding share. Some lawmakers opposed a provision that the president had to be consulted on telecommunications concessions. A separate provision of the bill pledged to create a new independent telecommunications regulator (Graham & Gutierrez, 2013). The regulator would possess the power to set maximum prices for provider interconnections, currently considered to be a severe obstacle to competitors in the fixed-line and wireless markets. The bill also permitted existing television networks — the duopoly consisting of Televisa and TV Azteca - offer their free over-the-air programming at no cost to cable operators, which will allow Slim to compete against his rivals for the first time. America Movil could then offer “triple play” bundled service packages including television, Internet, and phone (Estevez, 2013).

America Movil accounted for more than 15% of the Mexican stock market (Bases, 2013) and had lost about $19B year-to-date in market value (Alper, 2013). Its shares fell 22% in the year to date on investor fears that new regulations would force them to sell assets. BullTick Capital Markets head of research Alberto Bernal said, "It is complicated news for American Movil itself in the short-term, but clearly this is a positive development from the standpoint of potential growth.” (Bases, 2013). However America Movil stood to gain more by entrance into the paid TV sector - from which it had been barred by Mexican regulators - than it might lose by ceding its shares of the telephone and Internet markets. Also, Standard and Poor's cited promising chances for the government to complete its reforms, which would likely lead to an upgrade of its low investment grade rating of BBB (Graham & Gutierrez, 2013) decreasing its borrowing interest rates.
Slim said he welcomed the plan as a boon for competition. "The telecommunications law … coincides with everything this (broadband commission of the International Telecommunication Union) has sought: universal service, better prices, higher speeds, and convergence.” Asked whether he thought the bill would increase foreign and domestic investment, Slim said "Hopefully." (Alper, 2013). Slim said that the work of the Commission would “pressure” governments to provide “universal access” to their people and called for an increased investment in broadband around the world. To do this, governments needed to work with the private sector and learn from other best practices around the world (Estevez, 2013).

**Google Fiber**

Major end user Google had been purchasing dark fibers and remotely locating more of its servers further downstream to increase provision efficiency. However the local and last mile markets were still bottlenecks inhibiting end users’ access to Google’s services. Google then announced it would provide ISP service via fiber in select markets. Experts considered two possible reasons why Google was launching a fiber network. Google wanted to see what end users would do with a gigabit network connection, and Google’s YouTube was streaming movies and TV shows, so the service would benefit from faster network speeds and fewer delays. Others speculated that Google’s move was its answer to attacks on network neutrality by providers including Comcast, Verizon, and AT&T who complained about the price of upgrading and maintaining their network, and wanted to charge large end users like Google premium rates to allow end users faster access to its sites. Google might have wanted to prove that faster networks could be provided at more reasonable prices (Merrell, 2012).
Independent telecommunications analyst Jeff Kagan said Google’s entry into the market would bring true competition through price cuts from providers that would be terrified of Google's potential success. Consumers wanted lower prices to combat what has been a doubling of cable TV prices every ten years, he said. "It has been falling on deaf ears with the cables companies until competitors started coming in. If Verizon and AT&T were the only competitors, I'm afraid that wouldn't be enough to change things. Now that Google is making waves this is where the cable TV industry is either going to be fixed or stay broken." Both Google and Apple caused similar large impacts when they moved into the wireless market where neither had any previous experience in before. Kagan said, "Now they are one and two in that market. They could do the same thing with television. And if they do, it's going to throw Comcast and Cox and other cable providers into a whirlwind, a death spiral, as their customers leave. This is what we could see in the next few years." That potential scenario could be the only way to lower prices for consumers, said Kagan. "If and when [Google] gets this right, it's going to send quakes of terror through the cable TV industry." (Weiss, 2012). Forrester Research analyst Charles Golvin said, "In general, efforts like … Google Fiber that create new models for bringing higher speed broadband to customers are good for the market and for disrupting what is primarily a duopoly in broadband access in most markets.” (Farivar, 2012). However, Google is likely not interested in being an ISP, but rather in fostering a competitive climate in which ultrafast service becomes the norm (Hardy, 2012). It may have just wanted to encourage existing ISPs to offer higher speed services across the U.S. (Finley, 2013a).

Google chose the Kansas City area as the place to start their Google Fiber project after asking communities across the nation if they'd want to be the test site for the project. Google Access general manager Kevin Lo wrote, "More than 1,100 cities raised their hands, and those of
you in Kansas City, KS and Kansas City, MO won us over with your enthusiasm for better, faster web connections. Google Fiber works better when communities are connected together. So we’ve divided Kansas City into small communities we call ‘Fiberhoods.’ We’ll install only where there’s enough interest, and we’ll install sooner in fiberhoods where there’s more interest (Weiss, 2012).

Google chose an aerial installation for the fiber lines upon public power poles. CapStone Investments senior Internet analyst Rory Maher said, “Kansas City owns a lot of the infrastructure needed to build out the fiber network.” In the portion of the metro area located in the State of Kansas, the majority of power poles were controlled by the Board of Public Utilities rather than by private providers. Thus Google likely had an easy time negotiating with BPU for the right to string wires across their poles, and reportedly paid 50% less per pole than its competitors. Poles in other towns were usually owned by private providers, thus Google chose not to negotiate with them (Koerner, 2013, pp.28-29) initially in those areas. Broadpoint Amtech analyst Benjamin Schachter estimated that Google’s Kansas City network could cost over $1B to build. GigaOM reported though that Google saved on its deployments in various ways, such as piggybacking on existing power line infrastructure and building its own network equipment (Finley, 2013a). The fiber network facilitated data at speeds more than 100 times faster than what most U.S. end users had at the time, according to Google (Weiss, 2012). Google executive chairman Eric Schmidt said Google was delivering 760Mb/sec to and taking 720Mb/sec from end users (Hardy, 2012).

Google offered three service plans to end users.
• For $120 per month, end users received unlimited data up to 1Gb/sec upload and download speeds, and Google's IPTV service — a Nexus 7 tablet, TV Box, Storage Box, Network Box, and 1TB of storage on Google Drive on a two-year contract.

• For $70 per month, end users received unlimited data on up to 1Gb/sec upload and download, the Network Box, and 1TB of Google Drive storage.

• For $0 per month (but including the $300 upfront construction fee payable in $25 monthly installments), end users received up to 5Mb/sec download and up to 1Mb/sec upload, with unlimited data and the Network Box included. Google promised to keep this option free for at least seven years. The latter package was targeted to Kansas City residents who may not have had high speed services already (Taylor, 2012).

A difference in Google Fiber’s deployment from other competitors’ roll outs might have been its incentive to pay for the rollout by encouraging end users who wanted service to encourage their neighbors to sign-up in advance, thereby lowering the risk of deploying to a particular neighborhood (Finley, 2013a). If between 40 and 80 people in one area registered in six weeks, Google would then roll out fiber to their locale. During the introductory period for two of the plans, Google waived a $300 down payment requirement for end users to have the fiber installed (Taylor, 2012). Lo said neighborhoods with higher numbers of pre-registrations were the first ones to get the services. Google said, "The first homes will get service shortly after the rally ends, and all qualifying neighborhoods will receive service before the end of 2013." As part of the program, Google said it would also connect community buildings including schools, libraries, and hospitals with free Gigabit Internet if the fiberhoods reached their pre-registration goals (Weiss, 2012).
As previously discussed, gigabit speeds enabled new uses for end users. Google executive chairman Eric Schmidt said, "All of the distinctions, like HD, DVD, that we grew up with, go away. You really imagine that your computer is really in a data center. Teleconferences will become holographic. People take advantage of this kind of increase." Google found the more people that were on the Internet, the more they searched for things, which benefited Google's core advertising business. Schmidt said Google Fiber changed the landscape of cities where it was deployed. "There are all sorts of bizarre things. We started wiring one neighborhood, and a whole bunch of start-ups bought houses in the neighborhood so they could get faster bandwidth." Schmidt added that although the project was "good for real estate values, I'm not sure that's (a) sustainable real estate strategy." (Hardy, 2012). Lesa Mitchell, vice president at the multi-$B non-profit Kauffman Foundation that was aiding local start-ups and officials turn around Kansas City, said “What Google is providing is a catalyst. This infrastructure is enormously important to create a ripple effect of entrepreneurial activity.” (Google’s Kansas City experiment begins to yield start-ups, 2013). Fiber to the Home Council of the Americas President Heather Burnett Gold said of the gigabit rollout, “It will spur innovation. It’s like improving your highways. It’s something you need to do.” (Canon, 2013). GigaBit Squared president and co-founder Mark Ansboury believed that the more important issue might be inaction. “Not having this infrastructure is why certain businesses haven’t moved in, or have left.” (Finley, 2013a).

Startups and other ventures in Kansas City were exploring the consumer applications of gigabit connections, such as gaming and streaming media (Finley, 2013b). Kansas City Public Library officials were investigating virtual software checkouts. Traditionally, end users required a computer with sufficient processing power. Then the software of choice could cost say another
$300. But with the high speed connections, the library could instead keep the software on its servers and let end users remotely access and use it. On ordinary Internet service, working remotely with such bulky programs and large files was impractical. Kansas City Public Library digital branch manager David LaCrone said over gigabit connections, “It’s just putting the software in front of you. You’d see your 8-year-old computer do amazing things.” Google said, “We’ve heard from graphic designers, video producers, transcriptionists, people who work from home, students and lots of other folks who are obviously benefiting from faster speeds right now. We’ve been really excited about some of the ideas we’ve seen coming out of KC, and we can’t wait to see those ideas develop into cool new products.” U.S. Ignite executive director Bill Wallace said, “So far, developers have been working in an environment of scarcity. Only in the last couple of years have developers begun to imagine an environment of abundance.” (Canon, 2013). In other examples, 18-year-old game developer Nick Budidharma drove with his parents from Hilton Head, SC to live in a “hacker home” connected to Google’s Fiber network. Synthia Payne relocated from Denver to launch a start-up company to let musicians jam real-time online. Their sleepy weekly gathering for Web entrepreneurs recently attracted a standing-room-only crowd of 260 businesspeople, investors, and city officials (Google’s Kansas City experiment begins to yield start-ups, 2013).

In response to Google’s market entry, Time Warner Cable in Kansas City placed posters in its headquarters there asking employees to provide any information they heard about Google Fiber (Merrell, 2012). Time Warner Cable chief technology officer Irene Esteves downplayed the importance of offering service to compete with Google. “We’re in the business of delivering what consumers want, and to stay a little ahead of what we think they will want. We just don’t see the need of delivering that (gigabit service) to consumers.” Esteves thought only business
customers would need that kind of service, and she noted that Time Warner already offered
gigabit to businesses in some markets. She did say that if demand and applications increased,
Time Warner would be interested in offering faster service to communities.

Some thought however it might have been too late for Time Warner and other
incumbents to match Google. Experts believed that their reluctance had less to do with a lack of
customer demand and more to do with protecting their high margin ISP businesses. Bernstein
Research analyst Craig Moffet said Time Warner Cable made approximately 97% profit on its
existing services (Finley, 2013b). Verizon began offering FiOS fiber-based Internet in some
states in 2005 and stated its investment was $23B. But some questioned the claim, and investors
were uneasy about their investment all along. Verizon later confirmed that it would not expand
FiOS service to other states or roll out to additional neighborhoods (Finley, 2013a). FiOS was
also more expensive than Google Fiber (Finley, 2013b). DSL Reports author and ISP industry
watcher Karl Bode believed Verizon had a change of heart regarding FiOS. “I think ex-Verizon
CEO Ivan Seidenberg was very bullish on fiber. But after retirement, he was replaced by
executives who wanted to focus more heavily on wireless, given the lower cost of deployment
and the absolute killing that can be made charging users a significant amount per gigabyte.”
Bode also blamed “money men”. “Investors in this country are simply too myopic to wait the
required length of time to see adequate returns. These services are certainly profitable, they’re
just not profitable enough quickly enough for short-sighted investors.” Bode added Verizon was
neglecting not just FiOS, but all of its other fixed line services in favor of wireless services. “I
think both Verizon and AT&T have made the decision to hang up on any further fixed line
broadband competition and are happily letting those users flee to cable. “Cable in turn will help
them by directing their users to wireless services. We’ve effectively just seen the birth of a
significantly less competitive broadband market where cable has a monopoly on fixed line broadband, and nobody appears to have noticed.” Ansboury also said, “Competitors (such as Verizon) have been overbuilding, investors are wondering where the returns are. What you’re seeing is an entrenchment, companies leveraging what they already have in play.” (Finley, 2013a).
CHAPTER III: METHODOLOGY

The study’s research question was investigated by conducting an experiment emulating various wireline telecommunications local and last mile market segment constructs addressing the question’s equal open access and competition concerns. The experiment could have been tried and tested upon live real world networks, but researchers experimenting with protocol improvements inadvertently disrupted the Internet (McMillan, 2010). The more specific the design of an experiment, the more improved the quality of the data it should obtain. Thus for the feasibility of this study, smaller scale versions of sample contemporary local and last mile markets were modeled and emulated using standard network technology and off-the-shelf end user equipment in a laboratory-like environment to possibly predict effects prior to any real world implementation.

Modeling and emulation have been acceptable for use in other experiments. “Modeling” was an attempt to precisely characterize the essential components and interactions of a subject system – a representation of an object, system, or idea in some form other than that of the entity itself (Cook, 2001, p.8). A model was a physical, mathematical, or logical representation of a system, entity, phenomenon, or process intended to promote understanding. Models described how a simplified version of real world activity would perform, and could test hypotheses at a fraction of the cost of actually constructing the activities that the models simulated. One primary benefit of a model was that researchers could use a simple approximation of a system/process and gradually refine the model as their understanding of the system/process improved thus enabling them to achieve good approximations of very complex problems quickly. Models became increasingly accurate with additional refinements (Björlin, 2005, p.16).
Dynamic modeling (a.k.a. “Simulation”) was a software representation of the dynamic or time-based behavior of a system. While a static model involved a single computation of an equation, dynamic modeling was iterative and constantly recomputed its equations as time changed. Dynamic modeling could predict the outcomes of possible courses of action and account for the effects of variances or randomness (Björlin, 2005, p.16).

Simulation was the process of designing a computerized model of a system (or process) and conducting experiments with the model for understanding the behavior of the system, evaluating various strategies for the operation of the system, and determining real-world interactions. A simulation allowed a researcher to develop a logical abstraction (an object), and then examine how an object behaved under differing stimulus. Changes to the subject could then be implemented, tested, and evaluated in the simulation, which was easier, cheaper, and faster than creating many different physical subjects, each with only slightly different attributes. A simulation could be of benefit if it was impossible (or impractical) to construct an actual working subject to test changes. Before a simulation could be of benefit, a model of the system had to be developed to allow the simulation developer to construct the simulation. In a perfect world, the subject of a simulation would have precise rules for its attributes, operations, and interactions stated in natural language, or preferably in mathematical rules (Cook, 2001, p.8). Network simulation provided a controlled and repeatable environment for modeling and testing computer networks (Taleb, 2005, p.1) and different components such as hosts, routers, hubs, proxy caches, links, protocols for computer communication, and applications using the network components (Xu, 2006, p.1). Network simulation had long been the method of choice for testing various Internet protocols and applications. Network performance research could be performed on a laboratory network testbed consisting of co-located hosts and routers (Taleb, p.1). Large
network simulation models usually modeled network topology by assuming a number of end-nodes and a number of routers, with each end-node connected to only one router to represent the last hop link from the network to the end host, and the routers were interconnected to represent the backbone network (Xu, p.12). However, network simulation could be a very time-consuming and expensive solution as researchers had to purchase a lot of hardware and configure the network. Performing different types of experiments on the testbed needed much time since each experiment could require a reconfiguration of the network. Moreover, the performance of a small network testbed could greatly differ from the performance of Internet-scale networks. (Taleb, p.1) In some cases however, network simulation might not have been the appropriate tool for analyzing Internet-scale networks (Taleb, p.2).

Network “emulation” was a … powerful networking research tool … that enabled the testing of real network protocols and applications under a controlled simulation environment (Taleb, 2005, p.2). Emulation testbeds were used instead of simulators to conduct experiments with real hardware and software (Chertov, 2008, p.4). A network emulator allowed real network traffic to interact with traffic generated from a simulation environment, and the simulated network could be easily reconfigured to reflect different network characteristics (Taleb, 2005, p.5). The advantage of using a network emulator as opposed to a simulator was that an emulation environment afforded much higher fidelity since the emulation testbed used real devices with limited resources, real applications, and operating systems … to faithfully represent every host in an experiment - provided that it was correctly configured to avoid artifacts (Chertov, p.16). Simulators and emulation testbeds though did not always faithfully represent router characteristics, and few testbeds had real routers because the number/type of routers and ports were limited thus imposing limitations on the experiment topology scale. The routers had
to be emulated by computer workstations, hence sacrificing fidelity and potentially inducing artifacts (Chertov, p.4). Chertov reported his trials demonstrated that a regular commodity workstation running Linux could outperform low to mid-range Cisco routers (Chertov, p.16).

To collect network traffic data for his simulation experiment, Zhou used both passive data collection sensors ("sniffers") installed at each node or at the main network gateway, and active data collection by sending packets out and measuring the responses to the packets (Zhou, 2005, p.20). The instruments used in simulations and emulations presented concerns regarding experimental verification and validation. Björlin said if a model was going to be credible and a predictor of future behavior of a system/process, it had to pass a rigorous verification and validation process. “Verification” meant the model was behaving exactly as intended by the researcher after rigorous reviews of code and/or mathematical/logical proofs, inputs, and outputs. “Validation” meant the model was replicating the behavior of the system that it was modeling (Björlin, 2005, p.16), referring also to “External Validity” - generalizability, reliability, and reproducibility of the findings of the study under specific conditions. Chertov noted a key advantage of using such emulation testbeds was that the results were reproducible, allowing for detailed comparisons and careful sensitivity analysis. (Chertov, 2008, p.15). Cook elaborated upon validation and verification for simulations.

Validation of the model is required. These steps are just as important in a simulation as they are in any system. A system that is not validated has not been field-tested against the real world and could produce invalid results. Abstraction and validation are equally necessary to create a reliable model that correctly reflects the real world, and also contains all attributes necessary to make the model a useful tool for prediction. This validation must take place at two different times. The model must be
validated against the real world. Then the model must be validated again after the simulation has been created. The simulation outputs will help revalidate the model against the real world. The second validation focuses on validating the simulation against the model, with little emphasis on revalidating the model against the real world (Cook, 2001, p.8).

First the model is created and validated. Next the simulation is created, verified, and validated. Only then can meaningful results be obtained and carefully examined against reality. Tests must be performed to ensure that the model and simulation accurately represent the real world before the simulation can be used to predict behavior (Cook, 2001, p.10).

Reviewing and validating the model prior to and also after the simulation is created is recommended. A reevaluation of the validity of the model after coding is required. The creation of a valid model requires experts who understand the workings of the physical system. The experts must be available not only to help create the model, but also for all phases of verification and validation. If expertise is absent during verification and validation, only verification will be performed. This will result in a system that is consistent and internally correct, but also one that might not actually correspond to (and therefore cannot be used as a reliable predictor of) the real world (Cook, p.9).

Xu pointed out that larger scale simulations would produce more meaningful validation, since conclusions from smaller scale simulations might not be valid when scaled. Such large scale network research would demand the ability to simulate large networks (Xu, 2006, p.2). A potential challenge was to reduce the simulation resource requirements that larger simulations could fit into a single workstation without sacrificing the accuracy of the results. Certain
simulation details could be rationed to reduce resource requirements, but the validity of the simulation results could become questionable because of the loss of accuracy (Xu, p.3).

Design

The design of the study’s experiment involved several phases. Samples of actual hypothetical local and last mile wireline telecommunications markets were modeled into diagrams and grouped into related types of scenarios. Various factors including access restrictions, market control, and end user choices were then added to each of the scenarios’ conditions. Scaled-down emulations of each scenario model were then designed requiring network equipment, personal computers, and software. Additional computer workstations serving as emulated end users were to serve as the instrument. The workstations were to generate trace file data for verification and validation purposes and store it for later export. A set of non-technical observational questions pertaining to the scenario models and emulations regarding governance and business models, politics, network theory, etc., to be answered during the experiment was created to provide data for answering the research question. (Appendix B). Data generated by the experiment and the questionnaire was designed to be exportable in digital formats compatible for incorporation into this report.

Since the study did not involve human subjects, the West Virginia University Institutional Review Board replied that their authorization for this particular non-human study to be conducted was not necessary.
Models

Modeling a census of the actual and hypothetical local and last mile wireline telecommunication markets would ideally result in the most data results for optimum analysis. However for the practical feasibility of this study, only a number of select topology samples considered to be representative of contemporary local and last mile markets together with additional hypothetical constructs based upon the literature review, conversations with industry experts, and field observations were modeled into diagrams.

The models were categorized into 16 scenarios. In Part A of each scenario the first model featured a construct of an end-to-end network - the Internet being one example. One or two downstream end users had connections to one or more providers in the local market. In some scenarios those providers were interconnected to each other, in others they were not. In most of the scenarios the local market providers had access to the upstream Tier I provider, although in a few cases a provider did not have that access available. The Tier I ISP then connected to the Upstream End User’s router and workstation. Part B of the scenarios replicated Part A, except an additional ISP was added to the local market to represent their entry and potentially increased market competition and address the research question’s open access and competition concerns. Some scenarios included additional construct variants of the first Part B models featuring the competitive ISP’s optional access to the upstream Tier I provider, other local market providers, and the downstream end user(s). Certain scenarios included a Part C where the additional ISP represented Google Fiber. Not every possible model variant was included in the later scenarios since there was obvious duplicity that would have rendered identical results.

The models were then described with the following constructs and conditions.
1. A local market served by only one private provider that provides its own system and carriage service between upstream providers to local market end users.

2. A local market served by multiple providers that provide their own systems and carriage services between upstream providers to local market end users.

3. A local market dominated by two duopolistic providers where all providers provide their own systems and carriage services between upstream providers to local market end users.

4. A local market dominated by a monopolistic provider where all providers provide their own systems and carriage services between upstream providers to local market end users.

5. A local market served by only a public MAN that provides its own system and carriage service between upstream providers to local market end users.

6. A local market served by multiple providers including a public MAN that provide their own systems and carriage services between upstream providers to local market end users.

7. A local market including a public MAN dominated by two duopolistic private providers where all providers provide their own systems and carriage services between upstream providers to local market end users.

8. A local market including a public MAN dominated by a monopolistic private provider where all providers provide their own systems and carriage services between upstream providers to local market end users.

9. A local market served by multiple providers including a public MAN where all providers provide their own systems and carriage services between upstream providers to local market end users, and where other private providers and the public MAN can optionally access and use each others’ last mile systems to provide service.
10. A local market served by multiple providers including a public MAN, where two private providers are the only last mile system and service providers. Other private providers and the public MAN must access and use either or both of those private providers’ last mile systems to provide service.

11. A local market served by multiple providers including a public MAN, where one private provider is the only last mile system and service provider. Other private providers and the public MAN must access and use the sole private provider’s last mile system to provide service.

12. A local market served by multiple providers including a public MAN, where the public MAN is the only last mile system and service provider. Other private providers must access and use the MAN’s last mile system to provide service.

13. A local market served by one private provider and a public MAN, where the public MAN is the sole last mile system provider but does not provide upstream carriage service.

14. A local market served by multiple providers including a public MAN, where the public MAN is the sole last mile system provider but does not provide upstream carriage service.

15. A local market served by multiple providers including a public MAN that is dominated by two duopolistic providers. The public MAN is the sole last mile system provider but does not provide upstream carriage service.

16. A local market served by multiple providers including a public MAN that is dominated by a monopolistic provider. The public MAN is the sole last mile system provider but does not provide upstream carriage service.
Emulation

The emulation of the models in this experiment used networking equipment, computers, and software configured to represent providers’ and end users’ systems within a “laboratory” facility. Other appurtenances and accessories and technical assistance were required to support the emulation.

Emulation Hardware

The emulation test bed used a number of small office/home office routers and off-the-shelf personal computers to emulate providers’ and end users’ systems and workstations. The scenarios required each provider have one router and one computer used for controlling and monitoring the router. The test with the most extensive buildout required a total of nine routers and computers, and the tests with the most number of connections between the routers required those routers have six ports each plus one for their controlling computers.

Ten Netgear ProSafe FVS318G Firewall wireline-only routers with eight ports running at 1Gb/sec were acquired for use as the emulated routers. 15 used Dell Optiplex GX150 Pentium III desktop computers each running at 930MHz with 256MB RAM, between 20-40MB hard drives, one onboard 1Gb/sec Ethernet port, and one or two 1Gb/sec Ethernet PCI NICs were acquired, nine of which were used for the router controlling and monitoring computers. Three of the 15 computers were used for the one upstream and two downstream end user workstations, but those did not have access to the router’s control functions. An Apple iBook running at 600MHz with 384MB RAM and a 14GB hard drive was acquired for extra assistance in constructing and spot checking the emulations.
The acquired routers were all refurbished by the manufacturer. Based upon past experience, any equipment that required repairs could possibly malfunction again, thus there was some slight degree of risk to the reliability and functionality of the routers. Conversely, other similar routers previously purchased new also failed for various reasons. The particular model of Dell computers also had issues. It was learned after the computers were acquired that a lawsuit filed in a U.S. federal district court accused Dell of using bad Nichicon Corp. capacitors in its Optiplex desktop series computers and covering up the problems. Some leaking capacitors caused various problems that resulted in the computers malfunctioning, which Dell tried to blame on end user overuse of the processors (Vance, 2010). The routers and computers were monitored throughout the experiment for their proper functionality. The extra routers and computers were held in hot standby reserve in case of contingencies.

Emulation Operating Systems

The firmware used by the Netgear FVS318G routers was version 3.1.1-08. The operating systems installed on the Dell Optiplex 150GX units used for controlling and monitoring the routers was Red Hat Enterprise Linux derivative Community ENTerprise Operating System, a.k.a. CentOS, version 5.8. One Dell unit for testing and other purposes had Windows XP SP2 installed, and the iMac laptop used for similar purposes had OS 10.4.11 installed.

Emulation Software

The experiment required a number of software applications to emulate providers’ and end users’ routers and workstations. To access the routers’ internal web-based management software for control and monitoring, WWW browsers CentOS-based Mozilla Firefox ESR 10.0.12 and
Windows XP-based Microsoft Internet Explorer 6.0 were used on the Dell computers, and Apple OS X-based Safari 4.1.3 was used on the iBook.

Appurtenances and Accessories

Other items required and/or helpful to construct and conduct the experiment included monitors, mice, and keyboards for each computer, ANSI/TIA-568-B.2-1 Ethernet-based Category 6 cables with all segments kept shorter than the standard’s 100m maximum length, power cords, power strips, multiple power outlets, tables, and hand tools.

Technical Assistance

Construction, configuration, and operation of the emulation required the technical assistance of a network consultant since the researcher was not literate in networking beyond establishing basic one-router home networks.

Instrumentation

The instrument used in this experiment included most of the same hardware and operating systems used for the emulation, with additional software to produce and report data.

Instrument Hardware

The instrument used most of the same hardware as listed in the Emulation Hardware section. A Sony HandyCam DCR-TRV480 digital video camera and a Sony DSC-W150 Cybershot digital camera were available to record certain events during the experiment if necessary. Memory sticks were used to transfer trace files and other data saved on those
computers functioning as instruments to an external workstation for further processing and incorporation into this report.

*Instrument Operating Systems*

The firmware used by the Netgear FVS318G routers was version 3.1.1-08. The operating systems installed on the Dell Optiplex 150GX units used for the end user workstations was Red Hat Enterprise Linux derivative Community ENTerprise Operating System, a.k.a. CentOS, version 5.8. One Dell unit for testing and other purposes had Windows XP SP2 installed, and the iMac laptop used for similar purposes had OS 10.4.11 installed.

*Instrument Software*

The instrument required a number of software applications to generate and record the data from the three end user workstations. Windows XP-based software included Traceroute application Tracert 5.1 and Ping application Ping 5.1. Apple OS X-based software included Network Utility 1.4.2 featuring Ping and Traceroute.

*Appurtenances and Accessories*

Other items required and/or helpful to construct and conduct the experiment included monitors, mice, and keyboards for each computer, Ethernet network cabling, power cords, power strips, multiple power outlets, tables, and hand tools.
Technical Assistance

Construction, configuration, and operation of the instrument required the technical assistance of a network consultant since the researcher was not literate in networking beyond establishing basic one-router home networks.

Procedure

The following procedure was used to prepare for and conduct the experiment. All of the necessary hardware, operating systems, software, appurtenances, and accessories for the emulation and instrument were acquired. One monitor, keyboard, mouse, and power cord were connected to each Dell computer, and the power cords from the monitors and computers were connected to power strips that were plugged into wall sockets. The computers were then booted up and checked for their basic functionality. A couple workstations had problems, mostly due to dirt in the cooling fans causing noise, sticky liquids in the keyboards, and debris caking inside the mice. The affected components were cleaned and returned to service.

Due to the excessive cost of actual routers, an alternative using the free Vyatta routing software, multiple NICs, and managed switches was considered. The option would have utilized the Dell computers as routers with some basic capabilities on par with dedicated higher end routers. However the software was quite involved and required Linux literacy, and fortunately an affordable lot of ten refurbished Netgear routers became available and were acquired, thus the PCs were relegated as controls for the routers and as end user workstations.

Operating system CentOS 6.2 was initially loaded on one computer, but the installation failed after a number of attempts. Further research indicated the computers were not advanced enough to handle that version, so the older CentOS 5.8 was instead loaded on the unit, and was
successfully configured and deemed functional. A number of the other computers were loaded and configured with the operating system, and then were connected to the Internet for upgrades to the operating system that were downloaded and installed. One Dell computer was loaded with Windows XP SP2 and was deemed functional. That unit was not connected to the Internet so as to avoid acquiring viruses and the like. The iBook was acquired with its OS previously installed and upgraded to the highest version available for its processor and model type. During the construction of the experiment, one Dell unit overheated due to its fan thought to have been previously cleaned seizing up and affecting the hard drive and RAM. The unit was pulled from service and put on standby for parts. The iBook’s Ethernet port would only work with a specific cable attached between it and the Upstream End User router.

The routers were connected to power supplies and booted up to check their functionalities. The Dell computers running CentOS were attached to a port on each of the routers to be used as configuration and monitoring terminals. Time with the consultant was scheduled for consultation on configuring the routers and reviewing the construction and operation of the emulation and instrument for each model. Data was generated from the research filling out the observation questions for all of the scenario models.

The following sections detail the specific procedures for each scenario test.

**Scenario 1**

In Scenario 1, Part A will attempt to emulate a local telecommunications market served by only one incumbent provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.
Part A.

The procedure for Part A, Test 1.1 is as follows.

1. Secure and situate the following units.
   a. Five computers to be used as routers for an Upstream End User, Tier I ISP, LEC, ISP2, and Downstream End User.
   b. One switch for the Tier I ISP router.
   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together per Model 1.1.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router.
   c. Tier I ISP router-LEC router.
   d. LEC router-Downstream End User router.
   e. Downstream End User router-Downstream End User workstation.
Figure 3.1. Model 1.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 1.1.

7. When finished, power down the units.

Part B.

8. The procedure for Part B, Test 1.2 is as follows.

9. Disconnect the Upstream End User router and the LEC router from the Tier I ISP router.

10. Network a switch to the Tier I ISP router.

11. Network the Upstream End User router, LEC router, and ISP2 router to the Tier I router switch.

12. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User router.
Figure 3.2. Model 1.2 Test Topology.
13. Power up the units.

14. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.

15. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

16. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

17. Complete Section B of the questionnaire for Test 1.2.

18. When finished, power down the units.

The procedure for Part B, Test 1.3 is as follows.

19. Disconnect the downstream end of the LEC router-Downstream End User router connection.

20. Network the ISP2 router-Downstream End User router together.
Figure 3.3. Model 1.3 Test Topology.
21. Power up the units.

22. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.

23. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

24. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

25. Complete Section B of the questionnaire for Test 1.3.

26. When finished, power down the units.

**Scenario 2**

In Scenario 2, Part A will attempt to emulate a local telecommunications market served by multiple private providers between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

**Part A.**

The procedure for Part A, Test 2.1 is as follows.

1. Secure and situate the following units.
   a. Seven computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, ISP1, ISP2, and Downstream End User.
b. One switch for the Tier I ISP router.

c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

   a. Upstream End User workstation-Upstream End User router.

   b. Upstream End User router-Tier I ISP router switch.

   c. Tier I ISP router switch-LEC router.

   d. Tier I ISP router switch-CC router.

   e. Tier I ISP router switch-ISP1 router.

   f. LEC router-Downstream End User router.

   g. Connect a cable to the CC router destined to but not connecting with the Downstream End User router.

   h. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.

   i. Downstream End User router-Downstream End User workstation.
Figure 3.4. Model 2.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
   Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 2.1.

7. When finished, power down the units.

Part B.

8. The procedure for Part B, Test 2.2 is as follows.

9. Network the Tier I ISP router-ISP2 router together.

10. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User router.
Figure 3.5. Model 2.2 Test Topology.
11. Power up the units.
12. Configure the routers as needed.
13. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.
14. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.
15. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
16. Complete Section B of the questionnaire for Test 2.2.
17. When finished, power down the units.

The procedure for Part B, Test 2.3 is as follows.
18. Disconnect the downstream end of the LEC router-Downstream End User router connection.
19. Network the CC router-Downstream End User router together.
Figure 3.6 Model 2.3 Test Topology.
20. Power up the units.
21. Configure the routers as needed.
22. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the CC router as an additional route.
23. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.
24. Complete Section B of the questionnaire for Test 2.3.
25. When finished, power down the units.

The procedure for Part B, Test 2.4 is as follows.
26. Disconnect the downstream end of the CC router-Downstream End User router connection.
27. Network the ISP1 router-Downstream End User router together.
Figure 3.7. Model 2.4 Test Topology.
28. Power up the units.

29. Configure the routers as needed.

30. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP1 router as an additional route.

31. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

32. Complete Section B of the questionnaire for Test 2.4.

33. When finished, power down the units.

The procedure for Part B, Test 2.5 is as follows.

34. Disconnect the downstream end of the ISP1 router-Downstream End User router connection.

35. Network the ISP2 router-Downstream End User router together.
Figure 3.8. Model 2.5 Test Topology.
36. Power up the units.

37. Configure the routers as needed.

38. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

39. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

40. Complete Section B of the questionnaire for Test 2.5.

41. When finished, power down the units.

**Scenario 3**

In Scenario 3, Part A will attempt to emulate a local market dominated by two private duopolistic providers between the upstream providers to the end users. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2. Note – only a representative sample of all of the possible last mile connection combinations will tested.

Part A.

The procedure for Part A, Test 3.1 is as follows.

1. Secure and situate the following units.
   a. Seven computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, ISP1, ISP2, and Downstream End User.
b. One switch for the Tier I ISP router.

c. Three computers to be used as workstation clients of the Upstream End User, Downstream End User #1, and Downstream End User #2.

2. Network the following units together.

   a. Upstream End User workstation-Upstream End User router.

   b. Upstream End User router-Tier I ISP router switch.

   c. Tier I ISP router switch-LEC router.

   d. Tier I ISP router switch-CC router.

   e. Tier I ISP router switch-ISP1 router.

   f. LEC router-Downstream End User router.

   g. CC router-Downstream End User Workstation #2.

   h. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.

   i. Downstream End User router-Downstream End User workstation #1.
Figure 3.9. Model 3.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Downstream End User router-Downstream End User Workstation #1.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-
      Downstream End User Workstation #2.

6. Complete Section A of the questionnaire.

7. When finished, power down the units.

Part B.

The procedure for Part B, Test 3.2 is as follows.

8. Network the Tier I ISP router switch-ISP2 router together.

9. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User Workstation #2.
Figure 3.10. Model 3.2 Test Topology.
10. Power up the units.

11. Configure the routers as needed.

12. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

13. Attempt to configure the Tier I ISP router to utilize the ISP2 router as an additional route.

14. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User Workstation #2.

15. Complete Section B of the questionnaire.

16. When finished, power down the units.

The procedure for Part B, Test 3.3 is as follows.

17. Disconnect the downstream end of the LEC router-Downstream End User router connection.

18. Disconnect the downstream end of the CC router-Downstream End User Workstation #2 connection.

19. Network the ISP1 router-Downstream End User router together.

20. Network the ISP2 router-Downstream End User Workstation #2 together.
Figure 3.11. Model 3.3 Test Topology.
21. Power up the units.

22. Configure the routers as needed.

23. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

24. Attempt to configure the Tier I ISP router to utilize the ISP2 router as an additional route.

25. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User Workstation #1.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User workstation #2.

26. Complete Section B of the questionnaire.

27. When finished, power down the units.

Part C.

The procedure for Part C, Test 3.4 is as follows.

28. Disconnect the downstream end of the ISP1 router-Downstream End User router connection.

29. Disconnect the downstream end of the ISP2 router-Downstream End User Workstation #2 connection.

30. Network the LEC router-Downstream End User router together.

31. Network the CC router-Downstream End User Workstation #2 together.
32. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.12. Model 3.4 Test Topology.
33. Power up the units.
34. Configure the routers as needed.
35. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.
36. Attempt to configure the Tier I ISP router to utilize the Google router as an additional route.
37. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User Workstation #2.
38. Complete Section C of the questionnaire.
39. When finished, power down the units.

**Scenario 4**

In Scenario 4, Part A will attempt to emulate a local telecommunications market dominated by a monopolistic private provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

The procedure for Part A, Test 4.1 is as follows.
1. Secure and situate the following units.
   a. Seven computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, ISP1, ISP2, and Downstream End User.
   b. One switch for the Tier I ISP router.
   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router.
   d. Tier I ISP router switch-CC router.
   e. Tier I ISP router switch-ISP1 router.
   f. LEC router-Downstream End User router.
   g. Connect a cable to the CC router destined to but not connecting with the Downstream End User router.
   h. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.
   i. Downstream End User router-Downstream End User workstation.
Figure 3.13. Model 4.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 4.1.

7. When finished, power down the units.

Part B.

The procedure for Part B, Test 4.2 is as follows.

8. Network the Tier I ISP router-ISP2 router together.

9. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.
Figure 3.14. Model 4.2 Test Topology.
10. Power up the units.

11. Configure the routers as needed.

12. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

13. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

14. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

15. Complete Section B of the questionnaire for Test 4.2.

16. When finished, power down the units.

The procedure for Part B, Test 4.3 is as follows.

17. Disconnect the downstream end of the LEC router-Downstream End User router connection.

18. Network the CC router-Downstream End User router together.
Figure 3.15. Model 4.3 Test Topology.

Upstream
End User
WS

Upstream
End User
Router

Tier I
ISP

LEC

CC

ISP1

ISP2

Dnstream
End User
Router

Dnstream
End User
WS
19. Power up the units.

20. Configure the routers as needed.

21. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the CC router.

22. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the CC router as an additional route.

23. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

24. Complete Section B of the questionnaire for Test 4.3.

25. When finished, power down the units.

The procedure for Part B, Test 4.4 is as follows.

26. Disconnect the downstream end of the CC router-Downstream End User router connection.

27. Network the ISP1 router-Downstream End User router together.
Figure 3.16. Model 4.4 Test Topology.
28. Power up the units.

29. Configure the routers as needed.

30. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP1 router.

31. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP1 router as an additional route.

32. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

33. Complete Section B of the questionnaire for Test 4.4.

34. When finished, power down the units.

The procedure for Part B, Test 4.5 is as follows.

35. Disconnect the downstream end of the ISP1 router-Downstream End User router connection.

36. Network the ISP2 router-Downstream End User router together.
Figure 3.17. Model 4.5 Test Topology.
37. Power up the units.

38. Configure the routers as needed.

39. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

40. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

41. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

42. Complete Section B of the questionnaire for Test 4.5.

43. When finished, power down the units.

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**Scenario 5**

In Scenario 5, Part A will attempt to emulate a local telecommunications market served by only a public MAN between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

**Part A.**

The procedure for Part A, Test 5.1 is as follows.

1. Secure and situate the following units.
a. Five computers to be used as routers for an Upstream End User, Tier I ISP, Public MAN, ISP2, and Downstream End User.

b. One switch for the Tier I ISP router.

c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

   a. Upstream End User workstation-Upstream End User router.

   b. Upstream End User router-Tier I ISP router.

   c. Tier I ISP router-Public MAN router.

   d. Public MAN router-Downstream End User router.

   e. Downstream End User router-Downstream End User workstation.
Figure 3.18. Model 5.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 5.1.

7. When finished, power down the units.

Part B.

The procedure for Part B, Test 5.2 is as follows.

8. Disconnect the Upstream End User router and the Public MAN router from the Tier I ISP router.

9. Network a switch to the Tier I ISP router.

10. Network the Upstream End User router, Public MAN router, and ISP2 router to the Tier I router switch.

11. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User router.
Figure 3.19. Model 5.2 Test Topology.
12. Power up the units.

13. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.

14. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

15. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

16. Complete Section B of the questionnaire for Test 5.2.

17. When finished, power down the units.

The procedure for Part B, Test 5.3 is as follows.

18. Disconnect the downstream end of the Public MAN router-Downstream End User router connection.

19. Network the ISP2 router-Downstream End User router together.
Figure 3.20. Model 5.3 Test Topology.
20. Power up the units.

21. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.

22. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

23. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

24. Complete Section B of the questionnaire for Test 5.3.

25. When finished, power down the units.

Scenario 6

In Scenario 6, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a Public MAN between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

The procedure for Part A, Test 6.1 is as follows.

1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
b. One switch for the Tier I ISP router.

c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

a. Upstream End User workstation-Upstream End User router.

b. Upstream End User router-Tier I ISP router switch.

c. Tier I ISP router switch-LEC router.

d. Tier I ISP router switch-CC router.

e. Tier I ISP router switch-Public MAN router.

f. Tier I ISP router switch-ISP1 router.

g. LEC router-Downstream End User router.

h. Connect a cable to the CC router destined to but not connecting with the Downstream End User router.

i. Connect a cable to the Public MAN router destined to but not connecting with the Downstream End User router.

j. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.

k. Downstream End User router-Downstream End User workstation.
Figure 3.21. Model 6.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Downstream End User router-Downstream End User workstation.


7. When finished, power down the units.

Part B.

The procedure for Part B, Test 6.2 is as follows.

8. Network the Tier I ISP router-ISP2 router together.

9. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User router.
Figure 3.22. Model 6.2 Test Topology.
10. Power up the units.

11. Configure the routers as needed.

12. Using the network analysis software, record whether or not the Tier I ISP and Downstream End User routers acknowledge the ISP2 router.

13. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

14. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

15. Complete Section B of the questionnaire.

16. When finished, power down the units.

The procedure for Part B, Test 6.3 is as follows.

17. Disconnect the downstream end of the LEC router-Downstream End User router connection.

18. Network the CC router-Downstream End User router together.
Figure 3.23. Model 6.3 Test Topology.
19. Power up the units.

20. Configure the routers as needed.

21. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the CC router as an additional route.

22. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

23. Complete Section B of the questionnaire for Test 6.3.

24. When finished, power down the units.

The procedure for Part B, Test 6.4 is as follows.

25. Disconnect the downstream end of the CC router-Downstream End User router connection.

Figure 3.24. Model 6.4 Test Topology.
27. Power up the units.

28. Configure the routers as needed.

29. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Public MAN router as an additional route.

30. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

31. Complete Section B of the questionnaire for Test 6.4.

32. When finished, power down the units.

The procedure for Part B, Test 6.5 is as follows.

33. Disconnect the downstream end of the Public MAN router-Downstream End User router connection.

34. Network the ISP1 router-Downstream End User router together.
Figure 3.25. Model 6.5 Test Topology.
35. Power up the units.

36. Configure the routers as needed.

37. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP1 router as an additional route.

38. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

39. Complete Section B of the questionnaire for Test 6.5.

40. When finished, power down the units.

The procedure for Part B, Test 6.6 is as follows.

41. Disconnect the downstream end of the ISP1 router-Downstream End User router connection.

42. Network the ISP2 router-Downstream End User router together.
Figure 3.26. Model 6.6 Test Topology.
43. Power up the units.
44. Configure the routers as needed.
45. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.
46. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.
47. Complete Section B of the questionnaire for Test 6.6.
48. When finished, power down the units.

Scenario 7

In Scenario 7, Part A will attempt to emulate a local telecommunications market including a Public MAN dominated by two duopolistic private providers between the upstream providers to the end users. In Part B, competitor ISP2 will then attempt to enter the local and last mile markets. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2. Note – only a representative sample of all of the possible last mile connection combinations will be tested.

Part A.

The procedure for Part A, Test 7.1 is as follows.

1. Secure and situate the following units.
a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.

b. One switch for the Tier I ISP router.

c. Three computers to be used as workstation clients of the Upstream End User, Downstream End User #1, and Downstream End User #2.

2. Network the following units together.

a. Upstream End User workstation-Upstream End User router.

b. Upstream End User router-Tier I ISP router switch.

c. Tier I ISP router switch-LEC router.

d. Tier I ISP router switch-Public MAN router.

e. Tier I ISP router switch-ISP1 router.

f. Tier I ISP router switch-CC router.

g. LEC router-Downstream End User router.

h. CC router-Downstream End User Workstation #2.

i. Connect a cable to the Public MAN router destined to but not connecting with the Downstream End User router.

j. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User Workstation #2.

k. Downstream End User router-Downstream End User workstation #1.
Figure 3.27. Model 7.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User Workstation #2.

6. Complete Section A of the questionnaire for Test 7.1.

7. When finished, power down the units.

Part B.

The procedure for Part B, Test 7.2 is as follows.

8. Network the Tier I ISP router switch-ISP2 router together.

9. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User Workstation #2.
Figure 3.28. Model 7.2 Test Topology.
10.  Power up the units.
11.  Configure the routers as needed.
12.  Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.
13.  Attempt to configure the Tier I ISP router to utilize the ISP2 router as an additional route.
14.  Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
    b.  Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation #2.
15.  Complete Section B of the questionnaire for Test 7.2.
16.  When finished, power down the units.

The procedure for Part B, Test 7.3 is as follows.
17.  Disconnect the downstream end of the LEC router-Downstream End User router connection.
18.  Disconnect the downstream end of the CC router-Downstream End User Workstation #2 connection.
20.  Network the ISP2 router-Downstream End User Workstation #2 together.
Figure 3.29. Model 7.3 Test Topology.
21. Power up the units.
22. Configure the routers as needed.
23. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.
24. Attempt to configure the Tier I ISP router to utilize the ISP2 router as an additional route.
25. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User workstation #2.
26. Complete Section B of the questionnaire for Test 7.3.
27. When finished, power down the units.

Part C.
The procedure for Part C, Test 7.4 is as follows.
28. Disconnect the downstream end of the Public MAN router-Downstream End User router connection.
29. Disconnect the downstream end of the ISP2 router-Downstream End User Workstation #2 connection.
30. Network the LEC router-Downstream End User router together.
31. Network the CC router-Downstream End User Workstation #2 together.
32. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.30. Model 7.4 Test Topology.
33. Power up the units.

34. Configure the routers as needed.

35. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.

36. Attempt to configure the Tier I ISP router to utilize the Google router as an additional route.

37. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation #2.

38. Complete Section C of the questionnaire for Test 7.4.

39. When finished, power down the units.

*Scenario 8*

In Scenario 8, Part A will attempt to emulate a local telecommunications market including a public MAN dominated by a monopolistic private provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

**Part A.**

The procedure for Test 8.1 is as follows.
1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. One switch for the Tier I ISP router.
   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router.
   d. Tier I ISP router switch-CC router.
   e. Tier I ISP router switch-Public MAN router.
   f. Tier I ISP router switch-ISP1 router.
   g. LEC router-Downstream End User router.
   h. Connect a cable to the CC router destined to but not connecting with the Downstream End User router.
   i. Connect a cable to the Public MAN router destined to but not connecting with the Downstream End User router.
   j. Connect a cable to the ISP1 router destined to but not connecting with the Downstream End User router.
   k. Downstream End User router-Downstream End User workstation.
Figure 3.31. Model 8.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Downstream End User router-Downstream End User workstation.


7. When finished, power down the units.

Part B.

The procedure for Test 8.2 is as follows.

8. Network the Tier I ISP router switch-ISP2 router together.

9. Connect a cable to the ISP2 router destined to but not connecting with the Downstream End User router.
Figure 3.32. Model 8.2 Test Topology.
10. Power up the units.

11. Configure the routers as needed.

12. Using the network analysis software, record whether or not the Tier I ISP router
acknowledges the ISP2 router.

13. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2
router as an additional route.

14. Use network analysis software to confirm the connected units recognize the model’s
routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC
      router-Downstream End User router-Downstream End User workstation.

15. Complete Section B of the questionnaire for Test 8.2.

16. When finished, power down the units.

The procedure for Part B, Test 8.3 is as follows.

17. Disconnect the downstream end of the LEC router-Downstream End User router
connection.

18. Network the CC router-Downstream End User router together.
Figure 3.33. Model 8.3 Test Topology.
19. Power up the units.

20. Configure the routers as needed.

21. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the CC router.

22. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the CC router as an additional route.

23. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

24. Complete Section B of the questionnaire for Test 8.3.

25. When finished, power down the units.

The procedure for Part B, Test 8.4 is as follows.

26. Disconnect the downstream end of the CC router-Downstream End User router connection.

27. Network the Public MAN router-Downstream End User router together.
Figure 3.34. Model 8.4 Test Topology.
28. Power up the units.

29. Configure the routers as needed.

30. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Public MAN router.

31. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Public MAN router as an additional route.

32. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

33. Complete Section B of the questionnaire for Test 8.4.

34. When finished, power down the units.

The procedure for Part B, Test 8.5 is as follows.

35. Disconnect the downstream end of the Public MAN router-Downstream End User router connection.

36. Network the ISP1 router-Downstream End User router together.
Figure 3.35. Model 8.5 Test Topology.
37. Power up the units.
38. Configure the routers as needed.
39. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP1 router.
40. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP1 router as an additional route.
41. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
42. Complete Section B of the questionnaire for Test 8.5.
43. When finished, power down the units.

The procedure for Part B, Test 8.6 is as follows.
44. Disconnect the downstream end of the ISP1 router-Downstream End User router connection.
45. Network the ISP2 router-Downstream End User router together.
Figure 3.36. Model 8.6 Test Topology.
46. Power up the units.

47. Configure the routers as needed.

48. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

49. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

50. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

51. Complete Section B of the questionnaire for Test 8.6.

52. When finished, power down the units.

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**Scenario 9**

In Scenario 9, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN between the upstream providers to the end users, and where all providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

**Part A.**

The procedure for Part A, Test 9.1 is as follows.

1. Secure and situate the following units.
a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and the Downstream End User.

b. Six switches for the Tier I ISP, LEC, CC, Public MAN, ISP1, and ISP2.

c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

a. Upstream End User workstation-Upstream End User router.

b. Upstream End User router-Tier I ISP router switch.

c. Tier I ISP router switch-LEC router switch.

d. Tier I ISP router switch-CC router switch.

e. Tier I ISP router switch-Public MAN router switch.

f. Tier I ISP router switch-ISP1 router switch.

g. LEC router switch-CC router switch.

h. LEC router switch-Public MAN router switch.

i. LEC router switch-ISP1 router switch.

j. CC router switch-Public MAN router switch.

k. CC router switch-ISP1 router switch.

l. Public MAN router switch-ISP1 router switch.

m. LEC router switch-Downstream End User router switch.

n. Connect a cable to the CC router switch destined to but not connecting with the Downstream End User router.

o. Connect a cable to the Public MAN router switch destined to but not connecting with the Downstream End User router.
p. Connect a cable to the ISP1 router switch destined to but not connecting with the Downstream End User router.

q. Downstream End User router-Downstream End User workstation.
Figure 3.37. Model 9.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Downstream End User router-Downstream End User workstation.


7. When finished, power down the units.

Part B.

8. The procedure for Part B, Test 9.2 is as follows.

9. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
   f. Connect a cable to the ISP2 router switch destined to but not connecting with the
      Downstream End User router.
Figure 3.38. Model 9.2 Test Topology.
10. Power up the units.
11. Configure the routers as needed.
12. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.
13. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.
14. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
15. Complete Section B of the questionnaire for Test 9.2.
16. When finished, power down the units.

Scenario 10

In Scenario 10, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by two duopolistic private providers, and where all providers can optionally access and use each other’s local market systems. The two duopolistic private providers are the only last mile providers. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A

The procedure for Part A, Test 10.1 is as follows.
1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. Seven switches for the Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User routers.
   c. Three computers to be used as workstation clients of the Upstream End User, Downstream End User #1, and Downstream End User #2.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router switch.
   d. Tier I ISP router switch-CC router switch.
   e. Tier I ISP router switch-Public MAN router switch.
   f. Tier I ISP router switch-ISP1 router switch.
   g. LEC router switch-CC router switch.
   h. LEC router switch-Public MAN router switch.
   i. LEC router switch-ISP1 router switch.
   j. CC router switch-Public MAN router switch.
   k. CC router switch-ISP1 router switch.
   l. Public MAN router switch-ISP1 router switch.
   m. LEC router switch-Downstream End User router switch.
   n. CC router switch-Downstream End User workstation #2.
   o. Downstream End User router switch-Downstream End User workstation #1.
Figure 3.39. Model 10.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation 2.

6. Complete Section A of the questionnaire for Test 10.1.

7. Power down the units.

Part B.

The procedure for Part B, Test 10.2 is as follows.

8. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
Figure 3.40. Model 10.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   
   
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation 2.

14. Complete Section B of the questionnaire for Test 10.2.

15. When finished, power down the units.

Part C.

The procedure for Part C, Test 10.3 is as follows.

16. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.

17. Connect a cable to the Google router destined to but not connecting with the Downstream End User workstation #2.
Figure 3.41. Model 10.3 Test Topology.
18. Power up the units.
19. Configure the routers as needed.
20. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.
21. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.
22. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   b. Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation 2.
23. Complete Section C of the questionnaire for Test 10.3.
24. When finished, power down the units.

Scenario 11

In Scenario 11, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by a monopolistic private provider, and where all providers can optionally access and use each other’s local market systems. The monopolistic private provider is the only last mile provider. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.
Part A.

The procedure for Part A, Test 11.1 is as follows.

1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. Six switches for the Tier I ISP, LEC, CC, Public MAN, ISP1, and ISP2 routers.
   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router switch.
   d. Tier I ISP router switch-CC router switch.
   e. Tier I ISP router switch-Public MAN router switch.
   f. Tier I ISP router switch-ISP1 router switch.
   g. LEC router switch-CC router switch.
   h. LEC router switch-Public MAN router switch.
   i. LEC router switch-ISP1 router switch.
   j. CC router switch-Public MAN router switch.
   k. CC router switch-ISP1 router switch.
   l. Public MAN router switch-ISP1 router switch.
   m. LEC router switch-Downstream End User router.
   n. Downstream End User router-Downstream End User workstation.
Figure 3.42. Model 11.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Downstream End User router-Downstream End User workstation.


7. Power down the units.

Part B.

The procedure for Part B, Test 11.2 is as follows.

8. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
Figure 3.43. Model 11.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

14. Complete Section B of the questionnaire for Test 11.2.

15. When finished, power down the units.

Part C.

The procedure for Part C, Test 11.3 is as follows.

16. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.44. Model 11.3 Test Topology.
17. Power up the units.
18. Configure the routers as needed.
19. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.
20. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.
21. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
22. Complete Section C of the questionnaire for Test 11.3.
23. When finished, power down the units.

_scenario_12_

In Scenario 12, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by the monopolistic public MAN, and where all providers can optionally access and use each other’s local market systems. The monopolistic public MAN is the only last mile provider. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

The procedure for Part A, Test 12.1 is as follows.
1. Secure and situate the following units.

   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.

   b. Seven switches for the Tier I ISP, LEC, CC, Public MAN, ISP1, and ISP2 routers.

   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

   a. Upstream End User workstation-Upstream End User router.

   b. Upstream End User router-Tier I ISP router switch.

   c. Tier I ISP router switch-LEC router switch.

   d. Tier I ISP router switch-CC router switch.

   e. Tier I ISP router switch-Public MAN router switch.

   f. Tier I ISP router switch-ISP1 router switch.

   g. LEC router switch-CC router switch.

   h. LEC router switch-Public MAN router switch.

   i. LEC router switch-ISP1 router switch.

   j. CC router switch-Public MAN router switch.

   k. CC router switch-ISP1 router switch.

   l. Public MAN router switch-ISP1 router switch.

   m. Public MAN router switch-Downstream End User router.

   n. Downstream End User router-Downstream End User workstation.
Figure 3.45. Model 12.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 12.1.

7. When finished, power down the units.

Part B.

The procedure for Part B, Test 12.2 is as follows.

8. Network the following units together.

   a. Tier I ISP router switch-ISP2 router switch.

   b. ISP2 router switch-LEC router switch.

   c. ISP2 router switch-CC router switch.

   d. ISP2 router switch-Public MAN router switch.

   e. ISP2 router switch-ISP1 router switch.
Figure 3.46. Model 12.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

14. Complete Section B of the questionnaire for Test 12.2.

15. When finished, power down the units.

Part C.

The procedure for Part C, Test 12.3 is as follows.

16. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.47. Model 12.3 Test Topology.
17. Power up the units.

18. Configure the routers as needed.

19. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.

20. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.

21. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

22. Complete Section C of the questionnaire for Test 12.3.

23. When finished, power down the units.

**Scenario 13**

In Scenario 13, Part A will attempt to emulate a local telecommunications market served by only a public MAN. The public MAN is the sole last mile system provider but does not provide upstream carriage service. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

**Part A.**

The procedure for Part A, Test 13.1 is as follows.

1. Secure and situate the following units.
a. Five computers to be used as routers for an Upstream End User, Tier I ISP, Public MAN, ISP2, and Downstream End User.

b. One switch for the ISP2 router.

c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.

   a. Upstream End User workstation-Upstream End User router.

   b. Upstream End User router-Tier I ISP router.

   c. Public MAN router-Downstream End User router.

   d. Downstream End User router-Downstream End User workstation.
Figure 3.48. Model 13.1 Base Topology.
3. Power up the units.
4. Configure the routers as needed.
5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
7. When finished, power down the units.

Part B.

The procedure for Part B, Test 13.2 is as follows.
8. Network the following units together.
   a. Tier I ISP router-ISP2 router switch.
   b. Public MAN router-ISP2 router switch.
   c. Connect a cable to the ISP2 router switch destined to but not connecting with the Downstream End User Router.
Figure 3.49. Model 13.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Public MAN router-Downstream End User router-Downstream End User workstation.


15. When finished, power down the units.

The procedure for Part B, Test 13.3 is as follows.

16. Disconnect the downstream end of the Public MAN router-Downstream End User router connection.

17. Network the ISP2 router switch-Downstream End User router together.
Figure 3.50. Model 13.3 Test Topology.
18. Power up the units.

19. Configure the routers as needed.

20. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

21. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

22. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

23. Complete Section B of the questionnaire for Test 13.3.

24. When finished, power down the units.

Scenario 14

In Scenario 14, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN, where the Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

The procedure for Part A, Test 14.1 is as follows.
1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. Six switches for the Tier I ISP, LEC, CC, Public MAN, ISP1, and ISP2 routers.
   c. Two computers to be used as workstation clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router switch.
   d. Tier I ISP router switch-CC router switch.
   e. Tier I ISP router switch-Public MAN router switch.
   f. Tier I ISP router switch-ISP1 router switch.
   g. LEC router switch-CC router switch.
   h. LEC router switch-Public MAN router switch.
   i. LEC router switch-ISP1 router switch.
   j. CC router switch-Public MAN router switch.
   k. CC router switch-ISP1 router switch.
   l. Public MAN router switch-ISP1 router switch.
   m. Public MAN router switch-Downstream End User router.
   n. Downstream End User router-Downstream End User workstation.
Figure 3.51. Model 14.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Public MAN Router-Downstream End User router-Downstream End User workstation.


7. When finished, power down the units.

Part B.

The procedure for Part B, Test 14.2 is as follows.

8. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
Figure 3.52. Model 14.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN Router-Downstream End User router-Downstream End User workstation.


15. When finished, power down the units.

Part C.

The procedure for Part C, Test 14.3 is as follows.

16. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.53. Model 14.3 Test Topology.
17. Power up the units.

18. Configure the routers as needed.

19. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.

20. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.

21. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN Router-Downstream End User router-Downstream End User workstation.

22. Complete Section C of the questionnaire for Test 14.3.

23. When finished, power down the units.

**Scenario 15**

In Scenario 15, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN that is dominated by two private duopolistic providers. The Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.
Part A.

The procedure for Part A, Test 15.1 is as follows.

1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. Six switches for the Tier I ISP, LEC, CC, Public MAN, and ISP1, ISP2 routers.
   c. Two computers to be used as workstations for the clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router switch.
   d. Tier I ISP router switch-CC router switch.
   e. Tier I ISP router switch-ISP1 router switch.
   f. LEC router switch-CC router switch.
   g. LEC router switch-Public MAN router switch.
   h. LEC router switch-ISP1 router switch.
   i. CC router switch-Public MAN router switch.
   j. CC router switch-ISP1 router switch.
   k. ISP1 router switch-Public MAN router switch.
   l. Public MAN router switch-Downstream End User router.
   m. Downstream End User router-Downstream End User workstation.
Figure 3.54. Model 15.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Public MAN router-Downstream End User router-Downstream End User workstation.

6. Complete Section A of the questionnaire for Test 15.1.

7. When finished, power down the units.

---

Part B.

The procedure for Part B, Test 15.2 is as follows.

8. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
Figure 3.55. Model 15.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN router-Downstream End User router-Downstream End User workstation.

14. Complete Section B of the questionnaire for Test 15.2.

15. When finished, power down the units.

Part C.

16. The procedure for Part C, Test 15.3 is as follows.

17. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.56. Model 15.3 Test Topology.
18. Power up the units.

19. Configure the routers as needed.

20. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.

21. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.

22. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN router-Downstream End User router-Downstream End User workstation.

23. Complete Section C of the questionnaire for Test 15.3.

24. When finished, power down the units.

**Scenario 16**

In Scenario 16, Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN that is dominated by a private monopolistic provider. The Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.
Part A.

The procedure for Part A, Test 16.1 is as follows.

1. Secure and situate the following units.
   a. Eight computers to be used as routers for an Upstream End User, Tier I ISP, LEC, CC, Public MAN, ISP1, ISP2, and Downstream End User.
   b. Six switches for the Tier I ISP, LEC, CC, Public MAN, and ISP1, and ISP2 routers.
   c. Two computers to be used as workstations for the clients of the Upstream End User and Downstream End User routers.

2. Network the following units together.
   a. Upstream End User workstation-Upstream End User router.
   b. Upstream End User router-Tier I ISP router switch.
   c. Tier I ISP router switch-LEC router switch.
   d. Tier I ISP router switch-CC router switch.
   e. Tier I ISP router switch-ISP1 router switch.
   f. LEC router switch-CC router switch.
   g. LEC router switch-Public MAN router switch.
   h. LEC router switch-ISP1 router switch.
   i. CC router switch-Public MAN router switch.
   j. CC router switch-ISP1 router switch.
   k. ISP1 router switch-Public MAN router switch.
   l. Public MAN router switch-Downstream End User router.
   m. Downstream End User router-Downstream End User workstation.
Figure 3.57. Model 16.1 Base Topology.
3. Power up the units.

4. Configure the routers as needed.

5. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
      Public MAN router-Downstream End User router-Downstream End User workstation.


7. When finished, power down the units.

Part B.

The procedure for Part B, Test 16.2 is as follows.

8. Network the following units together.
   a. Tier I ISP router switch-ISP2 router switch.
   b. ISP2 router switch-LEC router switch.
   c. ISP2 router switch-CC router switch.
   d. ISP2 router switch-Public MAN router switch.
   e. ISP2 router switch-ISP1 router switch.
Figure 3.58. Model 16.2 Test Topology.
9. Power up the units.

10. Configure the routers as needed.

11. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the ISP2 router.

12. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the ISP2 router as an additional route.

13. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN router-Downstream End User router-Downstream End User workstation.


15. When finished, power down the units.

Part C.

The procedure for Part C, Test 16.3 is as follows.

16. Connect a cable to the Google router destined to but not connecting with the Downstream End User router.
Figure 3.59. Model 16.3 Test Topology.
17. Power up the units.

18. Configure the routers as needed.

19. Using the network analysis software, record whether or not the Tier I ISP router acknowledges the Google router.

20. Attempt to configure the Tier I ISP and Downstream End User routers to utilize the Google router as an additional route.

21. Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.
   a. Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Public MAN router-Downstream End User router-Downstream End User workstation.

22. Complete Section C of the questionnaire for Test 16.3.

23. When finished, power down the units.
CHAPTER IV: RESULTS

Trace file data generated by the end user workstations and certain observational data requested by the Ch. 3 Procedures and Scenario Questions (Appendix B - Scenario Questionnaire) were to be acquired (Appendix C - Data) for the analysis of each emulation’s validation and verification of its models.

Experiment Validation and Verification Data

Trace file data was requested by the Procedures for all of the models.

- Use network analysis software to confirm the connected units recognize the model’s routes, and record the results.

Data Acquisition Issues

The routers were thought to have been properly configured and wired correctly to reflect Model 1.1 and its projected routing table as follows.

1. Upstream End User Workstation 192.168.7.20
2. Upstream End User Router 192.168.7.1
3. Tier I ISP Router 192.168.4.1
4. LEC Router 192.168.6.1
5. Downstream End User Router 192.168.12.1
6. Downstream End User Workstation 192.168.7.20
The construct was documented visually in the following two photos (brightened 20% using Photoshop).

*Figure 4.1. Model 1.1 Test Topology.*
As a test, the Traceroute command was issued by the Upstream End User Workstation to access the Tier I ISP router being the next hop. However the request failed to recognize the Tier I ISP router as shown in an example of the output.

```
4-29-2013 21:58:23
Traceroute has started ...

traceroute to 192.168.4.1 (192.168.4.1), 64 hops max, 40 byte packets
  1  192.168.7.1 (192.168.7.1)  3.575 ms  17.337 ms  1.857 ms
  2  192.168.7.1 (192.168.7.1) 3008.866 ms !H  3005.810 ms !H 3006.944 ms !H
```
Numerous changes were made including reconfiguring the routers, swapping cables, swapping routers, using LAN port-WAN port and WAN port-LAN port router connections vs. LAN port-LAN port connections, and trying Traceroute from the downstream routers to the upstream routers, but the network was unable to have two neighbor routers recognize each other as required by the scenarios.

To confirm Traceroute itself and the workstation were not at fault, the Upstream End User Workstation was removed as a client of the Upstream End User router, connected to the researcher’s home Internet connection, had its IP changed from the static IP 192.168.7.20 to DHCP, and Traceroute was run with www.Google.com being the destination. The following route was generated.

```
4-29-2013 22:31:00
Traceroute has started ...

traceroute: Warning: www.google.com has multiple addresses; using 74.125.228.19
traceroute to www.google.com (74.125.228.19), 64 hops max, 40 byte packets
  1 192.168.2.1 (192.168.2.1)  0.824 ms  1.682 ms  0.289 ms
  2 10.15.44.1 (10.15.44.1)  1076.207 ms  62.182 ms  39.625 ms
  3 64-5-173-29.rev.omnicity.net (64.5.173.29)  195.465 ms  65.690 ms 110.043 ms
  4 68-142-163-1.rev.omnicity.net (68.142.163.1)  54.772 ms
       63.983 ms  21.990 ms
  5 rrcs-96-11-185-161.central.biz.rr.com (96.11.185.161)  39.543 ms
       980.867 ms  73.997 ms
  6 be14.clevohek-ccr01.mwrtn.rr.com (65.189.100.62)  73.069 ms
       60.793 ms  78.481 ms
  7 ae10-0.cr0.dca20.tbone.rr.com (107.14.19.14)  125.139 ms
       42.367 ms  84.075 ms
  8 ae-2-0.c1.nyc90.tbone.rr.com (66.109.1.49)  194.713 ms
```
The network was constructed and configured with only very minimal assistance received from any consultants, as most of them requested to provide service for the experiment, even with substantial compensation offered, failed to participate and/or help. The following was a rundown of the individuals and organizations that were contacted for consultation and the results (note - most of the actual names have been withheld).

- **Student** – A very gifted high school student quite literate in networking was requested to assist with the experiment. After his graduation from high school and enrolment into college a decade prior to the prospectus of this study being approved, he and his family left the area and were out of contact thereafter.

- **CTO #1** – A very knowledgeable chief technical officer of an area business indicated interest in the experiment, but later became more involved with his employer’s networks and was thereafter unavailable.

- **CTO #2** – A highly knowledgeable and experienced CTO of an actual ISP agreed to consult on the project, but a few years prior to the prospectus of this study being approved, he accepted a major business opportunity that understandably required an immense amount of his time. He subsequently ceased returning calls and emails.

- **Consultant #1** – A local independent consultant to numerous small businesses was interested in the project and even diagrammed a few configurations, but after numerous calls, emails,
and in-person meetings that in some later encounters were reduced to begging, he kept delaying his services saying he was too busy. Other friends of his said he had disappeared.

- WVU OIT – West Virginia University’s Office of Information Technology that provided some technical assistance to students was contacted for their potential assistance or if any of their staff could assist outside of their normal work. Their reply was as follows.

```
From: "Daniel L" <dlve@wifi7.com>
To: dlve@wifi7.com
Subject: Fwd: Dissertation Consult: *ref#24-587093
Date: Tue, 19 Mar 2013 05:49:46 -0400
----- Original Message ----- 
From: OITINCIDENT@mail.wvu.edu
To: dlve@wifi7.com
Cc: 
Sent: 26 Feb 2013 09:36:36 -0500
Subject: Dissertation Consult: *ref#24-587093
Hello,
I am sorry OIT does not offer anything like that.
OIT Help Desk
304-293-4444
*****The progress of your Incident can be obtained at http://oit.wvu.edu/helpdesk/selfservice. If you are responding with a screen shot please do not embed them within your message, please add them as an attachment.*****
ref#24-587093
Email sent using webmail from Omnicity
```

- Consultant #2 – A local firm that serves small and medium sized businesses (and known for their high prices) was visited in person to request their consultation. Their representative said the Linux operating system was rarely used, and that two consultants on staff that might know Linux and would call back later. The consultants never responded.
• Consultant #3 – A past acquaintance quite literate in Linux and networking was contacted via voice mail for his potential interest, but he never returned the call. Further followup with a mutual friend revealed he had an “episode” after marriage and fathering a child.

• Consultant #4 – The mutual friend then placed an advertisement on Facebook requesting consultation for the project, which was answered by a consultant having an extensive resume of projects and experience in operating systems and networking. He was interested in the project, but after reading a prospectus he later emailed that he was too busy with other clients. He did refer another independent consultant located in the area.

• Consultant #5 – An online background search showed the referred consultant was involved in a number of area projects, but he never returned a voice mail requesting his services.

• CTO #3 – A government official recommended a school system CTO as a possible consultant. After a couple requests by the official, the CTO replied she was not interested.

• Consultant #6 – The son of the aforementioned school system CTO was also identified as a consultant. The government official reported he too was not interested in the project.

• CTO #4 – A mutual friend who was once CTO of a medium-sized firm was contacted for his interest in the project. He never returned an email.

• Consultant #6 – Another local firm that served small and medium sized businesses (and known for advertising their services on local media outlets) was called and an initial meeting was scheduled for the next week due to their heavy workload. Upon arriving for the meeting, the consultant announced the meeting had been cancelled shortly after the initial call, and no future meeting was scheduled due again to their workload.

• CTO #5 – A government agency CTO was contacted by email and visited in person to explain the project and request their consultation. The CTO was pleasant but could not fully
understand the experiment, offered incomprehensible advice, and never seemingly understood the request for his consultation outside of work so as not to take up much of his time during official business and risk getting him in trouble.

• Consultant #7 – A Linux-literate consultant was interested in the project but also was very busy. He could only offer bits and pieces of information at a time, and his response time to calls and emails took up to a week at a time. He tried to reconfigure the scenarios to better reflect the actual end-to-end telecommunication industry including adding numerous market participants (Appendix D), but the network configurations were confusing, incomplete, and did not appear to make sense.

Internet searches and YouTube tutorials were a little helpful, but many of them featured different types of routers, various network configurations, few cases of connecting more than two routers, and most were primarily concerned with connecting routers and their clients to the Internet. The instructional quality of their presentations was also largely questionable.

The observation questions requesting verification and validation data for each scenario included the following.

• What are the constructs and conditions of the scenario?

During the experiment’s design phase, samples of actual hypothetical local and last mile wireline telecommunications markets were modeled into diagrams and grouped into related types of scenarios. Various factors including access restrictions, market control, and end user choices
were then added to each of the scenarios’ conditions. Those factors and conditions for each of the 16 scenarios served as responses to the question.

Other questions requesting verification and validation data for all Part A Base Models included the following.

- Describe what the model is trying to emulate.
- Comment upon the computer network emulation's conformity to the constructs and conditions.
- Do the connected units recognize each other?
- What is the potential routing table?
- Additional observations.

Data requested in all Part B Test Models included the following.

- Describe what the model is trying to emulate.
- Comment upon the computer network emulation's conformity to the constructs and conditions.
- Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?
- Do the connected units recognize each other?
- What is the potential routing table?
- Additional observations.
Data requested in all Part C Test Models where Google entered the market included the following.

- Describe what the model is trying to emulate.
- Comment upon the computer network emulation's conformity to the constructs and conditions.
- Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?
- Do the connected units recognize each other?
- What is the potential routing table?
- Additional observations.

The models’ routes from each procedure and the resulting trace file data were to accompany each of the Part A, B, and C observation question responses.

- Do the connected units recognize each other?

For example, Scenario 1, Part A, Test 1.1’s model used the following route.

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-
Downstream End User router-Downstream End User workstation.
The resulting trace file from the end user workstation should have shown the route previously listed, but as mentioned Traceroute never got past the first hop being the Upstream End User router. Both were to have been combined with the observation question and response.

- Do the connected units recognize each other? (was to be “Yes”, but due to the routing failure was listed as “No”).

Data acquired for the remaining observation questions was further described as follows.

- Describe what the model is trying to emulate.

The question requested additional information regarding the particular model being emulated. Observations included how well served the local market was, the situation that occurred when ISP2 entered the market, what provider the end user(s) chose as their upstream provider, what providers end user(s) could not choose and why, local market interconnectivity among providers, etc.

- Comment upon the computer network emulation's conformity to the constructs and conditions.

The question received responses regarding if the routers and end user workstations were successfully networked together and functioned per the model and the scenario. Any unavailable routes were to be confirmed as disconnections required by the model’s construct and conditions.
• What is the potential routing table?

The question requested all of the potential combinations of routings between the Upstream End User to the Downstream End User(s). As the number of providers, the number of last mile networks, and local market interconnections among providers grew, so too did the routing table to account for all of the permutations.

• Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?  
• Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

The Part B and C related questions requested verification that those providers’ routers were acknowledged by the network’s other routers.

Open Access and Competition Data

Other observational data requested by the Scenario Questions (Appendix B) was however successfully acquired (Appendix C) pertaining to the open access and competition concerns of the research question. The data acquired for each scenario model included the following.

• What are the constructs and conditions of the scenario?

During the design phase, samples of actual and hypothetical local and last mile wireline telecommunications markets were modeled into diagrams and grouped into related types of scenarios. Various factors including access restrictions, market control, and end user choices
were then added to each of the scenarios’ conditions. Those factors and conditions for each of the 16 scenarios served as responses to the question.

Other questions requesting open access and competition data for all Part A Base Models included the following.

- Describe what the model is trying to emulate.
- Comment upon the computer network emulation's conformity to the constructs and conditions.
- Describe the market competition between the Tier I ISP and the downstream end users.
- Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
- Indicate the business type (for-profit or non-profit) for each provider.
- Is there a potential conflict with differing business types within the local and last mile markets?
- Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?
- What fraction(s) or percentage(s) of the local and last mile markets does each provider have?
- How do the providers access downstream end users?
- Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
- Additional observations.

Data requested in all Part B Test Models included the following.
• Describe what the model is trying to emulate.

• Comment upon the computer network emulation's conformity to the constructs and conditions.

• Describe the market competition between the Tier I ISP and the downstream end users.

• Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

• Indicate the business type (for-profit or non-profit) for each provider.

• Is there a potential conflict with differing business types within the local and last mile markets?

• Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

• What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

• Does adding the ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

• Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

• How do the providers access downstream end users?

• Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

• Additional observations.

Data requested in all Part C Test Models where Google entered the market included the following.
• Describe what the model is trying to emulate.
• Comment upon the computer network emulation's conformity to the constructs and conditions.
• Describe the market competition between the Tier I ISP and the downstream end users.
• Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
• Indicate the business type (for-profit or non-profit) for each provider.
• Is there a potential conflict with differing business types within the local and last mile markets?
• Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?
• What fraction(s) or percentage(s) of the local and last mile markets does each provider have?
• Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?
• Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?
• How do the providers access downstream end users?
• Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
• Additional observations.

Data acquired for the observation questions was further described as follows.

• Describe what the model is trying to emulate.
The responses provided additional information regarding the particular model being emulated. Observations included how well served the local market was, the situation that occurred when ISP2 entered the market, what provider the end user(s) chose as their upstream provider, what providers end user(s) could not choose and why, local market interconnectivity among providers, etc.

- Comment upon the computer network emulation's conformity to the constructs and conditions.

Responses were to regard if the routers and end user workstations had been successfully networked together and functioned per the model and the scenario. Any unavailable routes were to be confirmed as disconnections required by the model’s construct and conditions. However because the routers could not be configured to network with each other, the emulations could not conform to the constructs and conditions.

- Describe the market competition between the Tier I ISP and the downstream end users.

Responses to the question identified the middle mile, local, and last mile market participants and the degree of competition in each market. Additional observations noted the effects of limited competition such as restricted marketplace entry for potential competitors.

- Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
The responses identified the construct for each providers’ local and last mile networks.

- Indicate the business type (for-profit or non-profit) for each provider.

Public MANs present in some models were typically considered non-profit government enterprises, while the other providers were usually for-profit corporations.

- Is there a potential conflict with differing business types within the local and last mile markets?

For those models where a Public MAN was in the same market with for-profit providers, there was the potential for business-related conflicts.

- Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

Local and/or last mile market control by one or more providers depended upon the construct of the model. Providers highlighted in bold type in the model’s topology had control and were noted as such. If providers did not extend their own last mile networks to the downstream end users (whether the end users subscribed to them or not), then the provider(s) with their own last mile networks were assumed to have potential control of that market. If the local market providers were interconnected, the providers without last mile networks could technically access end users via third party providers’ last mile networks if they were afforded equal open access.
One or more incumbent providers having control of the markets, and possibly together with other providers not having significant control in the market, could jointly collude to restrict further market entry by other potential competitors. The Public MAN could dominate markets given their government backing and potential control over public rights of way, poles, streets, etc.

- What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

In a truly competitive market, provider market shares could fluctuate between 100% for one provider and 0% for other providers, and vice versa. In lesser competitive markets, a monopoly provider will always have a majority of the market share over the other competitors, and duopoly providers will always have a combined majority of the market share over the other competitors. The market share split ranges also depended upon the number of competitors in each model.

- How do the providers access downstream end users?

Providers accessed the downstream end users either via their own last mile networks or via access to third party providers’ networks.

- Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

If the local market providers had their own last mile networks there was no concern for equal access. However if they did not and had to share local interconnections to other providers and
use their last mile networks then there was a concern of issues including access, discrimination, pricing, etc.

• Additional observations.

Responses to the question included traffic sharing issues among local market providers, how a Public MAN without its own last mile network might not technically qualify as a public MAN, the potential for a Public MAN to solely provide openly accessible last mile service without engaging in competitive local market service, the potential for Downstream End User 1 to use its router to switch among providers it currently subscribed to, etc.

Parts B and C had the following related questions.

• Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?
• Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

Responses were to verify that those providers’ routers were acknowledged by the network’s other routers, and if so it confirmed that those routers emulated the providers entering and providing service in the local market.

Data Categorization

Qualitative data is somewhat more difficult to present than quantitative data. Categorization of the data into various groupings could however assist with comparisons and
further analyses. Regarding topology groupings, Part A of the scenarios resulted in data from the Base models, Part B resulted in data featuring the entry of ISP2 and Google as ISP2 in some cases, and Part C resulted in data featuring the entry of only Google. Models in both Parts B and C featured more complex topologies than the Part A base models thereby yielding more data than Part A. Models with low numbers of providers kept those markets relatively “under-served” and resulted in less data than models with higher numbers of providers in the markets that were increasingly better-served. In some models the LEC and Public MAN were local market monopolies, and in other models both LEC and CC were a local market duopoly. Providers were highlighted in bold if they had excessive control of the local market, with one highlighted provider per market having a monopoly and two highlighted providers per market having a duopoly. (Oligopolies while commonplace in telecommunications and other markets were not modeled for this study.) Models without monopolies and duopolies in the local market were considered to be competitive. Some models featuring only one or two providers were not designated as monopolies or duopolies. The rationale was in those scenarios the providers were actually competitive, and due to various factors (capitalization, political power, etc.) they could not control the market or fend off future competition. Those markets were considered to be more easily enterable by competitors.

Each scenario featured an ISP2 or no ISP2 and Google or no Google in their models, while all of the later scenarios featured a Public MAN. Those three providers had distinctive market influences – all added to the market competition, the Public MAN may have enjoyed certain advantages as a public sector provider, and Google could completely dominate even a previously monopolized market.
A local market provider without its own upstream and/or downstream networks and being required to use third party networks was subject to potential discrimination and control by the other providers. Access from a local market provider to the Tier I market provider, and from a local market provider to the End Users, ranged among the following.

- No access.
- Access via a third party provider.
- Access via multiple third party providers.
- Access via its own lines.
- Access via multiple third party providers and its own lines.

Each model featured at least one and up to five last mile providers. Last mile lines were monopolized or duopolized unless other providers also owned and administered their own last mile lines, whereupon the last mile market would be more competitive. If a provider owned and operated its own lines to end users, they were considered to provide both infrastructure and service (the DubLink conduit-only infrastructure provider case discussed in the literature review was not included in the scenarios).

Market Participants

Data regarding the market participants could possibly be categorized. Generally the scenarios examined local markets with providers ranging among the following.
• LEC only.
• Public MAN only.
• Various combinations of up to five providers.
• LEC, CC, Public MAN, ISP1, and ISP2.
• LEC, CC, Public MAN, ISP1, and Google.

**Upstream Network Segment Providers**

All models featured an Upstream End User, Upstream End User Router, and Tier I ISP Router ordered in a linear configuration designed to standardize those upstream markets across all models and eliminate the need for additional variant data and analysis on those providers. The Tier I ISP was always connected to local providers except in Models 13.1 - 16.2 where it deliberately was not connected to the Public MAN.

**LEC and CC**

LEC and CC were modeled in numerous scenarios as typical incumbents. In some models the LEC was in a competitive market even as the sole provider. Usually though the LEC enjoyed a monopoly in the local and/or last mile market. (The size and power of an LEC could be correlated to the range of competitiveness of the market, i.e., a larger LEC was usually able to monopolize a market and defend itself from competitors.) Usually LEC and CC provided their own last mile system types. This resulted in each potentially having monopolies over the particular wireline type. Regardless, data could be transmitted over either type, so the wireline type differences were not modeled. The LEC’s main competition was usually from CC, thus if both were participating in the same markets, they could have a “double monopoly” (over
wireline types), or essentially a duopoly (over provided data). LEC and/or CC may or may not have interconnected with other providers in the local market. Such interconnections could have been used on an equal basis for redundancy and emergency purposes; however either could have possibly tried to discriminate against other providers if they were forced by say governments to “open access” their local and last mile lines. In some cases LEC and/or CC could also be the Tier I ISP, potentially vertically integrating the backbone provider, middle mile, local provider, and/or last mile market segments. (Such integration should be recognized but an analysis of the structure and data was beyond the scope of this report.)

**ISP1**

ISP1 was modeled as a local market competitor to the LEC and/or CC incumbents, although in numerous scenarios it was also a local market incumbent. A number of models featured ISP1 providing its own last mile network, however in reality independent ISPs typically refrained from constructing their own last mile networks and instead tried to use other providers’ networks to access end users. As discussed, such access via third party providers to end users could have been discretionary and restrictive, particularly in markets dominated by one or more incumbent providers. Such ISP1 providers were usually at a disadvantage to the incumbents in the local and last mile markets.

**ISP2**

ISP2 joined the local market as a competitive provider in each scenario’s Part B and in some other variants. Once entering the local market, it was then concerned with upstream and downstream access and possibly local marker interconnectivity. As discussed with ISP1’s,
upstream and downstream access via third party providers could be discretionary and restrictive, particularly in markets dominated by incumbent providers. Consequently such ISP2 providers were also usually at a disadvantage in the local and last mile markets. As discussed in the literature review, there was much advocacy for ISP2-like competitors to enter local markets. The popular solution was for governments to mandate forced access upon other providers’ networks vs. the challenge of ISP2s constructing from scratch and administering their own upstream, local market interconnections, and/or last mile networks.

Public MAN

A Public MAN provider was introduced in Scenarios 5 - 16. In some models the Public MAN was featured as a regular competitive ISP with both upstream and last mile connections; however in Models 13.1 – 16.3 it was without an upstream connection to Tier I ISP and therefore had to rely upon other providers for upstream connectivity if they were agreeable to local market interconnections. The Public MAN was the sole last mile provider in some models while in others it was without a last mile connection to one or both end users and therefore had to rely upon other providers for last mile connectivity if they were agreeable to local market interconnections. In theory if a Public MAN does not own and administer its own last mile network and must acquire access via a third party’s last mile network for service provision, it may risk being considered a true public MAN. In some models the Public MAN was the sole local market provider but the market remained competitive; competed against monopolists, duopolists, and equal competition; and was a monopolistic ISP vs. other providers in the local and/or last mile markets. In Models 13.2 – 16.3 the Public MAN had no upstream access of its own, was interconnected among the other local mile providers, and except for Part C cases was
the sole downstream last mile provider. The Public MAN could theoretically forgo being a local market ISP and instead act as an open access “bridge” so that other providers need not construct and administer their own last mile networks. Google’s own last mile network would be duplicative and inefficient if it had equal open access to the Public MAN’s local network and if its last mile featured sufficient speeds and capacities for their service provision.

Google

Google could substitute for ISP2 in most of the scenarios. However Google was be considered to be significantly different from standard ISPs entering the market as it most likely had the wherewithal to construct/extend its own middle mile network downstream, interconnect with other local market providers, and provide its own last mile network to most end users. Google could demonopolize any monopolized or duopolized last mile market by offering faster service at a fraction of the market price. Usually when Google entered a market it acquired significant market shares from incumbents and other competitors, and therefore could become a monopolist itself in the local and/or last mile markets. However Google had indicated it did not really want to be an ISP - it merely wanted faster and cheaper access and better service to end users in the markets, and it would provide ISP functions by itself to achieve those goals if necessary. Google was not likely to enter “unserved” markets investing in cutting edge infrastructure and providing services until it had entered other markets with uncompetitive incumbents and populated with more end users. Google was not only a major end user, but it had acquired its own backbone trunk lines and middle mile lines, and could somewhat be considered its own Tier I ISP as it created and extended its own WAN closer to the “edge”, i.e., downstream to the local market and end users. The scenarios and models did not represent that
construct, but it should be taken into consideration as more high end end users would likely emulate Google’s buildout and possibly compete and/or provide their own custom services in the local and last mile markets. Google recently purchased the Provo public MAN that was competing in a fairly well served market, though it would most likely not open access its local and last mile networks to those competitors.

**Downstream End Users**

Downstream End User 1 was assigned a router while Downstream End User 2 was not. DEU1 could therefore represent a business end user with a more powerful router and be able to connect with multiple providers potentially simultaneously and/or connect with multiple lines to a sole provider for increased throughput. DEU2 likely represented an average residential user with a basic router/switch and little or no need (at the present) for multiple simultaneous providers and/or multiple lines from a sole provider. Few actual constructs featured multiple providers serving end users with their own last mile networks, and typically end users were served by one type of wireline per provider. While the providers may have been well interconnected in some local markets, end users were modeled not to enjoy such redundancy in the last mile to the providers. (The topic is beyond the scope of this study, but it must be noted those models with sole last mile networks while more economically efficient as natural utilities were also more at risk technically particularly regarding downstream redundancy.)

**Model Filtering**

A question for qualitative studies was what to do with the data in the various groups. Perhaps a process of elimination by filtering out undesired models based upon the group types
(essentially simulating market restructuring) could help determine which model(s) were the most feasible, beneficial, and efficient per particular interest group. (As a quick reference aide for this discussion, just the models were copied from the scenarios into their own document and saved as Appendix E.) Such interest groups having their own goals and objectives could include the following.

- Downstream End Users.
- Upstream ASP End Users.
- Providers.
- Governments.
- Investors.
- Researchers.

Downstream End Users could be subdivided into those more literate, moderately literate, and less literate regarding their desires for local and last mile constructs. Literate end users might desire open access of the local market to maximize the number of potential providers; local market interconnectivity to ensure if their provider went down for some reason there was redundant access to others and to ensure their provider was able to route traffic upstream; a competitive local market for providers to offer their best services, speeds and least prices; and each provider owning their own last mile networks so in case of contingency the end user could switch quickly to an alternative provider. Lesser literate end users might not appreciate the issues as much unless they actually experienced the potential benefits of the restructuring.

Upstream Application Service Provider End Users could be divided into large end users (Google,
Facebook, Sony, etc.), medium, and small sizes. ASPs would likely want many of the same models that more literate Downstream End Users desired.

Providers could be divided among incumbents, competitors, for-profit/non-profit, and by sizes. Reserving non-profits for the following Government group, most for-profit incumbent providers would want models without forced access. They would want restrictions on competitors’ new last mile builds, but might consider using openly accessible neutral third party provider last mile networks. Others might advocate their continued control of both markets to better ensure continued profits. They might desire models with some local market interconnectivity in case of contingencies, or if they could control and discriminate the sharing. Incumbents would likely reject models increasing competition that would unnecessarily cause them to invest in increased speeds and services while lowering prices (and profit margins).

Smaller for-profit and/or competitive providers would likely advocate for forced access. They would want fewer restrictions on new competitive last mile builds, but might consider using openly accessible third party provider last mile networks more strongly than incumbents. Competitors would advocate less control of both markets. They might desire models with local market interconnectivity if there was less control and discrimination by incumbents in the sharing. Competitive providers would likely advocate models increasing competition that that could result in increased speeds and services while lowering prices and gaining some market shares.

Governments would likely advocate increased local market competition, but not necessarily for a large number of local providers (an “un-breakupable” oligopoly might suffice). They might advocate local market interconnectivity to assist providers with contingencies, but not if sharing increased costs or created other burdens upon providers. Depending upon their
political philosophical control at the time, governments could advocate forced access while sanctioning incumbent monopolies, or prohibit forced access respecting private property rights, and likewise still sanction incumbent monopolies. Australian-like market restructuring was unlikely in the U.S. at the time. Government enterprise Public MANs could enter markets as competitive providers even if the markets were fairly well served with no guarantee of acquiring necessary market shares to justify the enterprise. Governments could advocate a Public MAN monopoly as a weapon vs. incumbent monopolies and duopolies thinking the markets would ultimately be demonopolized (or more likely oligopolized), but completely overlook an option of the Public MAN being restricted from competing in the local market and serving only as a sanctioned openly accessible last mile “bridge” provider. Thus a government’s position on models could greatly vary.

Likewise investors could be categorized into numerous groups per their interests including market control advocacy, long term vs. short term profits, stock and bond investing vs. mergers and acquisitions investing, investors in ASPs vs. providers, etc. Obviously those investors seeking shorter term profits and pricing powers would likely advocate the incumbent provider models.

Researchers including Yochai Benkler, Barbara van Schewick, Tim Wu, etc. as discussed had opinions on what models should be advocated per their personal methodologies of desired access and competition. This study sought to answer the research question’s concerns of creating open access and competition in the local and last mile market segments. Fundamental filtering examples would include seamless end-to-end connectivity; therefore Model 13.1 would be eliminated since its last mile market and Tier I market were disconnected. Some level of local market competition beyond one sole provider was desirable in most markets; therefore Models
1.1 (LEC was the sole provider) and Models 5.1 and 13.1 (the Public MAN was the provider) would also be eliminated. Filters directly addressing the open access and competition concerns would include the following.

(Researcher’s Note - After the models were originally designed, Google then announced it intended entering the local and last mile markets. Due to the importance of the development upon this study, Google was therefore retrofitted into the models. Method One of doing so was by doubling Google and ISP2, meaning in some scenarios “ISP2” could either represent ISP2 or Google as they were equally interchangeable - see Model 2.5. Method Two was by designing ISP2 and Google as separate models if the two were not equally interchangeable in a scenario, i.e., Model 3.3 vs. Model 3.4. For the following filtering cases, the Method One models had to be converted to Method Two models by adding a “dummy” model to the model sets within each scenario. Thus for instance in Scenario 9, Model 9.2 was converted to only ISP2, and Model 9.2G was added to accommodate Google as ISP2. In retrospect, all scenarios where Google could have entered the markets should have had separate ISP2 and Google models to avoid confusion.)

**Competitive Local Market**

Since competitive local markets were desired, models with monopolies and duopolies would be eliminated except those where Google entered the market. Thus the following models would be eliminated.

- 3.1, 3.2, 3.3.
- 4.1, 4.2, 4.3, 4.4, 4.5 (except 4.5G where Google is ISP2).
Maximized Number of Local Market Providers

End users would likely desire a choice among local market providers, with the more choices available the better. End User access to four or more providers in the local market could possibly reduce monopolies, duopolies, and oligopolies. Access between End Users and providers could be direct or indirect via local market interconnectivity among providers. End User access restricted to three or fewer providers would eliminate those models. Thus the following models would be eliminated.

• 1.1, 1.2, 1.3.
• 2.1.
• 3.1, 3.2, 3.3.
• 4.1.
• 5.1, 5.2, 5.3.
• 13.1, 13.2, 13.3.
Local Market Provider Interconnectivity

Providers in the local market are desired to be interconnected and able to assist other providers trying to reach their upstream and downstream end users. No discrimination would be permissible in the sharing. Thus the following models would be eliminated for the lack of interconnectivity.

• 1.1, 1.2, 1.3.
• 2.1, 2.2, 2.3, 2.4, 2.5, 2.5G.
• 3.1, 3.2, 3.3, 3.4.
• 4.1, 4.2, 4.3, 4.4, 4.5, 4.5G
• 5.1, 5.2, 5.3.
• 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.6G.
• 7.1, 7.2, 7.3, 7.4.
• 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.6G.
• 13.1.

Individual Provider-Owned Last Miles

One method of achieving competition in the last mile would be to require all local market providers own and administer their own last mile networks to all Ends Users that desired access and service. No provider could share their last mile lines with other providers. Local market providers would have to access at least one End User downstream with their own network. Thus the following models would be eliminated.
Multiple Last Miles

Instead of requiring every provider to own and administer their own last mile networks, more than one network could be provided in the market to at least one End User. Last mile networks could be shared by multiple providers. Thus the following models would be eliminated.

• 1.1.
• 5.1.
• 10.1, 10.2.
• 11.1, 11.2.
• 12.1, 12.2.
• 13.1.
• 14.1, 14.2.
• 15.1, 15.2.
• 16.1, 16.2.
Consolidated Last Mile Networks

Instead of multiple last mile networks in the market, one network could be provided to all End Users if the provider was a neutral asset-only (last mile-only) provider and its network was able to be equally accessible and shared by all local market providers. The last mile-only provider would own and administer the sole last mile network in the market. No monopoly or duopoly local market providers could be the sole last mile network provider. Thus the following models would be eliminated.

• 1.2, 1.3.
• 2.1, 2.2, 2.3, 2.4, 2.5, 2.5G.
• 3.1, 3.2, 3.3, 3.4.
• 4.1, 4.2, 4.3, 4.4, 4.5, 4.5G.
• 5.2, 5.3.
• 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.6G.
• 7.1, 7.2, 7.3, 7.4.
• 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.6G.
• 9.1, 9.2, 9.2G.
• 10.1, 10.2, 10.3.
• 11.1, 11.2, 11.3.
• 12.1, 12.2, 12.3.
• 13.2, 13.3.
• 14.3
• 15.3.
Non-Profit Last Mile

If a Public MAN was the sole last mile provider, it could administer the network as a non-profit government agency and not as a for-profit middleman. No other provider could own and administer its own last mile network in the market. The Public MAN could not be an ISP in the local market having or sharing in any market control (i.e., not a monopoly or duopoly). Thus the following models would be eliminated.

- 1.1, 1.2, 1.3.
- 2.1, 2.2, 2.3, 2.4, 2.5, 2.5G.
- 3.1, 3.2, 3.3, 3.4.
- 4.1, 4.2, 4.3, 4.4, 4.5, 4.5G.
- 5.2, 5.3.
- 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.6G.
- 7.1, 7.2, 7.3, 7.4.
- 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.6G.
- 9.1, 9.2, 9.2G.
- 10.1, 10.2, 10.3.
- 11.1, 11.2, 11.3.
- 12.1, 12.2, 12.3.
- 13.2, 13.3.
- 14.1, 14.2.
Model Filtering Tabulation

The model filtering results from the previous section were tabulated in a spreadsheet (Appendix F, Model Filtering Results). Eliminated models were represented with the number “1” in the correlating cells, and retained models had no data entered in the correlating cells.

Model Filtering Scoring

The most desirable unfiltered models in each filtering case could be added together, and the models with the lowest scores could be considered as better achieving open access and competition in the markets. However because the four last mile market filtering cases are all desirable for different reasons, they cannot be added together for a total score. Instead the first five filtering cases could all be added together for a subtotal, and then one of the four last mile filtering cases could be added to them one at a time to determine a grand total. The resulting four sets of grand total scores could then be compared amongst each other more appropriately. Those four sets of scores were tabulated in another spreadsheet (Appendix F, Model Filtering Scoring Results). Each of the four sets was entered into its own worksheet within the spreadsheet.
CHAPTER 5: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

Discussion

The experiment’s validation and verification trace file data were all expected to accurately correlate with the models, thereby verifying and validating the emulation, and would ensure to a high degree of confidence the experiment and data was replicable by other researchers. Facing a deadline to complete the study and degree program, a decision was made by the researcher to cease spending numerous valuable hours “hacking” the experiment’s routers in hopes of making them function properly, and instead forego the emulation and report the subsequent failure. In doing so, the experiment could not be verified or validated against errors and questions; thus the scenarios and models remained more conceptual vs. realistic.

The most likely cause for failure was a router configuration setting or proper cabling among the ports. Proper consultation would probably have detected the errors and enabled the routers to communicate properly with each other, which would have ruled out other issues. There was a very outside but highly probable chance that the units were faulty because they were remanufactured models, and could even have been counterfeit as they were purchased online from a California-based liquidator that was not primarily a computer equipment outlet. Such cases of fake equipment are not unheard of in the industry, particularly in Asia. On 4-30-2013, Pricewatch.com listed eight vendors selling the same routers for between $107 to $152 each including shipping. The ten routers purchased as a lot on 4-23-2013 cost $188 minus shipping. Also, all of the serial numbers were blackened out on the bottoms of the units but could still be read from an angle. Determining internal router errors or counterfeit units would require expert analysis or returning a sample to Netgear for their examination and determination.
The observation questionnaire requested a routing table of all of the possible routes available for each model. To ensure verification and validation, trace files of all the permutations could be run, but due to time constraints on the study only the routes requested in the procedure for each model topology (that also appeared in the routing table) were to be run and generated. Most of the routing table permutations per model were unnecessary to actually trace, as routers are programmed to automatically seek and take available routes with the fewest hops among other routers. Routes containing more hops (such as in the models with local market interconnections) would be more inefficient and increase traffic delays. Some longer routes might be necessary so as to aggregate small providers’ traffic before interconnecting with larger providers’ networks in the local and/or upstream markets due to potentially imbalanced peering agreements (traffic interchange policies).

The model filtering scoring data results from Appendix F for the Individual Provider-Owned Last Mile Networks showed the following models had total scores of 0 (0 being the best score possible).

- 9.1, 9.2, 9.2G.

The model filtering scoring data results for the Multiple Last Mile Networks showed the following models had total scores of 0.

The model filtering scoring data results for the Consolidated Last Mile Networks showed the following models had total scores of 0.

- 14.1, 14.2.

The model filtering scoring data results for the Non-Profit Last Mile Networks showed the following models had total scores of 0.

- 14.1, 14.2.

Conclusions

The models that could be the most feasible, beneficial, and efficient regarding the Research Question’s concern for open access and competition in the local and last mile markets included the following. For markets where Individual Provider-Owned Last Mile Networks are desired, Scenario 9 (A local market served by multiple providers including a public MAN where all providers provide their own systems and carriage services between upstream providers to local market end users, and where other private providers and the public MAN can optionally access and use each others’ last mile systems to provide service), Models 9.1, 9.2, and/or 9.2G were recommended.

For markets where Multiple Last Mile Networks were desired, Scenarios 9 (A local market served by multiple providers including a public MAN where all providers provide their own systems and carriage services between upstream providers to local market end users, and where other private providers and the public MAN can optionally access and use each others’
last mile systems to provide service), Models 9.1, 9.2, and 9.2G; 10 (A local market served by multiple providers including a public MAN, where two private providers are the only last mile system and service providers. Other private providers and the public MAN must access and use either or both of those private providers’ last mile systems to provide service), Model 10.3; 11 (A local market served by multiple providers including a public MAN, where one private provider is the only last mile system and service provider. Other private providers and the public MAN must access and use the sole private provider’s last mile system to provide service), Model 11.3; 12 (A local market served by multiple providers including a public MAN, where the public MAN is the only last mile system and service provider. Other private providers must access and use the MAN’s last mile system to provide service), Model 12.3; 14 (A local market served by multiple providers including a public MAN, where the public MAN is the sole last mile system provider but does not provide upstream carriage service), Model 14.3; 15 (A local market served by multiple providers including a public MAN that is dominated by two duopolistic providers. The public MAN is the sole last mile system provider but does not provide upstream carriage service), Model 15.3, and 16 (A local market served by multiple providers including a public MAN that is dominated by a monopolistic provider. The public MAN is the sole last mile system provider but does not provide upstream carriage service), Model 16.3 were recommended. For markets where Consolidated Last Mile Networks and Non-Profit Last Mile Networks were desired, Scenario 14 (A local market served by multiple providers including a public MAN, where the public MAN is the sole last mile system provider but does not provide upstream carriage service), Models 14.1 and/or 14.2 were recommended.

The “best solution” referring back to Wyckoff’s rail proposal could possibly be a mixed market approach where providers of various types (for-profits, non-profits, coops, etc.) compete
in the local market, interconnect in the local market at least for contingency purposes, and access the last mile via an extensive multi-route last mile network provided by a non-profit Public MAN to further reduce end user costs and ensure open access to the End Users. Such market restructuring should enable more local market competition vs. relying solely upon market entry by competitors, forced access mandates, and likely subsidies that further skew the market.

Recommendations for Further Research

Other researchers should be able to conduct similar local and last mile market emulations, add more filtering items (properly standardized if not also weighted), and possibly verify the study conclusions using formulas with costs, speeds, and other factors for quantitative results and analyses. The Monte Carlo method could be utilized to simulate market shares for the models and to determine further optimizations and efficiencies. Perhaps the scaled models and emulations would be considered more representative of actual markets and networks if the experiment was better financed and conducted within a mode modern, well-equipped laboratory (i.e., GENI), and provided with a full research team (i.e., Benkler’s Berkman Center for Internet and Society at Harvard University). Note though that many initial telecommunication systems (most likely) evolved from experimental equipment and networking technology experiments within early laboratory and research settings, and the successful products were eventually were scaled up and rolled out into the field and markets.

The last mile market question remained open to debate regarding which of the four desired models were ideal. The apparent issues involved are technological robustness of the network vs. system buildout and administration economics vs. information (being transmitted over the networks) valuation economics.
The study’s results could further benefit the previously listed parties including providers, end users, governments, equipment providers, and investors requiring increased access to advanced and competitive telecommunications services. Educational providers could better implement previously discussed telepresence technologies and private WANs connecting providers, and expedite access to upstream high end academic and research networks given additional market competition and potentially reduced prices and increased available throughput. The study’s experiment could possibly be implemented as a real world proof of concept by governments to create new or possibly restructure their Public MANs per the recommended local and last mile market structures.

Throughout the study researcher was required to be aware of current events such as Australia’s telecommunication market restructuring, and its case research was fortunately able to be incorporated into the study. However Google was not anticipated entering the markets so quickly despite warnings of technological and market disruptions elsewhere. Omitting Google’s venture would have quickly dated the study’s research and limited the potential results. Google entering all U.S. markets would reportedly cost $140B (Yarow, 2012). Competitors would therefore have to expend additional amounts to stay competitive with Google. Are the competitors capitalized enough to catch up to and stay equal with Google, or might they consider ceasing business in the market? Wireline providers AT&T and Verizon were selling local exchanges to concentrate on wireless services, so the market outlook is in flux.

Some lessons learned during the course of the study included the necessity to confirm the abilities and reliability of outside consultants, particularly computer and network consultants. A few may mean well in trying to use their experiences and training to make recommendations for the researcher that could in fact change the intended construct of the experiment from that of the
researcher to their own solution. Their rationales may be oriented more towards standard networking practices and not adaptable to more experimental constructs and explorations of the capabilities of the equipment. Consultants may also accept too much new work and then get in trouble by not allotting adequate time to all of the clients and their projects.

Other student researchers may want to attempt trials of their experiments prior to waiting for official permission to start the experiment so as to avoid any potential setbacks such as those previously discussed. Confirming the equipment works and can be configured as intended prior to the experiment is highly recommended so that any problems can be addressed before time limits are reached.
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Appendix A

Network Data Reference Charts

**Ethernet**
- 10bT: 10Mb/sec
- 100bT: 100Mb/sec
- 1000bT: 1Gb/sec
- 10GigE: 10Gb/sec
- 1TbE: 1Tb/sec
- 10TbE: 10Tb/sec

**TDM Circuits**
- DS0/T0: 64Kb/sec 1 Circuit
- DS1/T1: 1.54Mb/sec 24 Circuits
- DS2/T2: 6.3Mb/sec 96 Circuits
- DS3/T3: 44.7Mb/sec 672 Circuits
- DS4/T4: 274.17Mb/sec 4032 Circuits
- DS5/T5: 400.352Mb/sec 5760 Circuits

**SONET Optical Carrier**
- OC1: 51.5Mb/sec
- OC3: 155.5Mb/sec
- OC12: 622Mb/sec
- OC48: 2.48Gb/sec
- OC192: 9.95Gb/sec
- OC768: 38.81Gb/sec
- OC3072: 160Gb/sec

**International System of Units Nomenclature**

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Appendix B

Observation Questionnaire
Scenario Questions

Scenario #

What are the constructs and conditions of the scenario?

Part A.

Test .1

Describe what the model is trying to emulate.

Comment upon the computer network emulation's conformity to the constructs and conditions.

Describe the market competition between the Tier I ISP and the downstream end users.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

Indicate the business type (for-profit or non-profit) for each provider.

Is there a potential conflict with differing business types within the local and last mile markets?

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

Do the connected units recognize each other?

What is the potential routing table?

How do the providers access downstream end users?

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

Additional observations.
Part B.

Test.

Describe what the model is trying to emulate.

Comment upon the computer network emulation's conformity to the constructs and conditions.

Describe the market competition between the Tier I ISP and the downstream end users.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

Indicate the business type (for-profit or non-profit) for each provider.

Is there a potential conflict with differing business types within the local and last mile markets?

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

Does adding the ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

Do the connected units recognize each other?

What is the potential routing table?

How do the providers access downstream end users?

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

Additional observations.

Repeat Part B if the scenario has additional models.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test.

Describe what the model is trying to emulate.

Comment upon the computer network emulation's conformity to the constructs and conditions.

Describe the market competition between the Tier I ISP and the downstream end users.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

Indicate the business type (for-profit or non-profit) for each provider.

Is there a potential conflict with differing business types within the local and last mile markets?

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

Do the connected units recognize each other?

What is the potential routing table?

How do the providers access downstream end users?

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

Additional observations.
Appendix C

Questionnaire Responses
Scenario Questions

Scenario #1

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by only one incumbent provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 1.1

Describe what the model is trying to emulate.

Model 1.1 is attempting to emulate a local market “under-served” by the only incumbent LEC that provides its own system and carriage service between the upstream provider and the DEU. The DEU has selected LEC as its upstream provider, although it is the only provider available to choose from participating in the local and last mile markets.

Comment upon the computer network emulation’s conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario.

Describe the market competition between the Tier I ISP and the downstream end users:

The middle mile market is virtually monopolized, as only ISP2 has its own connection from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates LEC does not have an actual monopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually monopolized, as LEC is the only provider. However the construct indicates LEC does have an actual monopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually monopolized, as only LEC has its own connection from the local market to the DEU. However the construct indicates the last mile market is
theoretically competitive as LEC is not a sanctioned natural utility, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides both infrastructure and service to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

LEC is typically a for-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Not applicable, as LEC is the only local and last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC does not have an actual monopoly, but it could potentially control the local and last mile markets since it is the only current provider in both markets thereby giving it de facto control over them. LEC cannot discriminate against other providers until there actually are other providers in the two markets. However LEC could announce discriminatory policies as a barrier towards potential competitors including network access restrictions, monopoly service under-pricing in the particular local market, etc.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

LEC has a 100% share of both the local and last mile market.

Do the connected units recognize each other?

No.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
How do the providers access downstream end users?

LEC accesses the DEU directly via its own last mile system.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as LEC uses its own last mile system to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s system for provision to the DEU.

Additional observations.
Part B.

Test 1.2

Describe what the model is trying to emulate.

Model 1.2 is attempting to emulate a local market “under-served” by the only incumbent LEC that provides its own system and carriage service between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice between the two providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cable being disconnected between the ISP2 and Downstream End User routers thereby interrupting the route represented the end user having access to ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users:

The middle mile market is virtually duopolized, as only LEC and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither LEC nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as LEC and ISP2 are the only providers. However the construct indicates neither LEC nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only LEC and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as neither LEC nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

LEC is typically a for-profit corporation. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since both providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither LEC nor ISP2 currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively.

Since both LEC and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by LEC to establish a monopoly in them more difficult. Likewise LEC makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

Both LEC and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both LEC and ISP2 use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s and/or ISP2’s systems for provision to the DEU.

Additional observations.
The DEU can use its router to instantaneously switch between LEC and ISP2 or use both simultaneously if it concurrently subscribes to both providers.

Repeat Part B if the scenario has additional models.
Test 1.3

Describe what the model is trying to emulate.

Model 1.3 is attempting to emulate a local market “under-served” by the incumbent LEC that provides its own system and carriage service between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice between the two providers and has switched to the ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cable being disconnected between the LEC and Downstream End User routers thereby interrupting the route represented the end user having access to LEC but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is virtually duopolized, as only LEC and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither LEC nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as LEC and ISP2 are the only providers. However the construct indicates neither LEC nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only LEC and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as neither LEC nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

LEC is typically a for-profit corporation. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since both providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither LEC nor ISP2 currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively.

Since both LEC and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>LEC</th>
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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by LEC to establish a monopoly in them more difficult. Likewise LEC makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

Both LEC and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both LEC and ISP2 use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s and/or ISP2’s systems for provision to the DEU.
Additional observations.

The DEU can use its router to instantaneously switch between LEC and ISP2 or use both simultaneously if it concurrently subscribes to both providers.
**Scenario Questions**

Scenario #2

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 2.1

Describe what the model is trying to emulate.

Model 2.1 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU. The DEU has an equal choice among the three providers and has chosen LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers and ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, and ISP1 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, and ISP1 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, and ISP1 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively.

Since LEC, CC, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:
Do the connected units recognize each other?

The CC and Downstream End User routers and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, and ISP1 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, and/or ISP1’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, and ISP1, or use two or more providers simultaneously if it concurrently subscribes to them.
Part B.

Test 2.2

Describe what the model is trying to emulate.

Model 2.2 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 2.3

Describe what the model is trying to emulate.

Model 2.3 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen CC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.
LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<tr>
<th>LEC</th>
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The potential last mile market share range is:

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<th>LEC</th>
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<th>ISP1</th>
<th>ISP2</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.
If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 2.4

Describe what the model is trying to emulate.

Model 2.4 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen ISP1 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.
LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>Provider</th>
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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.
If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 2.5

Describe what the model is trying to emulate.

Model 2.5 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.
LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<tr>
<th>LEC</th>
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<th>ISP2</th>
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The potential last mile market share range is:

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<th>LEC</th>
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<th>ISP1</th>
<th>ISP2</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.
If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.
**Scenario Questions**

Scenario #3

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local market dominated by two private duopolistic providers between the upstream providers to the end users. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2. Note – only a representative sample of all of the possible last mile connection combinations will tested.

Part A.

Test 3.1

Describe what the model is trying to emulate.

Model 3.1 is attempting to emulate a local market served by three incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and ISP1’s systems access DEU1, while CC’s system accesses DEU2.

DEU1 has an equal choice between LEC and ISP1 and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC since there is no last mile access to it. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or ISP1 since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cable being disconnected between the ISP1 and Downstream End User routers thereby interrupting the route represented End User 1 having access to ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.
The local market is competitive, as LEC, CC, and ISP1 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and ISP1 have their own connections from the local market to DEU1. The last mile market to DEU2 is virtually monopolized, as only CC has its own connection from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and ISP1 provide their own infrastructures and services to DEU1, and CC provides its own infrastructure and service to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers.

Since LEC, CC, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:
Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:

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<tr>
<th>LEC</th>
<th>CC</th>
<th>ISP1</th>
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<tr>
<td>50%</td>
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Note - No competitor can exceed the monopoly provider’s market share.

CC has a 100% share of last mile market to DEU2.

Do the connected units recognize each other?

The ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?


Upstream End User workstation—Upstream End User router—Tier I ISP router—CC router—Downstream End User Workstation #2.

Upstream End User workstation—Upstream End User router—Tier I ISP router—ISP1 router—Downstream End User router.

How do the providers access downstream end users?

LEC and ISP1 access DEU1 directly via their own last mile systems, and CC accesses DEU2 directly via its own last mile system.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct somewhat. Both LEC and ISP1 use their own last mile systems to DEU1 for service provision, while CC uses its own last mile system to DEU2 for service provision.

If LEC and/or ISP1 chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s system for provision to DEU2. If CC chose to provide service to DEU1, it would either have to establish its own system to DEU1 or interconnect with and be granted adequate access to LEC’s and/or ISP1’s system for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or ISP1’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s system for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch between LEC and ISP1 or use both simultaneously if it concurrently subscribes to both providers.
Part B.

Test 3.2

Describe what the model is trying to emulate.

Model 3.2 is attempting to emulate a local market served by three incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and ISP1’s systems access DEU1, while CC’s system accesses DEU2.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

DEU1 has an equal choice between LEC and ISP1 and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC or ISP2 since there is no last mile access to either of them. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or ISP1 since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the ISP1 and Downstream End User routers and the ISP2 router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to ISP1 and End User 2 having access to ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and ISP1 have their own connections from the local market to DEU1. The last mile market to DEU2 is also virtually duopolized, as only CC and ISP2 have their own connections from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and ISP1 provide their own infrastructures and services to DEU1, and CC and ISP2 provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>&gt; 25%</td>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:
The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CC</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 33.33% making the market more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into ISP1’s already minor market share. Likewise duopolists LEC and CC and incumbent provider ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at two. That market’s competitiveness remains unaffected and still relatively underserved due to the low number of total providers.

ISP2’s entry in the last mile market to DEU2 increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The ISP1 and Downstream End User routers and the ISP2 router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.
What is the potential routing table?

- Upstream End User workstation - Upstream End User router - Tier I ISP router - LEC router - Downstream End User router - Downstream End User Workstation #1.
- Upstream End User workstation - Upstream End User router - Tier I ISP router - CC router - Downstream End User router - Downstream End User Workstation #2.
- Upstream End User workstation - Upstream End User router - Tier I ISP router - ISP1 router - Downstream End User router - Downstream End User Workstation #1.
- Upstream End User workstation - Upstream End User router - Tier I ISP router - ISP2 router - Downstream End User workstation - Downstream End User workstation #2.

How do the providers access downstream end users?

- LEC and ISP1 access DEU1 directly via their own last mile systems, and CC and ISP2 access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. Both LEC and ISP1 use their own last mile systems to DEU1 for service provision, while CC and ISP2 use their own last mile systems to DEU2 for service provision.

If LEC and/or ISP1 chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s and/or ISP2’s systems for provision to DEU2. If CC and/or ISP2 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s and/or ISP1’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or ISP1’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s and/or ISP2’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch between LEC and ISP1 or use both simultaneously if it concurrently subscribes to both providers.
Repeat Part B if the scenario has additional models.
Test 3.3

Describe what the model is trying to emulate.

Model 3.3 is attempting to emulate a local market served by three incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and ISP1’s systems access DEU1, while CC’s system accesses DEU2.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

DEU1 has an equal choice between LEC and ISP1 and has chosen ISP1 as its upstream provider in the local and last mile markets, but cannot choose CC or ISP2 since there is no last mile access to either of them. DEU2 has chosen ISP2 as its upstream provider in the local and last mile markets, but cannot choose LEC or ISP1 since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers and the CC router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to LEC and End User 2 having access to CC but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and ISP1 have their own connections from the local market to DEU1. The last mile market to DEU2 is also virtually duopolized, as only CC and ISP2 have their own connections from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and ISP1 provide their own infrastructures and services to DEU1, and CC and ISP2 provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>Provider</th>
<th>Local Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC</td>
<td>50%</td>
</tr>
<tr>
<td>CC</td>
<td>50%</td>
</tr>
<tr>
<td>ISP1</td>
<td>0%</td>
</tr>
<tr>
<td>ISP2</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 33.33% making the market more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into ISP1’s already minor market share. Likewise duopolists LEC and CC and incumbent provider ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at two. That market’s competitiveness remains unaffected and still relatively underserved due to the low number of total providers.

ISP2’s entry in the last mile market to DEU2 increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers and the CC router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.
What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User Workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User workstation #2.

How do the providers access downstream end users?

LEC and ISP1 access DEU1 directly via their own last mile systems, and CC and ISP2 access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. Both LEC and ISP1 use their own last mile systems to DEU1 for service provision, while CC and ISP2 use their own last mile systems to DEU2 for service provision.

If LEC and/or ISP1 chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s and/or ISP2’s systems for provision to DEU2. If CC and/or ISP2 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s and/or ISP1’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or ISP1’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s and/or ISP2’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch between LEC and ISP1 or use both simultaneously if it concurrently subscribes to both providers.
DEU1 and DEU2 have selected ISP1 and ISP2 respectively as their providers even though LEC’s and CC’s monopolies likely make their provision more advantageous to end users.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 3.4

Describe what the model is trying to emulate.

Model 3.4 is attempting to emulate a local market served by three incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and ISP1’s systems access DEU1, while CC’s system accesses DEU2.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to both DEUs.

DEU1 has an equal choice among LEC, ISP1, and Google, and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC since there is no last mile access to it. DEU2 has an equal choice between CC and Google, and has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or ISP1 since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the ISP1 and Downstream End User routers, the Google and Downstream End User routers, and the Google router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to ISP1 and Google and End User 2 having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and Google have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and Google are all providers. The construct indicates LEC and CC had a duopoly, whereby limiting other providers’ abilities to enter the local market. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly.
The last mile market to DEU1 was virtually duopolized, as only LEC and ISP1 had their own connections from the local market to DEU1. However Google’s entry into the last market eliminates LEC’s and CC’s duopoly to DEU1. The last mile market to DEU2 is also virtually duopolized, as only CC and Google have their own connections from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and ISP1 provide their own infrastructures and services to DEU1, and CC and Google provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

Since LEC, CC, ISP1, and Google provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?
The potential local market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
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<td>0%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

The potential last mile market share range to DEU1 is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td></td>
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<tr>
<td>0%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th></th>
<th>CC</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 33.33% making the market more competitive and relatively well served due to the moderate number of total providers.

Google’s presence in the local market eliminates LEC’s and CC’s duopoly, and could further cut into ISP1’s already minor market share. Efforts by former duopolists LEC and CC and incumbent provider ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to DEU1 increases the number of providers by 50% making that market more competitive.

Google’s entry in the last mile market to DEU2 increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.
Do the connected units recognize each other?

The ISP1 and Downstream End User routers, the ISP1 router and Downstream End User 2 workstation, and the Google router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User Workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Google router-Downstream End User workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Google router-Downstream End User router-Downstream End User Workstation #1.

How do the providers access downstream end users?

LEC, ISP1, and Google access DEU1 directly via their own last mile systems, and CC and Google access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. LEC, ISP1, and Google use their own last mile systems to DEU1 for service provision, while CC and Google use their own last mile systems to DEU2 for service provision.

If LEC and/or ISP1 chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s and/or Google’s systems for provision to DEU2. If CC chose to provide service to DEU1, it would either have to establish its own system to DEU1 or interconnect with and be granted adequate access to LEC’s, ISP1’s and/or Google’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted
adequate access to LEC’s, ISP1’s, and/or Google’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s and/or Google’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch among LEC, ISP1, and Google, or use two or all simultaneously if it concurrently subscribes to multiple providers.
Scenario Questions

Scenario #4

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market dominated by a monopolistic private provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 4.1.

Describe what the model is trying to emulate.

Model 4.1 is attempting to emulate a local market served by three incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. The DEU has an equal choice among the three providers and has chosen LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers and the ISP1 and Downstream End User routers thereby interrupting the routes represented the End User having access to CC and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, and ISP1 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.
The last mile market is competitive, as LEC, CC, and ISP1 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, and ISP1 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The potential last market share range is:
Do the connected units recognize each other?

The CC and Downstream End User routers and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

- Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, and ISP1 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, and/or ISP1’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, and ISP1, or use two or more providers simultaneously if it concurrently subscribes to them.
Part B.

Test 4.2.

Describe what the model is trying to emulate.

Model 4.2 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the End User having access to CC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range is:

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<th>LEC</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

- Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 4.3.

Describe what the model is trying to emulate.

Model 4.3 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen CC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the End User having access to LEC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services.
Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 4.4.

Describe what the model is trying to emulate.

Model 4.4 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen ISP1 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the End User having access to LEC, CC, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 4.5.

Describe what the model is trying to emulate.

Model 4.5 is attempting to emulate a local market served by three incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice among the four providers and has chosen ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the End User having access to LEC, CC, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a government enterprise or non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

Since all providers are typically for-profit corporations, there are likely few if any significant conflicts regarding differing business types within the local and last mile markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-price to gain and retain more end users than the other providers or potential competitive providers.

Since LEC, CC, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?
ISP2’s entry in the local and last mile markets increases the number of providers by 33.33% making those markets more competitive and relatively well served due to the moderate number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.
Scenario Questions

Scenario #5

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by only a public MAN between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 5.1.

Describe what the model is trying to emulate.

Model 5.1 is attempting to emulate a local market “under-served” by the only incumbent Public MAN that provides its own system and carriage service between the upstream provider and the DEU. The DEU has selected the Public MAN as its upstream provider, although it is the only provider available to choose from participating in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is virtually monopolized, as only the Public MAN has its own connection from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates the Public MAN does not have an actual monopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually monopolized, as the Public MAN is the only provider. However the construct indicates the Public MAN does not have an actual monopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as the Public MAN is not a sanctioned natural utility, and other providers are therefore able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides both infrastructure and service to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise.

Is there a potential conflict with differing business types within the local and last mile markets?

Not applicable, as the Public MAN is the only local and last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates the Public MAN does not have an actual monopoly, but the Public MAN could potentially control the local and last mile markets since it is the only current provider in both markets thereby giving it de facto control over them. The Public MAN cannot discriminate against other providers until there actually are other providers in the two markets. However the Public MAN could announce discriminatory policies as a barrier towards potential competitors including network access restrictions, monopoly service under-pricing in the particular local market, certain governmental enterprise advantages, etc.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The Public MAN has a 100% share of both the local and last mile market.

Do the connected units recognize each other?

No.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?
The Public MAN accesses the DEU directly via its own last mile system.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as the Public MAN uses its own last mile system to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.
Part B.

Test 5.2.

Describe what the model is trying to emulate.

Model 5.2 is attempting to emulate a local market “under-served” by the only incumbent Public MAN that provides its own system and carriage service between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice between the two providers and has chosen to retain the Public MAN as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the ISP2 and Downstream End User routers thereby interrupting the route represented the End User having access to ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users:

The middle mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as the Public MAN and ISP2 are the only providers. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as neither the Public MAN nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
The Public MAN and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and ISP2 is typically a for-profit corporation, the Public MAN could have certain unfair advantages in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither the Public MAN nor ISP2 currently have actual monopolies nor a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against ISP2 and other potential providers in the local market too.

Since both the Public MAN and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>MAN</th>
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The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by the Public MAN to establish a monopoly in them more difficult. Likewise the Public MAN makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.
What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

Both the Public MAN and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both the Public MAN and ISP2 use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch between the Public MAN and ISP2 or use both simultaneously if it concurrently subscribes to both providers.

Repeat Part B if the scenario has additional models.
Test 5.3.

Describe what the model is trying to emulate.

Model 5.3 is attempting to emulate a local market “under-served” by the only incumbent Public MAN that provides its own system and carriage service between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU.

The DEU has an equal choice between the two providers and has switched to the ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the Public MAN and Downstream End User routers thereby interrupting the route represented the End User having access to the Public MAN but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as the Public MAN and ISP2 are the only providers. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as neither the Public MAN nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and ISP2 provide their own infrastructures and services o the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and ISP2 is typically a for-profit corporation, the Public MAN could have certain unfair advantages in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither the Public MAN nor ISP2 currently have actual monopolies nor a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against ISP2 and other potential providers in the local market too.

Since both the Public MAN and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>MAN</th>
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The potential last mile market share range is:

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<th>MAN</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by the Public MAN to establish a monopoly in them more difficult. Likewise the Public MAN makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The Public MAN and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

Both the Public MAN and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both the Public MAN and ISP2 use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s and/or ISP2’s systems for provision to the DEU.
Additional observations.

The DEU can use its router to instantaneously switch between the Public MAN and ISP2 or use both simultaneously if it concurrently subscribes to both providers.
Scenario Questions

Scenario #6

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a Public MAN between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 6.1.

Describe what the model is trying to emulate.

Model 6.1 is attempting to emulate a local market well served by four incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU. The DEU has an equal choice among the four providers and has chosen LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market between the Tier I ISP and the local market is competitive, as the construct indicates LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the local market too or currently refuses to participate there. The construct indicates the local market is competitive. The last mile market between the local market and the DEU is competitive since LEC, CC, the Public MAN, and ISP1 have their own connections to the DEU, and other providers are also able to enter the market.
The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, Public MAN, and ISP1 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from
accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:

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Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?
LEC, CC, Public MAN, and ISP1 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, and/or ISP1’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, and ISP1, or use two or more providers simultaneously if it concurrently subscribes to them.
Describe what the model is trying to emulate.

Model 6.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:
The potential last mile market share range is:

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<th>LEC</th>
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<th>ISP1</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-
Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public
MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-
Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last
mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if
necessary.

According to the construct yes, as all providers use their own last mile systems to the
DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would
either have to establish their own systems to the DEU or interconnect with and be granted
adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision
to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN,
ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to
them.

Repeat Part B if the scenario has additional models.
Test 6.3.

Describe what the model is trying to emulate.

Model 6.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen CC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, the Public MAN, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

<table>
<thead>
<tr>
<th>LEC</th>
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<th>ISP1</th>
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Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 6.4.

Describe what the model is trying to emulate.

Model 6.4 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen the Public MAN as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>LEC</th>
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The potential last mile market share range is:
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<th>LEC</th>
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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

- Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 6.5.

Describe what the model is trying to emulate.

Model 6.5 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen ISP1 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, the Public MAN, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<th>ISP1</th>
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The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last
mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if
necessary.

According to the construct yes, as all providers use their own last mile systems to the
DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would
either have to establish their own systems to the DEU or interconnect with and be granted
adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision
to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN,
ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to
them.

Repeat Part B if the scenario has additional models.
Test 6.6.

Describe what the model is trying to emulate.

Model 6.6 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, the Public MAN, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.
Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
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The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.
Scenario Questions

Scenario #7

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market including a Public MAN dominated by two duopolistic private providers between the upstream providers to the end users. In Part B, competitor ISP2 will then attempt to enter the local and last mile markets. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2. Note – only a representative sample of all of the possible last mile connection combinations will tested.

Part A.

Test 7.1.

Describe what the model is trying to emulate.

Model 7.1 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and the Public MAN’s systems access DEU1, while CC’s and ISP1’s systems access DEU2.

DEU1 has an equal choice between LEC and the Public MAN and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC or ISP1 since there is no last mile access to either of them. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or the Public MAN since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the Public MAN and Downstream End User routers and the ISP1 router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to the Public MAN and End User 2 having access to ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once
participated in the middle market too or currently refuses to participate there. Other providers
are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all
providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other
providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and the Public MAN
have their own connections from the local market to DEU1. The last mile market to DEU2 is
virtually duopolized, as only CC and ISP1 have their own connections from the local market to
DEU2. However the construct indicates the last mile market is theoretically competitive as none
of the providers are sanctioned natural utilities, and other providers are therefore able to enter the
market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and
service.

LEC and the Public MAN provide their own infrastructures and services to DEU1, and
CC and ISP1 provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1
are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government
enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could
have certain unfair advantages over them.

In the last mile market to DEU1 yes, since the Public MAN is typically a non-profit
government enterprise and LEC is typically a for-profit corporation, the Public MAN could have
certain unfair advantages.

In the last mile market to DEU2 no, since both CC and ISP1 are typically for-profit
corporations there are likely few if any significant conflicts regarding differing business types.

Is there an opportunity for a provider to control the local and last mile markets and/or
discriminate vs. other providers? How?
The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>MAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th>CC</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

Do the connected units recognize each other?

The Public MAN and Downstream End User routers and the ISP1 router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.
What is the potential routing table?

- Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User Workstation #2.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User Workstation #1.
- Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User Workstation #2.

How do the providers access downstream end users?

- LEC and the Public MAN access DEU1 directly via their own last mile systems, and CC and ISP1 access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. Both LEC and the Public MAN use their own last mile systems to DEU1 for service provision, while CC and ISP1 use their own last mile systems to DEU2 for service provision.

If LEC and/or the Public MAN chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s and/or ISP1’s systems for provision to DEU2. If CC and/or ISP1 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s and/or ISP1’s systems for provision to DEU2.

Additional observations.

- DEU1 can use its router to instantaneously switch between LEC and the Public MAN or use both simultaneously if it concurrently subscribes to both providers.
Part B.

Test 7.2.

Describe what the model is trying to emulate.

Model 7.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to DEU2. LEC’s and the Public MAN’s systems access DEU1, while CC’s and ISP1’s systems access DEU2.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

DEU1 has an equal choice between LEC and the Public MAN and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, ISP1, or ISP2 since there is no last mile access to either of them. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or the Public MAN since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the Public MAN and Downstream End User routers, the ISP1 router and End User 2 workstation, and the ISP2 router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to the Public MAN and End User 2 having access to ISP1 and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and the Public MAN have their own connections from the local market to DEU1. The last mile market to DEU2 is competitive, as CC, ISP1, and ISP2 have their own connections from the local market to DEU2.
However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and the Public MAN provide their own infrastructures and services to DEU1, and ISP1, and CC, ISP1, and ISP2 provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 yes, since the Public MAN is typically a non-profit government enterprise and LEC is typically a for-profit corporation, the Public MAN could have certain unfair advantages.

In the last mile market to DEU2 no, since CC, ISP1, and ISP2 are typically for-profit corporations there are likely few if any significant conflicts regarding differing business types.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a
barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>Provider</th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
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<td>&gt; 20%</td>
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<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
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</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:

<table>
<thead>
<tr>
<th>Provider</th>
<th>LEC</th>
<th>MAN</th>
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</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
<td></td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th>Provider</th>
<th>CC</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>&gt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
<td></td>
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</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into the Public MAN’s and ISP1’s already minor market shares. Likewise duopolists LEC and CC and incumbent providers Public MAN and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at two. That market’s competitiveness remains unaffected and still relatively underserved due to the low number of total providers.
ISP2’s entry in the last mile market to DEU2 increases the number of providers by 50% making that market more competitive.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The Public MAN and Downstream End User routers, the ISP1 router and Downstream End User 2 workstation, and the ISP2 router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User Workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User workstation #2.

How do the providers access downstream end users?

LEC and the Public MAN access DEU1 directly via their own last mile systems, and CC, ISP1, and ISP2 access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct somewhat. Both LEC and the Public MAN use their own last mile systems to DEU1 for service provision, while CC, ISP1, and ISP2 use their own last mile systems to DEU2 for service provision.

If LEC and/or the Public MAN chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or ISP2’s systems for provision to DEU2. If CC, ISP1, and/or ISP2 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or ISP2’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch between LEC and the Public MAN or use both simultaneously if it concurrently subscribes to both providers.

Repeat Part B if the scenario has additional models.
Test 7.3.

Describe what the model is trying to emulate.

Model 7.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and the Public MAN’s systems access DEU1, while CC’s and ISP1’s systems access DEU2.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

DEU1 has an equal choice between LEC and the Public MAN and has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose CC, ISP1, or ISP2 since there is no last mile access to either of them. DEU2 has chosen ISP2 as its upstream provider in the local and last mile markets, but cannot choose LEC or the Public MAN since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC router and End User 2 workstation, and the ISP1 router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to the LEC and End User 2 having access to CC and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually duopolized, as only LEC and the Public MAN have their own connections from the local market to DEU1. The last mile market to DEU2 is competitive, as CC, ISP1, and ISP2 have their own connections from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the
providers are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and the Public MAN provide their own infrastructures and services to DEU1, and ISP1, and CC, ISP1, and ISP2 provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 yes, since the Public MAN is typically a non-profit government enterprise and LEC is typically a for-profit corporation, the Public MAN could have certain unfair advantages.

In the last mile market to DEU2 no, since CC, ISP1, and ISP2 are typically for-profit corporations there are likely few if any significant conflicts regarding differing business types.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a
barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 20%</td>
<td>&gt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The potential last mile market share range to DEU1 is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>MAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 50%</td>
<td>&lt; 50%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th>CC</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
<td>&lt; 1/3rd%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market share.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into the Public MAN’s and ISP1’s already minor market shares. Likewise duopolists LEC and CC and incumbent providers Public MAN and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at two. That market’s competitiveness remains unaffected and still relatively underserved due to the low number of total providers.
ISP2’s entry in the last mile market to DEU2 increases the number of providers by 50% making that market more competitive.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC router and Downstream End User 2 workstation, and the ISP1 router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User Workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User workstation #2.

How do the providers access downstream end users?

LEC and the Public MAN access DEU1 directly via their own last mile systems, and CC, ISP1, and ISP2 access DEU2 directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. Both LEC and the Public MAN use their own last mile systems to DEU1 for service provision, while CC, ISP1, and ISP2 use their own last mile systems to DEU2 for service provision.
If LEC and/or the Public MAN chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or ISP2’s systems for provision to DEU2. If CC, ISP1, and/or ISP2 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s and/or the Public MAN’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or ISP2’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch between LEC and the Public MAN or use both simultaneously if it concurrently subscribes to both providers.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 7.4.

Describe what the model is trying to emulate.

Model 7.4 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEUs. LEC’s and the Public MAN’s systems access DEU1, while CC’s and ISP1’s systems access DEU2.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to both DEUs.

DEU1 has an equal choice among LEC, the Public MAN, and Google, and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC or ISP1 since there is no last mile access to either of them. DEU2 has an equal choice among CC, ISP1, and Google, and has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC or the Public MAN since there is no last mile access to either of them.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the Public MAN and Downstream End User routers, the Google and Downstream End User routers, the ISP1 router and End User 2 workstation, and the Google router and End User 2 workstation thereby interrupting the routes represented End User 1 having access to the Public MAN and Google and End User 2 having access to ISP1 and Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and Google have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and Google are all providers. The construct indicates LEC and CC had a duopoly, whereby limiting other providers’ abilities to enter the local market. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly.
The last mile market to DEU1 was virtually duopolized, as only LEC and the Public MAN had their own connections from the local market to DEU1. However Google’s entry into the last market eliminates LEC’s and the Public MAN’s duopoly to DEU1. The last mile market to DEU2 is competitive, as CC, ISP1, and Google have their own connections from the local market to DEU2. However the construct indicates the last mile market is theoretically competitive as none of the providers are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and the Public MAN provide their own infrastructures and services to DEU1, and ISP1, and CC, ISP1, and Google provide their own infrastructures and services to DEU2.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 yes, since the Public MAN is typically a non-profit government enterprise and LEC is typically a for-profit corporation, the Public MAN could have certain unfair advantages.

In the last mile market to DEU2 no, since CC, ISP1, and ISP2 are typically for-profit corporations there are likely few if any significant conflicts regarding differing business types.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly and could counter any
governmental advantages the Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

Since LEC, CC, the Public MAN, ISP1, and Google provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
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<td>100%</td>
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</tbody>
</table>

The potential last mile market share range to DEU1 is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>MAN</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
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<td>100%</td>
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</tbody>
</table>

The potential last mile market share range to DEU2 is:

<table>
<thead>
<tr>
<th>CC</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
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</tbody>
</table>

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

Google’s presence in the local market eliminates LEC’s and CC’s duopoly, and could further cut into the Public MAN’s and/or ISP1’s already minor market shares. Efforts by former duopolists LEC and CC and incumbent providers Public MAN and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.
Google’s entry in the last mile market to DEU1 increases the number of providers by 50% making that market more competitive.

Google’s entry in the last mile market to DEU2 increases the number of providers by 50% making that market more competitive.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Public MAN and Downstream End User routers, the Google and Downstream End User routers, the ISP1 router and Downstream End User 2 workstation, and the Google router and Downstream End User 2 workstation do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User Workstation #2.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Google router-Downstream End User router-Downstream End User Workstation #1.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Google router-Downstream End User workstation #2.

How do the providers access downstream end users?

LEC, the Public MAN, and Google access DEU1 directly via their own last mile systems, and CC, ISP1, and Google access DEU2 directly via their own last mile systems.
Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. LEC, the Public MAN, and Google use their own last mile systems to DEU1 for service provision, while CC, ISP1, and Google use their own last mile systems to DEU2 for service provision.

If LEC and/or the Public MAN chose to provide service to DEU2, they would either have to establish their own systems to DEU2 or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or Google’s systems for provision to DEU2. If CC and/or ISP1 chose to provide service to DEU1, they would either have to establish their own systems to DEU1 or interconnect with and be granted adequate access to LEC’s, the Public MAN’s, and/or Google’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would either have to establish their own systems to the DEUs, or interconnect with and be granted adequate access to LEC’s, the Public MAN’s, and/or Google’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s, ISP1’s, and/or Google’s systems for provision to DEU2.

Additional observations.

DEU1 can use its router to instantaneously switch among LEC, ISP1, and Google, or use two or all simultaneously if it concurrently subscribes to multiple providers.
Scenario Questions

Scenario #8

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market including a public MAN dominated by a monopolistic private provider between the upstream providers to the end users. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 8.1.

Describe what the model is trying to emulate.

Model 8.1 is attempting to emulate a local market well served by four incumbent providers that provide their own systems and carriage services between the upstream provider to the DEU. The DEU has an equal choice among the four providers and has chosen LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.
The last mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, and ISP1 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:
Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
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</tbody>
</table>

Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation- Upstream End User router- Tier I ISP router- LEC router- Downstream End User router- Downstream End User workstation.

Upstream End User workstation- Upstream End User router- Tier I ISP router- CC router- Downstream End User router- Downstream End User workstation.

Upstream End User workstation- Upstream End User router- Tier I ISP router- Public MAN router- Downstream End User router- Downstream End User workstation.

Upstream End User workstation- Upstream End User router- Tier I ISP router- ISP1 router- Downstream End User router- Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, and ISP1 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.
According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, and/or ISP1’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, and ISP1, or use two or more providers simultaneously if it concurrently subscribes to them.
Part B.

Test 8.2.

Describe what the model is trying to emulate.

Model 8.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
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</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 8.3.

Describe what the model is trying to emulate.

Model 8.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen CC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, the Public MAN, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
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</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-
Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Describe what the model is trying to emulate.

Model 8.4 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen the Public MAN as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
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</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25%, making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-
Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Test 8.5.

Describe what the model is trying to emulate.

Model 8.5 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to DEU2.

The DEU has an equal choice among the five providers and has chosen ISP1 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, the Public MAN, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.
LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
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</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP2 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.
How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

Repeat Part B if the scenario has additional models.
Describe what the model is trying to emulate.

Model 8.6 is attempting to emulate a local market very well served by four incumbent providers and a competitive ISP2, all of which provide their own systems and carriage services between the upstream provider to the DEU. The DEU has an equal choice among the five providers and has chosen ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The network cables being disconnected between the LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to LEC, CC, the Public MAN, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.
The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
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Note - No competitor can exceed the monopoly provider’s market shares.

The potential last mile market share range is:
Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The LEC and Downstream End User routers, the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-LEC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-CC router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

<table>
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<th>LEC</th>
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Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP1 router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

LEC, CC, the Public MAN, ISP1, and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.
Scenario Questions

Scenario #9

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN between the upstream providers to the end users, and where all providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 9.1.

Describe what the model is trying to emulate.

Model 9.1 is attempting to emulate a local market well served by four incumbent providers that provide their own systems and carriage services between the upstream provider to the downstream end user. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. The DEU has an equal choice among the four providers and has chosen LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, and ISP1 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.
The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, and ISP1 provide their own interconnections to the other providers, and their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

Since LEC, CC, the Public MAN, and ISP1 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from
accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the market does each provider have?

The potential local market share range is:

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The potential last mile market share range is:

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Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, and the ISP1 and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
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<thead>
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<th>Tier 3</th>
<th>Tier 4</th>
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Routing Table for Test 9.1.
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Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER 1 = Tier 1 ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

LEC, CC, the Public MAN, and ISP1 can access the DEU both directly via their own last mile systems and via the other providers’ last mile systems using interconnections.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as all providers use their own last mile systems and interconnect with each others’ systems for access to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, and/or ISP1’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, and ISP1, or use two or more providers simultaneously if it concurrently subscribes to them.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.
Part B.

Test 9.2.

Describe what the model is trying to emulate.

Model 9.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the downstream end users. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has an equal choice among the five providers and has chosen to retain LEC as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cables being disconnected between the CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers thereby interrupting the routes represented the end user having access to CC, the Public MAN, ISP1, and ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the local market to the DEU. Other providers are likewise able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC, CC, the Public MAN, ISP1, and ISP2 provide their own interconnections to the other providers, and their own infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

Since LEC, CC, the Public MAN, ISP1, and ISP2 provide their own last mile systems, none of those providers could use access restrictions to their own systems to prevent the others from accessing end users. Each could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?
The potential local market share range is:

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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 25% making those markets even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the markets makes any effort by the incumbent providers to establish a monopoly or duopoly in them more difficult. Likewise the incumbent providers make any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The CC and Downstream End User routers, the Public MAN and Downstream End User routers, the ISP1 and Downstream End User routers, and the ISP2 and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

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Key:

UEUWS = Upstream End User Workstation  
UEUR = Upstream End User Router  
TIER 1 = Tier 1 ISP  
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CC = CC Router  
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According to the construct yes, as all providers use their own last mile systems and interconnect with each others’ systems for access to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to LEC’s, CC’s, the Public MAN’s, ISP1’s, and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch among LEC, CC, the Public MAN, ISP1, and ISP2, or use two or more providers simultaneously if it concurrently subscribes to them.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.
Scenario Questions

Scenario #10

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by two duopolistic private providers, and where all providers can optionally access and use each other’s local market systems. The two duopolistic private providers are the only last mile providers. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 10.1.

Describe what the model is trying to emulate.

Model 10.1 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEUs. LEC’s system accesses DEU1, while CC’s system accesses DEU2.

DEU1 has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, or ISP1 without first accessing LEC since there is no direct access to the others available. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC, the Public MAN, or ISP1 without first accessing CC since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once
participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, and the Public MAN, ISP1 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually monopolized, as only LEC has its own connection from the local market to DEU1. The last mile market to DEU2 is also virtually monopolized, as only CC has its own connection from the local market to DEU2. CC, the Public MAN, and ISP1 either once had their own connections to DEU1 or currently refuse to provide their own, and LEC, the Public MAN, and ISP1 either once had their own connections to DEU2 or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as LEC and CC appear to be sanctioned natural utilities, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides its own interconnections to the other providers, and infrastructure and service to DEU1. CC provides its own interconnections to the other providers, and infrastructure and service to DEU2.

The Public MAN and ISP1 provide their own interconnections to the other providers, and can provide their own services to the two DEUs via LEC and CC.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 the question is not applicable, as LEC is the only last mile market provider.

In the last mile market to DEU2 the question is not applicable, as CC is the only last mile market provider.
Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC denied other providers access to its own network, it could also restrict last mile access to DEU1, enforcing that technique as an effective way to control the market. Likewise if CC denied other providers access to its own network, it could also restrict last mile access to DEU2, enforcing that technique as an effective way to control the market. If both LEC and CC denied the other providers access to their own networks, the other providers could use interconnections to each other but would not be able to access either of the DEUs, enforcing that technique as an effective way to control the market.

If the Public MAN and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC and/or CC. The Public MAN and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with LEC and CC as duopolists and the only last mile system providers wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

LEC has a 100% share of the last mile market to DEU1. CC has a 100% share of the last mile market to DEU2.
Do the connected units recognize each other?

No.

What is the potential routing table?
<table>
<thead>
<tr>
<th>LEC</th>
<th>DEUR</th>
<th>UEU</th>
<th>TIER</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
<th>ISPI</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
<th>ISPI</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
<th>ISPI</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
<th>ISPI</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
<th>ISPI</th>
<th>CC</th>
<th>UEU</th>
<th>TIER</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEUWS1</td>
<td>DEUWS1</td>
<td>DEUWS1</td>
<td>DEUWS1</td>
<td>DEUWS1</td>
<td>DEUWS1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>DEUWS2</td>
<td>DEUWS2</td>
<td>DEUWS2</td>
<td>DEUWS2</td>
<td>DEUWS2</td>
<td>DEUWS2</td>
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<td></td>
</tr>
</tbody>
</table>

Routing Table for Test 10.1.
<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>ISP1</th>
<th>MAN</th>
<th>CC</th>
<th>DEUWS2</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>MAN</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>ISP1</td>
<td>MAN</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>LEC</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>LEC</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>MAN</td>
<td>CC</td>
</tr>
</tbody>
</table>

Key:

UEUWS1 = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS1 = Downstream End User Workstation #1
DEUWS2 = Downstream End User Workstation #2
How do the providers access downstream end users?

LEC accesses DEU1 directly via its own last mile system, and CC accesses DEU2 directly via its own last mile system.

CC, the Public MAN, and ISP1 can indirectly access DEU1 via interconnections with LEC as the last hop in those routes. LEC, the Public MAN, and ISP1 can indirectly access DEU2 via interconnections with CC as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. LEC uses its own last mile system to DEU1 for service provision, while CC uses its own last mile system to DEU2 for service provision.

If LEC, the Public MAN, and/or ISP1 chose to provide service to DEU2, they would have to interconnect with and be granted adequate access to CC’s system for provision to DEU2. If CC, the Public MAN, and/or ISP1 chose to provide service to DEU1, they would have to interconnect with and be granted adequate access to LEC’s system for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would have to interconnect with and be granted adequate access to LEC’s system for provision to DEU1, or interconnect with and be granted adequate access to CC’s system for provision to DEU2.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.
Part B.

Test 10.2.

Describe what the model is trying to emulate.

Model 10.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEUs. LEC’s system accesses DEU1, while CC’s system accesses DEU2.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

DEU1 has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, ISP1, or ISP2 without first accessing LEC since there is no direct access to the others available. DEU2 has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC, the Public MAN, ISP1, or ISP2 without first accessing CC since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to DEU1 is virtually monopolized, as only LEC has its own connection from the local market to DEU1. The last mile market to DEU2 is also virtually monopolized, as only CC has its own connection from the local market to DEU2. CC, the Public MAN, ISP1, and ISP2 either once had their own connections to DEU1 or currently refuse to
provide their own, and LEC, the Public MAN, ISP1, and ISP2 either once had their own connections to DEU2 or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as LEC and CC appear to be sanctioned natural utilities, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides its own interconnections to the other providers, and infrastructure and service to DEU1. CC provides its own interconnections to the other providers, and infrastructure and service to DEU2.

The Public MAN, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the two DEUs via LEC and CC.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 the question is not applicable, as LEC is the only last mile market provider.

In the last mile market to DEU2 the question is not applicable, as CC is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.
All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC denied other providers access to its own network, it could also restrict last mile access to DEU1, enforcing that technique as an effective way to control the market. Likewise if CC denied other providers access to its own network, it could also restrict last mile access to DEU2, enforcing that technique as an effective way to control the market. If both LEC and CC denied the other providers access to their own networks, the other providers could use interconnections to each other but would not be able to access either of the DEUs, enforcing that technique as an effective way to control the market.

If the Public MAN, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC and/or CC. The Public MAN, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC and CC as duopolists and the only last mile system providers wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>Provider</th>
<th>Local Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC</td>
<td>50%</td>
</tr>
<tr>
<td>CC</td>
<td>50%</td>
</tr>
<tr>
<td>MAN</td>
<td>0%</td>
</tr>
<tr>
<td>ISP1</td>
<td>0%</td>
</tr>
<tr>
<td>ISP2</td>
<td>0%</td>
</tr>
</tbody>
</table>

Note: No competitor can exceed the duopoly providers’ market shares.

LEC has a 100% share of the last mile market to DEU1. CC has a 100% share of the last mile market to DEU2.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into the Public MAN’s and ISP1’s already minor
market shares. Likewise duopolists LEC and CC and incumbent providers Public MAN and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

ISP2 does not enter the last mile market to DEU2, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 10.2.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER 1</th>
<th>LEC</th>
<th>DEUR</th>
<th>DEUWS1</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>CC</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>MAN</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP1</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP2</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER 1</td>
<td>CC</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>CC</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>CC</td>
<td>ISP2</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>MAN</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER 1</td>
<td>ISP2</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP2</td>
<td>CC</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP2</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP1</td>
<td>CC</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER 1</td>
<td>ISP1</td>
<td>ISP2</td>
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<td>UEUWS</td>
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<td>UEUR</td>
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<td>ISP2</td>
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<td>MAN</td>
<td>ISP2</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
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<tr>
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<td>-----</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>ISP2</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>ISP2</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>LEC</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>ISP1</td>
</tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>ISP1</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>LEC</td>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
</tr>
</tbody>
</table>

Key:

UEUWS1 = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS1 = Downstream End User Workstation #1
DEUWS2 = Downstream End User Workstation #2
How do the providers access downstream end users?

LEC accesses DEU1 directly via its own last mile system, and CC accesses DEU2 directly via its own last mile system.

CC, the Public MAN, ISP1, and ISP2 can indirectly access DEU1 via interconnections with LEC as the last hop in those routes. LEC, the Public MAN, ISP1, and ISP2 can indirectly access DEU2 via interconnections with CC as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. LEC uses its own last mile system to DEU1 for service provision, while CC uses its own last mile system to DEU2 for service provision.

If LEC, the Public MAN, ISP1, and/or ISP2 chose to provide service to DEU2, they would have to interconnect with and be granted adequate access to CC’s system for provision to DEU2. If CC, the Public MAN, ISP1, and/or ISP2 chose to provide service to DEU1, they would have to interconnect with and be granted adequate access to LEC’s system for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would have to interconnect with and be granted adequate access to LEC’s system for provision to DEU1, or interconnect with and be granted adequate access to CC’s system for provision to DEU2.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 10.3.

Describe what the model is trying to emulate.

Model 10.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEUs. LEC’s system accesses DEU1, while CC’s system accesses DEU2.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to both DEUs. Google interconnects with the other local market providers, and also accesses both DEU1 and DEU2.

DEU1 has an equal choice between LEC and Google, and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, or ISP1 without first accessing LEC or Google since there is no direct access to the others available. DEU2 has an equal choice between CC and Google, and has chosen CC as its upstream provider in the local and last mile markets, but cannot choose LEC, the Public MAN, or ISP1 without first accessing CC or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cables being disconnected between the Google and Downstream End User routers and the Google router and End User 2 workstation thereby interrupting the routes represented End User 1 and End User 2 having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and Google have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, ISP1 and Google are all providers. The construct indicates LEC and CC had a duopoly, whereby limiting other providers’ abilities to
enter the local market. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly.

The last mile market to DEU1 was virtually monopolized, as only LEC had its own connection from the local market to DEU1. However Google’s entry into the last market eliminates LEC’s monopoly to DEU1. The last mile market to DEU2 is also virtually duopolized, as only CC and Google have their own connections from the local market to DEU2. CC, the Public MAN, and ISP1 either once had their own connections to DEU1 or currently refuse to provide their own, and LEC, the Public MAN, and ISP1 either once had their own connections to DEU2 or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as LEC and CC appeared to be sanctioned natural utilities, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utilities.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides its own interconnections to the other providers, and infrastructure and service to DEU1. CC provides its own interconnections to the other providers, and infrastructure and service to DEU2. Google provides its own interconnections to the other providers, and infrastructure and services to DEU1 and DEU2.

The Public MAN and ISP1 provide their own interconnections to the other providers, and can provide their own services to the two DEUs via LEC, CC, and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU1 the question is not applicable, as LEC is the only last mile market provider.

In the last mile market to DEU2 the question is not applicable, as CC is the only last mile market provider.
Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly and could counter any governmental advantages the Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC and Google denied other providers access to their own networks, they could also restrict last mile access to DEU1, enforcing that technique as an effective way to control the market. Likewise if CC and Google denied other providers access to their own networks, they could also restrict last mile access to DEU2, enforcing that technique as an effective way to control the market. If LEC, CC, and Google denied the other providers access to their own networks, the other providers could use interconnections to each other but would not be able to access either of the DEUs, enforcing that technique as an effective way to control the market.

If the Public MAN and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC, CC, and/or Google. The Public MAN and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC, CC, and Google as the only last mile system providers wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

Google’s presence in the local market eliminates LEC’s and CC’s duopoly, and could further cut into the Public MAN’s and/or ISP1’s already minor market shares. Efforts by former duopolists LEC and CC and incumbent providers Public MAN and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to DEU1 increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Google’s entry in the last mile market to DEU2 increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers and the Google router and Downstream End User 2 workstation do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

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**Key:**

UEUWS1 = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = Google Router
DEUR = Downstream End User Router
DEUWS1 = Downstream End User Workstation #1
DEUWS2 = Downstream End User Workstation #2
How do the providers access downstream end users?

LEC and Google access DEU1 directly via their own last mile systems, and CC and Google access DEU2 directly via their own last mile systems.

CC, the Public MAN, and ISP1 can indirectly access DEU1 via interconnections with LEC and Google as the last hops in those routes. LEC, the Public MAN, and ISP1 can indirectly access DEU2 via interconnections with CC and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. LEC and Google use their own last mile systems to DEU1 for service provision, while CC and Google use their own last mile systems to DEU2 for service provision.

If LEC, the Public MAN, and/or ISP1 chose to provide service to DEU2, they would have to interconnect with and be granted adequate access to CC’s and/or Google’s systems for provision to DEU2. If CC, the Public MAN, and/or ISP1 chose to provide service to DEU1, they would have to interconnect with and be granted adequate access to LEC’s and/or Google’s systems for provision to DEU1.

If other providers chose to enter the market and provide service to the DEUs, they would have to interconnect with and be granted adequate access to LEC’s and/or Google’s systems for provision to DEU1, or interconnect with and be granted adequate access to CC’s and/or Google’s systems for provision to DEU2.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.

DEU1 can use its router to instantaneously switch between LEC and Google, or use both simultaneously if it concurrently subscribes to both providers.
Scenario Questions

Scenario #11

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by a monopolistic private provider, and where all providers can optionally access and use each other’s local market systems. The monopolistic private provider is the only last mile provider. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 11.1.

Describe what the model is trying to emulate.

Model 11.1 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. LEC’s system accesses the DEU.

The DEU has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, or ISP1 without first accessing LEC since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.
The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers' abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only LEC has its own connection from the local market to the DEU. CC, the Public MAN, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as LEC appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides its own interconnections to the other providers, and infrastructure and service to the DEU.

CC, the Public MAN, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via LEC.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as LEC is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too.
All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If CC, the Public MAN, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC. CC, the Public MAN, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with LEC as a monopolist and the only last mile system provider wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
<td></td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

LEC has a 100% share of the last mile market to DEU.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 11.1.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>LEC</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>CC</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>CC</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>CC</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>CC</td>
<td>MAN</td>
</tr>
</tbody>
</table>
Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER 1 = Tier 1 ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

LEC accesses the DEU directly via its own last mile system. CC, the Public MAN, and ISP1 can indirectly access the DEU via interconnections with LEC as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. LEC uses its own last mile system to the DEU for service provision.

If CC, the Public MAN, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.
Part B.

Test 11.2.

Describe what the model is trying to emulate.

Model 11.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. LEC’s system accesses the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, ISP1, or ISP2 without first accessing LEC since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only LEC has its own connection from the local market to the DEU. CC, the Public MAN, ISP1, and ISP2 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as LEC appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC provides its own interconnections to the other providers, and infrastructure and service to the DEU.

CC, the Public MAN, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the DEU via LEC.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as LEC is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.
If CC, the Public MAN, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC. CC, the Public MAN, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC as a monopolist and the only last mile system provider wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

LEC has a 100% share of the last mile market to DEU.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s monopoly a little more difficult to maintain, and could further cut into CC’s, the Public MAN’s, and ISP1’s already minor market shares. Likewise monopolist LEC and incumbent providers CC, the Public MAN, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to the DEU, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?
What is the potential routing table?
Routing Table for Test 11.2.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>LEC</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP2</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>ISP2</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>CC</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>ISP2</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>ISP2</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP2</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP2</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>CC</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>CC</td>
<td>ISP2</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>ISP2</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP2</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>CC</td>
<td>ISP1</td>
</tr>
<tr>
<td>-------</td>
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<td>------</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
</tbody>
</table>

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

LEC accesses the DEU directly via its own last mile system. CC, the Public MAN, ISP1, and ISP2 can indirectly access the DEU via interconnections with LEC as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. LEC uses its own last mile system to the DEU for service provision.

If CC, the Public MAN, ISP1, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 11.3.

Describe what the model is trying to emulate.

Model 11.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. LEC’s system accesses the DEU.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to the DEU. Google interconnects with the other local market providers, and also accesses the DEU.

The DEU has an equal choice between LEC and Google, and has chosen LEC as its upstream provider in the local and last mile markets, but cannot choose CC, the Public MAN, or ISP1 without first accessing LEC or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cable being disconnected between the Google and Downstream End User router thereby interrupting the route represented the End User having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and Google have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and Google are all providers. The construct indicates LEC had a monopoly, whereby limiting other providers’ abilities to enter the local market. However Google’s entry into the local market eliminates LEC’s monopoly.
The last mile market to the DEU was virtually monopolized, as only LEC had its own connection from the local market to the DEU. However Google’s entry into the last market eliminates LEC’s monopoly to the DEU. CC, the Public MAN, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as LEC appeared to be the sanctioned natural utility, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utility.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

LEC and Google provide their own interconnections to the other providers, and infrastructures and services to the DEU.

CC, the Public MAN, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via LEC and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as LEC is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too. However Google’s entry into the local market eliminates LEC’s monopoly and could counter any governmental advantages the Public MAN
may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if LEC and Google denied other providers access to their own networks, they could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If CC, the Public MAN, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to LEC and Google. CC, the Public MAN, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC and Google as the only last mile system providers wielding the most power and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
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<tr>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The potential last mile market share range to the DEU is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.
Google’s presence in the local market eliminates LEC’s monopoly, and could further cut into CC’s, the Public MAN’s, and/or ISP1’s already minor market shares. Efforts by former monopolist LEC and incumbent providers CC, Public MAN, and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to the DEU increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Routing Table for Test 11.3.

<table>
<thead>
<tr>
<th>UEUWS</th>
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<th>TIER I</th>
<th>LEC</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>LEC</td>
<td>DEUR</td>
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<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>GOOGLE</td>
<td>LEC</td>
<td>DEUR</td>
</tr>
<tr>
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<td>MAN</td>
<td>LEC</td>
</tr>
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</tr>
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<td>CC</td>
<td>LEC</td>
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<td>CC</td>
</tr>
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<tr>
<td>UEUWS</td>
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<td>TIER I</td>
<td>LEC</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
</tbody>
</table>

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

LEC and Google accesses the DEU directly via their own last mile systems. CC, the Public MAN, and ISP1 can indirectly access the DEU via interconnections with LEC and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. LEC and Google use their own last mile systems to the DEU for service provision.

If CC, the Public MAN, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s and/or Google’s systems for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to LEC’s and/or Google’s systems for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is technically not a true public MAN in this model as it does not own and operate its own last mile system, and instead it must acquire last mile access from other providers.

The DEU can use its router to instantaneously switch between LEC and Google, or use both simultaneously if it concurrently subscribes to both providers.
Scenario Questions

Scenario #12

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN but dominated by the monopolistic public MAN, and where all providers can optionally access and use each other’s local market systems. The monopolistic public MAN is the only last mile provider. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 12.1.

Describe what the model is trying to emulate.

Model 12.1 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. The Public MAN’s system accesses the DEU.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, and ISP1 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.
The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. However the construct indicates the Public MAN has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as LEC appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates the Public MAN has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. It could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too.
All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN as a monopolist and the only last mile system provider wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 12.1.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
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<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
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</tr>
</tbody>
</table>
Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER 1 = Tier 1 ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.
Part B.

Test 12.2.

Describe what the model is trying to emulate.

Model 12.2 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. The Public MAN’s system accesses the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, ISP1, or ISP2 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates the Public MAN has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, ISP1, and ISP2 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates the Public MAN has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. It could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.
If LEC, CC, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN as a monopolist and the only last mile system provider wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&gt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td></td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make the Public MAN’s monopoly a little more difficult to maintain, and could further cut into LEC’s CC’s, and ISP1’s already minor market shares. Likewise the monopolist Public MAN and incumbent providers LEC, CC, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to the DEU, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?
No.

What is the potential routing table?
Routing Table for Test 12.2.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
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<td>MAN</td>
<td>DEUR</td>
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<td>TIER I</td>
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<td>MAN</td>
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<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>DEUR</td>
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<td>TIER I</td>
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<td>LEC</td>
<td>MAN</td>
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<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>ISP1</td>
<td>MAN</td>
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<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>ISP2</td>
<td>MAN</td>
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<td>UEUR</td>
<td>TIER I</td>
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<td>CC</td>
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<td>MAN</td>
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<tr>
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<td>ISP2</td>
<td>LEC</td>
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<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>ISP1</td>
<td>CC</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>ISP1</td>
<td>LEC</td>
</tr>
</tbody>
</table>

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, ISP1, and ISP2 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, ISP1, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 12.3.

Describe what the model is trying to emulate.

Model 12.3 is attempting to emulate a local market well served by four incumbent providers, all of which provide their own systems and carriage services between the upstream provider to the local market. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU. The Public MAN’s system accesses the DEU.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to the DEU. Google interconnects with the other local market providers, and also accesses the DEU.

The DEU has an equal choice between the Public MAN and Google, and has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cable being disconnected between the Google and Downstream End User router thereby interrupting the route represented the End User having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and Google have their own connections from the Tier I ISP to the local market. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and Google are all providers. The construct indicates the Public MAN had a monopoly, whereby limiting other providers’ abilities to enter the local market. However Google’s entry into the local market eliminates the Public MAN’s monopoly.
The last mile market to the DEU was virtually monopolized, as only the Public MAN had its own connection from the local market to the DEU. However Google’s entry into the last market eliminates the Public MAN’s monopoly to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as the Public MAN appeared to be the sanctioned natural utility, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utility.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and Google provide their own interconnections to the other providers, and infrastructures and services to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates the Public MAN has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. It could use certain governmental enterprise advantages against the incumbents and other potential providers in the local market too. However Google’s entry into the local market eliminates the Public MAN’s monopoly and could counter any governmental advantages the
Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN and Google denied other providers access to their own networks, they could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN and Google. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN and Google as the only last mile system providers wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
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<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The potential last mile market share range to the DEU is:

<table>
<thead>
<tr>
<th>MAN</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.
Google’s presence in the local market eliminates the Public MAN’s monopoly, and could further cut into LEC’s CC’s, and/or ISP1’s already minor market shares. Efforts by former monopolist Public MAN and incumbent providers LEC, CC, and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to the DEU increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Routing Table for Test 12.3.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
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Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN and Google access the DEU directly via their own last mile systems. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. The Public MAN and Google use their own last mile systems to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The DEU can use its router to instantaneously switch between the Public MAN and Google, or use both simultaneously if it concurrently subscribes to both providers.
Scenario Questions

Scenario #13

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by only a public MAN. The public MAN is the sole last mile system provider but does not provide upstream carriage service. In Part B, competitor ISP2 (as both an independent ISP and as Google) will then attempt to enter the local and last mile markets.

Part A.

Test 13.1.

Describe what the model is trying to emulate.

Model 13.1 is attempting to emulate a local market “under-served” by the only incumbent Public MAN that provides its own system and carriage service to the DEU, but not to the upstream provider. The DEU has selected the Public MAN as its upstream provider, although it is the only provider available to choose from participating in the local and last mile markets, and it cannot access any other networks further upstream directly from the Public MAN.

Comment upon the computer network emulation’s conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is unserved and not competitive, as the construct indicates no providers have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. The Tier I ISP, the Public MAN, and/or other third parties may have a virtual monopoly upon the middle mile ROW and/or infrastructure artificially restricting the market from being served. However the construct indicates the Public MAN does not have an actual monopoly, and other providers may therefore be able to enter the middle mile market.

The local market is virtually monopolized, as the Public MAN is the only provider. However the construct indicates the Public MAN does not have an actual monopoly, and other providers are therefore able to enter the local market.
The last mile market is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as the Public MAN is not a sanctioned natural utility, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides both infrastructure and service to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise.

Is there a potential conflict with differing business types within the local and last mile markets?

Not applicable, as the Public MAN is the only local and last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates the Public MAN does not have an actual monopoly, but the Public MAN could potentially control the local and last mile markets since it is the only current provider in both markets thereby giving it de facto control over them. The Public MAN cannot discriminate against other providers until there actually are other providers in the two markets. However the Public MAN could announce discriminatory policies as a barrier towards potential competitors including network access restrictions, monopoly service under-pricing in the particular local market, certain governmental enterprise advantages, etc.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The Public MAN has a 100% share of both the local and last mile market.

Do the connected units recognize each other?

The Tier I and Public MAN routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as the Public MAN uses its own last mile system to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.
Part B.

Test 13.2.

Describe what the model is trying to emulate.

Model 13.2 is attempting to emulate a local market “under-served” by the only incumbent Public MAN. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU. ISP2 also interconnects with the Public MAN.

The DEU has an equal choice between the two providers and has chosen to retain the Public MAN as its upstream provider in the local and last mile markets, but cannot access any other networks further upstream directly from the Public MAN, and must access ISP2 for further upstream connectivity.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cables being disconnected between the ISP2 and Downstream End User routers thereby interrupting the route represented the End User having access to ISP2 but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is virtually monopolized, as only ISP2 has its own connection from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as the Public MAN and ISP2 are the only providers. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last
mile market is theoretically competitive as neither the Public MAN nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and ISP2 provide their own interconnections to each other, and infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and ISP2 is typically a for-profit corporation, the Public MAN could have certain unfair advantages in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither the Public MAN nor ISP2 currently have actual monopolies nor a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against ISP2 and other potential providers in the local market too.

Both of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the other could still provide access via its interconnection if necessary, making that technique harder to use as an attempt to control the market.

Since both the Public MAN and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.
What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by the Public MAN to establish a monopoly in them more difficult. Likewise the Public MAN makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The ISP2 and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Public MAN router-Downstream End User router-Downstream End User workstation.
Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-
Downstream End User router-Downstream End User workstation.

How do the providers access downstream end users?

Both the Public MAN and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both the Public MAN and ISP2 use their own last mile systems and interconnect with each others’ systems for access to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch between the Public MAN and ISP2 or use both simultaneously if it concurrently subscribes to both providers.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is an intermediary hop since the DEU choose it as its upstream provider, though the Public MAN must use the shared interconnection with ISP2 for its direct connection further upstream to Tier I ISP.

Repeat Part B if the scenario has additional models.
Test 13.3.

Describe what the model is trying to emulate.

Model 13.3 is attempting to emulate a local market “under-served” by the only incumbent Public MAN. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the DEU. ISP2 also interconnects with the Public MAN.

The DEU has an equal choice between the two providers and has chosen ISP2 as its upstream provider in the local and last mile markets.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cables being disconnected between the Public MAN and Downstream End User routers thereby interrupting the route represented the End User having access to the Public MAN but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is virtually monopolized, as only ISP2 has its own connection from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the middle mile market.

The local market is virtually duopolized, as the Public MAN and ISP2 are the only providers. However the construct indicates neither the Public MAN nor ISP2 have an actual duopoly, and other providers are therefore able to enter the local market.

The last mile market is virtually duopolized, as only the Public MAN and ISP2 have their own connections from the local market to the DEU. However the construct indicates the last mile market is theoretically competitive as neither the Public MAN nor ISP2 are sanctioned natural utilities, and other providers are therefore able to enter the market.
Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and ISP2 provide their own interconnections to each other, and infrastructures and services to the DEU.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

Yes, since the Public MAN is typically a non-profit government enterprise and ISP2 is typically a for-profit corporation, the Public MAN could have certain unfair advantages in both markets.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates neither the Public MAN nor ISP2 currently have actual monopolies nor a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or both providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other provider or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against ISP2 and other potential providers in the local market too.

Both of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the other could still provide access via its interconnection if necessary, making that technique harder to use as an attempt to control the market.

Since both the Public MAN and ISP2 provide their own last mile systems, neither provider could use access restrictions to their own systems to prevent the other from accessing end users. Both could potentially use access restrictions to their systems as a barrier to market entry unless competitive providers likewise provide their own last mile systems.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:
The potential last mile market share range is:

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Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local and last mile markets increases the number of providers by 100% making those markets more competitive but still relatively underserved due to the low number of total providers.

ISP2’s presence in the markets makes any effort by the Public MAN to establish a monopoly in them more difficult. Likewise the Public MAN makes any effort by ISP2 to establish a monopoly in the markets more difficult.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?

The Public MAN and Downstream End User routers do not recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?

Upstream End User workstation-Upstream End User router-Tier I ISP router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Public MAN router-Downstream End User router-Downstream End User workstation.

Upstream End User workstation-Upstream End User router-Tier I ISP router-ISP2 router-Downstream End User router-Downstream End User workstation.
How do the providers access downstream end users?

Both the Public MAN and ISP2 access the DEU directly via their own last mile systems.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct yes, as both the Public MAN and ISP2 use their own last mile systems and interconnect with each others’ systems for access to the DEU for service provision.

If other providers chose to enter the market and provide service to the DEU, they would either have to establish their own systems to the DEU or interconnect with and be granted adequate access to the Public MAN’s and/or ISP2’s systems for provision to the DEU.

Additional observations.

The DEU can use its router to instantaneously switch between the Public MAN and ISP2 or use both simultaneously if it concurrently subscribes to both providers.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN is eliminated as an intermediary hop with the DEU choosing ISP2 as its upstream provider with its direct connection to Tier I ISP.
**Scenario Questions**

Scenario #14

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN, where the Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 14.1.

Describe what the model is trying to emulate.

Model 14.1 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once
participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. Other providers are likewise able to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for
instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN as the only last mile system provider wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the market does each provider have?

The potential local market share range is:

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The Public MAN has a 100% share of the last mile market to DEU.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 14.1.

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Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Part B.

Test 14.2.

Describe what the model is trying to emulate.

Model 14.2 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, ISP1, or ISP2 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1 and ISP2 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. Other providers are likewise able to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, ISP1, and ISP2 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN...
appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.
However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN as the only last mile system provider wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The Public MAN has a 100% share of the last mile market to DEU.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2 does not enter the last mile market to the DEU, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?

No.

Do the connected units recognize each other?
No.

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UEUWS  UEUR  TIER I  ISP2  ISP1  LEC  CC  MAN  DEUR  DEUWS

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, ISP1, and ISP2 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, ISP1, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Repeat Part B substituting Google Fiber for ISP2.

Describe what the model is trying to emulate.

Model 14.3 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to the DEU. Google interconnects with the other local market providers, and also accesses the DEU.

The DEU has an equal choice between the Public MAN and Google, and has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cable being disconnected between the Google and Downstream End User router thereby interrupting the route represented the End User having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and Google have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and Google are all providers. Other providers are likewise able to enter the local market.
The last mile market to the DEU was virtually monopolized, as only the Public MAN had its own connection from the local market to the DEU. However Google’s entry into the last market eliminates the Public MAN’s monopoly to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as the Public MAN appeared to be the sanctioned natural utility, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utility.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and Google provide their own interconnections to the other providers, and infrastructures and services to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates none of the providers currently have actual monopolies or a duopoly in the local and last mile markets. One of the providers could possibly try to control the local market, or two providers could possibly try to jointly control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers respectively. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too. However Google’s entry into the local market could counter any governmental
advantages the Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN and Google denied other providers access to their own networks, they could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN and Google. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with the Public MAN and Google as the only last mile system providers wielding the most power and potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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The potential last mile market share range to the DEU is:

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Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?

Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.
Efforts by incumbent providers LEC, CC, the Public MAN, and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to the DEU increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Routing Table for Test 14.3.

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<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>LEC</td>
<td>CC</td>
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<tr>
<td>UEUWS</td>
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<td>UEUWS</td>
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<td>CC</td>
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<td>UEUWS</td>
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<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>LEC</td>
<td>CC</td>
<td>ISP1</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>ISP1</td>
<td>CC</td>
<td>LEC</td>
</tr>
</tbody>
</table>

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = Google Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN and Google access the DEU directly via their own last mile systems. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. The Public MAN and Google use their own last mile systems to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

DEU1 can use its router to instantaneously switch between the Public MAN and Google, or use both simultaneously if it concurrently subscribes to both providers.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Scenario Questions

Scenario #15

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN that is dominated by two private duopolistic providers. The Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 15.1.

Describe what the model is trying to emulate.

Model 15.1 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once
participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly
service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with LEC and CC as duopolists and the Public MAN as the only last mile system provider wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 15.1.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>CC</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISPs1</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
</tbody>
</table>

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Describe what the model is trying to emulate.

Model 15.2 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, ISP1, or ISP2 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC and CC have a duopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, ISP1, and ISP2 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN
appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.
However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC and CC as duopolists and the Public MAN as the only last mile system provider wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 20%</td>
<td>&gt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the duopoly providers’ market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make LEC’s and CC’s duopoly a little more difficult to maintain, and could further cut into the Public MAN’s and ISP1’s already minor market shares. Likewise duopolists LEC and CC and incumbent providers Public MAN and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to DEU1, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?
Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 15.2.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>CC</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
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<td>LEC</td>
<td>MAN</td>
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<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
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<td>UEUR</td>
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<td>ISP2</td>
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<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>ISP2</td>
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<td>DEUR</td>
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</tr>
<tr>
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<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP2</td>
<td>ISP1</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>CC</td>
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<td>LEC</td>
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<td>MAN</td>
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<tr>
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<td>TIER I</td>
<td>LEC</td>
<td>ISP1</td>
<td>ISP2</td>
<td>MAN</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>ISP2</td>
<td>CC</td>
<td>MAN</td>
</tr>
</tbody>
</table>
Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, ISP1, and ISP2 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, ISP1, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 15.3.

Describe what the model is trying to emulate.

Model 15.3 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to the DEU. Google interconnects with the other local market providers, and also accesses the DEU.

The DEU has an equal choice between the Public MAN and Google, and has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cable being disconnected between the Google and Downstream End User router thereby interrupting the route represented the End User having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and Google have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and Google are all providers. The construct indicates LEC and CC had a duopoly, whereby limiting other
providers’ abilities to enter the local market. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly.

The last mile market to the DEU was virtually monopolized, as only the Public MAN had its own connection from the local market to the DEU. However Google’s entry into the last market eliminates the Public MAN’s monopoly to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as the Public MAN appeared to be the sanctioned natural utility, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utility.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and Google provide their own interconnections to the other providers, and infrastructures and services to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC and CC have a duopoly in the local market. The two providers could possibly try to jointly control the local market, by using for instance duopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages
against the incumbent and other potential providers in the local market too. However Google’s entry into the local market eliminates LEC’s and CC’s duopoly and could counter any governmental advantages the Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN and Google denied other providers access to their own networks, they could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN and Google. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC and CC as duopolists and the Public MAN and Google as the only last mile system providers wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
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<tr>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

The potential last mile market share range to the DEU is:

<table>
<thead>
<tr>
<th>MAN</th>
<th>Google</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?
Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

Google’s presence in the local market eliminates LEC’s and CC’s duopoly, and could further cut into the Public MAN’s and/or ISP1’s already minor market shares. Efforts by former duopolists LEC and CC and incumbent providers Public MAN and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to the DEU increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Routing Table for Test 15.3.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>CC</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>MAN</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>GOOGLE</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>GOOGLE</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>GOOGLE</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>GOOGLE</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>GOOGLE</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>GOOGLE</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>GOOGLE</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
</tr>
</tbody>
</table>
UEUWS  UEUR  TIER I  ISP1  MAN  LEC  CC  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  CC  LEC  ISP1  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  CC  ISP1  LEC  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  LEC  ISP1  CC  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  LEC  CC  ISP1  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  ISP1  CC  LEC  GOOGLE  DEUR  DEUWS
UEUWS  UEUR  TIER I  MAN  ISP1  LEC  CC  GOOGLE  DEUR  DEUWS

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = Google Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN and Google access the DEU directly via their own last mile systems. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. The Public MAN and Google use their own last mile systems to the DEU for service provision.

If LEC, CC, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

DEU1 can use its router to instantaneously switch between the Public MAN and Google, or use both simultaneously if it concurrently subscribes to both providers.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Scenario Questions

Scenario #16

What are the constructs and conditions of the scenario?

Part A will attempt to emulate a local telecommunications market served by multiple private providers including a public MAN that is dominated by a private monopolistic provider. The Public MAN is the sole last mile system provider but does not provide upstream carriage service. All providers can optionally access and use each other’s local market systems. In Part B, competitor ISP2 will then attempt to enter the local market. In Part C, competitor Google will then attempt to enter the local and last mile markets as ISP2.

Part A.

Test 16.1.

Describe what the model is trying to emulate.

Model 16.1 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, and ISP1 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once
participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, and ISP1 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise, and LEC, CC, and ISP1 are typically for-profit corporations.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, and ISP1 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to
gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, and/or ISP1 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, and ISP1 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The four providers could possibly jointly control the local market from other potential competitors entering, with LEC as a monopolist and the Public MAN as the only last mile system provider wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th></th>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
<td>&lt; 25%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Do the connected units recognize each other?

No.

What is the potential routing table?
Routing Table for Test 16.1.

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>CC</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>CC</th>
<th>LEC</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>CC</td>
<td>ISP1</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>LEC</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
<tr>
<td>UEUWS</td>
<td>UEUR</td>
<td>TIER I</td>
<td>ISP1</td>
<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
</tr>
</tbody>
</table>

| UEUWS | UEUR | TIER I | ISP1  | CC   | LEC  | MAN  | DEUR | DEUWS |

Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Part B.

Test 16.2.

Describe what the model is trying to emulate.

Model 16.2 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

ISP2 then enters the local market as a competitive ISP, providing its own system and carriage service between the upstream provider to the local market. ISP2 also interconnects with the other local market providers.

The DEU has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, ISP1, or ISP2 without first accessing the Public MAN since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and ISP2 have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1 and ISP2 are all providers. However the construct indicates LEC has a monopoly, whereby limiting other providers’ abilities to enter the local market.

The last mile market to the DEU is virtually monopolized, as only the Public MAN has its own connection from the local market to the DEU. LEC, CC, ISP1, and ISP2 either once had their own connections to the DEU or currently refuse to provide their own. However the construct indicates the last mile market is theoretically uncompetitive as the Public MAN
appears to be sanctioned natural utility, and other providers are therefore unlikely or unable to enter the market.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN provides its own interconnections to the other providers, and infrastructure and service to the DEU.

LEC, CC, ISP1, and ISP2 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation. ISP2 is likely not another government enterprise to avoid unnecessary public sector duplication and competition.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and other potential providers in the local market too.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.
However if the Public MAN denied other providers access to its own network, it could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC as a monopolist and the Public MAN as the only last mile system provider wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

<table>
<thead>
<tr>
<th>LEC</th>
<th>CC</th>
<th>MAN</th>
<th>ISP1</th>
<th>ISP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>&gt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

Note - No competitor can exceed the monopoly provider’s market shares.

The Public MAN has a 100% share of the last mile market to DEU.

Does adding ISP2 make the market in the models more competitive? Does adding ISP2 affect the conditions governing each scenario?

ISP2’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

ISP2’s presence in the local market may make the Public MAN’s monopoly a little more difficult to maintain, and could further cut into LEC’s, CC’s, and ISP1’s already minor market shares. Likewise the monopolist Public MAN and incumbent providers LEC, CC, and ISP1 could make any effort by ISP2 to establish a monopoly in the market quite difficult.

ISP2 does not enter the last mile market to the DEU, leaving the number of those providers at one. That market’s competitiveness remains unaffected and still underserved due to its sole provider.

Do the Tier I ISP and the Downstream End User routers acknowledge the ISP2 router?
No.

Do the connected units recognize each other?

No.

What is the potential routing table?
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<tr>
<th>UEUWS</th>
<th>UEUR</th>
<th>TIER I</th>
<th>ISP2</th>
<th>LEC</th>
<th>CC</th>
<th>ISP1</th>
<th>MAN</th>
<th>DEUR</th>
<th>DEUWS</th>
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<td>DEUWS</td>
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<td>CC</td>
<td>MAN</td>
<td>DEUR</td>
<td>DEUWS</td>
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Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
ISP2 = ISP2 Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN accesses the DEU directly via its own last mile system. LEC, CC, ISP1, and ISP2 can indirectly access the DEU via interconnections with the Public MAN as the last hop in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct no. The Public MAN uses its own last mile system to the DEU for service provision.

If LEC, CC, ISP1, and/or ISP2 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s system for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Part C.

Repeat Part B substituting Google Fiber for ISP2.

Test 16.3.

Describe what the model is trying to emulate.

Model 16.3 is attempting to emulate a local market well served by four incumbent providers. LEC, CC, and ISP1 provide their own systems and carriage services between the upstream provider to the local market. The Public MAN provides its own system and carriage service to the DEU, but not to the upstream provider. All of the providers are interconnected to each other, enabling a variety of routes between the upstream provider, the local market providers, and the DEU.

Google then enters the local market as competitive ISP2, providing its own system and carriage service between the upstream provider to the DEU. Google interconnects with the other local market providers, and also accesses the DEU.

The DEU has an equal choice between the Public MAN and Google, and has chosen the Public MAN as its upstream provider in the local and last mile markets, but cannot choose LEC, CC, or ISP1 without first accessing the Public MAN or Google since there is no direct access to the others available.

Comment upon the computer network emulation's conformity to the constructs and conditions.

The end user workstations, end user router, and provider routers were not successfully networked together and did not function properly to form the end-to-end network as envisioned by the model and under the constraints of the scenario. The interconnection of provider routers in the local market enabled route sharing among them. The network cable being disconnected between the Google and Downstream End User router thereby interrupting the route represented the End User having access to Google but not subscribing to them.

Describe the market competition between the Tier I ISP and the downstream end users.

The middle mile market is competitive, as LEC, CC, ISP1, and Google have their own connections from the Tier I ISP to the local market. The Public MAN either once had a connection to the Tier I ISP or currently refuses to provide one. The Tier I ISP either once participated in the middle market too or currently refuses to participate there. Other providers are likewise able to enter the middle mile market.

The local market is competitive, as LEC, CC, the Public MAN, ISP1, and Google are all providers. The construct indicates LEC had a monopoly, whereby limiting other providers’
abilities to enter the local market. However Google’s entry into the local market eliminates LEC’s monopoly.

The last mile market to the DEU was virtually monopolized, as only the Public MAN had its own connection from the local market to the DEU. However Google’s entry into the last market eliminates the Public MAN’s monopoly to the DEU. LEC, CC, and ISP1 either once had their own connections to the DEU or currently refuse to provide their own. The construct indicates the last mile market was theoretically uncompetitive as the Public MAN appeared to be the sanctioned natural utility, and other providers were therefore unlikely or unable to enter the market. However Google’s entry into the last market eliminates the natural utility.

Indicate if each provider provides only infrastructure, only service, or both infrastructure and service.

The Public MAN and Google provide their own interconnections to the other providers, and infrastructures and services to the DEU.

LEC, CC, and ISP1 provide their own interconnections to the other providers, and can provide their own services to the DEU via the Public MAN and Google.

Indicate the business type (for-profit or non-profit) for each provider.

The Public MAN is typically a non-profit government enterprise. LEC, CC, and ISP1 are typically for-profit corporations. ISP2 is typically a for-profit corporation, but could be a non-profit corporation.

Is there a potential conflict with differing business types within the local and last mile markets?

In the local market yes, since the Public MAN is typically a non-profit government enterprise and LEC, CC, ISP1, and ISP2 are typically for-profit corporations, the Public MAN could have certain unfair advantages over them.

In the last mile market to DEU the question is not applicable, as the Public MAN is the only last mile market provider.

Is there an opportunity for a provider to control the local and last mile markets and/or discriminate vs. other providers? How?

The construct indicates LEC has a monopoly in the local market. The provider could possibly try to control the local market, by using for instance monopoly service under-pricing to gain and retain more end users than the other providers or potential competitive providers. The Public MAN could use certain governmental enterprise advantages against the incumbent and
other potential providers in the local market too. However Google’s entry into the local market eliminates LEC’s monopoly and could counter any governmental advantages the Public MAN may have. Given Google’s corporate size and powers it could become a monopoly in the market if it so desired.

All of the providers’ local market networks are interconnected, so if one provider denied others access to its own network, the others could still provide access via their interconnections if necessary, making that technique harder to use as an attempt to control the market.

However if the Public MAN and Google denied other providers access to their own networks, they could also restrict last mile access to the DEU. The other providers could use interconnections to each other but would not be able to access the DEU, enforcing that technique as an effective way to control the market.

If LEC, CC, ISP1, and/or ISP2 denied the other providers access to their own networks, the others could still provide access via interconnections to the Public MAN. LEC, CC, ISP1, and ISP2 lacking their own last mile systems render using that technique as an attempt to control the market inconsequential.

The five providers could possibly jointly control the local market from other potential competitors entering, with LEC as a monopolist and the Public MAN and Google as the only last mile system providers wielding the most power, and the Public MAN potentially using certain governmental enterprise advantages for such control.

What fraction(s) or percentage(s) of the local and last mile markets does each provider have?

The potential local market share range is:

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<tr>
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<th>MAN</th>
<th>ISP1</th>
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The potential last mile market share range to the DEU is:

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Does adding Google make the market in the models more competitive? Does adding Google affect the conditions governing each scenario?
Google’s entry in the local market increases the number of providers by 25% making the market even more competitive and well served due to the larger number of total providers.

Google’s presence in the local market eliminates LEC’s monopoly, and could further cut into CC’s, the Public MAN’s, and/or ISP1’s already minor market shares. Efforts by former monopolist LEC and incumbent providers CC, Public MAN, and ISP1 to prevent Google from establishing a monopoly in the market if it so desired would be quite difficult for them.

Google’s entry in the last mile market to the DEU increases the number of providers by 100% making that market more competitive but still relatively underserved due to the low number of total providers.

Do the Tier I ISP and the Downstream End User routers acknowledge Google’s router?

No.

Do the connected units recognize each other?

The Google and Downstream End User routers do not directly recognize each other not only because of the disconnection since the whole emulation malfunctioned.

What is the potential routing table?
Routing Table for Test 16.3.

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Key:

UEUWS = Upstream End User Workstation
UEUR = Upstream End User Router
TIER I = Tier I ISP
LEC = LEC Router
CC = CC Router
MAN = Public MAN Router
ISP1 = ISP1 Router
GOOGLE = Google Router
DEUR = Downstream End User Router
DEUWS = Downstream End User Workstation
How do the providers access downstream end users?

The Public MAN and Google access the DEU directly via their own last mile systems. LEC, CC, and ISP1 can indirectly access the DEU via interconnections with the Public MAN and Google as the last hops in those routes.

Do all providers have equal access to the end users in the last mile market? Explain for each if necessary.

According to the construct somewhat. The Public MAN and Google use their own last mile systems to the DEU for service provision.

If LEC, CC, and/or ISP1 chose to provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

If other providers chose to enter the market and provide service to the DEU, they would have to interconnect with and be granted adequate access to the Public MAN’s and/or Google’s systems for provision to the DEU.

Additional observations.

The shared access model is possible in theory, but in a typical capitalistic/mixed economy, a host provider would likely require a guest provider to provide equivalent access, access fees, etc., to compensate provision expenses and to earn profits; else third party access is most likely an unfair model and cost for them.

DEU1 can use its router to instantaneously switch between the Public MAN and Google, or use both simultaneously if it concurrently subscribes to both providers.

The Public MAN could opt out of competitive service provision in the local market, and act solely as a common provider in the last mile. Thus no other local market provider would have to provide their own last mile system.
Appendix D

Model 1.1 Consultant Recommendations
Appendix E

Models Only
Model 1.1 Base Topology.
Model 1.2 Test Topology.
Model 1.3 Test Topology.
Model 2.1 Base Topology.
Model 2.2 Test Topology.
Model 2.3 Test Topology.
Model 2.4 Test Topology.
Model 2.5 Test Topology.
Model 3.1 Base Topology.
Model 3.2 Test Topology.
Model 3.3 Test Topology.
Model 3.4 Test Topology.
Model 4.1 Base Topology.
Model 4.2 Test Topology.
Model 4.3 Test Topology.
Model 4.4 Test Topology.
Model 4.5 Test Topology.
Model 5.1 Base Topology.
Model 5.2 Test Topology.
Model 5.3 Test Topology.
Model 6.1 Base Topology.
Model 6.2 Test Topology.
Model 6.3 Test Topology.
Model 6.4 Test Topology.
Model 6.5 Test Topology.
Model 6.6 Test Topology.
Model 7.1 Base Topology.
Model 7.2 Test Topology.
Model 7.3 Test Topology.
Model 7.4 Test Topology.
Model 8.1 Base Topology.
Model 8.2 Test Topology.
Model 8.3 Test Topology.
Model 8.4 Test Topology.
Model 8.5 Test Topology.
Model 8.6 Test Topology.
Model 9.1 Base Topology.
Model 9.2 Test Topology.
Model 10.1 Base Topology.

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Upstream End User WS

Upstream End User Router

Tier I ISP

LEC  CC  Public MAN  ISP1

Dnstream End User Router

Dnstream End User WS1  Dnstream End User WS2
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Model 10.2 Test Topology.
Model 10.3 Test Topology.
Model 11.1 Base Topology.
Model 11.2 Test Topology.
Model 11.3 Test Topology.
Model 12.1 Base Topology.
Model 12.2 Test Topology.
Model 12.3 Test Topology.
Model 13.1 Base Topology.
Model 13.2 Test Topology.
Model 13.3 Test Topology.
Model 14.1 Base Topology.
Model 14.2 Test Topology.
Model 14.3 Test Topology.
Model 15.1 Base Topology.
Model 15.2 Test Topology.
Model 15.3 Test Topology.
Model 16.1 Base Topology.
Model 16.2 Test Topology.
Model 16.3 Test Topology.
Appendix F

Model Filtering Results
Model Filtering Scoring Results

### Model Filtering Results

**Filters**

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## Model Filtering Scoring Results
### Non-Profit MANs

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# Model Filtering Scoring Results
## Non-Profit MANs

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## Model Filtering Scoring Results
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