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29 Digital Tornado: The Internet and Telecommunications Policy

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Digital Tornado: The Internet and Telecommunications Policy

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A. Background

The Internet, from its roots a quarter-century ago as a military and academic research tool, has become a global resource for millions of people. As it continues to grow, the Internet will generate tremendous benefits for the economy and society. At the same time, the Internet poses significant and difficult questions for policy makers. This working paper examines some of these emerging issues at the intersection of technology, law, economics, and public policy.

The United States federal government has long been involved in the development of the Internet. Through research grants, and by virtue of its status as the largest institutional user of computer services in the country, the federal government played a central role in bringing what we now call the Internet into being. Just as important, the federal government has consistently acted to keep the Internet free of unnecessary regulation and government influence. As the Internet has matured and has grown to support a wide variety of commercial activity, the federal government has transitioned important technical and management functions to the private sector. In the area of telecommunications policy, the Federal Communications Commission (FCC) has explicitly refused to regulate most online information services under the rules that apply to telephone companies.

Limited government intervention is a major reason why the Internet has grown so rapidly in the United States. The federal government's efforts to avoid burdening the Internet with regulation should be looked upon as a major success, and should be continued. The Telecommunications Act of 1996 (1996 Act) adopts such a position. The 1996 Act states that it is the policy of the United States "to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation,"[1] and the FCC has a responsibility to implement that statute. The draft "Framework for Global Electronic Commerce" developed by the White House with the involvement of more than a dozen federal agencies, similarly emphasizes the need to avoid unnecessary government interference with the Internet.[2]

This working paper addresses three overlapping telecommunications policy areas that relate to the Internet: law, economics, and public policy. Legal questions arise from the difficulty in applying existing regulatory classifications to Internet-based services. Economic

[1] Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56, *to be codified at* 47 U.S.C. §§ 151 *et. seq* (1996 Act), at § 230(b)(2). Hereinafter, all citations to the 1996 Act will be to the 1996 Act as codified in the United States Code.

[2] *A Framework for Global Electronic Commerce*, available on the World Wide Web at <http://www.whitehouse.gov>.

questions arise from the effects of Internet usage on the telecommunications infrastructure, and the effects of the telecommunications infrastructure on the Internet. Public policy questions arise from the need to maximize the public benefits that the Internet brings to society.

The Internet is a fluid, complex entity. It was designed to route around obstacles, such as failures at central points of the network, and it may respond in unexpected ways to pressures placed on it. It has developed largely without any central plan, especially in the past several years as the U.S. government has reduced its management role. It overcomes any boundaries that can be drawn, whether rooted in size, geography, or law. Because the Internet represents an ever-growing interconnected network, no one entity can control or speak for the entire system. The technology of the Internet allows new types of services to be layered on top of existing protocols, often without the involvement or even the knowledge of network providers that transmit those services. Numerous users can share physical facilities, and the mix of traffic through any point changes constantly through the actions of a distributed network of thousands of routers.

The chaotic nature of the Internet may be troubling for governments, which tend to value stability and certainty. However, the uncertainty of the Internet is a strength, not a weakness. With decentralization comes flexibility, and with flexibility comes dynamism. Order may emerge from the complex interactions of many uncoordinated entities, without the need for cumbersome and rigid centralized hierarchies. Because it is not tied to traditional models or regulatory environments, the Internet holds the potential to dramatically change the communications landscape. The Internet creates new forms of competition, valuable services for end users, and benefits to the economy. Government policy approaches toward the Internet should therefore start from two basic principles: avoid unnecessary regulation, and question the applicability of traditional rules.

Beyond these overarching themes, some more specific policy goals can be identified. For the FCC in particular, these include the following.

Promote competition in voice, video, and interactive services.
In passing the 1996 Act, Congress expressed its intent to implement a "pro-competitive deregulatory national communications policy." The Internet provides both a space for innovative new services, as well as potential competition for existing communications technologies. The FCC's role will be to ensure that the playing field is level, and that efficiency and market forces drive competition.

Facilitate network investment and technological innovation.
The Internet encourages the deployment of new technologies that will benefit consumers and produce jobs. The Commission should not attempt to pick winners, but should allow the marketplace to decide whether specific technologies become successful. By eliminating regulatory roadblocks and other disincentives to investment, the FCC should encourage both incumbents and new entrants to develop innovative solutions that transcend the capabilities of the existing network.

Allow all citizens to benefit from advanced technologies.
The communications revolution should benefit all Americans. In an age of new and exciting forms of interactive communications, the FCC should ensure that entities such as schools and libraries are not left behind. However, the mechanisms used to achieve this goal should be consistent with the FCC's broader policies of competition and deregulation.

B. Summary of Contents

This working paper reviews some of the major Internet-related issues that have already come before the Commission, as well as those that may come before the FCC in the near future.

This paper is not intended to be a comprehensive overview of every Internet topic that has implications for the FCC. I have focused on issues where I believe the Internet raises the most immediate questions for telecommunications policy, and especially those that have already been raised in FCC proceedings. Beyond those discussed in this paper, there are several other topics of great importance to the development of the Internet that may have implications for the FCC. These include: Internet governance (such as the allocation of domain names), intellectual property, network reliability, privacy, spectrum policy, standards, and security. By omitting these issues, I do not suggest that they are of less importance to the government or the private sector. The underlying policy recommendations of this paper are applicable to all Internet issues that come before a government agency such as the FCC, although specific subjects may require individualized consideration.

Because this paper is about the role of the FCC, it focuses almost entirely on the United States. The FCC's decisions depend on the specific legal and economic structures that govern the communications industry in this country. Likewise, the United States experiences more acutely many of the challenges the Internet generates, because this country has by far the largest percentage of the Internet's infrastructure and traffic. The Internet, however, is a global network. The essential characteristics that make the Internet so valuable, and also so difficult to understand in the context of traditional telecommunications policy, are relevant worldwide. Some Internet issues may best be addressed in international fora, and this paper does not suggest that all the issues described should be resolved by the United States government alone.

With these caveats in mind, the paper seeks to develop a consistent public policy approach for issues involving the Internet and telecommunications policy.

Section I provides a framework for understanding the dynamism of the Internet, and the fundamental forces that propel it. This section propounds the notion of the Internet as feedback loop, a constantly expanding spiral that creates the conditions for its further growth. The Internet spiral is driven by four factors. First, "deep convergence," which represents the impact of digital technology in breaking down barriers between different services and networks. Second, the interaction of Moore's Law (progressively higher computing power at a given cost) with

Metcalfe's Law (progressively more value to being connected to a network), combined with increasing network bandwidth, leads to plummeting costs and soaring performance for the Internet's underlying facilities. Third, through "the magnetism of money and minds," the market rewards innovation by attracting both the people and the financing necessary for further innovation. Fourth, unfettered competition pressures companies to take advantage of market opportunities and to utilize more efficient technologies.

Envisioning the Internet as a feedback loop leads to three recommendations for government policy. First, government should seek scalability, not just stability. Government policy should be forward-looking, recognizing that the Internet will continue to grow and evolve, and should not attempt to impose on the Internet the familiar limitations of traditional communications technologies. Second, government should swim with the current. In other words, government should harness the tremendous potential of the Internet to help achieve public policy goals. The challenge is to meet the exploding demand for bandwidth, not to restrain it. Third, government should promote the Network, not networks. Rather than focusing on individual companies or industries, government should create a climate that maximizes social welfare.

Section II identifies the salient characteristics of the Internet. To understand how the Internet affects and is affected by regulatory decisions, it is important to understand how services are provided over the Internet, and to distinguish the Internet from other communications technologies. This section also provides a brief history of the Internet, to place the analysis of the current Internet in a proper context.

Section III examines whether existing FCC regulatory and statutory requirements should apply to services provided over the Internet. The Commission has not yet confronted most of these legal questions directly, although it has expressed reservations about applying traditional rules to the Internet. However, the continued growth of the Internet and the development of new, hybrid services make it likely that the FCC will need to resolve some of these issues. The FCC's current division between "basic" and "enhanced" services, and the statutory definitions of entities such as "telecommunications carriers" and "broadcasters," provide only limited guidance. The paper recommends that government exercise caution in imposing pre-existing statutory and regulatory classifications on Internet-based services. The FCC should begin by identifying Internet services that clearly lie outside the scope of traditional regulatory requirements, so as to minimize market uncertainty while it confronts the more difficult categorization issues.

Section IV looks at the economics of Internet usage. The growth of the Internet pressures not only the current regulatory regime, but also the physical networks that carry Internet traffic. The FCC oversees the most of the underlying communications facilities upon which the Internet depends, including the public switched telephone network. FCC decisions on the pricing of traditional telecommunications services significantly impact the Internet, even as the growth in Internet usage itself affects the voice network. The debate in this context should focus on the future of the network. The FCC should strive to give companies market-efficient incentives to build high-capacity, high-performance networks that are optimized for data transport. This approach will allow the operation of the market and technological development to resolve difficulties such as congestion and limited bandwidth.

Section V considers the extent to which users can take advantage of the Internet. The FCC has for decades promoted "universal service" in telecommunications, and the emergence of the Internet requires a reassessment of how that responsibility should be interpreted today. The value of the Internet largely depends on the level of bandwidth that can be delivered to end users. Many different technologies are being developed to permit higher-speed connections than are currently affordable for most consumers. In addition, certain institutions, such as schools and libraries, as well as users who would otherwise be unable to access the Internet, should be able to benefit from the Global Information Infrastructure.

Section VI concludes by linking the Internet-specific issues with the FCC's overarching efforts to facilitate competition in all communications markets. Competition is a theme that runs throughout this paper. The technological shifts associated with the Internet dovetail with the communications industry's transition from regulated monopolies to a world of overlapping competitive firms. In the end, successfully opening the communications sector to competition will likely be the greatest contribution that government can make to the development of the Internet.

C. The Government Role

This working paper is intended to explore issues and to facilitate discussion, not to propose specific government actions. Many proponents of the Internet's development are wary of any government actions directed toward the Internet. Government, however, has been intimately involved with the Internet since the network's beginnings. Government decisions -- such as the FCC's directive that Internet service providers not be subject to interstate access charges, and the widespread requirement by state regulators that local calls be available at flat monthly rates -- continue to shape Internet development. Moreover, policy decisions are best made with knowledge and comprehension of their potential implications.

The goal of this paper, therefore, is to promote greater understanding, on the part of both government and the private sector, of the unique policy issues the Internet raises for the FCC and similar agencies. The discussion of a topic is not a suggestion that government regulation in that area is necessary or desirable. On the contrary, a fundamental position of this paper is that government should work to avoid unnecessary interference with the Internet's development.

Government may influence the evolution of the Internet in many ways, including directly regulating, participating in technical standards development, providing funding, restricting anti-competitive behavior by dominant firms, facilitating industry cooperation otherwise prohibited by antitrust laws, promoting new technologies, encouraging cooperation between private parties, representing the United States in international intergovernmental bodies, and large-scale purchasing of services. The FCC and other government entities may also play a useful role simply by raising the profile of issues and stimulating debate. A better understanding of the relationship between the Internet and telecommunications policy will facilitate intelligent decision-making about when and to what extent any of these government actions are appropriate.

I. Introduction: The Endless Spiral of Connectivity

Government officials, pundits, and market researchers often compare the Internet to established communications technologies such as telephony and broadcasting. These efforts are understandable. "Traditional" technologies have well-defined usage characteristics, growth patterns, and market behavior. Moreover, the Internet physically "piggybacks" on other networks, in particular the wireline telephone infrastructure.

Drawing analogies between the Internet and traditional media makes it easier to decide whether existing bodies of law or regulation apply to new Internet-based services. Thus, for example, the debate over the constitutionality of the Communications Decency Act (CDA), which seeks to restrict the transmission of indecent material over the Internet, has often boiled down to a conflict of analogies. Opponents of the CDA have compared the Internet to a telephone network, while supporters often describe the Internet as similar to broadcasting. Because telephone carriers are generally not legally responsible for the content routed over their networks, but broadcasters may be subject to fines for transmitting inappropriate material, the choice of analogy can predetermine the legal outcome.

Although such analogies are appealing, most break down upon closer analysis of the unique characteristics of the Internet. The Internet is substitutable for all existing media. In other words, the Internet potentially poses a competitive threat for every provider of telephony, broadcasting, and data communications services. At the same time, Internet-related businesses are substantial customers of existing telephony, broadcasting, and data companies. The Internet creates alternate distribution channels for pre-existing content, but more importantly, it permits delivery of new and hybrid forms of content. The Internet is one of many applications that utilize the existing telephone network. However, from another perspective, the telephone, broadcasting, and cable networks are simply nodes of the larger network that is the Internet.

Thus, the Internet is fundamentally different from other communications technologies. In most cases, simply mapping the rules that apply to other services onto the Internet will produce outcomes that are confusing, perverse, or worse. Any attempt to understand the relationship between the Internet and telecommunications policy must therefore begin with the distinguishing aspects of the Internet.

A. How the Internet is Unique

The distinctiveness of the Internet derives in large part from its technical architecture, which is described in greater detail in Section II. The Internet functions as a series of layers, as increasingly complex and specific components are superimposed on but independent from other components.[3] The technical protocols that form the foundation of the Internet are open and flexible, so that virtually any form of network can connect to and share data with other networks through the Internet. As a result, the services provided through the Internet (such as the World Wide Web) are decoupled from the underlying infrastructure to a much greater extent than with other media. Moreover, new services (such as Internet telephony) can be introduced without necessitating changes in transmission protocols, or in the thousands of routers spread throughout the network.

The architecture of the Internet also breaks down traditional geographic notions, such as the discrete locations of senders and receivers. The Internet uses a connectionless, "adaptive" routing system, which means that a dedicated end-to-end channel need not be established for each communication. Instead, traffic is split into "packets" that are routed dynamically between multiple points based on the most efficient route at any given moment. Many different communications can share the same physical facilities simultaneously. In addition, any "host" computer connected directly to the Internet can communicate with any other host.

A further distinguishing characteristic of the Internet is its fractal nature. Fractals are derived from the branch of mathematics known as chaos or complexity theory. Fractals exhibit "self-similarity"; in other words, a roughly similar pattern emerges at any chosen level of detail. Internet traffic patterns most clearly demonstrate the Internet's fractal tendencies. For traditional communications networks (including the telephone network), engineers have over many years developed sophisticated statistical models to predict aggregate usage patterns. Researchers have shown that usage of the Internet follows not the traditional "poisson" pattern, but rather a fractal distribution.[4] In other words, the frequency of Internet connections, the distribution between short and long calls, and the pattern of data transmitted through a point in the network tend to look similarly chaotic regardless of the time scale.

The fractal nature of the Internet confounds regulatory and economic models established for other technologies. However, as chaos theorists have shown, fractals have valuable attributes. In a fractal entity, order emerges from below rather than being dictated from above. The fact that the Internet does not have an easily-identifiable hierarchy or any clear organizational structure does not mean that all behavior is random. Many small, uncoordinated interactions may produce an aggregate whole that is remarkably persistent and adaptable.

Finally, the Internet has thus far not been regulated to the same extent as other media. The Communications Act of 1934 (Communications Act), which created the Federal Communications Commission to oversee telephony and radio broadcasting, is more than sixty

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[3] Tony Rutkowski, former Executive Director of the Internet Society, has written a more detailed discussion of the implications of Internet architecture for the development of the network. *See* Anthony M. Rutkowski, "Internet as Fractal: Technology, Architecture, and Evolution," in *The Internet as Paradigm* (Aspen Institute 1997).

[4] *See* Amir Atai & James Gordon, *Impacts of Internet Traffic on LEC Networks and Switching Systems* (Bellcore 1996); Vadim Antonov, *ATM: Another Technological Mirage*, available on the World Wide Web at <http://www.pluris.com/ip_vs_atm/>.

years old. By contrast, Internet service providers, and other companies in the Internet industry, have never been required to gain regulatory approval for their actions.

B. The Feedback Loop

If the Internet is not like any other established communications technology, what then is it? On one level, the Internet is whatever anyone wants it to be. It is plastic, decentralized, and constantly evolving network. Any simple concept to describe the Internet will necessarily be incomplete and misleading.[5] Such templates are useful, however, to promote greater understanding of aspects of the Internet that may not otherwise be obvious.

For purposes of this paper, I believe it is valuable to understand the Internet as a feedback loop. A feedback loop occurs when the output of a system is directed back into the system as an input. Because the system constantly produces fuel for its own further expansion, a feedback loop can generate explosive growth.[6] As the system expands, it produces more of the conditions that allow it to expand further. All networks are feedback loops, because they increase in value as more people are connected.[7] The Internet, however, is driven by a particularly powerful set of self-reinforcing conditions.

[5] For a thorough explication of various metaphors for the Internet, including the now well-worn notion of the "Information Superhighway" coined by Vice President Albert Gore, see Mark Stefik, *Internet Dreams: Archetypes, Myths, and Metaphors* (1996).

[6] For an extended discussion of the significance for feedback loops and control mechanisms as they relate to new technologies, see Kevin Kelly, *Out of Control: The New Biology of Machines, Social Systems, and the Economic World* (1994).

[7] *See infra* section (IV)(B).

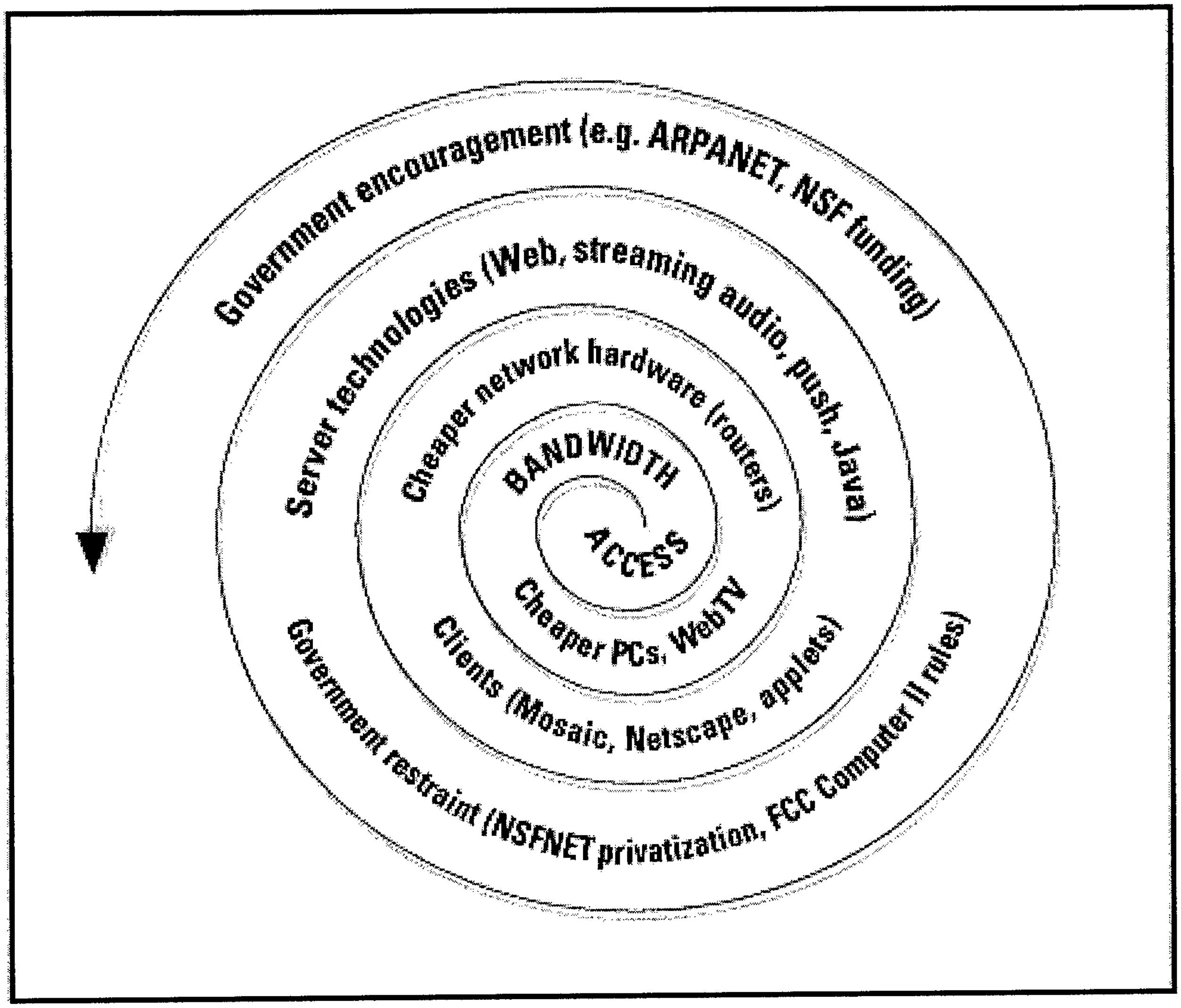

Figure 1 — The Internet Spiral

Figure 1 describes some of the interrelated factors that build upon each other to foster the growth of the Internet. Some "supply" factors (such as the availability of higher-capacity networks) permit an expansion of demand (for example, by allowing bandwidth-intensive services such as high-resolution video transmission). Like a digital tornado, the vortex continues, as the new level of demand creates the need for additional capacity, and so forth.[8] The Internet feedback loop is a fundamentally positive force, because it means that more and more services will be available at lower and lower prices. So long as effective self-correcting mechanisms exist, the Internet will overcome obstacles to its future growth.

Understanding the underpinnings of the Internet feedback loop is necessary to craft policies that facilitate, and do not hinder, its continuation. There are four primary factors that support the growth of the Internet:

Digitalization and "Deep Convergence"

As described above, the Internet exhibits characteristics of several media that had previously been distinct. Networks carry three types of information -- voice, video, and data -- and those categories are further subdivided into areas such as pre-recorded vs. live or real-time presentation, and still vs. moving images. Historically, these different forms of information have used different delivery vehicles. The telephone network delivered voice, private corporate networks delivered data, and broadcast networks delivered video. Each service was tightly coupled to a specific form of infrastructure -- the telephone network used copper wires to reach subscribers, broadcast television used the airwaves, cable television used coaxial cable, and so forth.

"Convergence" means that those lines are blurring. However, convergence is often understood in a shallow manner, as simply the opportunity for owners of one type of delivery system to compete with another type of delivery system, or as the opportunity for content owners to deliver their content using different technologies. In reality, convergence is something far more fundamental. "Deep convergence" is driven by a powerful technological trend -- digitalization. Digitalization means that all of the formerly distinct content types are reduced to a stream of binary ones and zeroes, which can be carried by any delivery platform.[9] In practical terms, this means not only that specific boundaries -- between a telephone network and a cable system, for example -- are blurred, but also that the very exercise of drawing any such boundaries must be fundamentally reconsidered or abandoned.

Digitalization has been occurring for decades. The long-distance telephone network in the United States is now almost entirely comprised of digital switches and fiber optic transmission links. These digital facilities, however, have been optimized to transport a single service -- voice. The Internet, by contrast, can transmit any form of data. Internet protocols are

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[8] The tornado metaphor has been used by Paul Saffo, Eric Schmidt, and others to describe the Internet.

[9] *See Digitization and Competition* (Computer Systems Policy Project 1996).

sufficiently flexible to overcome the boundaries between voice and other services. Innovators can develop new services and immediately load them onto the existing Internet infrastructure. Convergence creates new markets, and new efficiencies, because particular services are no longer locked into specific forms of infrastructure.

Moore's Law and Metcalfe's Law

As George Gilder has most clearly articulated, the two technological "laws" that most impact the growth of the Internet are Moore's Law and Metcalfe's Law.[10] Moore's Law holds that the maximum processing power of a microchip, at a given price, doubles roughly every eighteen months. In other words, computers become faster at an explosive rate, or conversely, the price of a given level of computing power decreases at that same dramatic rate. Metcalfe's Law says that the value of a network is equivalent to the square of the number of nodes. In other words, as networks grow, the utility of being connected to the network not only grows, but does so exponentially.

Moore's Law and Metcalfe's Law intersect on the Internet. Both the computers through which users access the Internet, and the routers that transmit data within the Internet, are subject to the price/performance curve described by Moore's Law. At the same time, advances in data transmission technology have expanded the capacity of the Internet's backbone networks. As the bandwidth available through the network continues to grow, Moore's Law states that the price of obtaining a given level of bandwidth continues to drop, while Metcalfe's Law dictates that the value of a connection increases exponentially. The ratio of the cost of Internet access to the value it provides plummets over time. And as it plummets, connectivity and higher-bandwidth connections become that much more important, generating more usage and more capital to upgrade the network.

The Magnetism of Money and Minds

Moore's Law and Metcalfe's Law describe the technological forces that push the growth of the Internet, but there are also business forces that exert a powerful influence. In a capitalist economy, the "invisible hand" of the market dynamically redirects capital where it is most highly valued, without any direct outside intervention. Companies that demonstrate superior potential for generating future revenues more easily attract investment, and for public companies, see their stock prices rise. Other companies in the same industry sector often see increases in their stock prices as well, as investors seek to repeat the pattern of the first company and to capitalize on economic trends.

As money flows into a "hot" sector, so do talented people seeking to obtain some of that money by founding or working at a company in that sector. The presence of so many top minds further attracts capital, reflecting a synergistic process I call "the magnetism of money and

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[10] *See, e.g.*, George Gilder, "The Bandwidth Tidal Wave," *Forbes ASAP*, December 5, 1994.

minds." This trend promotes the availability of financing to spur the future growth of the Internet.

Competition

Competition enables both the dynamic allocation of capital and talent, as well as the constant innovation in technology that leads to deep convergence and falling prices. In a competitive market, companies must constantly invest and innovate, or risk losing out to competitors. Intel CEO Andy Grove has observed that in the computer industry there are only two kinds of companies: the quick and the dead. Even those companies with strong positions must always look over their shoulder, because customer loyalty vanishes in the face of superior alternatives.

The benefits of competition are evident in the computer industry, where companies must constantly improve their products to remain successful. Competition in the Internet context means that many different providers of hardware, software, and services vie for customers. In a competitive market, providers that can offer superior service or prices are more likely to succeed. Technological innovations that lower costs or allow new service options will be valuable to providers and consumers alike.

C. Threats to the Continued Spiral

If the Internet truly operates like a feedback loop, why is government intervention necessary?

There are many ways the Internet spiral could be derailed. Any of the underlying drivers of Internet growth could be undermined. Moving toward proprietary standards or closed networks would reduce the degree to which new services could leverage the existing infrastructure. The absence of competition in the Internet service provider market, or the telecommunications infrastructure market, could reduce incentives for innovation. Excessive or misguided government intervention could distort the operation of the marketplace, and lead companies to expend valuable resources manipulating the regulatory process.

Insufficient government involvement may also, however, have negative consequences. Some issues may require a degree of central coordination, even if only to establish the initial terms of a distributed, locally-controlled system. A "tragedy of the commons" situation may arise when all players find it in their own self-interest to consume limited common resources. The end result, in the absence of collective action, may be an outcome that no one favors. In addition, the failure of the federal government to identify Internet-related areas that should not be subject to regulation leaves open opportunities for state, local, or international bodies to regulate excessively and/or inconsistently.

D. How Government Should Act

The novel aspects of the Internet require government policies that are sensitive to both the challenges and the opportunities of cyberspace. Three principles should guide such government decision-making:

Scalability, not just Stability

Rather than seeking to restrain the growth of the Internet, government should encourage it. As long as the underpinnings of the network support further expansion, and self-correcting mechanisms can operate freely, the Internet should be able to overcome obstacles to further development. Additional capital and innovation will be drawn to any challenge due to the prospect of high returns. In addition, a focus on scalability directs the attention of policy makers to the future of the network, rather than its current configuration. Given the rapid rate at which the Internet is changing, such a forward-looking perspective is essential. The "growth" of the Internet means more than an increase in the number of users. It also means that the network will evolve and change, becoming an ever more ubiquitous part of society.

Nevertheless, stability remains important. The Internet must achieve a sufficient level of reliability to gain the trust of consumers and businesses. However, even such stability requires an architecture that is built to scale upward. Otherwise, periods of calm will inevitably be followed by crashes as the Internet continues to grow.

Swim with the Current

The economic and technological pressures that drive the growth of the Internet should not be obstacles for government. Rather, government should identify ways to use those pressures to support the goals that government hopes to achieve. In telecommunications, this means using the pricing signals of the market to create incentives for efficiency. In a competitive market, prices are based on costs, and the firm that can provide a service for the lowest cost is likely to succeed. Such competitive pressures operate far more effectively, with lower administrative costs, than direct government mandates.

Similarly, government should look for mechanisms that use the Internet itself to rectify problems and create opportunities for future growth. For example, new access technologies may reduce network congestion, as long as companies have proper incentives to deploy those technologies. Filtering systems may address concerns about inappropriate content. Competition from Internet services may pressure monopolies or outdated regulatory structures. Government agencies should also use the Internet themselves to receive and disseminate information to the public.

The Network, not networks

The Internet is a network, but so are AT&T, TCI, and NBC. The FCC's goal should not be to foster the development of any one of those networks individually, but to maximize the public benefits that flow from the Network that encompasses all of those networks and many more. With the growth of competition and the elimination of traditional regulatory, technological, and economic boundaries, networks are more likely than ever to be interdependent, and a policy that benefits one network may have a detrimental effect on others. For example, a mandate that Internet service providers be entitled to connect to the telephone network for free might stimulate Internet use, but telephone companies might be forced to increase their rates or offer lower quality service to recover the increased cost of supporting such connections.

Although government should support the growth of the Internet, this support need not involve explicit subsidies that are not independently justified as a matter of public policy and economics. Instead, government should create a truly level playing field, where competition is maximized and regulation minimized.

II. WHAT IS THE INTERNET?

Although the Internet has been the subject of tremendous media, corporate, and public interest in recent years, most people have only a vague notion of how the Internet actually works. It is often easier to identify what the Internet is *not* than to explain in non-technical terms what the Internet *is*.[11] This uncertainty presents a significant challenge for policy-makers, and especially for governmental entities such as the FCC that must clearly define the scope of their actions.

A. General Description

The Internet is an interconnected global computer network of tens of thousands of packet-switched networks using the Internet protocol (IP).[12]

The Internet is a network of networks.[13] For purposes of understanding how the Internet works, three basic types of entities can be identified: end users, Internet service providers, and backbone providers. Figure 2 shows the general relationships between these entities; a more detailed Internet architecture diagram is provided as Appendix A. **End users** access and send information either through individual connections or through organizations such as universities and businesses. End users in this context include both those who use the Internet primarily to receive information, and content creators who use the

[11] For example, the Internet is not just electronic mail or the World Wide Web; both are services or applications that run over the Internet infrastructure. The Internet is not America Online; AOL is just one of the many networks interconnected with the global Internet. Finally, the Internet is not the information superhighway; that term describes a broader concept of the current and future networks that could deliver communications, entertainment, education, health care, and other services to users.

[12] IP defines the structure of data, or "packets," transmitted over the Internet. The higher-level "transmission control protocol" (TCP) and "user-defined protocol" (UDP) control the routing and transmission of these packets across the network. Most Internet services use TCP, and thus the Internet is often referred to as a "TCP/IP" network.

[13] Because of the focus of this paper, and the limits of the US government's jurisdiction, most of the discussion in this section focuses on the portion of the Internet within the United States. The Internet outside the United States operates for the most part based on the same general model, although the topology of the networks varies in different regions and countries.

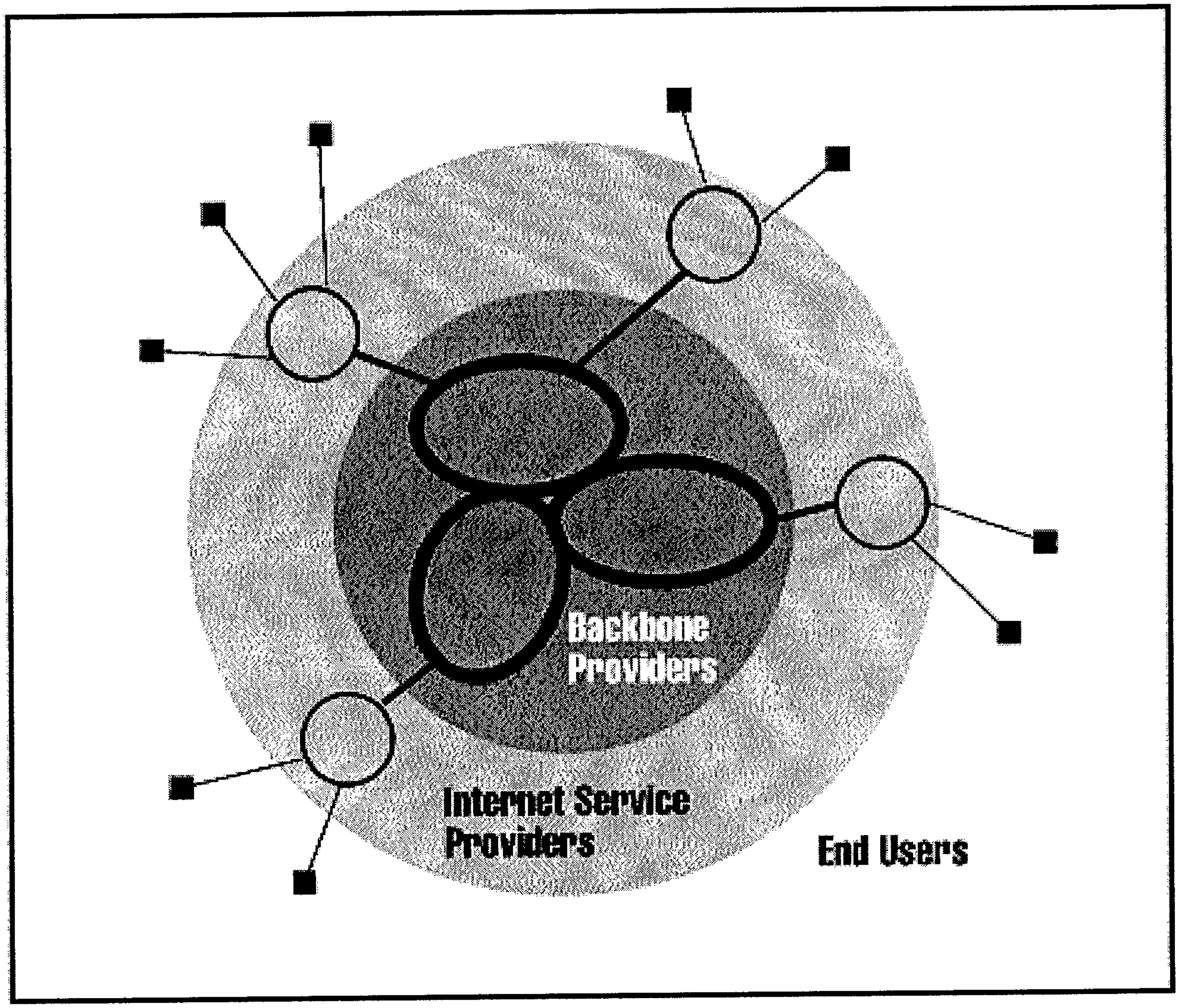

Figure 2 — Conceptual Overview of the Internet

Internet to distribute information to other end users. **Internet service providers** (ISPs), such as Netcom, PSI, and America Online, connect those end users to Internet backbone networks.[14] **Backbone providers**, such as MCI, UUNet, and Sprint, route traffic between ISPs, and interconnect with other backbone providers.

This tripartite division highlights the different functionalities involved in providing Internet connectivity. The actual architecture of the Internet is far more complex. Backbone providers typically also serve as ISPs; for example, MCI offers dial-up and dedicated Internet access to end users, but also connects other ISPs to its nationwide backbone. End users such as large businesses may connect directly to backbone networks, or to access points where backbone networks exchange traffic. ISPs and backbone providers typically have multiple points of interconnection, and the inter-relationships between these providers are changing over time. It is important to remember that the Internet has no "center" and that individual transmissions may be routed through multiple different providers due to a number of factors.

End users may access the Internet though several different types of connections, and unlike the voice network, divisions between "local service" providers and "long-distance" providers are not always clear.[15] Most residential and small business users have dial-up connections, which use analog modems to send data over the plain old telephone service (POTS) lines of local exchange carriers (LECs) to ISPs. Larger users often have dedicated connections using high-speed ISDN, frame relay or T-1 lines, between a local area network at the customer's premises and the Internet. Although the vast majority of Internet access today originates over telephone lines, other types of communications companies, such as cable companies, terrestrial wireless, and satellite providers, are also beginning to enter the Internet access market.

At present, there is no generally-applicable federal statutory definition of the Internet. The 1996 Act, in the limited context of offensive material transmitted interactive computer networks, defined the Internet as "the international computer network of both Federal and non-Federal interoperable packet switched data networks."[16]

B. An Extremely Brief History of the Net

[14] Dedicated Internet service providers, which offer a connection to the Internet but no proprietary content, are distinguished from online service providers (such as America Online) that provide access to proprietary content and also allow their users to access the Internet. Such distinctions are blurring, however, as online service providers such as the Microsoft Network move their content to the Internet, and as dedicated Internet service providers begin to offer some local content. For purposes of this paper, all of these providers are labeled as "ISPs," because all of them, as a component of their service, connect end users to the Internet.

[15] These divisions in the voice world are, of course, largely a result of historical and regulatory events, such as the breakup of AT&T into a competitive long-distance carrier and seven regional Bell operating companies. As competition develops, such arbitrary divisions will almost certainly collapse.

[16] 47 U.S.C. § 230.

The roots of the current Internet can be traced to ARPANET, a network developed in the late 1960s with funding from the Advanced Research Projects Administration (ARPA) of the United States Department of Defense.[17] ARPANET linked together computers at major universities and defense contractors, allowing researchers at those institutions to exchange data. As ARPANET grew during the 1970s and early 1980s, several similar networks were established, primarily between universities. The TCP/IP protocol was adopted as a standard to allow these networks, comprised of many different types of computers, to interconnect.

In the mid-1980s, the National Science Foundation (NSF) funded the establishment of NSFNET, a TCP/IP network that initially connected six NSF-funded national supercomputing centers at a data rate of 56 kilobits per second (kbps). NSF subsequently awarded a contract to a partnership of Merit (one of the existing research networks), IBM, MCI, and the State of Michigan to upgrade NSFNET to T-1 speed (1.544 megabits per second (Mbps)), and to interconnect several additional research networks. The new NSFNET "backbone," completed in 1988, initially connected thirteen regional networks.[18] As shown in Figure 3, individual sites such as universities could connect to one of these regional networks, which then connected to NSFNET, so that the entire network was linked together in a hierarchical structure. Connections to the federally-subsidized NSFNET were generally free for the regional networks, but the regional networks generally charged smaller networks a flat monthly fee for their connections.

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[17] For a somewhat more detailed history of the Internet, see Katie Hafner & Matthew Lyon, *Where Wizards Stay Up Late: The Origins of the Internet* (1996). *See also* Jack Rickard, "Internet Architecture," available on the World Wide Web at <http://www.boardwatch.com/isp/archit.htm>, and Henry Edward Hardy, "A Short History of the Net," in Gary Welz, *The Internet World Guide to Multimedia on the Internet*, available on the World Wide Web at <http://found.cs.nyu.edu/found.a/CAT/misc/welz/internetmm/02history/history1.html>.

[18] The original thirteen sites were: Merit, the National Center for Atmospheric Research, the Cornell Theory Center, the National Center for Supercomputing Applications, the Pittsburgh Supercomputer Center, the San Diego Supercomputer Center, the John Von Neumann Center, BARRNet, MIDnet, Westnet, NorthWestNet, SEQUINET, and SURANET.

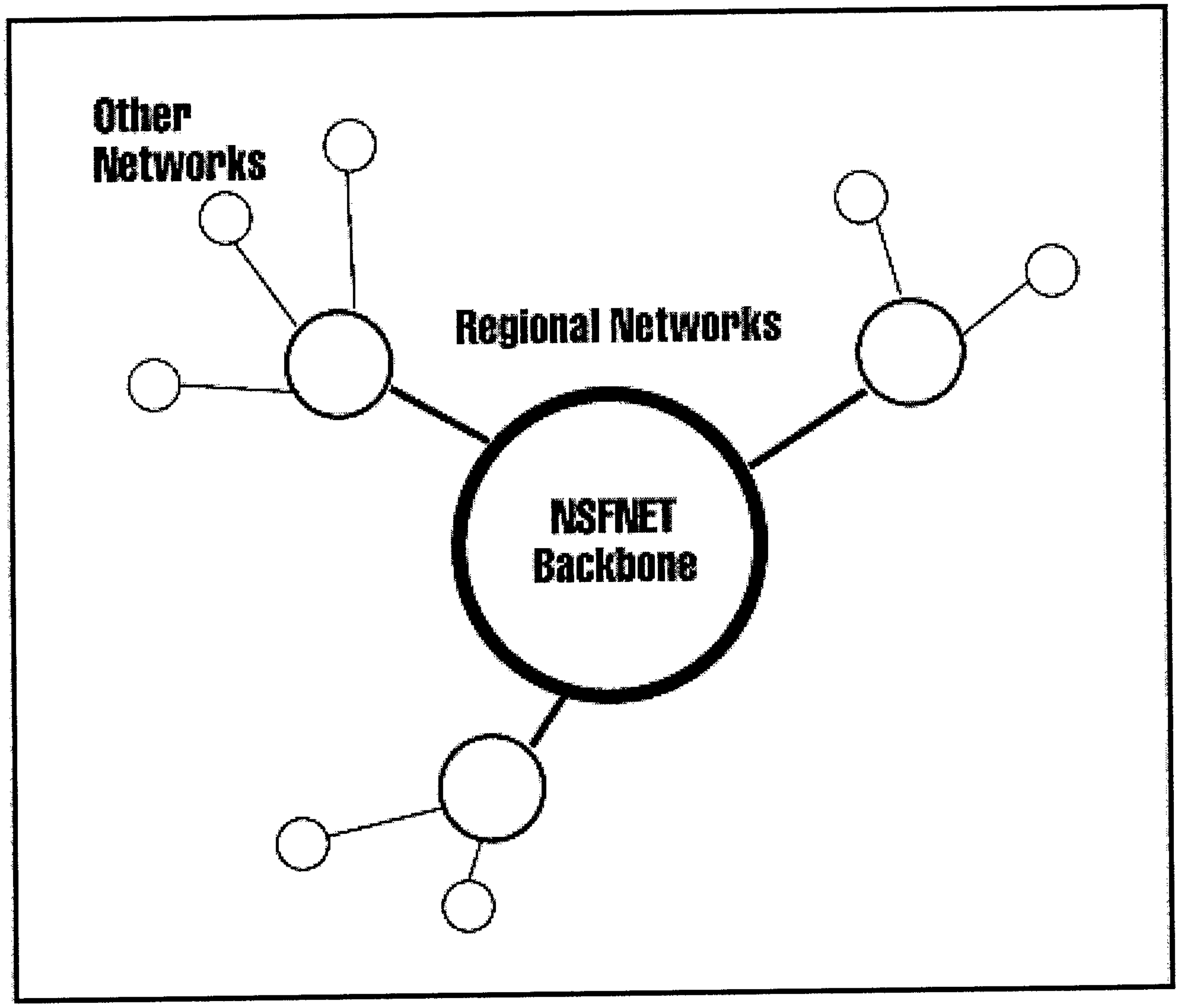

Figure 3 — NSFNET Architecture

The military portion of ARPANET was integrated into the Defense Data Network in the early 1980s, and the civilian ARPANET was taken out of service in 1990, but by that time NSFNET had supplanted ARPANET as a national backbone for an "Internet" of worldwide interconnected networks.[19] In the late 1980s and early 1990s, NSFNET usage grew dramatically, jumping from 85 million packets in January 1988 to 37 billion packets in September 1993.[20] The capacity of the NSFNET backbone was upgraded to handle this additional demand, eventually reaching T-3 (45 Mbps) speed.

In 1992, the NSF announced its intention to phase out federal support for the Internet backbone, and encouraged commercial entities to set up private backbones. Alternative backbones had already begun to develop because NSFNET's "acceptable use" policy, rooted in its academic and military background, ostensibly did not allow for the transport of commercial data.[21] In the 1990s, the Internet has expanded decisively beyond universities and scientific sites to include businesses and individual users connecting through commercial ISPs and consumer online services.[22]

Federal support for the NSFNET backbone ended on April 30, 1995. The NSF has, however, continued to provide funding to facilitate the transition of the Internet to a privately-operated network. The NSF supported the development of three priority Network Access Points (NAPs), in Northern California, Chicago, and New York, at which backbone providers could exchange traffic with each other,[23] as well as a "routing arbiter" to facilitate traffic routing at these NAPs. The NSF funded the vBNS (Very High-Speed Backbone Network Service), a non-commercial research-oriented backbone operating at 155 megabits per second. The NSF provides transitional funding to the regional research and educational networks, as these networks are now required to pay commercial backbone providers rather than receiving free interconnection to NSFNET. Finally, the NSF also remains involved in certain Internet

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[19] Although the precise origin of the term is unclear, the word "Internet" became commonly used in the early 1980s to refer to the interconnection of multiple networks to form a virtual "inter-network."

[20] Jeffrey K. MacKie-Mason & Hal Varian, *Some Economics of the Internet*, available on the World Wide Web at <http://www-personal.umich.edu/~jmm/papers.html>.

[21] In addition, the NSFNET contractors established in 1991 a for-profit subsidiary of Advanced Network and Services (ANS), the non-profit company they had created to operate the NSFNET backbone. This subsidiary, ANS CO+RE Systems, was set up specifically to handle commercial traffic.

[22] The number of Internet sites or "domains" identified with the ".com" suffix designating commercial sites has exceeded the number of education sites represented by the ".edu" suffix since mid-1994. *See* Anthony M. Rutkowski, *Internet Trends*, available on the World Wide Web at <http://www.genmagic.com/internet/trends/sld001.htm>.

[23] In addition to the three "official" NAPs, Metropolitan Fiber Systems (MFS) operates several "metropolitan area ethernets" (MAEs), which in effect are unofficial NAPs, and a few other legacy exchange points from the period before the closure of NSFNET. For simplicity, all such exchange points are referred to throughout this paper as "NAPs."

management functions, through activities such as its cooperative agreement with SAIC Network Solutions Inc. to manage aspects of Internet domain name registration.

Since the termination of federal funding for the NSFNET backbone, the Internet has continued to evolve. Many of the largest private backbone providers have negotiated bilateral "peering" arrangements to exchange traffic with each other, in addition to multilateral exchange points such as the NAPs. Several new companies have built nationwide backbones. Despite this increase in capacity, usage has increased even faster, leading to concerns about congestion. The research and education community, with the support of the White House and several federal agencies, recently announced the "Internet II" or "next-generation Internet" initiative to establish a new high-speed Internet backbone dedicated to non-commercial uses.[24]

Another important trend in recent years has been the growth of "intranets" and other corporate applications. Intranets are internal corporate networks that use the TCP/IP protocol of the Internet. These networks are either completely separate from the public Internet, or are connected through "firewalls" that allow corporate users to access the Internet but prevent outside users from accessing information on the corporate network. Corporate users are often ignored in discussions about the number of households with Internet access. However, these users represent a substantial portion of Internet traffic. In addition, intranets generate a tremendous amount of revenue, because companies tend to be willing to pay more than individual users in order to receive a level of service that they value.

Perhaps surprisingly, the Internet's growth rate has actually been quite stable for some time, with the number of hosts roughly doubling every year.[25] The rate appears to have accelerated in recent years only because the numbers have gotten so large, and the Internet has entered into popular consciousness.

C. How the Internet Works

1. Basic Characteristics

Just as hundreds of millions of people who make telephone calls every day have little conception of how their voice travels almost instantaneously to a distant location, most Internet users have only a vague understanding of how the Internet operates. The fundamental operational characteristics of the Internet are that it is a distributed, interoperable, packet-switched network.

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[24] *See* "Clinton Announces Moves for Improving Access to the Internet," *Wall Street Journal*, October 11, 1996, at B5; "Internet 2 Project General Information," available on the World Wide Web at <http://www.internet2.edu/about_i2/>.

[25] A "host" is a computer directly connected to the Internet. Although this figure gives a good indication of the size of the Internet, is does not accurately reflect the actual number of Internet users. For example, America Online, with approximately eight million members as of early 1997, has only has a handful of "host" computers through which those users receive their Internet connectivity.

A **distributed** network has no one central repository of information or control, but is comprised of an interconnected web of "host" computers, each of which can be accessed from virtually any point on the network. Thus, an Internet user can obtain information from a host computer in another state or another country just as easily as obtaining information from across the street, and there is hierarchy through which the information must flow or be monitored. Instead, routers throughout the network regulate the flow of data at each connection point. By contrast, in a centralized network, all users connect to single location.[26] The distributed nature of the Internet gives it robust survivability characteristics, because there is no one point of failure for the network, but it makes measurement and governance difficult.

An **interoperable** network uses open protocols so that many different types of networks and facilities can be transparently linked together, and allows multiple services to be provided to different users over the same network. The Internet can run over virtually any type of facility that can transmit data, including copper and fiber optic circuits of telephone companies, coaxial cable of cable companies, and various types of wireless connections. The Internet also interconnects users of thousands of different local and regional networks, using many different types of computers. The interoperability of the Internet is made possible by the TCP/IP protocol, which defines a common structure for Internet data and for the routing of that data through the network.

A **packet-switched** network means that data transmitted over the network is split up into small chunks, or "packets." Unlike "circuit-switched" networks such as the public switched telephone network (PSTN), a packet-switched network is "connectionless."[27] In other words, a dedicated end-to-end transmission path does (or circuit) not need to be opened for each transmission.[28] Rather, each router calculates the best routing for a packet at a particular moment in time, given current traffic patterns, and sends the packet to the next router. Thus, even two packets from the same message may not travel the same physical path through the network. This mechanism is referred to as "dynamic routing." When packets arrive at the destination point, they must be reassembled, and packets that do not arrive for whatever reason must generally be re-sent. This system allows network resources to be used more efficiently, as many different communications can be routed simultaneously over the same transmission facilities. On the other hand, the inability of the sending computer under such a "best effort"

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[26] In some cases, centralized networks use regional servers to "cache" frequently accessed data, or otherwise involve some degree of distributed operation.

[27] Some newer technologies, such as asynchronous transfer mode (ATM) switching, allow for the creation of "virtual circuits" through the Internet, which allow traffic to follow a defines route through the network. However, information is still transmitted in the form of packets.

[28] In actuality, much of the PSTN, especially for long-distance traffic, uses digital multiplexing to increase transmission capacity. Thus, beyond the truly dedicated connection along the subscriber loop to the local switch, the "circuit" tied up for a voice call is a set of time slices or frequency assignments in multiplexing systems that send multiple calls over the same wires and fiber optic circuits.

routing system[29] to ensure that sufficient bandwidth will be available between the two points creates difficulties for services that require constant transmission rates, such as streaming video and voice applications.[30]

2. Addressing

When an end user sends information over the Internet, the data is first broken up into packets.[31] Each of these packets includes a header which indicates the point from which the data originates and the point to which it is being sent, as well as other information. TCP/IP defines locations on the Internet through the use of "IP numbers." IP numbers include four address blocks consisting of numbers between 0 and 256, separated by periods (*e.g.* 165.135.0.254).[32] Internet users generally do not need to specify the IP number of the destination site, because IP numbers can be represented by alphanumeric "domain names" such as "fcc.gov" or "ibm.com." "Domain name servers" throughout the network contain tables that cross reference these domain names with their underlying IP numbers.[33] Thus, for example, when an Internet user sends email to someone at "microsoft.com," the network will convert the destination into its corresponding IP number and use that for routing purposes.

Some top-level domains (such as ".uk" for Britain) are country-specific; others (such as ".com") are "generic" and have no geographical designation. The domain name system was originally run by the United States Department of Defense, through private contractors. In 1993, responsibility for non-governmental registration of generic domains was transferred to the NSF. The NSF established a cooperative agreement with Network Solutions Inc. (NSI), under which NSI handles registration under these domains.[34] NSI currently charges $50 per year to register a domain name; a portion of this money goes to NSI to recover their administrative costs, and a portion goes into an "Internet intellectual infrastructure fund." The cooperative agreement is

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[29] In a "best effort" delivery system, routers are designed to "drop" packets when traffic reaches a certain level. These dropped packets must be resent, which to the end user is manifested in the form of delay in receiving the transmission.

[30] "Streaming" voice and video applications are those in which the data available to the receiving user is updated as data packets are received, rather than waiting until an entire image or sound file is downloaded to the recipient's computer.

[31] TCP/IP packets are not uniform in size, in part because routers along the route can add additional header information to indicate the routing of a particular packet. As of early 1994, the average packet size was approximately 240 bytes, including headers, and was steadily increasing. *See Some Economics of the Internet* at 4. Some other packet-switching technologies, such as ATM, use fixed-size packets, which facilitates more rapid and reliable delivery of data under certain conditions.

[32] In technical terms, the address blocks are separate bytes of a 32 bit address. The growth of the Internet has raised concerns that this number space will eventually be exhausted. As a result, the next version of the Internet's underlying protocol, referred to as IP version 6 or simply IPv6, includes a much larger 128 bit address space.

[33] Every "top-level" domain name, such as "whitehouse.gov," must be associated with a primary and a secondary name server.

[34] NSI was subsequently acquired by SAIC, a privately-held defense contractor.

scheduled to end in mid-1998. Country-specific domains outside the United States are generally handled by registration entities within those countries.

The existing registration process for generic top-level domains has generated substantial controversy. Some parties have objected to what they consider to be NSI's monopoly control over a valuable resource, especially since an entity in the United States is responsible for assigning addresses with international ramifications. There have been several lawsuits raising intellectual property questions, as domain names may overlap with existing trademark rights throughout the world. Several proposals have been made to expand the space of generic top-level domains. The International Ad Hoc Committee (IAHC), comprised of representatives from the Internet Society, International Telecommunications Union (ITU), the World Intellectual Property Organization (WIPO), and other groups, has issued a wide-ranging proposal to restructure generic top-level domain name system. However, the authority and ability of the IAHC to implement such changes remains unclear.

3. Services Provided Over the Internet

The actual services provided to end users through the Internet are defined not through the routing mechanisms of TCP/IP, but depend instead on higher-level application protocols, such as hypertext transport protocol (HTTP); file transfer protocol (FTP); network news transport protocol (NNTP), and simple mail transfer protocol (SMTP). Because these protocols are not embedded in the Internet itself, a new application-layer protocol can be operated over the Internet through as little as one server computer that transmits the data in the proper format, and one client computer that can receive and interpret the data. The utility of a service to users, however, increases as the number of servers that provide that service increases.[35]

By the late 1980s, the primary Internet services included electronic mail or "email," Telnet, FTP, and Usenet news. Email, which is probably the most widely-used Internet service, allows users to send text-based messages to each other using a common addressing system. Telnet allows Internet users to "log into" other proprietary networks, such as library card catalogs, through the Internet, and to retrieve data as though they were directly accessing those networks. FTP allows users to "download" files from a remote host computer onto their own system. Usenet "newsgroups" enable users to post and review messages on specific topics.

Despite the continued popularity of some of these services, in particular news and email, the service that has catalyzed the recent explosion in Internet usage is the World Wide Web.[36] The Web has two primary features that make it a powerful, "full service" method of accessing information through the Internet. First, Web clients, or "browsers," can combine text and graphical material, and can incorporate all of the other major Internet services such as FTP,

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[35] The significance of this point of "network economics" is discussed in greater detail below in Section IV.

[36] The Web was originally developed at CERN, the European laboratory for particle physics research, to enable researchers around the world to more easily share research.

email, and news into one standard interface. Second, the Web incorporates a "hypertext" system that allows individual Web "pages" to provide direct "links" to other Web pages, files, and other types of information. Thus, full-scale user interfaces and complex services such as online shopping, continuously-updated news information, and interactive games can be provided through the Internet over a non-proprietary system. The Web thus forms the foundation for virtually all of the new Internet-based services that are now being developed.

4. Governance and Management

There is no one entity or organization that governs the Internet. Each facilities-based network provider that is interconnected with the global Internet controls operational aspects of their own network. With the demise of the NSFNET backbone, no one can even be sure about the exact amount of traffic that passes across the Internet, because each backbone provider can only account for their own traffic and there is no central mechanism for these providers to aggregate their data. Nonetheless, the Internet could not function as a pure anarchy. Certain functions, such as domain name routing and the definition of the TCP/IP protocol, must be coordinated, or traffic would never be able to pass seamlessly between different networks. With tens of thousands of different networks involved, it would be impossible to ensure technical compatibility if each network had to coordinate such issues with all others.

These coordinating functions have traditionally been performed not by government agencies, but by an array of quasi-governmental, intergovernmental, and non-governmental bodies. The United States government, in many cases, has handed over responsibilities to these bodies through contractual or other arrangements. In other cases, entities have simply emerged to address areas of need.

The broadest of these organizations is the Internet Society (ISOC), a non-profit professional society founded in 1992. ISOC organizes working groups and conferences, and coordinates some of the efforts of other Internet administrative bodies. Internet standards and protocols are developed primarily by the Internet Engineering Task Force (IETF), an open international body mostly comprised of volunteers. The work of the IETF is coordinated by the Internet Engineering Steering Group (IESG), and the Internet Architecture Board (IAB), which are affiliated with ISOC. The Internet Assigned Numbers Authority (IANA) handles Internet addressing matters under a contract between the Department of Defense and the Information Sciences Institute at the University of Southern California.

The legal authority of any of these bodies is unclear. Most of the underlying architecture of the Internet was developed under the auspices, directly or indirectly, of the United States government. The government has not, however, defined whether it retains authority over Internet management functions, or whether these responsibilities have been delegated to the private sector. The degree to which any existing body can lay claim to representing "the Internet community" is also unclear. Membership in the existing Internet governance entities is drawn primarily from the research and technical communities, although commercial activity is far more important to the Internet today than it was when most of these groups were established.

D. Development of the Internet Market

1. The Internet Today

As of January 1997 there were over sixteen million host computers on the Internet, more than ten times the number of hosts in January 1992.[37] Several studies have produced different estimates of the number of people with Internet access, but the numbers are clearly substantial and growing. A recent Intelliquest study pegged the number of subscribers in the United States at 47 million,[38] and Nielsen Media Research concluded that 50.6 million adults in the United States and Canada accessed the Internet at least once during December 1996 -- compared to 18.7 million in spring 1996.[39] Although the United States is still home to the largest proportion of Internet users and traffic, more than 175 countries are now connected to the Internet.[40]

According to a study by Hambrecht & Quist, the Internet market exceeded one billion dollars in 1995, and is expected to grow to some 23 billion dollars in the year 2000. This market is comprised of several segments, including network services (such as ISPs); hardware (such as routers, modems, and computers); software (such as server software and other applications); enabling services (such as directory and tracking services); expertise (such as system integrators and business consultants); and content providers (including online entertainment, information, and shopping). The Internet access or "network services" portion of the market is of particular interest to the FCC, because it is this aspect of the Internet that impacts most directly on telecommunications facilities regulated by the Commission. There are now some 3,000 Internet access providers in the United States,[41] ranging from small start-ups to established players such as Netcom and AT&T to consumer online services such as America Online.

2. Internet Trends

Perhaps the most confident prediction that can be made about the Internet is that it will continue to grow. The Internet roughly doubled in users during 1995, and this trend appears to be continuing.[42] Figure 4 shows one projection of the growth in residential and business users

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[37] Network Wizards Internet Domain Survey, January 1997.

[38] *See* "US on-line population reaches 47 million - Intelliquest survey results," *Internet IT Informer*, February 19, 1997, available on the World Wide Web at <http://www.mmp.co.uk/mmp/informer/netnews/HTM/219n1e.htm>.

[39] *See* Julia Angwin, "Internet Usage Doubles in a Year," *San Francisco Chronicle*, March 13, 1997, at B1.

[40] Network Wizards Internet Domain Survey, January 1997, available on the World Wide Web at <http://www.nw.com/zone/WWW/top.html>.

[41] *Boardwatch Directory of Internet Service Providers* (Fall 1996).

[42] *See* "Market Size," *CyberAtlas*, available on the World Wide Web at <http://www.cyberatlas.com/market.html>.

over the remainder of the decade. Estimates suggest as many as half a billion people will use the Internet by the year 2000.[43]

As the Internet grows, methods of accessing the Internet will also expand and fuel further growth. Today, most users access the Internet through either universities, corporate sites, dedicated ISPs, or consumer online services. Telephone companies, whose financial resources and network facilities dwarf those of most existing ISPs, have only just begun to provide Internet access to businesses and residential customers. Cable companies are also testing Internet access services over their coaxial cable networks, and satellite providers have begun to roll out Internet access services. Several different forms of wireless Internet access are also being deployed.

[43] Paul Taylor, "Internet Users 'Likely to Reach 500m by 2000,'" *Financial Times*, May 13, 1996, at 4.

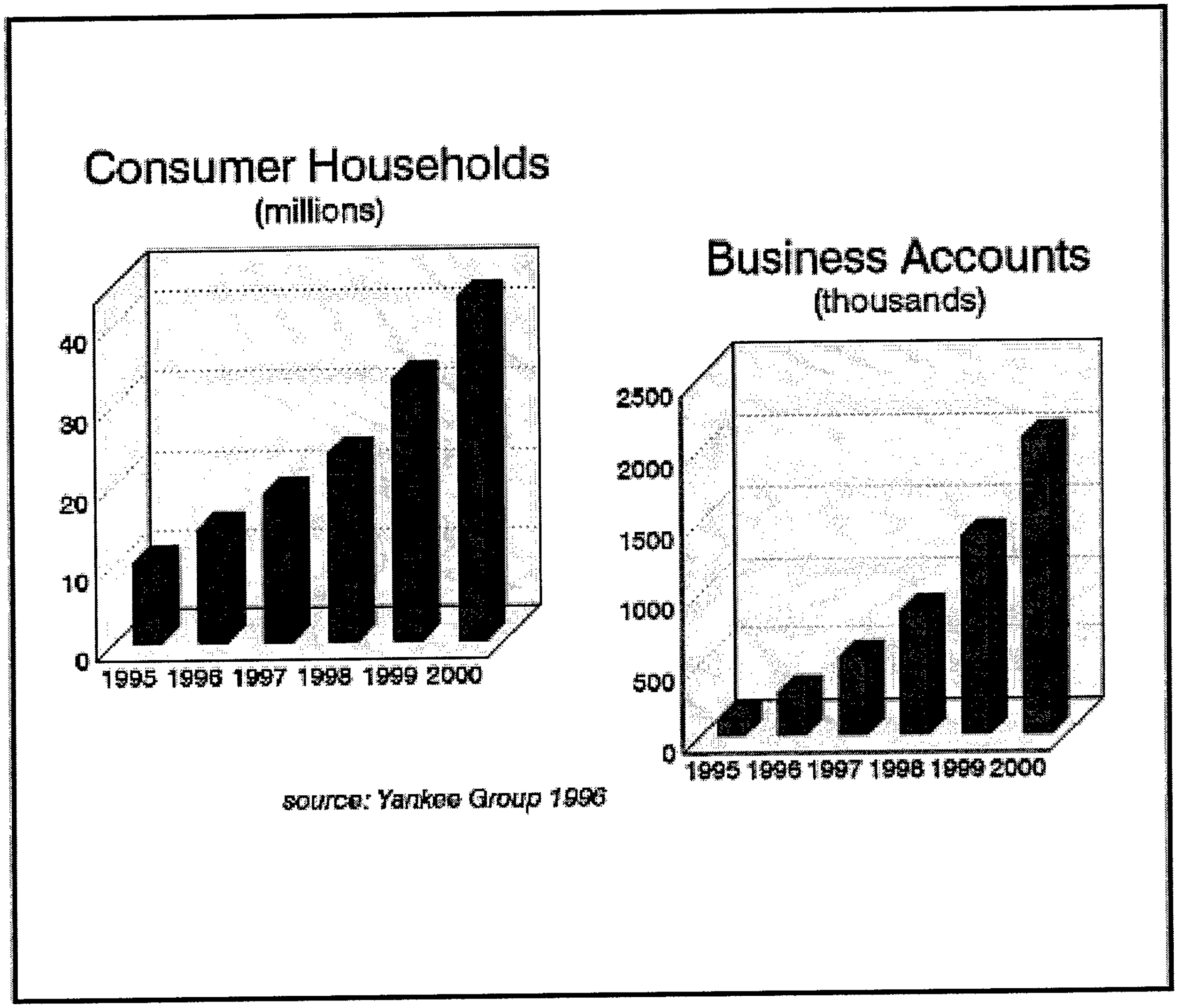

Figure 4 — Internet Growth Projections

At the same time as these new access technologies are being developed, new Internet clients are also entering the marketplace. Low-cost Internet devices such as WebTV and its competitors allow users to access Internet services through an ordinary television for a unit cost of approximately $300, far less than most personal computers. Various other devices, including "network computers" (NCs) for business users, and Internet-capable video game stations, promise to reduce the up-front costs of Internet access far below what it is now. These clients promise to expand greatly the range of potential Internet users. Moreover, as Internet connectivity becomes embedded into ordinary devices (much as computer chips now form the brains of everything from automobiles to microwave ovens), the Internet "market" will expand even more.

Bandwidth will continue to increase to meet this new demand, both within the Internet backbones and out to individual users. There is a tremendous level of pent-up demand for bandwidth in the user community today. Most users today are limited to the maximum speed of analog phone lines, which appears to be close to the 28.8 or 33.6 kbps supported by current analog modems, but new technologies promise tremendous gains in the bandwidth available to the home.[44] In addition, the backbone circuits of the Internet are now being upgraded to OC-12 (622 Mbps) speeds, with far greater speeds on the horizon.[45] With more bandwidth will come more services, such as full-motion video applications. Virtually every one of the challenges identified in this paper will become more acute as bandwidth and usage increase, and as the current limitations of the Internet are overcome. Thus, even though some of the questions that the Internet poses are of limited practical significance today, policy-makers should not wait to consider the implications of the Internet.[46]

Throughout the history of the Internet, seemingly insurmountable obstacles have been overcome. Few people would have expected a network designed for several dozen educational and research institutions to scale to a commercial, educational, and entertainment conduit for tens of millions of users, especially with no means of central coordination and administration. Governments should recognize that the Internet is different from traditional media such as telephony and broadcasting, although lessons can be learned from experience in dealing with those technologies. At the same time, the Internet has always been, and will continue to be

[44] Several manufacturers are beginning to deploy 56kbps modems. *See* "U.S. Robotics Launches the New Battle -- 56kbps Modems," *Boardwatch*, January 1997. This technology provides higher downstream transmission rates, but requires ISPs to have digital connections to the local exchange network. The throughput of these modems under real-world conditions will depend on the nature of each user's connection, and will usually be lower than 56 kbps. In addition, current FCC technical rules governing line power may limit the maximum connection speed of these modems to 53kbps.

[45] MCI, for example, currently plans to upgrade its backbone to OC-48 speed (2.5 Gbps) by 1998.

[46] Of course, widespread penetration of new, higher-bandwidth services may take far longer than some breathless commentators predict today. *See* Jonathan Weber, "Internet Video: Idea Whose Time Will Come ... Slowly," *Los Angeles Times*, May 13, 1996, at B8. Although policy-makers and regulators should be aware of the possibilities that the Internet created, concrete actions should not be taken based on mere speculation about the potential impact of a service.

influenced by the decisions of large institutions and governments. The challenge will be to ensure that those decisions reinforce the traditional strengths of the Internet, and tap into the Internet's own capability for reinvention and problem-solving.

III. CATEGORY DIFFICULTIES

The FCC has never directly exercised regulatory jurisdiction over Internet-based services. However, the rapid development of the Internet raises the question of whether the language of the Communications Act of 1934 (as amended by the Telecommunications Act of 1996), or existing FCC regulations, cover particular services offered over the Internet.

Governments act by drawing lines, such as the jurisdictional lines that identify which governmental entity has authority over some activity, or the service classifications that differentiate which body of law should be applied in a particular case. Governments traditionally determine the treatment of new services by drawing analogies to existing services. For example, the FCC regulates long-distance telephony, but does not regulate dial-up remote access to corporate data networks. ISPs almost exclusively receive calls from their subscribers, but so do retailers taking catalog orders or radio stations holding call-in promotions. Figure 5 shows some how dial-up access to the Internet resembles, but differs from, other types of connections.

There are reasons to believe that a simple process of drawing analogies to familiar services will not be appropriate for the Internet. The Internet is simultaneously local, national, and global, and is almost infinitely plastic in terms of the services it can support. As a result, it confounds any attempt at classification. Failure to consider such category difficulties is, however, itself a form of line drawing. As long as some communications services are subject to regulatory constraints, legal boundaries will be necessary. New approaches may therefore be necessary to avoid inefficient or burdensome results from existing legal and regulatory categories.

A. FCC Authority Generally

The Communications Act provides little direct guidance as to whether the Commission has authority to regulate Internet-based services. Section 223 concerns access by minors to obscene, harassing, and indecent material over the Internet and other interactive computer networks, and sections 254, 706, and 714 address mechanisms to promote the availability of advanced telecommunications services, possibly including Internet access. Section 230 states a policy goal "to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation."[47] None of these sections, however, specifically addresses the FCC's jurisdiction.

[47] 47 U.S.C. §230(b)(1).

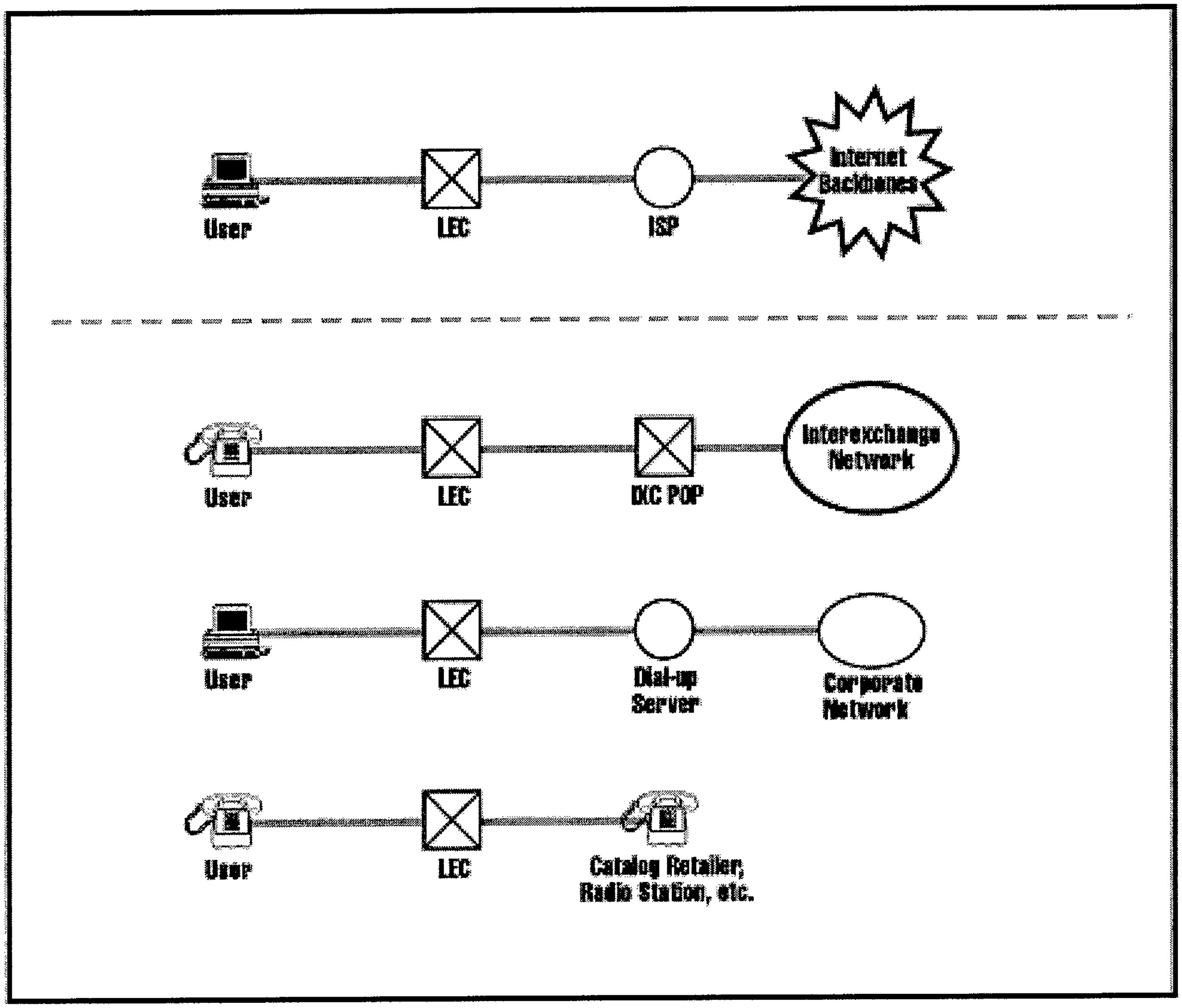

Figure 5 — What is the Correct Analogy?

In fact, nothing in the Act expressly limits the FCC's authority to regulate services and facilities connected with the Internet, to the extent that they are covered by more general language in any section of the Act. Although some early versions of the bill that became the 1996 Act contained language prohibiting "economic regulation" or "content or other regulation" of the Internet by the FCC, such language does not appear in the final version of the Act.[48] Moreover, it is not clear what such a prohibition would mean even if it were adopted. The Communications Act directs the FCC to regulate "interstate and foreign commerce in communication by wire and radio,"[49] and the FCC and state public utility commissions indisputably regulate the rates and conditions under which ISPs purchase services and facilities from telephone companies. Would a prohibition on FCC "regulation" of the Internet invalidate limits on the rates LECs can charge to ISPs? Would such language prevent the FCC from mandating discounted Internet access for schools and libraries? Such language would likely result in confusion at best.

Given the absence of clear statutory guidance, the Commission must determine whether or not it has the authority or the obligation to exercise regulatory jurisdiction over specific Internet-based activities. The Commission may also decide whether to forebear from regulating certain Internet-based services. Forbearance allows the Commission to decline to adopt rules that would otherwise be required by statute. Under section 401 of the 1996 Act, the Commission must forbear if regulation would not be necessary to prevent anticompetitive practices and to protect consumers, and forbearance would be consistent with the public interest.[50] Finally, the Commission could consider whether to preempt state regulation of Internet services that would be inconsistent with achievement of federal goals.

The Commission has struggled with such questions before as new technologies emerged. For example, prior to the passage of federal legislation in the 1980s, the Communications Act had no provisions that would directly cover cable television. The Commission concluded that, because of the competitive implications of cable for the regulated broadcasting industry, jurisdiction over cable television was "reasonably ancillary" to the Commission's established authority.[51] Section 303 of the Communications Act of 1934 states broadly that:

> the commission from time to time, as public convenience, interest, or necessity requires shall ... [m]ake such rules and regulations and prescribe such restrictions and

[48] Similar language was introduced in the subsequent FCC Modernization Act of 1996, but this legislation was not adopted before the 104th Congress recessed.

[49] 47 U.S.C. §151.

[50] 47 U.S.C. §160.

[51] *See* United States v. Southwestern Cable Co., 392 U.S. 157 (1968).

> conditions, not inconsistent with law, as may be necessary to carry out the provisions of this Act....[52]

This language gives the Commission broad authority to use its expertise to address novel situations. The Internet, however, is not cable television, and the FCC today is moving rapidly to deregulate existing services rather than to expand the scope of its regulatory ambit. Nonetheless, it would be difficult to claim that the Internet does not, at some level, involve interstate communications, or that the Internet will not at some point (if it does not already) have a significant competitive impact on existing providers of regulated communications services. Moreover, the only way to wholly exclude the Internet from regulation would be to develop a precise definition of what is and is not an "Internet" service, now and in the future, which is exactly what the Internet makes it difficult to do.

The FCC's theoretical jurisdiction over the Internet is quite expansive, because the Internet relies on communications facilities and services over which the FCC has longstanding and broad authority. Such a conclusion, however, provides little or no guidance in answering the question about how the Commission *should* act towards Internet-based services and companies. For example, the Commission's existing framework for "enhanced services" provided through the telephone network, developed in the *Computer II* proceeding, states that the FCC has authority to regulate these services, but that regulation would not serve the public interest.

Those who oppose "regulation of the Internet," generally do not wish to make the Internet a zone in which all government authority, such as prohibitions on theft and fraud, or guarantees of property rights, cease to exist. Rather, the debate is about whether new legal constructs are needed to address Internet-based transactions, and whether existing constructs meant for different situations should be applied to the Internet. In other words, would a particular type of service, offered by a particular type of company, be subject to particular requirements and prohibitions?

The Commission can and should greatly limit the extent to which its actions interfere with the functioning of the Internet services market. Communications regulation has traditionally been justified by the presence of dominant firms, by overwhelming public interest imperatives, or by the inherent invasiveness of broadcast media. Most of these justifications simply do not exist in the Internet realm.

[52] 47 U.S.C. §303(r).

B. Telephony

1. Legal Framework

a. Carrier Obligations

Title II of the Act generally regulates the activities of two overlapping classes of entities: communications common carriers and telecommunications service providers. Under the 1934 Act, common carriers (such as telephone companies) must be certificated and file tariffs setting forth a schedule of their charges in order to provide service to the public.[53] Common carriers are prohibited from unreasonably denying requested services, or from unreasonably discriminating in their terms and conditions of service, and are subject to various other requirements and fees.

The 1996 Act adds a related category, "telecommunications" service, defined as follows:

> The term "telecommunications" mean the transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received.[54]
>
> The term "telecommunications carrier" means any provider of telecommunications services.... A telecommunications carrier shall be treated as a common carrier under this act only to the extent that it is engaged in providing telecommunications services....[55]
>
> The term "telecommunications service" means the offering of telecommunications for a fee directly to the public, or to such classes of users as to be effectively available to the public, regardless of the facilities used.[56]

To what degree do Internet-based services meet the three-pronged definition of "telecommunications?" For example, the sender of an email message selects the person to receive the information and chooses the information to be transmitted, with no alteration (other than protocol conversion and other administrative overheads of the network) of the information sent and received. Real-time "Internet relay chat"[57] and "Internet telephony"[58] are even easier to

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[53] Common carriers are also subject to regulation by the state public utilities commissions of each state in which they provide service.

[54] 47 U.S.C. §153(43).

[55] 47 U.S.C. §153(44).

[56] 47 U.S.C. §153(46).

[57] Internet Relay Chat (IRC) is a service that allows multiple Internet users to conduct a real-time "chat" by typing statements into a computer. Other participants in the "chat" see these utterances as they are typed.

[58] Internet telephony is discussed in greater detail in section (III)(B)(2)(c).

fit within the statutory definition. If some Internet services fall within the definition of "telecommunications," however, who are the "carriers" that should be subject to regulation?[59] Would it be possible to regulate some services and not others, such as Usenet newsgroups,[60] which do not seem to satisfy the three-pronged test?

Ultimately, such micro-level exercises in statutory interpretation can lead to results that appear strange or worse. Common sense suggests that Congress did not intend to treat any company that facilitates the transmission of email as a local telephone company, subject to the full panoply of public-utility-derived regulation that applies to such companies. Nonetheless, the language of the statute cannot be ignored.

b. Basic vs. Enhanced Services

Beginning with the *Computer II* proceeding in the 1970s, the Commission has distinguished between "basic" and "enhanced" communications services.[61] Basic services are standard voice transmission offerings, while enhanced services are defined as:

> ...services, offered over common carrier transmission facilities used in interstate communications, which employ computer processing applications that act on the format, content, code, protocol or similar aspects of the subscriber's transmitted information; provide the subscriber additional, different, or restructured information; or involve subscriber interaction with stored information.[62]

Specific enhanced services include protocol processing, alarm monitoring, voice messaging, and electronic publishing, as well as the provision of access to data networks such as commercial online services and the Internet.

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[59] A similar debate about the application of existing communications regulation to the Internet is taking place in Europe. European regulators have argued that services provided over the Internet that constitute "like services" to traditionally-regulated media such as telephony and broadcasting are subject to the rules and regulations that govern those areas. This analysis generally distinguishes Internet-based services such as electronic mail from services such as Internet telephone, which is "real time," and therefore a "like service" to conventional telephony. Efforts to apply existing regulatory frameworks to the Internet have also created some confusion in Europe. For example, a dispute recently arose in Great Britain between the Independent Television Commission, which regulates video services, and Oftel, which oversees phone communications, over who has jurisdiction over the Internet. *See* "Warning as ITC tries to muscle in on Internet," *London Telegraph*, April 1, 1996, at 29.

[60] Usenet newsgroups are topic-specific discussion groups. Users "post" messages to the group, which can then be read by all subscribers to the group. Unlike email, which is sent to a user's mailbox, Usenet news requires users to connect to a "news server" and select the particular newsgroup they wish to view. There are now more than 10,000 Usenet newsgroups in operation.

[61] *See Computer II Final Order*, 77 FCC2d 384 (1980). For a discussion of the history of the basic/enhanced distinction and its applicability to Internet access, see Robert Cannon, "What is the 'Enhanced Service Provider' Status of Internet Service Providers?" *FCBA News* , February 1997.

[62] "Enhanced services" are defined in section 64.702(a) of the FCC's rules. *See* 47 C.F.R. 64.702(a)

The basic/enhanced framework has two primary purposes. First, it defines a class of enhanced service providers (ESPs), that use the telephone network but are not subject to regulation under Title II of the Communications Act. Although the FCC may have jurisdiction to regulate ESPs, such regulation would be unnecessary and harmful to the development of the competitive enhanced services industry. Second, it provides a framework to ensure that when incumbent LECs (in particular the regional Bell Operating Companies (BOCs)) offer enhanced services, they do not use their control over bottleneck basic services to disadvantage competing ESPs.[63] The 1996 Act incorporates something similar to the basic/enhanced dichotomy in its distinction between telecommunications and "information" services.

The Internet in its current form did not exist at the time the FCC created the basic/enhanced distinction. However, in *Computer II* and in subsequent orders, the Commission has addressed the implications of packet-switching technologies for this framework. In *Computer II*, the Commission described basic communications services as providing "pure transmission capability over a communications path that is virtually transparent in terms of its interaction with customer-supplied information."[64] The use of packet switching and error control techniques "that facilitate the economical, reliable movement of [such] information [do] not alter the nature of the basic service."[65] Thus, for example, in subsequent decisions the Commission has determined that packet-switched networks following X.25 protocols, and frame relay service offerings, provide a basic transport service.[66]

Although some underlying packet-switched transport functions are considered to be basic services, Internet access has always been treated as an enhanced service. ISPs have never been subject to regulation by the FCC under Title II of the Communications Act. In addition, BOCs have been required to file comparable efficient interconnection (CEI) plans when they themselves offer Internet access, to ensure that they do not disadvantage competing ISPs.[67] ISPs engage in various information processing functions, such as authentication, email storage and

[63] BOCs have incentives to disadvantage competing ESPs that must interconnect with them to provide service. Therefore, the Computer III rules require the BOCs to comply with accounting safeguards to ensure they do not cross-subsidize their enhanced services with revenues from their regulated basic services. In addition, BOCs must file open network architecture (ONA) plans detailing how they will offer competing ESPs comparable network features and functions to those used by the BOC's own enhanced services, or comparable efficient interconnection (CEI) plans for specific enhanced services they offer. BOCs must also make new features and functions available upon a reasonable request from an independent ESP, through a process overseen by the information industry liaison committee (IILC), an industry group.

[64] *Computer II Final Order*, 77 FCC2d at 420.

[65] *Id.*

[66] *Application of AT&T for Authority under Section 214 of the Communications Act of 1934, as amended, to Install and Operate Packet Switches at Specified Telephone Company Locations in the United States*, 94 FCC2d 48, 55-57 (1983); *Independent Data Communications Manufacturer's Association, Petition for Declaratory Ruling that AT&T's InterSpan Frame Relay Service is a Basic Service,* Memorandum Opinion and Order, DA 95-2190 (released October 18, 1995).

[67] *See, e.g., Bell Atlantic Offer of Comparable Efficient Interconnection to Providers of Internet Access Services*, Order, CCBPol 96-09 (released June 6, 1996).

retrieval, Web page hosting, and domain name server lookups. Many ISPs, especially online services such as America Online, offer access to local content through databases, message boards, and chat areas. These functions involve substantial computer processing and interaction with customer-supplied information, and therefore fall squarely within the definition of enhanced services.

2. Implications

The legal and regulatory categories described above have significant consequences. Because of the unique characteristics of the Internet, as described in this paper, such general frameworks may produce unintended results when applied to Internet-based services. Discussions of the status of ISPs or specific Internet services should not be based solely on abstract legal analysis, but rather should take into account the real-world implications of such decisions.

a. Section 251 Interconnection Obligations

Sections 251 and 252 of the 1996 Act mandate that incumbent LECs take various steps to open their local networks to competition. Under these sections, incumbent LECs must make interconnection, unbundled network elements, and wholesale services available to such new entrants at reasonable rates.[68] However, under the terms of section 251, these services are available only to "requesting telecommunications carriers." In the *Local Competition Order*, which implemented section 251, the Commission concluded that providers fell within this definition only to the extent that they provided telecommunications directly to the public. Thus, companies that provide both information and telecommunications services are able to request interconnection, unbundled network elements, and resale under section 251, but companies that provide information services only are not.[69] The Commission did not state more specifically how it would define the two categories for this purpose, although it did conclude that companies that provided both telecommunications and information services should be considered telecommunications service providers in this context.[70]

Because, under Section 251(c)(3), LECs must permit purchasers of their unbundled network elements to combine such elements in order to provide a telecommunications service,[71] Internet access providers may be able to design their networks more efficiently and economically

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[68] 47 U.S.C. §251-52. All LECs are required to interconnect with other telecommunications carriers on request, but only incumbent LECs are subject to the unbundling, resale, and pricing requirements of the 1996 Act.

[69] *Implementation of the Local Competition Provisions of the Telecommunications Act of 1996,* CC Docket No. 96-98, FCC 96-325 (released August 8, 1996) (*Local Competition Order*), *petition for review pending sub nom. and partial stay granted, Iowa Utilities Board et. al v. FCC*, No. 96-3321 and consolidated cases (8th Cir., Oct. 15, 1996), at 493-95, ¶¶ 992-95.

[70] *Id.* at ¶ 995.

[71] 47 U.S.C. §251(c)(3).

by using unbundled elements in this manner. In order to do so, however, such companies must overcome the "telecommunications carrier" restriction in the Act. One means of doing so would be to classify themselves as providers of telecommunications service, and thus be subject to the requirement that they interconnect with all other carriers[72] and potentially other regulatory provisions governing telecommunications carriers. Some ISPs are already considering this course.[73]

Alternatively, Internet access providers could enter into an arrangement with a telecommunications carrier, such as an IXC, which could purchase the unbundled elements and in effect resell them to the ISP. MFS Worldcom, which provides telecommunications service but owns a major ISP, UUNet, is already exploring this latter course, purchasing unbundled loops and using them to offer high-speed ISDN and xDSL Internet access to corporate customers through UUNet.[74] The FCC's *Local Competition* order expressly stated that incumbent LECs could not restrict the services that competitors could provide over unbundled network elements.[75]

Other possible mechanisms under which Internet access providers could make use of the unbundling provisions of the 1996 Act would likely require additional action by the FCC to clarify the legal framework. For example, ISPs could negotiate directly with LECs to lease network elements they needed to offer high-speed data services, outside of the framework of section 251. Such arrangements could be embodied in experimental or contract tariffs, subject to Commission approval. Because section 251 would always be available as a fallback that the ISPs could use to gain access to similar facilities, as described in the previous paragraph, the FCC would not need to scrutinize closely the rates LECs charged under such arrangements. At this time, however, there is no legal basis for LECs and ISPs to negotiate such agreements outside of section 251.

Another theoretically possible route would be through the Commission's open network architecture (ONA) process, which was designed prior to the passage of the 1996 Act to give enhanced service providers access to elements of local networks. However, ONA has been criticized by many ESPs as being cumbersome an ineffective for achieving true network unbundling. ONA was also designed facilitate unbundling of software functionality within LEC switches, rather than physical network elements.

The interconnection provisions of the 1996 Act also require that pricing for "transport and termination of traffic" between telecommunications carriers be based on reciprocal

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[72] 47 U.S.C. §251(a).

[73] *See, e.g.*, Brock Meeks, "ISPs Prepare 'Doomsday Defense,'" MSNBC, December 21, 1996, available on the World Wide Web at <http://www.msnbc.com/news/47762.asp>.

[74] *See* Carol Wilson, "MFS Pushes DSL into Mass Market," *Inter@ctive Week*, December 16, 1996.

[75] *Local Competition Order* at 149, ¶ 292.

compensation.[76] In other words, when a user on one carrier's network makes a local call to a user on a second carrier's network, the first carrier must pay the second carrier for terminating that call. Reciprocal compensation arrangements operate on the assumption that traffic between two networks will be relatively balanced, because on average users receive about as many calls as they make. In the case of an Internet service provider, this assumption breaks down. ISPs exclusively receive calls from their subscribers over LEC networks. Therefore, if an ISP were considered a telecommunications carrier under section 251, LECs would presumably be required to pay that ISP for terminating traffic on the ISP's network. This result would represent the opposite of the current flow of funds, in which ISPs pay LECs for connecting to the LEC network to receive calls.

b. Section 254 Universal Service Obligations

Under section 254, all "telecommunications carriers" that provide "interstate telecommunications services" must contribute to mechanisms established to preserve and advance universal service. The Commission may require "any other provider of interstate telecommunications" to also contribute to such mechanisms, "if the public interest so requires." Thus, to the extent that, as discussed above, Internet access providers or others are considered to be both "telecommunications carriers" and providers of "interstate telecommunications services," the Act requires these entities to participate in whatever federal universal service funding mechanism the Commission ultimately adopts.

Pursuant to section 254, the Commission convened a federal-state joint board to recommend an explicit and nondiscriminatory funding mechanism for universal service. In its recommendations, the joint board concluded that information and enhanced service providers not be required to contribute to the universal service funding mechanism.[77] The joint board also concluded that Internet access services provided to schools and libraries should be entitled to universal service subsidies under section 254(h).[78]

The joint board recommendations, however, leave open several questions. As with the interconnection rules, the precise definition of "telecommunications" and "information" services as applied to various types of Internet-based service providers remains unclear. The decision that information service providers are not required to contribute to universal service funding, but can receive universal service subsidies under section 254(h) raises issues of competitive equity when such companies are competing with traditional telecommunications carriers to provide connectivity to schools and libraries. Finally, although as the joint board concluded, it would be unreasonable to require ISPs to segregate their revenues between "content" and "conduit"

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[76] 47 U.S.C. § 252(d)(2).

[77] *Federal-State Joint Board on Universal Service,* Recommended Decision, FCC 96J-3, CC Docket No. 96-45, at 398 ¶¶790-91 (*Universal Service Joint Board Recommended Decision*).

[78] *Id.* at 237-38, ¶¶462-65.

services, the universal service framework is designed only to subsidize connections, not proprietary content.

c. Internet Telephony

Several companies now offer software that allows for real-time voice conversations over the Internet (Internet telephony or "voice on the Net" (VON)).[79] These services work by converting voices into data which can be compressed and split into packets, which are sent over the Internet like any other packets and reassembled as audio output on the at the receiving end. Most Internet telephony software today requires both users to use computers that are connected to the Internet at the time of the call, but some recently announced services will allow the receiving party, or even both parties, to use an ordinary POTS telephone.[80]

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[79] *See, e.g.*, Douglas Lavin, "Small Phone Company Plans to Slash International Rates With Internet Link," *Wall Street Journal* (November 10, 1995) at B7A.

[80] *See, e.g.*, Fred Langan, "Internet Phone Calls -- Without Computers," *Christian Science Monitor*, August 21, 1996; Mike Mills, "Phone Service Via Internet May Slash Rates," *Washington Post*, August 11, 1996, at A1; Bill Frezza, "Internet Phone: The Ultimate Bypass," *Network Computing*, July 1, 1996.

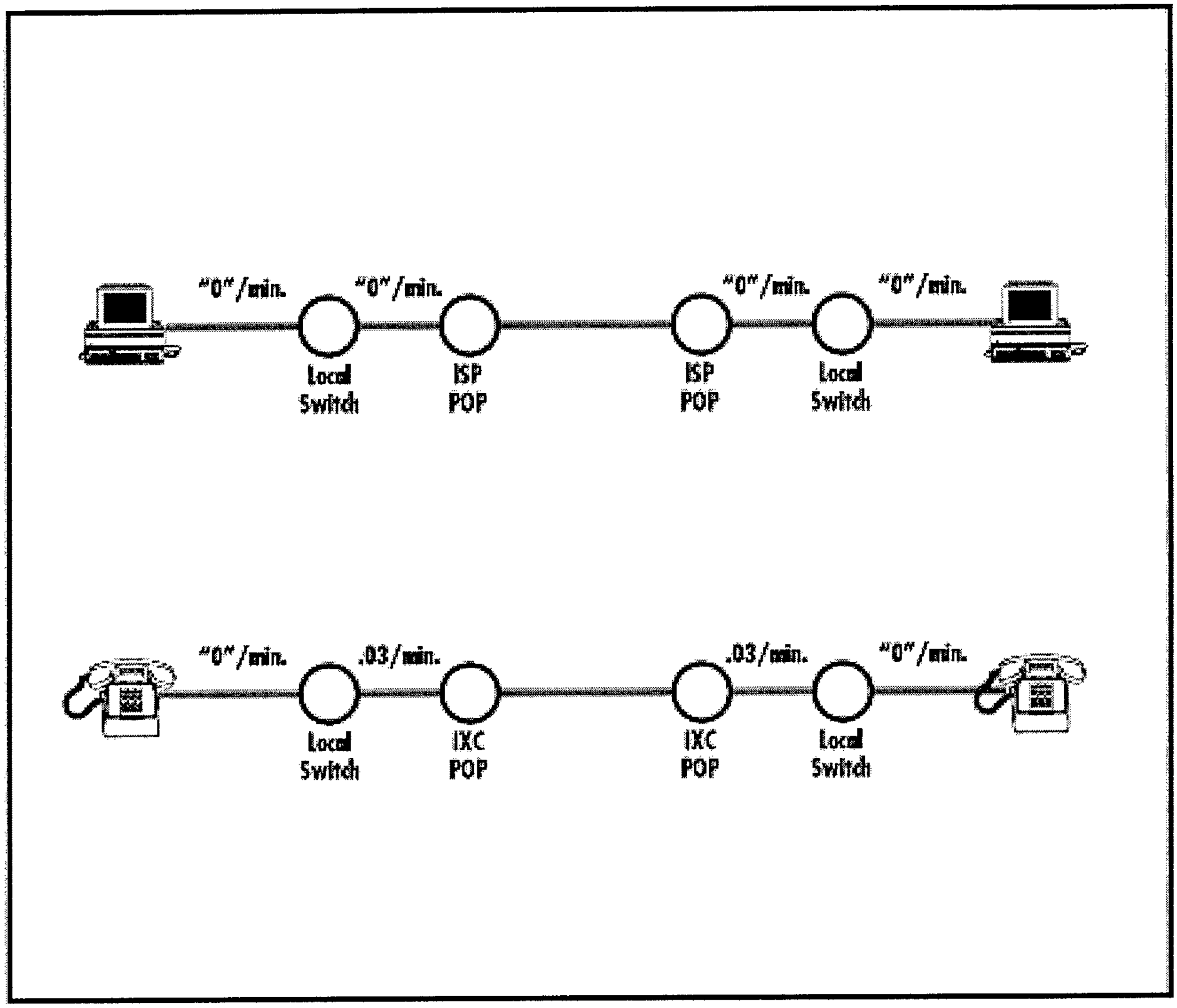

Figure 6 — Internet vs. Conventional Telephony

Internet telephony consultant Jeff Pulver estimates that approximately 55,000 - 60,000 people now use Internet telephony products on a weekly basis, although usage has been increasing rapidly and a much larger number of people have access to Internet telephony software.[81] Netscape and Microsoft, the manufacturers of the leading Web browser software, have released versions of their software that incorporate Internet telephony.

The FCC has not attempted to regulate the companies that provide the software and hardware for Internet telephony, or the access providers that transmit their data, as common carriers or telecommunications service providers.[82] In March 1996, America's Carriers Telecommunication Association (ACTA), a trade association primarily comprised of small and medium-size interexchange carriers, filed a petition with the FCC asking the Commission to regulate Internet telephony. ACTA argues that providers of software that enables real-time voice communications over the Internet should be treated as common carriers and subject to the regulatory requirements of Title II. The Commission has sought comment on ACTA's request. Other countries are considering similar issues.[83]

The ACTA petition raises the fundamental question of whether a service provided over the Internet that appears functionally similar to a traditionally-regulated service should be subject to existing regulatory requirements.[84] The petition argues that VON providers should be considered as fundamentally analogous to switchless long-distance resellers, and thus should pay the same rates to LECs for use of local networks to originate and terminate interstate calls. Under this analysis, shown in Figure 6, the current pricing structure allows VON providers to charge an effective usage charge of zero, while long-distance carriers must pass on roughly six cents per minute in access charges for every interstate call.

ACTA's view, however, oversimplifies the comparison between VON and long-distance voice telephony. There are many differences, beginning with quality of service. Current Internet telephony products do not provide comparable sound quality to traditional long-distance service. Most existing systems require both parties to be connected to the Internet through a personal computer at the time of the call, and the sound quality of Internet telephony products

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[81] Conversation with the author, December 30, 1996.

[82] Section 223(c)(6) of the Act, as amended by the 1996 Act, states that "Nothing in this section shall be construed to treat interactive computer services as common carriers or telecommunications carriers." This language, however, applies only to interactive computer services in the context of restrictions on access by minors to indecent and obscene materials, and only states that the defenses in this section of the Act do not mean that these entities are to be treated as common carriers or telecommunications carriers. This section would not appear to be inconsistent with a finding that Internet access providers are "telecommunications carriers" because the services they provide fall within the definitions set forth in section 153 of the Act.

[83] Portugal, for example, has reportedly banned Internet telephony. On the other hand, the Telecom Finland has announced that it will soon begin offering Internet telephony itself. *See* "Telecom Finland to Unveil Phone Service for Internet," *Wall Street Journal*, December 9, 1996, at B7

[84] *See generally* John Simons, "Wrestling Over the Future," *US News and World Report*, April 15, 1996, at 53.

tends to be appreciably worse than circuit-switched voice telephony. At this time, Internet telephony is in most cases not a comparable substitute for long-distance voice service.

However, distinctions in quality and ease of use should not be the sole basis for regulatory decisions. Cellular telephony typically provides poorer sound quality than wireline service, but this fact does not affect the classification of cellular as a telecommunications service. Moreover, service providers are working to improve sound quality and ease of use, and several providers have begun to deploy "gateways" that allow Internet telephony conversations to be terminated or even originated on an ordinary telephone. When such gateways are used, however, the pricing structure changes. Gateway providers must pay for hardware at points of presence to route voice traffic between the Internet and the voice network, and must also pay local exchange carriers to terminate or originate calls over voice lines. Thus, gateway providers plan to charge per-minute rates for their Internet telephony services, rather than the "free" calling available through current computer-computer Internet telephony products.

Even these current products, however, do not really provide for "free" calling. Service providers and users still must pay for their connections to the local phone network, and for their connections to the Internet. If these services are priced in an inefficient manner, the issue is not one related to Internet telephony, but is a broader question about the pricing for Internet access and enhanced services that use local exchange networks. The issue of pricing for Internet access is discussed in detail in the following section. The fact that some Internet packets now encode voice rather than data does not alter the fundamental economics and technical characteristics of network traffic. If anything, a shift toward usage of the Internet for voice telephony might result in usage patterns that looked more like those of circuit-switched voice calling. The issue of how exactly Internet telephony affects network usage, and how pricing affects usage of Internet telephony, is not at all settled. Local calling throughout virtually all of the United States is priced on a flat-rated basis, yet people do not tend to stay on the phone all day.

Internet telephony is also technically different from long-distance voice calling. A circuit-switched voice call uses an entire 56 kbps channel for every call. By contrast, Internet telephony uses digital compression techniques that can encode voice transmissions in as little as 4 kbps. Internet telephony is also packet switched, which means that it does not tie up a call path for the portion of the call carried over the packet-switched Internet. Of course, when a packet-switched Internet telephony call is originated through a modem over a dial-up circuit-switched connection to an ISP, the potential efficiency benefits of packet-switched voice transmission may not be realized. In some cases, the long-distance and international voice transmission networks, which are in most cases digital today, may actually do a better job of compression than Internet telephony products. All of these possibilities, however, reinforce the notion that the cost comparison between Internet and circuit-switched voice telephony is not obvious, and is highly contingent on network arrangements that are evolving rapidly.

Finally, as a practical and policy matter, regulation of Internet telephony would be problematic. It would be virtually impossible, for example, for the FCC to regulate as carriers those companies that merely sell software to end users, or to require the ISPs segregate voice and data packets passing through their networks for regulatory purposes. Rather, VON software could more appropriately be compared to unregulated customer premises equipment (CPE), like telephone handsets, which facilitate calling but do not themselves carry calls from one party to another. Moreover, although ACTA claims that Internet telephony unfairly deprives interexchange carriers of revenues, others argue that these services provide valuable competition to incumbent carriers.[85] The existing systems of access charges and international accounting rates, to which long-distance carriers are subject, are both inefficient artifacts of monopoly regulatory regimes. If circuit-switched long-distance carriers are paying excessive and inefficient rates as a result, the best answer is to reform those rates rather than attempting to impose them on other parties.

The FCC should consider whether to exercise its preemption authority in connection with Internet telephony. ACTA has submitted a petition, similar to its FCC filing, to the Florida Public Service Commission. In addition, the Nebraska Public Service Commission staff recently concluded that an Internet telephony gateways service operated by a Nebraska ISP was required to obtain a license as a telecommunications carrier.[86] If federal rules governing Internet telephony are problematic, state regulations seem even harder to justify. As discussed below in section D, there is a good argument that Internet services should be treated as inherently interstate. The possibility that fifty separate state Commissions could choose to regulate providers of Internet telephony services within their state (however that would be defined), already may be exerting a chilling influence on the Internet telephony market.[87] Netscape, in its comments on the ACTA petition, argued that the Commission should assert exclusive federal jurisdiction and preempt states from regulating Internet telephony.[88]

C. Broadcasting and Cable

The provision of real-time, or "streaming" audio and video services over the Internet raises the question of whether some Internet-based services qualify as "broadcasting" subject to Title III of the Communications Act. "Broadcasting" is defined in the Act as:

[85] *See, e.g.*, Alan Cane and Tim Jackson, "Net Telephony Anxieties Intensify," *Financial Times*, April 22, 1996, at 19.

[86] *See* Jean Field, "ISP Fights Nebraska Regulation of IPhone," *Wired News*, February 11, 1997, available on the World Wide Web at <http://www.wired.com/news/politics/story/986.html>; Scott Bauer, "Telephone Service Via Internet Must End," *Associated Press*, January 2, 1997.

[87] *See* Rebecca Sykes, "Internet Telephony Group Seeks FCC Action," *InfoWorld Electric*, January 30, 1997; Nick Wingfield, "FCC Pressed on Net Phones," *C|Net News*, January 30, 1997, available on the World Wide Web at <http://www.news.com/News/Item/0,4,7513,00.html?dtn.head>.

[88] *See* Joint Opposition of Netscape Communications Corporation, Voxware, Inc. and Insoft Inc., RM No. 8775 (May 8, 1996).

(153)(6) Broadcasting. -- The term "broadcasting" means the dissemination of radio communications intended to be received by the public, directly or by the intermediary of relay stations.[89]

"Internet radio" services exist today that transmit continuous, real-time audio over the Internet. Many other sites now offer a selection of real-time audio clips that users can choose to listen to, such as news, weather forecasts, and music. Users must access theses sites, generally through a World Wide Web browser, and must have the proper software and hardware to receive and play streaming audio. Although analog modem bandwidth is largely insufficient to support real-time video transmissions over the Internet, such services are already available for users with higher-bandwidth connections. For example, software known as CU-See Me has been available for some time that allows real-time video conferencing over the Internet, and a other products such as VDOLive will allow real time simultaneous video and audio conferencing. Live video of several events has been broadcast over the MBONE, a service that allows certain users with high-speed connections to receive real-time video feeds through the Internet.

The Commission has never considered whether any of the rules that relate to radio and television broadcasters should also apply to analogous Internet-based services. The vast majority of Internet traffic today travels over wire facilities, rather than the radio spectrum. As a policy matter, however, a continuous, live, generally-available music broadcast over the Internet may appear similar to a traditional radio broadcast, and the same arguments may be made about streaming video applications. The Commission will need to consider the underlying policy principles that, in the language of the Act and in FCC decisions, have formed the basis for regulation of the television and radio broadcast industries. One significant different may be the fact that radio and television broadcasts are subject to the inherent scarcity of the usable electromagnetic spectrum, whereas such transmissions over the Internet are simply a different type of data packets, indistinguishable at any moment from other types of traffic passing through the network.

Similar issues arise in the context of cable television regulations under Title VI of the Communications Act. The Act defines "video programming" as "programming provided by, or generally considered comparable to programming provided by, a television broadcast station."[90] A "cable service" means "the one-way transmission to subscriber of ... video programming." A "cable system" is "a facility, consisting of a set of closed transmission paths ... that is designed to provide cable service," but not "a facility that serves only to retransmit the signals of one or more television broadcast stations; ... a facility that serves subscribers without using any public right-of-way; ... [or] a facility of a common carrier" that does not provide video programming

[89] 47 U.S.C. §153(6).

[90] 47 U.S.C. §522(20).

directly to subscribers (except solely to provide interactive on-demand services) or serve as an open video system under section 653 of the Act.[91]

To what extent is real-time video transmitted over the Internet "comparable" to broadcast television? The technology of the current Internet limits video transmission, even for users with relatively high-speed access, to relatively low-quality images. Most Internet users today are able to connect to the network at only 14.4 kbps or 28.8 kbps, which supports only rudimentary video images that can easily be distinguished from broadcast television images. These limitations are not permanent, however. As compression technology develops and end-user access speeds increases, Internet video applications will provide service that increasingly resembles the quality of television broadcast stations. In addition, the number of entities providing real-time video over the Internet is today relatively small, but is certain to increase rapidly over time as bandwidth increases. It seems inevitable that, at some point, consumers will be able to view images that are virtually indistinguishable in quality and equally varied in selection to those provided by television broadcasters. At what point will the threshold of "comparability" be crossed?

A determination about whether Internet-based video applications constitute "video programming" under the Act would not necessarily mean that these services would legally be treated as cable systems. Section 602(7)(B) of the Act states that facilities that do not use any public right-of-way are not considered cable systems. The Internet uses public right-of-way to the extent that it runs over the existing telephone network, and in the future over existing cable company facilities. The provision of video services over the Internet, however, generally requires no additional use of public right-of-way beyond that necessary to provide basic Internet connectivity, or to provide existing telephony or cable services. An additional definitional issue is the extent to which Internet video services provided by common carriers such as telephone companies are considered "interactive on-demand services," and therefore not treated as cable systems, since many Internet-based video concepts require the user to select a specific "program" to view. An Internet-based video service might be considered an "open video system," since the Internet itself is an inherently open platform that allows capacity to be shared among all entities with broadcast capabilities. Finally, certain providers of Internet-based video services could be classified as "multichannel video programming distributors" (MVPDs) under 602(11) of the Act. MVPDs are entities that "make[] available for purchase, by subscribers or customers, multiple channels of video programming."

Policy-makers must consider the policy rationales behind Title VI of the Act, and whether they apply to Internet-based video delivery systems with the same force. It does appear, however, that at some point the Internet may have significant competitive effects. A recent survey suggested that 61% of Internet users watch less television in order to spend more time

[91] 47 U.S.C. §522.

online.[92] The FCC's 1995 Cable Competition Report notes the possibility that the Internet will affect the video marketplace, "perhaps significantly," but concludes that it is too early to assess the impact of the Internet on this market.[93] At some point, if the Internet continues to grow and greater bandwidth is widely available to end users, the Internet may have even more significant competitive effects on the video marketplace. Moreover, with the deployment of Internet access over cable facilities and digital cable set-top boxes, however, the Internet may exert an influence over the cable market not only as a competitor, but as a component of cable service as well.

The fact that the Internet may affect competition in the video marketplace is not itself a justification for additional regulation. If the Internet enhances competition, it may in fact justify reducing regulation on all video service providers. Moreover, existing regulations for broadcasters and cable operators were never designed with Internet services in mind, and could produce strange results if applied blindly to companies that enable streaming audio or video transmissions over the Internet.

D. Relationship to Content

The FCC has made no effort to regulate the content of services transmitted over the Internet. Nonetheless, the Commission does address content-related issues in broadcasting (such as indecency and educational programming) and to a limited extent in telephony (principally relating to dial-a-porn services).

The 1996 Act also more directly addresses Internet content with its so-called "Communications Decency Act" provisions. These provisions criminalize the knowing transmission using the Internet or other interactive computer services of indecent material to children under the age of 18.[94] The statute further states that "[i]t is a defense to a prosecution" to show that a person has "requir[ed] use of a verified credit card, debit account, adult access code, or adult personal identification number" or otherwise "has taken, in good faith, reasonable, effective, and appropriate actions under the circumstances to restrict or prevent access by minors" to indecent material.[95] Although the primary focus of this section of the Act is on criminal liability, the Act provides that the Commission may describe additional measures "which are reasonable, effective, and appropriate to restrict access to prohibited

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[92] *Broadcasting & Cable*, November 5, 1995, at 113. *See also* "The Internet May be Cutting into TV's Audience," *New York Times News Service*, January 31, 1997.

[93] *Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming*, CS Docket No. 95-61, FCC 95-491 (released December 11, 1995) at para. 127. ("Being an open network, the Internet has the potential to affect the video marketplace, perhaps significantly. However, it appears too early to assess its impact.")

[94] 47 U.S.C. §223.

[95] 47 U.S.C. §223(e)(5).

communications."[96] At the same time, however, the Act places substantial limits on the Commission's authority in this area:

> Nothing in this section authorizes the Commission to enforce, or is intended to provide the Commission with the authority to approve, sanction, or permit, the use of such measures. The Commission shall have no enforcement authority over the failure to utilize such measures. The Commission shall not endorse specific products relating to such measures.[97]

The Commission has not taken any action in response to this section of the Act, and enforcement of these provisions is currently enjoined by a federal court, pending appeal to the Supreme Court.

In most cases, the Commission's existing content rules would apply to Internet services only to the extent that the Commission treated these services as broadcasting. Some activities now conducted over the Internet would likely be prohibited if transmitted over television or radio networks. For example, existing rules proscribe broadcasting of advertisements for cigarettes and gambling services, but such companies have created sites on Web.

The decentralized nature of the Internet may doom any attempt to regulate content in order to prevent access to undesirable material.[98] Many different kinds of entities and individual provide services through the Internet, and limited assumptions about providers or recipients of information may prove unworkable. Creators of online content may have differing levels of control over how the material they send or make available over interactive computer networks such as the Internet can be accessed. Finally, the Internet is international in scope, while the jurisdiction of governments that may seek to regulate Internet content is limited to a single nation, creating both legal and practical difficulties. If content is hosted on a server outside the United States, where the information provided is perfectly legal, can U.S. law be extended to the provider of that content?

In general, the FCC should seek to avoid regulation of Internet content. The legal rationales for FCC regulation of content in other media -- such as scarcity of transmission capacity and invasiveness -- do not necessarily apply to the Internet. Moreover, the Internet provides new mechanisms to solve the very problems it creates. Several companies now provide filtering software that allows users -- such as parents -- to block access to inappropriate Internet

[96] 47 U.S.C. §223(e)(6).

[97] 47 U.S.C. §223(e)(6).

[98] Steven Titch, "Controlling the Internet," *Telephony* 230:7 (February 12, 1996) at 52.

sites.[99] Government regulation of content raises important constitutional issues involving freedom of speech, and thus should not be undertaken lightly.

E. Administrative Issues

Unlike the voice network, which has evolved under the federal-state framework of the Communications Act of 1934, the Internet has no built-in jurisdictional divisions. More important, because the Internet is a dynamically routed, packet-switched network, only the origination point of an Internet connection can be identified with clarity. Users generally do not open Internet connections to "call" a discrete recipient, but access various Internet sites during the course of a single connection. A voice call originates and terminates at two discrete points, and therefore calls can readily be assigned into jurisdictional categories such as local, intraLATA toll, interLATA intrastate, interLATA interstate, intraLATA interstate, and international. The requirement that users dial ten digits instead of seven for calls outside their area code provides some indication of the categorization of a particular call. Similarly, a cable system has a defined boundary, and a broadcast signal, although propagating indefinitely, must have a defined origination point.

For an Internet connection, by contrast, the user may have no idea where the sites he is viewing are located. One Internet "call" may connect the user to information both across the street and on the other side of the world. Furthermore, dynamic routing means that packets may take different routes across the Internet to reach the same site, so even the location of the site the user is contacting does not provide sufficient information to identify the routing of the call for jurisdictional purposes. Internet routers have also not been designed to record sufficient data about packets to support jurisdictional segregation of traffic.

Any regulatory system that applies different rules to different types of Internet services would require, however, some method of identifying and/or segregating Internet traffic. For example, if Internet telephony is subject to Title II of the Communications Act, but basic Internet data connectivity is not, some system would be required to determine whether or not Internet access providers are carrying telephony traffic. Internet protocols currently do not differentiate between different types of packets in a manner that would allow this type of monitoring, and the overhead of such a system could be considerable. Moreover, the definition of what constitutes an "Internet phone call" is not obvious, and changing technology may render any "bright lines" obsolete very rapidly.

Internet connections may be also used for many different purposes. Some uses of the Internet -- such as voice telephony -- may fall more clearly within a plausible reading of the Communications Act. However, service providers that carry such services may not even know what type of data packets are passing through their networks at any given moment.

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[99] *See* Amy Harmon, "Firms Unveil Rating Standard for the Internet," *Los Angeles Times*, May 10, 1996, at A1.

These characteristics pose difficulties for virtually every type of regulation. For example, jurisdictional divisions are the basis not only of the regulatory status of companies themselves, but also the decisions as to which rates regulated telephone companies can charge to unregulated entities. Federal, state, and local governments use such distinctions as the basis for deciding whether they have franchising or taxation authority over companies. The problem is magnified because the Internet is international. Different countries may have completely different laws governing issues such as acceptable content, intellectual property, and privacy, and virtually any company that touches the global Internet could arguably be subject to all of them. Moreover, any domestic regulatory regime must consider the treatment traffic that originates outside the United States and therefore the jurisdiction of the FCC.[100]

F. Toward a Rational Approach

The primary goal of this paper is to identify issues, not to offer specific policy recommendations. It is important to remember that, despite the tremendous attention given to the Internet in the past few years, it remains orders of magnitude smaller in terms of usage and revenues than the voice telephone network in the United States. Many of the questions raised here will answer themselves as service providers fine-tune their business models and as the communications industry evolves. Once competition is sufficiently well-developed, regulation may become largely unnecessary. At some point, companies will be disciplined more strongly by market forces than by the dictates of regulators. Nonetheless, some thoughts about how to address the categorization challenges raised in this section are appropriate.

So long as some services are regulated, a line-drawing process must take place. When Internet services are involved, this line drawing will be inherently messy and imprecise. However, even the premise that Internet services should not be regulated requires a precise assessment of what constitutes an "Internet" service. With the increasing prevalence of hybrid services, joint ventures, and alternative technologies, such distinctions will always be difficult. No matter how sophisticated the regulator, companies in the marketplace will devise clever means of avoiding regulatory restrictions. No matter how well-intentioned the regulator, government intervention in the private sector can have unexpected and unfortunate consequences.

Thus, government should apply blunt instruments that achieve underlying goals, rather than struggling for an elegant or precise solution that will cover every case. Wherever possible, market forces should be harnessed to take the place of direct regulatory intervention. Although new services like Internet telephony and streaming video may create legal headaches, these developments are positive ones that government should encourage. Such new technologies are valuable both because of the new options they represent for consumers, but also because of the potential competitive pressure they may exert on incumbent providers.

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[100] *See, e.g.*, "France Proposes Net Standards," *Web Review*, April 29, 1996, available on the World Wide Web at <http://webreview.com/96/04/29/news/france.html> (describing a memorandum from the French Telecommunications Minister acknowledging that any regulation of the Internet must be international in scope).

The first task of government policy towards these new Internet-based services should therefore be to identify those areas where regulation is clearly not appropriate. By distinguishing these "easy cases," government can provide greater certainty to the private sector that regulation will not be extended to the theoretical boundaries of statutory authority. For example, when a company such as Vocaltec sells retail software that allows end users to make voice phone calls through the Internet, and nothing more, it makes little sense to classify that company as a telecommunications carrier subject to federal and state regulation. Such software providers merely enable end users to utilize a functionality through the network, much like companies that sell fax machines. They do not themselves transport telecommunications traffic. Similarly, an ISP should not be classified as a telecommunications carrier simply because some of its users choose to use Internet telephony software to engage in voice calls. By stating that such companies are not subject to the Communications Act, the FCC could eliminate fear and uncertainty, while still leaving room to analyze the harder questions.

The next step should be to identify relatively simple and flexible structures that achieve underlying policy goals. The initial assumption ought to be that new Internet-based services should not be subject to the regulatory constraints of traditional services. Government policy should be sensitive to the fact that technology is changing rapidly, and that the Internet landscape a few years in the future may look very different than it does today. Market forces may lead to the creation of differentiated classes of service, with users paying higher rates for higher quality, thus de facto distinguishing between different types of service offerings, without any intervention by the government.

The analytical process must work in both directions. Government should think not only about the regulatory treatment of new services, but about the implications of those new services for the regulatory treatment of existing services. If a competitive imbalance exists because a new technology is not subject to the same regulatory constraints as a competing older technology, the answer should be reduced regulation of the older technology. Of course, such deregulation should be dependent on the existence of sufficient competition to police the actions of incumbents. The ultimate objective, however, should be less regulation for all, rather than more regulation for some.

IV. PRICING AND USAGE

The FCC does not regulate the prices charged by ISPs or Internet backbone providers. However, the vast majority of users connect to the Internet over facilities of existing telecommunications carriers. Those telecommunications carriers are subject to varying levels of regulation at both the federal and the state level. Thus, regulatory decisions exercise a profound influence over the economics of the Internet market. Economics will drive the development of both the Internet and of other communications technologies. Consequently, the pricing structure for Internet access, and its interrelationship to the public switched telephone network, are of central importance.

A. Current Internet Access Pricing

To access the Internet, a user must pay an ISP, and any applicable charges to connect to that ISP. Most ISPs charge a flat, monthly fee, although some assess a per-hour charge above a certain monthly threshold.[101] The vast majority of users reach their ISPs today through the telephone network. The phone call to reach an ISP is usually a considered a local call, because the ISP has established a point of presence (POP) in that local calling area.[102] Local telephone service for residential users is typically a flat, monthly fee (in contrast to long-distance service which is typically billed by the minute).

Thus, in the typical scenario for dial-up Internet access, as shown in Figure 7, an Internet user "sees" a monthly telephone connection charge, a monthly charge from the ISP, and a usage charge of zero. By contrast, a subscriber making a long-distance telephone call today sees a monthly local connection charge from a LEC, plus a usage charge from an interexchange carrier (IXC) for each minute of long-distance calling.[103]

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[101] The trend for ISP pricing has been to move towards unlimited usage for a flat monthly rate, especially since AT&T began offering unlimited Internet access for $19.95 per month in early 1996. America Online, which provides Internet access along with proprietary content to eight million subscribers, is now offering an unlimited usage $19.95 per-month pricing plan.

[102] Users in rural areas may be able to reach an ISP POP through a local call. *See infra* section (V)(C).

[103] Of course, this paradigm may change as new competitors enter both the local exchange and interexchange marketplace, especially as integrated providers increasingly offer both local and long-distance services.

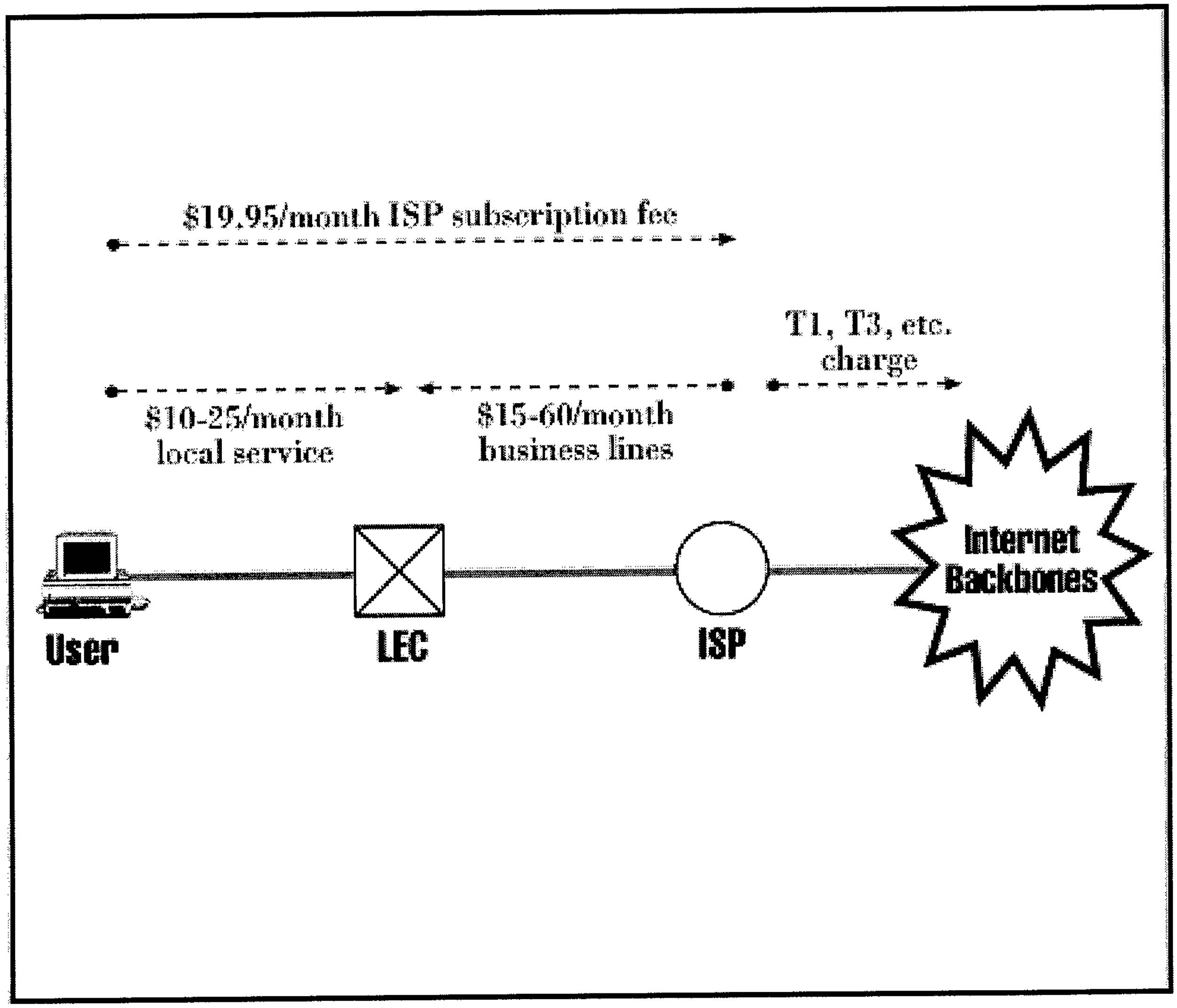

Figure 7 — Current Dial-Up Internet Access Pricing

There are three fundamental reasons why most Internet users do not pay usage charges: (1) residential local service tends to be flat-rated, and ISPs have located their POPs to maximize the number of subscribers who can reach them with a local call; (2) Internet backbone providers tend to charge non time-sensitive rates to each other and to ISPs; and (3) ISPs typically connect to LECs through business lines that have no usage charges for receiving calls.

Because Internet access is understood to be an enhanced service under FCC rules, ISPs are treated as end users, rather than carriers, for purposes of the FCC's interstate access charge rules. This distinction, created when the FCC established the access charge system in 1983, is often referred to as the "ESP exemption."[104] Thus, when ISPs purchase lines from LECs, the ISPs buy those lines under the same tariffs that any business customer would use -- typically voice grade measured business lines (1MBs) or 23 channel ISDN primary rate interface (PRI). Although these services generally involve a per-minute usage charge in addition to a monthly fee, the usage charge is assessed only for outbound calls. ISPs, however, exclusively use these lines to receive calls from their customers, and thus effectively pay flat monthly rates.

By contrast, IXCs that interconnect with LECs are considered carriers, and thus are required to pay interstate access charges for the services they purchase. Most of the access charges that carriers pay are usage-sensitive in both directions. Thus, IXCs are assessed per-minute charges for both originating and terminating calls. As the Commission concluded in the *Local Competition Order*, the rate levels of access charges appear to significantly exceed the incremental cost of providing these services.[105] The Commission in December 1996 launched a comprehensive proceeding to reform access charges in a manner consistent with economic efficiency and the development of local competition.[106]

The FCC's originally explained its decision to treat ESPs as users rather than carriers as a temporary response to concerns about "rate shocks" if ESPs were immediately forced to pay access charges.[107] In 1987, the FCC proposed to require ESPs to pay interstate access charges, on the theory that ESPs used LEC networks in the same manner as IXCs, but this proposal was

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[104] *MTS and WATS Market Structure*, Memorandum Opinion and Order, 97 FCC 2d 682, 711-22, ¶¶ 75-90 (1983) (*Access Charge Reconsideration Order*). In the *Access Charge Reconsideration Order*, we initially exempted several other types of entities, such as WATS resellers, from the requirement that they pay interstate access charges. The exemptions for those other entities were subsequently lifted. *WATS-Related and Other Amendments of Part 69 of the Commission's Rules*, Second Report and Order, CC Docket No. 86-1, FCC 86-377 (released August 26, 1986).

[105] *Local Competition Order* at ¶718.

[106] *See Access Charge Reform,* Notice of Proposed Rulemaking, Third Report and Order, and Notice of Inquiry, FCC 96-488 (released December 24, 1996) (*Access Reform Notice*).

[107] *Access Charge Reconsideration Order*, 97 FCC 2d at 715, ¶ 83 ("Other users who employ exchange service for jurisdictionally interstate communications, including ... enhanced service providers ... would experience severe rate impacts were we immediately to assess carrier access charges upon them.").

withdrawn after intense opposition.[108] In closing the 1987 docket, however, the FCC explained that "this is not an appropriate time to assess interstate access charges on the enhanced services industry,"[109] implying that it still viewed the treatment of ESPs as a temporary accommodation. In the FCC rules, however, there is no "exemption" or "waiver;" only carriers are subject to access charges, and ESPs are defined separately from carriers.[110]

The Access Reform NPRM took up the question of whether enhanced service providers should be subject to access charges as currently constituted, and tentatively concluded that they should not.[111] The Commission argued that, given the inefficiencies of the existing access charge system, "[w]e see no reason to extend this regime to an additional class of users, especially given the potentially detrimental effects on the growth of the still-evolving information services industry."[112] At the same time, the Commission issued a Notice of Inquiry (NOI) seeking comment more broadly on actions relating to Internet and interstate information service providers.[113]

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[108] *Amendments of Part 69 of the Commission's Rules Relating to Enhanced Service Providers*, Notice of Proposed Rulemaking, 2 FCC Rcd 4305 (1987) (*ESP Exemption NPRM)*; *Amendments of Part 69 of the Commission's Rules Relating to Enhanced Service Providers*, Order, 3 FCC Rcd 2631 (1988) (*ESP Exemption Order*). We also sought comment on possible modifications to the ESP exemption in the context of the implementation of our open network architecture (ONA) rules. *Amendments to Part 69 of the Commission's Rules Relating to the Creation of Access Charge Subelements for Open Network Architecture and Policy and Rules Concerning Rates for Dominant Carriers*,6 FCC Rcd 4524, 4534-35 (1991).

[109] *ESP Exemption Order* at 2633, ¶ 20.

[110] 47 C.F.R. § 69.704(a).

[111] *Access Reform Notice* at ¶¶ 282-90.

[112] *Id.* at ¶ 288.

[113] *See id.* at ¶¶ 311-18.

B. Network Economics

In recent years, there has been extensive academic literature on the economics of the Internet.[114] Much of the economic debate concerns the implications of various pricing models for Internet usage. Pricing generates incentives that affect usage patterns, and that also affect the manner in which service providers construct their networks. The FCC and state commissions, through their regulatory authority over the rates charged by local phone companies and other mechanisms, exercise great influence over the pricing of Internet access. Therefore, the underlying economics of the Internet, and of networks generally, are of great importance for any discussion of the relationship of the FCC to the Internet.

The value of networks to each user increases as additional users are connected.[115] For example, electronic mail is a much more useful service when it can reach fifty million people worldwide than when it can only be used to send messages to a few hundred people on a single company's network. The same logic applies to the voice telephone network, and is an important underpinning of the FCC's public policy goal of universal service.[116]

However, this increasing value also can lead to congestion. Network congestion is an example of the "tragedy of the commons:" each user may find it beneficial to increase his or her usage, but the sum total of all usage may overwhelm the capacity of the network. With the number of users and host computers connected to the Internet roughly doubling each year, and traffic on the Internet increasing at an even greater rate, the potential for congestion is increasing rapidly. The growth of the Internet, and evidence of performance degradation, has led some observers to predict that the network will soon collapse,[117] although so far the Internet has defied all predictions of its impending doom.

Two types of Internet-related congestion should be distinguished: congestion of the Internet backbones, and congestion of the public switched telephone network when used to access the Internet. These categories are often conflated, and from an end user standpoint the point of congestion matters less than the delays created by the congestion. However, there are two fundamental differences. First, prices that carriers charge for use of local exchange facilities

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[114] *See, e.g.* Lee McKnight & Joseph Bailey, *Internet Economics* (forthcoming 1997); Jeff MacKie-Mason & Hal Varian, *Pricing the Internet*, in *Public Access to the Internet* (Kahin & Keller, eds. 1994); Alok Gupta, Dale Stahl, and Andrew Whinston, "Pricing Services on the Internet," available on the World Wide Web at <http://cism.bus.utexas.edu/alok/pricing.html>.

[115] Nicholas Economides, "The Economics of Networks," *International Journal of Industrial Organization* 14:2 (March 1996).

[116] *See, e.g.*, Amy Friedlander, *Natural Monopoly and Universal Service: Telephones and Telegraphs in the U.S. Communications Infrastructure 1837-1940*, at 54 (CNRI 1995).

[117] John Simons, "Stress, Strain and Growing Pains: As Usage Soars, the Net Could Face Brownouts," *US News and World Report*, May 6, 1996. This article quotes Bob Metcalfe, the developer of Ethernet and founder of 3Com Corp., as stating, "The Internet is about to collapse" from excessive usage. *See also* Jeff Pelline and Jon Swartz, "Internet Gridlock is Getting Worse," *San Francisco Chronicle*, April 16, 1996.

are regulated, while those that Internet backbone providers charge are not. This regulatory distinction is based on the reality that today there is generally only one LEC that an ISP can use in a given area, while there are many competing Internet backbone providers. Second, the PSTN generally uses circuit switching, while the Internet is packet switched. The congestion patterns and pricing issues for the PSTN, which carriers both voice and Internet traffic, are therefore different than those in the Internet backbone world.

Congestion of the Internet backbones results largely from the shared, decentralized nature of the Internet. Because the Internet interconnects thousands of different networks, each of which only controls the traffic passing over its own portion of the network, there is no centralized mechanism to ensure that usage at one point on the network does not create congestion at another point. Because the Internet is a packet-switched network, additional usage, up to a certain point, only adds additional delay for packets to reach their destination, rather than preventing a transmission circuit from being opened. This delay may not cause difficulties for some services such as email, but could be fatal for real-time services such as video conferencing and Internet telephony. At a certain point, moreover, routers may be overwhelmed by congestion, causing localized temporary disruptions known as "brownouts."[118]

Backbone providers have responded to this congestion by increasing capacity. Most of the largest backbones now operate at 155 Mbps (OC-3) speeds, and MCI has upgraded its backbone to OC-12 (622 Mbps) speed.[119] Backbone providers are also developing pricing structures, technical solutions, and business arrangements to provide more robust and reliable service for applications that require it, and for users willing to pay higher fees. Some network providers, such as the @Home cable Internet service, are relying on "caching" multiple copies of frequently-accessed documents to ease the congestion burden.[120] In addition, hardware vendors are working to improve the speed and interoperability of their Internet routers and switches.[121]

Congestion on Internet facilities may also be alleviated by the development and implementation of technical protocols, such as HTTP version 1.1, IP version 6, IP multicasting, and RSVP, that facilitate more coordinated and efficient use of bandwidth.[122] These technologies may allow for more differentiated levels of service quality, with associated

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[118] For a more detailed explanation of Internet congestion, see Vadim Antonov, "ATM: Another Technological Mirage," available on the World Wide Web at <http://www.pluris.com/ip_vs_atm/>.

[119] For comparison, the NSFNET was upgraded from 56 kbps to 1.544 Mbps (T-1), and then to 45 Mbps (T-3) before it was replaced by the commercial backbones.

[120] "The Interminablenet," *The Economist*, February 3, 1996, at 70-71.

[121] Michael Shapiro, "Trio Targets Gridlock," *Web Review News*, May 9, 1996, available on the World Wide Web at <http://webreview.com/96/05/09/news/network.html>.

[122] These protocols generally work by reducing duplication in sending high-bandwidth data to multiple recipients, or by allowing users to "reserve" (and pay for) a guarantees level of bandwidth for a specific use. *See* Joe McGarvey, "Beyond Bandwidth: Solving Net Traffic Jams," *Inter@ctive Week*, April 22, 1996, at 58.

differentiation in pricing.[123] The pricing of backbone services may affect end user charges for Internet access, even if ISPs continue to pay flat rates to LECs.

Internet backbone congestion raises many serious technical, economic, and coordination issues. Higher-bandwidth access to the Internet will be meaningless if backbone networks cannot provide sufficient end-to-end transmission speeds. Moreover, the expansion of bandwidth available to end users will only increase the congestion pressure on the rest of the Internet. However, Internet backbone providers are not regulated by the FCC in the same manner as LECs. This paper concentrates primarily on the congestion and pricing issues that affect the public switched telephone network, because it is in that area that decisions by the FCC and other regulatory entities will have the greatest significance.

C. Implications for Local Exchange Carriers

Most residential subscribers reach their ISPs through dial-up connections to LEC networks. Figure 8 shows the typical scenario for a dial-up user. A modem at the customer premises is connected to a local loop, which is connected to a switch at a LEC central office. ISPs also purchase connections to the LEC network. In most cases, ISPs either buy analog lines under business user tariffs (referred to as "1MBs") or 23-channel primary rate ISDN (PRI) service. When a call comes into an ISP, it is received through a modem bank or a remote access server, and the data is sent out through routers over the packet-switched Internet.[124] Both subscribers and ISPs share usage of LEC switches with other customers.

[123] There is a significant economics literature on priority-sensitive pricing models for the Internet.

[124] For simplicity, this description leaves out many other functions of ISPs, such as user authentication and domain name queries.

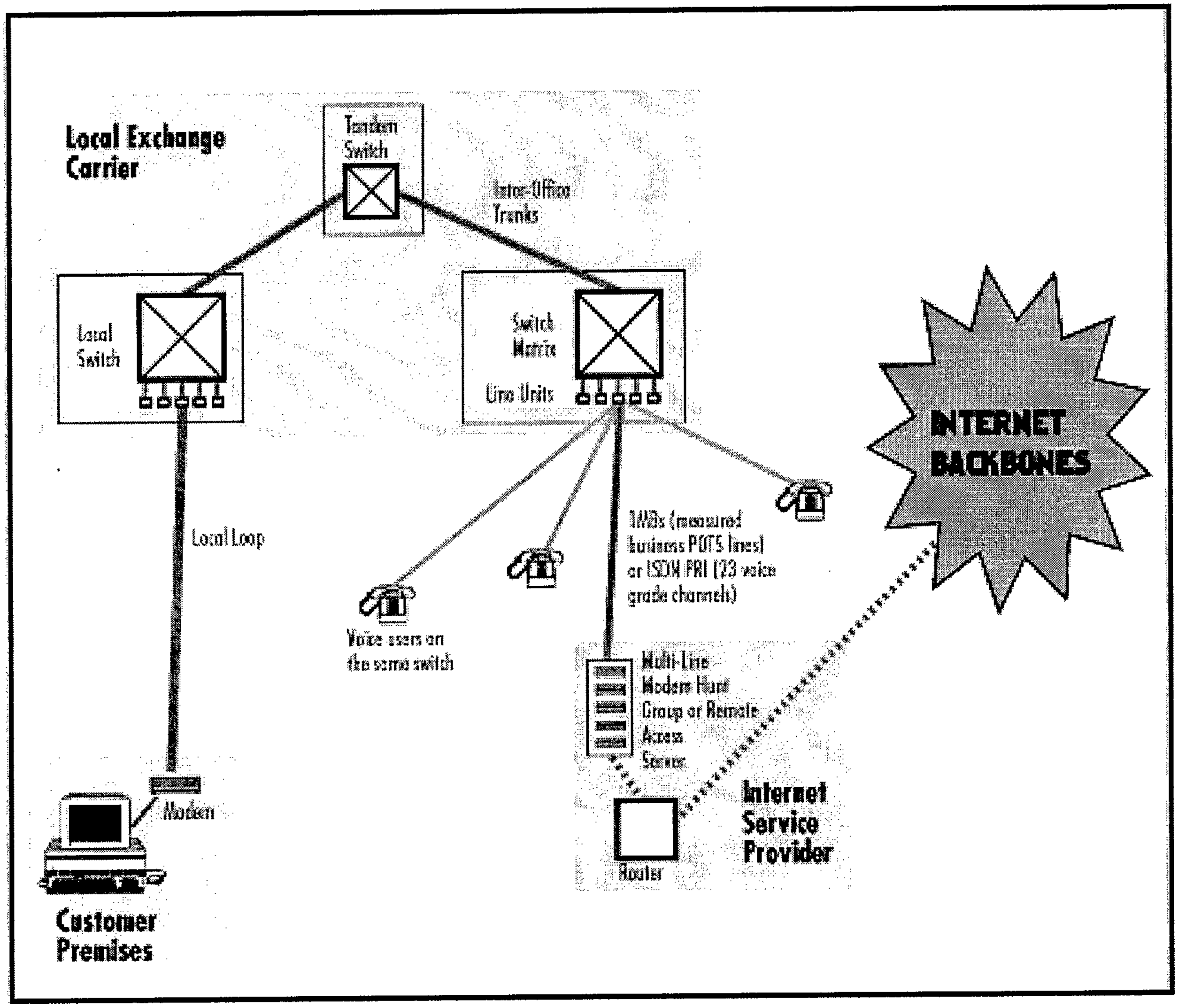

Figure 8 — Typical Dial-Up Internet Access Architecture

1. Pricing Issues

Ever since 1983, when the FCC first decided that ESPs would not be subject to interstate access charges, parties have challenged the "ESP exemption" as an inefficient temporary subsidy that unfairly deprives LECs of revenues.[125] The FCC has itself come close to endorsing this view in the past, most notably in the infamous "modem tax" proposal in 1987.[126] Nonetheless, the current pricing structure for enhanced services has stayed in place for fourteen years. The telecommunications landscape has changed tremendously in that time, with the emergence of the Internet being among the most significant developments. The Access Reform NPRM proposes to leave the current pricing structure for ISPs in place for now. In the companion NOI, the Commission seeks comment on, among other issues, how these changes should affect the pricing structure applicable to ISPs.

Access charges are designed to recover the LECs' interstate revenue requirements for the underlying facilities. These revenue requirements were derived from rate-of-return, accounting cost mechanisms designed to recover the embedded costs of monopoly LECs. Since 1990, large LECs have been subject to price cap regulation of their access services, which has allowed rate levels to diverge to some degree from embedded costs, but LEC access charges are still not based on any calculation of forward-looking cost. Another aspect of the revenue requirement that distorts rate levels is the fact that the jurisdictional separations system apportions costs between the interstate and intrastate jurisdictions in a manner that does not accurately reflect cost-causation. Finally, the interstate access charge regime includes various forms of cost-shifting and averaging. For example, the carrier common line charge (CCLC) is a per-minute charge that is assessed on all LEC access customers, but it recovers costs associated with end user subscriber lines.[127]

IXCs, ISPs, and others have long argued that access charges are substantially higher than they would be in a competitive market, and the Commission essentially adopted this view in the *Access Reform* and *Local Competition* proceedings. The argument for requiring ESPs to pay access charges has generally been premised on the notion that ESPs impose similar costs on the network to providers of interstate voice telephony, and that ESPs should therefore pay the same rates for these services. For example, the FCC's 1987 proposal stated that:

> Enhanced service providers, like facilities-based interexchange carriers and resellers, use the local network to provide interstate services. To the extent that they are exempt from

[125] *See, e.g.*, "Access Charge Reform: What's Past is Prologue and Pretty Scary," *Communications Today*, February 5, 1996 (quoting former FCC Common Carrier Bureau Chief Albert Halperin as stating that the ESP exemption "is one of the significant weaknesses in the existing [access charge] plan.")

[126] *See ESP Exemption NPRM.*

[127] The CCLC was established to recover costs that could not be recovered due to caps on the flat end user subscriber line charge (SLC). The Commission is currently considering whether to retain the current CCLC in the context of its Universal Service proceeding.

access charges, the other users of exchange access pay a disproportionate share of the costs of the local exchange that access charges are designed to cover.[128]

ESPs have rejected this analysis, and have claimed that they do not need or use many of the features and functions of the network that IXCs require to set up voice calls. In addition, ESPs have argued that imposition of interstate access charges would cause tremendous damage to the enhanced services industry with the corresponding benefit of only a tiny reduction in charges to other users. ESPs, and particularly the Internet access industry, have also emphasized the public interest benefits of spurring growth in Internet access and other enhanced services. According to a March 1995 white paper by the Commercial Internet Exchange (CIX), a trade association of ISPs, "ESPs have enjoyed this status because of the public policy need to foster an on-line nation."[129]

The development of Internet telephony provides an additional argument that at least some enhanced services use LEC networks in a manner similar to IXCs. Voice telephony over the Internet may operate as a direct substitute for telephony service provided by IXCs over their voice networks. Today, however, Internet telephony does not provide the same quality and convenience as traditional voice telephony. Commercial Internet telephony products are also a relatively new phenomenon, and as a result of these factors the number of users of Internet telephony is minuscule compared to users of the voice network. These characteristics may change in the future, especially if Internet telephony continues to be available at significantly cheaper rates than conventional telephony. As discussed in the previous section, the architecture of Internet telephony services differs from circuit-switched voice telephony in ways other than quality and ease of use. The real questions concern the economic implications of Internet services that use the public switched network.

The current pricing structure of wireline service in the United States operates on the principle of "sender pays" for transactions between users and carriers.[130] The fact that a subscriber only pays for making phone calls, not for receiving them, does not mean that the LEC does not incur costs for the subscriber to receive a call; it only means that those costs are recovered indirectly through the rates users pay for outbound calls and monthly service This rule generally holds true even if the subscriber is a member of a distinct user category with a different cost causation pattern. For example, a customer service center operated by a computer company receives many times more calls from customers than it originates, but the call usage is charged -- if at all -- to the customers.[131] The 1996 Act essentially adopts a "sender pays" rule

[128] *ESP Exemption NPRM* at 4306, para. 7.

[129] Commercial Internet Exchange, *White Paper: A Telecommunications Policy Framework for Internet Service Providers* (March 1995) (*CIX White Paper*).

[130] This pricing structure is not, however, followed in the cellular telephone industry today.

[131] The company could choose to reverse the charges with an 800 or 888 toll-free number, but this would be a voluntary action on the part of the company in order to increase convenience for its customers.

for interconnection between carriers in the form of "transport and termination" charges; originating telecommunications carriers must pay whenever they hand off local traffic to another carrier.

2. Switch Congestion

Several LECs and others now argue that the current pricing structure for Internet access contributes to the congestion of LEC networks. Switch congestion can arise at three points in LEC networks -- the switch at which the ISP connects to the LEC (the terminating switch), the interoffice switching and transport network, and the originating end user switch. The point of greatest congestion is the switch serving the ISP, because many different users call into the ISP simultaneously.

LECs have engineered and sized their networks based on assumptions about voice traffic. In particular, several decades of data collection and research by AT&T, Bellcore, and others has shown that an average voice call lasts 3-5 minutes, and that the distribution between long and short calls follows a well-established curve. Because very few people stay on the line for very long periods of time, there is no need for LEC switches to support all users of the switch being connected simultaneously. Instead, LEC switches are generally divided into "line units" or "line concentrators" with concentration ratios of typically between 4:1 and 8:1 (see Figure 8). In other words, there are between four and eight users for every call path going through the switch. Call blockage on the voice network tends to be negligible because a significant percentage of users are unlikely to be connected simultaneously.[132]

The distribution of Internet calls differs significantly from voice calls. In particular, Internet users tend to stay on the line substantially longer than voice users. As shown in Figure 9, several LECs and Bellcore have submitted studies to the Commission documenting the difference between Internet and voice usage patterns.[133] ISPs, although challenging the methodologies and conclusions of the studies, generally acknowledge that Internet calls tend to be longer than voice calls.

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[132] LEC switch and network architecture is actually somewhat more complex than described here, but the basic principles set forth still hold true.

[133] Amir Atai & James Gordon, *Impacts of Internet Traffic on LEC Networks and Switching Systems* (Bellcore 1996); letter from Joseph J. Mulieri, Bell Atlantic, to James D. Schlichting, FCC (June 28, 1996); letter from Kenneth Rust, NYNEX, to James Schlichting, FCC (July 10, 1996); letter from Glenn Brown, US West, to James Schlichting, FCC (June 28, 1996); letter from Alan Ciamporcero, Pacific Telesis, to James Schlichting, FCC (July 2, 1996).

	Office Avg. Busy Hour Usage	ISP Avg. Busy Hour Usage	Office Avg. Call Hold Time	ISP Avg. Call Hold Time
BELL ATLANTIC	3 CCS	26-28 CCS	4-5 minutes	17.7 minutes
US WEST	3 CCS	27 CCS	2.4 minutes	16.7 minutes
PACIFIC BELL	4 CCS	19 CCS	3.8 minutes	20.8 minutes

Source: studies submitted to the FCC based on traffic during first quarter 1996 (available in file CCB/CPD 96-16)

CCS means 100 call seconds (e.g. 6 CCS = 600 seconds or ten minutes).
"Busy hour usage" means the amount a circuit is in use during the busiest hour of the day.
"Call hold time" means the length of an individual call.

Figure 9 — RBOC Network Usage Studies

Because LEC networks have not been designed for these longer usage patterns, heavy Internet usage can result in switches being unable to handle the load ("switch congestion"). Internet connections tie up a end-to-end call path through the PSTN for the duration of the call. When the average hold time of calls through a switch increases significantly, the likelihood of all available call paths through the switch being in simultaneous use also goes up. If a particular line unit has an 8:1 concentration ratio, only one eighth of the subscriber lines into that line unit need to be connected at one time in order to block all further calls.

Because of the relatively short average duration of voice calls, the primary limiting factor on the capacity of current digital switched for voice calls is the computer processing power required to set up additional calls. Computer processing power can be expanded relatively easily and cheaply, because modern switch central processing units are designed as modular systems that can be upgraded with additional memory and processing capacity. On the other hand, LECs argue, Internet usage puts pressure not on the call setup capacity of the switch, but on the number of transmission paths that are concurrently open through the switch.

ISPs dispute the extent to which switch congestion currently represents a serious problem. A study by Economics and Technology, Inc. (ETI), commissioned by the Internet Access Coalition, argues that the growth of Internet traffic poses no threat to the integrity of the voice network.[134] According to the study, incidents of congestion have been localized, are easily corrected, and are primarily attributable to inadequate planning and inefficient engineering by the LECs.[135] The ETI study also concludes that LECs received approximately $1.4 billion of revenue from additional residential subscriber lines used for online access in 1995, and that this number far exceeds even the LECs' own estimates of the costs of network upgrades to ameliorate congestion.[136] Other opponents of imposing usage charges on ISPs point to the fact that LEC state business line tariffs are designed to recover the costs LECs incur for usage of their network, and that if flat-rated charges are compensatory for local service it is illogical to argue that they are non-compensatory for Internet access. Long voice calls, these advocates claim, impose the same costs on the network as long Internet connections, but LECs are still able to provide local service at flat monthly rates.

The Network Reliability and Interoperability Council, an industry group that tracks reliability of the public switched telephone network and makes recommendations to the FCC, has stated that Internet usage has not yet resulted in any outages above the NRIC's outage

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[134] Lee L. Selwyn & Joseph W. Laszlo, *The Effects of Internet Use on the Nation's Telephone Network* (January 22, 1997) (*ETI Study*).

[135] *Id.* at 19-22.

[136] *Id.* at 27.

reporting threshold.[137] Internet usage, however, continues to grow rapidly. Low-cost Internet access devices such as Web TVs and network computers (NCs) that have recently come on the market are likely to fuel substantial Internet traffic growth in the next several months.

A distinction should also be made between the larger class of ESPs -- which include companies such as voice mail providers, alarm monitoring companies, credit card validation services, and internal corporate data networks -- and Internet or online service providers. Current FCC rules refer only to ESPs, but the arguments LECs are now making about switch congestion are directed specifically at the small subset of ESPs that provide Internet access. The fact that Internet usage may be placing new demands on LEC networks is not necessarily a reason to impose usage charges on enhanced service companies other than ISPs. There may be arguments that other ESPs should pay usage charges, because they generate costs for LECs that otherwise cannot be recovered. In fact, the previous debates about the ESP exemption occurred before there was any significant amount of commercial or residential Internet usage. If the Commission wishes to consider the LEC arguments about switch congestion, however, the discussion should only apply to pricing of services for ISPs, not all ESPs.

3. Responses to Switch Congestion

Addressing switch congestion is ultimately a matter of money. No one argues that LECs cannot upgrade their networks to remove and prevent blockages. There is, however, disagreement about the costs of such upgrades, and whether changes in pricing structures would send efficient economic signals.[138] The ultimate question is whether LECs have appropriate incentives to upgrade their networks in the most efficient manner, and ISPs have appropriate incentives to use the most efficient available method of access. Most parties agree that, as a technical matter, packet-switched Internet traffic could be transported more efficiently through a packet-switched network, rather than tying up the circuit-switched PSTN. However, different technical solutions will likely be most appropriate in different regions, depending on factors such as the infrastructure and business plans of the incumbent LEC, the competitive landscape, and the level of Internet traffic in a specific area. The goal of policy makers should be to create incentives that encourage these efficient results, rather than choosing any one solution.

Several technical, economic, and regulatory responses to switch congestion have been proposed.

a. Pricing Changes

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[137] *See* "Hundt asks Network Reliability and Interoperability Council to Monitor Impact of Internet Growth on Public Networks," FCC News Release, November 1, 1997. Additional information about the Network Reliability and Interoperability Council is available on the World Wide Web at <http://www.fcc.gov/nric/>.

[138] Pricing and regulatory decisions will not mandate how providers deploy their networks or serve their customers, but will only shape economic incentives on companies.

Some LECs argue that, because of the possibility of switch congestion, the Commission should allow them to assess per-minute usage charges for ISPs to receive calls from their subscribers. From the LEC perspective, usage pricing would have two salutary effects. First, because ISPs (and presumably their customers, as ISPs themselves shifted to measured rates to recover their costs) would be paying more for longer calls, they would have incentives not to over-use the network. In other words, users would stay connected only as long as they found the additional connect time worth the cost, and ISPs might have stronger incentives to migrate away from their current practice of purchasing tremendous numbers of analog business lines. Second, and more importantly, with usage pricing, LECs would receive more revenue from longer Internet calls than from shorter ones.[139] Thus, the LECs argue, their revenues would more closely match their costs, which also increase with longer connection times due to the necessary network upgrades to prevent switch congestion.

The notion of "usage charges" should be distinguished from current interstate access charges. The discussion of this topic is often framed in terms of whether to "lift the ESP exemption," or "impose access charges on ISPs." However, even if one agrees with the LEC arguments, this does not lead to the conclusion that ISPs should pay today's access charges. Current access charges far exceed the economic cost of providing access services, and in many ways are structured in an economically inefficient manner. It would make no sense, under the guise of creating a more efficient rate structure for ISPs, to impose the existing access charge system that all parties agree is inefficient. In addition, access charges have been structured based on the features and service bundles used by IXCs to handle voice calls, which may be different than those ISPs would choose. The Commission based its tentative conclusion in the *Access Reform* NPRM that ISPs should not be subject to current access charges on these sorts of arguments.[140]

The real question is whether ISPs should pay some new cost-based usage charges. ISPs should pay the same charges as IXCs only if those charges are appropriate for a competitive market and for the manner that ISPs use LEC networks. The Commission could also establish a separate set of interstate charges for ISPs distinct from those assessed on IXCs, or even distinct from those for other ESPs with different cost causing characteristics. Finally, if the FCC does not change the current classification of ISPs as end users, LECs could alter their state tariffs to impose usage charges on ISPs. Such a result could involve tariffs based on the characteristics of ISP traffic (many long hold-time incoming calls) that in effect required ISPs to pay usage-sensitive rates, or alternate tariffs that ISPs could select voluntarily. The Commission might be required to respond to changes in state-level pricing for ISPs to the extent that such changes affected BOC open network architecture (ONA) plans.

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[139] The second point is more important because the ultimate goal is to maintain and enhance the network, not to restrict usage.

[140] *See Access Reform Notice* at ¶ 288.

LECs could also fashion and seek FCC approval of experimental or contract tariffs for services they offer to ISPs. Current FCC rules limit LECs' ability to offer individualized prices, because of concerns about discrimination and predatory pricing. However, a specialized federal tariff offering geared to ISPs, especially if developed in conjunction with some large ISP customers, might prove to be a useful experiment.

The term "usage charges" itself requires some further qualifications. The cost of shared telecommunications facilities is generally driven not by total usage, but by usage at peak periods. The marginal cost of a off-peak call is often close to zero. For this reason, long-distance pricing in the United States has traditionally operated on a multi-level model, with calls during daytime hours (when usage is heaviest) priced highest, and calls during night and weekend hours priced lowest. Internet usage can cause switch congestion because usage at peak periods may exceed the capacity of a switch, and because a higher percentage of Internet users engage in extremely long calls (*i.e.* more than two hours). A relatively small number of long calls may make a significant contribution to the degree of congestion on a switch. Therefore, a pricing structure that incorporated usage charges only for a small percentage of users (for example, those that were connected more than 200 hours per month), might reduce switch congestion without affecting the vast majority of Internet users.

There are many difficulties with peak-load pricing schemes. Users may respond to the pricing structure by shifting their calling patterns to avoid the peak charges, thereby shifting the peak. Customers have also shown a strong preference for simple pricing systems, and especially for those that offer a flat rate for unlimited usage, even if the flat rate would actually result in a higher bill for their particular level of usage. Nonetheless, more thought should be given to pricing structures other than straight per-minute charges. Such alternatives may eventually prove unworkable or undesirable, but they should stimulate creative thinking and a more precise understanding of the causative relationship between specific usage patterns and congestion.

At first blush, the economic argument that ISPs should pay usage charges to LECs seems compelling. Switching and transport capacity in the PSTN are scarce resources, and heavier use of those resources results in higher costs to the service provider. To the extent that these costs cannot be recovered from the discrete groups responsible for the heavier usage, rates for all users will increase. This result seems undesirable as a matter of equity (why should all users pay more so that a portion of users can access the Internet) and as a matter of efficiency (why should Internet users be given the misleading signal that unlimited Internet usage is "free" for the network).[141] At a more general level, if a minute of Internet usage looks the same to the phone network as a minute of voice usage, economic cost-causation principles suggest that they be subject to the same pricing structure.

The reductive argument for usage charges is problematic on several levels. Most fundamentally, it assumes that other aspects of telecommunications pricing follow similar

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[141] *See, e.g.*, J. William Gurley, "Internet Economics:The FCC Chimes In," available on the World Wide Web at <http://www.upside.com>; J. William Gurley & Michael Martin, "The Price Isn't Right on the Internet," *Fortune*, January 13, 1997, at 152; Adam Thierer, "End Free Ride on the Internet," *Wall Street Journal*, March 7, 1997, at A14.

principles of economic efficiency. The same argument about the perils of flat-rated pricing could be applied to residential local phone service in the United States. There are many classes of users that can be identified as making or receiving unusually large volumes of calls, such as teenagers and customer support centers for businesses, yet separate rate structures have not been established for these groups. All tariffed prices for telephone services involve some level of averaging, so the mere fact that some users vary from the average does not by itself suggest that they should pay different rates.

The argument for usage pricing also assumes that ISPs use the existing, circuit-switched network, rather than the alternative access technologies described in the next section. An unanswered question, therefore, is whether LECs would have incentives use the additional revenues generated by usage pricing to further expand the circuit-switched network, or to invest in more efficient, "data-friendly" alternatives. To address this concern, if an alternate rate structure for ISPs were developed, it could be conditioned in some way on LEC commitments to build out data networks in a specific time frame.

LECs also receive substantial additional revenues as a result of Internet usage. In particular, second line deployment, which was stable for some time, has increased dramatically over the last few years. A major reason why many subscribers are ordering second lines is to support modem connections without tying up a primary voice phone line. LECs recognize that second lines after often used for data connection, and many LECs are specifically marketing second lines to consumers for this reason.[142] Recent LEC earnings statements emphasize second line growth as a major contributor to LEC bottom lines. Many homes are wired to support at least two lines without any additional infrastructure, so second lines often cost LECs little to install and generate very high profit margins.

The ETI study estimated that in 1995, BOCs generated revenue from additional residential lines for online access that was six times the amount Bellcore claimed would be required to upgrade their networks to handle additional Internet traffic.[143] On the other hand, residential lines in some states are deliberately priced low by state commissions, on the assumption that LECs will "make up" the revenue through toll usage and "vertical features" such as call waiting. In cases where LECs must actually install additional copper pairs, therefore, the profitability of second lines will depend heavily on decisions of state regulators. Any discussion of costs imposed on LECs by Internet traffic should attempt to take into account second line growth and other countervailing revenues.

The metric of usage charges may also be significant. Access charges are metered by minute, and the billing and accounting systems of the PSTN are generally designed to measure traffic on a time-sensitive ("per-minute") basis. An appreciable component of carrier costs goes

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[142] Pacific Bell, for example, recently targeted a sales pitch to Internet users in which it offered to waive installation charges, and offers five free months of Internet access for subscribers that purchase a second line.

[143] *ETI Study* at 27.

to support this billing and accounting infrastructure. By contrast, the Internet has developed under flat-rated pricing and interconnection between backbone providers on the basis of "bill-and-keep" (no settlements), and thus has none of these accounting mechanisms or costs.[144]

Once traffic is converted into packet form and routed through the Internet, the notion of a "minute of use" evaporates. The Internet is a connectionless network. Packet data does not monopolize a set transmission path for a given period of time, it filters through the network through multiple routes at varying rates. Thus, packet traffic is more appropriately described in usage levels based on bandwidth (such as bits per second) rather than time. Concerns about usage pricing for Internet access tend to involve objections to time-sensitive pricing, not to bandwidth-sensitive pricing (e.g. a 1.544 megabits per second T-1 circuit being more expensive than a voice grade connection). Internet backbone providers and ISPs are now discussing technical and logistical aspects of "bandwidth reservation" systems, under which a user of a service such as streaming video could pay a higher price for guaranteed bandwidth. Such differential pricing would likely be voluntary for users, as users that did not wish to pay additional charges could always switch to a different ISP.

The LEC networks have been designed to support metering and accounting of traffic for billing purposes, and LECs today charge usage-sensitive access charges to interexchange carriers that interconnect with LECs for the provision of long-distance telephony. It would therefore not be administratively difficult for LECs to measure the total amount of traffic, in minutes of usage, passing between the LEC and an ISP, and to charge the ISP according to its level of usage.[145] Because ISP costs would vary with the level of usage their customers generated, such a pricing system would create incentives for ISPs to move to some form of usage-based end-user pricing. Such a system might impose additional costs on ISPs usage on a per-minute basis, since ISPs have not generally developed the same type of billing infrastructure of the LECs.

Changing the pricing structure applicable to ISPs could have other, more subtle effects. Under the existing system, ISP usage is considered jurisdictionally intrastate, while IXC usage is jurisdictionally interstate. The imposition of access charges or other federally-mandated usage charges on ISPs could result in ISP usage being reclassified as interstate. This shift would affect the operation of the separations system, which allocates revenues between the federal and state jurisdiction. Such large revenue shifts would also affect the price cap system that governs interstate rates charged by incumbent LECs, which begins with revenues derived from separations.

The purpose of this section is not to suggest that some form of usage charges for ISPs will necessarily always be the wrong answer as a matter of public policy. Rather, the point is that the question is complex, and must be viewed in the context of several different factors. More

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[144] Although backbone providers have generally not assessed usage charges, many ISPs have charged some usage fees to end users above a certain usage threshold, and thus may have experience with metering and accounting of traffic.

[145] "Special Report: Telcos and ISPs Grapple Over Access Charges," *Internet Week*, March 25, 1996.

comprehensive data on Internet usage, congestion levels, and network costs will be crucial to an effective discussion of switch congestion and pricing structures for ISPs.

Although Internet access is usually priced at a flat monthly fee for "unlimited usage," most large ISPs automatically disconnect users after long periods of inactivity in order to avoid tying up the ISPs' equipment, such as modem banks. Thus, few users may actually "nail up" lines for 24 hours a day. Software does exist to fool these ISP systems, and as services such as America Online experience congestion problems due to insufficient numbers of modems, users may be more likely to keep a connection open once they have actually gotten through. As this example shows, ISP usage patterns are affected by many factors. The FCC's Notice of Inquiry is designed to gather data to form a better foundation for policy development. The Commission also held a public forum on Access to Bandwidth on January 23, 1997, which addressed many of the questions raised in this paper.[146]

b. Technical Solutions

The imposition of usage charges on ISPs would not, by itself, solve the problem of switch congestion. At best, this action would give LECs additional revenue to pay for network upgrades. Congestion will continue to occur, however, so long as users continue to use the circuit-switched voice network to connect to the packet-based Internet. Usage charges might also depress Internet usage, which would reduce congestion but could also stifle the growth of innovative new Internet-based services. The real challenge is to find ways to take that data traffic off the PSTN, preferably before it reaches the first LEC switch.

The best answer to the current switch congestion problem will be to remove Internet traffic, or at least heavy Internet users, from the existing circuit switched network. LECs and ISPs agree that such a network upgrade would best address their concerns. The two sides differ, however, on the question of how the Commission's decision about usage charges for ISPs will effect the deployment of these new technologies. LECs argue that they have no incentive to invest in upgrading their networks when they recover no additional revenues from ISPs for supporting heavy Internet use, especially given the uncertainties about cost recovery in a world of unbundled network elements as required under the 1996 Act. ISPs argue that LECs will have no incentives to invest in long-term network upgrades if they recover metered charges that allow, and even encourage, them to keep investing (and profiting) in the existing circuit-switched network.

There are several methods to address switch congestion. These can loosely be grouped into four categories:

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[146] A transcript of the Bandwidth Forum, along with statements from many of the participants, is available on the World Wide Web at <http://www.fcc.gov/bandwidth>.

Network Expansion and Aggregation

The most straightforward response to switch congestion is to expand the capacity of the exiting network wherever it is being stressed. These steps include load balancing (shifting circuits among sub-units of a switch to better distribute heavy traffic directed a single source such as an ISP), transferring ISP traffic to a larger central office with greater switching capacity, adding additional capacity to switches, reducing the concentration ratio of switches with heavy Internet usage, adding additional interoffice trunking, and ultimately purchasing additional switches. A slightly more fundamental alternative involves "modem pooling" -- persuading ISPs to lease large banks of modems operated by LECs in a central location, so that Internet traffic can be more efficiently aggregated at high-capacity points of the network. A similar approach involves setting up a single number that ISP customers in multiple areas could call into. LECs are experimenting with or implementing all these responses today, but ultimately they still involve routing data traffic through at least one circuit switch at the originating end.

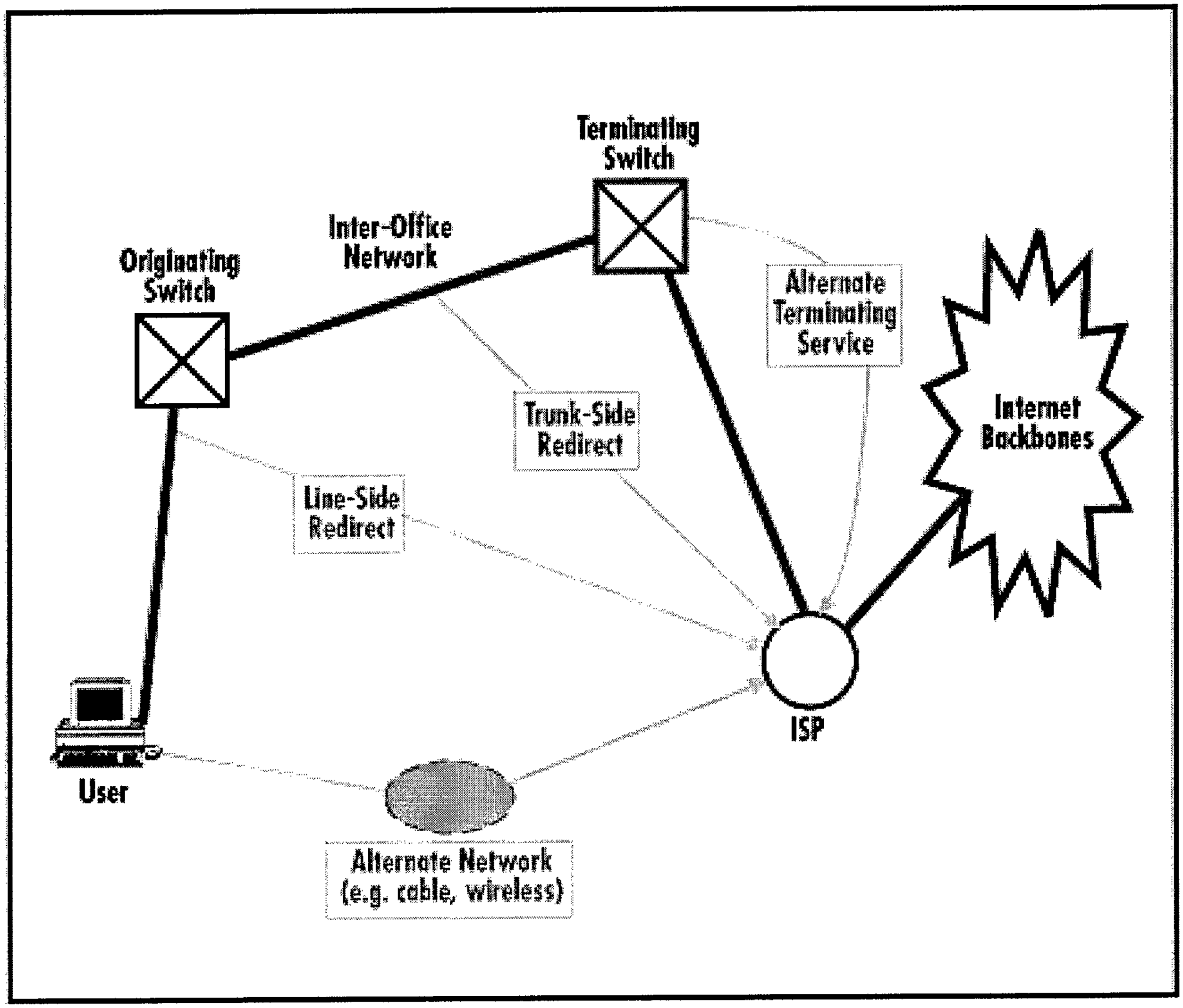

Figure 10 — Some Solutions to Switch Congestion

Workarounds

Most LECs have existing tariffed service offerings that route data through data networks using frame relay or switched multimegabit data service (SMDS) rather than analog modem connections to a local switch. However, ISPs have rarely taken these services, because they believe they will increase their costs over their current practice of purchasing large numbers of business lines. ISPs have also expressed concerns about ceding control over user access to LECs. Such reluctance may be due to inefficiencies in state tariffing of such data services, which may not have been designed with current Internet usage patterns in mind. An alternate form of workaround, which would not necessarily require ISPs to change their current access arrangements, involves upgrades to LEC switching or signaling networks. Virtually every major equipment vendor, including Lucent, Nortel, and DSC, has announced or is developing a solution to screen data traffic and pull it off the voice network onto a packet-based data network, either before the first LEC switch or at some point in the interoffice network.

Alternate Access Technologies

A third set of answers involves alternate access technologies to replace the analog modems that most users now employ for Internet access. ISDN, which is available today in virtually all LEC central offices but is only used by a handful of residential customers, uses the network in a more efficient manner than analog modems, and also provides up to 128 kilobits per second of bandwidth.[147] ISDN line units are generally non-blocking; in other words, ISDN is provisioned so that every line into a switch module has a corresponding path through the switch. However, ISDN is a circuit-based technology, and thus usage will continue to strain the PSTN. Other new technologies, such as digital subscriber line (xDSL), which provides up to 6 megabits per second of downstream throughput over ordinary copper lines, promise to avoid this constraint.[148] xDSL modems can be connected directly to a packet network, thus avoiding switch congestion at the same time as they increase bandwidth available to end users.[149] However, although prices are dropping rapidly, xDSL modems are currently very expensive relative to analog modems, and a substantial (but not clearly defined) percentage of LEC loops may not be able to support xDSL without additional conditioning.[150]

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[147] As of April 1, 1996, the BOCs and GTE had approximately 485,000 ISDN lines in service, or less then 1% of all access lines. *Broadband Week*, April 1, 1996. A survey of Internet users in early 1996 found that only 1.4% used ISDN for Internet access. IDC/Link Resources survey, summarized on Cyberatlas, available on the World Wide Web at <http://www.cyberatlas.com>.

[148] Technically, ADSL is one of a larger class of digital subscriber line technologies, referred to as xDSL, and there are several different variants of ADSL itself.

[149] *See* Carol Wilson, "Will ADSL Technologies Prove to be ISDN Killers?" *Inter@ctive Week*, April 22, 1996, at 55.

[150] ADSL bandwidth decreases as loop length increases, up to a maximum loop length of 18,000 feet. In addition, equipment such as loading coils and bridge taps, which are deployed on many local loops, interfere with ADSL transmission.

In the long term, the LEC industry has already begun planning to migrate its networks from their existing circuit switched architecture to an architecture based on asynchronous transfer mode (ATM) switching. ATM is designed to achieve some of the reliability and quality of service benefits of circuit-switched technologies, along with some of the bandwidth efficiency and speed of packet-switching. ATM is now widely used in Internet backbones and corporate networks, but no ATM switches yet have the necessary features and functions to replace existing LEC end office switches. In addition, a technical debate is now underway in the Internet community about the effectiveness of ATM as a data switching platform. LECs do not expect to even begin this transition for several years, and the transition itself is likely to take years to complete. Replacing existing end office switches will involve enormous costs. Although this network upgrade may provide a long-term solution, some more near-term action will be necessary as Internet usage continues to increase.

Alternate Network Providers

Many cable companies are in the process of deploying cable modems, which typically provide a maximum theoretical bandwidth of 10 megabits per second, although some newer cable modems offer only 1.2 megabits per second maximum bandwidth in order to reduce costs.[151] Cable modems are an always connected, packet-based system, so they do not result in switch congestion when used over a two-way cable system. However, cable companies have experienced technical difficulties deploying cable modems, as well as upgrading their networks and operations support systems to handle Internet traffic and the associated customer support. These difficulties are aggravated by the highly leveraged position of most cable companies, which constrains their access to capital.

In order to deploy cable modems more cheaply and quickly, cable operators are now considering use of "one way" devices over unimproved cable plant. These one-way cable modems use the high-speed cable network for receiving data from the Internet, and a telephone line for upstream transmissions. Although this architecture reduces costs for the cable operator, it potentially increases the congestion of LEC networks, due to the long holding times. In addition, due to the reciprocal compensation requirements of the 1996 Act, cable networks that operate as competitive local exchange carriers may be entitled to compensation for "terminating" LEC traffic over these connections.

Wireless systems are another promising means to break the bandwidth gridlock. Some companies, such as Metricom, already offer wireless Internet access at speeds comparable to analog POTS lines, typically through municipal 900 Mhz spread spectrum systems. Other wireless technologies, such as local multipoint distribution service (LMDS) and multipoint microwave distribution service (MMDS) are being tested specifically for Internet access applications. Wireless access provides not only a competitive alternative to LECs, but potentially a means for LECs to offload some of their Internet traffic while keeping their

[151] Actual bandwidth is shared among users and thus usually much lower than the theoretical maximum, but still much greater than possible with an analog modem.

existing customers. Pacific Bell recently signed a wireless resale agreement with the wireless provider Winstar, in part to offload Internet traffic from Pacific's switches. Finally, satellites may provide an alternative for some Internet access. Hughes recently began offering its 400 kilobits per second DirectPC service, although customers are required to purchase a satellite dish and the system requires use of an analog telephone line for the upstream channel. Thus, like one-way cable modems, the DirectPC service will not necessarily alleviate congestion of LEC networks, but may, in fact, increase it.

4. State Tariffing Issues

The revenue effects of Internet usage today depend to a significant extent on the structure state tariffs. Internet usage generates less revenue for LECs in states where flat local service rates have been set low, with compensating revenues in the form of per-minute intrastate toll charges. Because ISPs only receive local calls, they do not incur these usage charges. By contrast, in states where flat charges make up a higher percentage of LEC revenues, ISPs will have a less significant revenue effect. ISP usage is also affected by the relative pricing of services such as ISDN Primary Rate Interface (PRI), frame relay, and fractional T-1 connections, which are alternatives to analog business lines. The prices for these services, and the price difference on a per-voice-channel basis between the options available to ISPs, varies widely across different states. In many cases, tariffs for these and other data services are based on assumptions that do not reflect the realities of the Internet access market today. The scope of local calling areas also affects the architecture of Internet access services. In states with larger unmeasured local calling areas, ISPs need fewer POPs in order to serve the same customers through a local call.

5. Competitive Dynamics

To the extent that competitors, such as IXCs, cable, or wireless providers, are able to offer voice or data services to customers in competition with the LECs, there will be pressure on the LECs to lower their rates or otherwise take action to retain their customers. To the extent that such competition is driven by the underlying efficiencies and business strategies of companies using different technologies, such competition will benefit consumers. On the other hand, to the extent that competitors are able to gain market share primarily as a byproduct of regulatory restrictions on the LECs, such competitive entry may have detrimental consequences. For example, some high-speed data architectures proposed by the cable and satellite industry only provide for downstream transmission. Unimproved cable systems, which were designed solely for the delivery of video programming into consumers' homes and not for interactive services, have this characteristic. Cable companies may choose to use their infrastructure to deliver high-bandwidth downstream services to users, and use LEC telephone lines for upstream transmission to a local headend. LECs argue that such systems represent a regulatory anomaly that gives cable companies an unreasonable competitive advantage in delivering broadband services to residential users at rates that are in effect subsidized by the LECs.

Competitive alternatives to LEC facilities may also reduce the burdens on LECs. If cable companies and others enhance their networks to provide two-way service and attract Internet access customers on the basis of their ability to provide higher bandwidth at lower cost, they may reduce or reverse the recent increase in Internet access through LEC networks. Such competition could reduce LEC revenues, because LECs would not receive any payments from Internet users that switch to cable or other providers, but the burden on LEC networks would also be reduced. An additional competitive dimension of Internet access pricing concerns the effects of imposition of access charges on ESPs. By raising the cost for most users of connecting to the Internet through LEC facilities, such a decision would likely increase the number of users who find alternative providers, such as cable, to be more cost-effective than the LECs. Although these alternatives today represent only a limited threat to incumbent LECs, the possibility of such shifts should at least increase the pressure on LECs to price services to ISPs efficiently.

V. Availability of Bandwidth

The Internet is only useful to people if they are able to access it, and the value of the Internet is, to an increasing extent, dependent on the level of bandwidth available to end users. Thus, issues of service availability and affordability, especially with regard to services that provide higher bandwidth than analog POTS lines, will be central to the development of the Internet as a mass-market phenomenon that benefits all Americans.

The Commission has historically played a major role in promoting "universal service," which has been understood as the availability of some basic level of telephone service to all Americans. Some universal service mechanisms, such as the Universal Service Fund (which provides assistance to high-cost LECs) and the Telecommunications Relay Service Fund (which underwrites services that allow people with hearing impairments to use telecommunications facilities), are explicit. Other support for universal service has traditionally been provided through implicit subsidy flows, in which regulators have allowed certain rates to be set at levels far in excess of cost so that rates in high-cost or underserved areas can be set at levels deemed affordable.

The 1996 Act directs the Commission to preserve and extend universal service, but to do so in a manner consistent with the development of competition. In addition to the general language regarding universal service funding,[152] the 1996 Act contains several provisions dealing specifically with availability of advanced communications services. In particular, Section 254 (which promotes universal service) and Section 706 (which discusses incentives for deployment of advanced telecommunications services) state:

> (254)(b)(2) Access to Advanced Services.-- Access to advanced telecommunications and information services should be provided in all regions of the Nation.
>
> (706)(a) The Commission ... shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms)....

In discharging these responsibilities the FCC must address two inter-related issues: the deployment and pricing of high-speed access technologies, and the availability of existing services to rural and low-income communities as well as schools, libraries, and others.[153] A major aspect of the Commission's role will be to foster the development of market-based solutions that make access to the Internet and other interactive services widespread and affordable. Beyond the specific universal service mandates of the 1996 Act, the Commission's

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[152] *See supra* section (III)(B)(2)(b).

[153] "High-speed" or "high-bandwidth" access technologies in this context refer to access at speeds substantially greater than the 28.8 kbps now available using analog modems.

primary focus should be to remove barriers to availability of high-bandwidth technologies, and to bring parties together to develop solutions, rather than to mandate particular deployment patterns.

Universal service policies benefit the Internet because they expand the scope of the network. If more people can access the Internet, the value of connectivity will increase, and demand for Internet-related hardware, software, and services will be stimulated.

A. Deployment and Pricing of High-Speed Access Technologies

Most residential Internet access today uses ordinary analog POTS lines.[154] Although POTS connections have fueled the explosive growth of residential Internet access in recent years, the low bandwidth available on these lines substantially limits the services that can be delivered to users, and reduces the value of the Internet experience as users have to wait for information to be received. Several technologies that are either commercially available today or in development promise to remove these limitations.[155]

Figure 11 lists some of the major technologies that may deliver high-bandwidth Internet access to end users. In almost every case, the actual throughput available to subscribers will depend on the particular infrastructure and customer premises equipment used, in addition to factors such as the location of the subscriber. The technologies listed are those which appear likely to be able to deliver substantially greater bandwidth to a significant number of subscribers over the next 2-4 years. Other systems, such as those that extend fiber optic circuits to a small cluster of homes or event each individual home, may eventually supplant all these alternatives. Given current deployment plans and the expenses involved, however, widespread implementation of such systems appears to be significantly farther in the future.

[154] Most of the discussion of high-speed Internet access technologies focuses on residential access, since businesses generally already have access to, and resources to afford, high-bandwidth connections through various dedicated services now available from ISPs and local phone companies. In addition, although the use of Internet in business applications will doubtless continue to increase and be of great significance, it is the prospect of widespread individual access to the Internet that creates the promise of "information superhighway" services such as electronic commerce, online health care, and interactive on-demand entertainment.

[155] Although the focus of this paper is on the value of high-bandwidth networks for Internet access, such networks may provide many other services. For a discussion of integrated broadband networks prior to the recent growth in Internet usage, see Robert Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy, and Institutional Change* (Office of Plans and Policy Working Paper No. 24, 1988)

Figure 11 -- Major End-User Internet Access Technologies

Technology	Downstream	Upstream	Summary
POTS (analog voice telephony)	28.8 - 33.6 kbps (56 kbps in 1997)	28.8 - 33.6 kpbs	94% of homes have POTS service; requires no additional telco investment and only a computer and (inexpensive) analog modem at the user premises.
ISDN	56 - 128 kbps (230 kbps under development)	56 - 128 kbps (230 kbps under development)	Approximately 70% of access lines are now capable of supporting ISDN, but less than 5% of Internet subscribers use ISDN. New pricing, standardization, and marketing efforts may increase penetration in 1997.
xDSL	384 kbps (SDSL) 768 kbps (HDSL) 1.5 - 8 Mbps (ADSL)	384 kbps (SDSL) 768 kbps (HDSL) 12 - 500 kbps (ADSL)	Significant deployment of SDSL and HDSL today for corporate networks and T1 service. Commercial ADSL deployment by most telcos planned to begin in 1997. Actual deliverable bandwidth, especially for ADSL, depends heavily on loop conditions.
Cable Modems	1.2 - 27 Mbps (shared capacity)	128 kbps - 10 Mbps (shared capacity) or POTS line used for upstream	Several companies are deploying infrastructure (e.g. @Home, Comcast, Time-Warner), with commercial availability in late 1996 or early 1997. Many technical questions remain.
Wireless	28.8 kbps (900 Mhz) 1.5 Mbps (LMDS) 1.5 Mbps (MMDS)	28.8 kbps (900 Mhz) 1.5 Mbps (LMDS) 1.5 Mbps (MMDS)	These are only some of the technologies under development that could provide wireless Internet access (NII/Supernet band and 2.3 Ghz auction may also open spectrum for this application). Actual bandwidth will depend on environmental factors as well as details of deployment.
Satellite	400 kbps (DirectPC)	POTS line used for upstream	Several other systems under development.

B. The ISDN Case Study

ISDN is by far the most well-established and widely available higher-bandwidth access technology. ISDN uses existing twisted pair copper phone lines to transmit data at up to 128 kbps.[156] Unlike analog modems, ISDN creates an end-to-end digital connection path, which also facilitates faster call setup times and additional options using a built-in out-of-band "D" channel. In order to support ISDN, local exchange carriers must install digital line cards in their central office switches, and subscribers must purchase new "digital modems" to operate at their premises. Beyond this investment, however, ISDN does not require any significant reconfiguration of LEC networks in order to support higher bandwidth than analog transmission. ISDN technology has been commercially available for well over a decade, and approximately 70% of existing local access lines in the United States are now configured to support ISDN.

At the present time, however, despite growing interest in ISDN as an Internet access technology, only a relatively small number of customers have ISDN lines in service. According to one study, approximately 1.4% of modem users connected to the Internet using ISDN in early 1996.[157] One barrier to more widespread deployment of ISDN has been the lack of standardization and the large number of site-specific parameters that must be configured when an end user wishes to purchase an ISDN line. Users must often determine a host of arcane configuration options, and telephone company personnel must be trained in the various pricing and configuration options, in order for ISDN to be installed. Several steps are now being taken to address these provisioning problems, including "one stop shopping" efforts by vendors such as Motorola and Microsoft that provide customers with a central point for ordering and obtaining information, and efforts by standards bodies and the local exchange industry to simplify the process of installing ISDN.[158] Vendors such as AT&T, 3Com, and US Robotics have also launched efforts to make ISDN easier to install.[159]

Many parties have argued that pricing is another barrier that has constrained ISDN deployment. Rates charged by local exchange carriers for ISDN service are regulated by state public utilities commissions, and these rates vary greatly from carrier to carrier. A March 1996 survey of ISDN tariffs showed a variation among major carriers between approximately $30 per month and over $300 per month for equivalent usage levels.[160] Some ISDN supporters argue

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[156] "Basic Rate Interface" ISDN, which runs over two-wire twisted pair copper, provides two bearer or "B" channels which operate at 56 kbps, and one data or "D" channel that operates at 16 kbps. For data services such as Internet access, these channels can be "bonded" together to provide "2B+D" transmission at a rate of 128 kbps. Farallon recently announced technology that increases the bandwidth of ISDN BRI connections to 230 kbps.

[157] *See* "Modems," *Cyberatlas*, available on the World Wide Web at <http://www.cyberatlas.com/modems.html>.

[158] Nick Wingfield, "Vendors Introduce Kinder, Gentler ISDN," *C|Net News*, March 18, 1996, available on the World Wide Web at <http://www.cnet.com/>.

[159] Shira McCarthy, "Vendors Team Up for New ISDN Group," *Telephony* 230:5 (Jan. 29, 1996) at 19.

[160] Consumer Project on Technology Information Policy Notice, "Selected ISDN Tariffs," March 9, 1996.

that even rates at the low end of this spectrum far exceed the incremental cost to telephony companies of supporting ISDN service.[161] In many states ISDN is tariffed only as a business service, although residential ISDN offerings are increasingly available. In addition to the monthly rates, virtually all local exchange carriers now charge some per-minute fees for ISDN usage above a designated threshold, or charge a higher monthly rate for a higher threshold or unlimited calling. Carriers argue that these usage-sensitive charges, especially for peak-period usage, are essential to avoid overuse of network capacity, but consumer groups and others claim that the costs of providing ISDN service are essentially fixed, and do not vary substantially based on usage.

An additional component of ISDN pricing is the federal subscriber line charge (SLC). Although the vast majority of ISDN rates are encompassed by the monthly rates and usage charges regulated by state commissions, ISDN users are also subject to the SLC, which recovers some of the interstate allocated costs of subscriber loops. For residential customers, the SLC is currently capped at $3.50 per line per month, and for multi-line businesses, the cap is $6.00 per month. Because ISDN is a derived channel technology that, in addition to providing greater data bandwidth, also allows multiple voice channels, the question has arisen as to whether multiple SLCs should be assessed on each ISDN connection. The FCC has requested comment on this question in the Access Reform NPRM, and has temporarily refrained from imposing more than one SLC.[162]

As Internet usage and demand for higher bandwidth to the home has accelerated, many LECs have proposed new pricing structures for ISDN. In some cases, such as Bell Atlantic's April 1996 proposal, these new structures involve rate decreases. In others, such as Pacific Bell's January 1996 request to the California Public Utilities Commission, the new tariffs include substantially higher rates in response to increases in ISDN usage and concerns about additional costs to support this usage.[163] Several state commissions are now review LEC residential ISDN tariffs, and are evaluating the incremental costs of offering ISDN service.

ISDN, however, is not a packet-based technology. Because of certain architectural efficiencies and the design of ISDN line cards in most local exchange switches, ISDN may place a less significant congestion burden on the network than analog connections.[164] However, although digital, ISDN was designed to conform to the existing architecture of the circuit-

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[161] *See, e.g.*, Consumer Project on Technology's Comments on Bell Atlantic's ISDN Tariff, Virginia State Corporation Commission Case No. PUC950078 (filed April 19, 1996); Alex Lash, "ISDN Supporters Lodge Complaints," *C|Net News*, April 15, 1996, available on the Internet at <http://www.cnet.com/>.

[162] *Access Reform Notice* at ¶¶ 68-70; *End User Common Line Charges*, Notice of Proposed Rulemaking, 10 FCC Rcd 8565 (1995).

[163] Chris Bucholtz, "ISDN's Move into Suburbs Triggers Rate Hike Request," *Telephony* 230:3 (January 15, 1996) at 9.

[164] Specifically, ISDN line units are generally "non-blocking." In other words, every subscriber line going into the line unit can be in use at the same time.

switched voice network.[165] Moreover, although ISDN provides greater bandwidth than POTS, it is insufficient for full-motion video and many of the new multimedia applications that are rapidly becoming available. The unanswered question at this point in time is whether the window of opportunity for ISDN has passed, or whether ISDN, as the most mature and most widely available higher-bandwidth service, will be used increasingly over the next several years.

The FCC is interested in seeing higher bandwidth available to end users. However, the Commission's role is not to endorse any particular technology, or to artificially subsidize the deployment of such services generally. Instead, the Commission should investigate areas where regulatory rules may either be preventing technologies from being deployed, or distorting investment patterns and incentives for innovation. ISDN tariffs and the application of the SLC to ISDN may fall within this category. More generally, the deployment of high-bandwidth Internet access technologies may be constrained by the ability of competitors to take advantage of the existing network, either by purchasing existing tariffed services from local exchange carriers, or by leasing pieces of the network and combining them in new ways.

The FCC's interconnection, access charge, and price cap rules will therefore influence the deployment of higher bandwidth. In addition, the Commission is in the process of developing a Notice of Inquiry on innovation, to seek comment on other ways that FCC rules can provide incentives for both incumbents and competing providers to invest in their networks and deploy new technologies. Ultimately, only the market will decide which of these investments are wise and which technologies will succeed, but the FCC must provide a level playing field for those market forces to operate.

C. Universal Service and Advanced Access Technologies

Section 254 of the 1996 Act sets forth a set of requirements designed to preserve and advance universal service in an era of new technologies and new forms of competition. The Commission has historically been committed to universal service in telecommunications, and has promoted efforts to make telephone service available to all Americans. Universal service has traditionally been conceived in terms of access to voice telephony. With the development of the Internet and other interactive computer networks, the Commission and state regulators must consider whether access to these newer services should also be included in the conception of universal service. Although most Internet subscribers can access an ISP POP through a local call, users in some remote and rural areas, or regions with small local calling areas, must pay toll charges to reach an ISP, which may make it more difficult for those users to take advantage of the Internet.

[165] The ISDN specification designates only 16 kilobits for the "D" or data channel, because ISDN was designed primarily as an advanced technology to deliver voice. Fortunately, the two "B" channels can both be used to deliver data, at rates considerably greater than the "D" channel.

The Federal-State joint board on universal service, formed in accordance with the 1996 Act, recommended that providers of interstate information services not be required to contribute to the new federal universal service fund. The joint board stated that, to these extent that information service providers do not offer for a fee any of a listed set of "telecommunications services," they are not "carriers that provide interstate telecommunications services" as specified in the 1996 Act.[166]

The joint board also recommended that Internet access not be considered a "core service" subject to universal service support under section 254(c)(1).[167] Core services under the Act are limited to telecommunications services, and the Commission is required to consider factors such as whether the service is available to a majority of residential subscribers in the country. Despite the increasing levels of Internet usage, Internet access today is not nearly as essential to most Americans as basic voice grade access to the local phone network. In addition, because most users access the Internet through the phone network, universal service subsidies to reduce local phone rates for rural, low-income, and high-cost subscribers will effectively make Internet access more affordable as well.

Current data do not provide a good estimate of the percentage of rural subscribers that cannot access an ISP through a local call. The major national ISPs each offer several hundred POPs throughout the country, and usually provide access in other areas through a toll-free number for an additional charge of approximately $5.00 per hour. There is anecdotal evidence that many rural areas are served by smaller regional and local ISPs, even when national ISPs do not find it economical to serve those areas.[168] Further time and study will be needed to understand whether market forces alone will be sufficient to ensure affordable Internet access throughout the country. Given the rapid rate of growth and change in the Internet industry, the affordability of Internet access today may not be an accurate indicator of the situation in the future.

In addition to the requirements of Section 254, Section 706 and 714 of the 1996 Act direct the Commission and other regulatory bodies to take specific actions in order to make advanced telecommunications technology widely available. Section 706 directs the Commission, within thirty months of the passage of the Act, to initiate a notice of inquiry concerning the availability of advanced telecommunications capability to all Americans, and schools in particular.[169] "Advanced telecommunications capability" is defined as "a high-speed, switched, broadband

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[166] *Joint Board Recommended Decision at* 398-99, ¶ 790.

[167] *Id.* at 37, ¶ 69.

[168] *See e.g.*, Bob Rankin, "SoDak Net: Wiring Rural South Dakota," *Boardwatch*, August 1996. A recent study of fiber optic network deployment found that advanced communications capabilities were available in most rural areas. Although not specific to Internet access, this study suggests that, as Internet penetration increases, rural areas may not be left out. *See* John Markoff, "A Differing View of the Spread of Technology: Rural Areas in U.S. Are Not Being Left Out, New Study Finds," *New York Times*, February 24, 1997, at B6.

[169] 47 U.S.C. §706(a)

telecommunications capability that enables users to originate and receive high-quality voice, data, graphics, and video telecommunications using any technology."[170] If the Commission determines that such capability is not being deployed in a reasonable and timely manner, the Commission is directed to take "immediate action" to remove barriers to such deployment.[171] Section 714 establishes the Telecommunications Development Fund to promote the development and deployment of telecommunications services, particularly by small businesses.[172]

The 1996 Act contains specific requirements for the provision of services associated with universal service at discount rates to schools, libraries, and rural health care providers, and allows the Commission to designate other services to be covered under this requirement.[173] Studies have shown that advanced services such as Internet access are not yet widely available in classrooms, especially in low-income areas. Only nine percent of all instructional rooms (classrooms, labs, and library media centers) were connected to the Internet as of early 1996.[174] Schools with large proportions of students from poor families are half as likely to provide Internet access as schools with small proportions of such students.[175]

Internet access will also be important for rural health care facilities. Telemedicine allows doctors in remote areas to share data with experts elsewhere in the country, greatly enhancing the level of care. These services often involve transmission of high-resolution images, and therefore require large amounts of bandwidth. The FCC has formed a Telemedicine Task Force which has made recommendations for making this bandwidth available to health care providers.

The joint board recommended a system of discounts, between 20-90%, for schools and libraries that purchased telecommunications and other services under this provision, to be funded by a fund of up to $2.25 billion per year.[176] Under the joint board's recommendations, ISPs would be able to provide these services, and receive subsidies. The joint board concluded that it would be impractical to separate the "conduit" services offered by ISPs and online service providers from "content," even though universal service subsidies are designed to fund only the connectivity portion of the service.[177] The recommendations, however, leave open the question

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[170] 47 U.S.C. §706(c)(1)

[171] 47 U.S.C. §706(b).

[172] 47 U.S.C. §714.

[173] 47 U.S.C. §254(h)(1)(B); §254(c)(3).

[174] National Center for Education Statistics, United States Department of Education, *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools 1995*, (February 1996).

[175] *Id.*

[176] *Joint Board Recommended Decision* at 224-25, ¶¶ 438-40.

[177] *Id.* at 237, ¶ 462.

of whether a system in which ISPs need not contribute to the universal service funding mechanism, but may benefit from it, creates a competitive distortion.

Even if services are provided at discount rates, schools and libraries will desire the most economical means of providing Internet connectivity. For example, the wireless NII/SUPERnet system may, in some areas, provide more cost-effective network access for school campuses than wired local area networks. Thus, the general issues about the economics of high-bandwidth access technologies will be important in this area as well.

VI. Conclusion

This working paper has reviewed many difficult and complex issues that have arisen as the Internet has grown to prominence. I have attempted to identify government policy approaches that would have a positive influence on the development of the Internet. This final section seeks to place the challenges described throughout this paper into a broader context.

A. The Internet and Competition in Telecommunications

The movement toward deregulation and local competition in telecommunications in the United States may be the single most significant development for the future of the Internet. The decisions that the FCC, state regulators, and companies make about how to create a competitive marketplace will determine the landscape in which the Internet evolves. The shape of local competition will influence what types of companies are able to provide Internet access to what categories of users, under what conditions, and at what price. The removal of barriers between different industries -- such as the prohibition on BOCs offering in-region long-distance service -- will accelerate the convergence that is already occurring as a result of digitalization and other technological trends.

Internet providers are potentially both substantial customers of circuit-switched voice carriers, and competitors to them. It is ultimately in the interests of both ISPs (who depend on the PSTN to reach their customers) and LECs (who derive significant revenue from ISPs) to have pricing systems that promote efficient network development and utilization. If the costs of Internet access through incumbent LEC networks increase substantially, users will have even stronger incentives to switch to alternatives such as competitive local exchange carriers, cable modems, and wireless access.

Dial-up Internet access today tends to be priced on a flat-rated basis, for both the PSTN portion of the connection and the transmission of packets through Internet backbones. By contrast, interexchange telephone service tends to be charged on a per-minute basis.[178] However, both networks run largely over the same physical facilities. There is some evidence that Internet and long-distance pricing are beginning to move towards each other.[179] This paper has discussed some of the arguments about usage pricing for Internet connections through the PSTN; similar debates are occurring among Internet backbone providers in response to congestion within the Internet. With the development of differentiated quality of service mechanisms on Internet backbones, usage pricing seems likely to become more prevalent on the Internet, although usage in this context may be measured by metrics other than minutes.

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[178] Outside the United States, local telephone service is usually charged on a per-minute basis as well.

[179] *See generally* "Too Cheap to Meter?," *The Economist*, October 19, 1996, at 23.

In the telephone world, flat-rated pricing appears to be gaining ground. The FCC established the subscriber line charge (SLC), because the fixed costs it represented were more efficiently recovered on a flat-rated basis. The *Access Reform* proceeding raises questions about whether other usage-sensitive charges (such as the Transport Interconnection Charge and the Carrier Common Line Charge) should be replaced with flat-rated charges, and there was substantial debate in the *Interconnection* proceeding about whether LEC switching capacity should be sold on a flat-rated basis in the form of a "switch platform." Pressure toward flat-rated pricing is also arising for business reasons -- for example, Southwestern Bell has reportedly considered offering a flat-rated regional long-distance plan when it receives interLATA authorization. Customers in the U.S. seem to prefer the certainty of flat-rated pricing even where it winds up costing more for their particular level of usage.

There are, of course, important differences in the architectures of the Internet and the public switched telephone network. However, both of these architectures are evolving. There will not be one universal pricing structure for the Internet or the telephone network, for the simple reason that there will not be one homogenous network or one homogenous company running that network. Technology and business models should drive pricing, rather than the reverse.

Today, the vast majority of Internet users and ISPs must depend on incumbent LECs for their connections to the Internet. These incumbent LECs have huge investments in their existing circuit-switched networks, and thus may be reluctant, absent competitive pressure, to explore alternative technologies that involve migrating traffic off those networks. The economics of the Internet are uncertain, since the market is growing and changing so rapidly. Competition will enable companies to explore the true economics and efficiencies of different technologies. The unbundling mandated by the 1996 Act will allow companies to leverage the existing network to provide new high-bandwidth data services.

Competition can lead to instability or confusion, especially during periods of transition. Monopolies provide certainty of returns that, by definition, cannot be achieved in a competitive market. With many potential players, forecasting the future of the industry can be difficult. Companies must choose between different technologies and business models, and those companies that do not choose wisely will see the impact on their bottom lines.

Yet, as the Internet demonstrates, uncertainty can be a virtue. The Internet is dynamic precisely because it is not dominated by monopolies or governments. Competition in the Internet industry, and the computer industry that feeds it, has led to the rapid expansion of the Internet beyond anything that could have been foreseen. Competition in the communications industry will facilitate a similarly dynamic rate of growth and innovation.

B. The Right Side of History

The legal, economic, and technical underpinnings of the telecommunications infrastructure in the United States have developed over the course of a century, while the Internet as a service for consumers and private businesses is less than a decade old, and the national framework for competition in local telephone telecommunications markets was adopted scarcely more than a year ago. Challenges that seem insurmountable today may simply disappear as the industry and technology evolve.

As significant as the Internet has become, it is still near the beginning of an immense growth curve. America Online, the largest ISP, has grown from under a million subscribers to eight million in roughly four years. But those eight million subscribers represent only a fraction of the eighty million households served by AT&T. The revenues generated by the Internet industry, although growing rapidly, pale in comparison to those generated by traditional telephony. Only about 15% of the people in the United States use the Internet today, and less than 40% of households even have personal computers. A decade from now, today's Internet may seem like a tiny niche service. Moreover, as Internet connectivity is built into cellular phones, television sets, and other household items, the potential number of Internet hosts will mushroom beyond comprehension. Computers are now embedded in everything from automobiles to cameras to microwave ovens, and all of these devices may conceivably be networked together. The Internet may exert the greatest influence on society once it becomes mundane and invisible.

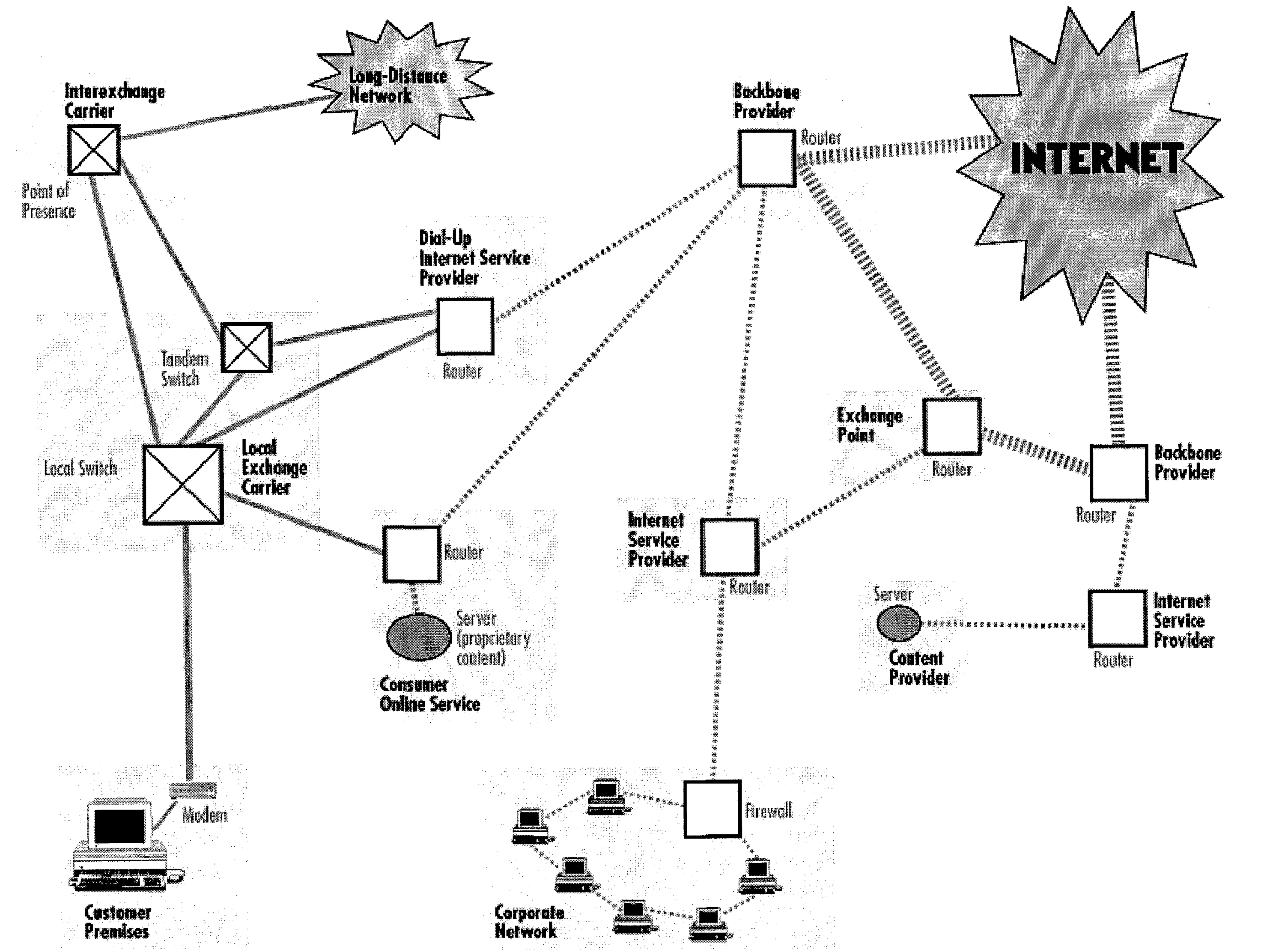
The growth potential of the Internet lends itself to both pessimistic and optimistic expectations. The pessimist, having struggled through descriptions of legal uncertainties, competitive concerns, and bandwidth bottlenecks, will be convinced that all these problems can only become worse as the Internet grows. The optimist, on the other hand, recognizes that technology and markets have proven their ability to solve problems even faster than they create them.

The global economy increasingly depends on networked communications, and communications industries are increasingly shifting to digital technologies. Bandwidth is expanding, but so is demand for bandwidth. None of these trends shows signs of diminishing. As long as there is a market for high-speed connections to the Internet, companies will struggle to make those high-speed connections available in an affordable and reliable manner. Once a sufficiently affordable and reliable network is built, new services will emerge to take advantage of it, much as the World Wide Web could take off once the Internet had reached a certain level of development.

Difficulties and confusion may arise along the way, but improvements in communications technology will continue to provide myriad benefits for individuals, businesses, and society. In the long run, the endless spiral of connectivity is more powerful than any government edict.

APPENDIX A -- INTERNET ARCHITECTURE

The diagram on the following page illustrates some of the mechanisms for accessing the Internet. Although this illustration provides greater detail than the conceptual diagrams in Section II, it remains greatly simplified in comparison to the actual architecture of the Internet.


Long-Distance Network
Interexchange Carrier
Point of Presence
INTERNET
Backbone Provider
Router
Dial-Up Internet Service Provider
Router
Tandem Switch
Local Switch
Local Exchange Carrier
Router
Server (proprietary content)
Consumer Online Service
Exchange Point
Router
Backbone Provider
Router
Internet Service Provider
Router
Server
Content Provider
Internet Service Provider
Router
Firewall
Corporate Network
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