

Changes in Telecommunications: Convergence and Cable Open Access

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TABLE OF CONTENTS

BACKGROUND	3
A HISTORY OF REGULATION	3
THE TECHNOLOGY	6
THE PLAYERS	7
KEY CONFLICTS	12
THE LAST MILE	12
ACCESS TO CONDUIT	14
TECHNICAL FEASIBILITY	14
SCALABILITY	16
COST CONCERNS	16
REGULATORY DISPARITY	17
CONSISTENT REGULATION: LOCAL VS. FEDERAL JURISDICTION	19
POLICY RECOMMENDATIONS	19
RECOMMENDATIONS FOR THE IMMEDIATE SITUATION	19
LESSONS LEARNED FROM THE CABLE DEBATE	22
LESSONS LEARNED: WHAT THEY MEAN FOR THE FUTURE	24
PRIORITY ONE: INFRASTRUCTURE	24
PRIORITY TWO: INTERCONNECTION	25
PRIORITY THREE: SCALABILITY	27
CONCLUSION	32
BIBLIOGRAPHY	33

The cable open access debate, the debate over whether or not cable owners should be forced to sell the right to use their networks, will be a touchstone for the future of telecommunications policy. This debate forces regulators to make tough decisions about the Internet, about higher speed access to data, and about telecommunications as a whole. With the boom of the Internet and hundreds of billions of dollars at stake, this debate will be of particular interest to all Americans.

A couple of events have brought cable issues to the recent attention of regulators. First, the boom of the Internet has fueled a growing demand for data. Technology has responded with broadband, the ability to move information at 200 kilobits per second (kbps) or faster.¹ This is significantly faster than the 56 kbps to which narrowband is limited.² Second, as more information is digitized, and the distinctions between voice, video, and data have been blurred, formerly separate industries have converged into one. Since these formerly separate industries were also regulated separately and differently, it is no longer clear how to regulate now that these industries are beginning to offer the same services. The challenge for regulators is to make sense of the resulting regulatory jumble to create a vibrant broadband market that will satisfy the growing demand for data.

All agree that competition is the best way to create a successful broadband market. In a booming economy with a market that is doing well, the general sentiment is to remove the government as much as possible and let market forces “regulate” the telecommunications industry. While everyone agrees that competition is key, virtually no one agrees on how best to cultivate competition.

¹ “Broadband Internet Regulatory Relief Act of 1999”, S. 877, Definitions.

² “Remote Access Technology”, <http://web.syr.edu/~jmwobus/dialups/comfaqs/serial~technology.html>,

No one wants to make a mistake in settling the cable debate because it could have a disastrous effect on the US economy. The telecommunications industry is a multi-billion dollar industry, with tens of billions of dollars being invested just in broadband facilities.³ Furthermore, the growth in this industry has contributed to the creation of hundreds of thousands of new jobs in the last year alone and contributes nearly one tenth of US GNP.⁴ As a major contributor to the growth of the US economy, the cable issue is particularly critical.

The challenge for regulators will be to build a regulatory framework that will encourage competition so that the telecommunications market will grow and will provide the consumer with lower prices and better services and products.

BACKGROUND

A History of Regulation

The history of regulation in the telephone and cable industries makes moving towards a deregulated, competitive telecommunications market difficult, particularly with the speed at which technology changes. Initially, telephone and cable were regulated differently because the social contexts in which they were regulated were different. The telephone industry was first regulated in the 1930's when the public was more receptive to government intervention. The cable industry, however, was first regulated in the 1960's, when there was more distrust of government.

6/9/99.

³ Federal Communications Commission, "Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996." FCC 99-5, 2/2/99.

⁴ Representative Jon Conyers, Jr, (D, MI), House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.

As the original legislation was amended, the differences in regulating the two industries has been due to differences in the services they offered. However, when both telephone and cable companies offer Internet, video, and telephone services, it makes little sense to have different regulations for the same services simply because their services differed historically.

The Communications Act of 1934 defines a common carrier as “any person engaged as a common carrier for hire, in interstate and foreign communications.”⁵ While this is not a particularly enlightening definition, what is important is that telephone companies are considered common carriers while cable companies are not. Furthermore, as common carriers, telephone companies are subject to regulation as specified under Title II of the Telecommunications Act of 1996 (Telecom Act). Title II requires common carriers to allow other telecommunications carriers to interconnect with their facilities, and it also requires them to sell their telecommunications services to other telecommunications carriers for a reasonable price.⁶ Cable is not subject to these interconnection requirements.

Title II also restricts local exchange carriers’ ability to enter the long distance market. When the Modification of Final Judgment (MFJ) divided AT&T into regional bell operating companies (RBOC’s), it divided the US into several Local Access and Transport Areas (LATA’s) and prohibited the RBOC’s from carrying telecommunications traffic between LATA’s. Only long distance carriers, such as AT&T, MCI, and Sprint, were allowed to carry such traffic.⁷ The Telecom Act allows the RBOC’s to enter the long distance market provided that they open the local market to competition to the satisfaction of the requirements specified under Section 271 of

⁵ Communications Act of 1934, Section 3, Definitions.

⁶ Telecommunications Act of 1996, Section 251.

⁷ A. Michael Noll, *Highway of Dreams: A Critical View Along the Information Superhighway* (Mahway, New Jersey: Lawrence Erlbaum Associates, Publishers, 1997) 126.

the Telecom Act.⁸ It is important to note that the interLATA restrictions placed on the RBOC's apply to data services as well as voice communications, impeding their ability to provide a variety of broadband services.

The cable industry is regulated under Title VI of the Telecom Act, not as a Title II common carrier. Regulators recognized that cable was capable of providing two-way high-speed communications. They created Title VI regulations to maintain control over these anticipated broadband services and at the same time avoid dealing with cable systems as common carriers.⁹ Regulators did not anticipate that technology would enable copper loops to provide broadband services. Consequently, while both telephone and cable are capable of providing broadband services, they are being regulated differently.¹⁰ This is a source of contention amongst Internet Service Providers (ISP's) who want access to cable networks.

Since the Telecom Act was passed in 1996, the telecommunications industry has shifted to being data driven rather than voice driven, and it is not clear whether all aspects of the Telecom Act are still applicable to this new data driven, converging markets telecommunications industry. The Telecom Act was passed before the Internet boomed and before industries began to converge. Like past regulation, it treats common carriers, cable TV, and the wireless and satellite industries as separate entities. It remains to be seen whether or not the Telecom Act will be sufficient as a regulatory framework for a future that will almost definitely be characterized by rapid technological change and innovation.

⁸ Telecommunications Act of 1996, Section 271.

⁹ Barbara Esbin, "Internet Over Cable: Defining the Future in terms of the Past", OPP Working Paper Series 30, Federal Communications Commission, (Washington, D.C.: Federal Communications Commission Office of Plans and Policy, 1998) 66.

¹⁰ Esbin, 5.

The Technology

There are two competing wire line technologies that offer broadband - digital subscriber line (DSL) technology and cable modem technology. It is not clear that one technology is necessarily superior to the other. Both have the potential to offer comparable transmission speeds, both are ubiquitous, and while both are technically capable of providing broadband, both have sections of infrastructure that will need to be upgraded before being ready to support broadband throughout their network.

By taking advantage of copper's higher frequencies, DSL can provide broadband access via existing copper loops. There are several variants of DSL collectively known as xDSL, and they each offer Internet access at slightly different speeds. All DSL variants provide an Internet connection that is always on. Asymmetric DSL or ADSL, is one of the more widely offered types of DSL. It allows speeds of 1.544 Mbps to 6.1 Mbps downstream and 16 Kbps to 640 Kbps upstream.¹¹ This is a significant improvement over ISDN, the technology which came before xDSL; ISDN offers only speeds of 126 Kbps upstream and downstream.¹² DSL speeds are heavily dependent on distance - the closer the end user to the central office, the faster the transmission speeds.¹³ DSL is convenient because it does not require complex setup, like ISDN, and it allows simultaneous transmission of voice and data without any performance loss.

The cable modem provides Internet access via the cable which carries cable television. It offers downstream speeds of 10Mbps to 40 Mbps and upstream speeds between 28kbps and 15 Mbps.¹⁴ Unlike the copper network, however, the cable network is a shared network — the more

¹¹ "What is . . . DSL and xDSL?" <http://whatis.com/dsl.htm> 6/7/99,

¹² "High speed alternatives", <http://www.zdnet.com/.p/features/exc10198/dsl/adsl3.html>, 6/7/99.

¹³ Stagg Newman, Chief of the Network Technology Division, FCC Office of Engineering and Technology, personal interview, 7/21/99.

¹⁴ "Remote Access technology", <http://web.syr.edu/~jmwobus/dialups/comfaqs/serial-technology.html>,

people that are on the network, the slower the transmission speeds. While cable can potentially offer faster transmission speeds, in actuality, transmission speeds are almost always slower than optimal.

Cable, like copper, passes nearly every home in America.¹⁵ Of those homes, cable provides cable TV to 66%, or 64 million homes.¹⁶ Similarly, copper services virtually every home and business in America. However, not all copper loops are ready to provide DSL services, and most will require significant upgrading to make them DSL capable. For example, Ameritech has approximated that xDSL will only work on 55% of its current loops, and 20% of their loops may be incapable of ever providing DSL.¹⁷ Similarly, cable will also need significant investment to provide broadband services across America. It is predicted that by 2001 only 63% of cable systems will be ready to offer broadband services.¹⁸

The Players

Because there is so much at stake, both in terms of money and consumer benefit, those involved in the cable debate are particularly vociferous in advocating their positions. Within industry there are several competing claims each advocating different, not necessarily compatible, solutions.

6/9/99

¹⁵ George Abe, *Residential Broadband* (Indianapolis, IN: Macmillan Technical Publishing, 1997) 161.

¹⁶ Patrick R. Parsons and Robert M. Frieden, *The Cable and Satellite Television Industries* (Needham Heights, MA: Allyn and Bacon, 1998) 3-4.

¹⁷ Federal Communications Commission, "Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996." FCC 99-5, 2/2/99.

¹⁸ Ibid.

First, there are the RBOC's, the local telephone companies. These companies own most of the copper loops and include SBC and Ameritech who own a third of the copper loops in the US.¹⁹ The RBOC's feel that the current regulatory environment is working against them. At a recent hearing at the Senate Judiciary Committee, Ivan Seidenberg, CEO of Bell Atlantic said that the Telecom Act is "working for everyone but us."²⁰ Because they are limited by interLATA restrictions, they would like to see a resolution to the problem which allows them to enter the long distance data market more quickly.

Opposing these phone companies to a certain extent are the cable operating companies. This would include AT&T, who upon completion of its acquisition of TCI, would arguably control a third of the cable lines across America.²¹ Because the cable industry was not deregulated by the Telecom Act, those who control cable are looking to maintain their control over this infrastructure. They feel that this will introduce more competition and more deployment of infrastructure to the broadband market.²²

In addition to these industry players, there are also the ISP's. Those who have worked out agreements with cable companies and can also provide services over copper are well positioned for the current market. These ISP's, such as @Home and RoadRunner, wish to maintain the status quo and leave the cable industry alone. Milo Medin, founder and chief technology officer of @Home, has emphasized the regulatory difficulties of creating a regulatory scheme to govern cable interconnection. He feels that opening cable networks would create a

¹⁹ William Sweet, "Battling for Local Phone Customers", IEEE Spectrum May 1999: 32-37.

²⁰ Ivan Seidenberg, CEO Bell Atlantic, testimony, Senate Judiciary Hearing "Broadband: Competition and Consumer Choice in High-Speed Internet Services and Technologies," 7/14/99.

²¹ Sweet, 32-37

²² Mark C. Rosenblum, Vice President - Law and Chief Litigation and Federal Regulatory Counsel, AT&T, written statement, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.

“regulatory Vietnam”,²³ difficult to resolve, and difficult for the government to end its involvement.

However, those ISP’s who do not have agreements with cable companies are lobbying to gain access to cable networks so that they can reach a wider audience. The most vocal of these ISP’s has been America Online (AOL), the largest ISP in the world.²⁴ AOL claims that failure to deregulate the cable industry will result in a monopoly that will hinder the Internet’s development. According to George Vradenburg, Senior Vice President Global and Strategic Policy at AOL, “The infrastructure should be open to every ISP so that telephone companies and cable companies can’t control what kind of service is offered to consumers that are using that infrastructure.”²⁵

Finally, content providers, such as television networks and software manufacturers also have a vested interest in how government and industry resolve these issues. With AT&T recently agreeing to carry NBC’s programming through 2008, a deal worth more than \$850 million, content providers will be sure to follow this issue closely.²⁶ Pure content providers have largely gone unnoticed in the regulatory struggle between copper and cable primarily because they have a means to reach a large audience, whether it is the television or the PC. However, once infrastructure is established and broadband is ubiquitous, content providers will need to scramble for conduit access in order to continue to ensure a large audience.

In addition to industry, the government will play a role in how broadband issues are resolved. However, the government, both local and federal, is not united in what course of action

²³ Bloomberg News, “FCC Wants to Push More Broadband Options,” 5/19/99, e-mail forward from Deborah Rudolph, Manager, Technology Policy IEEE-USA, 6/7/99.

²⁴ Matthew Broersma and Joel Deane, “Broadband Access Battle Heats Up,” ZDNN, <http://www.zdnet.com/...tories/news/o,4586,2288935,00.html>, 7/12/99.

²⁵ George Vradenburg, Senior Vice President for Global and Strategic Policy, America Online, personal interview, 7/19/99.

²⁶ Dean Starkman, “AT&T to Carry NBC’s Digital TV Programming” Wall Street Journal, 6/8/99: A3.

to pursue. Congress, representing constituents in the form of industry and consumers, is moving in several different directions. Similarly, local governments are taking their own action which is not necessarily consistent with local decisions in other parts of the nation. Finally, there is the Federal Communications Commission (FCC), an independent regulatory body that has more technical expertise on the subject than any other government body.

The FCC will be a fundamental player in the ensuing debate because they have a vested interest in protecting the American consumer of broadband services and because they play a key regulatory role. The FCC is currently examining this issue in depth, but has not yet made any decisions. Believing that it is too early to intercede with heavy-handed regulations, the FCC's current national policy is to see what develops with the understanding that they are monitoring the issue closely.²⁷

Because the FCC has not yet made any concrete decisions, the perception in Congress is that the FCC is doing nothing. Congress has responded by introducing two bills concerning cable open access and competition in the broadband market in the House of Representatives and one bill in the Senate. The Goodlatte-Boucher bill, HR 1686, regards the issue as an anti-trust issue, maintaining that a closed cable system represents a monopoly. Not only does it make cable legally obligated to open its network, it also frees RBOC's of their Section 271 obligations, allowing them to enter interLATA data services before demonstrating that their local loops are open to competition. Making it an anti-trust issue, however, puts it under the jurisdiction of the judiciary committee in addition to the commerce committee. Representative Tauzin (R-LA) does not think this issue belongs in the judiciary committee and has introduced a competing bill HR

²⁷ Douglas Sicker, Chief Technologist for the Internet, New Media, Office of Engineering and Technology, Adviser for Chief Technologist and Chief Engineer, Federal Communications Commission, personal interview, 7/9/99.

2420 which would not force cable to unbundle, but like the Goodlatte-Boucher bill would free RBOC's of their Section 271 obligations. The Senate bill, the Broadband Internet Regulatory Relief Act of 1999 (S 877), relieves RBOC's of the duty to offer unbundled access or resell network elements for broadband uses. It does not obligate cable to open its network nor does it free RBOC's of their Section 271 obligations. All of these bills are designed to level the playing fields between the cable and copper platforms, and they strongly reflect various industry positions.

There is some question as to whether Congress would actually like to see these bills become law or not. These bills reflect short term thinking - if AOL and AT&T come to an agreement, or if RBOC's satisfy their Section 271 requirements, these bills will be moot. These bills may be industry motivated and may have been introduced to satisfy constituent concerns or they may be vehicles to motivate discussion.²⁸ In this case, Congress shows excellent foresight in examining these issues early on.

Local governments will also play a role in resolving the cable debate. Currently, cable is regulated at the local level by local franchising authorities which are part of the state or municipal government, depending on the area. These franchising authorities have the authority to regulate any area that the FCC does not prevent them from regulating. This would include regulating franchise renewals, public access obligations, and subscriber service requirements.²⁹ Approving AT&T's acquisition of TCI and AT&T's merger with MediaOne, to a certain extent also falls under the jurisdiction of these local franchising authorities. Since local governments are still waiting for the FCC to formulate its decisions regarding a more concrete national policy on the question of cable open access, they have been free to come to their own conclusions. However,

²⁸ Newman, 7/21/99.

²⁹ The FCC website, "General Cable Television Industry and Regulation Information Fact Sheet", <http://www.fcc.gov/csb/facts/csgen.html>, 7/20/99.

local governments are not necessarily coming to the same conclusions. For example, Portland, OR and Broward County, FL have mandated that cable open its networks, while Los Angeles, CA has decided that now is not the time to impose such regulations.³⁰ Local governments will play a major role in determining how jurisdiction over the Internet and broadband deployment will be divided between them and the federal government.

KEY CONFLICTS

The conflicts surrounding the open access cable debate are mainly concerned with how best to keep the Internet open and how best to ensure competition. To meet these two goals, debate has focused on preventing monopoly control of potential bottlenecks in the network. The priorities include ensuring competition in the “last mile”, having access to the infrastructure, eliminating regulatory disparities which might make a monopoly possible, and formulating a consistent policy by adjudicating between local and federal concerns.

The last mile

The local market is one critical part of the broadband market because it encompasses the “last mile”, the connection between the home or business and the rest of the network. It is particularly important for this connection to be open to competition because the entity that controls the last mile can determine who can access the network. To prevent monopoly of this critical section of network, the Telecom Act made RBOC entry into interLATA services contingent on their opening the local market to competition.

³⁰ Kathy Chen, “FCC’s Kennard to Argue Against Rules on Broadband Web Access at Local Level”, Wall

There is currently debate over whether or not this is good for the broadband market. The Goodlatte-Boucher bill and the Tauzin bill both remove this condition to interLATA market entry by freeing the RBOC's of their Section 271 obligations, with the hope that this will bring more competition to the more profitable long distance market.³¹ The RBOC's support this position, arguing that this will also be beneficial in bringing more competition to the broadband market. However, long distance phone companies, such as MCI and AT&T, oppose the RBOC's because they feel that long distance relief would fail to fulfill the Telecom Act's goal of introducing competition to the local telephone market.³²

Proponents of this policy have emphasized the fact that RBOC's will only be allowed to provide interLATA *data* services, not voice services. However, after being allowed to enter the long distance data market, it is unlikely that the RBOC's will open the local market to competition so that they can enter the long distance voice market because future growth will be in data, not voice. Analysts predict that 85% of all interLATA growth will be in data. Tod A. Jacobs, a Senior Telecommunications Analyst at Sanford and Bernstein and Co framed the issue this way: “[I]f the RBOC's are allowed into interLATA data, thus gaining access to 85% of all interLATA growth even without access to traditional long distance voice - are they likely to be proactive in opening up the \$90 billion local market in order to gain access to the other 15% of the growth?”³³ The potential effectiveness of freeing RBOC's from their Section 271 obligations is overshadowed by the fact that it will discourage competition in the local market.

Street Journal, 7/21/99: A4.

³¹ Monica Azare, Legislative Director, Rep. Billy Tauzin's office, personal interview, 6/24/99.

³² Michael Salsbury, Executive Vice President and General Counsel, MCI Worldcom, Inc, written testimony, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.

³³ Tod A. Jacobs, Senior Telecommunications Analyst Sanford C. Bernstein and Company, written

Access to conduit

Another area for a potential monopoly is in the conduit, the medium over which data travels. The growth of the Internet could be stunted if companies and users are denied access to the conduit. There are several dimensions to this issue. First, is open access technically feasible? Second, can an open access cable system handle the amount of traffic it will need to be able to handle? Third, is it affordable?

Technical feasibility

Companies such as AOL or GTE argue that it is technically feasible to create an open access cable network. The cable companies claim that while an open access cable network is possible, it is not practical to create such a network and be able to service customers as promised because it is more difficult to manage a shared network like cable than a closed network like copper.

Both parties have a technical basis for their claims. While it may be technically possible to create an open access cable network, the network proposed by GTE and AOL would require additional hardware, software, and maintenance. Recently, GTE and AOL demonstrated an open access cable system with multiple ISP's using the cable network to provide Internet services to different users.³⁴ Excite@Home, a company that provides Internet services via cable modem, claims that this demonstration "oversimplified a complex technological and service issue, and

testimony, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.

³⁴ "Press Release -- Excite@Home Responds to Misleading Claims by GTE and AOL", http://www.home.net/news/pr_990615.html, 6/23/99.

would force a re-architecting of the way cable data networks operate. . . .”³⁵ Excite@Home further claims that “[t]here is no way using today’s standards based modem technology to adequately partition the cable networked capacity in an efficient manner amongst different ISP’s and services.”³⁶ It is not clear who has the stronger case.

There are many ways to create an open access cable system. One category of solutions would encompass solutions which require the cable company to assign each ISP a certain amount of bandwidth and let the ISP take care of how many customers it serves. This means that the ISP would be responsible for how slow the network would run at maximum capacity, handle customer complaints, and identify and fix any hardware problems.³⁷ However, this would require housing an additional cable modem termination system (CMTS), a unit that must be physically housed at the head end and is used to act as the link between the outside network and the cable network.³⁸ This unit can handle partitioning the bandwidth of the system as described above.³⁹ However, there are technical implications to this approach which may have adverse consequences in the long term, especially in its affect on the upstream bandwidth of a network designed like TCI’s.⁴⁰

GTE and AOL have proposed two alternatives which fall in another category of solutions. Their proposal would require the cable operator to “[provide] a basic data switching function to ISP’s”⁴¹ This approach would also require changes to the CMTS and installation of

³⁵ Ibid.

³⁶ Ibid.

³⁷ Engineer Federal Communication Commission, personal interview, 6/29/99.

³⁸ “Cable Modem FAQ”, <http://cablemodem.com/FAQ.html>, 6/23/99.

³⁹ “Source of Truth”, <http://www.home.net/source/thetruth.html>, 6/23/99.

⁴⁰ “Draft Analysis, Cable Open Access Issues”, Douglas Sicker Chief Technologist for the Internet, New Media, Office of Engineering and Technology, Adviser for Chief Technologist and Chief Engineer, Federal Communications Commission and Stagg Newman , Chief of the Network Technology Division, FCC Office of Engineering and Technology, 7/31/99.

⁴¹ Ibid.

additional hardware and software. It may even require additional software on the end user's PC.⁴² AOL claims that this is economically feasible, but offers little evidence to back this claim. A report on techniques Canada is using to create an open access cable system was submitted describing a new routing technique which may serve as a possible solution. However, this technology is new and its effectiveness must still be verified in the lab. In sum, this report offered incomplete paper solutions which left many unanswered questions.⁴³ While it may be technically feasible to create an open access cable system, the techniques proposed do not fully address the additional hardware, software, and maintenance concerns that would accompany these proposals.

Scalability

There is some debate over whether or not open access cable networks would be able to manage the expected additional traffic. The ISP's who would like to gain access to the cable network, claim that software and hardware are now available to solve this problem. Cable owners dispute this claim. The FCC has no formal record on the topic and has not issued any official statements on the issue.⁴⁴ However, unofficially, technologists at the FCC have said that they are not convinced that the open access cable systems proposed by GTE and AOL would not be able to scale up.⁴⁵

Cost Concerns

⁴² Ibid.

⁴³ Ibid.

⁴⁴ Ibid.

⁴⁵ Sicker, 7/22/99.

While it may be technically possible to create an open access cable system, the costs of creating such a system may outweigh the benefits. One of the solutions proposed by AOL and GTE, would impose additional costs in performance because it requires an additional layer of complexity to provide access. This solution also has higher overhead costs than a closed access system. Furthermore, the hardware and software necessary for these open access solutions are fairly expensive, and the cost may be prohibitive for underdeveloped or rural areas.⁴⁶

While it is technically possible to have an open access cable system that is capable of handling the requisite number of users without a breakdown in the network, it would impose additional costs. These costs would invariably be passed on to the consumer, and it may not make business sense to create an open access system. However, no formal cost-benefit analyses exist for the moment.⁴⁷

The networking issues surrounding cable open access feasibility have larger implications. What is going to happen when every American wants to have broadband services? Cable owners, copper owners, and wireless technologies will eventually need to find better ways to manage more traffic as the number of Internet users and time spent on-line grows.

Regulatory Disparity

Regulatory disparities could skew the competitive playing field in favor of one group over another. The debate over whether and how disparities should be remedied has centered on the fact that telephone companies are required to unbundle their networks while cable companies can

⁴⁶ Sicker, 7/22/99.

refuse to sell network elements to others. Regulators are being cautious in taking action, however, because they are concerned that changing any of the current regulatory scheme may disrupt investment flow into the information infrastructure.

Stagg Newman, the Chief of the Network Technology division at the FCC's Office of Engineering and Technology feels that "competition and fear drive investment. . . and right now you have the Bells scared to death of AT&T, and AT&T scared that the Bells are going to get long distance relief, and so they'd better get in there and have last mile access."⁴⁸ Indeed, while DSL technology has been available for a number of years, it has only been under the threat of cable modems that RBOC's have reported that they will begin making the \$8-12 billion investment necessary to upgrade the 50-60% of their network not currently capable of providing xDSL service.⁴⁹ According to Tod A. Jacobs, a Senior Telecommunications Analyst at Sanford C. Bernstein & Company, "It is precisely the AT&T national cable-telephony strategy, along with the general aggressive investment posture of the other cable companies with respect to high-speed data deployment that has driven the RBOC's to begin to aggressively deploy xDSL."⁵⁰

Regulators are also hesitant to regulate because they do not know how the market will develop and because it is not clear if immediate change is necessary. The regulatory disparity between telephone and cable regulation has incited conflict because of new technology. Because regulators are not sure what new technology will be developed or how the market will develop, they are hesitant to take immediate action.

⁴⁷ "Draft Analysis, Cable Open Access Issues".

⁴⁸ Newman, 7/21/99.

⁴⁹ Jacobs.

⁵⁰ Ibid.

Consistent regulation: local vs. federal jurisdiction

It is important for regulation at the local and national levels to be consistent to provide an environment that will attract a consistent source of investment. To avoid the regulatory “chaos”⁵¹ of having 30,000 different franchising authorities coming to their own decision, FCC Chairman William Kennard announced that the FCC will intercede by filing a brief in a court case considering the right of local regulators to require an open access cable system.⁵² Wanting to guarantee that the Internet remains relatively free from government regulation, his brief will emphasize the importance of a national policy on this issue. The National Association of Counties, an association representing two-thirds of the nation’s counties, has responded with a resolution asserting local authority over open access cable and insisting that local governments must have the option to require open access even if the federal government considers a national policy.⁵³ Clearly, the cable issue will set a precedent for defining the jurisdiction of federal and local governments over broadband services.

POLICY RECOMMENDATIONS

Recommendations for the Immediate Situation

As previously mentioned, there have been various bills introduced in Congress to correct the regulatory disparity between cable and telephone regulations. However, if any of the bills

⁵¹ William, Kennard, "The Road Not Taken: Building a Broadband Future for America," National Cable Television Association, Chicago, 6/15/99.

⁵² Chen, A4.

currently under consideration passed, they may not make the best policy solutions. While they may offer partial solutions to immediate problems, they could become obsolete quickly. For example, if AT&T agrees to open its network for AOL, it may obviate the need for legislation like the Goodlatte-Boucher bill. If the RBOC's satisfy their Section 271 obligations, the Tauzin bill will not be as effective. If the Senate bill passes, many ISP's could go out of business because they will no longer have access to copper loops. In addition, these bills may have unanticipated long-term results which go beyond the intent of the original legislation. The developing market demands more open-ended solutions that are not satisfied by these bills.

Because there are so many unknowns, for the moment, the FCC's strategy of waiting to see how the market will develop is prudent. In looking at the present situation, regulators should not mandate cable open access for several reasons. First, the broadband market is still developing. Only 750,000 out of 40 million Internet households use broadband services, according to FCC estimates.⁵⁴ While the market for broadband is expected to explode, infrastructure upgrades must be completed before this can happen. This gives regulators at least a couple of years to consider the issue before broadband becomes widespread. This is not to say that regulators should wait to consider regulatory possibilities, but it does mean that it may be early for far reaching intervention.

Second, the market appears to be moving in the right direction with investment into broadband climbing and deployment of infrastructure and services increasing. For example, in the copper market, Ameritech is planning to spend \$3 billion in 1999 on its communication networks,

⁵³ Ibid.

⁵⁴ Matthew Broersma, "The battle for better bandwidth - should cable networks be open?" <http://dailynews.yahoo.com/headlin...html> 7/12/99.

while on the cable side, TCI has earmarked \$1.8 billion for its networks.⁵⁵ This investment is expected to contribute to more rapid deployment of infrastructure. Increased investment and more rapid deployment are exactly what regulators would like to see, and they should be careful not to disrupt this process.

Finally, regulators will still be able to revisit the issue later, and if necessary, mandate cable open access. If regulators are serious about wanting to deregulate, then they need to allow the market to work. The market may even correct existing disparities. For example, once infrastructure is deployed, it will probably be in AT&T's best interest to permit open access. If, for example, a customer wants service from ISP A, but ISP A does not have an agreement with AT&T, that customer may switch over to DSL service in order to get service from ISP A. AT&T would rather have a customer stay with the cable modem than switch to DSL. This means that AT&T will eventually need to learn how to manage a shared network, as the number of broadband users grows. However, it may not be best for the government to mandate how and under what conditions cable should provide open access because there are still many unknowns. Will cable be able to manage providing telephone services over the cable network? Will telephone companies be capable of providing full motion video services? Will wireless broadband be a competitor? Will wireless dominate the broadband market? What technological developments will occur? The market may resolve some of these issues, but first it must be given a chance to work. Because the situation is unpredictable, regulators should monitor the situation, and only loosely direct market development.

⁵⁵ Federal Communications Commission, "Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996." FCC 99-5, 2/2/99.

Simply because the market should be left to develop on its own does not mean that there is no role for federal regulators. With the market still developing, regulators now have the opportunity to look towards establishing broad guidelines for the future that will help foster and develop the market's growth. However, the danger of maintaining distance from the market as it develops is that it may leave room for others to step in with undesirable regulation. For example, while the FCC appears to be taking the latter position, Congress is moving in with actions relevant to immediate concerns that may not serve as long term solutions. The debate between Congress and the FCC is a normal function of the US government, a demonstration of the system of checks and balances that is the foundation for US government. Both parties should continue with their business as usual.

Local governments are also taking the opportunity to establish their own rules for cable. The FCC should do something to resolve discrepancies between local municipalities. By coming forth with a set of national regulations on this subject the FCC will be able to create consistent regulations which will in turn create a more consistent and reliable investing environment. The FCC appears to be on the brink of doing exactly this, with Kennard's announcement that the FCC will file a brief in a court case that will determine the extent of local jurisdiction in the cable open access debate.⁵⁶ The FCC must not wait too much longer on this, as more local franchise areas are slated to rule on this issue soon.

Lessons learned from the cable debate

⁵⁶ Chen, A4.

Several lessons can be learned from examining the cable debate, and regulators should use these lessons to create a framework within which the market can work to accomplish regulators' goals for telecommunications. This framework should work to help ensure that the market will be competitive, will preclude the need for regulators to move at the speed at which technology develops, and will develop technology that can satisfy growing demands for data speed and volume.

The first lesson learned from the cable debate is the value of competition. Not only is investment increasing and deployment occurring more rapidly, new products and companies are continually surfacing. The incredible amount of investment in broadband is evidence of this.

Second, the cable debate serves as example of policy not being able to anticipate or keep pace with technology. No one predicted the emergence of DSL, and almost everyone marvels at the speed with which the Internet and related telecommunications technologies have developed. For example, the number of Internet users increases 37% annually, while Internet traffic grows more than 100% ever year.⁵⁷ With these growth rates, it is understandable why regulators are always trying to play catch-up.

Third, the cable debate sends a warning to regulators that consumers will continue to demand more data at faster speeds. To satisfy this demand industry will digitize more information because digital information is more easily compressed, transmitted, and reassembled accurately. Digitization will lead to more convergence, and as industries converge, regulators will no longer be able to split hairs in distinguishing between "cable services" and "advanced services". From these lessons, regulators can establish priorities to help accomplish their goals for the future.

⁵⁷ "Investment Insights: Telecommunications: the race for Bandwidth," Merrill Lynch, Global Securities Research and Economics Group, 5/24/99.

Lessons learned: what they mean for the future

While there are still many unknowns, based on the lessons learned from the cable debate, regulators know that they should promote competition and that they should look for ways that they can help industry move more bits faster. This means that regulators should focus their attention on three things. First, to move data, they will need a medium over which that data can travel. Regulators should concentrate on ensuring that the necessary infrastructure is being deployed. Second, to have a successful network, each node and subnetwork must be able to interconnect. Regulators should ensure that interconnections are seamless. Third, the network needs to be able to grow. Regulators should look into higher speed networks and making certain that these new networks can interconnect with older generation networks.

It is important, however, that regulators maintain a deregulatory hands-off approach. They should promote competition and let the marketplace take care of as much as possible. While regulators should not *do* the suggestions above, they should encourage them to be done. Regulators can set out these goals as broad guidelines, and watch the market's development with these priorities in mind. If these priorities do not look like they will be met, regulators should reevaluate the possibility of regulating.

Priority One: Infrastructure

Regulators' first concern should be the deployment of infrastructure. For the most part, deployment of wire-line and even wireless technologies are progressing, as discussed earlier in this paper. While regulators should continue to monitor the situation, for the moment, it looks as if

infrastructure needs will be met in the near future.⁵⁸ The government should also encourage the development of technology which makes it possible to use existing infrastructure more effectively. Companies will invest in research and development in this area if they think that there will be a significant return on investment. While it is not the government's job to guarantee a return on investment, it can provide a predictable regulatory environment to encourage investment. A predictable regulatory environment is important in any industry, but it will be particularly important to broadband infrastructure because installing and efficiently using infrastructure is the necessary first step in developing a booming broadband market.

Priority Two: Interconnection

Regulators' second concern should be interconnection. The terms of interconnection will determine the conditions for who accesses the network and how. Seamless interconnections will be critical to developing a successful network.

If the FCC is looking for a way to get broadband distributed as quickly as possible, interconnection issues, such as peering, should be a major concern. A peering arrangement is made when two networks agree to carry each other's traffic to other parts of the network.⁵⁹ Typically, there is no money exchanged because it is expected that traffic exchange will be approximately equal in volume. Following this philosophy, MCI, Sprint, and UUNET decided in

⁵⁸ Federal Communications Commission, "Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996." FCC 99-5, 2/2/99.

⁵⁹ Brain Caulfield, "Big Networks Shun Small as Peering Issue Heats up", ISP World, September 28, 1998. Lexis Nexis, 7/27/99.

early 1997 that they would only peer with ISP's that carried a certain volume of traffic.⁶⁰ The rest of the ISP's would have to pay for their traffic to be carried. As larger ISP's, they could not justify carrying traffic for an ISP that could not provide the same amount of bandwidth in return. However, smaller ISP's are complaining that paying for their traffic to be carried would put them out of business. This could have a significant impact on the Internet's reach and the nature of the ISP business.

Efforts within industry have been made and are being made to resolve this issue without government intervention. Michael Gaddis, Vice President of Marketing at ISP Savvis Communications, proposed the Brokered Exchange System to resolve the problem. It established nine regional peering locations so that traffic could be managed regionally.⁶¹ However, this proposal did not generate enough support to go anywhere.⁶²

A second option is to create a traffic based billing system. Eric Paulak, research director at the Gartner Group, predicts that ISP's will move towards a billing scheme where each ISP pays only for the traffic it asks other networks to carry. To measure this traffic would require a device such as the one currently being developed by Hewlett-Packard and Cisco Systems, the Dynamic LocalDirector. This device allows ISP's to collect more information about Internet traffic in order to develop a traffic based billing scheme.⁶³ This prediction, however, has not yet been proven. It is not yet clear that this route makes the most sense.

Other options are also being explored. Reed Hundt, the former chairman of the FCC, has recently announced that in August 1999 he will sponsor a forum on Internet peering problems

⁶⁰ Kate Gerwig, "Peering Standoff Must Come to an End", Insights and Incites, perspective, September 7, 1998, Lexis Nexis, 7/27/99.

⁶¹ Gerwig.

⁶² Gaskin.

⁶³ Caulfield.

with the hope of avoiding the need for government intervention. The forum is going to discuss issues of billing for interconnection and whether or not different types of traffic should be billed differently.⁶⁴ Hopefully, this forum will be able to reach consensus on how to handle peering arrangements.

Interconnection agreements will be determined best by market forces. In the future, interconnection agreements are likely to be a hybrid of things currently in use and under discussion.⁶⁵ Different traffic will be transmitted and routed differently, and interconnection agreements will reflect these differences. For example, voice traffic is tolerant to error, but not delay, while computer data traffic is tolerant to delay, but not error. Consequently, voice and computer data will probably be transmitted differently. While voice will be billed based on the amount of time talking, computer data might be billed based on volume transmitted.⁶⁶ However transmissions are billed, customers will gravitate towards whatever company can offer them the best quality for the best price. The most successful companies will be those that find the best ways to move data across the network, whether it be voice or computer data. Part of moving data quickly will be finding better interconnection techniques. To impose interconnection standards will stifle innovation in finding such techniques because there is less incentive to do so. Consequently, interconnection arrangements should be left to the market to determine.

Priority Three: Scalability

⁶⁴ Robin Gareiss, Data Communications “FCC Chairman to Set Up Peering Forum”, June 10, 1999, Lexis Nexis, 7/12/99.

⁶⁵ Shastri Divakaruni, Director of Engineering, Broadband, Wireless, Cisco Systems, personal interview, 8/3/99.

⁶⁶ Divakaruni, 8/3/99.

Finally, regulators should be concerned with scalability – can the current Internet continue to grow? Currently, there are several groups working on gigabit networks capable of carrying more information faster. This network is restricted to academic use, however; commercial traffic is not allowed. The development of this high performance network is a coordinated effort between the National Science Foundation (NSF), the White House and Congress, industry, and academia, in addition to a variety of other government agencies.

There are currently three different entities working on a high performance network. These are the Clinton Administration’s Next Generation Internet (NGI) initiative, the NSF, and a group called Internet 2, who is working with the University Corporation for Advanced Internet Development (UCAID) to build a high speed network called Abilene. All three work for the advancement of high speed networking technologies for research and educational purposes. Like Internet 2, the NSF has built its own backbone, the very High Performance Backbone Network Service (vBNS), to support this traffic.⁶⁷ The two networks, vBNS and Abilene, interconnect, but they use different technologies. The hope is that the diversity of technology will augment knowledge about advanced networking technology.⁶⁸ This cooperation between industry, government, and research institutions is an excellent way to develop something like the Internet because it allows enough freedom for innovation, while encouraging communication amongst participants. The original Internet was developed in much the same manner, and based on its success, this development method has been quite successful.

This next generation Internet, like the original Internet, is primarily a research tool, closed to commercial applications. To connect to the vBNS network, an application must be filed and

⁶⁷ “NSF High Performance Networking, Next Generation Internet, and Internet 2, Fact Sheet”, <http://www.nsf.gov/od/lpa/news/media/fs325.htm>. 7/25/99.

⁶⁸ Abilene Project FAQ, <http://www.ucaid.edu/abilene/html/faq-genearl.html>, 7/25/99.

the NSF will permit connection if accepted after being peer reviewed.⁶⁹ To connect to the Abilene network, you must be a member of the UCAID. Only institutions of higher learning and corporations who promote research and development of advanced network technologies in the interest of education can be members of UCAID.⁷⁰

If one of the primary goals of NGI is to “accelerate the commercial availability of new products, services, and technologies,”⁷¹ why is this network closed to commercial traffic? First, researchers do not want the speed of their transmissions to be slowed down by commercial traffic.⁷² Second, the government, who funds much of the next generation Internet project, does not want to subsidize commercial traffic. Third, the institutions that are currently a part of this high-speed network have no desire to compete with commercial ISP’s providing slower access via the current Internet backbone. In addition, these institutions have no desire to manage such a backbone.⁷³

However, in examining the history of the current Internet, it would make sense to look for a solution to these problems and commercialize this high-speed backbone sooner rather than later. The current Internet was originally a Department of Defense project designed in the ’70’s so that command centers would have a way to communicate in the event of a nuclear war. In the ’80’s and ’90’s, the NSF became involved, linking more computers faster and setting a new pace for innovation. Soon other government agencies began to participate as well.⁷⁴ Like the new high-speed network, the original Internet had a policy that prohibited commercial traffic. In 1991, the

⁶⁹ “NSF High Performance Networking, Next Generation Internet, and Internet 2, Fact Sheet”, <http://www.nsf.gov/od/lpa/news/media/fs325.htm>. 7/25/99.

⁷⁰ UCAID, Membership requirements, http://www.internet2.org/ucaid/html/corporate_membership.html#, 7/30/99.

⁷¹ “NGI questions and answers”, <http://www.ngi.gov/white-house/questions.html>, 7/26/99.

⁷² Richard Fagen, Caltech Director of Information Technology Services, personal interview, 7/28/99.

⁷³ Jeff Ubois, Internet 2, personal interview, 7/28/99.

NSF lifted this ban, allowing commercial traffic to pass over its backbone. For a number of reasons, this was a natural step in the networking environment that had developed. First, it had become difficult to separate the commercial traffic from academic. Some research was done in cooperation with industry, so it was not uncommon to communicate with commercial entities, and it was nearly impossible to differentiate between academic and commercial communications. In addition, there were also several private entities building networks and backbones which allowed commercial traffic to pass. These networks interconnected with the NSFNet, raising issues of transparency; often end users did not know whether their traffic was moving over the NSFNet or not, so they could not know if they were complying with the acceptable use policy. By the time the NSF allowed commercial traffic to flow over their backbone, it was a pragmatic move and almost a moot point.⁷⁵ There does not appear to be anything vastly different between this next generation Internet, and the original Internet, suggesting that eventually, this new high-speed network will carry commercial traffic.

Researchers currently use less than 1% of the available capacity of the high-speed network.⁷⁶ It seems unlikely that allowing commercial traffic onto this network will slow academic transmissions down. In anticipation of increased commercial traffic, however, the government should focus on developing ways to separate traffic, so that academic and research related transmissions can be separated from commercial traffic and be insulated from network slowdown. Allowing commercial traffic onto this high-speed network will also encourage development of new applications. Some applications are not developed until private users have access to the network, such as Mosaic, an Internet information browser. Allowing commercial

⁷⁴ "Short History of the Internet By Bruce Sterling", <http://w3.aces.uiuc.edu/AIM/scale/nethistory.htm>, 7/30/99.

⁷⁵ Ubois, 7/28/99.

traffic onto this network will tap into this second set of applications and will speed the process of innovation.

The government's fear of subsidizing commercial traffic is a legitimate concern. However, the government could avoid subsidies while still allowing commercial traffic on this high speed net if they condition access. For example, the government could allow commercial traffic as long as the company managing this traffic can clearly demonstrate that they can keep their traffic separate from research traffic, that they can monitor the volume of traffic they put onto the network, and that they will yield to research and academic traffic. Companies would be encouraged by the chance to offer higher speed access to data to innovate to meet these conditions. The technology developed to meet the conditions proposed above could also be used in managing an open access cable system, or any other shared network. Not only would these developments have multiple applications, they would also allow the Internet to grow. This is also a highly flexible solution since companies are not obligated to invest in any specific technology and are free to innovate as they see fit.

However, these problems can not be ignored. There is a finite amount of bandwidth available, and while there is currently more than enough available now, it is conceivable that more efficient uses of bandwidth will need to be developed. When this happens, government, academic, and commercial traffic will run alongside each other. To prevent any entity from paying for more than its share, it will be necessary to find a way to distinguish between different types of traffic so that they can be billed appropriately. Government should encourage industry and research facilities to develop the technology necessary to do this.

⁷⁶ Fagen, 7/28/99.

CONCLUSION

Keeping pace with technology is perhaps the real challenge to regulators, but it is nearly impossible to do successfully. Whether market forces will be more successful than government at keeping pace with technological innovation remains to be seen. However, this is the path regulators have chosen. Now they must be careful that the market does not run away from them. Regulators must act as a watchdog to protect consumers from irresponsible competition while encouraging a competitive market to innovate.

BIBLIOGRAPHY

- Abilene Project FAQ, <http://www.ucaid.edu/abilene/html/faq-genearl.html>, 7/25/99.
- Abe, George. *Residential Broadband*. Indianapolis, IN: Macmillan Technical Publishing, 1997.
- Azare, Monica. Legislative Director, Rep. Billy Tauzin's office. Personal interview, 6/24/99.
- Bloomberg News. "FCC Wants to Push More Broadband Options," 5/19/99. E-mail forward from Deborah Rudolph, Manager, Technology Policy IEEE-USA, 6/7/99.
- "Broadband Internet Regulatory Relief Act of 1999", S. 877, 106th Congress.
- Broersma, Matthew. "The Battle for Better Bandwidth - Should Cable Networks be Open?" <http://dailynews.yahoo.com/headlin...tml?...> 7/12/99.
- Broersma, Matthew and Joel Deane. "Broadband Access Battle Heats Up," ZDNN, <http://www.zdnet.com/...tories/news/o,4586,2288935,00.html>, 7/12/99.
- "Cable Modem FAQ", <http://cablemodem.com/FAQ.html>, 6/23/99.
- Caulfield, Brain. "Big Networks Shun Small as Peering Issue Heats Up." ISP World. September 28, 1998. Lexis Nexis, 7/27/99.
- Chen, Kathy. "FCC's Kennard to Argue Against Rules on Broadband Web Access at Local Level." Wall Street Journal, 7/21/99: A4
- Communications Act of 1934.
- Conyers, John Jr. (D, MI), House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.
- Divakaruni, Shastri. Director of Engineering, Broadband, Wireless, Cisco Systems. Personal interview, 8/3/99.
- Esbin, Barbara. "Internet Over Cable: Defining the Future in terms of the Past", OPP Working Paper Series 30, Federal Communications Commission. Washington, D.C.: Federal Communications Commission Office of Plans and Policy, 1998.
- Engineer Federal Communication Commission, personal interview, 6/29/99.
- Fagen, Richard. Caltech Director of Information Technology Services. Personal interview, 7/28/99.

Federal Communications Commission. "Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996." FCC 99-5. 2/2/99.

Federal Communications Commission website, "General Cable Television Industry and Regulation Information Fact Sheet." <http://www.fcc.gov/csb/facts/csgen.html>, 7/20/99.

Gareiss, Robin. Data Communications "FCC Chairman to Set Up Peering Forum", June 10, 1999. Lexis Nexis, 7/12/99.

Gaskin, James E. "Can the Industry Resolve Its Own Peering Debate?" Internet World. April 26, 1999. Lexis Nexis, 7/28/99.

"General Cable Television industry and Regulation Information Fact Sheet", <http://www.fcc.gov/csb/facts/csgen.html>, 7/20/99.

Gerwig, Kate. "Peering Standoff Must Come to an End", Insights and Incites, Perspective, September 7, 1998. Lexis Nexis, 7/27/99.

"High speed alternatives", <http://www.zdnet.com/..p/features/exc10198/dsl/adsl3.html>, 6/7/99.

Hundt, Reed. Former Chairman of the Federal Communications Commission. Personal interview, 7/22/99.

Jacobs, Tod A. Senior Telecommunications Analyst Sanford C. Bernstein and Company, written testimony, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.

Kennard, William. "The Road Not Taken: Building a Broadband Future for America." National Cable Television Association, Chicago. 6/15/99.

Merrill Lynch, Global Securities Research and Economics Group. "Investment Insights: Telecommunications: the race for Bandwidth." 5/24/99.

Newman, Stagg. Chief of the Network Technology Division, Federal Communications Commission, Office of Engineering and Technology, personal interview. 7/21/99.

"NGI questions and answers", <http://www.ngi.gov/white-house/questions.html>, 7/26/99.

"NSF High Performance Networking, Next Generation Internet, and Internet 2, Fact Sheet", <http://www.nsf.gov/od/lpa/news/media/fs325.htm>. 7/25/99.

- Noll, Michael A. *Highway of Dreams: A Critical View Along the Information Superhighway*. Mahway, New Jersey: Lawrence Erlbaum Associates, Publishers, 1997.
- Parsons, Patrick R. and Robert M. Frieden. *The Cable and Satellite Television Industries*. Needham Heights, MA: Allyn and Bacon, 1998.
- “Press Release -- Excite@Home Responds to Misleading Claims by GTE and AOL.” http://www.home.net/news/pr_990615.html, 6/23/99.
- “Remote Access Technology”, <http://web.syr.edu/~jmwobus/dialups/comfaqs/serial-technology.html>, 6/9/99.
- Rosenblum, Mark C. Vice President - Law and Chief Litigation and Federal Regulatory Counsel, AT&T. Written Statement, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.
- Salsbury, Michael. Executive Vice President and General Counsel, MCI Worldcom, Inc, written testimony, House of Representatives Committee on the Judiciary, Hearing on HR 1685 and HR 1686, Washington, D.C., 6/30/99.
- Seidenberg, Ivan. CEO Bell Atlantic, testimony, Senate Judiciary Hearing, “Broadband: Competition and Consumer Choice in High-Speed Internet Services and Technologies,” 7/14/99.
- “Short History of the Internet By Bruce Sterling”, <http://w3.aces.uiuc.edu/AIM/scale/nethistory.htm>, 7/30/99.
- Sicker, Douglas. Chief Technologist for the Internet, New Media, Office of Engineering and Technology, Adviser for Chief Technologist and Chief Engineer, Federal Communications Commission. Personal interview, 7/9/99.
- Sicker, Douglas and Stagg Newman. “Draft Analysis, Cable Open Access Issues.” FCC Office of Engineering and Technology, 7/31/99.
- “Source of Truth”, <http://www.home.net/source/thetruth.html>, 6/23/99.
- Starkman, Dean. “AT&T to Carry NBC’s Digital TV Programming.” Wall Street Journal, 6/8/99: A3.
- Sweet, William. “Battling for Local Phone Customers.” *IEEE Spectrum* May 1999: 32-37.
- Telecommunications Act of 1996.

Ubois, Jeff. Internet 2. Personal interview, 7/28/99.

UCAID, Membership requirements,
http://www.internet2.org/ucaid/html/corporate_membership.html#, 7/30/99.

Vradenburg, George. Senior Vice President for Global and Strategic Policy, America Online. Personal interview, 7/19/99.

“What isDSL and xDSL?” <http://whatis.com/dsl.htm> 6/7/99,