Summary of Proceedings
(Revised)

THE INTERNET: BOOM, BUST, AND BEYOND

Prepared by
Timothy R. Gulden

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Panel I: Policy Lessons from the 1990s:
The Legacy of Telecom Reform and the Utopian Vision of the Internet

Jonathan Sallet (University of Maryland) discussed the nature of and policy challenges posed by "next-generation" networks. He defined next-generation networks as networks that qualitatively improve on existing networks. Such networks generally offer higher bandwidth and new functions like wireless access.

To highlight the changing policy environment, Sallet divided the history of the telecom industry into two eras. The first era focused on building separate, technology-specific networks. The AT&T telephone network (before its breakup) and the various local cable television monopolies were typical of this era. Even the Internet, in its early development, was in many respects a distinct network, sharing some equipment but essentially no functionality or business operations with the telephone system.

While the first era focused on technological islands, Sallet pointed out that the second era has focused on synergy. This era began with the privatization of the Internet in the mid 1990s. In this second era, networks are increasingly coming to be defined by function rather than technology. This shift has the potential to allow networks to compete in ways that were not possible when networks were defined by physical hardware and technology. Voice services, for example, could at one time only be delivered using AT&T owned copper wiring and AT&T switching equipment.

Sallet went on to present an overview of public policy issues for next-generation networks. He described the key themes as the global opening of telecom markets (as typified by the US Telecom Act and the WTO Basic Telecommunications Services Agreement), new resources like wireless spectrum (including specific technologies like 3G, WiFi, and UltraWideBand), the structure of telecommunication markets in light of large mergers (like the AOL/Time Warner merger and the failed WorldCom/Sprint merger), and promoting the social and economic benefits offered by broadband technology (requiring an examination of policy devices like tax incentives, loans and subsidies).

He discussed the merits of opening markets to competition, but emphasized the need to balance these benefits against the risks associated with poorly conceived market structures. He pointed to the disastrous overbidding that resulted from the 3G spectrum auctions in Europe, where European telecom companies essentially bankrupted themselves in an effort to capture the first mover advantages associated with gaining early market share in this new area.

Sallet also examined some of the ways that United States telecom reform did not produce the intended results. In particular, he talked about how the regional Bell companies have maintained about 90% of the market for "last mile" services and are edging toward bankruptcy (perhaps as a new competitive tactic). He cited the failure of the Telecommunications Act of 1996 to take into account the economic incentives involved in the market.

Sallet then moved to a discussion of the idea of "openness" in telecommunications networks. He suggested that the idea of a clean dichotomy between closed and open networks is a fiction. The old Bell network, for example, was entirely closed in terms of hardware but entirely open in terms of content. He presented four approaches for thinking about policy decisions regarding network openness. The "engineering" approach balances the end-to-end Internet view, where network intelligence is primarily at the edges, with the classic Bell view, where a smart network can be made very reliable and secure but only if it is centrally controlled (i.e. closed). The "economics" approach balances first mover advantages that can lead to monopoly with the idea of fostering facilities-based competition to promote investment. The "philosophical" approach balances the Jeffersonian values of diversity and speech with the more libertarian notion of freedom as an end in itself. Finally the "legal" approach must examine competition policy, both horizontal and vertical.

He then discussed four levels at which the idea of openness is operative. At the end user level, the network can be more or less open with respect to participation, content, applications and devices. At the level of competing networks, they can be more or less open with respect to interconnection, access, resale and unbundling of services. At the service provider level, the network can be more or less open with respect to content offered, applications, and equipment. Finally, at the level of ownership, networks can be more or less open with respect to foreign ownership and "concentrated" ownership (for example, current rules forbid the same company to own both telephone and cable networks in the same geographic area).

Having built a framework for thinking about openness, he went on to examine the telephone, Internet and wireless markets with respect to these ideas. Telephony, as represented primarily by the incumbent Bell network, is open with respect to content and applications, is open with respect to interconnection and traffic exchange with other networks, and provides for the resale of some retail services. It is less open, however, with regard to unbundling of services. The Internet is open at the level of end-to-end services (i.e. if users on both ends agree on the service, it can work). On the other hand, it is not required to be open on the network level of traffic exchange (though it has been historically). There is also no requirement for interoperable applications, a situation exemplified by competing and incompatible instant messaging programs. The only really successful digital wireless network to date is the Japanese iMode network, which offers wireless web browsing, email and e-commerce. It is closed at the level of network equipment and operation, but is in many respects open to content providers.

Overall Sallet sees current trends running against openness in networks, raising the need for continued policy vigilance against monopoly control.

Panel I Discussion

Sallet's presentation was followed by a panel discussion moderated by **Vonya McCann** (Sprint) and including **Donald Ableson** (FCC), **Jennifer Sims** (Johns Hopkins SAIS), and **Gigi Sohn** (Public Knowledge, Inc.).

Donald Abelson began the discussion with a reflection on the telecommunications reform effort over the past decade. His central point was that both government and industry had oversold what the Internet could deliver. An implication of much of the policy discussion has been that deregulation and pro-competition reform would automatically deliver tremendous economic growth. Competition reforms would bring growth to rich nations and connectivity (followed by growth) to poor nations. In many cases, however, the introduction of new forms of competition to state monopolies proved extremely destabilizing. These stability issues have raised questions about the wisdom of telecommunications reform efforts as they have previously been pursued.

Jennifer Sims continued by discussing the use that the government (particularly the Department of State) has made of the Internet and other modern telecommunications technologies. Her main observation was that the State Department is far behind private industry and the military in its use of the Internet and the development of flexible telecommunications capacity and that this poses real security concerns. She speculated that the problem was probably as bad or worse in the Federal Bureau of Investigation and other civilian security-related agencies.

Sims pointed out that national security related telecommunications networks are, for the most part, in private hands. Although the military is still engaged in developing and maintaining its own telecommunications satellites, more and more of its traffic is going on commercial carriers. This makes issues of imposing security requirements or developing secure contingency plans for operations in hostile environments more difficult for government agencies.

She went on to discuss the founding, utopian vision of the Internet, which she analyzed in terms of three main characteristics. The first of these is *universality* – that everyone should have access from everywhere. The second is *convergence* – that all media should be available on one platform. The third is *emergence* – that the complex administration of the Internet would be conducted from the bottom up, rather than from the top down. She said that all three of these principles have been called into question.

For purposes of these comments, Sims emphasized ways in which the principle of universality has broken down. She pointed out that the "digital divide" is usually applied to nations as well as individuals. Modern telecommunications have brought great benefit to developed regions but not to poor countries. This trend works to further widen the gap between them.

The second digital divide is less well recognized and yet is perhaps more important from the standpoint of U.S. national security: the gap between governments and the private

sector in capacity for networked communications. She pointed out that, in 2000, only about 20 of 280 State Department posts overseas had secure web and Windows based networking capability with other US government agencies. Moreover, few senior officials had access to the Internet from their desktops, even in Washington. This meant that most State Department officials overseas have not had access to commercial imagery, news reports and other critical information that the rest of the developed world takes for granted. This situation often forced State Department officers to use home computers to connect with the rest of the world, with attendant risks for security. State Department officers have not been permitted to use mobile phones and palm pilots in many parts of the world because of security concerns. Although the necessary technology exists to provide solutions for the Department of State in these areas, chronic under-funding of the Department's infrastructure has made State Department communications a seriously weak link in the nation's national security infrastructure. Since other USG agencies rely on services and infrastructure provided by State overseas, this weakness translates into weakness for other USG activities as well – particularly in the law enforcement area.

The military is generally much better equipped than the diplomatic and law enforcement agencies but the nature of modern war, which requires networking among all agencies, renders the military as vulnerable as its weakest partner. The lack of either secure and flexible telecommunications capacity or Internet connectivity on the part of civilian agencies seriously hampers their ability to communicate clearly and efficiently with their military counterparts. She observed that the State Department could have been well positioned to take advantage of the Internet; but the identification of secure telecommunications with wholly owned or leased point to point commercial service has delayed an innovative approach and caused the Department to rely either on scarce DOD telecoms capacity or on commercial services subject to host government controls under international law. In the meantime, our terrorist adversaries are using the highly flexible and secure worldwide capabilities of the Internet for their command, control and communications functions.

Vonya McCann added that the State Department had clung to its existing telecommunications infrastructure because it did not understand the potential of the Internet.

Gigi Sohn prefaced her remarks by saying that her perspective was that of a communications attorney who has been working on issues of intellectual property and communications technology and that her knowledge was primarily U.S.-centric.

Sohn said that Sallet might have been overly negative in his assessment of the Internet's success in delivering on its promise. She characterized the impact of the Internet as being revolutionary if perhaps not utopian. She pointed out that from her experiences with running not-for-profit organizations, she could testify that the Internet has allowed NGOs to do far more with far fewer resources.

She also questioned the extent to which policymakers have come to define networks by functionality rather than technology. She pointed out that digital subscriber line (DSL) and cable modem networks provide essentially identical service but are regulated quite differently. A similar situation exists with IP (Internet protocol) vs. landline telephony. Broadcast television is treated quite differently from cable and satellite television.

Sohn placed emphasis on the issue of spectrum management as a central one in understanding the current and near future issues in the development of telecommunications technology. She discussed the movement to open up more unlicensed spectrum and observed that proper reallocation of spectrum could solve the "last mile problem." Spectrum is currently managed inefficiently, forcing technology companies to emphasize wired rather than wireless solutions.

McCann began the general discussion by observing that during the development of the Internet, the US government has avoided regulating it.

Abelson said that the issue is what one means by the word "regulate." Strong government intervention to determine the organization of the Internet is clearly not where we are headed. Abelson foresees a softer regulatory approach, where the government fosters cooperative efforts to solve problems.

Sohn pointed out that there has always been some regulation of the Internet, including rules forbidding taxation of many Internet transactions and regulating aspects of e-commerce. She went on to say that there are currently several proposals for regulation of various aspects of the Internet.

McCann observed that the head of the FCC had proposed that the FCC should be able to regulate exit from the data carrier market. This proposal came in reaction to the danger that UUNET (a major data carrier) might go out of business, creating disruptions in Internet backbone service.

Sallet analyzed the evolution of regulation of the Internet as being guided by the dual nature of the Internet as both a technology and an ideal. The Internet arose from heavily subsidized development on a heavily regulated network by a highly homogeneous group of people. The ideal that developed in this environment is that government regulation is not needed. Now that the Internet has become a commercial communications medium, however, the situation may have changed. Sallet theorized that if the same technology had evolved from a different set of ideals, the government might feel that it was critical to regulate it. He further speculated that as the technology became increasingly mature, the government would come to regulate it as it does anything else with major societal impact.

Brian Kahin (University of Maryland) pointed out the growing importance of private rather than government regulation in the workings of the Internet. This trend is more evolved in the United States than it is in Europe. Contracts are the classic form of private regulation, with the Uniform Computer Information Transactions Act (UCITA) proposing to expand the power of private contracts tremendously. Patents and, to a

lesser extent, other forms of intellectual property provide a powerful means of private regulation. Kahin further pointed out that this had become a security concern in China, where the power of Microsoft to control and obscure the functionality of the Windows operating system had led the government to move toward Linux. There are similar concerns in Europe.

Abelson discussed differing national attitudes toward content control, with China and countries in the Middle East feeling strongly that they needed to control the content that their citizens could access. Such concerns also resonated in countries like France and Canada where governments and citizens were concerned about there being too much United States influence on culture. He predicted that this would continue to be a factor in global telecommunications regulation.

Sims discussed the emergence of Internet-related freedom of information laws and programs in many countries. Under such laws, governments are required to disclose large amounts of non-classified information. This has been driven by, and has also fueled, the emergence of civil society organizations. Much of this openness began in the United States, but now the United States is leading the backlash against disclosure. She said that it is not clear where the United States or the world in general is headed with regard to public disclosure of non-classified government information. Civil society groups are pushing for more disclosure in the interest of transparency, but governments are pushing for less in the interest of security.

Bill Nolte (NSA) said that the cost of filtering Internet content was prohibitive for most countries. He related an anecdote about a student at Tehran University who contacted him by email about a paper he had presented. When Nolte suggested that such contact was not wise on the student's part, the student said that such contacts were tolerated now. Nolte was not entirely convinced, but did agree that the Internet had significantly undermined government attempts to limit citizens' access to information.

Sallet pointed out that the Internet could be used both to broaden and to focus information gathering ability. While it is possible to use the Internet to inquire about a broad range of subjects, it is also possible to use the Internet to find and communicate with like-minded people about a very restricted range of information. This can be contrasted with television, where limited bandwidth and high production costs mean that many people with differing views end up watching the same programming. The Internet has the potential to facilitate discussion without considering alternative views – thus potentially hardening extreme positions.

Sims reinforced Sallet's observation by citing Steven Johnson's book *Emergence*, in which he predicts that Internet-type connectivity leads to clusters of agreement rather than universal consensus. She pointed out that this might be useful from an intelligence perspective because it would make it easier to identify like-minded groups across boarders.

Sallet went on to point out that our constitutional system is designed to keep a group of like-minded people from having too much power.

Sims made a distinction between the Internet and the political system. While the Internet may promote clustering, the political system proceeds by the broadcast media and by the actual apparatus of government. Both of these systems tend to foster mixing. She speculated that the enhanced private discussion facilitated by the Internet might actually strengthen the public political process.

Sallet speculated that we were one or two election cycles away from the Internet becoming more important than television in the political system. He proposed that this would change the nature of political advertising, making it much more focused on particular groups and making consensus harder to develop.

Panel II: Economic Trends: Consolidation, Integration and Network Control

Francois Bar (Stanford University) began this session by differentiating between the dot-com bust and the telecommunications industry collapse. The dot-com bust was largely the collapse of bad ideas, with speculators rushing into a new market that they did not understand. The ensuing bust was a disaster for these investors, but was not a major setback for the real economy. The telecom collapse, in contrast, was a much more serious problem for the economy. The telecom industry employed more people than the dot-com sector and was a large and established part of the economy. Telecom infrastructure was critical for the workings of many other kinds of businesses in the economy.

Bar then explored the reasons for the telecom collapse. One hypothesis would be lack of demand, but it is not clear that this was the problem. Certain parts of the industry went though growth spurts, doubling every three to four months. This slowed to doubling every year, still a very rapid rate of growth. The rest of the industry was growing at a rate of 5 to 8 percent per year – a rate that well outstrips the rest of the economy. A second hypothesis would be the failure of technology to deliver what was expected from it. For the most part, telecommunications technology has delivered what was expected, so this is not the reason for the collapse. He cited capacity oversupply as the real reason for the collapse. The fiber-optic infrastructure in which the industry had invested heavily worked too well, leading to serious oversupply and collapsing prices.

Bar then compared the Internet market of the 1990s with the wireless market of today. The Internet market was typified by cheap bandwidth and low barriers to entry for Internet service providers (ISP's). Today's wireless market is typified by licensed bandwidth and high entry costs for new providers. The Internet market was based on competition over the implementation of public standards. The wireless market is based on competition over developing proprietary standards. In the Internet market, applications were developed by users (i.e. not by service providers). In the wireless market applications are developed and provided by the network owners.

Bar then laid out what he termed "the paradox of the best network." The best network is open, provides end-to-end connectivity and is "stupid" – passing information through with a minimum of handling. He described such a network as technically preferable to other approaches but one from which it is very hard for businesses to make money.

Bar differentiated between the local service telecom market, which is doing reasonably well, and the long haul & CLEC (Competitive Local Exchange Carrier) markets, which are in crisis. He attributed the stability of the local service market to the real and billable nature of maintaining "last-mile" service. Long haul providers, on the other hand, are essentially selling a commodity (bandwidth) that is in major oversupply. He identified three options for dealing with this crisis. The first is reverticalization, where local and long haul companies would be permitted to merge into a structure more like the old bell system. A second is "competitive bankruptcy," where carriers begin declaring bankruptcy to ease their credit terms while continuing to operate. The third option is to let the current long-haul companies fail quickly so that the market can move on to a new generation of businesses with more workable business plans and debt structures. He said that it is probably possible to create a commodity-like market in "bit moving," but that it presents a challenge to preserve incentives for infrastructure investment under this model.

He then discussed reasons why the network market may be moving away from the "end-to-end" or "stupid" network toward "smart" network technology. Beyond the business model problems discussed above, he pointed to various technical issues that have been becoming increasingly significant. First, as the Internet has grown people deal increasingly with untrustworthy users at the other end of their connections. Spam, viruses, pop-up advertising, "spyware," etc. create demand for filters within the network – moving away from pure end-to-end data transport. Also, demanding applications like real-time video mean that current "best effort" packet delivery is often inadequate. Market pressures for ISPs to differentiate themselves by providing different services further this trend. The rise of third-party networks, including peer-to-peer file sharing networks, has created traffic problems for ISPs, reducing their inclination to pass traffic along without intervention. Finally, the increased commercialization of the Internet has created a large class of less sophisticated users who value usability more highly than control. All of these factors provide a challenge to the model of an open, end-to-end network.

Panel II Discussion

Bar's presentation was followed by a panel discussion moderated by **Bill Nolte** (NSA) and including **Yuan Lee** (Morgan Stanley), **Blair Levin** (Legg Mason), and **Jaron Lanier** (Advanced Network and Services).

Yuan Lee (Morgan Stanley) began the discussion with a presentation on China and the Internet. Lee described an essential asymmetry in the Internet between the masses and the authorities. He described these groups in both political terms (i.e. citizens and

government) and also in commercial terms (consumers and producers). For authorities, the Internet has been a disruptive force. It enables the masses to interact with authorities in many different ways from many different places. The result is a disorganized and uncontrollable interaction that can make life very difficult for a government or a corporation. For the masses, the Internet can have a powerful integrating effect. Consumers can get anything they want from the Internet. Citizens can find out whatever information they want and can communicate with anyone they want. This asymmetry makes the Internet an important factor in the development of China as it continues to experience political and economic change.

Lee presented a fact sheet to give a sense of the state of development of the Chinese Internet. As of July 2002, China had 45.8 million Internet users. This represented a 36 percent growth over January 2002. Seventy percent of these users are under the age of 30, with 37 percent between 18 and 24 years of age. Fifty-five percent of Chinese Internet users have a college degree, while an additional 30 percent hold a high school diploma. Twenty-five percent of users earn less that 500 RMB monthly, while an additional 25 percent earn between 501 and 1,000 RMB, and 16.5 percent earn between 1,001 and 1,500 RMB. The average logon time is 8.3 hours per week and the average frequency of logons is 3.1 days per week.

Lee described the central planning mentality as the largest hurdle for China to overcome. He discussed the struggle between authorities and dissidents, the role that an open content Internet has played in this struggle and Chinese government efforts to guide and control the development of the Internet in China. However this struggle plays out, Lee predicted that Chinese contributions would become an increasingly important part of the content of the Internet.

Blair Levin (Legg Mason) continued the discussion by saying that telecom investments are generally long term investments and therefore require a stable investment climate. If the rapid pace of technological change is likely to render an investment in telecom hardware obsolete within five years, that investment will not be made. He proposed this as a reason that there has been a great deal of investment in telecom generally but less investment in "last mile" infrastructure.

He suggested that wireless technology has been a great success for consumers, but less so for investors. High margin wired networks are being eroded by competition from low margin wireless networks. Given the rapidly changing nature of wireless technology, this trend poses a problem for future investment.

Jaron Lanier (Advanced Network and Services) began his remarks by describing the emerging technology referred to as "tele-immersion." Tele-immersion is a type of virtual reality that allows people at several different locations to conduct meetings and other activities with the feeling of being in the same room. It differs from standard video-conferencing in that eye contact and other non-verbal cues are preserved in ways that a single camera angle cannot duplicate. He said that prototype testing has shown the technology to be highly desirable to many people. He also said that it was

technologically quite feasible, though not yet ready for commercial service. He suggested that if tele-immersion did not become a common technology, it would likely be because policymakers had thwarted it.

Lanier indicated that the implementation of this technology would require a great deal of bandwidth – sufficient to more than consume the current fiber-optic capacity glut. He said that tele-immersion technology required users to use bandwidth symmetrically, in contrast to current ADSL (Asymmetric Digital Subscriber Line), cable modem and satellite broadband solutions, which provide more downstream capacity than they do upstream capacity. He pointed out that such a jump in demand for symmetrical bandwidth would pose a major problem for last mile service delivery. He suggested that spread spectrum wireless would probably be the best solution to this problem.

Lanier then shifted to the subject of intellectual property rights. He said that digital network technology posed fundamentally new problems in this area, making it very hard to design a system that preserved intellectual property rights while at the same time permitting fair use. Thus far, all attempts to strike a balance between these two have failed, making it likely that the world will have to choose between total content management and totally free exchange of copyrighted material.

He pointed out that very few musicians make any money from selling recordings – almost all of the profits from record sales go to record companies. Instead, most musicians make their living from playing live performances. He suggested that the live, interactive nature of performances is what allowed performers to retain control over their proceeds, because live interactivity cannot be copied in the same way recordings are. He suggested that ultra-high bandwidth last mile connectivity could create more opportunities for live interaction and thereby provide a partial solution to intellectual property problems.

He went on to suggest that another approach to protecting intellectual property would be to eliminate anonymity on the Internet by building verifiable identity into future communications protocols. This approach would promote accountability in many areas where the Internet is currently subject to abuse and allow traditional intellectual property regulations to function.

Lanier proposed that the U.S. could start a program of blacklisting servers that support anonymity, which might be accomplished in cooperation with other countries under the auspices of the UN. A blacklisted server would be unable to access anything legitimate and would, therefore, become a focus of intelligence concerns. Blacklisting would make it much more difficult for rogue groups, whether spammers, thieves or terrorists, to abuse the Internet. While the number of servers is great, he stated, it is not insurmountable.

With regard to the ethical implications of this course of action, Lanier expressed the belief that it is in fact ethical, presuming that privacy is diminished symmetrically. In explanation, Lanier stated that in exchange for allowing the government to spy on and potentially shut down his server, he would expect some compensation on various levels

Lanier concluded by observing that the diversity of cultures connected to the Internet has had a positive influence on the development of Internet technology. While the Internet began as an American project, it took the development of HTML by European scientists to make the World Wide Web come into being. He cited Linux and MP3 as other European technologies that have created shared space on the Internet.

John Steinbruner (University of Maryland) suggested that the idea of denying anonymity to Internet users was a major step and asked how this could be done while protecting personal information.

Lanier responded that this depended on the level of accountability one wanted to provide. He said it would be possible to make it very difficult to send from a false IP address by working authentication into basic communications protocols. He suggested that this would be enough to track down the worst abusers without major infringement of liberties.

Steinbruner asked what the impact would be on the Arab world and on China of reducing anonymity – given that users in these areas prize anonymity because they run very real risks by communicating about subjects unpopular with the authorities.

Lee said that China is so big that it is hard to look at everything that happens on its Internet and that people have been effective at thwarting some aspects of government control, but he was not sure what would happen in this case.

Bar said that there are benefits to a certain amount of volatility because it creates opportunities for innovation and avoids the development of a technological monoculture. He suggested that a degree of volatility might be seen as a policy goal, rather than an obstacle to sound policymaking.

Levin pointed out that the volatility in the wireless market has allowed for the development of better wireless standards. He contrasted the older European GSM standard with the generally superior American CDMA standard and explained how volatility kept the GSM standard from locking in too early in the development of the market.

Lunchtime Presentation: Scenario Creation Templates and Process

Steven Weber (UC-Berkeley) presented a framework for thinking about future scenarios for network development. He suggested that it is useful for people to develop ideas about various future paths as a way of better understanding the present. He pointed out that it is often assumed that we know the past and the present, but not the future. However, there is much uncertainty about the past and present as well – particularly about the

significance of various events. The process of thinking about alternative futures helps to organize known facts about the past and present into a more coherent whole. The object of scenario creation, then, is to develop a series of hypotheses that vary the future environment for network development and keep us from being held captive by aspects of our current understanding.

Weber presented the core question to be addressed as being the shape and character of the next generation of network development over the next decade. He pointed out that this question is far too complex to think about coherently. As a way to address this complexity, he proposed two critical dimensions of uncertainty and presented them as perpendicular axes on a graph. He emphasized that the object of these axes was not to reduce the complexity of the question, but to parse the complexity and to organize it. He also said that ideally the workshop would debate and develop the axes as part of its process, but that the limited schedule of the workshop did not allow for this.

Weber first presented the Y-axis, which he labeled "Applications." Toward the bottom were bandwidth-conserving applications; toward the top were bandwidth-consuming applications. At the bandwidth-conserving end, a cable modem would continue to provide plenty of capacity. Applications would be developed, but they would be very efficient. At the bandwidth-consuming end, applications would require tremendous capacity. Tele-emersion would be such a bandwidth consuming application.

He then presented the X-axis, which he labeled "Market for Bit Transport". Toward the left were competitive markets; toward the right were choke point markets. Competitive markets would involve a variety of technologies, firms and business models providing various ways to deliver bits under various cost structures. Choke point markets would involve monopolistic or tight oligarchic control of transit somewhere in the process. This might be because competitors were priced out of the market, because the market was regulated to the point where there was no real competition, or because competing technologies simply failed to deliver adequate service. He pointed out that it would be possible to envision competing closed networks. He also pointed out that this question is at least as much about business models as it is about technology, citing guerilla WiFi networks as a technology with no business model.

At the upper left of this graph he presented a world with virtually unlimited bandwidth and lively competition. He described this world as having a great many "fat" applications and highly competitive bit transport. In this environment, the high demand for bandwidth would come from a network with very "smart" edges. He speculated that such an environment would probably involve robust wireless networks as part of the last mile solution. He observed that such a world would likely involve quick business turnover and price volatility in transport costs. Such a market would require the development of a successful business model for the transport of bits as a commodity. He pointed out that this kind of a market might have difficulty attracting infrastructure investment.

At the bottom left Weber described a world with relatively narrowband connections and lively competition. He pointed out that there are many technologies capable of delivering 1.5 megabits per second and that such a market might develop sophisticated pricing structures as users fine-tuned their access. Some solutions might favor high security, low latency, or special content. He encouraged people to think about what this world would look like in 2008; considering both the business end and the technical, network end. He wondered how we might get to this state. What problems had to be solved and what developments needed to occur to get there? He further asked what challenges would remain to make such a world reasonably stable.

At the upper right was a scenario with high bandwidth applications and very limited competition and at the lower right was a scenario with low bandwidth applications and very limited competition.

Weber encouraged breakout session groups to break their scenario descriptions down into three parts: a general description of what the environment looked like, a description of how this environment came into being from the current environment and the challenges which this environment would present to business and to regulators. He further encouraged the groups to think about extreme cases, near the edges of the graph, so that the exercise would produce strongly contrasting results.

Concluding Session – Discussion; Description; Implications of Scenarios

Conference attendees divided into four breakout groups to discuss the four scenarios. After an hour and a half, the groups reported their thoughts back to the conference.

Weber moderated the discussion and asked a representative from each breakout group to give a five to seven minute presentation of the group's findings.

Group A: Upper Left Quadrant

Francois Bar (Stanford University) presented the scenario that the group had titled "Darwinian Jungle." In this world, virtually anything could be done from any place, but not by anybody. Those with more skills would have a large advantage over those with less. The digital divide would be exacerbated. Distance would come to matter less, but there would be more capability in some places than in others – leaving less developed places at a disadvantage. The real and the virtual would become increasingly blurred. Power on this network would reside in the edges. Governments would also become highly networked.

Bar explained that this world would come into being through a series of business and technical innovations. High bandwidth wireless would become available virtually everywhere as a local loop solution. Wireless communications technology would be embedded in many electronic devices, allowing these devices to self-organize into a mesh network. From a policy standpoint, the opening of more frequency bands would make all

of this possible. The long haul market would involve competition from multiple fiber-optic backbones. Existing physical fiber capacity would gain tremendous capability through the use of sophisticated multiplexing transceivers.

Bar pointed out that this environment presented various challenges and was not particularly good. This environment is likely to be highly volatile in many respects. It is not clear what kind of business model could provide stable service in this world. Such powerful but unevenly distributed access could lead to high social and political instability. In this world of smart edges and very limited central control, it would be hard to know whom to trust and hard to take time for reflection. It is an environment that could foster mob behavior, organized crime and other difficult security problems.

Group B: Upper Right Quadrant

Yuan Lee (Morgan Stanley) presented this scenario, which the group had titled "Ma Bell Turnpike." This scenario has high bandwidth requirements, but only a few providers of bit transport services. In this scenario, the information superhighway becomes a toll road. The large telecommunications companies come to dominate the market because security demands come to require verification of all data packets. Given the processing demands created by this packet authentication, providers would create tiers of service – providing expedited service for a higher fee. Server and switch producers would be winners in this scenario because of the heightened need for processing power. Consumers would be losers because of the higher rates and inefficiencies associated with monopoly control. Open source vendors would loose because there would be no place for them in this market.

Balancing civil liberties against security would be a major challenge of this scenario. A further challenge would be dealing with the effects of monopoly control of the network. Development along these lines could eventually require another breakup of the telecommunications industry along the line of the breakup of AT&T in the 1980s. Until such a breakup could be achieved, consumers would have to deal with reduced innovation and higher prices. A further regulatory challenge would be determining who would control the elaborate security apparatus, private companies or the government. Also challenging, given the heightened security concerns, would be the task of maintaining efficient communications with other countries.

Group C: Lower Right Quadrant

Michael Pelcovits (MiCRA) presented this scenario, which involved limited bandwidth applications and a choke point network market. In this world there would be few Internet service providers. These providers would look something like MSN and AOL. The providers would provide applications that worked with their own network (e.g. AOL and MSN Instant Messenger). Because of the lack of competitive pressures, services would not tend to be customized but would have more of a one-size-fits-all feel. Last mile

service might be delivered by wireless service, but current 1.5 mbps technology would be sufficient for most users. Cable television might add more video on demand service, but most of the high bandwidth services that have been discussed would fail to materialize.

This scenario would come about primarily because of limited demand. This environment would lead to mergers and acquisitions as the industry scrambled to deal with a reduced market. This failure of demand could also lead to major consolidation in the wireless market.

Monopoly would be the primary challenge posed by this scenario. Consumers would have to deal with the usual monopoly problems of reduced innovation and increased prices. This monopoly situation would also have international implications. A worldwide monopoly or oligopoly would present tremendous governance problems. On the other hand, a set of national monopolies could lead to a balkanization of networks. Other challenges posed by this scenario would be posed by content controls, privacy problems, and constrictions on diversity of both technology and ideas.

Group D: Lower Left Quadrant

Mary Brown (Lawler, Metzger & Milkman) described a scenario with relatively low bandwidth requirements and high competition. She suggested that this world would contain many of the same players that we see today. DSL, cable, WiFi and local ISP's all remain relevant because of the modest bandwidth demands. Applications in this scenario would be typified by things like buying tickets over the Internet or from a cell phone, email, gambling and other applications that provide high perceived value at a low bandwidth. Inexpensive wireless devices would increasingly be used to conduct small transactions. Because of limited bandwidth, usage based pricing would be likely to emerge as a common pricing model.

This world would come about because high bandwidth service remains expensive, suppressing demand. Also, compression technology continues to improve and to take advantage of powerful desktop computers. Also contributing to this development would be increased use of peer-to-peer file sharing services. Finally, this scenario might be driven by government action aimed at delivering universal service.

Since this scenario would not involve a major technological shakeout, the harmonization of regulation in different areas would continue to pose a challenge to regulators. Increased use of wireless technology would require spectrum reallocation by the government. Usage based pricing might lead to privacy concerns because data would have to be tracked to be billed. Competitors would face the challenge of differentiating themselves in a mature market. Options for differentiation might include branding, mobility and reliability among other things.

Scenario Discussion

The presentation of scenarios was followed by discussion by a panel chaired by **Steven Weber** (Stanford University) and composed of **Victor Mayer-Schoenberger** (Harvard University), **Adam Clayton Powell III** (Howard University), and **Charles Weiss, Jr.** (Georgetown University).

Victor Mayer-Schoenberger (Harvard University) began the discussion by noting that the shape of network infrastructure is ultimately tied to the nature of network content. He pointed out that the field of Science and Technology Studies examines how society impacts technology and how technology impacts society. He suggested that existing work in this area could be used to refine the scenarios that had been developed at the workshop.

He went on to observe that some choke points remained in most of the scenarios. The important factor in analyzing the scenarios is examining who controls these positions of power. He said that the recent trend was toward the denationalization of choke points. He presented the example of a Swedish NGO hiring the European satellite company SPOT to take a picture of a Russian nuclear plant. It was this picture and its distribution on CNN that broke the Chernobyl story and forced the Russian to admit to the disaster.

He also discussed how the revolution in information processing has given non-government users processing power that was once reserved for government labs. This situation is reinforced by the fact that commercial research and development efforts dwarf those of government defense research. This also contributes to a shift in power away from government.

Finally, he discussed the way in which information distribution over the web and other media has limited the ability of governments to control the information that their citizens can access. He presented the common use of home satellite receivers in Saudi Arabia as an example of how technology has undercut government control of information.

Adam Clayton Powell III (Howard University) described the current network market environment as highly uncertain. He pointed out that bankruptcies could be part of market evolution by passing assets from companies with poor business models to companies with more workable ones. He highlighted the rapid and continuous change that takes place in the computer and network markets.

He further observed that many bandwidth intensive "killer apps" have failed to catch on. These range from Vint Cerf's somewhat humorous idea of a networked refrigerator, which orders groceries when they get low, to various forms of customized remote sensing and teleconferencing. He suggested, however, that if tele-immersion did catch on, as Lanier predicts it will, it would be a major force in driving bandwidth demand.

Powell concluded by pointing out that Microsoft is one of the few companies that has consistently managed to navigate the rapidly changing technology environment, and that

Microsoft's actions and decisions would be likely to play a large role in the future of network development.

Charles Weiss, Jr. (Georgetown University) underscored the difficulty of balancing security against liberty; describing it as a tough, multidimensional problem. He pointed out that in 19th century Europe, control of communications was considered an issue of national sovereignty. He said that pursuing both security and liberty meant pursuing two objectives that are to some degree contradictory. Ideally, he said, we would like unfettered, anonymous access for people that we like (e.g. democracy advocates in China), but very limited and accountable access for people we do not like (e.g. terrorists).

Weiss also stressed that issues of international equity have not been adequately addressed. He posed this as both an economic and a security issue. He said that we lose benefits by not having all people connected to the network, both because of lost opportunities for trade and because a more diverse idea base fosters innovation. On the other hand, it would cost money to connect these people – money that they generally do not have. On the security side, he pointed out that a major motivation for terrorists is a sense that they are working on behalf of disenfranchised people and nations. Empowering those left out of globalization by facilitating their connection to the network would work to undercut this basis of terrorism.

Concluding Remarks

John Steinbruner (University of Maryland) concluded the workshop by reflecting on some non-market aspects of network development related to his field of national and international security. He observed that social change had been unable to keep pace with the sustained and rapid improvement in the cost of information processing, storage and transmission. He speculated that such change would continue for the foreseeable future and would continue to raise new social issues.

Steinbruner went on to say that a socially important class of applications would relate to protective monitoring. Such monitoring would likely be applied to environmental variables, particularly as they relate to global environmental problems like climate change. Other network intensive monitoring applications might be aimed at preventing the deliberate misuse of technology, particularly biotechnology. It might also be used directly or indirectly to monitor individuals, such as suspected terrorists. He pointed out these applications have a public goods nature and are unlikely to arise from market forces alone.

He said that the security implications of next generation networks would likely require revision of the norms which constitute the social contract and would require a great deal of new legal specification. He speculated that these non-market changes might have as large an impact on people's lives as the market based changes.