

Testimony of

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Executive Summary

What innovative activity is likely if the US government commits to no regulatory intervention in Internet access markets? What actions would one expect from unfettered carriers?

These questions are inherently challenging to answer. Careful historical research cannot uncover a single factor that alone explains why firms behave the way they do. In addition, until recently regulatory restraints prevented all carriers from taking certain actions, so there is little experience from which to forecast how they would behave in the absence of such restraint.

Unfettered carriers have incentives to become less transparent. Acting on mixed incentives, carriers also have incentives to blocking some content of rivals or give low priority to the traffic from erstwhile competitors. A mixed incentive arises when the commercial activities in one line of business – for example, broadband service – affects the prospects in another – for example, IP telephony, video entertainment. Many factors also push carriers towards more transparency, such as standardization processes. Other factors reduce a carrier's incentives to block traffic, such as user tendencies to substitute to alternative carriers. The testimony identifies these opposing forces, identifies several open questions for the future, and shows why these questions remain open at this time.

The commercial Internet has been quite innovative for fifteen years. The rate of innovation may decline if there is any movement towards less transparency and more blocking and more discrimination of traffic. Such behavior could raise transaction costs, which have been low historically, and have played an important role in making the commercial Internet so innovative. Transactions costs were low, in part, because of conditions in the Internet access market. Any firm could enter without worrying about problems interconnecting with any other firm, and, largely, without worrying about gaining the permission of any gateway firms. Entry and experimentation were easier because firms could not holdup one another, even when they had opposing commercial interests.

The economic stakes behind these issues are high. Much economic growth and productivity advance arises from the set of innovative actions linked to the deployment and adoption of broadband and the building of applications that interact with it. Policy should favor faster deployment and use, and avoid risks that potential slow it down.

1. The Internet access market has been very innovative for fifteen years. How would behavior change if regulatory oversight were removed?

What innovative activity is likely in the absence of regulatory intervention in Internet access markets? Will the industry remain as innovative? These questions are inherently challenging to answer. Slogans will not capture the nuances behind innovative conduct, and careful historical research cannot uncover a single factor that alone explains how the commercial Internet became so innovative in the last fifteen years. Some part of the innovation in the Internet would have arisen under any circumstances and with any degree of governance, while some would not have.

This testimony argues that low transaction costs played an important role in making the Internet so innovative. That is, the transaction costs behind innovation were low. That does not necessarily mean the monetary costs of innovation were low. Taking an innovative service to mass markets can be expensive, and it usually is. Rather, low transactions costs means the hassles behind exploring and developing innovative activities were low. In the Internet entrepreneurs and intrepid incumbents faced minimal delays from negotiating with other firms, and did not have to clear many hurdles before undertaking their economic experiments in the market place. The technical details were available to anyone and without restrictions on their use, whether an established firm liked it or not.

Transactions costs were low, in part, because of conditions in the Internet access market. Any firm could enter without worrying about interconnecting with any other firm, without worrying about gaining the permission of the carriers of data. Entry and experimentation were easier because firms could not holdup one another, even when they had opposing commercial interests.

The connection between low transaction costs, innovation, and the conditions in the Internet access market will frame a set of questions. What type of innovative conduct would one expect in the absence of regulatory restraints on the behavior of Internet access providers? The testimony will argue that more blocking and less transparency will likely arise in some settings, and this could slow down the rate of innovation from entrepreneurs.

This focus arises from many changes in the last decade. The Internet today obviously differs from the setting that gave birth to it almost two decades ago. Certainly it is bigger and more varied in

use, involves many more commercial participants, and generate a much larger fraction of GDP. This testimony focuses principally on only one aspect that has changed, the concentration of firms providing access services. Concentration raises concerns about the presence of market power in retail markets. It also raises concerns about carriers who possess negotiating leverage with either affiliated or unaffiliated business partners, and who shape innovative behavior by acting as gatekeepers.

Advocating a particular regulatory approach *is not* the primary purpose of this testimony. Rather, it concentrates on what innovative activity one would expect in the absence of government intervention, namely, in the face no negotiating restraint on less transparency, more blocking and more discrimination of traffic from rivals. Recent proposals to end all FCC intervention motivate this question. This would be a change in the regulatory regime governing Internet access, motivating an examination about what one might expect, and why.

Government policy has played a role in access markets ever since the inception of the commercial Internet. Congress played a key role, for example, when it passed the amendment to the National Science Foundation's charter, ending any disputes about who could send traffic over the newly privatized backbone – namely, any commercial firm, not only IBM's and subsidiaries, who operated the NSFNET. The NSF also played a key role with its comparatively smart design for the nation's Internet backbone and interconnection points, a platform that enabled new entry of access and backbone firms, upon which industry subsequently experimented, producing even greater efficiencies. The Department of Justice also played a key role, preventing World Com from owning too much Internet backbone – which would have resulted from its merger with MCI and then Sprint. Lack of concentration prevented monopolization of a key asset, and, unlike many other countries in the world, the US today continues to enjoy competitive supply of backbone services.

The FCC has played a key role in access policy, albeit that role has evolved over time. Nonetheless, one could characterize this history under a unifying theme: the presence of oversight, coupled with only occasional action. At the beginning of the commercial Internet the FCC maintained the comparatively developed regulatory framework, a regime known as Computer II, and applied it to the commercial Internet. This regime reduced transactions costs for dial-up access entrepreneurs, and partly explains why the United States had such a competitive access industry during the first wave of investment in the Internet. Later the FCC has also negotiated a series of conditions for mergers (e.g., the

AT&T/Bell South merger) that shaped Internet access market. In more recent times the FCC has maintained a set of guidelines oriented towards keeping the Internet open – i.e., the four freedoms. In the few instances when ISPs greatly varied from those guidelines the FCC took swift and decisive action (e.g., Madison River Communications).

The testimony follows this outline: The next section discusses how the actions of many firms support innovation in the commercial Internet. The third section discusses the role of transparency in reducing transactions costs for innovation. The fourth section discusses the role of platforms for the Internet innovation. The fifth section examines the origins of broadband concentration. The sixth and seventh sections consider what transparency and blocking behavior and discriminatory routing might emerge in the absence of regulatory restraint. The last section considers the relationship between economic growth and the type of innovative actions linked to the diffusion of broadband.

A little truth in advertising: The testimony draws heavily from prior writing, particularly those devoted to understanding factors that contribute to developing a healthy market structure for innovation. These are listed at the end of testimony. In addition, this testimony focuses on trying to understand what will occur in absence of any government intervention to encourage transparency or prevent blocking of legitimate content. While this analysis also has implications for discriminatory routing, that last topic also involves many additional aspects which this testimony does not address.

2. Innovation did not arise from one source alone. It arose from the accumulated and collective actions of the industry's many participants.

The commercial Internet differs from any network that came before it. It has a unique market structure and the structure of fostered an innovative ecosystem. Broadband carrier play an essential role, but it is important to recognize that they are but one of many participants in the network. Backbone firms, software vendors, and Internet hosting companies are equally important, as are many application developers, as are sites developing electronic commerce and advertising-supported media. Collectively all these participants have developed a range of innovative services.

The system has been self-reinforcing in the last decade and a half. Participants developed their services in anticipation of better infrastructure on which to run it, sending their applications across broadband lines that behave the same way everywhere. Carriers built that capacity in anticipation of applications that generated increasing user demand for the Internet. Many participants, both firms and users were satisfied with outcomes.

Many participants made these investments with business partners, and many did not coordinate those investments by contract. That is because, in comparison to other major networks, the structure of the commercial Internet has a unique feature, the substitution of open institutions for commercial contracts at several crucial points (more below).

While commercial contracts govern many facets of behavior between direct partners – for example, between an ISP and a backbone firm, or between a web site and a caching firm – no direct contract governs the relationship between millions of global web sites and hundreds of worldwide ISPs. In general, all have agreed to be compatible with the same computing software protocols, allowing for seamless movement of data. Altogether this allows tens of millions of users to draw data from millions of sources, achieving a scale of traffic that makes everyone better off.

Almost by definition, if a large firm has unfettered discretion, it is a natural ask about how they will use it, and whether they will make contracts with content providers with whom they affiliate, and, specifically, how they will treat the millions of unaffiliated suppliers in the Internet.

Said concretely, a broadband carrier with market power potentially faces what is often called “mixed incentives.” A mixed incentive arises when the commercial incentive to invest in activities in one line of business – broadband services, say – affects the prospects in another – IP telephony, video entertainment, say. That is, improvement in the carrying data has consequences for another line of business owned and managed by the same firm. Until recently all carriers were forbidden from acting on mixed incentives, asking what should be expected in the absence of restraints is necessarily a speculative question.

The question touches topics that tend to generate very heated debate, and the heat can be easily illustrated with a series of colloquial questions. Just ask your sister what they would think if her broadband carrier slowed Skype and told all users they had to go through an approved vendor of IP

telephony? Would your neighbor be frustrated if they could not go to Hulu, but instead had to go to the approved TV distributor who worked with the access provider for the neighborhood?

None of that has happened. There are several explanations for why. In many cases it was not in the competitive interest of a carrier to consider such an action. In other cases it was not even an option. Until the spring of 2010, until a court ruled, every actor in the market presumed it was forbidden by broad regulatory action. In addition, at various times in the last decade many major carriers agreed not to act on their mixed incentives in order to gain regulatory approval.

This discussion has two implications. First, questions about innovation cannot be understood solely as a technical or engineering-oriented phenomenon. In other words, the behavior of commercial firms should be understood in economic terms, namely, in terms of a firm's line of business – a firm's contracts, its business conduct, and the incentives it faces in light of the market conditions in which it resides.

Second, this is what economics calls a situation with many complements in supply. That is, innovation does not result solely from one component or one vendor. Innovation results from the interaction and interoperable functioning of many, in this case, software firms, server-side electronic commerce firms, broadband firms, hosting firms, or any number of other participants in the commercial Internet. Hence, the behavior of one shapes the behavior of many.

3. The transparency of carriers is one important element in reducing the transaction costs of innovating, especially by entrepreneurs.

In the commercial Internet efficient delivery of services depends on advanced agreement about how their business activities interrelate. Transactions cost play an important role in such activity because it shapes the design and operation of the value chain. Transaction cost refers to two distinct areas of cost affiliated with two related activities. First, it refers to the cost of designing and setting up procedures to deliver a new service. Second, it refers to the cost of executing a set of proscribed processes and procedures of delivering a service to a user.

Almost by definition, transaction cost (in both senses) plays an important role in innovation because virtually every valuable activity on the Internet involves multiple participants – hardware vendors, software vendors, non-commercial participants, and users. Transactions cost arise whenever a participant tries to alter processes that multiple parties perform.

Transparent processes are those in which participants know what change is imminent. Participants in transparent processes inform others openly and vocally. In other words, participants' actions make it known—sometimes well in advance—when their changes will diminish or enhance the returns on others' innovative investments. In addition, in transparent processes participants can acquire information, and use that without restriction or limitation (e.g., they do not have to keep it secret).

In the pre-commercial era virtually all activity was transparent in principle (albeit, not necessarily always in practice). That is, since most infrastructure design and application development took place under the broad sponsorship of either DARPA or NSF, there was an understanding of shared purpose, and expectation that researchers would let others know about their experiments. In addition, and perhaps more mundane in detail, there was a process for sharing information using the system based on Request For Comment (RFC), as sponsored by the Internet Engineering Task Force (IETF) from the late 1980s onward, and, more informally, by its predecessors in the academic community.

The IETF's processes still operate today, though today it operates on a vastly larger scale. In addition, today's Internet involves much more than just the IETF's activities. The commercial Internet inherited the norms and practices of the commercial computing and telecommunications markets, to be sure, but many more institutions presently have a role. For example, the IEEE committee 802 plays an important role in designing Ethernet and many extensions, such as WiFi. So does the World Wide Web Consortium, and so does the consortia that support Linux and Apache. So too does Microsoft's support staff for Internet Explorer or Windows 7, as does the support staff for developers making apps for Apple's iPhone and iPad, as well as the support staff for many Cisco switches and routers.

In other words, in no way should any observer take transparency for granted. In many setting suppliers share a norm of transparency as a matter of principle and practice, and sometimes not. It is a choice, often a strategic choice.

Transparency arises in the Internet partly because it plays an important role in standards processes. Standards processes play an important role in shaping the transaction cost of setting up new processes and protocols, supporting development of new services. Many participants in standards processes participate because they believe transparency has great importance in interdependent value chains. Other firms will not make long-term investments if they cannot understand at a fine level of detail how their software must interact with another firm's software or hardware.

As a result of transparent standards processes, here is one economic archetype for what happens after the issuance of a standard: Interested parties monitor the designs (because they can), and know that their near rivals do the same (because the data are available to anyone). Then all those parties plan to match each other along the dimension of the standard and differentiate along the dimensions in which each has competitive advantage (such as cost, features, brand, installed base, or distribution channel). Competition ensues once the standard is upgraded from its Beta to an endorsed and official standard.

4. Platform leaders adopt a variety of approaches to transparency. The non-transparency practices of some platform leaders do not provide a model for carrier conduct.

Several other factors play a role in shaping transaction cost. Next consider the role of platforms.

A computing platform is a reconfigurable base of compatible components on which developers build applications. Platforms are most readily identified with their technical standards, i.e., engineering specifications for compatible hardware and software. In other words, there is a Windows platform, a Linux platform, an iPhone platform, and so on.

Platforms have become a central feature of the commercial Internet because use of Internet-related services requires successful execution of a set of technically interrelated activities coming from many independent firms. The failure or reduction in performance of any of these activities can lead to inferior outcomes. Hence, well-designed platforms hold one of the keys to successful innovation.

Strategies and tactics for designing and deploying platforms played an important role in computing before the commercialization of the Internet. For a variety of reasons many firms organized their strategic approach for commercial opportunities on the Internet with similar outlook. There is, nonetheless, considerable variance in the opinion among leading executives about the best practices for managing platforms. This variance has been present ever since the Internet commercialized. Competition between firms with distinct views about platforms has been one of the hallmarks of Internet innovativeness.

The symptoms of this variance are still apparent today. There are proprietary and non-proprietary platforms, all of which interoperate to provide services and some of which compete at the same time. The list of platforms today is long. Many prominent platforms are involved in providing service on to Internet users. These include Microsoft (Internet Explorer, Xbox live, Bing), Apple (iPad, iPhone, app store), Intel (Centrino), Google (Search, AdSense, AdWords), Cisco (switching, routers), Research in Motion (Blackberry), Yahoo! (list-based search, news, mail), Oracle (enterprise databases), E-Bay (auctions), Amazon (electronic retailing, CDNs), as well as many others.

If we allow for a broad definition of platforms, then non-proprietary activities also fall within this umbrella. In that case, platforms include important examples such as Linux (operating systems), Apache (web server), the World Wide Web (HTML, URL, HTTP), Firefox (browsers), Wikipedia (open encyclopedia), Webkit (browser rendering engines), as well as many others.

The rise of platforms on the Internet is a source of both celebration and consternation. Platforms perform functions that firms and/or users value. Their presence usually suggests that some firms/users are better off with them than without. At the same time, successful and dominant platform leaders possess market power with consumers, negotiating leverage with business partners, and some possess non-transparent processes. That will raise questions about whether those firms use their discretion in ways that lead to more innovation, or whether mixed incentives get in the way of pursuing all innovations.

More aphoristically, the Internet has been called a “network of networks” since it first began to diffuse out of its non-commercial origins. Yet, distilling the Internet to that aphorism is misleading about its structure today; it does not reflect how commercial behavior shaped the evolution of how the

Internet gets used in the last decade and a half, and it does not reflect the factors that shape the evolution of transactions cost on the Internet. Leading firms and their business partners view the commercial Internet through the same lens they view activities in the rest of computing. For them, the commercial Internet is a “network of platforms.”

Here is one economic archetype for how the presence of platforms shapes transparency: A platform leader, such as Apple, will announce a coming change to a product, but leave out the details, making it clear that these will come later. Interested parties, such as a developer, monitor the announcements, but cannot make their designs until all details are revealed. Knowing this, the platform leader withholds information until it is ready to support those who have shown interest, and it has achieved its own strategic goals. Then the details are released, and peripheral makers and application makers differentiate along the dimensions in which each has competitive advantage (such as cost, features, brand, installed base, or distribution channel). Competition ensues and, in successful cases, the platform leaders sell a lot of product.

Platform leaders also often designate some firms as special partners. In that instance, there are strong economic incentives to support direct partners with more transparency than others – that is, to provide partners with more information about the operation of the platform, the recent directions of change, the long term plans for change, and so on. The incentives are strong because the platform provider directly sees the benefit in their own economic prosperity if they support their business partners so directly.

This emergence of platforms has three implications for understanding the role of transparency.

First, almost by definition, managing the release of information is central to the behavior of the platform leadership. Lack of transparency characterizes this approach. Indeed, for this reason, there is ongoing tension within industry over how transparent one business partner is with another.

Second, if carriers adopted similar practices, then in the absence of compelling competitive reasons, carriers would have incentives to be transparent with some suppliers and affiliated business partners, but not all participants. Related, in the absence of compelling motive, one would expect the unaffiliated business partners, small business with limited niche marketing ambition, entrepreneurs without status, and many other participants, to not be granted access to the same level of information.

Third, this is a world where many platform firms face mixed incentives, that is, incentives to manage their financial interest in multiple lines of business. If a carrier adopted platform leadership practices, any carrier aligned with a platform firm would also, therefore, face similar mixed incentives in a negotiation over the conduct of partnership.

It is possible to characterize transparency at a platform in more detail, and at the cost of belabouring the point, a bit of detail illustrates the variety. There are a variety of forms for governing platforms, but most share these four functions:

- Designing a standard bundle of technical implementations that others used in their applications;
- Operating processes to alter those standards and inform others about those alterations;
- Establishing targets and roadmaps to coordinate developer and user investments;
- Providing tools and alternative forms of assistance to others who wanted to build applications using their technical standards.

It is possible to do all four with transparent process, and it is possible to do all four with processes that are not transparent. Perhaps one historical example can illustrate their importance.

There was no profit-oriented organization providing platform leadership for the commercial Internet in mid 1995, while there was a profit-oriented set of leaders for the PC. Two commercial firms in the PC market, Microsoft and Intel, retained and guarded their right to make unilateral decisions about the pervasive standards embedded within the platform. Microsoft's processes were proprietary. In contrast, the Internet at the time employed a consensus process for determining the design of pervasive standards and protocols, as embedded in the processes at the IETF. The predominant processes employed documented standards and did not restrict access to these documents or their use by any participant in the Internet.

This difference shaped the diffusion of new technology in the Internet in the mid 1990s. Tim Berners-Lee was able to invent the World Wide Web, and despite actively competing with the IETF for authority to guide and govern standards development for many important applications, he was able to access information from the IETF without any restriction. In contrast, during the earliest moments of the web, the World Wide Web Consortium found itself in conflict with Microsoft and Netscape and their

coalition of business partners for control over the direction of change in html and related tools for the web, as the commercial firms tried to “fork” development of the code to support their own interests. Fortunately for the history of the World Wide Web, and for global innovation more generally, Berners-Lee prevailed in establishing his transparent organization, supporting an explosive growth of a body of *compatible and interoperable* applications for the Web.

This historical example illustrates a broad point. Transparency by key actors has played an important role in the commercial Internet, allowing participants to engage in interoperable activities, and potentially with low transactions costs. A regulatory regime consistent with such transparency is, therefore, reducing transactions costs for entrepreneurs and encouraging innovation more broadly.

5. Concentration in the supply of broadband raises potential concerns about mixed incentives.

The deployment and adoption of broadband by US households is both a cause for both celebration and concern. Broadband’s position reflects the ascendancy of a superior product and service replacing dial-up, which is an unambiguous economic improvement over the near past. After all, a decade ago fewer than 5% of US households had access to broadband. Today it is close to 70%. Many of the firms who supply broadband succeeded in deploying the technology in a financially successful business. Today many of these firms enjoy enviable gross margins in a healthy business.

Why is it a source of consternation? The dominance of broadband raises concerns about the presence of market power, negotiating leverage, mixed incentives, and the way those might distort the incentives to innovate by other participants in the Internet.

There is a traditional argument about the potential distortions, and frankly, while it may matter, there are also reasons to think it represents the less salient concern. The traditional argument is as follows: At a broad level, while society benefits from giving incentives to firms to create superior products and services, rewarding firms with monopoly power leads to high prices for their services while

their provide those services. Firms with market power may face weaker incentives to innovate than firms in any more competitive market structure. Fear of cannibalization and excessive institutional inertia around existing technological paradigms are the typical concerns, observed many times in many case studies. Both lead a firm insulated from competitive pressure to introduce new innovation more slowly (or not at all) than would occur in a competitive setting.

While this may be a source of concern, this testimony will largely focus its attention elsewhere, on the factors that shape innovative activity – namely, the interplay between market power, negotiations, and mixed incentives. What does that mean specifically here? In the last ten years the ascendancy and diffusion of broadband interacted with a range of applications that blossomed, and in many instances the efforts and investments of broadband carriers played a positive role in that blossoming.

This means, generally speaking, four types of rather different uses share the same capacity: (1) browsing and e-mail, which tend to employ low bandwidth and tolerate delay; (2) video downloading, which can employ high bandwidth and can tolerate some delay; (3) voice-over IP and video-talk, which tend to employ high bandwidth and whose quality declines with delay; and (4) peer-to-peer applications, which tend to use high bandwidth for sustained periods of time, and can tolerate delay, but, in some applications (*e.g.*, Bit-Torrent) can impose delay on others.

While that diversity of applications wrings additional productivity out of the same capital supporting the network, it comes with a potential drawback: the use of one application can affect the productivity of another. In part this is due to capacity constraints at bottleneck positions in the network, or there are few backbone pathways to support browsing in isolated positions. Contributing to these constraints are geographically localized negative externalities – *e.g.*, many modern peer-to-peer applications employ all available bandwidth, diminishing the quality of other applications in the same cable network that cannot tolerate delay. In any case, improving efficiency requires some management of competing interests and users.

The causes for concern arise directly from this market structure. The National Broadband Plan (NBP) makes clear that many wireline broadband firms operate with very few competitors. Indeed, most households employ service from only one of two large firms – 78% have choices among two wireline

providers, 13% have one, and 5% have none. Only 4% of the US population live in a location with three or more suppliers. Most large wireline broadband providers effectively face competition from only one other large wireline firm.

The NBP offers evidence that this configuration arose as a consequence of the distribution of income and density across the country, which further suggests that these traits of the market will not likely change over time. That supports the concern that the absence of competitive checks on market power in local markets may be a persistent feature of the network, which further motivates a question about whether market power can shape the transactions cost of others.

One open question, also framed by the NBP, is whether wireless provision provides a substitute for wireline networks for a majority of households. It offers evidence that 98% of the population lives in census tracts with at least one 3G providers. Of these, 77% live in tracts with three providers, 12% have two, 9% have one.

Does this provide a competitive check? If wireless is a perfect substitute for wireline then this structure alleviates many competitive concerns, particularly urban areas. If 3G services offer differentiated services, then the existing structure alleviates few of the competitive concerns. That is, the open question is whether wireless platforms support a set of applications that wireline largely does not offer and visa versa.

Due to the mobility of wireless services and its very limited capacity constraints, almost by definition, wireline and wireless are not perfect substitutes in demand today. So the open question is whether they will be, and if so, how fast that will occur in mass market. That is, will many users drop their wireline use in favour of their wireless Internet use? There is considerable speculation among observers about this question. The answer clearly depends on many factors, such as how fast new spectrum becomes available, who will offer it, how users value different applications in new devices, what uses will be dominant, and whether growth in demand will exceed increases in supply. In addition, with the general growth in demand for Internet services across both wireline and wireless applications, it is virtually impossible to make any prediction about their substitutability in a few years with any confidence.

6. What would happen to transparency in the absence of regulatory oversight? Would carriers continue to act in transparent ways?

At present the actions of access providers is governed by rather light norms of transparency, such as the legal limitations inherent in service contracts with users. In the era of competitive provision of dial-up access this was of little concern. Most providers inherited the legacy norms and practices of the pre-commercial Internet, and users had many options to switch dial-up providers without changing local telephone companies (due to Computer II). It is a bit of an exaggeration, but not far from the truth, that competitive forces prevented lack of transparency, and there was little reason for concern.

This situation motivates the open question: what would happen in the absence of regulatory intervention about transparency? Many of the largest broadband carriers in the US agreed to abide by the FCC's "four freedoms" as conditions for accepting mergers, and despite the ambiguity of those principles, over the last half decade these seemed to preclude many actions. As noted, in some cases competitive pressure also must have pushed in that direction. In short, that means there is no historical precedent for observing such unfettered choice over behavior.

While the answer is necessarily speculative, it is possible to speculate from many existing practices in the present regulatory regime, informed by reasoning about economic incentives.

To begin, communication between engineers in firms is quite common, and so is access to the same set of engineering knowledge about how the network operates. In the recent past it was quite difficult for any carrier to do anything novel (from an engineering level) without others knowing what was being done, knowing about it as it was being done, or finding out about it eventually. Regular meetings within standards committees reinforced these tendencies. Nonetheless, lack of transparency can still emerge in spite of such institutions. It is quite common among wireless handset devices today, for example. Apple follows a very weak transparency norm, as does Microsoft. Both release information periodically, at strategic intervals, as part of their general approach to platform leadership.

Lack of transparency played a role in Comcast's unilateral declaration to throttle P2P applications on its lines with resets, as yet another example. There were many facets to this event, and I will focus on aspects that illustrate general points about the transparency of network management practices, as well as the transparency of other facets of firm conduct.

As it played out, one striking feature about this event was the willingness of all parties to act without telling anyone in advance what was happening. P2P users acted as if they could run any application on any time of day, irrespective of its consequences for others, even when it degraded the quality of service for neighbors during peak-load time periods. Comcast acted as if it had full discretion to manage its data over its facilities without informing other suppliers of applications on the Internet, or informing its own customers. It also acted as if it had no obligation to inform the other users with whom Comcast's customers were communicating and sharing files. When confronted directly and in public, the firm even denied certain actions that others could verify, suggesting there was even a lack of transparency inside the organization about its own policies and practices.

This feature is even more striking because the carrier had a well understood goal, bringing some efficiency to the use of the assets shared by all users of Comcast's network. The economics were straightforward on one level. Management could internalize the externality one user imposes on others—managing traffic for many users' general benefit. That is, P2P applications, like BitTorrent, can impose negative externalities on other users, particularly in cable architectures during peak-load time periods. Hence, on one level, Comcast's goals did not depart from widely accepted principles – namely, a firm should try to manage their assets to reduce cost and enhance efficient use for a customer base. In addition, a firm should try to manage the quality of the experience for its own customer base, and make choices to trade-off one its own customer's quality with another.

Why not give Comcast unfettered discretion to manage the situation then? There is at least one additional transaction cost to consider, that between Comcast and other providers of applications, namely, application providers other than BitTorrent. That includes innovative entrepreneurs with plans to develop further applications, and it might include those who are not in the market at present, but might be in the near term. In addition, it might include other users, those who are not direct Comcast customers, but do communicate with Comcast customers, and anticipate certain operational practices.

Simply stated, transparency affects many other Internet participants. Comcast's transparency shapes the activities of more than merely the users of BitTorrent and others in the neighborhood where the activity takes place. It shapes the transaction costs for many other suppliers of applications.

Unfettered discretion for Comcast could raise the transaction cost to many other application developers, particularly if Comcast retains the right to remain non-transparent about its management policies. If Comcasts' policies about network management further remain shrouded, then a future entrant cannot develop applications without knowing what to expect, when it will change, and how it might be altered in the future. That is a high transactions cost for setting up innovative applications.

In sum, Comcast's behavior had many less appealing aspects, such as its lack of transparency, as well as its virtually one-sided negotiating stance with all other application providers. It also illustrates a lack of clear statements about its own actions in advance or even while they were taking place.

It is not my goal to fully analyze the Comcast/Bit-Torrent events, and it is important to acknowledge that Comcast pledged to alter its practices after these events. I raised this example with a narrow purpose in mind, to illustrate the role of transparency in broadband access and innovation. More to the point, this example raises at least two general possibilities:

First, what if each of the major carriers in the United States used their discretion to pursue quite distinct approaches to managing their broadband operations, and did not make those practices transparent to other application developers or other users? That would raise transactions cost for many other providers of new innovative applications, as each new change worked its way through a maze of a variety of technical issues, each different in different carrier's network, each subject to change without notice. That would take the United States closer to a balkanized commercial Internet, and it would make entrepreneurship much harder, as well as application development for the whole country much harder.

Second, and perhaps most importantly, transparency does not come for free. Transparency about management practices can be costly to those who are required to be transparent. That should be said with some sympathy for those who must provide it. Management must notify others, communicate with those who have questions, and make effort to make sure the right participants address the right concerns. Does a firm have proper incentives to incur the costs affiliated with being transparent? In

other words, if management were given discretion, would they make decisions about transparency that aided collective invention? The answer is necessarily speculative.

A few key factors seem salient. On the one hand, programmers and engineers spend many parts of their professional lives in professional societies and standards committees. Firms want to provide services with high efficacy for their users. Cooperating with such standards committees is essential for that goal. Hence, there are some down-to-earth and straightforward economic forces pushing firms to be partially transparent, especially about technical matters.

I conjecture, however, that if firm management could push back they would have incentives to do so, particularly in the presence of market power and negotiations with business partners. I would conjecture that those with market power face incentives to not incur the cost of transparency that fully internalizes the gains that others reap from such transparency. The gains are wide and diffuse, outside the range of feasible commercial contracts by a single firm. Providing information yields gains for others than a firm simply does not internalize. In part incentives are low because a firm resists providing information to potential competitors, especially if a firm has stated their intention to become a rival.

By similar reasoning, there is also reason to be concerned if broadband firms get into commercial relationships with platform leaders.

In short, economic reasoning suggests that broadband firms with market power face weak economic incentives to notify others about changes to their management practices, or provide technical guidance about the future direction of change, and so on. Yet, the gains from lowering of transaction cost among many application and software providers exceed the cost of making the notification due to its importance to all the participants in the Internet.

7. What would happen to blocking of traffic and discriminatory routing in the absence of regulatory oversight? How would carriers behave?

In a network with a high degree of technical interrelatedness, there are general gains to all parties from bringing routines into business processes and activities, which lowers transaction cost.

Adopting such routines may require negotiation between multiple parties, and it requires uniform conformance with widely accepted protocols for exchanging traffic.

At present provider actions are governed by a rather well known norm about blocking and routing. This has been enforced in the last half decade by the FCC declaration about the “four freedoms” – i.e., all users shall have access to all legitimate Internet traffic, and should treat all traffic equally, subject to standard management practices. It has also been weakly enforced by user and application developer complaints about access provider services – e.g., the complaints from a user of Bit-Torrent set off the investigation into Comcast’s throttling of traffic with resets.

This situation motivates the open question: what would happen in the absence of regulatory intervention about blocking and discriminatory routing? What actions would one expect from a different regulatory regime than the one governing the system until now, one with totally unfettered carriers?

Once again, because a variety of carriers face a variety of situations across the country, there is nuance to the answer. To focus on the core issue, initially consider the use of blocking of traffic by a carrier for the purposes of generating negotiating leverage with others. Such negotiation could mimic what has become more common recently in cases that stretch from infrastructure to application, such as Madison River’s attempt to block a competitive supplier of IP telephone services, such as Cogent’s negotiations with Sprint for a peering relationship, such as Comcast’s recent negotiations with Level3, such as Intel’s negotiations over Centrino with Dell, and, such as Orbitz’ negotiations with American Airlines.

Why focus on negotiations? These are inherent in the operations of the Internet.

The very thing that makes the Internet economically successful—the accumulation of innovation that supports a wide set of applications for many participants, including entrepreneurs—gives rise to conditions that make it harder to negotiate around the uncertainty. More to the point, while the value chain probably will look similar next month, only a naïve fool expects little change over several years, namely, the time periods over which many innovative investments reap their returns. In short, the economic dynamism of the system gives firms the opportunity to negotiate, and one should expect them to do so, and vigorously.

Such negotiation offers no guarantee of success. Many outcomes are possible. Occasionally both parties want an agreement, but just as often one party will desire it more than the other. Alternatively, one party may have an ability to generate a better deal than the other, and, thus, perceives moments of negotiation as an opportunity to generate a strategic advance or gain additional revenue. As a general rule, the structure of bargaining sometimes can work out to a Goldilocks equilibrium that is just right—not too hot and not too cold—but more often it does not. One firm gets too powerful or another prominent bargainer loses its way.

Most interesting for policy, such negotiations cannot cover innovation when the relevant party may not even exist yet – if they will be entrepreneurial start-ups – and, thus, lack representation in even a basic form, such as trade-group or related commercial organization. For example, how would any broadband firm have negotiated with Mark Zuckerberg when he was a junior in college and visa versa? At the outset his entrepreneurial business depended critically on the availability of transparent processes, not any negotiation.

That is an especially salient issue in the Internet. That is, decisions today shape entrepreneurship tomorrow, but few speak up for those future interests, and negotiation breakdowns that shape future entrepreneurs impose high costs on society. Said another way, there is policy interest in protecting the conditions that support later entry of entrepreneurs, even though few today are there to keep established firms from raising transaction cost on later participants in the value chain.

For purposes of this discussion let me define one term-of-art. In the extreme, negotiation can become one-sided, with one party asking for something while the other refuses to provide it or only agrees to it at a high cost. The simplest manifestation of this extreme situation arises when the more powerful party declares a “take-it-or-leave-it” offer, leaving other parties no choice but one that favors the powerful party, or “refuses to deal”, leaving other parties with no choice at all, if the more powerful party perceives that no deal is in their interest.

The absence of one-sided bargaining and the absence of refusal-to-deal is a sign of well-functioning bargaining environment, while the presence of one-sided bargaining is a sign of potential illness, which might have adverse consequences that might spread. The key question is whether the less powerful parties have access to reasonable alternatives.

As illustration, consider a mild case that did not involve carriers, the disagreement Intel had with Dell over including WiFi in the standard laptop design. Intel negotiated a series of agreements with numerous OEMs about putting the Intel Inside and Centrino brands on their products to signal to users that the laptop includes a Wi-Fi compatible motherboard and antennae (compatible with designs approved by Intel). In addition, Intel often included compensation for the marketing expenses of putting the Intel copyrighted material inside an advertisement or marketing campaign for a PC.

This example illustrates that breakdowns can occur for many reasons. Initially Dell refused to carry the Centrino branded systems, preferring its own branded solutions, and, accordingly, did not receive the compensation as quid pro quo. Both parties went on their merry way for many years. Dell continued to carry both Intel products, but after that incident began to more prominently distribute designs with AMD chips. At the same time Intel reached deals with every other major OEM, and succeeded in making Centrino a feature of the majority of notebooks in use.

What else does this example illustrate? First, that Intel's market power had its limits with Dell. It eventually reached a point in its negotiation with Dell where Intel gave Dell a take-it-or-leave-it offer and, indeed, Dell chose to leave it (unlike virtually everyone else in the industry). Second, as long as Dell had plenty of other options, the losses to Dell or society at large were not large. Indeed, there might have been gains, since Dell's choices translated into more buyer options beyond the Centrino.

The presence of choices shaped how the negotiations proceeded. Users had choice among laptop suppliers. That fostered incentives at Dell to support their own brand. The largest laptop assembler in the world, Dell, had a choice among suppliers of Microprocessors, allowing it to push back against the largest provider, Intel. It was not many choices and options, but it was enough to prevent one firm from having its way.

More broadly, many alternatives at a key place in the value chain help users and society at large. In that case there are fewer justifications for policy concerns about negotiations between participants. When there are plenty options, if users are unhappy with a supplier, or vendors are unhappy with a business partner, they switch.

In the presence of few market options and concentrated supply, however, policy concerns are heightened. As noted earlier, it is the limited supply of wireline suppliers in many parts of the country that heightens these policy concerns.

Take-it-or-leave-it or refusal-to-deal can have some serious additional consequences when embedded in a network. Let me illustrate with one proposal. Some years ago there was a proposal to let all Internet participants simply negotiate compensation between them, so that Google/Yahoo/Disney would negotiate with Comcast/Time-Warner/Verizon, and every other possible combination. Intel's example suggests the obvious problem with such a proposal: it leaves out the concerns of users. Imagine the uproar among Internet users in the locations where such negotiations failed to come to resolution and no other close substitutes existed. It would be far worse than the brief uproar among Yankee fans who could not get local baseball telecasts due to a negotiation breakdown between Major Leagues Baseball, the Yankees, and a local cable provider. The most recent fight between Fox and cable firms is yet another example.

The concerns about what would happen in the presence of frequent negotiation lead to a related set of concerns about the absence of restriction on blocking and discriminatory routing. It is quite common in many parts of the economy for partner firms to refuse to deal with one another as a negotiating tactic. For the most part, this tactic has not been a part of Internet practice, but there is a concern if it is slowly becoming one. Moreover, once the industry begins to go down this path, it is clear that it would be far worse for an entrepreneurial firm or small start up.

I would conjecture that a muddled situation seems much most likely, with occasional deals here and occasional breakdowns there, some sites blocked, some not, some traffic making it through without any issues, some having a slow experience in some circumstances. As noted earlier, the economic world of the Internet is quite nuanced, and large variance in experience is the norm.

To close, it is important to note that this argument has used blocking to illustrate a broad point, in part because blocking is a rather blunt instrument in negotiations. The section extended the logic to discriminatory routing in places, but, in part, that is because many of the incentives to block traffic from near rivals yield a similar line of reasoning about discrimination of traffic by carriers, and similar analysis of payments for priority. To say it concretely, if a broadband firm had its own IP telephone service and

there was no restriction on slowing down Skype and no competitive check on its ability to do this, why wouldn't they do so?

It would be misleading, however, to stop there. When it comes to discussing management of traffic, there are numerous other economic considerations to account for. For example, carriers have to manage traffic as part of their operations, and doing so helps achieve desirable efficiencies. In wireless applications especially, carriers face many issues managing the allocation of capacity. Carriers have to make investments in anticipation of realizing these efficiencies as well, and these involve many trade-offs, depending on the setting and customers base.

In short, speculating about carrier behavior and conduct over traffic management – namely, in the absence of restraints – is a more complex topic than what has so far been discussed. This testimony leaves many aspects of that topic unaddressed. While it has identified the open question, readers should not regard this analysis as complete.

8. Why do the practices of carriers deserve attention? A well crafted and executed regulatory framework leads to more innovation, and more innovation creates more economic growth.

At one level this testimony is not saying anything new. Many broadband firms are well run and efficient at many of their core tasks, transporting data on a large scale from many sources to many households. Many analysts have recognized that. Given their success so far, many of these firms have ambitions to move into other commercial areas. Comcast's management is ambitious. So is AT&T's, and so is Verizon's, and so are others. The managers should be ambitious because that is what the stockholders of their firm expect.

The relevant policy question is whether this ambition leads those firms to take action that fosters innovation in the entire country. For that question consider the two twins of innovation inside a dominant firm. One twin is a model citizen. Commercial ambition from a dominant firm yields great outcomes for the country when that firm pursues competitive conduct, innovative services, and

invading of new service territories. The other twin is not a model citizen. Ambition from dominant firms is not in everyone's interest when it motivates blocking a rival's access to channels, when it leads dominant firms to refuse to deal with potential rivals, and when it leads dominant firms to raise a rival's cost.

It is naïve to expect one twin to show up to executive meetings without the other also voicing opinions. It is also not a foregone conclusion that one of them will influence decision making more than another.

Why care about which twin has more influence at dominant firms? As with other facets of this testimony, the answer is an economic one: so much economic growth arises from innovation. This innovation is important to the country, and it is important to protect the environment that fosters it.

Place the observation in context. The broadband industry in the US is quite healthy. Revenue for US Internet access more than doubled during the first decade of the millennium owing to some simple arithmetic: the number of households using the Internet increased, and prices for broadband access averaged twice those of dial-up. More concretely, in the summer of 2000, of the 41.5 percent of connected US households, only 4.4 percent had broadband. By October 2009, 63.5 percent of connected US households had broadband.

Many other industries around broadband are also healthy. The upgrade to broadband initially led most US households into the same activity found in dial-up (for example, checking e-mail, reading news, and shopping). Only gradually did users add activities that dial-up couldn't handle (such as watching YouTube video, downloading music, or reading many blogs). By now, the transformation is rather apparent: broadband has played a role in helping bring more users online and, moreover, these users are more valuable users of electronic commerce and advertising-supported media.

The relationship between broadband's growth and other online markets is what economists call a *growth spillover*—that is, growth in one market spilled into another. For example, as just noted, broadband's diffusion produced positive spillovers for electronic commerce and advertising media, as well as for businesses supporting both chains, such as UPS. The spillover is symmetric as well. The innovation in electronic commercial and advertising media produced more users of broadband.

Broadband also produced positive spillover for online video sharing, such as YouTube, as well as new equipment, such as wifi antennae, and visa versa in the same symmetry.

In general, spillovers can be negative as well, and such relationships tend to be more asymmetric. Broadband policy also should recognize that. For example, broadband's diffusion produced negative spillovers for the printed magazine and newspaper business and music retailing, in a process that is often labeled creative destruction. Creative destruction is a process that creates growth through radically reshaping businesses, lowering prices, altering market structure, and potentially generating radically new services.

Spillovers don't need to be confined to a geographically local area, so they're often challenging to observe and trace. For example, most economists do not know whether the geographic pattern of negative spillovers—for example, to newspapers and magazines—correspond closely to the geographic pattern for positive spillovers to electronic commerce and retailing. It is also unclear whether the geography of positive spillovers to online firms resembles the pattern for equipment suppliers, another beneficiary of positive spillovers from broadband.

Do not equate untraceable with unimportant. Much of modern understanding about economic growth presumes – based on many historical examples – that important technologies have a defining characteristic: their deployment and uptake produces large spillovers, and those spillovers comprise a large component of economic growth. Said simply, spillovers lead to lower prices, more services, and more productivity growth. That allows users to save money, spending on other goods and services.

In short, broadband's diffusion generated economic growth just like other major technical transitions. It resulted in negative and positive spillovers, and it is reasonable to expect these spillovers to continue to arise over the next decade.

More concretely, the commercial Internet has begun to transform digital markets, such as telephony, entertainment, and media business, which are a large and significant fraction of economic activity. Moreover, many heavy users of digital information – such as financial industries, insurance, wholesaling, logistics and transportation – have experienced significant productivity gains due to the advances in the commercial Internet, and should continue to do so. We should expect lower prices and new productivity advances.

In general, historical examples also illustrate a simple principle: The country benefits from the fastest development of spillovers as possible. It would, therefore, be a poor policy choice to allow any factor to slow down this diffusion and deployment. This is a big risk, and one worth avoiding. In short, the economic stakes are high.

Standard economic analysis talks about different risks in regulatory action, the risk of inaction versus the risk of action. Incurring such risks is a policy choice. In that sense this testimony's main theme can be summarized simply: there are risks from committing to regulatory inaction; the risks are plausible but not certain to arise; if the worst-case scenario turns out to be right, then users, entrepreneurs, and many suppliers will pay a high cost. A wide array of economic activities touched by the Internet will be diminished as a result.

9. Summary

What innovative activity is likely in the absence of no government intervention in Internet access markets? This testimony has reached the conclusion that the United States commercial Internet functions well today, as it has in the last fifteen years, because it avoids a number of industry practices that would raise the transactions costs of innovation. Related, in the absence of regulatory intervention some economic factors push in different directions. Some push towards the continuation of such practices, while others push towards the emergence of less transparency, blocking of legitimate content for gain in negotiations, and discriminatory routing of traffic for strategic gain. None of the latter is desirable for users or for many established firms or future entrepreneurs.

Taking away regulatory oversight out of this market, therefore, risks the emergence of many undesirable consequences. It risks the emergence of behavior that has not been prevalent in the past, and that would not contribute to innovation. While this testimony is not primarily aimed at one specific set of policies, and it is not aimed at comparing one alternative policy against another, it does lead to a favorable outlook for policies that tend towards continuity, namely, continued regulatory presence with occasional and consistent action.

10. Source material for this testimony

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