

**STATEMENT OF FCC COMMISSIONER JONATHAN S. ADELSTEIN**  
**EN BANC HEARING ON**  
**BROADBAND NETWORK MANAGEMENT PRACTICES**  
**Palo Alto, CA – April 17, 2008**

It's entirely appropriate that we convene this hearing on the future of the Internet here at Stanford, which has fueled so much of the innovation that has made the Internet the powerful tool it has become today. Mr. Chairman, I commend you for holding this hearing, especially here as we had discussed, and developing such an informative agenda.

The outstanding panelists we invited, as well as the people from this area who will have the opportunity to testify, will improve our understanding of the dynamic environment of broadband Internet access. There is nowhere better than Silicon Valley to shine a spotlight on how we reach the full promise of the Internet.

I would also like to thank Stanford University, the Law School, and the Center for Internet and Society for hosting us. Stanford is not only my alma mater, but is, in my unbiased opinion, the finest institution of higher learning the world. Bias aside, it does feel appropriate that I'm returning to Stanford to continue my studies about this topic. I am especially glad not to be paying tuition this time around.

You are fortunate to be represented by a delegation in Congress – Senators Boxer and Feinstein, and Rep. Eshoo – who truly understand the importance of maintaining America's leading technological edge.

Today we will hear from legal scholars, technology experts, entrepreneurs, and industry representatives. We will also add important new voices including representatives of families and children, as well as the creative arts community. They each bring a needed perspective, and I would like to thank all of them for joining us today.

The vast range of broadband users means that we cannot hear at one time from all of the affected communities. We could fill many more panels with countless numbers of innovators located here in Silicon Valley, alone. Broadband touches so many communities that I am particularly glad that we will have two full hours of public testimony. This will allow us to hear directly from consumers about their expectations. There are over 35 thousand comments filed in the FCC's docket on these issues – the vast majority from public citizen commenters. So, there clearly is deep public concern about these issues.

Consumers have come to expect and will continue to demand the open and neutral character that has always been the hallmark of the Internet. The movement for Internet freedom is tapping the same American spirit that fueled the movement against media consolidation. In an age when traditional media markets are dominated by a handful of giant conglomerates, there is optimism about the rise of broadband. There is a sense it can restore decentralized, locally-rooted and entrepreneurial voices to the media landscape that are reflective of the best aspects of the American media before the rise of consolidation. Consumers are saying, "don't tread on me." Any network provider that treads on freedom does so at their peril, and the government

that looks the other way does so at its peril.

That is why it's so welcome that we are looking at this squarely today. Basic decisions are being made about the development of Internet that will shape it for years to come. The beauty of the Internet is that nobody is in charge and everybody is in charge. Its open nature has enabled those with unique interests and needs to meet and form virtual communities like no tool before it. It has also empowered consumers as citizens and as entrepreneurs. Consumers are increasingly creative in the way that they use these new technologies – nowhere more so than here in Silicon Valley.

As a result, high speed access to the Internet is revolutionizing the way we work, learn, seek medical advice, gather our news, engage in public discourse, interface with government, socialize, and almost every aspect of the way we live.

At the same time, we are all making our way through a sea of changes -- in technology, to the communications marketplace, and to our legal framework -- that are literally reshaping consumers' on-line experiences. There are many positive developments. Over the past decade, we have seen considerable investment by providers in new broadband facilities, growth in the number of broadband users, and an explosion of new applications available to consumers.

But there are also warning signs that should not go unheeded. Over the past few years, there has been dramatic consolidation among the nation's leading broadband providers. We have seen the formation of the largest broadband provider in the nation, last mile providers have purchased backbone providers, providers are clustering their service territories, and we've seen new combinations of content and services.

We desperately need greater competition in the broadband marketplace. Effective competition will provide real incentives for broadband providers to maintain neutral and open networks. We all have high hopes for the development of alternative technologies like wireless. But the FCC's own statistics show that telephone and cable operators control over 90 percent of the residential market. Our recent 700 MHz auction largely dashed hopes of a nationwide third channel into the home and solidified the hold of the largest incumbents. For many consumers, there is no meaningful choice of providers.

With a limited number of broadband options, our attention is all the more important. Independent observers, like the Congressional Research Service, have determined that leading broadband providers -- which control the last mile connections to the home -- may have the ability and incentive to discriminate, and to limit the choices available over the Internet. Others have observed that the large broadband providers also face conflicting incentives, as Internet access increasingly competes with their historical lines of business.

Against this backdrop, we have allegations that broadband providers are exercising increasingly greater control over the applications and content accessed by their customers. The Commission has pending before it several proceedings – petitions for declaratory ruling and for rulemaking, and formal complaints – which argue that broadband providers have intentionally and secretly degraded applications in a way that undermines the open and interconnected character of the Internet. We also will hear concerns about the provisioning of wireless text messaging short codes, where we have seen providers refuse service to groups that were deemed “controversial.”

We now face difficult questions about our role in preserving the unique characteristics of the Internet. Those questions are made harder by the Commission’s recent efforts to reshape the legal framework that we have operated under since the dawn of the Internet. The effect of those decisions is that we have cast doubt about the rules of the road and left open questions about what protections apply.

To our credit, the Commission has taken the important step of adopting a statement of Internet policy principles, designed to preserve and promote the open and interconnected nature of the Internet. Yet, as we saw at our hearing at Harvard Law School, not all broadband providers believe we have the ability to enforce our own Policy Statement. These issues are simply too important to leave this question unanswered.

I also believe that it is time for the Commission to strengthen and enhance the Policy Statement. We need to add a “fifth principle” to our Policy Statement to address incentives for anti-competitive discrimination. Consumers want to be able to choose an independent VoIP provider, or to be able to access video clips, and not just video programming from the largest media companies. Consumers do not want the Internet to become another version of old media, dominated by a handful of corporate giants. We also need a strong commitment to monitoring and enforcing compliance on a case-by-case basis. These would be significant steps toward reaching the full promise of the Internet.

As the Commission has eliminated its traditional safeguards, new questions are also emerging about consumers’ rights in this broadband world. The recent allegations have raised concerns about level of transparency and disclosure between broadband providers and their consumers. I come to this issue with a strong presumption that broadband providers should provide clear and accurate information – in plain English – about their policies and how they affect consumers’ use.

As consumers shift from a narrowband to broadband world, we also must confront new questions about how to protect consumer privacy. A recent article documented a growing practice by which broadband providers – using deep packet inspection -- can track almost every keystroke of their on-line users. Providers hope to capitalize on a treasure trove of information about their customers’ interests and habits. But it is far from clear what consumers are told about these monitoring practices and what protections are in place to safeguard their interests. Given the highly personal uses of the Internet – from managing bills and investments, seeking medical information, exploring religious beliefs, or conducting a job search -- this trend should give all consumers pause.

As we contemplate these uses of the Internet, I also look forward to hearing from my friend Jim Steyer, founder of Common Sense Media. Common Sense Media has worked to improve our understanding of the impact of our media and the Internet on the social, emotional, and physical development of our nation's children. More than ever, we must teach our children to be media savvy and that includes on-line media. We need to empower parents with the tools to manage their children's Internet experiences. These efforts are critical and they are also fully consistent with efforts to maintain an open and neutral Internet. In the on-line world, we need to put the consumer – and the parent -- in control.

Before we turn to today's panel, we must also take note of developments since our first hearing. At the top of the headlines, Comcast and BitTorrent announced an agreement to work together to address network management problems. I am encouraged that broadband providers are listening to the chorus of consumer calls for open and neutral broadband Internet access, and I look forward to learning more about this today. The FCC (through its oversight on these issues), consumer groups (through their vigilance and advocacy), and industry (through a renewed effort at collaboration) can all take credit for these developments.

I am also interested in the status of broader industry discussions and learning more about whether the agreements we have heard about are company-specific solutions or ones that will benefit the broader community of on-line innovators. We have also heard recent reports about progress in the collaborative P4P discussions and I would like to hear greater discussion of the role of industry bodies.

Recognizing the complexity of the task before us, I am reminded of Judge Learned Hands' observation that, "The spirit of liberty is the spirit which is not too sure that it is right." That is why we are here to learn, because it is so important to get rules that govern these networks right. Decisions being made today about the architecture of the Internet will affect its character for years to come. So, it is important that we make our expectations clear. Internet freedom, like liberty itself, is a cherished right that deserves our vigilance and protection. With that, I look forward to hearing directly from our panelists and the public. Thank you, all, for engaging with us today.



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**STATEMENT OF THE SONGWRITERS GUILD OF AMERICA  
ON BROADBAND NETWORK MANAGEMENT PRACTICES**

**NETWORK MANAGEMENT AND CONSUMER EXPECTATIONS  
STANFORD UNIVERSITY  
April 17, 2008**

Chairman Martin and members of the Commission, thank you for this opportunity to testify regarding Network Management and Consumer Expectations. In summary, I believe the current proposals to regulate the Internet are more likely to harm than to help the fight against music piracy, which will only lead to greater consumer frustration, and therefore I suggest you proceed with great caution.

My name is Rick Carnes and I am President of The Songwriters Guild of America (SGA). I am a working songwriter and have lived in Nashville since 1978. While I have been fortunate to have had a modicum of success in my career -- including co-writing number one songs for Reba McEntire ("I Can't Even Get the Blues") and Garth Brooks ("Longneck Bottle") along with songs for Steve Wariner, Alabama, Pam Tillis, Conway Twitty, and Dean Martin among others -- I am reminded constantly of the perilous economic existence that all of us who have chosen songwriting as a profession labor under daily.

SGA represents over five thousand of America's best known and most well respected music creators and their heirs. Established in 1931, SGA is the oldest and largest organization in the United States run exclusively by and for songwriters. SGA is an unincorporated voluntary association headquartered in Nashville, with offices in New York and Los Angeles. It provides royalty collection and audit services for its members, as well as music licensing.

Historically, SGA has been extremely active in representing the rights and interests of music creators throughout the country, and frequently appears before Congress, the Copyright Office, Federal Agencies, and in the courts and administrative proceedings in the course of its efforts to protect and advocate on behalf of the American songwriter community.

On behalf of SGA, I am here to emphasize the importance of allowing responsible Internet Service Providers (ISPs) to monitor and manage the content that flows on their networks, to detect *illegal content* and to help eradicate the plague of copyright piracy, which threatens the very existence of the songwriting profession and compromises the quality of content that all consumers will have available to them.

### The Opportunity of the Internet and the Scourge of Piracy

As a forward looking organization committed to preserving not only the great canon of American music, but also the ability of songwriters and composers to continue to earn a living at their craft in the twenty-first century, SGA is convinced that digital commerce—and particularly the digital consumption of music—is the key to a successful future for American music creators. And from the consumer standpoint, there can be no doubt that the Internet has expanded exponentially the access and opportunity of the listening public to enjoy the *legitimate* consumption of music.

Unfortunately, however, there is another side to this story. The reality of the current situation in the digital world is that online piracy of music is rampant. Sources like IFPI suggest that songs downloaded illegally may outnumber songs downloaded legally by a factor of some 20 to one worldwide. Network experts have indicated that up to 70% of the volume of traffic on broadband networks is Peer-to-Peer, or P2P traffic relating to 5% of the users, and easily 90% of such traffic is unlawful.<sup>1</sup> Since stolen music provides no compensation to songwriters, this online piracy has deeply and materially affected the creative community. To cite just one example of the devastation caused by the loss of songwriter revenue to piracy, over half of the songwriter positions that existed at music publishing houses across the country as recently as five to ten years ago have simply vanished. Some companies appear to have eliminated the practice of hiring staff songwriters entirely. Piracy, in other words, is destroying our community by eliminating songwriting as a viable livelihood. A vital and iconic piece of American culture (and a valuable source of American revenue and positive trade balance) is in danger of extinction.

Obviously, it is not only songwriters who will suffer if our profession is decimated. The American music consumer will have fewer options and far lower quality of new and available music in the future. And please do not believe that songwriters will continue to create because we do so out of love for our craft. We do love what we do, but we need to

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<sup>1</sup> See Comments of NBC Universal, Inc., *In the Matter of Broadband Industry Practices*, FCC WC Docket No. 07-52, Feb. 13, 2008 at 2 (citing various sources).

get paid for our creative efforts. Like all other Americans, we have mortgages, car payments, bills for the education of our children, medical expenses and everyday costs for food, gas, medicine and other necessities. If we cannot earn a living for our families writing songs we will have to turn to something else.

Moreover, the consumer will be affected in other, more indirect ways. As noted, a vibrant music business is one of the great engines of the American economy. It has been said many times that the whole world loves American music; if that music is not protected it will cost jobs, spending power and tax revenue. In addition, unprotected content means lower quality content and a smaller amount of content for consumers. The existence of Internet piracy is a lose-lose situation for creators and consumers alike.

### The Positive Anti-Piracy Role of Internet Service Providers

Beyond the effect of piracy on songwriters and consumers, piracy is also one of the main contributors to the current network congestion problem. Thus, SGA believes that ISPs must be allowed the flexibility to manage traffic on their networks in a manner that: (1) permits, protects and encourages *legitimate* online commerce such as licensed music services to thrive, and (2) deters *illegitimate* conduct such as music piracy (including piracy of video content with embedded music), which will have the added benefit of reducing network congestion in the long term. Although as yet there may be no definitive technological solution to online piracy, it is critical that ISPs and content owners are allowed to develop technologies and take action to deter piracy, which would have the important added benefit of reducing network congestion as well.

The principles that the Commission delineated in its Internet Policy Statement relate only to *lawful content*. Therefore, the FCC should not only allow, but encourage, ISPs to help identify and discriminate against all pirated, illegitimate content, just as ISPs currently identify and attempt to prevent spyware, malware, and other harmful traffic from adversely impacting their customers. I think the greatest risk of an anti-competitive result comes from current regulatory proposals to prohibit or limit responsible ISPs from managing their networks. At the moment, the free market is the best weapon we have to combat Internet piracy. Technology created the illegal file sharing monster, but more technology can detect and deter those practices that are illegal. In other words, we must fight technology with technology. Unfortunately, a number of pending regulatory proposals would prevent the nascent technological counter-attack against Internet piracy.

In keeping with the spirit of the Commission's policy statement, actions by the ISPs to deter piracy should be applied evenly over all types of pirated content (whether movies, music, etc.) to the extent technologically feasible. This is particularly important where the choice to deter certain types of piracy but not others would raise competitive concerns. While SGA is primarily concerned with the sharing of illegal music files, it is not only our livelihoods that is at risk. An unmanaged Internet allows for the sharing of unlawful materials including child pornography, a problem that was well-described by Representative Debbie Wasserman Schultz (D-FL) during the recent House Judiciary

Committee Task Force on Competition Policy and Antitrust Laws hearing on "Net Neutrality and Free Speech on the Internet".

How Competition Among Broadband Networks to Address Piracy Would Help Songwriters and Consumers

Some network operators, such as AT&T, are researching whether there might be a technological means to identify and/or filter unlawful content transmitted over the Internet. In my view, this would make good economic sense, because lawful owners of copyrighted content would be anxious to make their works available on those networks that incorporated such technology – given the lower risk of digital theft of their works. Assuming that the free market is working the way it should, then those networks might risk alienating some consumers because of the filtering, but would stand to gain significantly from having more robust content to offer to a wider audience. And that is what the free market is all about: creating a distinctive product and challenging competitors with an inferior product.

In a market free of undue or unwise regulation, the economic winners and losers would be chosen by consumers who have a wide range of choices about what type of Internet service to purchase and what kind of material might be distributed over those networks. I can tell you as a songwriter and as a copyright owner that my choice would be to have my works distributed by someone who invested in trying to stop digital theft of my and my colleagues' creations. And I believe that competition—and concomitant consumer benefits—would be enhanced if broadband network operators were free to decide to manage their networks in such a manner. The Commission's actions in this regard must be careful to avoid a result that would have anti-copyright owner, and therefore anti-consumer, effects.

It is in the consumer's direct interest to choose a network provider with the fastest and safest connection. It is fair to say that consumers have a reasonable expectation that they will get the high speed access to the Internet that each is paying for. As a matter of public policy, however, there cannot be a legitimate public expectation that unlicensed copyrighted works will be available on an unfiltered peer to peer basis. There is a clear correlation between unregulated peer to peer file sharing – the majority of which is illegal – and slower Internet connections. Most consumers will favor the services of ISPs who limit illegal file sharing. Despite the common misperception that such regulation would prevent watching YouTube videos or allow ISPs to filter e-mails, this is not the case. The ISPs have absolutely no interest in limiting the consumer's access to any legitimate materials and if they were to do so, consumers would simply change providers. There is no slippery slope when allowing for ISPs to regulate P2P file sharing, as the consumers can serve as a check on any inappropriate limitations. On the other hand, imposing a regulatory regime where broadband network operators are prohibited from managing congestion or filtering for unlawful content would simply be irrational, for not only would creators and copyright owners suffer, but so would consumers as well.

If a broadband network operator is considering taking technological steps to stop piracy, SGA would say, “more power to you.” And, “the sooner, the better.” And finally, “how can we help?”

### Conclusion

My final thoughts about regulating network management practices are as follows. It strikes me as odd that the problem of broadband network congestion caused largely by illegal file sharing has been addressed so far by proposing that ISPs be denied the ability to manage such congestion. If regulation is to be considered, then the heart of the problem should be at the top of the agenda – **illegal file sharing and piracy generally**. The current proposals seem to have it all backwards. I am comfortable letting the market reward those ISPs that behave responsibly and letting current law apply to those who misbehave. But if regulation (or legislation at some point) is the course chosen, but one that I would not recommend, then the first order of business is to detect and stop illegal file sharing and digital piracy.

At bottom, there must be respect for the rule of property rights and law over the Internet, especially in regard to the Constitutional imperative to protect and encourage the advancement of science and the arts. This respect can be facilitated by allowing ISPs to manage their networks in furtherance of *legitimate* commerce. Such a result would clearly be in the public interest because it would allow legitimate businesses to flourish, protect the songwriting profession and similar artistic endeavors from outright theft, and benefit American consumers by assuring that they would have access to the best creative efforts on the fastest and safest networks anywhere in the world.

Thank you for this opportunity to present my views.



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# **NETWORK MANAGEMENT AND CONSUMER EXPECTATIONS**

**RICK CARNES, PRESIDENT, SGA  
STANFORD UNIVERSITY**

**APRIL 17, 2008**

# PROBLEM: ILLEGAL FILE SHARING

- Decimates songwriter and copyright industries
- Dimishes quality and quantity of music available to consumers
- In addition, illegal file sharing is responsible for a significant and disproportionate percentage of broadband network congestion

# POTENTIAL SOLUTION

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- Some ISPs are considering network management measures to reduce broadband congestion
- Such practices would significantly reduce/deter illegal file sharing
- Market-based solution: many consumers would be drawn to networks that protect content and therefore attract high-quality creative works

# RESPONSIBILITY OF REGULATORS

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- Don't regulate when the market appears to be addressing a problem with a pro-consumer result
- FCC should not frustrate responsible network management
- Any regulatory action should focus on the real problem: **Internet Piracy**

**STATEMENT OF COMMISSIONER MICHAEL J. COPPS**  
***EN BANC* HEARING ON BROADBAND**  
**NETWORK MANAGEMENT PRACTICES**  
**STANFORD UNIVERSITY, PALO ALTO, CALIFORNIA**  
**APRIL 17, 2008**

Thank you, Chairman Martin, for convening this second hearing on the importance of broadband and Internet Freedom. I hope there will be more such hearings around the country because so much, in terms of economic growth and individual opportunity, hinges on protecting the integrity and the openness of the Internet. Before delving a little into that, I would be remiss not to first thank this area's Congressional delegation for the work it does in this regard and, indeed, across the whole telecommunications landscape. The Speaker and your Senators—and we work frequently with Senator Boxer because of her important position on the Commerce Committee—provide thoughtful and truly effective leadership on these issues. And I can't say enough about your own Congresswoman, and my very good friend, Anna Eshoo. She's just an inspiration. She is a visionary leader who understands the transformative power of the Internet and the impact that technology, innovation and competition has on the economy, on creativity in this country, and on the daily lives of American consumers.

Out here in Silicon Valley, and at this great university, we have the perfect opportunity to talk about innovators, inventors, and entrepreneurs. This is the place, really, where so many of the things we take for granted every day actually got their start. Semi-conductors, personal computers, graphical user interfaces, search engines, devices like the iPhone—these are all innovations that have revolutionized communications and that got their start or went through an important stage in their evolution right here, in a place that once was just a sleepy farming community before Stanford came to the area and, later, companies and institutions such as Hewlett-Packard, Xerox PARC, Fairchild Semiconductors, Intel, Apple—the list goes on—and all the venture capitalists on Sand Hill Road who helped turn the area into the world's leading center of innovation and wealth creation. What a story!

But, you know, that innovation, that productivity, that entrepreneurship shouldn't be seen as a luxury, something that's really nice to have. Keeping it going is, rather, an urgent necessity, vital not only to the fulfillment of our individual lives but to our economic well-being and to our nation's competitive posture in the world. We've come a long way, thanks to many people in this room, but there are no guarantees for the future. And that wonderful, open and dynamic Internet—perhaps the most liberating technology since the printing press, if not even greater than that—is, in fact, under threat. We will keep it open and free only by acting to make it happen. Its future is not on autopilot and, indeed, powerful interests would bring it under their control for their own purposes—which may not be your purposes. I'm not presenting a novel theory here, I'm only learning from history. History shows that when somebody has the ability to control technology, and also has a business incentive to do so, they're going to try. And that, my friends, is what this issue of Internet Freedom or net neutrality, or whatever you want to

call it, is all about. When I say this, I'm not talking about bad people—but I am talking about some really bad results!

Let's look at it from an inventor's perspective. His or her job is to come up with the idea, go out and attract venture capital funding for it, and hopefully bring that innovation to consumers. Before they devote years of their lives, and ask investors to devote huge sums of money to their dream, they need confidence that if they invent a better mousetrap they will indeed be able to bring it to consumers. They need to know that their innovation won't be prevented from getting to market by a handful of network operators who have consolidated their control over broadband pipes all across this country. Inventors and creators need to know, up-front, that they have the right to innovate without going on bended knee to seek permission from a few who have amassed too much control in their own hands. And if they have that right, that is really good news for innovation and for consumers.

The future of that right is by no means guaranteed. Important decisions that could codify such a right have been postponed or avoided. And this is why it's time to insist upon action now. Now is the time for the FCC to add an enforceable principle of non-discrimination to our Internet Policy Statement—a clear, strong declaration that we will not tolerate unreasonable discrimination by network operators and that we have in place enforcement policies to make sure that anyone with other ideas isn't going to get away with them. And, by the way, this policy should apply to wireless as well as wireline operators.

Now I grant this won't be simple to do. These are evolving technologies and sometimes the line between reasonable network management and outright discrimination can be less than crystal clear. But that's why we need a for-sure enforcement process, to sift through complaints, to make the judgment calls, and, over time, to compile some case law and precedent so things become clearer. But I can tell you this: if everyone knew the FCC was on the job, that we had forthrightly staked out our principles, that everyone knew we would deal with any and all complaints that came in, and that those who do discriminate will be punished, word would get out pretty fast that no one should be messing around with the openness of the Net. We've done this before under Title II of the Telecommunications Act with policies and procedures that supported innovation at the edges of the networks, like the answering machine, fax machines, personal computer modems, and dial-up home Internet services like AOL and others (which provided most Americans with their first exposure to the Internet).

And while such an approach provides important safeguards for entrepreneurs just starting to get their innovative juices flowing, it does something else, too. It gives clarity to investors, not just investors here, but on Wall Street, too. An approach wherein the Commission had an enforceable rule of non-discrimination and then determines whether complex network practices abide by such a principle on a case-by-case basis would give investors in these networks more certainty, not less. Network operators and some on Wall Street might have to reconfigure the lens through which they view the Commission's principles, but I believe they would quickly come to appreciate having a clear understanding of what the rules are, and that we have a system that can account for

changes in technology and reasonable business practices. That kind of certainty breeds more, not less, investment.

We have two excellent panels with us today. I hope they will address whether net neutrality principles can be consistent with other important policy objectives as well as the ones I have mentioned—objectives like the protection of intellectual property and the protection of our children from obscene and dangerous Internet content. These are all in my estimation critical outcomes, but they raise a number of important questions which are central to our Internet dialogue.

Media historian Paul Starr points out that our country has made, at various critical points in its national passage, what he calls “constitutive choices”—important government decisions that have substantially guided the course of the nation’s media and its impact on American culture and politics. For example, by subsidizing the postal service (especially into rural areas), the nation encouraged vibrant newspaper circulation and a deeply engaged electorate in the early days of the nation. Later, in setting the rules for licensing commercial broadcasting stations (often affiliated with nationwide networks), the Federal Radio Commission and later the FCC adopted a model to ensure that for-profit programming would not ride roughshod over the notion that the people’s airwaves must serve the people’s interest. Unfortunately, we’ve too often lost our compass on that one.

Now we face a constitutive choice with the Internet—a choice between closed networks where the network operators control the user experience and open networks that are controlled by end users. This is an issue in which you must engage, not just because you are innovators and business people, but because you are citizens. If I see what’s happening accurately, I believe we will have an opportunity, before very long, to decide this issue of Internet Freedom. It will be a major fight, with powerful forces on the other side. We’ll all have to work—and much as I know folks out here like to keep their focus on all the good entrepreneurial things they are doing, they—you—are going to have to focus on this issue, focus on Washington, and put your commitment and your resources into making sure the decision comes out right. Without that kind of participation, we will likely lose. With it, we have a real shot to win. I hope you’ll join up!

Thank you very much.

My name is Jason Devitt, and I am the CEO of a new company called Skydeck. Skydeck's mission is to help consumers to take back control of their cell phones and their cell phone bills, by providing them with the tools and the information that they need to do so.

How can we measure the effects of regulation? Every so often the economy presents us with a natural experiment: two almost identical markets that differ only with respect to the regulatory environment.

I have two computers in front of me today, both very powerful, both offering multiple applications, both able to connect to broadband wireless networks.

I like a lot of the software that came with this computer, but I always have other choices. I did not like their browser, so I chose another. Since that browser is itself an open platform, I added several features that made it more powerful. They offer a service for backing up my hard drive, but I found a much better one online. There's no GPS chip in this computer, but an independent company has worked out how to estimate my location based on the WiFi hotspots around me, and I chose to install their software.

I use this computer on multiple networks on a regular basis: Comcast, Covad, Verizon Wireless, many WiFi networks. That's not evidence of broadband choice by the way. Covad does not serve my home, Comcast does not serve my office, neither serves this table, and last time I traveled I found that Verizon did not serve my hotel room. I did, however, have a choice when two of those carriers pestered me to install their software on my computer and to use some of their branded services. I said no.

This computer on the other hand works on only one network. I cannot change the default browser, or upgrade it, or extend its functionality so that I can visit obscure web sites like YouTube. The manufacturer offers only one way to back up all the contents of this computer, and their software is not compatible with my other computer. It should be easy for me to copy my address book across using

Bluetooth, but my carrier blocks that. This computer does have a GPS chip – but only applications sold by my carrier can use it.

What is the difference between these two computers? Is it price? No, because my carrier won't sell me a more open device at any price. Is it because one network requires careful management? No, because right now they are both connected to the same wireless network. Is the cellular market less competitive? No, the reverse is true, I have at least 5 wireless carriers to choose from in the Bay Area, while practically speaking I have no choice in wireline Internet service and the market for PC software has at times been distorted by a monopoly.

Here is the difference; here is our natural experiment. The people who designed this computer had to presume a neutral network: common carriage and Carterfone rules. The people who designed this computer did not.

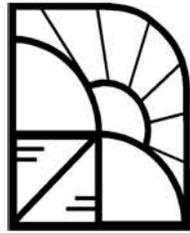
For better or for worse, I have built my career on the wireless Internet. But if this were a Dickens novel, then I would be the Ghost of Internet Future.

Within a year or two, modems like these will be built in. When you start up a new laptop computer you will be asked - repeatedly - to sign a contract with a broadband wireless network. Why? Because the commission which carriers will pay to the manufacturer will be double the profit that they make on selling the computer. Just as with cell phone manufacturers today, their primary customer will become the carrier, not you. If they have no duty to you under the law, if you are no longer their primary customer, then what power will you have? Even if your carrier nominally allows you to connect any device to their network, who is going to make and sell a device that your carrier doesn't like?

On this computer, I cannot tell you what 'network management' technologies my carrier is using, because I cannot install an application to detect them. I do not know whether they are blocking any

legitimate text messages to me because I have no way of knowing what messages they block. I cannot even check if they are billing me correctly each month, because I cannot get a complete record of my activity – my calls, messages, and data usage – off this computer to compare to my bill.

But that does allow me to end on an optimistic note. Quit worrying about whether the network is neutral; because soon you might not be able to tell.



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**Testimony of**

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Studies**

**Before the**

**Federal Communications Commission**

**Open Meeting on Network Neutrality and Broadband Network  
Management**

**Stanford University**

**April 17, 2008**

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Mr. Chairman and Commissioners, good afternoon and thank you for inviting me to testify today.

My name is Dr. George S. Ford, and I am the Chief Economist of the Phoenix Center for Advanced Legal and Economic Public Policy Studies, a non-profit 501(c)(3) organization that studies broad public policy issues related to governance, social and economic conditions, with a particular emphasis publishing scholarly research on the law and economics of telecommunications and high-tech industries. We have written nearly fifty papers on telecommunications policy in the last nine years, many of which have been published in scholarly journals. Moreover, we make all of our research—as well as rebuttals by those who do not agree with us—available for free at our website, [www.phoenix-center.org](http://www.phoenix-center.org).

Before beginning my testimony today, I wish to make it clear that the Phoenix Center makes it a policy not to endorse or support any particular proposed regulation or

regulatory outcome. Our mission is not to tell policymakers *what* to think about an issue, but to help them with *how to think* about it. We do so by constructing analytical frameworks for evaluating problems and policy proposals as well as empirics that attempt to quantify the relevant tradeoffs. We believe that in the absence of a suitable analytical framework, it is difficult if not impossible to make a decision that will do more good than harm. Further, unlike many participants in the policy debate, we refuse to ignore the institutional realities and economic constraints of the communications business. Economic theories derived in an idealized environment are often not useful in industries like telecommunications that have scale economies, externalities, and regulation. There are simply no easy answers here.

The Phoenix Center has published a number of studies on the economics of network neutrality and broadband network management. Almost all of these papers include original theoretical or empirical work. Our efforts to model theoretically the consequences of particular and general proposals on network neutrality and network management reveal, almost universally, that the efforts to place more regulation on the Internet are problematic, and in many cases, decidedly anti-consumer. These results are consistent with other research.<sup>1</sup>

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<sup>1</sup> B. E. Hermalin and M. L. Katz, *The Economics of Product-Line Restrictions: With An Application to the Network Neutrality Debate*, COMPETITION POLICY CENTER PAPER CPC06-059 (July 2006) (available at:<http://repositories.cdlib.org/iber/cpc/CPC06-059>); M. Jamison and J. Hauge, *Getting What You Pay For: Analyzing the Net Neutrality Debate*, Working Paper: <http://ssrn.com/abstract=1081690>; N. Economides and

## **The Importance of a Sound Analytical Framework when Considering Network Neutrality Regulation**

The task of policymakers is to sort through the many and varied claims of interested parties and determine which policy prescription can be expected to advance the interests of consumers and overall economic welfare best. It is the responsibility of the parties and other participants, like me, to provide you with the tools and information you need to make prudent policy decisions. As such, every request to impose significant regulatory change should be accompanied by a serious attempt to determine the probable winners, losers, and other consequences of the proposed changes. If the parties fail to provide you such a framework and analysis, then regulation is little more than a religion.

Today, the arguments for network neutrality seem more like a Christmas list of “I wants” than a serious effort to improve on the status quo. You, the government, play the role of Santa Claus, checking twice to determine whether firm conduct is “naughty” or “nice.” The idea of network neutrality is an important one and deserves much better. The undeveloped and unspecific state of network neutrality proposals opens the door for effective and often lethal criticism. Research by the Phoenix Center and others, for example, shows that the very entities intended to be helped by many of the proposed regulations would, in many cases, actually be harmed by those proposals. The

inconsistencies between intent and consequence arise due to the lack of any analytical foundation for existing network neutrality proposals.

So how can we improve the status of the network neutrality debate? My recommendation to you is that you first insist that all proponents of network neutrality or network management regulation show convincingly that the proposed rules will indeed have their intended effect of increasing consumer and/or social welfare. Second, the regulation must do so efficiently, in that the expected costs of the regulations are less than the expected benefits. The burden of proof should rest on those proposing regulation, since the 1996 Act explicitly calls for deregulation in communications.<sup>2</sup> Thus far, such analyses are completely absent from the debate.

This additional discipline will greatly simplify your work, since most of what is proposed and debated today could not satisfy either requirement. As I discuss below, what little research we have seen supporting network neutrality regulation shows that network neutrality regulation has, at best, ambiguous welfare effects and, at worst, is decidedly anti-consumer and harmful to the content industry it aims to protect or enrich. At the Phoenix Center, we have provided policymakers with some theoretical and empirical analysis of network neutrality and network management proposals, with

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<sup>2</sup> 1996 TELECOMMUNICATIONS ACT, Preamble (“to promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies.”).

our focus being upon the welfare impacts of proposed regulation. We find generally that the welfare effects of the existing network neutrality proposals do not increase consumer or aggregate welfare. While we do not pretend to have all the answers, we do believe that our approach to these questions is important to your deliberations, and I welcome this opportunity to present our research to you.

### **Impact of Network Neutrality Regulation on Market Structure**

The Phoenix Center takes a realistic—some would say pessimistic—view of the potential for competition and entry into the broadband network industry.

Our core approach to these issues rests upon the reality that building broadband networks—either wireline or wireless—is *difficult and costly*. As explained in PHOENIX CENTER POLICY PAPER NO. 21,<sup>3</sup> policymakers need to recognize and account for this fact. Phoenix Center and other academic research shows that because it is costly to build and operate communications networks, even in a “best case scenario,” only a few firms will be able to provide advanced communications services over their own network.

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<sup>3</sup> G. S. Ford, T. M. Koutsky and L. J. Spiwak, *Competition after Unbundling: Entry, Industry Structure and Convergence*, PHOENIX CENTER POLICY PAPER NO. 21 (July 2005)(available at <http://www.phoenix-center.org/pcpp/PCPP21Final.pdf>) and reprinted in 59 FEDERAL COMMUNICATIONS LAW JOURNAL 331 (2007)I see also J. B. Duvall and G. S. Ford, *Changing Industry Structure: The Economics of Entry and Price Competition*, PHOENIX CENTER POLICY PAPER NO. 10 (Apr. 2001) (available at <http://www.phoenix-center.org/pcpp/PCPP10Final.pdf>) and reprinted in 7 TELECOM. AND SPACE JOURNAL 11 (2002)); T. R. Beard, G. S. Ford and L. J. Spiwak, *Why ADCo? Why Now? An Economic Exploration into the Future Industry Structure for the “Last Mile” in Local Telecommunications Markets*, 54 FED. COM. L. J. 421 (May 2002); J. Sutton, *SUNK COST AND MARKET STRUCTURE* (1995).

Policymakers need to begin with the assumption that there will, at best, be only a “few” facilities-based firms. As a result, policies should not impede sustainable competition among the few firms that the market can actually support and should not nudge the industry toward increased consolidation. At the most basic level, our research suggests that policies should be avoided that make the market smaller, promote the commoditization of network services, or raise the entry costs of firms. In an industry with large sunk costs, each of these actions will result in a more concentrated market that can cause harm to consumers. The softening of price competition through, say, consumer-friendly product differentiation may allow multiple firms to exist in a market that is otherwise a natural monopoly with homogeneous products.<sup>4</sup> Commoditization, then, should be avoided in communications markets with large fixed and sunk costs.

Now, what does that have to do with network neutrality and broadband network management?

Understanding the underlying market structure conditions are important because in my opinion, many, if not most, of the proposed network neutrality rules will promote industry concentration by shrinking markets, commoditizing services, and raising entry costs. Proposals that a network firm can deal with congestion only by

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<sup>4</sup> Commoditization results in the possibility of intense price competition that favors highly-concentrated markets. It may seem paradoxical to say that intense price competition in such a situation can harm consumers, but this condition is called the “Bertrand Paradox” and is well-established in economic theory. See J. Tirole, *THE THEORY OF INDUSTRIAL ORGANIZATION* (1995) at 209-212.

expanding capacity obviously will increase the capital outlays required for the network. This will raise the cost of building networks and necessarily reduce the number of firms sustainable in equilibrium.

In addition, network neutrality proposals that would limit network firms to the selling of raw bandwidth capacity would effectively commoditize broadband service. In my opinion, this is the unstated goal of many of those that would have the FCC prohibit broadband network management practices—broadband networks be operated on a “stupid” rather than “intelligent” basis.

Doing so would intensify the role of scale economies and possibly render monopoly outcomes in many markets. In PHOENIX CENTER POLICY PAPER NO. 24<sup>5</sup>, we discuss this issue in relation to network neutrality using a standard, neoclassical economic framework.<sup>6</sup> Our analysis in that PAPER shows that such proposals to “commoditize” broadband access services is likely to deter facilities-based competition,

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<sup>5</sup> G. S. Ford, T. M. Koutsky and L. J. Spiwak, *Network Neutrality and Industry Structure*, PHOENIX CENTER POLICY PAPER NO. 24 (April 2006) (available at: <http://www.phoenix-center.org/pcpp/PCPP24Final.pdf> and reprinted as T. R. Beard, G. S. Ford, T. M. Koutsky, & L. J. Spiwak, *Network Neutrality and Industry Structure*, 29 HASTINGS COMMUNICATIONS AND ENTERTAINMENT LAW JOURNAL 149 (2007)).

<sup>6</sup> Rebuttal to this POLICY PAPER, and the responses thereto, are available on the Phoenix Center website. See *Network Neutrality and Scale Economies: A Response to Dr. Roycroft* (May 2006)(available at: <http://www.phoenix-center.org/RoycroftResponseFinal.pdf>); *A Response to Dr. Roycroft (Redux)* (July 2006)(available at: <http://www.phoenix-center.org/RoycroftReduxFinal.pdf>). Despite repeated correction, however, the Consumer Federation of America, Consumers Union and Free Press continue to mischaracterize our work before the FCC. Comments of the Consumer Federation of America, Consumers Union and Free Press in Docket No. WC Docket No. 07-52, In re Broadband Industry Practices, filed June 15, 2007 at *passim* (available at: [http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native\\_or\\_pdf=pdf&id\\_document=6519529581](http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519529581)).

reduce the expansion and deployment of advanced communications networks, and increase prices.

The potential impact of network neutrality proposals upon market structure is important. Network neutrality proponents often indicate that their proposed regulations are needed because there is a “broadband duopoly” between cable and telephone firms. But in this situation, the prescription may be worse than the disease, as network neutrality rules can be expected to *encourage more* industry consolidation. The “market power monster” is not slain by network neutrality regulation; instead, it is fed by it. Similarly, in both POLICY PAPER NO. 12 and POLICY BULLETIN NO. 17, we show that it is *regulation* that induces firms to sabotage their rivals.<sup>7</sup> Oddly enough, network neutrality regulation provides the incentives for broadband providers to treat content firms badly; it does not eliminate such incentives.<sup>8</sup>

The impact on market structure is not just a theoretical possibility concocted by the Phoenix Center. Network neutrality advocate David Isenberg, who is known for the

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<sup>7</sup> T. R. Beard, G. S. Ford and L. J. Spiwak, *Why ADCo? Why Now? An Economic Exploration into the Future Industry Structure for the “Last Mile” in Local Telecommunications Markets*, PHOENIX CENTER POLICY PAPER NO. 12 (November 2001) and reprinted in 54 FED. COM. L. J. 421 (May 2002); see also G. S. Ford, T. M. Koutsky and L. J. Spiwak, *Wireless Net Neutrality: From Carterfone to Cable Boxes*, PHOENIX CENTER POLICY BULLETIN NO. 17 (April 2007) (available at: <http://www.phoenix-center.org/PolicyBulletin/PCPB17Final.pdf>).

<sup>8</sup> See J. Farrell and P. Weiser, *Modularity, Vertical Integration, and Open Access Policies: Towards a Convergence of Antitrust and Regulation in the Internet Age*, 7 HARVARD JOURNAL OF LAW AND TECHNOLOGY 85-134 (2003). For a thorough analysis of sabotage, see T. R. Beard, D. Kaserman and J. Mayo, *Regulation, Vertical Integration and Sabotage*, 49 JOURNAL OF INDUSTRIAL ECONOMICS 319-333 (2001).

notion of the “Stupid Network,” fully recognizes, to his credit, that it is privately unprofitable to build the ideal neutral network, and that rate-of-return regulation and subsidization of a monopoly is the likely outcome.<sup>9</sup> It is not clear to me that this consequence advances the interests of consumers or society, but reasonable minds can disagree. What is important is to understand the consequences of regulatory actions; we can then debate the desirability of the consequences.

### **Welfare Implications of Broadband Network Management**

With regard to broadband network management specifically, in POLICY PAPER NO. 32<sup>10</sup>, we provided a formal economic analysis of the likely welfare consequences of network management that is designed to control network congestion.

The key point is to recognize that network congestion creates a negative externality, much like pollution. This is a type of market failure. These “congestion externalities” occur when the use of applications by some users harm other users of a broadband network, without compensation, by causing delays or other service quality problems. When one person’s use of BitTorrent affects the quality of the connection to

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<sup>9</sup> D. Isenberg, *The Rise of the Stupid Network*, COMPUTER TELEPHONY (Aug. 1997) at 16-26 (“the best network is the hardest to make money running. So who builds it? Who runs it? Who fixes it when it breaks? And who develops the next generations of faster, simpler infrastructure?”; “The transport companies would be have [sic] government incentives (e.g., assured return on investment), to make fiber, pole attachment, and right of way available to all service providers.”).

<sup>10</sup> G. S. Ford, T. M. Koutsky and L. J. Spiwak, *The Welfare Impacts of Broadband Network Management: Can Broadband Service Providers be Trusted?* PHOENIX CENTER POLICY PAPER NO. 32 (March 2008) (available at: <http://www.phoenix-center.org/pcpp/PCPP32Final.pdf>).

his neighbor, this is a classic negative externality that is not that much different than a farmer who drains a river for irrigation or a chemical factory that spews toxic fumes into the air. The model we present in our PAPER reveals that when a congestion externality is present, network management—including, but not limited to, the differential treatment of particular applications—is pro-consumer and welfare enhancing.

Our approach is useful for policymakers because it shows that from a social welfare perspective, private firms will *inadequately* respond to the congestion externality. For the same reason some argue that broadband firms under invest in network by responding only to profits and not the full social benefits of broadband service, broadband firms can be expected to fail to sufficiently curb congestion. This is because their focus is only on profits and not on the full consumer impact of quality degradation.<sup>11</sup>

What does that mean for the debate we are having today? In one sense, it indicates that perhaps we are looking at network management from the wrong perspective, at least as it applies to congestion. Broadband network providers like AT&T and Comcast are not going to go out willy-nilly and unduly blocking Internet applications and websites at the drop of a hat, even if those uses cause congestion.

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<sup>11</sup> This point is discussed in most general economics texts. See, e.g., D. W. Carlton and J. M. Perloff, MODERN INDUSTRIAL ORGANIZATION (2005) at 82-3; P. R. G. Layard and A. A. Walters, MICROECONOMIC THEORY (1978) at 189-95; R. J. Carbaugh, CONTEMPORARY ECONOMICS: AN APPLICATIONS APPROACH (2006) at 188-91.

Economic theory tells us that these private firms—because they do not fully internalize the negative externality cost of congestion—will actually engage in *less* of this type of behavior than a social welfare-maximizing entity would do. The widespread blocking of P2P traffic on university networks is instructive.

Our approach also provides a framework for analyzing disputes like Comcast-BitTorrent. In particular, once it is shown that a congestion externality is present and that the traffic management technique alleviates that congestion, it appropriate to presume that this type of traffic management is legitimate and welfare enhancing.<sup>12</sup> This places the focus of the analysis upon two particular factual inquiries: (1) whether there a congestion externality that is caused by this particular application; and (2) whether the traffic management technique at issue sufficiently targeted and actually alleviate the congestion.

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<sup>12</sup> This failure to recognize that congestion imposes an externality on users is consistently found in those proponents of network neutrality who argue that broadband providers are too aggressive in the management of congestion and call for *per se* prohibitions against all network management practices. For example, in their petition to the FCC regarding Comcast's treatment of BitTorrent traffic, Free Press and others assert that "no economic argument supports the notion that degrading applications is reasonable network management." In particular, Free Press asserts that "the transaction costs" of metered Internet usage "must not be prohibitively high" because bandwidth use is metered in Australia. As a result, Free Press states that blocking or degrading applications should be prohibited that that network providers simply rely on other options—such as setting "dynamic quotas" on bandwidth for end users, "charge by usage," "provide more bandwidth to all users," or "actually offer high symmetric bandwidth speeds." Free Press, Public Knowledge *et al.* Petition for Declaratory Ruling, CC Docket Nos. 02-33, 01-337, 95-20, 98-10, GN Docket No. 00-185, CS Docket No. 02-52, WC Docket No. 07-52 (filed Nov. 1, 2007) (hereinafter "Free Press Petition"), at 29-32. See also, R. Frieden, *Wireless Carterfone: A Long Overdue Policy Promoting Consumer Choice and Competition*, Working Paper, New America Foundation (2008) (available at: [http://www.newamerica.net/files/Wireless\\_Carterfone\\_Frieden.pdf](http://www.newamerica.net/files/Wireless_Carterfone_Frieden.pdf)); C. Holohan, *Time Warner's Pricing Paradox: Proposed Changes in the Cable Provider's Fees for Web Use Could Crimp Demand for Download Services and Hurt Net Innovation*, BUSINESS WEEK (Jan. 28, 2008).

These inquiries are factual and indeed engineering questions. I would suggest that you speak to and rely upon the judgment of Internet engineers to answer these questions—not the lawyers and economists that are dominating these panels today. In my view, if the answer to the above two factual questions are “Yes,” then it is appropriate to presume that the traffic management tool being employed by the broadband provider is welfare-enhancing.

Our approach also indicates that different networks are likely to have different network management practices. For example, wireless broadband networks today may face more severe capacity constraints than wireline networks, in part because all users share the common pool of spectrum capacity that is used to provide such services. As a result, we should expect that wireless carriers will likely be the most diligent in managing traffic—not because they violate a public trust but simply as a result of network architecture and spectrum limitations. Likewise, it seems that BitTorrent was particularly troublesome for certain cable network architectures and not DSL or fiber networks, so it not surprising that the congestion-relieving action was implemented by cable operators first. Capacity constraints and applications using that capacity are apt to change over time and vary by network. As a result, judging the appropriateness of traffic management techniques is best done on a case-by-case basis rather than through prescriptive, ex ante regulations and prohibitions of general applicability. Further, if we see a pattern of network management that follows these expectations, then we may sensibly start from the position that such actions are legitimate.

### **Incentive to Invest in Network Management Technology**

We have also studied a firm's decision to invest in network management technology and demonstrated that a firm would never invest in network intelligence unless that investment increases consumer welfare.<sup>13</sup> Importantly, we modeled the "worst case" scenario for network neutrality proponents—we modeled a monopoly network provider and a situation in which consumers value a "stupid" broadband network over an "intelligent" one. Even in this extreme situation that is clearly biased against consumer welfare improvements due to investments in network intelligence, we found that the monopoly network provider's incentives to build intelligence into the network align with the interests of consumers.

This is an important point, since most of the network neutrality debate is couched in terms of a zero-sum game of buyers versus sellers. We show that this slant on the issue is inappropriate, and that policymakers should initially trust firms to do what is in the interest of consumers with regard to investments in network intelligence until someone proves otherwise.

### **Differential Impact in Rural, High-Cost Areas**

The distribution of the costs and benefits of network neutrality regulation is also important. In PHOENIX CENTER POLICY PAPER NO. 25 we show that the cost of network

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<sup>13</sup> George S. Ford, Thomas M. Koutsky and Lawrence J. Spiwak, *The Efficiency Risk of Network Neutrality Rules*, PHOENIX CENTER POLICY BULLETIN NO. 16 (May 2006).

neutrality mandates will be felt disproportionately in rural and high-cost regions of the country.<sup>14</sup> Our empirical analysis shows that the distribution of costs across markets of different sizes and population densities causes the network neutrality mandates to more severely curtail of network deployment in rural areas. On average, rural, high-cost areas will bear the burden of network neutrality mandates at a magnitude of six times the impact relative to lower-cost urban areas.

As we described in POLICY BULLETIN NO. 16, if broadband traffic management is prohibited and broadband providers are only permitted to invest in more “bandwidth” to address capacity problems, the potential size of these increased costs, according to some estimates, is very high.<sup>15</sup> In rural, high-cost areas, these increased costs may be the difference between whether entire swaths of this country get left behind and do not see investment in broadband infrastructure.

Stated simply, if you drive up the costs of building and operating a broadband network by limiting traffic management options, then the impact of that decision will be felt far more in high-cost rural areas than Palo Alto, California or Cambridge, Massachusetts.

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<sup>14</sup> G. S. Ford, T. M. Koutsky and L. J. Spiwak, Spiwak, *The Burden of Network Neutrality Mandates on Rural Broadband Deployment*, PHOENIX CENTER POLICY PAPER NO. 25 (July 2006)(available at: <http://www.phoenix-center.org/pcpp/PCPP25Final.pdf>).

<sup>15</sup> G. Ford, T. Koutsky and L. Spiwak, *The Efficiency Risk of Network Neutrality Rules*, PHOENIX CENTER POLICY BULLETIN NO. 16 (May 2006) (available at: <http://www.phoenix-center.org/PolicyBulletin/PCPB16Final.pdf>).

### **Increases in Transaction Costs Can Harm Consumers**

Network neutrality proponents seem ever-fearful of commercial transactions between broadband service providers and on-line content firms. Out of a concern over vertical leveraging, there have been legislative proposals to prohibit AT&T, Comcast, Verizon, or any of the other broadband service providers from contracting with Amazon, Google, the National Football League, or any other content firm to ensure timely delivery of purchased content. (Notably, such voluntary arrangements already exist.<sup>16</sup>) Any arrangement for a higher quality transaction, the argument goes, is best made between the consumer and broadband provider after the transaction is made between the consumer and the content provider. Arguably, the intent of the rule is to protect both consumers and content firms from the exercise of market power by the broadband provider.

In POLICY PAPER NO. 28, however, we showed that under plausible conditions, rules that prohibit efficient commercial transactions between content and broadband service providers could, in fact, be bad for everyone—consumers would pay higher

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<sup>16</sup> S. Nassauer, *ESPN Charges Net Providers for Right to Offer Broadband Web Site*, WALL STREET JOURNAL (Aug. 1, 2006).

prices, broadband service providers earn lower profits, and even the Internet content, software and application firms see lower sales.<sup>17</sup>

Transaction cost economics teaches that over time, the market will tend to develop relationships that are efficient and minimize transaction costs, thereby expanding output. However, a network neutrality rule jumps the government in the middle into these transactions and alters decisions. The result would be that otherwise-efficient transactions are replaced with more expensive ones. This hardly seems like good policy. Despite the obvious shortcomings of prohibiting this entire category of voluntary exchange, calls for such a prohibition remain an important part of the network neutrality agenda.

### **Welfare Consequences of Network Neutrality**

To date, network neutrality advocates have not adequately taken into account the welfare consequences of their proposals. Because the purpose of regulation is to improve welfare, the general absence of welfare analysis is a significant shortcoming.

Instead, what we see are statements that “upstream” providers—the Googles and Microsofts of the world—would benefit if network neutrality rules were applied across the board. But enriching one set of firms at the expense of another says little

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<sup>17</sup> G. S. Ford, T. M. Koutsky and L. J. Spiwak, *Network Neutrality and Foreclosing Market Exchange: A Transaction Cost Analysis*, PHOENIX CENTER POLICY PAPER No. 28 (March 2007)

about overall consumer or social welfare. Little or no research has been done to actually *prove* or *show* that this transfer of wealth from one industry sector to another will actually benefit consumers and society as a whole.

Nicolas Economides, an economist at New York University who has contributed much to network economics over his distinguished career, has presented a theoretical analysis of a two-sided market in which a broadband provider can levy a charge on either or both users and content firms. The problem modeled is clearly relevant to the debate, and Dr. Economides generally supports network neutrality regulation.

Dr. Economides shows that under certain conditions, the upstream charge can reduce welfare, thereby supporting portions of the network neutrality agenda. But it is not difficult to find equally plausible parameterizations of the model where the upstream charge increases welfare. The theoretical result, then, is ambiguous. As an economist, it is difficult to imagine how it could be any other way. Dr. Economides' model, as would any sensible model of this problem, shows that charges by network firms to service providers may enhance welfare—a result that makes untenable the presumption that such charges are always undesirable.

The paper by Dr. Economides is an important contribution, and others have tried to undertake a more technical analysis of network neutrality regulation. Last year,

much was made by network neutrality advocates about a study by University of Florida researchers from the Department of Decision and Information Sciences.<sup>18</sup> Yet the paper is rarely cited today because on close analysis it shows that under no circumstances will consumer welfare be improved by network neutrality regulation. In fact, the Florida Study suggests that the only “winners” from network neutrality regulation are the Internet content providers—with broadband service providers and consumers being worse off (or, in some cases, unaffected).<sup>19</sup>

Moreover, a subsequent study on the same topic by Economics Professor Mark Jamison, also at the University of Florida and a recognized scholar on communications policy, has been entirely ignored by the network neutrality advocates. It tackles the same problem as the original Florida Study, using more reasonable assumptions and better modeling techniques. It comes out with the conclusion that network neutrality regulation would reduce, not increase, network investment. Jamison also finds that offering premium services to content firms stimulates innovation at the network edge and is beneficial to content firms, and more beneficial to smaller content providers than larger ones. Subscription also increases. The analysis suggests that network

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<sup>18</sup> *The Debate on Net Neutrality: A Policy Perspective*, Working Paper, Department of Decision and Information Sciences, Warrington College of Business Administration, University of Florida (Mar. 2007) (“Florida Study”)(available at <http://ssrn.com/abstract=959944>).

<sup>19</sup> George S. Ford, PHOENIX CENTER PERSPECTIVES NO. 07-01: *University of Florida Study Shows Only Winners from Network Neutrality Regulation to be Content Providers, Consumers Lose* (March 14, 2007)(available at: <http://www.phoenix-center.org/perspectives/Perspective07-01Final.pdf>).

neutrality limiting premium services to content firms is obviously not a good thing in nearly any dimension.

With regard to the incentives to engage in the types of behavior network neutrality regulation aims to prevent, the most frequently cited paper is authored by Dr. Barbara Van Schewick.<sup>20</sup> The topic of exclusionary conduct has been widely studied by economists, and Joe Farrell and Phil Weiser provide a good introduction to that literature.<sup>21</sup> Their paper shows that while there are instances where firms have incentives to engage in exclusionary behavior, the general rule is that they do not.<sup>22</sup> Even in the presence of exclusionary conduct, the welfare consequences of exclusionary acts are often ambiguous, so in a policy context not only must one demonstrate the incentive exists for anticompetitive exclusion, but also establish that the act reduces welfare. This is no easy task.

Dr. Van Schewick claims to provide “new exceptions” to the general rule that a monopolist will not leverage its market power into related markets. While she purports to present “new theory,” there is in fact no theoretical analysis in the paper of a technical nature, which is required for these problems. Essentially, Dr. Van Schewick adopts the theoretical conclusions from papers by Farrell and Katz (2000) and Whinston (1990), yet

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<sup>20</sup> Barbara van Schewick, *Toward an Economic Framework for Network Neutrality Regulation*, 5 JOURNAL ON TELECOMMUNICATIONS AND HIGH TECHNOLOGY LAW 329-391 (Winter 2007).

<sup>21</sup> *Supra* n. 8.

<sup>22</sup> This point is echoed by Van Schewick, *supra* n. 20 at 340-1.

applies them to an entirely unrelated set of assumptions than those found in either of papers.<sup>23</sup> Obviously, this approach is invalid. Theoretical conclusions are intimately tied to the assumptions upon which they rest.

Upon closer inspection of Dr. Van Schewick arguments, neither the Farrell-Katz or Whinston paper have anything much to do with her scenarios. In fact, the notion of “outside revenues” that she introduces suggests independent rather than complementary goods, so it seems that much of the exclusionary literature is largely irrelevant to her problem. Models of exclusion, tying, and foreclosure are typically limited to goods with demand interdependencies. It is hard to say much specific about the Van Schewick paper, however, since there is no theoretical model to evaluate. Dr. Van Schewick does not indicate whether her “new theory” is one of fixed or variable proportions, whether goods are complements or independent, whether the cost and demand relationships are linear or otherwise, whether there is perfect or imperfect competition in the complementary market, and so forth. There is no way that the standard tools of economics can be applied to the scenario she describes given the lack of specificity.

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<sup>23</sup> J. Farrell and M. Katz, *Innovation, Rent Extraction, and Integration in Systems Markets*, 48 JOURNAL OF INDUSTRIAL ECONOMICS 413-432 (2000); M. D. Whinston, *Tying, Foreclosure, and Exclusion*, 80 AMERICAN ECONOMIC REVIEW 837-859 (1990).

What we can loosely infer from her specific use of Whinston is the following, though I urge caution since it is impossible to say anything too specific given the vagueness of what is been provided in the paper. In the sense Dr. Van Schewick relies on Whinston, for tying to be a profitable strategy to the broadband provider it would need to eliminate all competition in the content market—every single firm.<sup>24</sup> The broadband firm, for example, must monopolize search engines, monopolize book sales, monopolize advertising sales, monopolize pornography sales, and so forth. This seems highly improbable.

The use of Farrell-Katz is perhaps even more awkward, but Dr. Van Schewick relies heavily on their conclusions. Farrell-Katz make the following observations, “[the monopolist] has broad incentives to cooperate with independents, and no incentives to hinder them, whether or not the [the monopolist] is integrated.” And, the authors note, “threatening exclusion could be profitable [for the monopolist] although carrying out the threat is never profitable[.]”<sup>25</sup> Obviously, if you are pushing for network neutrality regulation, this is a somewhat odd paper to rely on.

For one of her “new exceptions,” Dr. Van Schewick merely observes the well known theoretical result that regulation can lead to sabotage. The treatment, or

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<sup>24</sup> Whinston, *id* (“firm 1 would never commit to tying unless this would succeed in driving firm 2 out of the market.”).

<sup>25</sup> Farrell-Katz, *supra* n. 23, at 422.

mistreatment, of VoIP providers is generally based on the regulated price for access charges for such providers (at zero), which incents some local exchange carriers, primarily rural carriers with very high access charges, to sabotage VoIP. This finding is not new, and Dr. Van Schewick mistakes the regulation-induced action for something else. If local exchange carriers were allowed to price more freely, then they would have no reason to sabotage VoIP.

The welfare effects are even more problematic for Dr. Van Schewick. Whinston concludes “when tying does lead to exclusion of rivals, the welfare effects both for consumers and for aggregate efficiency are in general ambiguous.... This fact, combined with the difficulty of sorting out the leverage-based instances of tying from other cases, makes the specification of a practical legal standard extremely difficult.”<sup>26</sup> The same is true for Farrell-Katz. The actions of the monopolist have ambiguous welfare effects.<sup>27</sup>

These first two studies make up the bibliography of the technical analysis that allegedly supports network neutrality regulation. As discussed, neither really does in any unambiguous sense, and one provides senseless results based on senseless assumptions and mathematical error. Dr. Van Schewick’s paper provides no technical analysis, but incorrectly applies theoretical results from entirely different scenarios to her own. Even absent this error, the welfare effects of her alleged exclusionary acts are

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<sup>26</sup> Whinston, *supra* n. 23, at 839, 856.

<sup>27</sup> Farrell-Katz, *supra* n. 23, at 430.

ambiguous, or perhaps uncertain is more legitimate given the lack of specificity in the analysis. The welfare effects in such models, however, are almost always ambiguous.

Advocates for network neutrality are today arguing for significant regulatory intervention into the operation of the Internet. Ignoring the welfare implications of such regulations is unacceptable. Supporting network neutrality regulation with papers showing that that consumers are made worse off by the regulation is shameful. In my opinion, ambiguity in welfare effects is evidence for inaction or at least caution; certainly ambiguity does not support a presumption that a behavior is undesirable.

#### **IV. Conclusion**

Let me summarize my main points:

*First*, I recommend that the FCC insist that all proponents of network neutrality or network management regulation show convincingly that their proposed rules will indeed have the intended effect of increasing consumer and/or social welfare. Moreover, the regulation must do so efficiently, in that the costs of the regulations are less than the benefits. The burden of proof should rest on those proposing regulation, since the 1996 Act explicitly calls for deregulation in communications.

*Second*, I encourage the FCC to avoid policies that nudge the industry in the direction of economic consolidation. The market likely will be concentrated for the foreseeable future, and there is little one can do to improve things. But, policy can make it worse. As a result, try to avoid actions that shrink the revenues of facilities based firms by

excluding or limiting access to markets, avoid actions that increase fixed and sunk entry costs, and avoid exacerbating scale economies by commoditizing services. Policymakers must also recognize that network neutrality regulations are likely to have a disproportional effect on small firms and rural markets.

*Finally*, with regard to broadband traffic management practices in particular, recognize that contrary to popular belief, targeted remedies for congestion are welfare-enhancing. Consumer surplus and total social welfare rise when network operators use traffic management tools such as differential pricing, traffic prioritization, traffic shaping, and even blocking to manage congestion. The welfare gains are larger when the remedy is highly targeted to the source of the problem, even if that source is a particular application. Broad, untargeted solutions are likely to be highly inefficient. Further, because a for-profit network operator will not fully internalize the cost to society of a negative, we can presume that a for-profit network operator's actions to control congestion are legitimate absent compelling evidence otherwise.

Thank you once again for the opportunity to testify before you today, and I look forward to your questions.

Prepared Remarks of Brett Glass

Owner and Founder of LARIAT, an ISP serving Laramie and Albany County, Wyoming  
Delivered at the FCC *en banc* hearing on network management  
practices  
Stanford University, April 17, 2008

Chairman Martin and Members of the Commission:

I'm extremely grateful for the opportunity to speak to you today and would like to thank you for inviting me. It's good to be back at my Alma Mater and again to be on this stage -- where I spoke and performed music several times while I was here obtaining my Master's Degree in Electrical Engineering. When I arrived at Stanford in 1983, the ARPAnet -- for that is what it was called at the time -- had just transitioned from the outdated "Network Control Protocol" to the newfangled "TCP/IP", which is now the *lingua franca* of the Internet. I followed the network's trials and tribulations as I studied, and also participated in a project, headed by Dr. Michael Flynn, whose goal was to develop digital radios for the recently available unlicensed 900 MHz band. As part of that project, I independently invented a digital coding technique known as Trellis Coding, which is used in all manner of modems and radio equipment today. At around the same time, our colleagues and football rivals across the Bay at UC Berkeley were working on a digital radio project called the Daedalus project. All of this work, and the work of other researchers, were eventually integrated by NCR into a product called WaveLAN -- the granddaddy of today's Wi-Fi.

Several years later, as the ARPAnet was becoming today's Internet, I moved from the San Francisco Bay area to Laramie, Wyoming, a city with which I had fallen in love when I was much younger and where I'd decided to put down roots. Folks there had heard about this Internet thingie, but all that was available at the time -- except on the University of Wyoming campus -- was CompuServe at 2400 bits per second. Not wanting our small city of about 25,000 people to fall behind the curve, I founded LARIAT -- a rural telecommunications cooperative -- to bring Internet to the community. I and other interested business owners started by borrowing a bit of bandwidth from the University to build a "proof of concept" network, and then transitioned to buying our own. At the time, a T1 line cost \$6,000 a month, but we pooled our money and partnered with other providers to bring the connection into my office.

The problem, once we got it there, was how to divvy it up among all the people who were paying for it. The answer turned out to be the technology upon which I'd worked here at Stanford. We bought some of the NCR radio equipment and set up a metropolitan area network spanning downtown Laramie. As far as I or anyone else can tell, this made us the world's first WISP, or wireless Internet service provider.

Fast forward to 2003. The Internet was now well known, and the growing membership of

LARIAT decided that rather than being members of a cooperative, they simply wanted to buy good Internet service from a responsible local provider. So, the Board prevailed upon me and my wife -- who had served as the caretakers of the network -- to take it private. We did, and have been running LARIAT as a small, commercial ISP ever since. But after all these years, our passion for bringing people good, economical Internet service hasn't changed. And nothing can beat the sense of achievement we feel when we hook up a rural customer who couldn't get broadband before we brought it to them -- or when we set up a customer who lives in town but has decided to "cut the cord" to the telephone company or cable company and go wireless with us. We make very little per customer; our net profit is between \$2.50 and \$5 per customer per month. But we're not doing this to get rich. We're doing this because we love to do it.

In other words, from the Internet's earliest days, we at LARIAT have been the strongest possible advocates of consumer choice; of free speech; of inexpensive, fast, high quality access to the Internet. It's our mission and our passion. And we are unqualified advocates of network neutrality as it was originally defined: namely, the principle that Internet providers should refrain from leveraging their control of the pipes to engage in anticompetitive behavior. It is inexcusable for the cable company to throttle or block video because it competes with their own services, or for a telephone company to block Voice over IP because it's another way of making a telephone call. And I think pretty much everyone -- except maybe some of those monopolies -- agrees.

Unfortunately, because "network neutrality" seems like such a sensible idea and has so much momentum, various parties have sought to extend the definition beyond this basic principle -- in ways that favor their own interests and which are, ironically, non-neutral. These attempts to "hijack" the network neutrality bandwagon are dangerous because many of them seek to force ISPs not to manage our networks; not to stop abuse or exploitation of our networks; and not to insist that we be paid for the use of our networks. And if rules and legislation are enacted that enforce these expanded definitions of "network neutrality," they actually could put our small, competitive provider out of business.

Several people who have spoken before this Commission and before Congress have claimed that Internet service is the province of a cable/telco "duopoly" which must be reined in by regulations to keep it from exploiting its market power. Fortunately, as of the moment, this is not true. Estimates vary, but most agree that there are between 4,000 and 8,000 small, independent, competitive ISPs such as ourselves. These small operators need to be nurtured, protected from anticompetitive behavior, and given an opportunity to grow.

The "hot button" issue in the recent hearings has been ISPs' throttling or blocking of so-called "P2P" activities, including those carried on via software such as GNUtella, BitTorrent, eDonkey, and KaZaA. Because my time here is brief, I've summarized the situation in two slides. Here, in the [first slide](#), you see the way that content and services are normally delivered on the Internet. The provider of the content or service sets up a server -- usually in a building

called a "server farm" -- where Internet bandwidth is cheap and plentiful. The information travels across the Internet backbone and reaches the ISP, which pays much higher prices for bandwidth -- often as much as \$300 per megabit per second per month. (By the way, these prices have lately been increasing -- not decreasing -- due to mergers and consolidation in the backbone market.) The ISP also maintains the expensive infrastructure that connects users to the backbone. The user pays the ISP to do this. This situation fulfills the implicit contract of the Internet which has been in place ever since it stopped being the government funded ARPAnet: everyone buys his or her connection to the backbone.

In the [second slide](#), you see what happens when you have P2P. In this case, the content or service provider doesn't pay its full freight for connectivity to the backbone. Instead, it turns the users' computers into servers, which in turn distribute its content or services. And users often don't even know that this is occurring. All they know is that they installed the "downloading software" or other software that let them access the product.

This situation is great for the content provider; its bandwidth costs are reduced to nearly zero. And the customer -- who in the United States virtually always has flat rate service -- doesn't pay any more, because the service is flat rate. So, where do the bandwidth costs go? The answer: they are dumped on the ISP. What's more, because the ISP -- especially a rural ISP, but it applies to all of them -- pays much more per megabit to buy bandwidth and deliver it to customers, the costs are not only shifted but multiplied several hundredfold in the process. It's obvious to anyone that this isn't fair and it isn't in any way "neutral." The content provider is, in essence, setting up a server on the ISP's network without permission and without compensation. This is why ISPs virtually always prohibit P2P and also the operation of servers on residential connections by contract. Our contract with our users says this, and we fully disclose it; we do not hide it. If someone does want to operate servers on our network, we can offer him or her "business grade" bandwidth, for which we charge a fair price that takes these extra costs into account. But P2P makes the bottom lines of such companies as Vuze look better, so of course they want to mandate that it be allowed on all connections -- no matter how non-neutral this is or what harm it does to ISPs.

This is clearly the motivation of companies like Vuze -- and also of BitTorrent, which provides its software -- in asking that P2P throttling be prohibited. But what about Free Press and the other petitioners who claim that limiting P2P harms free speech? As a strident advocate of free speech myself, I can say that their hearts appear to be in the right place, but they do not seem to recognize where the real threats to free speech lie. Throttling or prohibiting P2P activity is not a threat to free speech, because any content or service which can be delivered via P2P can also be delivered by conventional and fair means. (I've cited a few examples in my [third slide](#).) What *would be* a threat to consumers and to free speech is the elimination of competition -- which, ironically, is just what would happen if rules were imposed which prevented ISPs from doing something to rein in P2P. If this Commission grants the petitions entered by Vuze and of Free Press et al, it will sting some of the large providers like Comcast.

But it would drive smaller competitors with higher backbone bandwidth costs out of business -- and thus would likely create the "duopoly" about which many are justifiably concerned. You may have seen the news reports from the United Kingdom that widespread deployment of the BBC's "iPlayer" P2P software is causing a similar effect. While the BBC is not a for-profit entity, the fact that it is shifting the cost of wildly popular and voluminous video content to ISPs is causing even some of the larger ones, such as Tiscali, to say, "That's not cricket."

There are other problems with P2P as well. It congests networks, degrading quality of service for other customers. It exploits known weaknesses in the TCP/IP protocol -- which became obvious when I was here at Stanford but have never been adequately fixed -- to seize priority over applications such as voice over IP that really need priority. And it's mostly used for piracy of intellectual property -- something we can't condone.

What's the answer to this problem? Some parties claim that we should meter all connections by the bit. But this would be bad for consumers for several reasons. Firstly, users tell us overwhelmingly that they want charges to be predictable. They don't want to worry about the meter running or about overage charges -- one of the biggest causes of consumer complaints against cell phone companies. Secondly, users aren't always in control of the number of bits they download. Should a user pay more because Microsoft decides to release a 2 gigabyte service pack for Windows Vista? Or because Intuit updates Quicken or Quickbooks? Or because a big virus checker update comes in automatically overnight? We don't think so. And we don't need to charge them more, so long as they are using their bandwidth just for themselves. It's when third parties get hold of their machines, and turn them into resource-consuming servers on our network without compensating us for those resources, that there's a problem. Thirdly charging by the bit doesn't say anything about the quality of the service. You can offer a very low cost per bit on a connection that's very unsteady and is therefore unsuitable for many things users want to do -- such as voice over IP. And finally, a requirement to charge by the bit could spark a price war. You can just imagine the ads from the telephone company: \$1 per gigabyte. And then the ads from the cable company: 90 cents per gigabyte. And then one or the other will start quoting in "gigabits" to make its price look lower, and so on and so forth. All Internet providers will compete on the basis of one number, even though there's much more to Internet service than that.

The problem is, small ISPs cannot win or even compete in this price war, especially when -- as is true in most places -- the monopolies backhaul their connections to the Internet and thus control their prices. Again, we wind up with duopoly.

I would submit that the best answer is that, rather than micromanaging ISPs' businesses or trying to dictate their business models or price structures, the FCC should do three things. Firstly, it should make strong rules prohibiting anticompetitive behavior, since this is something nearly everyone agrees on. Secondly, it should ensure that all ISPs have access to the Internet backbone at a fair and reasonable cost -- something which, again, has become harder and harder due to mergers and acquisitions and refusal to deal. (For example, the three fiber

backbones traversing the Laramie valley, once owned by Wiltel, Broadwing, and Level3, are now all owned by Level3 -- which sells access to very large companies such as Cox and Echostar but has been refusing to open a point of presence to sell access to us.) And finally, the Commission should require full disclosure from all parties -- not only ISPs but also content and service providers who try to commandeer users' computers as their own servers. I've laid out a series of basic principles for network neutrality and sound regulation on my Web site at <http://www.brettglass.com/principles.pdf>. You'll note that the very first principle says that users should absolutely have access to the legal content and services of their choice -- but not in a way that abuses the network or allows third parties to abuse it.

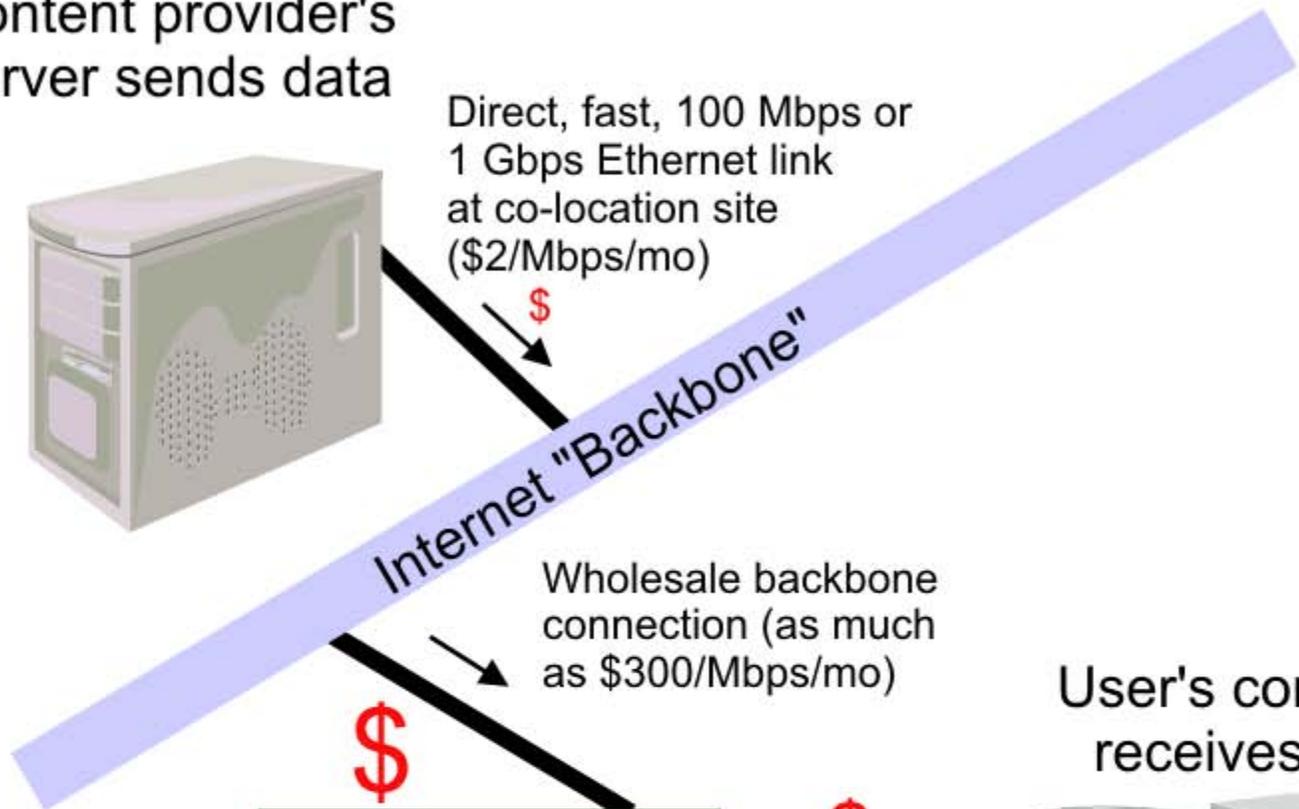
Please consider that document -- which I have also submitted as an attachment to an ex parte memo in the docket -- as a basis for sound regulation that will help, rather than hurt, the cause of true network neutrality.

Brett Glass, Owner and Founder  
LARIAT  
PO Box 383  
Laramie, WY 82073-0383  
(307)745-0351

# Client-Server Content Delivery

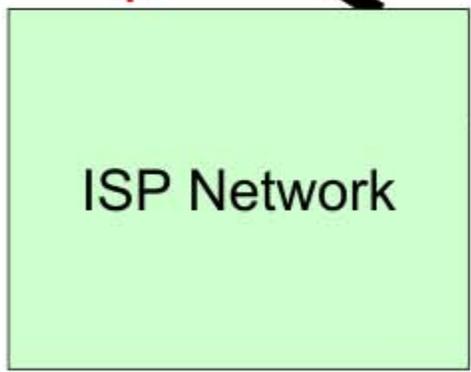
Content provider's server sends data

Direct, fast, 100 Mbps or 1 Gbps Ethernet link at co-location site (\$2/Mbps/mo)



Internet "Backbone"

Wholesale backbone connection (as much as \$300/Mbps/mo)



User's computer receives data



Local loop (DSL, cable modem, wireless)

\$

\$

\$

# Does restricting P2P limit speech? Or access to lawful content and services?

- Any content or service deliverable via P2P is also deliverable via other means
- Therefore, if content is inaccessible, it is not the fault of an ISP who blocks P2P simply to prevent cost-shifting or enforce its terms of service. The onus falls upon the content provider to offer non-P2P-based access as an alternative.
- Examples of P2P-based and non-P2P-based services:

<b>Service</b>	<b>P2P vendor</b>	<b>Non-P2P vendor</b>
Telephony	Skype	Vonage
Video	Vuze	YouTube
Gaming	Blizzard Entertainment*	Blizzard Entertainment*

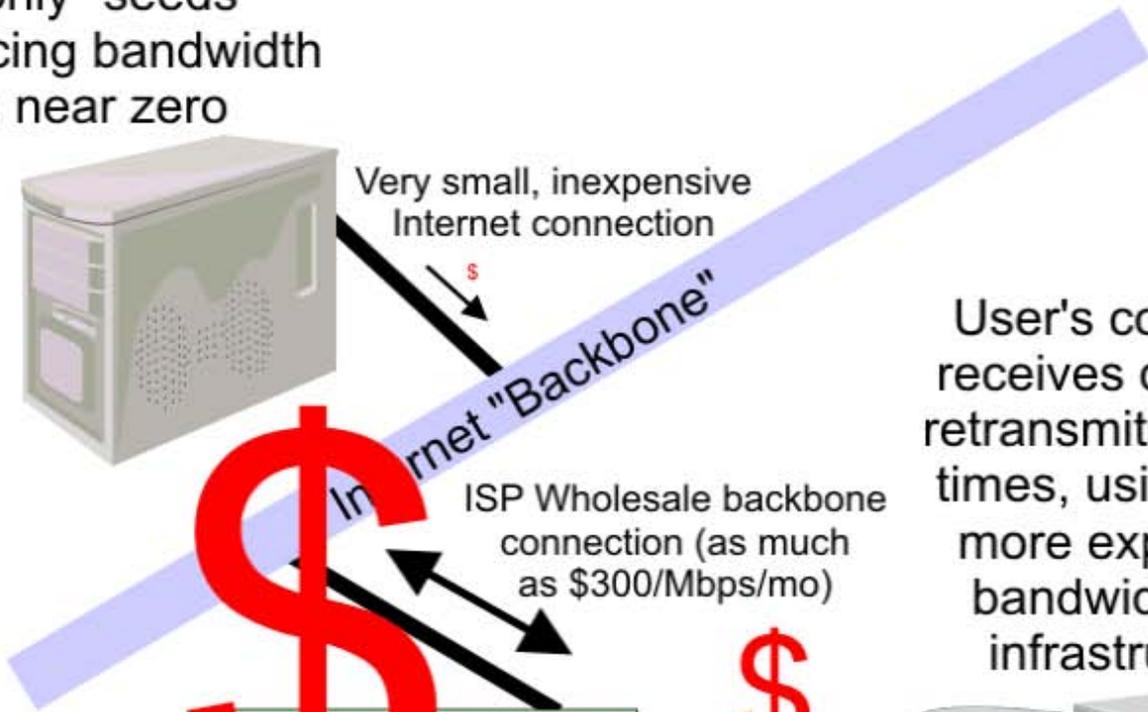
\* Blizzard Entertainment allows both P2P and non-P2P downloads of updates to its online games.

# P2P Content Delivery

Content provider's server only "seeds" data, reducing bandwidth cost to near zero



Very small, inexpensive Internet connection



Internet "Backbone"

User's computer receives data and retransmits it many times, using ISP's more expensive bandwidth and infrastructure

ISP Wholesale backbone connection (as much as \$300/Mbps/mo)



Because user has flat rate service, ISP is saddled with huge bandwidth costs



ISP Network



Local loop must be upgraded to handle bigger loads



# Seven Principles

- "Seven Network Neutrality Principles and Guidelines for Appropriate Regulation" at <http://www.brettglass.com/principles.pdf>
- -
- Contains *original* principles of "network neutrality," including prohibition of anticompetitive conduct
- Recognizes that content providers as well as ISPs have responsibilities -- in particular, to make content accessible via software that does not attempt to exploit ISPs' networks or set up servers there without permission or compensation
- Disclosure of ISP terms of service required
- Right of network operators to halt abuse preserved
- Document is a work in progress; input welcome

**OPENING STATEMENT OF  
COMMISSIONER ROBERT M. McDOWELL**

**Second Public *En Banc* Hearing  
On Broadband Network Management Practices  
Stanford University, Palo Alto, California  
April 17, 2008**

Thank you Mr. Chairman. Also, many thanks to Stanford for hosting us today. And I also thank our distinguished panelists for speaking with us. But I am disappointed that, apparently, AT&T, Comcast, Verizon and Time-Warner did not accept our invitation to appear today. So it appears that we have only one network operator witness for our hearing on network management. Nonetheless, it's good to be back here in the Bay Area. It's also fitting that we come from Washington, D.C., the birth place of the Internet's ancestor, ARPANET, to a part of the country that has played such an important role in the Internet's development and success.

We are here today not only to examine more closely the question of what is appropriate network management, but also to reassure American consumers that the FCC takes allegations of anticompetitive conduct seriously.

At the heart of this discussion is an allegation that Comcast inappropriately manipulated the upstream bits of certain peer-to-peer (P2P) video applications, namely those of BitTorrent. This allegation is especially serious because many P2P applications carry video content that competes directly with Comcast's video content. Additionally, most residential consumers only have a choice of two broadband pipes into their homes: a cable modem pipe or a DSL pipe from the incumbent local phone company. Additionally, for several years now, roughly two-thirds of residential broadband subscribers have been cable modem customers, in part because the cable industry was

first-to-market with such broadband technology. In short, the allegations boil down to a suspicion that Comcast was motivated not by a need to manage its network, but by a desire to discriminate against BitTorrent for anticompetitive reasons. However, the conversation we are having about this matter is a healthy one and is yielding positive and constructive results.

In the meantime, America's online video market is exploding in a wonderfully energetic and chaotic way. comScore reported that Americans downloaded an unbelievable ten billion online videos last December alone! According to the *New York Times* last month, a Nielsen Media Research study revealed that thirty-nine percent of Internet users ages 18 to 34 have downloaded full-length television episodes over a three month period.<sup>1</sup> When NBC's comedy, "The Office," premiered last September, one in five of its viewings was seen online. "The Office's" premiere attracted 9.7 million broadcast viewers, while it was streamed from the Web 2.7 million times in one week.

But the world's apparent overwhelming thirst for online video content is posing an engineering challenge to network providers. Several analyses estimate that P2P applications comprise over 75 percent of the Internet's traffic. And, while I'm here in California, the intellectual property capital of the world, I would be remiss if I did not observe that pirated content is a significant part of all P2P traffic.

P2P works by "seeding" millions of consumers' computers all over the world with pieces of videos. When a consumer wants to download a video from a P2P provider, the application calls on these millions of seeded computers to send their pieces of the show upstream. At times, only five percent of broadband users are consuming as much as 90 percent of network capacity. P2P usage is causing congestion, especially on the upstream

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<sup>1</sup> Brian Stelter, *Serving Up Television Without the TV Set*, N.Y. TIMES, Mar. 10, 2008, at C1.

portion of networks that were designed and built years ago, before these P2P applications were invented.

In the future, Internet usage is likely to be largely wireless. As we discuss and debate these issues, we must consider how what we do, or don't do, will affect today's build out of tomorrow's wireless networks. Like cable networks, wireless networks are shared. They also suffer from uploading challenges. Most emerging wireless broadband providers are not also video providers in the same way as cable companies. Accordingly, if wireless broadband providers are required to manage the demands placed on the upstream portions of their networks, unlike the situation with cable, allegations of anticompetitive conduct against online video content may ring hollow. But we may not know for a long time. As a result, we should examine this complicated issue carefully before rushing headlong to codify a "solution" that may create more engineering problems than it solves.

In the meantime, the weight of the evidence in the record thus far tells us that Comcast was manipulating upstream, not downstream bits. If its actions were intended to be anticompetitive, would Comcast not have been interfering with video downloads instead? If the evidence shows that consumers could not perceive any slowing of downloaded videos due to the manipulation of uploads, is such evidence exculpatory of the charge of anticompetitive conduct? Are answers to these questions clearer after the March 26 BitTorrent/Comcast agreement? These, and many other questions, abound.

Nonetheless, contrary to rumor, the P2P congestion challenge is not unique to the United States. Japan, which offers fatter and faster pipes on average, is also experiencing vexing congestion problems when it comes to P2P applications. According to the

Japanese Embassy, a mere one percent of Japanese users consume more than half of the broadband capacity in that nation. With widespread 100 mbps service across Japan, the lesson here is that substantially more bandwidth alone in the last mile does not solve the P2P congestion problem. Something more must be done.

And something more is being done. Through a number of initiatives, the FCC has been creating opportunities for more competition in the last mile. While those efforts take root, however, the private sector is not standing still. In fact, last summer, long before the BitTorrent complaint was filed, the private sector created the P4P Working Group. The mission of this coalition of cable companies like Comcast, application providers like BitTorrent, content producers, engineers, universities and others is to:

work jointly and cooperatively with leading Internet service providers (ISPs), peer-to-peer (P2P) software distributors, and technology researchers to ascertain appropriate and voluntary best practices for the use of P4P mechanisms to accelerate distribution of content and optimize utilization of ISP network resources in order to provide the best-possible performance to end-user customers ....<sup>2</sup>

In fact, just last week, on April 9, the P4P Working Group announced the completion of successful field tests of new P2P protocols that increase delivery speeds for consumers while removing network delivery obstacles for ISPs. The results show increased delivery speeds of up to 235 percent for P2P content carried on U.S. cable networks and up to 898 percent speed increases for other networks.

And just this past Tuesday, April 15, Comcast and P4P Working Group co-chair Pando Networks, announced that they will lead an industry-wide effort to create a “P2P Bill of Rights and Responsibilities” (BRR) for P2P users and ISPs.<sup>3</sup>

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<sup>2</sup> Haiyong Xie, The P4P Working Group, <http://cs-www.cs.yale.edu/homes/yong/p4p/p4pwg.html>.

<sup>3</sup> Press Release, Comcast Corporation, *Comcast and Pando Networks to Lead Creation of “P2P Bill of Rights and Responsibilities” for Peer-to-Peer Users and Internet Service Providers* (Apr. 15, 2008).

These announcements come on top of the Comcast/BitTorrent agreement of March 26. Comcast agreed to migrate to a capacity management technique that is protocol-agnostic while BitTorrent acknowledged the need of ISPs to manage their networks, especially given that the Internet has matured into the rich media environment it has become. In their joint press announcement, Comcast and BitTorrent expressed the view that “these technical issues can be worked out through private business discussions without the need for government intervention.”<sup>4</sup>

As I have said for a long time, it is precisely this kind of private sector solution that has been the bedrock of Internet governance since its inception. America’s Internet economy is the strongest in the world. It got that way not by government fiat, but by all interested parties working together toward a common goal. By definition, the Internet, a network of networks, is a “Wiki” environment which we all share, shape, build and, ultimately, pay for. Since it was opened up for public use, as a society we have worked hard to ensure that the Internet remains open and free. We have also worked hard to ensure that the Internet works, period. We call this: Internet governance. But since the days of ARPANET, Internet governance has migrated further away from government regulation, not closer to it.

By flattening out the governance structure into a bottom-up rather than government-mandated top-down environment, it has long been believed that the Internet is better able to flourish as a more dynamic and democratic entity. In contrast, an illustration of more government control of the Internet is China’s Internet model. While

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<sup>4</sup> PR Newswire, *Comcast and BitTorrent Form Collaboration to Address Network Management, Network Architecture and Content Distribution* (Mar. 27, 2008), available at <http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=104&STORY=/www/story/03-27-2008/0004781055&EDATE=>.

this may be an extreme example, some argue that societies that regulate the Internet less are more democratic, while societies that regulate it more are less democratic.

Early efforts to keep the Internet open and free sparked the creation of non-state-controlled Internet governance entities. For example, the Internet Society (ISOC), an umbrella organization founded in 1992, develops technical standards for the Internet. It is a non-profit corporation with a board of trustees and is funded by individuals and organizations in the Internet community virtually free from any government influence. Several organizations work with ISOC on a variety of Internet governance issues.

Among them are: the Internet Engineering Task Force (IETF); the Internet Engineering Steering Group (IESG); the Internet Research Task Force (IRTF), the Internet Research Steering Group (IRSG); and the Internet Architecture Board (IAB), among others.<sup>5</sup>

These organizations are largely self-governing and self-funded, with individuals and representatives of private organizations and companies serving on their boards.

Similarly, the Internet Corporation for Assigned Names and Numbers (ICANN) is a private non-profit entity that works to govern the Internet's domain name system.

ICANN manages the domain name system through a joint project agreement with the Department of Commerce. Furthermore, ICANN is a non-profit corporation funded and governed by private entities. The P4P Working Group is essentially no different.

The point is that the Internet has flourished by operating under the principle that: engineers should solve engineering problems, not politicians and bureaucrats. But don't take my word for it. Let me close with a quote from someone we all know and who had a great deal of influence over how the Internet became privatized.

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<sup>5</sup> Association for Computing Machinery, *A Concise Guide to the Major Internet Bodies*, [http://www.acm.org/ubiquity/views/v6i5\\_simoneli.html](http://www.acm.org/ubiquity/views/v6i5_simoneli.html).

Though government played a role in financing the initial development of the Internet, its expansion has been driven primarily by the private sector. For electronic commerce to flourish, the private sector must continue to lead. Innovation, expanded services, broader participation, and lower prices will arise in a market-driven arena, not in an environment that operates as a regulated industry.

Accordingly, governments should encourage industry self-regulation wherever appropriate and support the efforts of private sector organizations to develop mechanisms to facilitate the successful operation of the Internet. Even where collective agreements or standards are necessary, private entities should, where possible, take the lead in organizing them.<sup>6</sup>

Any guesses as to who said this? It comes from the Presidential Directive announcing the “Framework for Global Electronic Commerce” signed by President Bill Clinton in 1997.

We should heed President Clinton’s advice. The government should encourage collaborative private sector solutions, such as those created by the P4P Working Group and the BitTorrent/Comcast agreement. But state intrusion into these partnerships will only inhibit future constructive endeavors. So to those who argue for more government control, I say be careful what you wish for.

Is now the time to discard that model which has served us so well after so many years of tremendous success? Would those who favor even seemingly innocuous consumer disclosure requirements on network owners regarding how they manage P2P traffic mind if a similar requirement were imposed on applications providers to reveal to consumers that their computers must be “seeded” and work 24 hours a day at the expense of your computer’s processing power to allow the P2P system to work? Such disclosure

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<sup>6</sup> Memorandum from the White House Office of the Press Secretary to the Heads of Executive Departments and Agencies (July 1, 1997), *available at* <http://www.landfield.com/govnews/mail-archives/root-hcc/0779.html>.

might be beneficial to the public interest. But isn't the private sector the best forum to initially try to resolve these conflicts?

Having said that, I want to thank BitTorrent, Free Press and Vuze for their filings at the FCC. You have stimulated the debate and spotlighted these important issues. In the end, I am optimistic that if we encourage all Internet stakeholders to continue their dialogue -- and collaboration -- we will see more win-win agreements that ultimately benefit consumers.

Thank you again to Stanford for hosting this hearing and I look forward to hearing from our distinguished panelists and members of the public.



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## Opening statement

Good afternoon Mr. Chairman and Commissioners, my name is George Ou and I am a former Network Engineer who designed and built network and server infrastructure for Fortune 100 companies. Thank you for inviting me here to speak to you about this critical matter of Network Management. I'm here to explain why network management has and always will be an essential part of the Internet.

## Past Internet crises

The Internet is an evolving standard that had its share of growing pains and it continues to face them today. The rise of FTP (File Transfer Protocol) caused "congestion collapse" in 1986 because the Internet at the time lacked a functional congestion avoidance mechanism. This was patched in 1987 by Van Jacobson's congestion avoidance algorithm which fairly allocated network resources to the applications of its time. Despite newer and more efficient congestion control standards, Jacobson's algorithm has remained dominant for over 20 years.

By the mid 1990s, the rise of the web browser turned the "World Wide Web" in to the "World Wide Wait". Because the first web browsers weren't optimized for resource utilization, they were tuned to be more resource friendly in the re-write of HTTP between version 1.0 and 1.1.

## Today's crisis on the Internet

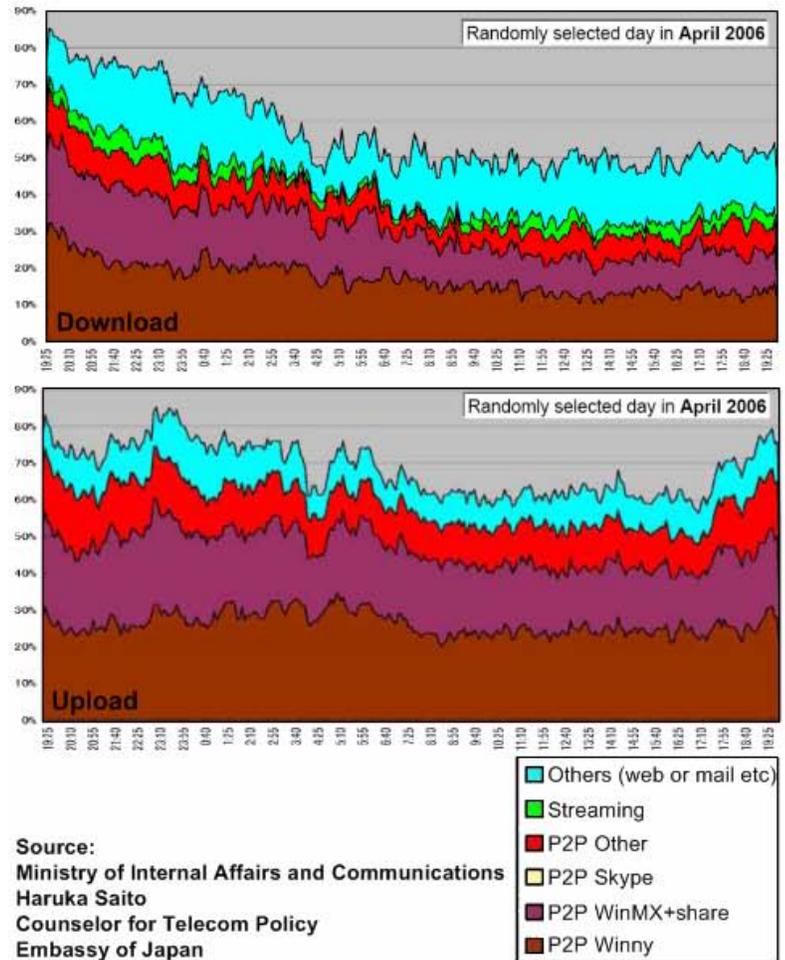
Today we face a whole new problem. P2P (Peer-to-Peer) applications are causing a new congestion collapse because broadcast video is migrating to VOD (Video on Demand) over the Internet. Because of loopholes in the TCP standard, a small percentage of users utilizing P2P are appropriating the vast majority of network capacity at the expense of every other consumer. Interactive applications like web browsing or real-time applications like Voice over IP are being unnecessarily degraded not by carriers, but by P2P users.

Even Japan, with one of the world's fastest Internet broadband infrastructure, where many homes have access to 100 Mbps or even 1000 Mbps fiber service are facing the same P2P induced congestion collapse. This has caused their government to spend the last two years studying the issue. Recently, the Japanese Ministry of Internal Affairs and Communications released a study showing that just 1% of Japan's broadband users using P2P account for roughly 47% of Japan's Internet usage. Furthermore, only 10% of Japan's broadband users using P2P account, on average, for 75% of all Internet usage.

This would be like 10 passengers on a 100-seat airplane taking up 75 seats and forcing the other 90 passengers to share the remaining 25 seats. One of those 10 passengers would take up 47 seats while the other 9 take up 28 seats. While it's perfectly acceptable for 10 people to take 75 seats when there are only 25 other people on the plane who don't mind using a single seat, it is outrageous when 90 passengers who paid just as much for their ticket as the 10 seat hogs get "de-prioritized" in to 25 seats.

On the airplane, the obvious thing to do is to tell those people to take their feet and bags off the other seats so that other passengers may sit down. Yet on the Internet because it isn't easy for everyone to see what is really going on, the P2P bandwidth hogs yell "discrimination" and persuade activists to portray them as the victims of evil corporations who are being deprived of their civil rights. If anyone dares to throttle their overconsumption in any way, activist groups demand trillion-dollar FCC fines and immediate injunctions<sup>1</sup> before the facts are even in. But there's nothing neutral or fair about what these groups are asking for and they're not the protectors of consumer rights they portray themselves to be.

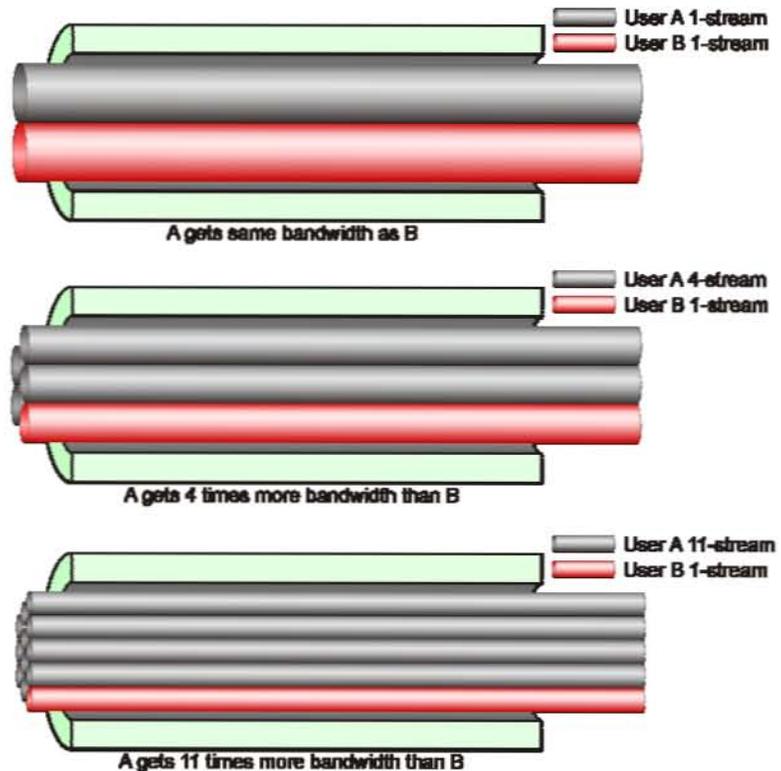
1) [http://www.freepress.net/files/fp\\_pk\\_comcast\\_complaint.pdf](http://www.freepress.net/files/fp_pk_comcast_complaint.pdf)



### The unfairness of TCP congestion control

So how could such an extreme state of unfairness be possible when TCP congestion control was supposedly fair? It's because Jacobson's TCP algorithm was only designed for the FTP problem of the 1980s, not the problems of the 1990s and beyond. It had a major loophole because it only sought to balance the flow rate of each TCP stream with no regard to how many TCP streams a person's application could open. While Jacobson's TCP algorithm worked for early Internet applications that only used one active TCP stream at a time, it's completely ineffective for the applications of today.

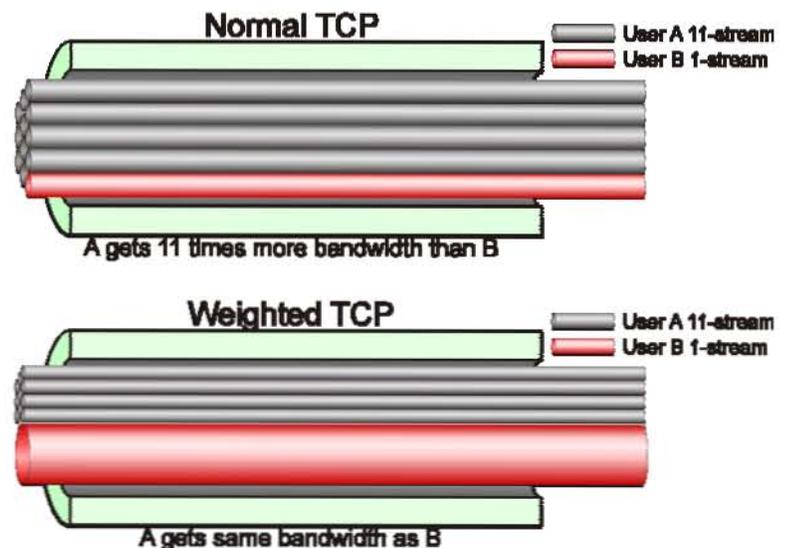
By 1999, the first P2P application called "Swarmcast" appeared on the Internet and began fully exploiting that loophole. When a P2P application opens up multiple TCP streams, each TCP stream flows at the same rate of TCP stream. That means a person using 4 TCP streams gets 4 times more bandwidth on a congested network than a person using the normal single TCP stream. The person using 11 TCP streams will get 11 times more bandwidth. Coupled with the fact that P2P applications operate non-stop throughout the day while normal applications only transmit and receive data a small percentage of the time, in short bursts, it is easy to see how only 1% of users, using P2P, have the ability to consume nearly half of all resources.



### Fixing the unfairness of TCP

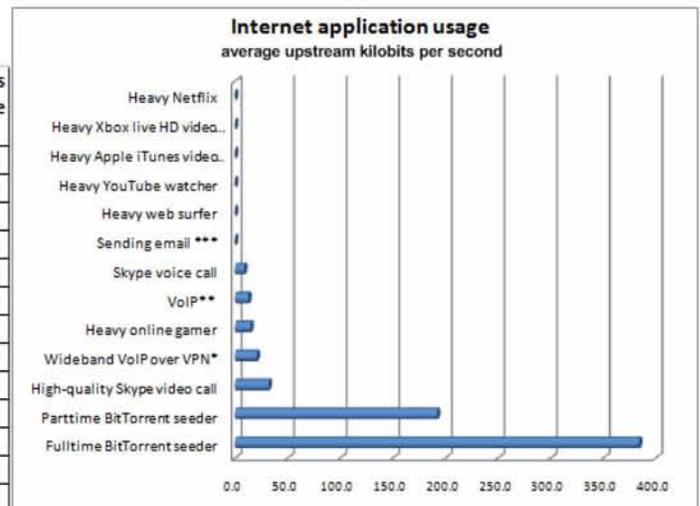
Thanks to the work of Frank Kelly and BT chief researcher Bob Briscoe, the matter of TCP unfairness is now before the IETF (Internet Engineering Task Force). Briscoe has issued an official IETF problem statement and he wants close the loopholes in TCP.

Unfortunately, making fundamental changes at the TCP standards level is extremely difficult and time consuming. Even when superior TCP congestion control mechanisms like ECN (Explicit Congestion Notification) were standardized in 2001, we have yet to see any real-world deployments because we can't force the billion-device installed base to upgrade. We're no longer in a time when a few thousand system administrators could patch all 30,000 computers on the entire Internet with Jacobson's algorithm in 1987.



## The effect of non-stop application usage on base loads

	Hours used per day	In-use upstream kbps	Average upstream kbps	Kilobytes sent per day	Sessions in use
Fulltime BitTorrent seeder	24	384	384.0	4,147,200	~20
Parttime BitTorrent seeder	12	384	192.0	2,073,600	~20
High-quality Skype video call	2	384	32.0	345,600	1
Wideband VoIP over VPN*	5	98.8	20.6	222,300	1
Heavy online gamer	10	35	14.6	157,500	1
VoIP**	6	50.8	12.7	137,160	1
Skype voice call	6	34.8	8.7	93,960	1
Sending email ***	0.0031	384	0.05	535	1
Heavy web surfer	12	0.1	0.05	<500	1
Heavy YouTube watcher	12	0.1	0.05	<500	1
Heavy Apple iTunes video user	12	0.1	0.05	<500	1
Heavy Xbox live HD video user	12	0.1	0.05	<500	1
Heavy Netflix	12	0.1	0.05	<500	1



\* Corporate VPN telecommuter worker using G.722 codec @ 64 kbps payload and 33.8 kbps packetization overhead

\*\* Vonage or Lingo SIP-based VoIP service with G.726 codec @ 32 kbps payload and 18.8 kbps packetization overhead

\*\*\* I calculated that I sent 29976 kilobytes of mail over the last 56 days averaging 0.04956 kbps

In the real world, it's extremely unlikely that there would be a BitTorrent or P2P seeder who isn't a bandwidth hog. Anyone saturating the upstream nonstop and using multiple TCP streams is by definition hogging a much larger share of bandwidth than anyone else. Even if a P2P user manually sets his/her bandwidth consumption down to a fraction of the peak upload and only seeds for 12 hours a day, the amount of upstream resources used still dwarfs every other application. As I show in the chart above, just the persistence advantage alone allows a BitTorrent client to take an order of magnitude more upstream bandwidth than even the next heaviest upstream application.

Just as it is possible to "game" the TCP algorithm using P2P applications, it is also possible to construct a contrived example in which someone uses a P2P application to upload a 4.23 MB copy of the King James Version of the Holy Bible in order, they posit, to distribute the Bible to a single person. Then, when the downloading party tries to obtain the content with enough trials, they eventually trigger Comcast's network management response (which is not accustomed to seeing the anomalous situation in which a P2P application is used to exchange information between only two users). The "testing" party can then claim that even a minimal use of upstream bandwidth by a P2P application was targeted unfairly by Comcast's TCP resets. On the face of it, this claim sounds plausible and might suggest that something is wrong. But the minute you realize that Comcast gives you a gigabyte of web hosting space which allows you to distribute to many times more people at more than 20 times the speed of using a BitTorrent seed without the need to tie up your personal computer and broadband connection, you realize the implausibility of this scenario as a practical matter.

To illustrate this point, Richard Bennett used his Comcast-allocated web space to host that copy of the King James Bible at [http://home.comcast.net/~richard\\_bennett/site/](http://home.comcast.net/~richard_bennett/site/) which is far more accessible to anyone with a web browser at blazing fast speeds. This not only benefits the users because it's easy and fast, it also alleviates congestion on the scarce upstream path on a cable broadband provider's last-mile DOCSIS network.

## Limitations of shared-medium broadband networks

	Upstream	Downstream	# of BitTorrent 24×7 seeders to kill unmanaged network
Cable DOCSIS 1.1	10 Mbps	40 Mbps	Less than 26 <sup>(1)</sup>
Cable DOCSIS 3.0 <sup>(4)</sup>	30 Mbps	80 Mbps	Less than 30 <sup>(2)</sup>
Wireless 802.11b ISP	4 to 6 Mbps shared		One <sup>(3)</sup>

1. Fewer than 26 fulltime P2P seeders saturating their upstream at 384 kbps 24×7 kills an unmanaged DOCSIS 1.1 network.
2. Fewer than 30 fulltime P2P seeders saturating their upstream at 1 Mbps 24×7 kills an unmanaged DOCSIS 3.0 network.
3. One fulltime P2P seeders OR P2P uploaders/downloaders can kill an unmanaged Wireless 802.11g network.
4. First implementations of Comcast's DOCSIS 3.0 use 2 bonded-channels downstream and a single upstream channel.

## How do we deal with the immediate crisis?

The reality is that we cannot expect any meaningful fixes on TCP for the foreseeable future, let alone world-wide deployment of such a remedy. The solution must be found in the network itself because we cannot expect ordinary users to patch their computers to behave more politely even if a patch was approved and standardized. The network must implement and enforce fairness or else we have a state of anarchy where the “wants” of the few constrain the majority of the capacity that was intended for all paying users.

But as with any technology, there are growing pains in network-managed fairness. The first generation solutions would typically use protocol throttling techniques to neutralize the disproportionately large amounts of bandwidth that P2P applications consume. Throttling is not always the most accurate method and it can't work in all network topologies but it is cheap to deploy and used where it is effective. Other first-generation solutions like the Sandvine appliance used by cable broadband companies had occasional false positives like the accidental blockage of IBM Lotus Notes, but those bugs were quickly fixed as soon as they were identified.

The bigger problem with these first generation solutions is that they may not identify all of the bandwidth hogs and they can be fooled by protocol obfuscation techniques. It is also less than ideal to force a complete stoppage of a P2P BitTorrent seed even if it's only for a few minutes at a time during congested periods of the day rather than just slowing them down. But slowing down a specific bandwidth hog requires more drastic in-line changes to the network infrastructure, as opposed to the out-of-band Sandvine boxes that merely issued TCP resets to occasionally stop P2P seeding.

**Note:** TCP resets are a commonly implemented feature in Internet firewalls and routers. TCP resets operate on the “control bits” in the transport layer and they do not constitute any modification or forgery of user data.

Critics like the Free Press and EFF claim that it would be better if users controlled their own throttling through economic incentives in the form of metered Internet access. But that would be far more draconian since users have to manually shut down P2P completely for 12 hours a day compared to having the ISP automatically shut down P2P seeds a few minutes at a time while not affecting normal P2P uploading and downloading. Any parent would appreciate the risk of their teenage child racking up thousand-dollar broadband bills because they thought it would be cool to try a new application that happens to conscript their computer as a P2P file distribution seed.

The immediate crisis is even more problematic for the wireless industry where spectrum and bandwidth is even scarcer and the capacity shared between more people than a cable DOCSIS network. One option in use today is to tell customers upfront that P2P applications aren't supported. Small wireless operators like LARIAT operating in the unlicensed 2.4 GHz spectrum space have so little shared capacity and their backhaul connections to the Internet are so expensive that they can't afford to have uploading bandwidth costs of other content corporations shifted on to them. Not only are the bandwidth costs shifted to them under the P2P distribution model, the costs are amplified by an order of magnitude because bandwidth out in the rural areas cost far more than the concentrated bandwidth in the data centers. These small wireless ISPs are often times the only Internet Service Providers in their space because larger corporations don't want to serve these less lucrative areas. As Dr. Robert D. Atkinson and Philip J. Weiser of ITIF argued<sup>2</sup>, “Even port blocking, for example, might be defensible under certain circumstances.” In this case, having a small ISP that blocks P2P serve an area is better than none at all or better than one that charges by the bit.

2) A “Third Way” on Network Neutrality <http://www.itif.org/files/netneutrality.pdf>

## Next generation network management technologies

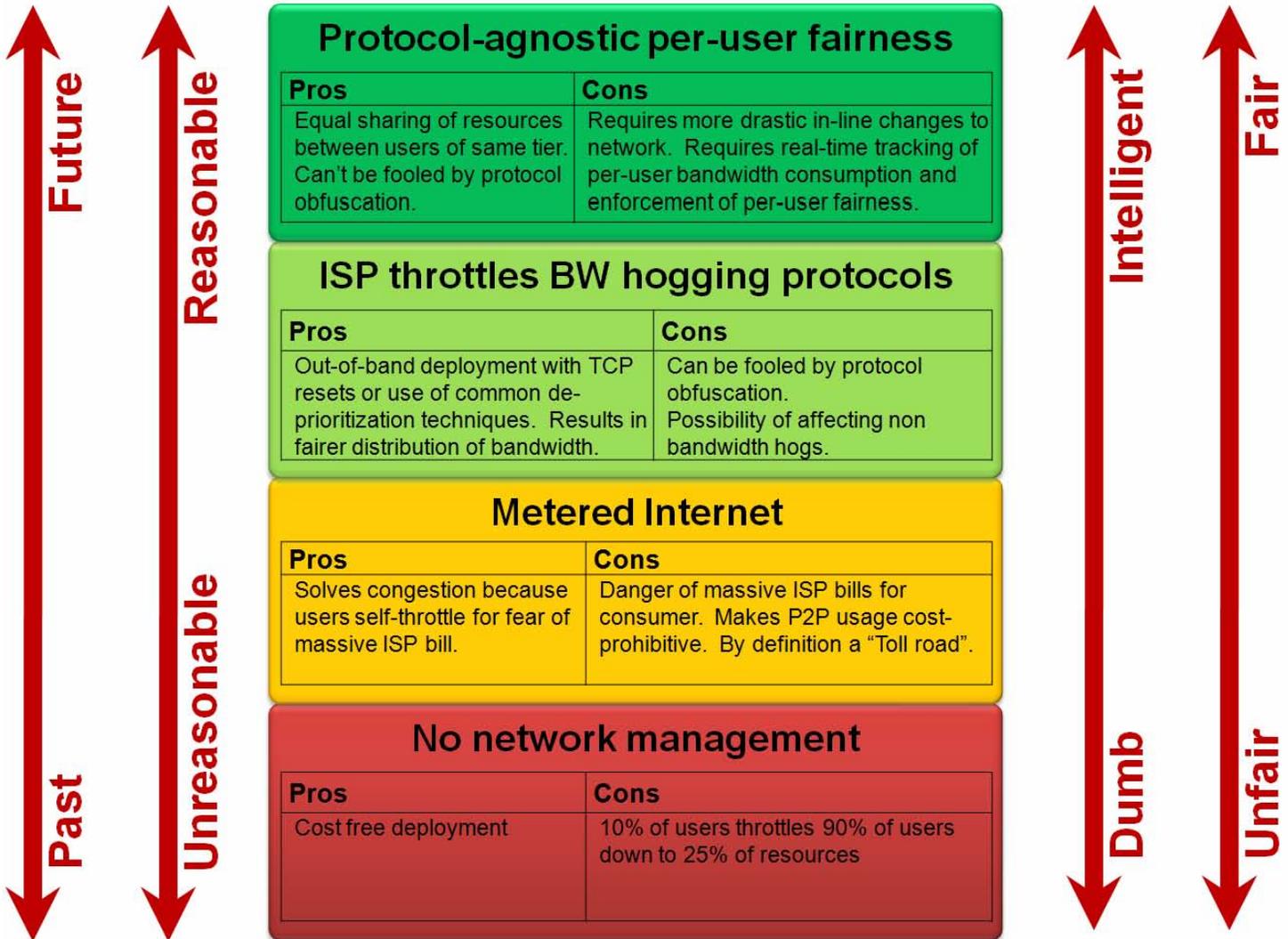
As technology matures and network management becomes more sophisticated, companies that are most susceptible to P2P congestion (those using cable or wireless shared media transmission) are committing to newer in-line technologies that are protocol-agnostic and enforce real-time, per-user bandwidth fairness. These newer technologies will avoid false positives or false negatives and more importantly, they can't be fooled by protocol obfuscation techniques because they only look at bandwidth usage patterns. They also respond to bandwidth hogs by slowing them down rather than occasionally stopping them with TCP resets.

Comcast's CTO Tony Werner explained that any congested link on their network will have 2% of the users taking approximately half of all capacity at the expense of everyone else and this is consistent with the data from Japan's government. The new in-line technology Comcast is experimenting with now will de-prioritize and throttle that 2% of bandwidth hogs down to roughly 25% of all resources and that will be enough to alleviate congestion for everyone else. When the network isn't congested, those few P2P users can resume taking as much as they please.

BitTorrent Corporation knows that the metered Internet service plans promoted by Free Press will severely harm use of their application and their business model, which is why they know it's in their best interest to work with ISPs. BitTorrent will begin to clearly label their own traffic as P2P instead of obscuring their protocol headers like most P2P clients so that network operators can properly manage them. BitTorrent is also working closely with the P4P working group to make P2P clients more efficient by selecting nearby peers instead of random peers to minimize load on the network. Finally, BitTorrent K.K., BitTorrent's Japanese subsidiary, was part of a recent working group of ISPs and applications developers in Japan that has developed "best practices" guidelines for traffic shaping—recognizing that the mere addition of network capacity will not correct a problem created by an application designed to consume all available capacity.

**How do we define what is “reasonable network management”?**

It should be reasonable to conclude that “fairness” to each paying consumer should be a key criterion in determining how reasonable a solution is. Based on that criterion, I worked out the chart below with the solutions that are either in use or being proposed.



I've defined "No network management" as the most unreasonable form of network management because it allows 10% of the users to throttle 90% of the users by leaving them with 25% of the resources. What does it matter that it's a small minority of users doing the "throttling" here rather than some corporation? Isn't the greatest amount of harm being perpetrated on the largest number of paying consumers under a non-managed network?

The Free Press argues that protocol-agnostic per-user fairness, Metered Internet, or No network management (random packet drops) would all be superior to the protocol throttling methods that employ de-prioritization or TCP reset and that protocol throttling should be banned. While we can all agree that we should move to the protocol-agnostic per-user fairness model of network management, it would be harmful to the vast majority of consumers if we insisted on immediate perfection today and banned something that was mostly fair and mostly reasonable. The market is already moving to the newer more advanced network management techniques and we should give that a chance to mature rather than forcing a change for the worst in the meantime.

## Network management ensures a harmonious coexistence

As Japan's broadband experience has shown, we will never grow our way out of congestion and we will never have enough bandwidth. But managing a network can ensure a harmonious coexistence where P2P background applications and traditional interactive or real-time applications all get what they want. All too often, non-technical Network Neutrality proponents confuse network priority with network throughput when they in fact have nothing to do with each other.

P2P will always consume the lion's share in traffic volume but they can have all the volume in the world even when they have the least priority. Interactive and real-time applications fundamentally have low volume requirements and there's no reason they shouldn't get maximum priority. It makes no difference to a P2P application if you send the interactive or real-time packets in a quick priority burst since that would only get them out of the way sooner. The interactive or real-time applications only have a small and fixed amount of data to transport so the amount they can displace the larger P2P file transfers remains constant regardless of priority given to the smaller payloads. The P2P file transfer will still be completed in the same amount of time whether that's an hour or a day. But receiving priority makes all the difference in the world to the interactive and real-time application because a human is waiting for an immediate response and voice or gaming applications can't tolerate delays that are more than a tenth of a second.

So with network management, background applications like P2P can get all the traffic volume they want in the same timely fashion with no need for draconian metered pricing. Interactive or real-time applications get the priority they need so they don't get drowned out P2P applications. But without network management regardless of how much capacity you throw at the problem, P2P applications won't run much faster but they will drown out the interactive and real-time applications on the Internet.

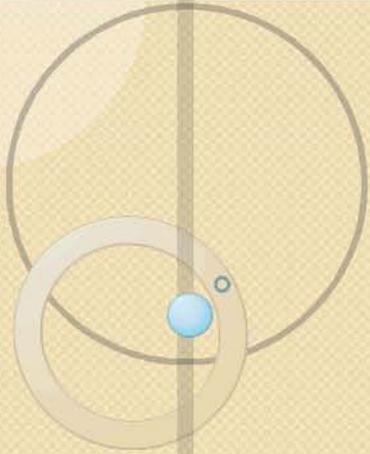
## Conclusion

The purpose of my testimony is for the Commission to recognize the efforts the networking industry is making to improve network traffic management and consumer disclosure. The industry faces a hard up-hill climb to educate consumers about the services they offer, their limitations, and their terms of use because we aren't a nation of network engineers. Perhaps the worst side-effect of the current controversy over P2P management is the large number of false and misleading statements about network engineering that have become part of the public debate. The Commission should be particularly mindful of its role in educating the public toward a genuine understanding of the Internet and its unique properties compared to the traditional telephone network. Networking is a difficult and complicated subject and I hope the Commission will consider the pragmatic, engineering concerns when crafting its policy solutions. Chairman Martin, and the other members of the Commission, thank you for taking the time to listen.

Sincerely,  
George Ou  
Former Network Engineer

## Acknowledgements

I'd like to thank Network Architect Richard Bennett, who testified at the FCC hearings at Harvard, for contributing some of the ideas and edits to this paper. I'd also like to thank BT chief researcher Bob Briscoe for his influence on this paper as well and anyone else who helped edit this paper.



# Network Management

**has always been and always will be essential to the Internet**

FCC Broadband Industry Practices Hearing  
WC Docket No. 07-52  
Stanford University  
April 17, 2008

Testimony of George Ou  
Former Network Engineer  
[www.LANArchitect.net](http://www.LANArchitect.net)



# Internet meltdown in 1980s

- Lack of adequate congestion control in TCP allowed too many FTP users to overload Internet around 1986
- Van Jacobson created congestion control algorithm for TCP in 1987
  - Congested routers randomly dropped packets to force every TCP end-point (client) to cut flow rate in half
  - TCP clients then slowly increased flow rate with every successful transmission until next packet drop
  - Caused all TCP streams to home in towards equal flow rate
  - Fair bandwidth sharing, but only for applications of its time
- Jacobson's algorithm saved the Internet in 1987 and remains dominant standard after 20 years
- Early example of managing network congestion



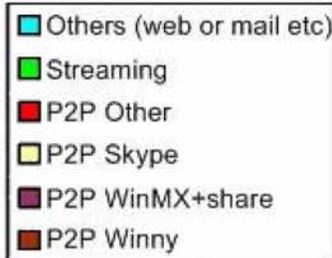
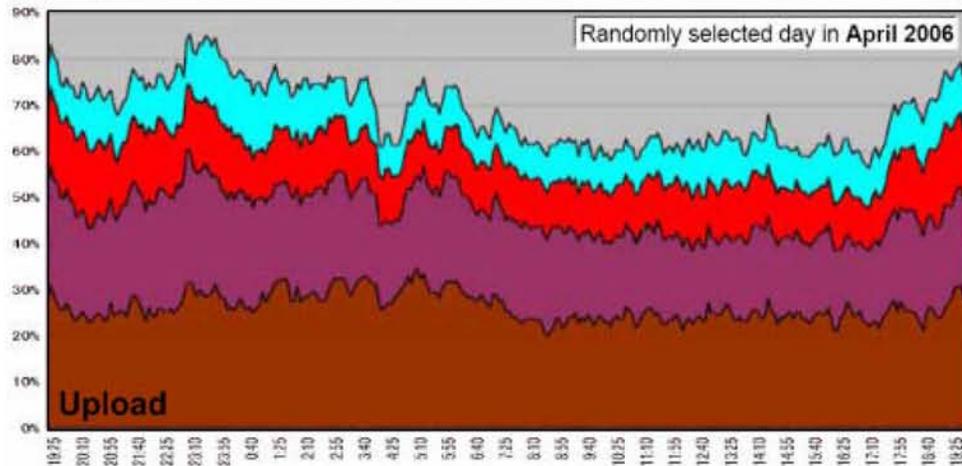
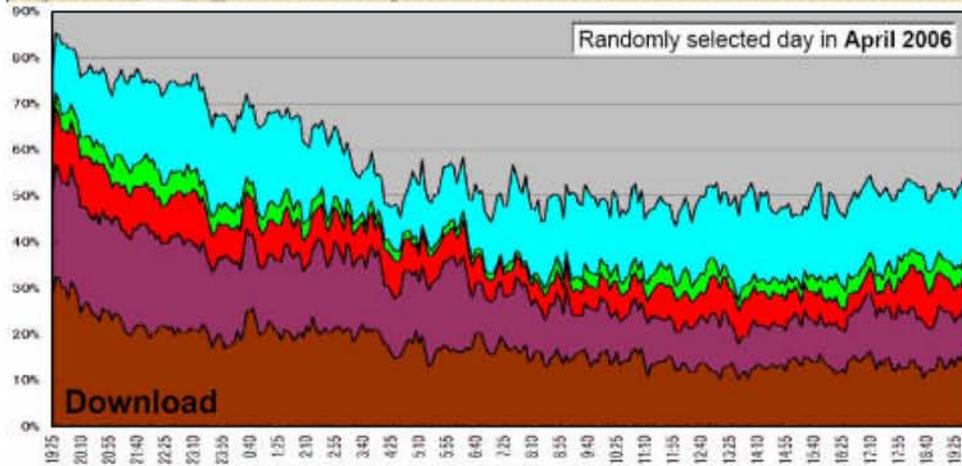
# World Wide Wait in 1990s

- First generation of web browsers were not optimized for Internet
- World Wide Web turned in to the World Wide Wait
- Version 1.1 of HTTP revamped to efficiently use resources over 1.0

# Today's crisis on the Internet

- Video-induced congestion collapse
  - Efficient existing broadcast model migrating to bandwidth-intensive Video on Demand model over IP
  - Full migration of video could require 100- to 1000-fold increase in Internet capacity
  - Exponentially more bandwidth required as video bit-rate and resolution increase to improve quality
- P2P is the dominant distribution model because most of its content is “free” (read pirated)
- Video can fill any amount of bandwidth

# More bandwidth doesn't help



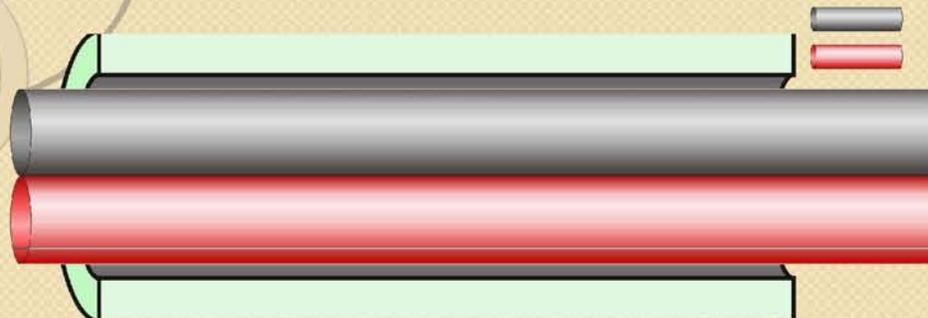
Source:  
Ministry of Internal Affairs and Communications  
Haruka Saito  
Counselor for Telecom Policy  
Embassy of Japan

The few throttling the many

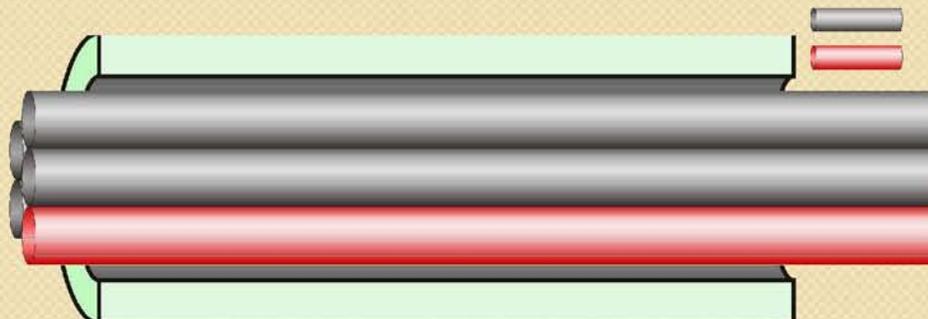
According to the Japanese Government  
1% of users account for ~47% of traffic  
10% of users account for ~75% of traffic  
90% of users get leftover 25%

Bandwidth hogs

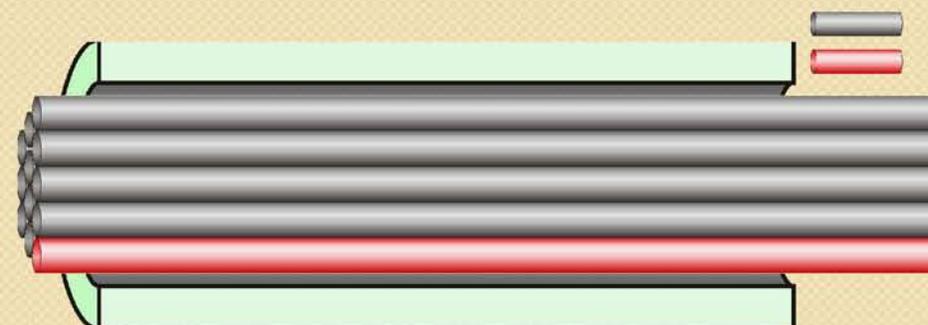
# Exploiting Jacobson's algorithm



50/50  
Fair



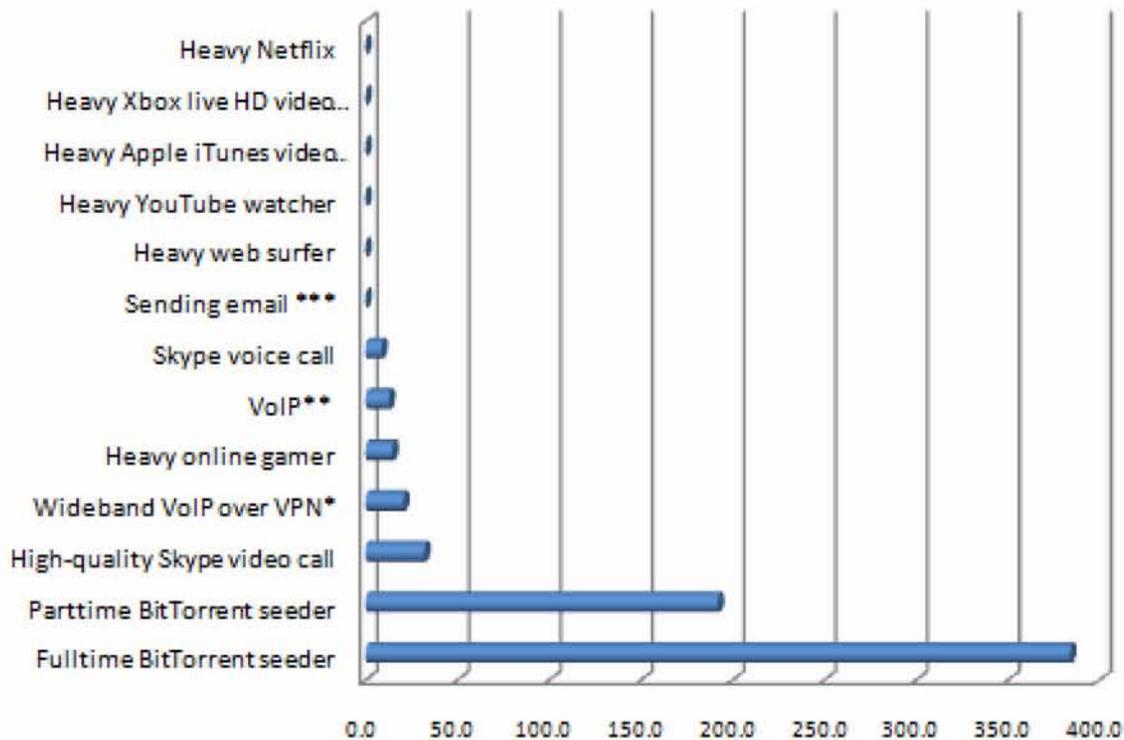
80/20  
Unfair



92/8  
Unfair

# Persistence advantage in P2P apps

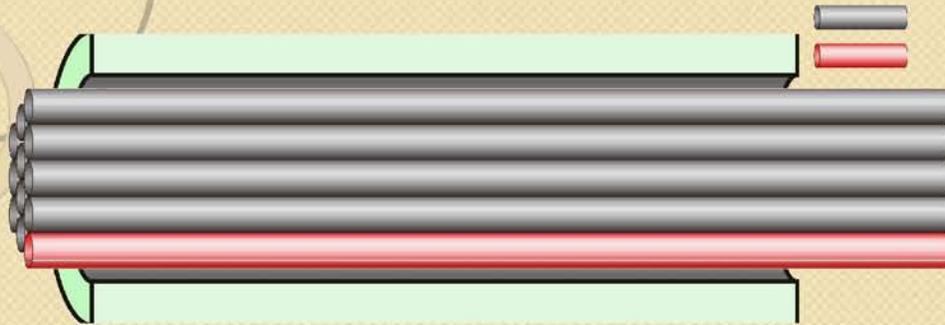
**Internet application usage**  
average upstream kilobits per second



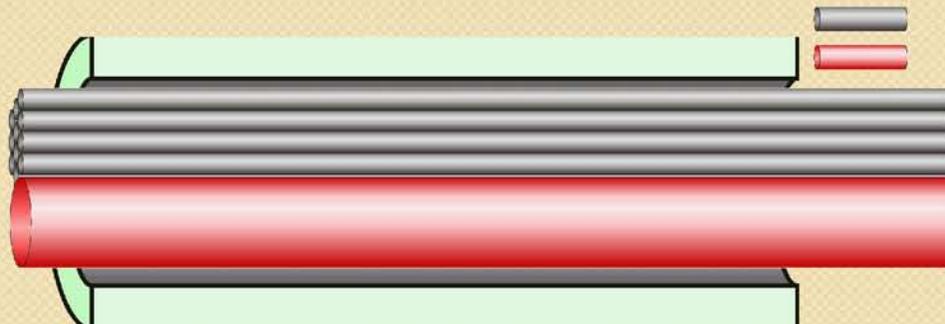
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Heavy Netflix	12	0.1	0.05	<500	1

\* Corporate VPN telecommuter worker using G.722 codec @ 64 kbps payload and 33.8 kbps packetization overhead  
 \*\* Vonage or Lingo SIP-based VoIP service with G.726 codec @ 32 kbps payload and 18.8 kbps packetization overhead  
 \*\*\* I calculated that I sent 29976 kilobytes of mail over the last 56 days averaging 0.04956 kbps

# Weighted TCP: Per-user fairness



92/8  
Unfair



50/50  
Fair

- BT chief researcher Bob Briscoe proposes TCP fix before the IETF to neutralize multi-stream loophole
- Changing TCP takes many years, but it's even harder to get over a billion devices to switch to new TCP client
- Newer network-based solutions being implemented

# Present and future solutions

- **Present solutions use protocol throttling**
  - P2P applications use disproportionately large amounts of bandwidth so they're throttled to balance them out
  - Use conventional router de-prioritization techniques on P2P
  - Use TCP resets to occasionally stop P2P seeders
  - Potentially affect an extremely rare low-bandwidth P2P user
  - Can be fooled by protocol obfuscation techniques
- **Future solutions are protocol-agnostic**
  - Weighted packet dropping at router and/or fair upstream scheduling on CMTS accomplishes per-user fairness
  - Only targets bandwidth hogs and forces them to back off
  - Cannot be fooled by protocol obfuscation

# What is reasonable network management?

Future

Reasonable

## Protocol-agnostic per-user fairness

### Pros

Equal sharing of resources between users of same tier. Can't be fooled by protocol obfuscation.

### Cons

Requires more drastic in-line changes to network. Requires real-time tracking of per-user bandwidth consumption and enforcement of per-user fairness.

Intelligent

Fair

## ISP throttles BW hogging protocols

### Pros

Out-of-band deployment with TCP resets or use of common de-prioritization techniques. Results in fairer distribution of bandwidth.

### Cons

Can be fooled by protocol obfuscation. Possibility of affecting non bandwidth hogs.

## Metered Internet

### Pros

Solves congestion because users self-throttle for fear of massive ISP bill.

### Cons

Danger of massive ISP bills for consumer. Makes P2P usage cost-prohibitive. By definition a "Toll road".

Past

Unreasonable

## No network management

### Pros

Cost free deployment

### Cons

10% of users throttles 90% of users down to 25% of resources

Dumb

Unfair

# Network management ensures harmonious coexistence

- P2P applications need volume, not priority
- Interactive applications (Web) and real-time applications (VoIP) want priority and not volume
- P2P, Interactive, and real-time applications each get what they want under a managed network
  - Interactive and real-time apps have small/fixed volume so no matter how much they're prioritized, they cannot slow down a P2P download.
- Unmanaged networks regardless of capacity will always be unfair and hostile to interactive and real-time applications

## **Jon M. Peha**

### **Carnegie Mellon University**

**Associate Director, Center for Wireless & Broadband Networking  
Professor of Electrical Engineering and Public Policy**

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**Views expressed are those of the presenter alone.  
Not affiliated with any major actor in this debate**

## **Just The Facts**

- Incorrect to say Comcast merely “delays” P2P
  - They terminate P2P TCP sessions, block P2P traffic
- Comcast practices are “discriminatory”
  - Unless they’ve blocked traffic from all applications
- Incorrect to say Comcast “does not degrade P2P”
  - Service degraded for senders, recipients, & originators
- Incorrect to say Comcast targets P2P because P2P has an adverse effect on other applications.
  - All traffic contributes to congestion, not just P2P.
  - Comcast polices implicitly give them the right to selectively block based on any criteria

## The Comcast Case

- It was reported that Comcast promised not to block, degrade, interfere with, or discriminate against P2P.
  - Customer expectations were violated.
- *If* these reports were accurate, Comcast is guilty of false advertising and probably fraud.
- But what does this mean for network neutrality?
  - about transparency
  - about discriminatory practices

## Misinformation and Transparency

- Misinformation about Comcast practices did harm
  - Users of Lotus notes lacked information needed to diagnose problems with their system.
  - Users of closed P2P network might be fooled into thinking that there was a server problem
  - Users who fear secret measures may take countermeasures
- Providers may profit through misinformation about congestion and how it is handled
  - Info may convince consumers to switch providers
  - If all ISPs provide enough info, consumers can choose

## Harmful and Beneficial Discrimination

- Discriminatory blocking can harm consumers
  - Example: Cable company blocks dissemination of 30-minute videos to protect legacy service
- Discriminatory blocking can benefit consumers
  - Example: ISP blocks denial of service attack
- Congestion is a legitimate problem
  - ISPs need some flexibility to address congestion
  - Discrimination can be useful for congestion.
    - There are good reasons to treat P2P differently from VOIP
  - FCC should not mandate “protocol-agnostic” approaches

## Future Policy on Discrimination

- FCC should
  - continue oversight of discriminatory practices
  - further clarify policies to support intervention in egregious cases
  - be cautious about adopting overly broad limitations.



For more info, see

**Misstatements on Comcast P2P Practices, and  
Implications for Network Neutrality**

[http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native\\_or\\_pdf=pdf&id\\_document=6519870758](http://fjallfoss.fcc.gov/prod/ecfs/retrieve.cgi?native_or_pdf=pdf&id_document=6519870758)

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**Testimony before FCC En Banc Hearing, April 17, 2008**

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**Testimony before FCC En Banc Hearing, April 17, 2008**

## 4/17: FCC Hearing on Broadband Network Management Practices

### Panel Discussion 2 - Consumer Access to Emerging Internet Technologies and Applications

Jon Peterson, co-Director, Real-time Applications & Infrastructure Area, Internet Engineering Task Force

The Internet Engineering Task Force (IETF) is a multinational body of engineers participating on a volunteer basis as individuals rather than as representatives of their employers or other affiliations. Over the past twenty years, the IETF has managed standardization for protocols such as TCP/IP, DNS, and protocols underlying email and the web. It is not a membership organization; participation in its meetings and mailing lists is open to all who wish to contribute to the IETF's work. The IETF is committed to its mission as described in RFC3935: "to produce high quality, relevant technical and engineering documents that influence the way people design, use, and manage the Internet in such a way as to make the Internet work better." As a purely technical body, the IETF does not establish consensus in matters of public policy.

The usage model of the Internet is changing, and traditional methods for managing high network load may no longer reflect the optimum responses to new applications. One example of this evolution are real-time applications, which suffer when exposed to significant latency. As link loads near capacity, latency is a common side-effect, and delay-intolerant applications bear the consequences.

New applications of the Internet inevitably introduce new challenges. While the IETF has not yet arrived at a consensus on a best current practice for managing resources in the face of competition between elastic and inelastic applications, various aspects of this problem space, including congestion control, quality-of-service, and friendliness of application behavior have been studied in the IETF for some time. It is likely that some of this previous work is relevant to the challenges raised by new applications; it is also likely that these new applications will require new thinking and some new technical development efforts. Some of these areas are within the IETF's expertise, and the IETF is considering whether it can make a useful contribution in this space.

In thinking about any potential IETF study of this or any other space, there are a few points about the IETF to keep in mind:

First, as a volunteer, consensus-based body, the IETF is highly dependent on its participants. Our ability to address technical problems is predicated on the contributions of informed engineers and computer scientists from the academic, operator and vendor communities, especially those with first-hand knowledge of the problem space. The key to tackling serious issues in deployments is reliable information – knowing what practices are followed by Internet Service Providers and application implementers. If the IETF is to address the evolving challenges associated with managing network resources, we will need the participation of Internet community members on the leading edge of application development and deployment in order to reach a well-informed basis for industry consensus.

Second, the IETF does not attempt to judge what is or is not "Internet service," a term that resists easy definition. In the marketplace today, there exists a variety of operational policies, and the IETF does not attempt to rate their respective propriety. Instead, the IETF looks at questions in more practical terms. For example, in order for application behavior to be deterministic, and to meet end-user expectations, the IETF notes in RFC4084 (BCP104) that "it is important that providers disclose the services they are making available and the filters and conditions they are imposing." RFC4084 goes on to recommend that

More generally, the provider should identify any actions of the service to block, restrict, or alter the destination of, the outbound use (i.e., the use of services not supplied by the provider or on the provider's network) of applications services.

Third, The IETF does not have a policing function. IETF specifications can detail the pros and cons of particular approaches to engineering, but implementers and operators must make their own informed decisions based on the technical trade-offs associated with solutions.

We appreciate the opportunity to participate in this forum today, and we look forward to responding to any questions you might have.

**Statement of Jean Prewitt  
President & CEO  
Independent Film and Television Alliance (IFTA)**

**Before the  
Federal Communications Commission  
Second Public *En Banc* Hearing on Broadband Network Management Practices  
Stanford University, Palo Alto, California**

**April 17, 2008**

Good Afternoon, Mr. Chairman and Commissioners. Thank you for inviting me to testify today on broadband network management practices and consumer expectations.

My name is Jean Prewitt and I am the President and CEO of the Independent Film & Television Alliance, also known as IFTA. IFTA is the trade association that represents the companies that produce, distribute and finance independent films and television programming.

The term “independent” is often assumed to mean low-budget, art house or unknown. In reality “independent programming” refers to the fact that financing for the film or television program came from sources other than the seven major U.S. studios. Far from being “unknown”, IFTA members produce, distribute and finance some of the world’s most successful films. IFTA members have been responsible for many Academy Award winning films, including “Juno”, “The Departed”, “Crash”, “Lord of the Rings”, and “Million Dollar Baby”, among many others. Other recent independent productions include “The Great Debaters”, “Mr. Magorium’s Wonder Emporium”, “The Golden Compass”, and the cable television series “The Tudors”.

IFTA commends the FCC for holding this hearing and for recognizing the role that content creators will play in realizing the potential of the Internet. The Commission’s initial Policy Statement assured consumers that they would have access to the content and services offered by the Internet. We now ask you to set policies to ensure that diverse content and innovative services are not blocked or discouraged under the rubric

of “network management”. Without policies that speak to content supply, the promises made to consumers cannot be kept.

The question of access for suppliers and service providers is one of particular significance for independent programming. Today, independently produced programming has little place on U.S. broadcast or cable television. A decade of vertical integration has merged major studios, networks and cable channel ownership. Much of American television programming is produced internally within the consolidated entities and then recycled. Independent producers are asked to relinquish significant rights and to accept below-cost pricing, if indeed any offer is made. Source diversity has been eliminated from U.S. television and the consumer must look elsewhere to hear voices other than the major studios and networks.

For the independents, the Internet offers a new route to reach consumers and a new creative medium that will change the very form that story-telling will take. The Commission has the chance now to set policies that will keep the Internet open and competitively accessible to all users. Neither we, nor the consumers, can afford to have large gatekeepers lock up the Internet as they have locked up network and cable television.

The risks are already apparent. There are a small number of large broadband providers who have the ability to discriminate unilaterally against some categories of users or

types of traffic or to offer preferential treatment to certain content providers. This is all done under the broad and ambiguous claim of “network management”.

While we acknowledge that there are some legitimate issues related to the technical management of networks, the imprecision of the term offers far too much opportunity for providers to discriminate against some users. We have already seen cases of unequal treatment, a prime example being the decision by Comcast to slow traffic to peer-to-peer sites. Blocking internet applications and interfering with the public’s ability to access information is discriminatory and must not be a consequence of acceptable network management practices. Additionally, there must be transparency, equal treatment and a method of redress when the providers’ private decisions impair fair rights of others and the public interest.

It has been claimed that copyright enforcement requires that we cede these broad powers of “network management” to broadband providers. I assure you that copyright issues are vital to our industry, but copyright concerns should not be an excuse to deny open access, which is absolutely critical to ensuring a vibrant film industry and a diversity of programming. Blocking legitimate users and applications is not a strategy to prevent infringement – it is an abuse that may well backfire as consumers lose faith in the very laws we hope to enforce.

We urge you to consider these issues and the impact on independent programmers and the public when considering future action regarding the future of the internet. Specifically, we ask that the Commission establish sound rules to prevent network operators from blocking or discriminating against any lawful use of the internet.

Thank you again for the invitation to speak and I look forward to answering your questions.

**Testimony of Gregory L. Rosston**

Deputy Director and Senior Research Scholar,  
Stanford Institute for Economic Policy Research  
Deputy Director, Public Policy Program  
Stanford University



**Federal Communications Commission**  
*En Banc* **Hearing on**  
**Broadband Network Management Practices**

**Stanford University**  
**April 17, 2008**

## Testimony of Gregory L. Rosston

Thank you very much for the chance to appear before you today. I have written academic articles about open access and network neutrality and generally my research focuses on the effects of regulation on communications networks so I am pleased to have the chance to share my views.<sup>1</sup>

Policy decisions regarding broadband networks and associated content and services can have important effects on the economy. The best broadband policy for the United States would result in lots of choice, innovation, and low prices. Such a utopian policy framework, however, may be hard to achieve.

Today's hearing focuses on how broadband providers' management practices affect consumers. The main issues are not new. Policy analysts and economists have debated broadband network management under names like "openness" and "network neutrality" for more than a decade; these same issues have been debated far longer in other contexts. Nonetheless, there is little agreement even about what the terms mean.

It is hard to be against openness and neutrality – they sound as American as apple pie. In some contexts, openness and neutrality have benefits, such as giving entrepreneurs easy access to networks and providing improvements to our democratic process by permitting fair and open debate of key political issues. But regulated openness and neutrality have costs, too, such as possibly reducing efficiencies from vertical integration.

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<sup>1</sup> For articles dealing directly with Network Neutrality, see "[Communications Policy for 2005 and Beyond](#)," Stanford Institute for Economic Policy Research Discussion Paper No. 04-07, August 2004 *Federal Communications Law Journal*, Vol. 58 No. 1, December 2005 (with Hundt, R.), and "[Local Broadband Access: Primum Non Nocere or Primum Processi? A Property Rights Approach](#)," Stanford Institute for Economic Policy Research Discussion Paper No. 02-37, July 2003 in *Net Neutrality or Net Neutering: Should Broadband Internet Services be Regulated*, Lenard, T. and May, R. (ed.s) Springer: New York, 2006 (with Owen, B.)

The economic issues underlying network management, openness, and network neutrality are similar in that they all involve a network operator interacting with its end-user customers and also with companies that may compete with the network operator for other products. My goal is to provide an economic analysis of network management and some recommendations for regulatory policy to mitigate possible problems. Finally, I provide some reflections on wireless open access requirements in light of this analysis.

## **I. Economics of Network Management**

Network management encompasses at least two broad economic issues: 1) management of a scarce resource that exhibits externalities; and 2) possible competitive issues surrounding vertical relationships.

### **A. Scarce resources, externalities, and pricing**

Management of scarce and common resources occurs throughout the economy. For example, restaurants serve dinner to multiple customers who all enjoy the same ambience and service staff. One noisy or especially demanding diner affects how much other patrons enjoy their meals. We rely on market forces (competition among restaurants) to give restaurant owners appropriate incentives to deal efficiently with such patrons, but owner's decisions may not mean that all customers get the same service even in the same restaurant when they order exactly the same meals. In a competitive business like restaurants, management of the common resource will be different based on the demands of customers, costs, and other factors.

Like restaurants, broadband networks must satisfy widely varying demands for service. Some people use their connections sparingly, while others consume large amounts of bandwidth. Initial proposals for network neutrality and openness did not differentiate among different types of users. More recent proposals recognize the need to allow network owners to charge for bandwidth or usage in some circumstances.

If all purchasers face a uniform access price, without regard to usage, the common resource would be allocated inefficiently. Overall benefits to users can be increased by charging users in relation to their usage or to the costs they cause.

In some cases, the cost to monitor and meter may be high relative to the benefits. That means that there may be some benefit to having additional mechanisms in place for traffic management. For example, it may make sense to offer pricing that varies with usage in blocks, rather than continuously, and to find non-price means to limit high usage during peak periods, rather than offering a complex and confusing non-linear price schedule. It might be more transparent for firms to offer higher tier service for more intensive users, with charges based on upstream usage, downstream usage, or both.

Pricing can be an important tool for providing higher-value services. All packets do not have equal value. If consumers pay for bandwidth or capacity and are part of a shared network that treats “all bits equally,” it might not be possible to offer broadband content that requires delivery priority or guaranteed arrival times. For example, high-quality real-time video conferencing requires that packets of bits not be delayed. But, if the local provider is required to treat all bits equally, the packets that are going to the high school student downloading a pirated copy of the new *21* movie and setting up a peer-to-peer upload will have the same priority as the conference call. Given capacity constraints in the network, the lack of prioritization could cause the video conference quality to be suboptimal, even though delay in delivering the movie to or from the student’s hard drive would be completely inconsequential because such transmissions are easily buffered. Requiring that a network operator treat all bits equally would, in this and other cases, needlessly harm high-value services, reducing consumer welfare.

Similarly, some advocates propose that network operators should only be able to charge their own end-user customers for service and bandwidth choices. Such a requirement could actually harm consumers. For example, a network owner may charge its customers low rates for low bandwidth capacity. An unaffiliated content provider may develop a product that requires higher bandwidth. Under some proposals, the unaffiliated provider

could not offer to pay the network owner to increase the user's bandwidth for its application. Essentially, such a regulation would be the equivalent of banning toll-free 1-800 calls. In the same way that changing the nature of payment for telephone calls can increase efficiency, a bar on charging both sides of a broadband "two-sided market" could harm efficiency.

Overall, network management issues are not unique to broadband. Many industries have users that make intensive use of resources, and those users pay for the privilege. Broadband should be no different – those who cause the costs should be charged. The comments about network management above do not depend on the degree of competition among network providers. Most "network management" proposals would be bad for consumers even if there were only a single, monopoly, broadband network.

The next section takes up some of the competition issues that arise in the context of network management.

### **B. Vertical Relationships**

The economics of network management also involves the complex issue of relationships between a network operator and other providers. Vertical relationships between network operators and other providers—for example, the need for network operators to have content flowing over their pipes—are an important part of broadband. No single firm will ever provide all the content consumers want, so firms with conduit and content will have to interact in some fashion to provide service. The relationship between suppliers and conduit providers raises the competitive concern that a network operator could favor its own content (or the content of an affiliate) over that of an unrelated competitor.

The economic literature on vertical relationships has gone through nearly a complete circle, from broad agreement that vertical integration was bad to the Chicago School view that all problems with vertical relationships stemmed solely from horizontal problems, to

the current nuanced “post-Chicago” view that there can be problems with vertical relationships depending on the circumstances.

In the broadband context, the analysis should focus on whether a local broadband provider has the incentive and ability to use its position to extract rents from content providers and harm consumers in the process. Vertical integration may also have beneficial efficiency effects. For example, vertical integration or vertical relationships can align incentives for investment. For example, the early cable operators were the key investors in cable television networks to ensure availability of programming. In theory, vertical relationships could hurt consumers, help consumers, or both help them in some ways and hurt them in others.

Which of these outcomes is most likely depends on supplier incentives, which in turn depend on the market structure and regulation. In almost all models that predict adverse effects from vertical relationships, the problems arise because of market power at one level or another of the vertical chain. But often, vertical relationships raise no competitive issues even if there is market power. In other cases, even if adverse effects arise, the effects are less costly to consumers than inefficiencies that might arise from regulatory intervention. Nonetheless, there are indeed instances where firms do have the ability and incentive to harm competition in vertically-related markets. The *Madison River* case is emblematic of this theory. In that case, the FCC stepped in to protect consumers. The FCC and antitrust authorities (as well as private antitrust enforcers) should intervene when a dominant network takes actions that harm competition and consumers.

In general, an access provider wants to enhance the demand for its own services, in part by promoting complementary services. This was the case with the early cable content investments discussed above. An access provider cannot extract rents from services that do not exist. There may be an incentive to exclude or raise the costs of those that offer content that competes with its own, but only if the substitute content is offered at the same or higher cost or if the content produces negative external effects on the overall

demand for Internet content.<sup>2</sup> In this context, an access provider can act opportunistically to raise rivals' costs, but it cannot persist in such behavior without reducing the supply of content that it requires.

Yahoo! And AT&T provide an example of the fears and potential efficiencies from vertical relationships. Yahoo! and AT&T have had an agreement jointly to provide service for AT&T's DSL customers. This vertical relationship advantaged Yahoo! relative to other information portals such as AOL, MSN, and Google. But it does not appear to have harmed consumers. Bundled AT&T/Yahoo! service does not prevent subscribers from using any other Internet services, including Yahoo!'s most direct competitors. In principle, AT&T could do a variety of things to make it more difficult for users to turn to rival sources of aggregated content and premium service, but I am not aware of any allegations of such behavior. In these circumstances, a policy that prevents a relationship between AT&T and Yahoo! could deny consumers a more attractive product or lower cost. Rivals to Yahoo! may protest the vertical relationship with AT&T. But their protests need not stem from fear of discrimination; they may fear a more effective competitor.

The key conclusion here is that vertical relationships when a firm has market power can be both pro-competitive and anti-competitive depending on the circumstances and the actions. A preemptive regulation can prevent both types; relying on *ex post* antitrust enforcement can target more closely anticompetitive actions, but has a risk of delay and under-enforcement. These tradeoffs lead to the analysis of what government regulators should do at this point in time.

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<sup>2</sup> See Farrell and Weiser (2002) for a discussion of incentives for a monopolist to exclude downstream content.

## **II. What should regulators do?**

### **A. Framework**

Evaluations of the competitive effect of broadband network management policies depend critically on one's view about the future of competition for broadband access. Policy choices can lead to self-fulfilling prophecies about the future of access competition.

If one believes that there is already as much competition and investment in local broadband access as possible, and one believes that two wireline providers is insufficient to provide a competitive deterrent, then one might think that *ex ante* regulation of actions by network providers would be appropriate. A dominant local access firm could use its power to extract rents from upstream providers through a variety of pricing and discrimination methods. Whether a firm with such power would take advantage of its power would also depend on the nature of demand of its subscribers.

If, on the other hand, one believes that competition for local broadband access is not as vigorous as it could be, then one might have a different conclusion about regulation. With the potential for additional competition, one would not want to institute rules that would frustrate new competitors and new investments. If vertical integration was an important competitive strategy, new entrants might be frustrated from entering if they could not vertically integrate. For example, some new entrants in broadband markets have usage restrictions to manage their networks and make entry more attractive.

Policy can affect the entry incentives of new entrants and investment incentives of incumbents. For any investment to take place, firms have to believe they will be better off from having made the investment than not. If policy reduces the returns to investment, at the margin, firms are less likely to invest. For new entrants, more onerous regulation can affect the scale and scope of entry, or make entry unviable.

## **B. Specific Proposals**

I think that we can have more competition for local broadband access. Therefore, my policy proposals focus on facilitating new entry and investment to reduce the potential problems from vertical relationships. The FCC in particular has tools that can increase local competition, and remove barriers to new entry – it just needs to use them. At the same time, we need to ensure that the regulatory authorities have the power, will and tools to step into the market when there are competitive problems.

Since most of the problems and concerns about vertical leveraging arise from concentration at the local access level, the most important thing that government should do is to stimulate competition at that level. Obviously, it would be great if it were economic for multiple firms to string fiber optic cable around all neighborhoods in the United States. That is unlikely to happen. But the FCC has tools to make facilities-based competition more likely and more viable.

First and foremost, the FCC should get even more spectrum out into the marketplace. And it is probably important that the spectrum not continue to go into the hands of the two incumbent landline telephone companies that also have by far the most valuable wireless spectrum. In the 700 MHz auction, Verizon and AT&T each bought large amounts of spectrum and, in many geographic areas, control more spectrum than the FCC's threshold of 95 MHz. While they each will use the spectrum, they do not have the same competitive incentives that independent competitors would have. The FCC should investigate to see if there are competitive problems in the wireless business and more importantly in the ability of a competitor to use wireless to provide a competitive alternative to the cable and DSL lines.

One quick way to get more spectrum into the market is to push government users to relocate more quickly. Leap Wireless, MetroPCS and T-Mobile all bought spectrum in the AWS band in 2006 and but cannot use it because the US. Government has not

vacated the spectrum. The FCC should do whatever it can inside the government to expedite this process and enable these competitors to use AWS spectrum.

Competition from independent wireless companies should benefit consumers and provide a competitive alternative. Independent broadband wireless providers would provide competitive pressures on the cable and DSL companies not to abuse vertical relationships. Increased competition in broadband access is the best way to “regulate” vertical relationships.

The current universal service program is also a barrier to competition and is so inefficient that it should be scrapped. Instituting a low-cost, efficient and competitively neutral universal service program would be much better for competition. Perhaps the most obvious and egregious problem is the proposal to pay incumbent telephone providers more than new competitors for providing the same services. The incumbents are right that we should not pay the new entrants the high rates that incumbents get – instead, all providers, including the incumbents, should get the minimum amount necessary for the most efficient provider to provide service. But incumbents have been able to use the regulatory process to forestall competition. Getting rid of this bias would help competition and again diminish the need for *ex ante* regulation of vertical relationships.

In addition, the antitrust authorities and the FCC should continue to be vigilant. Until we have more competition, there may be more instances like *Madison River* and the regulatory authorities should be ready to step in when there is abuse.

Increasing the amount of spectrum, speeding the relocation of government users, vigorous antitrust enforcement (including the prevention of excessive aggregation of wireless spectrum) and revamping universal service to be competitively neutral are “easy” economically. The answers are clear, and the benefits are big. The only question is whether we have the political will to do the right thing.

**Appendix: The 700 MHz Openness Provisions – the good and the bad**

The 700 MHz C block is useful for illustrating some of the issues related to network management: competition, complexity and regulatory uncertainty.

The FCC mandated that the 700 MHz Upper Band C Block have an open platform for devices and applications, subject to “reasonable network management.” The Commissions order was vague on the actual requirements for openness, and it was also vague about the meaning of “reasonable network management.”

It is curious that the FCC required openness for a Commercial Mobile Radio Services (CMRS) when has deemed CMRS to be competitive. As discussed above, the competitive issues in vertical relationships almost always require some degree of market power. While wireless service is not a perfectly competitive market, the FCC competition reports year after year have claimed that the service is competitively provided. As such, it is unlikely that there is a problem that an openness mandate will solve. So, there may be a cost to the provision and enforcement of the provision because other firms will rely upon the “right” to openness and defend that right, while at the same time, there may be little benefit from the new rule.

In addition, the vagueness of the openness requirements and network management exceptions make it difficult to believe that the enforcement will be satisfactory. Proponents of openness are likely to say that the licensee has not gone far enough in opening its network and the network operator is likely to say it has gone further than necessary. In addition, there are likely to be disputes about what “reasonable network management” for a wireless provider means. It may well be different than “reasonable network management” for a wireline broadband operator.

One potential benefit of the imposition of the openness requirements on the C block is the ability to use this “experiment” in openness to shed some light on the costs and benefits of such provisions on a more widespread scale. If openness is problematic, the

interactions between the C block licensee and upstream providers and downstream customers are likely to reflect such problems. If openness provides large benefits and works smoothly, then other carriers, having to compete with an open access provider, may also adopt open platforms.

In addition, by limiting the scope of the openness provisions to a single block of spectrum that it was auctioning for the first time, the Commission was able to avoid any concerns about “takings” due a change in rule for existing licensees. Instead, bidders knew (to some extent) the rules on the spectrum they were buying.

## Stanford Testimony – Ben Scott, Free Press

Good afternoon Mr. Chairman and commissioners. Thank you for the opportunity to testify. I am the policy director for Free Press. We have a large membership in the Bay Area that I am proud to represent here today.

I'm the last panelist at the end of a long day. So I want to use my remarks to sum things up.

This hearing is a pivotal moment in the short history of Internet policymaking.

The arguments we've heard today fall roughly in line with two competing visions for the future of the Internet -- open versus closed. Will we embrace the openness that has shaped the Internet to the present day? Or will we permit network owners to move to the closed systems of content control we have had with cable television and broadcasting? Obviously, there are arguments on both sides.

It is not hyperbole to say that few choices in the history of the FCC carry as much weight as this one does...So no pressure.

Let's be clear: Openness does not mean an end to all network management. It does not mean every bit should be treated exactly alike on the Internet. Openness does not reject protecting children or copyright or security on the Internet.

Openness simply means that Internet policy should promote free speech and commerce in the online marketplace. Openness means faithfully guarding against interference from the cable and telephone companies who have the power to become gatekeepers between consumers and producers of Internet content.

The Comcast case is a bellwether. It's a test of the 2005 Internet Policy Statement on openness. That is why it has been the focus of so much money, influence and attention. It is *not* ordinary.

The Commission adopted its Policy Statement to stand in place of long-established and successful nondiscrimination provisions in the Communications Act. Many of us feared then that handing over the legacy of an open communications systems to such a weak guardian was a dangerous business. Today we are testing the mettle of that guardian.

The recent history of deregulation has led us to a bright red line of basic consumer protection. We should not stray beyond it. We see the clash between open and closed most famously in the Net Neutrality debate – but it is also in merger proceedings, spectrum auctions, wireless policy, white spaces, text messaging -- and now, network management. Several key decisions have leaned toward openness, rather than against it.

So what plot line in this story brings you to Stanford? Was it Silicon Valley finally organizing its corporate might to challenge the telephone and cable companies in a battle of the titans?

Nope. It was a barber shop quartet. As you've heard from Robb Topolski, he began the testing that ultimately exposed Comcast's interference with peer-to-peer software because he couldn't share with his friends his favorite recordings of barber shop tunes. Comcast first denied blocking, then acknowledged it, then directly challenged the legitimacy of the Policy Statement, and finally reversed itself and promised to stop in the future.

Honestly, I couldn't make this stuff up. Robb has proven why this debate isn't about Google, AT&T or Comcast. It's about every consumer wanting to seek or share information on the Internet.

But few of us are even capable of doing what Robb did. Fewer still will witness their personal conflict with the cable company become first tier business for a federal agency. Yet the pressure of public scrutiny and regulatory oversight was highly effective—triggering some industry collaboration. But that doesn't mean the FCC can pack up and go home.

The response to this case has been extraordinary precisely because it is a bellwether, a one-off chance to pass or fail a signal test. The side deals do not show us the magic of the market at work. They show us the magical threat of regulatory intervention.

If the agency doesn't act decisively, it will not have sent the correct signals to the market. Violations are almost certain to recur when the dust settles.

From a consumer perspective, openness on the Internet, is a user experience. That's what is at risk here. In turn, that user experience depends on preserving the seedbed for emerging technologies, new ideas and the latest invention. This test case will partly determine whether entrepreneurs choose to introduce their ideas in

our markets or others. It will determine whether consumers get access to the new services, devices and content that this open environment breeds.

Finally, I would be remiss if I did not extend the olive branch to the cable industry. In my view, cable has a legitimate issue with network congestion—mostly because they have not yet upgraded their networks for the future of broadband. It will only get worse if we do not acknowledge and address that.

There are many legitimate ways for network providers to handle capacity problems together with consumers and innovators. Application blocking simply isn't one of them. Meanwhile, consumers pay for all-you-can-eat broadband that is too limited and a fixed menu of cable TV that is too broad. As consumer demand for bandwidth increases, the cable industry will shift capacity to high speed Internet services. The Commission should encourage that outcome.

At the end of the day, consumers are relying on the Commission to set a baseline standard to protect openness on the Internet. A duopoly market of access providers will not discipline itself. Nor can we expect that fans of barber shop quartets will always be the white knights that ride to the rescue. This is a clear moment for the agency to act. The future of the Internet for everyone depends on it.

I thank you for your time and look forward to your questions.

Jim Steyer, Founder and CEO, Common Sense Media  
Testimony to Federal Communications Commission  
En Banc Hearing, Stanford University, April 17, 2008

As a graduate of Stanford Law School and a member of the faculty here, I'm pleased to welcome you to Stanford.

These discussions about broadband network management have focused almost entirely about business issues that concern adults and media companies. While those issues are important, Common Sense Media is here to urge you to focus your deliberations on the most important group of consumers of the Internet and digital media: our kids.

I think it is especially appropriate for this Commission to focus on kids. Because whether it has been leading new efforts on childhood obesity, or requiring media companies to clean up their act when kids comprise a large part of their audience, this Commission's work on behalf of kids will be a hallmark of your legacy. Each of you deserves great credit for the bipartisan manner in which you have consistently tried to promote the best interests of children and families.

You've heard testimony about ensuring that consumers and businesses can effectively access the content they want. But we also need to talk about empowering families and educators as consumers, so they can protect children from content they *don't* want, and help them find top quality content quickly and easily.

I want to focus my remarks on ways that everyone involved can keep the interests of kids and families front and center. The most important of these is harnessing the educational power of the Internet, so that it continues to improve children's opportunities for learning.

First, some basic facts about kids and media:

- A recent Pew survey found that 93% of teens use the Internet today. Pre-teens are there in the tens of millions, and whether we like it or not, we have 3- and 4-year olds using the Internet today.
- Just as importantly, kids and teens are no longer just consumers – many are becoming content providers. The Pew survey found that 39% of online teens share their own artistic creations online – including artwork, photos and videos.
- In Common Sense Media's recent national survey, 85 percent of parents said that the Internet is the medium that poses the greatest risk to kids. Yet 74 percent said the Internet is the medium that offers kids the greatest opportunities for learning and growth.

The seemingly contradictory feelings actually make complete sense. The Internet and the growing world of digital media are full of *both* perils and possibilities. They can and do pose potential dangers for children, but they also create extraordinary, unparalleled opportunities for their education and development.

One thing is already clear. This isn't about how the Internet and this 24/7 digital reality *will* change children's lives – it already *has*, and is constantly changing them. We adults are just

visitors and immigrants to the world of the Internet – our children are the true natives. They are leading digital lives, with huge implications for our discussions here today and in the future.

- For example, you cannot define literacy in the 21<sup>st</sup> century without understanding the ever expanding presence of the internet and other digital media. Many of us lament that the average American high school kid cannot find Japan on a map. But those same kids can use the Internet and find the name of the third largest city in Japan in about 20 seconds, and probably learn more about that city than kids ever knew a generation ago.
- Whatever decisions the Commission makes about network management, your decisions must continue unleashing the incredible educational potential of the Internet.

We want to be very clear – Common Sense Media believes in sanity, not censorship. We believe that an informed consumer is the best consumer. We want all of the media companies with stakes in today’s discussion to do more to help parents, families and educators. By providing better tools and information, service providers and content providers can empower families to make smart choices for kids – and help them to make sure their kids find the good stuff, and avoid the bad stuff, in this changing media world.

Several of the commissioners have talked about how the Internet has fostered innovation. On behalf of children and families, we want the FCC to call on service providers and content providers to use that innovation to greatly expand the quality and quantity of tools and resources they provide to families, so that parents can choose media they feel is helpful and appropriate. This spirit of innovation can foster a ‘public Internet’ that truly serves the public interest by meeting the 21<sup>st</sup> century education needs of children and families.

I’d like to close by reiterating that an important aspect of this Commission’s legacy will be the bipartisan work that you have done – and can still do – on behalf of children and families. With that in mind, I have one final recommendation for you:

We would urge that this fall, you hold one more En Banc hearing, focusing exclusively on kids, and on the ways that the Internet and digital media can best serve the interests of kids in the 21<sup>st</sup> century.

**Statement of Commissioner Deborah Taylor Tate  
At *En Banc* Hearing on  
Broadband Network Management Practices  
Dinkelspiel Auditorium  
471 Lagunita Drive  
Stanford University  
Palo Alto, CA  
April 17, 2008  
(As prepared for delivery)**

Thank you, Chairman Martin, for your leadership in holding this hearing on this very important issue, and thank you to Stanford Law School for hosting this event.

Today we gather in Silicon Valley, a place whose name evokes an entire geographical locale of technological innovation, newly discovered chemical compounds and uses for magnetic-radio waves, reminiscent of the Industrial Revolution, the dawn of the automobile, and airplane flight. Brilliant scientists, bold entrepreneurs and college students with unrivaled curiosity flocked here to create not merely a valley, but an entirely new, vibrant technological ecosystem -- a place that continues to maintain its status as one of the top research and development centers in the world, and that includes 10 of the 20 most inventive towns in America.<sup>1</sup> Stanford University, professors and graduates have played a pivotal role not only in the scientific, but also in the business, investment, and financial underpinnings of our society as well. None more revered than Vint Cerf, the Father of the Internet.

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<sup>1</sup> <http://online.wsj.com/article/SB115352188346314087.html>.

It is appropriate that here in this area so steeped in technology and innovation we hold a national hearing to examine the intersection of the extraordinarily connected, digital world in which we live and the role and appropriate level of governmental intervention, oversight and public policy.

As I have said many times, broadband is revolutionizing how we communicate, how, where and when we work, how we educate our children, the delivery of healthcare and public safety, as well as how we entertain ourselves. So this discussion is not about companies and not about regulators. This discussion is about patients, students, public safety officials and ultimately all Americans.

We must remain vigilant against intrusive governmental action that could disrupt the progress of broadband deployment. We must choose a path that is carefully balanced, providing the appropriate regulatory relief which resolves a specific “harm,” allowing networks and carriers to respond to marketplace demands efficiently and effectively, ensuring that consumers are informed and protected and competition is encouraged through the least intrusive and least costly regulatory action.

Our decisions should fuel-inject the broadband turbines of the information economy. Freedom to innovate, not the shackles of regulation, drives productive solutions.

I have consistently favored competition and market forces rather than government regulation across all platforms-- especially in this dynamic, highly technical marketplace. I am pleased that since we last gathered in

Boston, BitTorrent and Comcast have announced several industry-based solutions for acceptable network capacity management and lawful content distribution. Comcast and P2P company Pando just announced an industry-wide effort to create a “P2P Bill of Rights and Responsibilities” for peer-to-peer users and Internet service providers. Both Comcast and Time Warner announced speed upgrades and tiered pricing for consumers in certain areas. Again, technology and the competitive marketplace seem to be responding to the appropriate oversight mechanism

As both a state regulator and now at the federal level, I have worked to remove legacy regulations to increase incentives for investment in new infrastructure, allowing services, applications and business plans to develop and proliferate in a less regulatory environment. And they have.

Notably, Internet providers continue to invest billions of dollars to upgrade and expand their networks. Spending on broadband networks was \$15 billion in 2007 and is expected to dramatically rise to \$23 billion by 2010. The Commission’s most recent report on broadband deployment shows that the U.S. remains the largest broadband market in the world, and finds continued dramatic growth in broadband deployment to over 100 million lines as of June 2007, an increase of 55%.

These network upgrades allow Internet service providers to offer broadband service at ever-increasing speeds. We have come a long way since the 56 kilobytes-a-second dial-up speeds- with companies offering consumers download speeds of 50 megabits per second, and plans to offer speeds as much as hundreds of megabits per second. This multi-billion dollar

investment by private enterprise in complex networks is critical to ensure that consumers continue to reap the benefits of innovation. Some call for government regulation that, rather than continue, would actually greatly diminish future and essential investment.

Another byproduct of government regulation, especially in such nascent arenas, while both technology and business plans are still under development, is the “unintended” and often negative consequences of government intervention. As we review our own policies and learn more about especially P2P applications, I am particularly concerned about the growing problems of illegal content distribution, from pirated movies and music, to online child pornography, as well as the issue of child online safety and privacy in general. I look forward to even more collaborative, industry-based solutions, which are often the most effective and efficient means of resolving complex, technical network disputes.

To that end, I am glad that we are hearing from my friend and fellow Nashvillian Rick Carnes, President, Songwriters Guild of America, and also Jim Steyer and Common Sense Media today. Jim and Common Sense Media have been engaged in advocacy for children and families in the offline world and are now engaged in efforts to keep children safe in the online world. I also would like to recognize and mention that the National Center for Missing and Exploited Children very much wanted to participate but literally cannot be here with us today due to two other hearings in which they were already involved – one in Ireland signifying the growing global nature of this issue. However, I wanted to share some of what Mr. Allen would probably have described as one of the most successful public-private

partnerships that this digital age has fostered and why we should tread very lightly into any type of government regulatory action.

Many of us probably do not realize that the child pornography industry is a multi-billion dollar industry with most of the financial benefit accruing to organized crime in other countries while most of the demand is right here in the U.S. Through incredible technology, and unique public-private partnerships between sometimes unlikely partners, great strides are being made to crackdown on illegal content and money laundering problems. Internet service providers are able to differentiate these illegal images and through voluntary agreements with financial institutions—95% of them to date—are able to shut down the financial enterprise that allows payments over the Internet. While this has not stopped the criminal behavior, it certainly makes it more and more difficult to utilize the Internet for these illegal purposes. Mr. Allen cannot be here today as he is actually in Ireland, meeting with officials from law enforcement and financial institutions and technology companies with international presence to expand these voluntary efforts internationally. Countries around the world are interested in duplicating what we have done here in just two short years. The statistics are staggering and the technology such as peer-to-peer has unfortunately provided even more ease of access by people across the globe. Just to give you an example and this is a graphic one so I apologize to those of you who find this discomforting: through British law enforcement, a child pornographer was located and shut down; the Internet site allows viewers to watch the abuse of a child under 1 year of age. This is shocking. This is illegal. This is harmful to our children and their families and our society. Thus, I want to make sure that we weigh the unintended consequences of

any regulatory action we may take regarding more openness with these successful voluntary steps to use not just reasonable but extraordinary network management and technologies to fight crime rather than harbor and encourage it. We must be vigilant regarding our children so I think it is important not only to encourage and utilize the Internet in new, innovative and exciting ways; but also fully appreciate all the illegal, unlawful and predatory uses technology allows or exacerbates as well -- whether our financial information, our privacy, our most personal information, and most of all our young children.

Thank you, esteemed panelists for joining us here at Stanford. We look forward to hearing from you and learning from you regarding these important policy issues as we attempt to find the right balance in order to provide all our citizens the vast opportunities of the broadband world of today to compete in the global economy of tomorrow.

# **Network Management and Consumer Expectations**

by Robert M. "Robb" Topolski - [robb@funchords.com](mailto:robb@funchords.com)

for the **Federal Communications Commission**

April 2008 En Banc Hearing on Broadband Practices

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Thank you for inviting me to speak on this panel.

For the past 25 years, I've been working on Networking protocols, products and platforms, starting as a hobby and eventually, as a profession. I've worked on projects ranging from Amateur Radio packet BBS systems, to one of the first commercial ports of the NCSA Mosaic browser to scalable datacenter servers. Over the years, I have been responsible for ensuring that numerous networking products behaved according to established Standards.

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Another hobby of mine is barbershop harmony.

Over the years, I had collected samples of printed and recorded musical history, in the old-time Barbershop Quartet style. While trying to use the Peer-to-peer networks to share this with others, I found that I was completely unable to upload any of it on the Gnutella network.

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Using packet traces and end-to-end comparisons between Comcast and non-Comcast connections, I concluded that TCP Reset flags were being used to tear down P2P connections when the uploading peer was on the Comcast network.

Investigating this technology further, I found that it was nearly universally despised – it's the same method used by "The Great Firewall of China." Dr. Sally Floyd, wrote a paper which the IETF later adopted as a "Best Current Practice," demonstrated that TCP resets used for network management are both rare and harmful (BCP 60, "Inappropriate TCP Resets Considered Harmful").

As technologists are apt to do, I publically posted about my findings and described my tests and results. My findings have since been independently verified, have been covered in thousands of press articles, and are at the heart of these hearings on these practices.

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The impacts of an ISP behaving this way strike at the heart of the ability to innovate on the Internet. At the February hearing, David Reed told you that, "Providing Internet Access implies adherence to a set of standard technical protocols and technical practices that are essential for the world-wide Internet to work for all its users." The entire Internet community counts on that fact, every day.

I have to know, as a developer, that the Web Browser that I am developing in a lab in Santa Monica, California will work on an ISP anywhere in Africa. As a consumer, I expect that Slingbox, which was developed in Israel, will work on my Cable ISP in Hillsboro, Oregon.

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Consumers and the Internet community were harmed when Comcast offered “High Speed Internet” yet secretly delivered something much less and different.

Consumers obviously got significantly less product than they purchased; and their applications they tried to use did not work correctly. The developers were also harmed, as they down user issues that they could not reproduce to debug.

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This situation continues today. It has not stopped.

Using RST flags to tear down established and working TCP connections is an extreme act, having no place in Reasonable Network Management.

Comcast’s interference occurs during all hours of every day, a fact which does not jive with the idea that it is somehow responding to rare moments of congestion.

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As a ham radio operator, I see this simply as – without regard to the Network Neutrality implications – a jamming complaint.

The FCC usually does a fantastic job of putting active jamming activity on the top of their list, however this period of jamming has continued from sometime in 2006 until present day – and this “Jammer” assures us that he’ll stop when he’s damned good and ready to change his ways to something else yet to be determined – hopefully by the end of the year.

This is both unprecedented and unacceptable. The FCC should take immediate action, today if possible, to stop Comcast from using this technology any longer.

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The various complainants in this case have asked for certain relief. Considering those requests seems to be the appropriate and logical next steps in this case.

In such that we have a case of under-delivery of services, restitution is in order.

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Most importantly, the FCC needs to prepare. The advent of high-speed Deep-Packet-Inspection hardware such as that used by Comcast opens up a whole new set of capabilities – many involving changing the behavior or even the content of Internet messages.

These products are in the field, now.

Technology like this is nearly impossible to detect. For the integrity of the Internet “product,” there needs to be a way to monitor and protect it.

# ***Network Management and Consumer Expectations***

Robert M. “Robb” Topolski  
robb@funchords.com

# Hello, I'm Robb Topolski...

- 25 years, **Amateur Radio Operator**
  - Public Service: Disaster recovery, Navy MARS, USAF MARS
  - Digital modes, RTTY and packet, PBBS, NET/ROM, Digipeaters
  - Southern California Digital Communications Council member
- 15 years, **Software Quality Assurance and Testing**
  - Networking products and platforms
- **Internet “Settler” (early 1990s)**
  - Both for work and personal research
  - Known by my own name; signed the Nat'l Science Foundation AUP
  - The WWW just starting and it was a fun “Information Dirt Road”

# ...and I am a Comcast Customer.

- **I could not upload** certain legal and historical Tin-Pan Alley and Barbershop Quartet era content – 24 hours a day, for months

# ...and I am a Comcast Customer.

- **I could not upload** certain legal Tin-Pan Alley and Barbershop Quartet era content – 24 hours a day, for months
- **I posted a technical report** about it on “DSL Reports,” a long-standing bulletin-board service shared by Broadband enthusiasts
- **My reports were independently confirmed** and widely reported in the blogs and print media: Comcast injects forged packets to tear down established connections

# The Simple Problem

- Consumers, developers, content creators and service providers all **expect and depend** upon **network operators** using the **same standardized set of protocols and principles common to the Internet.**

# The Simple Problem

- Consumers, developers, content and service providers **expect and depend** upon **network operators** using the **same standardized set of protocols and principles common to the Internet**.
- **Consumers and the Internet community were harmed** when **Comcast offered “High Speed Internet”** yet **secretly delivered something much less and different**.

# The Simple Problem

- Consumers, developers, content and service providers **expect and depend** upon **network operators** using the **same standardized set of protocols and principles common to the Internet**.
- **Consumers and the Internet community** were **harmed** when **Comcast offered “High Speed Internet”** yet **furtively** delivered **something much less and different**.
- The interference remains **unreasonable**, undisclosed, arbitrary, and unauthorized. It **constantly** attacks **both ends** of TCP links established by **P2P applications** in a way that **hides the source** of those attacks and **prevents customers** from uploading.

# The Simple Solution

- **Immediately stop the interference**
  - It is no different than any other malicious interference (jamming) case affecting authorized communications; the FCC takes quick action to stop jamming.

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- **Begin the process of granting relief**
  - ISPs who under-deliver should pay fair restitution
  - ISPs who conspire to secretly deliver less service than was sold, should also be punished with greater severity
  - ISPs who compound the problem by unethically diffusing, denying, or deflecting the truthful examination of their acts should face compounded punishment as a result.

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  - ISPs who compound the problem by unethically diffusing, denying, or deflecting the truthful examination of their acts should face compounded punishment as a result.
- Establish proactive oversight: *today, DPI ... Tomorrow?*
  - Create improved processes, rules, or procedures for the future
  - Obtain appropriate access to technical and complaint data

Barbara van Schewick  
Assistant Professor of Law and (by courtesy) Electrical Engineering  
Co-Director, Center for Internet and Society  
Stanford Law School

**Oral Testimony at the  
Federal Communications Commission's Second Public En Banc Hearing  
on Broadband Network Management Practices  
at Stanford University, Stanford, CA on April 17, 2008,  
Docket No. 07-52**

Mr. Chairman, Commissioners,

Thank you for inviting me to testify today. My name is Barbara van Schewick. I'm an Assistant Professor at Stanford Law School; I also have a courtesy appointment at Stanford's Electrical Engineering Department. Together with Larry Lessig, I co-direct the Center for Internet and Society at the Law School. I have a PhD in computer science and a law degree. For the past eight years, my research has focused on the relationship between Internet architecture, innovation and regulation.

In my opening statement, I would like to make three points:

1. Allowing network providers to single out specific applications and block or degrade them to manage bandwidth on their networks would harm user choice and application-level innovation – the two things that the Internet Policy Statement is designed to protect.
2. Even with disclosure, the market will not solve this problem.
3. To protect application-level innovation and user choice, the FCC needs to clarify that singling out specific applications and blocking or degrading them to manage bandwidth on a network is not reasonable network management and violates the Internet Policy Statement.

Users choose the applications that best meet their needs and that provide the most value to them. If I'm working on an open source project that uses BitTorrent to distribute its source code, and the network provider chooses to single out BitTorrent to manage bandwidth on its network, I am unable to use the application that best meets my needs and use the Internet in the way that is most valuable to me. This is pretty obvious.

But what is the impact on application-level innovation? I recently met a graduate of Stanford's computer science program. Together with other graduates, he started a company that will develop a video application with a peer-to-peer component. Because he had a great concept, he was able to present his idea to six private equity firms. He entered into formal discussion with three. In these talks, the investors discussed the risk factors associated with his product. That network providers would block or degrade his application was one of the top risk factors for all investors.

If there was no market demand for his product, it would fail. And, worse, if there was market demand, it would be blocked. The more likely it was to succeed, the more likely it was to be blocked. Each of the three firms passed on funding his innovation.

This is a real problem. This story is not unique. And this story will become the norm unless the FCC adopts some baseline protections ensuring that network providers cannot target and degrade particular applications to manage bandwidth on their networks.

In my submitted testimony, I discuss three points.

First, I explain the need for more in-depth and standardized disclosure for consumers.

Second, I explain that the current level of disclosure in the US marketplace is inadequate.

Third, I explain why disclosure is not enough and why the FCC must enforce clear non-discrimination principles beyond mere disclosure.

There is a market failure here, in fact several. First, we do not have effective competition in the broadband market. The market for broadband internet services is an effective duopoly. In addition, this market is afflicted with significant switching costs.

Second, because of the prevailing flat-rate pricing structure, network providers have the perverse incentive to block or degrade applications that consume more bandwidth or consume it in unexpected ways. If the use of the network increases, the network provider's costs increase as well, but due to flat-rate pricing, its revenue stays the same.

Third, the history of the Internet (as well as theoretical analysis) shows that network providers prefer solutions that constitute a "quick fix" without considering the impact on the long-term evolvability of the Internet. The deployment of asymmetric cable and DSL, network address translators and Comcast's tactics to manage congestion are all examples of this problem.

All this suggests that network providers will find it more attractive to choose a specific application and block or degrade it than to try to find a non-discriminatory way of managing their network. A large literature describes the problems for application-level innovation that result when network providers, not users, pick winners and losers among applications. This is worse. When network providers choose applications to degrade in order to manage bandwidth, they will use all sorts of criteria (is the application easy to recognize; does the application constitute a significant chunk of bandwidth; what are the applications blocked by a particular vendor's product), but these criteria are very different from the criteria users employ when deciding which application to use. It is impossible to predict which applications a network providers would want to block; today it's p2p, next year it may be YouTube, the year after that it may be this exciting new application that we haven't even thought of yet. The only thing we know is that the mechanism that is most attractive to network providers is most harmful for application-level innovation and user choice.

Telling Comcast that its particular practice constitutes unreasonable network management is not enough. Network providers will still have an incentive to single out specific applications, and the risk of being blocked if they are successful will still be the number one risk factor for applications developers and investors who consider potentially bandwidth intensive applications. By declaring

that “reasonable network management does not include practices that single out specific applications and block or degrade them to manage bandwidth on their networks”, the FCC can restore application developers’ and investors’ confidence that they will be able to use the network. This ability to use the network is not unlimited. Network providers will still need to manage congestion on their network, but the tools they use will affect all applications, and won’t just make one application the odd man out.

In the Internet Policy Statement, network management is the exception, not the rule. The rule protects application innovation and user choice. Allowing network providers to target specific applications to manage bandwidth on their networks would make the rule meaningless. It is on the FCC to prevent this from happening.

Thank you for your attention, and I’m looking forward to your questions.

Barbara van Schewick  
Assistant Professor of Law and (by Courtesy) Electrical Engineering  
Co-Director, Center for Internet and Society  
Stanford Law School

**Official Testimony at the  
Federal Communications Commission's Second Public En Banc Hearing  
on Broadband Network Management Practices  
at Stanford University, Stanford, CA on April 17, 2008,  
Docket No. 07-52**

Mr. Chairman, Commissioners,

Thank you for giving me the opportunity to testify today. I would like to make four points:

1. The FCC should require broadband providers to disclose their broadband management practices.
2. The current level of disclosure is not sufficient.
3. Disclosure alone is not enough.
4. The FCC needs to establish some ground rules for reasonable network management. In particular, it should ban network management practices that single out specific applications or classes of applications in order to manage bandwidth consumption on broadband networks.

**1. The FCC should require broadband providers to disclose their broadband management practices.**

Full disclosure is a necessary condition to enable competition to work. Disclosure improves competition by enabling customers to make informed decisions when choosing providers. Disclosure also enables competitors to differentiate themselves along these dimensions.

Today, network providers in the US compete based on maximum upload and download speed and price. If, however, customers are unable to note the differences between the offerings along other dimensions (e.g. how oversubscribed is the network, how often is traffic management used, how is traffic prioritized), they cannot take these factors into account when making a decision, and network providers do not have an incentive to compete on these factors.

Compare this with the situation in Europe: A quick look at network provider offerings shows that ISPs compete on much more than just price and maximum upload or download bandwidth. For example, BT offers customers three different options with differing monthly bandwidth allowances that indicate the maximum amount of bandwidth you are allowed to use in a month. To protect customers from unexpected increases in their broadband bills, BT does not charge customers if they exceed their monthly usage allowance in one month.<sup>1</sup> Laribu, a provider in Belgium, offers three service packets which offer different combinations of upload/download speed and monthly bandwidth allowances. Usage that occurs during 2 am and 8 am only counts with half of the actual bandwidth used, an offering that clearly targets customers interested in peer-to-peer file sharing.<sup>2</sup> PlusNet, an ISP in the UK that is an independent subsidiary of BT, offers different combinations of maximum upload/download speed, monthly volume caps and traffic prioritizations; traffic between midnight and 8 am is not counted towards the monthly volume cap.<sup>3</sup> This type of differentiation enables someone who knows she wants to do a lot of file-sharing or who is an avid gamer to choose the Internet service offering that best supports her needs.

The UK providers have clearer descriptions of their acceptable use policies, and of the type of network management they use in their network.<sup>4</sup> For example, BT's policy usage allowance and fair use policy informs customers that "[...] we restrict P2P speeds if it's having a negative impact on the online experience of the majority of our customers. We normally place restrictions in the evenings at peak time, but we do apply them during the day if a lot of customers are using P2P at the same time."<sup>5</sup> BT's broadband management practices are very different from Comcast, and their disclosure is clearer. PlusNet explicitly states how different traffic is prioritized on their network, and what bandwidth rates customers can expect for different applications at different times of day.<sup>6</sup> As a side effect, such disclosure may help alleviate congestion by enabling customers to adjust their behavior.

Disclosure provides visibility to regulators, competitors and industry observers. It avoids the waste of resources spend when users or application or content providers try to figure out what is going on on a particular network, as when the Associated Press, EFF or private parties like Robert Topolski and David Reed were running tests on Comcast's network to understand what Comcast was doing. Additionally, testing by end users may be unable to detect the "next generation" of network management tools, which may be completely hidden from end users.

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<sup>1</sup> BT (2008).

<sup>2</sup> LaTribu (2008).

<sup>3</sup> PlusNet (2008a); PlusNet (2008c).

<sup>4</sup> Not all these practices would be considered reasonable network management under the standard advanced below. The point here is that the disclosure is clearer than the disclosure of practices in the US.

<sup>5</sup> BT (2008).

<sup>6</sup> PlusNet (2008b); PlusNet (2008c).

Finally, under effective competition, disclosure can discipline provider's behavior.<sup>7</sup> Customers who do not like how a provider manages its traffic can switch to another provider.

## **2. The current level of disclosure is not sufficient.**

To realize these goals, disclosed information must provide enough detail to enable customers to make an informed decision and to enable them to adjust their behavior. Comcast's current acceptable use policy falls short of these goals. Customers shopping for Internet service on Comcast's website are not directed to the acceptable use policy (if you click on terms and conditions, the pop-up window states: "Service is subject to terms and conditions of Comcast High-Speed Internet Subscriber Agreement and Home Networking Amendment if applicable. For restrictions, minimum requirements and details about service and prices, call 1-800-Comcast.")<sup>8</sup> While Comcast new acceptable use policy mentions that Comcast employs traffic management during periods of heavy usage, it does not give any indication when that may be, or how often it occurs. There also is an unresolved tension between the prohibition on running servers, and the allowing of peer-to-peer file-sharing applications. Compare "Examples of prohibited equipment and servers include, but are not limited to, e-mail, Web hosting, file sharing, and proxy services and servers"<sup>9</sup> with "Common activities that may cause excessive bandwidth consumption in violation of this Policy include, but are not limited to, numerous or continuous bulk transfers of files and other high capacity traffic using (i) file transfer protocol ("FTP"), (ii) peer-to-peer applications, and (iii) newsgroups, whether provided by Comcast or a third party."<sup>10</sup> and "Does Comcast block peer-to-peer ("P2P") traffic or applications like BitTorrent, Gnutella, or others? No. Comcast does not block P2P traffic or applications."<sup>11</sup> The "Frequently Asked Questions on Network Management and Excessive Use" are buried on the website under "Customers -> [FAQs / Product Information / Comcast High-Speed Internet](#)" under the heading "hot".<sup>12</sup> Comcast also reserves the right to change this policy at any time without giving notice to the consumer, forcing their customers to constantly monitor the acceptable use site, if they want to understand what is going on.

To support the effectiveness of disclosure, the FCC could set up a website where network providers would have to post their network management practices in a standardized format that would enable customers to compare providers' network management practices easily.

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<sup>7</sup> van Schewick (2007), p. 376-377 (explaining how network providers' ability to secretly degrade the performance of applications limits the effectiveness of competition in the market for broadband Internet services); van Schewick (forthcoming 2009), chapter 5 (noting how disclosure requirements may alleviate the market power provided resulting from secret degradation).

<sup>8</sup> Comcast (2008a).

<sup>9</sup> Comcast (2008b), under "Technical restrictions".

<sup>10</sup> *Ibid.*, under "Are there restrictions on bandwidth consumption that apply to the Service?".

<sup>11</sup> Comcast (2008d).

<sup>12</sup> Comcast (2008c).

### **3. Disclosure alone is not enough.**

Disclosure can only facilitate competition and discipline providers if there is effective competition. In order for disclosure to have a disciplining effect, customers need to be able to switch to another provider that does not impose a similar restriction, and they need to be able to do so at low costs. In the US, none of these conditions is currently satisfied:

First, according to the GAO, the median number of broadband providers accessible to broadband Internet service customers in the US is two.<sup>13</sup> This market structure is often characterized as “duopoly +/-”.<sup>14</sup> In some parts of the country, customers are facing a monopoly. According to the FCC’s own data, 34 % of ZIP codes have one or less cable or ADSL provider who serves at least one subscriber living within the ZIP code.<sup>15</sup> As the GAO has pointed out, this measure (i.e. the number of providers reporting at least one subscriber in a certain ZIP code) overstates the level of competition to individual households.<sup>16</sup> While a duopoly is often better than a monopoly, duopolists enjoy a degree of market power that enables them to impose restrictions on their customers that they would not be able to impose in a competitive market.<sup>17</sup>

Second, as I have described in detail in my written work, the market for Internet services is characterized by significant switching costs that limit the effectiveness of competition. Although rules that require network providers to disclose whether and how they interfere with applications and content on their networks may reduce the problem of incomplete customer information, they cannot reduce the switching costs in the market for Internet services, and still leave the network provider with a substantial degree of market power over its customers that enables it to restrict some applications and content on its network without losing too many Internet service customers.<sup>18</sup>

### **3. The FCC needs to establish some ground rules for reasonable network management. In particular, it should ban network management practices that single out specific applications or classes of applications in order to manage bandwidth consumption on broadband networks.**

Without such a rule, “reasonable network management” becomes the back door that enables network providers to undermine the non-discriminatory nature of the Internet that the FCC’s Internet Policy Statement is designed to protect. The Internet Policy Statement promotes user choice and fosters application-level innovation by providing application developers with the certainty that they will not be discriminated against. If network providers can single out specific applications in order to manage bandwidth on their network, application developers face a fundamental uncertainty. The network may turn against them at any time. This risk of being cut off from access to end users at any time

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<sup>13</sup> United States Government Accountability Office (2006), p. 18.

<sup>14</sup> See, e.g., Farrell (2006), p. 202.

<sup>15</sup> Federal Communications Commission (2008), Table 16.

<sup>16</sup> United States Government Accountability Office (2006).

<sup>17</sup> See, e.g., Farrell (2006), pp. 202-205.

<sup>18</sup> van Schewick (2007), pp. 374-377; van Schewick (forthcoming 2009), chapter 5.

and at the sole discretion of the network provider constitutes a substantial risk that will make it much more difficult to get funding. For application developers, the impact of the threat of being discriminated against on their incentives to innovate<sup>19</sup> is the same, regardless of the motivation of the network provider, e.g. whether it is technically anticompetitive or not. Given the nature of the Internet as a general purpose technology, this reduction in application-level innovation is bad for society as a whole.<sup>20</sup>

Given that there is no real competition and significant switching costs, disclosure alone will not be sufficient to constrain network providers' incentives to impose restrictions that are not in the public interest.

As long as the current pricing structure continues to be based on flat-rate pricing, network providers have the perverse incentive to block or degrade applications on their network that use more bandwidth or deviate from the usage patterns for which the network was designed.<sup>21</sup> Applications that use more bandwidth than expected or exhibit usage patterns that deviate from the expected ones may put strain on the existing access network or the links to other providers, threatening congestion if the network provider does not upgrade the capacity of the network, or increase network providers' operating costs by raising their interconnection fees. From the network provider's point of view, blocking or degrading selected applications is a quick fix that requires less investment than upgrading the network or coming up with a non-discriminatory solution. As Brett Frischmann and I have shown in a recent paper, singling out specific applications to control bandwidth on a network has significant social costs that are not internalized by network providers. It harms application-level innovation by distorting the playing field between applications, and reduces consumer welfare by preventing users from using the applications of their choice.<sup>22</sup>

The original architecture of the Internet was based on a design principle called the end-to-end arguments.<sup>23</sup> As a result of this design, the network is general and can support a large variety of applications with different requirements. The network is not optimized in favor of specific applications. While this may increase the performance of particular applications, it also constitutes an unnecessary and therefore inefficient feature for applications that do not need this function and may even rule out the implementation of

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<sup>19</sup> van Schewick (2007), pp. 378-380 (describing the impact of a threat of discrimination on application developers' incentives to innovate).

<sup>20</sup> *Ibid.*, pp. 382-386; Frischmann and van Schewick (2007), pp. 423-425 (describing the benefits for social welfare associated with application-level innovation).

<sup>21</sup> MIT Communications Futures Program and Cambridge University Communications Research Network Broadband Working Group (2005); van Schewick (forthcoming 2009), chapter 5.

<sup>22</sup> Frischmann and van Schewick (2007).

<sup>23</sup> There are two versions of the end-to-end arguments: a narrow version, which was first identified, named and described in a seminal paper by Saltzer, Clark and Reed in 1981 (Saltzer, Reed and Clark (1981)), and a broad version which was the focus of later papers by the authors (e.g., Reed, Saltzer and Clark (1998); Blumenthal and Clark (2001)). While both versions have shaped the original architecture of the Internet, only the broad version is responsible for the application-blindness of the network. For a detailed analysis of the two versions and their relationship to the architecture of the Internet, see van Schewick (2004), pp. 87-129.

applications that are not foreseen at the time of the design. Instead, all application-specific functionality is implemented at the end hosts, i.e. the computers at the edge of the network. As I show in my forthcoming book, this design results in an economic environment for innovation that is much more conducive to application-level innovation than network architectures that deviate from the broad version of the end-to-end arguments.<sup>24</sup>

However, while maintaining the openness for new applications, general solutions are sometimes more complicated to design and more costly to implement. As my forthcoming book shows, there is a market failure regarding the evolution of the core of the Internet.<sup>25</sup> While society as a whole has an interest in keeping the architecture non-discriminatory and general in order to preserve its openness for new applications, network providers' incentives are not necessarily aligned with this goal. Recent years have seen a myriad of technical solutions driven by the short-term interests of particular actors which do not take account of the impact on the long-term evolvability of the Internet.<sup>26</sup> The deployment of asymmetric DSL and cable, network address translators and now the Comcast tactics for managing bandwidth on their portion of the Internet are examples of such solutions. They solve the problem at hand, but at the same time reduce the generality of the Internet, with significant costs for application-level innovation. Network providers' preference for short-term solutions is not surprising.<sup>27</sup> While the benefits of deviating from the broad version such as the reduction in cost or the improvement in performance of certain applications are immediately apparent, the associated costs for the evolvability of the system are almost impossible to determine: The applications that may suffer from the deviation are yet unknown. This makes it impossible to determine whether and to what extent some of these future applications would be harmed. As the application is not known yet, the value of the application to society cannot be known either; this makes it impossible to determine what the ultimate costs to society will be. As research in behavioral economics has shown, humans tend to assign disproportionately more weight to present benefits than to future costs that are yet uncertain, making it more likely that network designers would deviate from the broad version of the end-to-end arguments. The fact that network providers are unable to capture all of the gains associated with a non-discriminatory Internet,<sup>28</sup> further exacerbates the problem.

By prudently defining limits to what constitutes reasonable network management, the FCC can provide network providers with incentives to work towards general solutions that preserve the openness of the Internet for new applications and consumer choice.

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<sup>24</sup> van Schewick (forthcoming 2009).

<sup>25</sup> Ibid..

<sup>26</sup> See, e.g., Braden, Clark, Shenker and Wroclawski (2000), pp. 5-9.

<sup>27</sup> The following paragraph is based on van Schewick (forthcoming 2009), chapter 2.

<sup>28</sup> For example, they will not be able to capture all the productivity gains that users get from introducing new applications, or the positive spillovers associated with users' productive uses of the Internet (such as the improvement in democratic discourse resulting from widespread blogging on the Internet). For a long version of the argument, see Frischmann (2005); For a short summary, see Frischmann and van Schewick (2007), pp. 424-425.

If the openness of the Internet for new applications is to be preserved, the network providers need to manage their networks in a non-discriminatory way – without singling out specific applications or classes of applications. Of course, there needs to be an exemption for malicious applications that are engaged in an attack on the network.

Network providers would be able to enforce fairness among users, but how a user decides to use its “share” of bandwidth, both in general and at a particular point in time should be decided by the user. Network management solutions that enable network providers to police the amount of bandwidth used by a particular user are available today.

Some may claim that forcing network providers to treat a user’s traffic in a non-discriminatory way may ultimately harm the user, as some of the user’s applications may be more sensitive to the delay than others. They would suggest that enabling network providers to differentiate between classes of applications according to their needs (i.e. prioritize real-time VoIP traffic over file-sharing) would be in the interest of the user and should therefore be allowed.

While intuitively appealing, this view overlooks that the value a user attaches to a particular application is not necessarily fixed:<sup>29</sup> my priorities may differ considerably depending on the circumstances: if I’m using BitTorrent to download a movie that I want to watch tomorrow, I do not care if the download is delayed a bit. If, however, I’m using BitTorrent to download a critical security patch that I need to get quickly or if I’m a programmer and want to download the source code for the project that I want to work on now, this may have priority over all the other applications I’m currently using.

Similarly, if I’m doing a VoIP call to my friend and just want to chat, I may not care as much about the quality of the call as when I’m doing a job interview or a project phone conference using VoIP and want to hear or be heard in a crystal clear way.

This implies that having users signal their priority instead of having network providers determine prioritization within the network based on classes of applications may be preferable.<sup>30</sup> For users who do not want to set their own priorities, network providers could offer different sets of potential prioritizations, among which users could choose. Thus, network providers could offer and users could opt-in to prioritization based on application class, but without enforcing this prioritization on users whose needs differ. (To maintain the non-discriminatory nature of the Internet, prioritization choices offered by the network provider would have to treat applications belonging to the same class in the same way).

Why the emphasis on user choice? First, user choice is fundamental if the Internet is to create the maximum value to society. The Internet is a general purpose technology. It does not create value through its existence alone.<sup>31</sup> It creates value by enabling users to

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<sup>29</sup> Briscoe, Moncaster and Burness (2007), section 3.3.

<sup>30</sup> David Clark made the same point when he testified at the first FCC En Banc Hearing on Broadband Network Management Practices in Harvard.

<sup>31</sup> See, e.g., van Schewick (2007), pp. 385-386; van Schewick (forthcoming 2009).

do the things they want or need to do. Users know best what this is. As a result, users, not network providers should be able to decide how they would like to use the network, and what is important to them. Of course, in order for users to behave efficiently, they also need to bear (at least some of) the costs of their actions, something which the current system does not sufficiently provide.

User choice is also a fundamental component of the mechanism that enables application-level innovation to function effectively.<sup>32</sup> In the current Internet, it is impossible to predict what future successful applications will be. Enabling widespread experimentation at the application-level and enabling users to choose the applications they prefer is at the heart of the mechanism that enables innovation under uncertainty to be successful.

By singling out specific applications, network providers start picking winners and losers on the Internet. As we have seen, whom they pick may be driven by a number of motivations that are not necessarily identical with what users would prefer, leading to applications that users would not have chosen and forcing users to engage in an Internet usage that does not create the value it could. Consumers, not network providers, should continue to choose winners and losers on the Internet.

While there are mechanisms available that enable network providers to manage their networks in non-discriminatory ways now, the ways in which the Internet bandwidth on the Internet will be allocated between users and applications and in which it will deal with congestion is still evolving. Constraining the range of possible solutions in a way that provides network providers with incentives to evolve the Internet in a way that is good for society, not just good for network providers, while maintaining enough freedom to come up with good technical solutions, is the challenge in front of the FCC.

Thank you again for the opportunity to testify. I look forward to your questions.

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<sup>32</sup> van Schewick (2004), chapter 11.

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