

# **“Beyond Frustrated”**

## **The Sweeping Consumer Harms as a Result of ISP Disputes**

# ABOUT THE TEAM

---

The Open Technology Institute at New America is committed to freedom and social justice in the digital age. OTI conducts data-driven research, develops policy and regulatory reforms, and builds real-world pilot projects to impact both public policy and the built communications environment that people experience. The OTI policy team works at the local, national, and international level to promote policies that support ubiquitous, secure, and affordable access to the Internet. Our current focus areas include network neutrality, broadband access, surveillance, privacy and security, and Internet governance.

# EXECUTIVE SUMMARY

---

- > In 2013 and 2014, the policies implemented by some of the nation’s largest communications companies led to significant, months-long degradation of a consumer product for millions of people without explanation or compensation. In this paper, we analyze the full picture of the interconnection disputes described in a recent technical report produced by the Measurement Lab (M-Lab) consortium and describe the widespread, direct consumer harm that resulted. We argue that to avoid repeat offenses, the Federal Communications Commission (FCC) and other policymakers must continue to fully analyze what happened in 2013 and the subsequent actions and implement appropriate policies to remedy the situation. Those policy recommendations should necessarily include transparent, open measurement and oversight of interconnection performance, the groundwork for which M-Lab has already laid.
- > The paper begins with an introduction and overview of the harms revealed in the M-Lab data, situating those harms in the context of the user experience documented in consumer complaint forums. Part I details the immense scope of those harms — both in terms of the number of users affected, and the significance of the degradation of service many of those users experienced. Part II explains why the resolution of one particular interconnection dispute does not mitigate the need for continued attention from regulators, and ultimately long-term oversight and policy reforms to ensure that it does not occur again.
- > Part III contains a detailed exploration of the M-Lab data, divided into relevant case studies of both dramatic and incremental degradation. Taken in sum, these case studies present a compelling overview of the challenges that have emerged in the context of interconnection negotiations and recent disputes. Part IV, in turn, details a number of suggested immediate and long-term reforms that the FCC should undertake to ensure that consumers receive the service for which they are paying. The status quo is unacceptable, as is anything similar to a repeat of the dramatic degradation of throughput that occurred in 2013 to early 2014. This paper lays the groundwork for both understanding the problem and addressing it effectively going forward.

# TABLE OF CONTENTS

---

<b>Executive Summary</b>	<b>ii</b>
<b>Introduction: “Beyond Frustrated”</b>	<b>1</b>
<b>Part I: The Hidden Threat of Interconnection Disputes</b>	<b>2</b>
The Broad Scope of Consumer Harm	4
<b>Part II: Why You Should Worry</b>	<b>6</b>
<b>Part III: Empirical Analysis</b>	<b>9</b>
Incident Type #1 - Dramatic Degradation	10
February 2014 and the Cogent “Coda”	13
Consumer Harm - Real World Impact	14
Incident Type #2 - Incremental Degradation	17
<i>Example #1 - Verizon over Level 3 (July 2013 - present)</i>	17
<i>Example #2 - Comcast over XO (January 2012 - present)</i>	19
<b>Part IV: Remedy</b>	<b>21</b>

# INTRODUCTION: “BEYOND FRUSTRATED”

---

In the late spring of 2013, millions of Americans shared the same frustrating experience: some of their favorite Internet applications and services were not working properly. Netflix would not load and play movies in the evening. Access to company Virtual Private Networks (VPNs) for telecommuting would not maintain a steady connection in the afternoon. Download speeds slowed to a trickle. Telephone systems between corporate offices operating over the Internet could not maintain a steady voice call. Video conferencing was out of the question. High-bandwidth online gaming was nearly impossible. These outages and freezes happened at the worst possible time — at the end of the work day and throughout the evening. Just when people were looking to upload their work for the day and download some entertainment, their connection to the Internet slowed to a crawl.

Here is what bewildered most consumers: it wasn't that the Internet in general was slow, but rather only particular websites and services. People tried everything to fix the problem, assuming it must be something they had done wrong. Calls to the help-line at their Internet Service Providers (ISPs) provided no relief. Tier 1 customer service representatives had people restarting their computers, rebooting their browsers, recycling the power switch on the modem, and sending technicians out to the premises. Nothing worked. The 20, 30, and 50 Mbps connections for which consumers had paid their ISPs were failing miserably. In many cases, these lines were delivering less than the 4 Mbps that the Federal Communications Commission (FCC) currently defines as the minimum standard for “broadband.” For many people, the speeds often bottomed out at less than 1 Mbps — a download speed that might have been acceptable 15 years ago, but which is inadequate for even moderate Internet use today.

Consumer outrage escalated, especially as the problem continued for months. Angry consumers poured onto technology forums all over the Internet seeking anyone who could offer a solution. Thousands of complaints were registered on customer service boards and phone lines at Netflix as well as almost all of the nation's largest ISPs. Some consumers switched ISPs from cable modem service to DSL in hopes of finding a better service, only to find the same problem on both networks. Many followed up with complaints to the FCC and the Better Business Bureau (BBB).

After nine months, no one could provide relief or even a clear explanation of what was actually going on. The only thing customers knew for certain was that they weren't getting what they paid for from their Internet service providers. The stories people posted on consumer forums all featured a common pattern: a fast Internet connection on all kinds of websites, but total failure on particular (and in many instances very popular) services, including Netflix. A Verizon customer (who ultimately filed a complaint with the BBB) in June of 2013 reported: “Playing anything in HD after 8pm ET is almost impossible. Calling and talking to Verizon tech support has been completely fruitless. They have been unwilling to assist me in identifying the issue nor have they been willing to talk to Netflix with me.”<sup>1</sup> One consumer wrote: “I have spoken with both Netflix and Comcast now several times... **Beyond frustrated.**”<sup>2</sup>

# PART I: THE HIDDEN THREAT OF INTERCONNECTION DISPUTES

---

Verizon customer: *“Look at how old some of these Netflix threads are. This has been going on for roughly a year. Sometimes it’ll be fine, sometimes it’ll be 100% unusable but you can guarantee they have no interest in fixing it.”*<sup>3</sup>

What happened over the course of 2013 and 2014 was not a software bug, a network outage, or a natural evolution in the Internet marketplace. It was the result of intentional policies by some of the nation’s largest communications companies, which led to significant, months-long degradation of a consumer product for millions of people without explanation or compensation. The cable and phone companies involved in these policies provide service for more than two-thirds of all American Internet subscribers. Regardless of who shoulders the majority of the blame, this was a major market failure, and it resulted in widespread, direct consumer harm. Moreover, no one can point to any decisive action that has been taken by the industry or by the regulators to prevent it from happening again. Indeed, according to the empirical evidence presented in this study, not only was the damage that occurred extraordinary and unreported, but similar problems are continuing across other networks to this day. The full picture of interconnection disputes and consumer harms documented in this report suggest that it is a recurring phenomenon that reflects a contest among powerful industry actors over the economics of the Internet. It cannot be acceptable for consumers to suffer the consequences of that contest. To avoid similar repeat offenses, the FCC and others must continue to analyze the story of 2013 and subsequent actions in full.

Back in the summer and fall of 2013, as the months wore on, the media picked up on the problem and pointed to

business disputes between large Internet companies as the cause. In a nutshell, this was a dispute over money between the ISPs that sell consumers Internet service (e.g. Comcast, Verizon, Time Warner Cable), the companies that put content in data centers to sell to customers via the Internet (e.g. Netflix), and the transit network operators that run the backbone of the Internet and bring content from data centers to access networks. The place where transit networks meet access networks is the exchange point (or point of interconnection) and these companies have contracts for exchanging traffic at those points. As traffic flow increases from one network to another, the capacity of the link at the point of interconnection must also grow. If it does not, the link becomes congested with traffic. Some data is lost, and the quality of service for the end-user is degraded, sometimes to the point of total failure. This scenario is what played out on a grand scale.<sup>4</sup>

The problem started when broadband customers of ISPs (cable and phone companies) attempted to use their service to view streaming videos from Netflix. To get the requested movie to the customer, Netflix was using multiple transit network operators, including Cogent, Level 3, and XO. Generally, the job of these transit operators is to take content requested by an end user from the Netflix data center to the nearest point of interconnection with the cable and telecom companies. These ISPs in turn deliver the movies their subscribers requested.

Looking at Comcast and Cogent as an example helps explain how the problem developed.<sup>5</sup> As Netflix grew in popularity, the amount of traffic that Cogent delivered from Netflix to the front door of the Comcast network on its way to Comcast subscribers also grew. Comcast wanted Cogent and Netflix to pay more. Cogent and Netflix argued that they paid their fair share by bringing the data to Comcast's front door. They pointed out that it was Comcast's own customers who were asking for the Netflix content, and that those customers had already paid Comcast for monthly Internet service to access the Internet, including content from Netflix. Comcast responded that without more money, there would be no increase in capacity at the exchange point. Netflix, in turn, was already paying — in this case paying money to Cogent for transport of their traffic over the Internet.

Cogent and Netflix based their arguments for maintaining status quo on the way the economics of interconnection have typically worked (content companies pay for transit, transit companies bring traffic to interconnection points of access networks for no-cost handoff, access networks pay to deliver to consumers, and consumers pay both access networks and content providers). Comcast wanted to change this conventional model to move away from no-cost interconnection and toward payment for access to their network, arguing the increases in traffic flow required this shift. Both sides entirely rejected the arguments of the other.

The result was congestion between Cogent and Comcast.<sup>6</sup> As a result, Netflix service failed for millions of people. But it wasn't just Netflix that failed — it was *all* of the other content and services being hosted at data centers served by Cogent (as well as companies whose facilities connect to the Internet via Cogent) and requested by subscribers of ISPs in dispute with Cogent. The scope of those affected by this one dispute is therefore enormous. Cogent is the transit provider for 10 percent of addresses on the Internet,<sup>7</sup> including the servers for corporate VPNs, online-gaming services, video conferencing applications and others.

Simply put, this was a business negotiation over the terms of an interconnection contract. Both sides dug in for a stand-off and consumers were caught in the middle for at least nine months. Until the press picked up on the issue, and even long after, the companies were not clear with consumers about what was going on. After nine straight months of degraded service between Cogent and Comcast, and ample press coverage of the dispute, a Comcast engineer responded to a string of complaints on the Comcast user forum with this message: “We are aware of these threads and the concerns expressed here. We are actively engaged. It is sensitive and we can't really say more than that right now.”<sup>8</sup>

And even if consumers knew about the dispute, they were often powerless to do anything about it. Many were in markets where both of the available “competitive” ISPs were in the same dispute with Cogent at the same time. One Verizon customer vented on the company's online service forum: “I really only have FiOS and Comcast as broadband options here and I despise Comcast more than Verizon, so here I am....I am aware of the battles between Verizon and Cogent, and I can understand occasionally slow performance, but under 2 Mbps on a 50 Mbps plan? THAT is ridiculous.”<sup>9</sup>

In February of 2014, the dam broke. Netflix announced (reluctantly) that it was cutting deals with Comcast and later other major ISPs to pay to increase capacity at interconnection points and resolve the dispute. The degraded quality of service that millions were experiencing began to resolve. The ISPs were satisfied since they had won the debate. And many industry observers and analysts concluded that the market had resolved the problem. The millions of angry consumers who were affected by this debate were rarely given a comment on the matter. Meanwhile, the FCC, apparently not understanding the scope of the problem, did little to intervene.

## The Broad Scope of Consumer Harm

At the time of these disputes and the months of consumer harm from congested interconnection points, the vast majority of the reporting was about Netflix and the ire of Netflix viewers. However, this problem was far bigger than Netflix. As the data in the recently published study by Measurement Lab (M-Lab) demonstrates, the impact of the interconnection dispute created conditions in which a wide variety of applications would degrade to the point of near-zero functionality.<sup>10</sup> Not all of these applications fail because of low bandwidth. Some fail because of high latency or high rates of packet loss. Both in the analysis of past incidents and the monitoring of future congestion problems in the interconnection market, it is critical to track all of these performance metrics. There are many applications on the Internet that rely on specific minimum standards of bandwidth and latency to function properly. It is important to consider the scope of the services affected in order to fully understand the breadth of the consumer experience as a result of highly congested interconnection points between those users and the content and services they are accessing.

First, there are applications that need low latency and high bandwidth. These applications range from the most frivolous and fun (rich media real-time online games) to the most serious and vital (telemedicine remote diagnostics). Both of these applications require latency that is extremely low, and often send a lot of data and therefore need high bandwidth availability. For example, the FCC estimates that two-way HD gaming requires a minimum of 4 Mbps.<sup>11</sup> For latency, every specific application has different requirements, but negative performance starts to become noticeable with a measurable effect on consumer experience if round-trip times move above 100ms.<sup>12</sup> For example, Microsoft recommends these minimums to use Xbox Live: 3 megabits per second down, 0.5 megabits per second up, and latency under 150 ms.<sup>13</sup> Online gaming communities represent a large number of American Internet users. The Entertainment Software Association

reports that 59 percent of Americans play video games and a high percentage of those games require fast, low-latency connections.<sup>14</sup> World of Warcraft alone has seven million players.<sup>15</sup> Final Fantasy adds an additional million.<sup>16</sup> League of Legends boasts 27 million players *per day*.<sup>17</sup>

Similar requirements are necessary for many telemedicine applications, which are becoming normative for many Internet users. Data from the Information Technology Supplement to the American Hospital Association's 2012 annual survey of acute care hospitals show that 42 percent of US hospitals have telehealth capabilities.<sup>18</sup> A recent study estimates that the number of households using remote video for medical consultations will grow from 900,000 in 2013 to 22.6 million in 2018.<sup>19</sup>

Some applications may not require high bandwidth but will require low latency. Quality of service for VoIP requires a minimum of 150 to 200 ms latency according to the ITU, but Cisco puts that number down below 100 ms and the FCC requires that broadband companies that receive subsidies adhere to a 100 ms standard to ensure VoIP quality of service.<sup>20</sup> Applications like security alarms for health IT monitoring technologies require even lower latencies. According to the FCC, they need 50 ms for primary links and 120 ms for backup links.<sup>21</sup> Beyond these specific use cases, there is a well established literature of market analytics showing that any website that loads slower than 200 ms begins to see decreasing consumer interest and commercial viability.<sup>22</sup>

Many other applications need low latency and middling bandwidth (levels that were impacted in the 2013 interconnection congestion analyzed below). The most popular among these services is video-conferencing or video-chat. Minimum quality of service requires less than 150 ms of latency, under one percent packet loss, and 460 Kbps of bandwidth.<sup>23</sup> Higher quality video services (e.g. Skype, Facetime, and Google Hangout) may demand more bandwidth and similar limits on latency and packet loss to maintain real-time interactive audio.<sup>24</sup>



Latency and packet loss are a major issue for people who telecommute through secure links known as Virtual Private Networks (VPNs). Complaints from business customers during the Cogent dispute were typically related to poor performance on VPNs. Depending on the application running over the VPN, differing bandwidth levels are required, but a minimum of 512 Kbps is recommended. And the latency must be low. One IT consulting and services company recommends latencies no higher than 60 ms.<sup>25</sup> Common telecommuting products are offered by companies like Citrix and Adobe. Adobe Connect is relied on by more than one million Department of Defense employees for over 35 million web conferencing minutes per month.<sup>26</sup> Another Adobe Connect customer is the American Society of Civil Engineers, whose IT Director took to Verizon's forum to note that "all of our employees who have FIOS in the DC area... have issues connecting to AC [Adobe Connect] in Palo Alto, CA."<sup>27</sup> He noted: "Telecommuters can lose their jobs over these kinds of issues."<sup>28</sup> It is not just about job retention — it is about efficiency and productivity. Telecommuting is not an isolated phenomenon. For example, more than a quarter of all federal employees now telecommute at least one day a week.<sup>29</sup>

---

**"Telecommuters can lose their jobs over these kinds of issues."**

*-IT Director at the American Society of Civil Engineers*

---

Depending on the service, video over the Internet may not require low latency. Buffering can alleviate some latency problems if the video service is not interactive or real-time. But the bandwidth requirements are fixed. For SD video, Google reports that 700 Kbps to 2.5 Mbps is the necessary bandwidth to maintain a smooth viewing experience. For HD, that minimum threshold must hold steady above 2.5 Mbps.<sup>30</sup> These minimums may not sound like much, but when ISPs fail to deliver this quality of service, the scale of users impacted is very large. In summer of 2014,

there were 36 million Netflix subscribers in the U.S.<sup>31</sup> And market analysts at Park Associates estimate that over half of all U.S. broadband households now use some form of paid Internet video service.<sup>32</sup> As video services become more popular, they may also become more feature-rich and demand more bandwidth. And, of course, with these kinds of numbers, it is likely that many households will frequently have multiple simultaneous users of online video. That pushes the minimum bandwidth requirements up higher — but of course, today's offerings of 25 and 50 Mbps *should* easily be able to handle the load. The fact that ISPs chose not to handle the load with standard, incremental upgrades is the heart of the problem.

# PART II: WHY YOU SHOULD WORRY

---

Some observers of this dispute between network operators and content providers have concluded that since it resolved in a business agreement, the market functioned appropriately. It did not. Nine months of major consumer harm, during which an Internet service that not only underperformed the advertised product but failed to perform at all on critical applications, received no meaningful change in policy from either industry leaders or regulators. This situation persisted despite thousands of consumer complaints, millions of frustrated Internet users, untold numbers of wasted hours with customer service reps, and, eventually, significant media coverage explaining the nature and scale of the problem.

Even if the particular scale and severity of the Cogent incident were unlikely to recur (though it certainly may recur), the FCC should implement a policy framework to ensure proper processes and rules are in place to protect consumers. At minimum, the Commission should set up a monitoring system to catch these congestion events early so that, at the very least, consumers are properly informed from the start and regulators are vigilant and poised to act. The data presented in Part III below underscores that congestion problems at interconnection points persist to this day. And this time, the interconnection scenarios are not with Cogent. They include Level 3 — a much larger player in the transit market — as well as XO. Basic consumer protection in this case requires some oversight from the FCC.

To be clear, the Cogent episode was not an isolated incident that involved a small number of companies. Millions of people were affected all across the country. Consider the size of the market controlled by the four principal access networks involved in the Cogent dispute — Comcast, Time Warner Cable, AT&T and Verizon. Together they represent

58.76 million subscribers — 68 percent of all American Internet households.<sup>33</sup> Netflix has more than 35 million U.S. subscribers and Cogent is upstream from 10 percent of all addresses on the Internet.<sup>34</sup>

Consider for a moment what this incident tells us about recent debates in technology policy and calls for regulation and oversight of giant telecommunications companies. In the context of the network neutrality debate (essentially whether a rule should prohibit network owners from creating discriminatory business models that privilege some content over other content on the Internet), ISPs have used the same argument over the years to combat additional protections, calling network neutrality “a solution in search of a problem.” The ISPs swear up and down that they would never create “slow lanes” on the Internet that would degrade *any* online content or services, much less popular ones. They claimed that any business model that sought to extract profits from congested networks (pricing access to scarce bandwidth with discriminatory rates) would run counter to their fundamental commitment and incontrovertible business incentives to provide quality products to their customers.

Indeed, all of the major consumer ISPs have been arguing for years that they would never engage in business practices in pursuit of greater profits that resulted in the degradation of the consumer experience. They dismissed those who called for regulations prohibiting this conduct as radicals who were predicting a harm that would never happen because of basic incentives for serving consumers. And yet, when facing a business dispute with Cogent and Netflix, none of them hesitated to permit massive congestion in their networks that significantly degraded the consumer experience for millions of subscribers. Ultimately, the only conclusion that consumers can

### ISPs promise to not degrade traffic:

**NCTA:** *"It would be irrational for broadband providers to undermine the very openness that has long buoyed their businesses for some short-term gain, or to block or degrade access to Internet content that competing providers make readily available."*<sup>35</sup>

**AT&T:** *"AT&T has no intention of creating fast lanes and slow lanes or otherwise using prioritization for discriminatory or anticompetitive ends."*<sup>36</sup>

**Comcast:** *"For its part, Comcast has not entered into a single 'paid prioritization' arrangement, has no plans to do so in the future, and does not even know what such an arrangement would entail as a practical matter."*<sup>37</sup>

**Verizon:** *"Verizon's customers demand and desire open Internet services, and value Verizon's services precisely because they afford access to all the lawful content and applications the Internet makes available. A policy of impeding access to services customers wish to access would only push those customers to other providers."*<sup>38</sup>

**Time Warner Cable:** *"The economic imperative to recover the substantial costs of building and operating broadband networks by attracting and retaining customers creates a significant disincentive to acting in ways that would alienate consumers, and thereby reduce revenues."*<sup>39</sup>

**USTA:** *"A broadband customer who is unable to access particular content or use a particular application on the Internet will not be a customer of that broadband provider for very long. Should a broadband provider take action to limit or prevent consumers from enjoying the benefits of an open Internet, the provider undoubtedly would suffer the competitive consequences.."*<sup>40</sup>

draw from these events is that the ISPs are not really that concerned about their experience. This apparent lack of concern is instructive about intentions in the network neutrality debate, and it points to deep-seated problems of market concentration and the absence of competition in the ISP market. Cogent and Netflix must also shoulder part of the blame for the consumer harms resulting from these disputes (particularly for not telling consumers from the beginning what was going on). But the stark divergence between the pledges and the actions of the nation's largest ISPs should trouble the regulators at the FCC.

So far, the FCC's response has been attentive but modest in action. In May, the FCC Chief of Staff framed the problem and pledged that the Commission is looking into it: "Are such [peering] disputes, in fact, business negotiations that can be resolved adequately in the marketplace? Or are they an advance warning sign of a breakdown of the functioning marketplace of interconnection and traffic exchange on the Internet? We don't know the answer. But we do know that we need to learn more about how the marketplace is, or is not, functioning."<sup>41</sup>

In a blog post published in June 2014, more than year after the incidents between Cogent and major ISPs began, the FCC's top engineers wrote that, based on their own observations and the formal complaints filed with the agency, it was clear that "consumers are frustrated by recent trouble with their Internet experience."<sup>42</sup> In August, the FCC's investigation requested the specifics of paid peering deals of several ISPs.<sup>43</sup> The analysis in this report and the empirical findings that underscore it should assist in that effort.

And while the FCC's response to this market failure has reached no conclusion yet, it is worth noting that other parts of the U.S. government have seen this kind of market activity before and spoken out vociferously against it. In fact, all of the major American ISPs, as well as many technology companies, joined them in that opposition. The key difference? The demands for extra fees for content companies to reach ISP customers were coming from *foreign* telecommunications operators.

In the period before the 2012 World Conference on International Telecommunications (WCIT) in Dubai, the association of European Telecommunications Network

Operators (ETNO) proposed that the International Telecommunication Union (ITU) create global regulations to permit the implementation of a “sending party pays” regime for the Internet.<sup>44</sup> The proposal recommended that network operators be authorized to break peering agreements (settlement free interconnection) and charge discriminatory fees for interconnection to access networks. The proposal triggered a lengthy debate in which ETNO explained that what they wanted to do was to charge fees from American content and services companies that were pushing ever more data towards European consumers.<sup>45</sup> The content companies (and their American transit network partners) countered that it was the European consumers who were requesting that content, and that it was only fair for European ISPs to deliver it as they always had.

The ETNO proposal was strongly opposed by the US government, led among others<sup>46</sup> by then-U.S. Ambassador to the EU and former FCC Chairman William Kennard. Ambassador Kennard spoke at an ETNO conference with unequivocal frankness:

At the upcoming WCIT meeting in December, the United States will oppose efforts to amend the ITRs to give new jurisdiction over the Internet to the ITU. This means that we will oppose the ETNO proposal to amend the ITRs.

I appreciate this opportunity to explain why we have taken this decision. But first, I want to say that this is the unanimous view of the United States government. It represents the position of the Obama Administration, the Federal Communication Commission, both houses of Congress—our Senate and our House of Representatives—and remarkable unity of all stakeholders outside of government. Those in business and civil society have all come together, showing remarkable unanimity of support for this position.<sup>47</sup>

Ambassador Kennard was indeed correct that ETNO’s proposal was opposed by the entire U.S. tech and telecom industry, including the network operators involved in almost precisely this same conduct at home at almost the same moment. This hypocrisy notwithstanding, the concerns of the U.S. government and industry are well warranted. It is much more difficult for the United States to argue against attempts by foreign governments and network operators to charge access fees from U.S. content companies and operators if American ISPs are allowed to behave similarly at home.

A former U.S. Coordinator for International Communications and Information Policy for the Department of State, Ambassador David Gross, presented at the time a very sharp analysis of the ETNO proposal.<sup>48</sup> Ambassador Gross described the problem with the idea in the following way:

The concept of “sender party pays” is unclear. But in essence, it appears that what they want to do is say that, if my customer — if I’m a carrier — my customer makes a query, sends out a search for certain information, and they access a website because of that, that the party associated with a website that has the content that is responding to that search, that the content provider must pay for transmitting that content to the requester. This is a completely new economic concept to the Internet. And it could have a radical and profound impact on the economics of the Internet, especially in the developing world.<sup>49</sup>

Given the widespread opposition to a sender party pays approach internationally, it is surprising to see similar norms emerging on U.S. soil.

# PART III: EMPIRICAL ANALYSIS

A recently published technical report from Measurement Lab<sup>50</sup> studied the interconnection problem by looking at longitudinal data from millions of consumer Internet performance tests taken from 2012 to the present. The study is the most comprehensive empirical analysis performed of the interconnection disputes of 2013 and 2014. M-Lab has unique data resources that measure Internet performance — both in size (geographic scope of measurement coverage) and density (number of daily measurements per market). M-Lab data is used by the FCC and other national regulators, and it is cited as an authoritative source by the ISPs, transit network operators, and content companies.<sup>51</sup> The data is all public and the testing methods and software infrastructure are open source to ensure maximum transparency and replicability.

The M-Lab study examines the interconnection relationships between ISPs and the transit providers that deliver content from the rest of the Internet to the ISPs' subscribers. The individual measurements represent tests of connections performed by actual consumers that capture real-world performance data from many different ISPs across several different transit networks. Despite Netflix's role in the congestion, M-Lab evaluates streams of data that are not specific to any application.

The sum of the measurement results is the clearest picture we have of the significant consumer harms that happened through much of 2013 and early 2014. The M-Lab data shows the performance (data throughput, latency, and packet loss) of Internet service compared between different pairs of interconnecting transit providers and ISPs. It is a remarkably accurate picture of what real Internet experiences look like for real consumers — a diverse mix of content coming from the different networks whose interconnection makes up the “inter” in the Internet.

Using the M-Lab data, we can see what it was like for customers of Comcast, Verizon, Time Warner Cable, and other ISPs when they tried to download content from the Cogent network between April 2013 and February 2014. And we can see the difference in quality of service for those ISPs, such as Cablevision, who were *not* in business disputes with Cogent. Beyond the obvious disruptions of the Cogent dispute, the M-Lab data also tracks other forms of congestion in the interconnection market — including ongoing problems with interconnection between Level 3, XO and several major ISPs, including Verizon and Comcast. The data demonstrate how far the quality of service dropped off for many consumers and allow us to get an empirical picture of the consumer harms that we can otherwise only see anecdotally from venting in the frustrated comments of consumers on ISP complaint forums.

There are two primary phenomena presented in the data. For simplicity, we can call them: 1) “Dramatic Degradation,” e.g. the Cogent dispute resolved in mid-2014; and 2) “Incremental Degradation,” e.g. the Level 3 congestion with Verizon that continues to the day of this publication. The discussion that follows presents the M-Lab data in graphic visualizations taken directly from the technical report. Short explanations describe what consumer experience the data shows. And, where possible, we have pulled a sampling of the actual consumer complaints from ISP forums that we can source to the network operators and time periods shown in the data. In both cases, the periods of serious degradation (during peak hours for millions of users) were sufficient to disrupt the functionality of a broad suite of bandwidth and latency-sensitive applications common to most Internet users' daily lives.

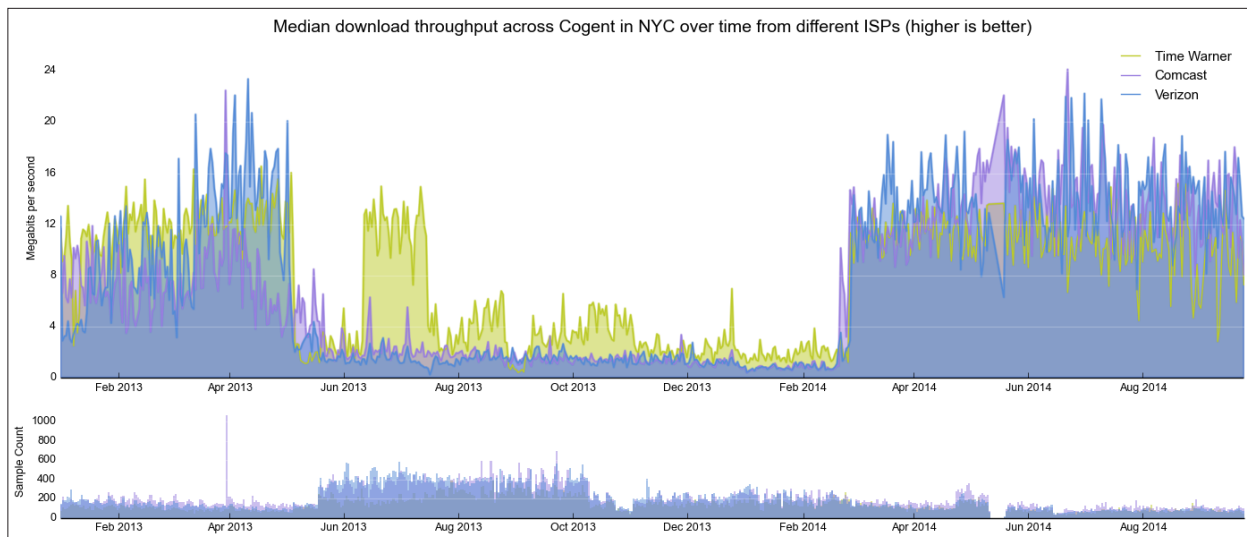
## Incident Type #1—Dramatic Degradation

The dispute between Cogent/Netflix and most of the major ISPs in America is clearly captured in the M-Lab data. The phenomenon is systematic across all the markets where M-Lab has measurement points hosted by Cogent, which include New York City, Seattle, Dallas, and Los Angeles. In each market, the pattern is the same. For those ISPs in business disputes with Cogent, the performance of consumer Internet connections for traffic inbound from the Cogent network experience dramatic degradation in throughput, latency, and packet loss. In the New York City market, the same ISPs showing major problems over Cogent have no such problems for traffic flowing inbound from another transit provider, Internap. And in each market, for those ISPs that are *not* in disputes with Cogent, traffic performance is unaffected across all transit providers. Figure 1 below shows the decline in download throughput for ISPs interconnecting with Cogent in the New York City market.

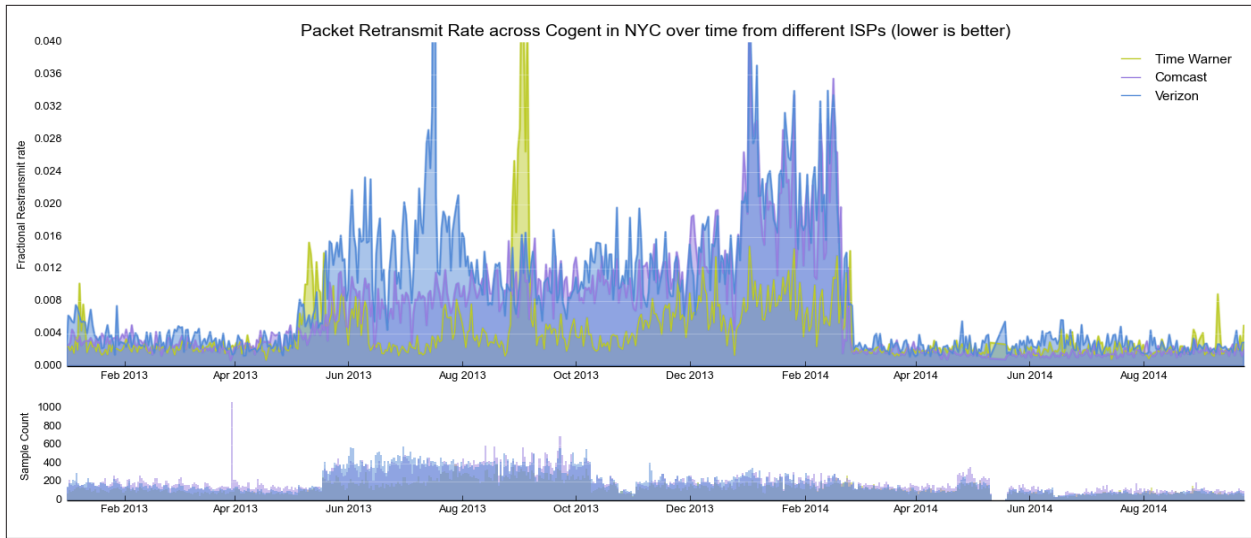
The data presented here show the reason why so many consumers were complaining loudly for so long about

the quality of their Internet service. From May of 2013 to February of 2014, median download speeds for Comcast and Verizon customers accessing content from the Cogent network (like Netflix) fell below the 4 Mbps threshold that the FCC defined as the minimum standard for broadband back in 2010. Time Warner Cable performed somewhat better, but also experienced sustained degradation. Notably, the other major ISP in New York City — Cablevision — experienced no such degradation. Service between Cogent and Cablevision was unaffected and normal throughout this period of time. This is likely because Cablevision has a direct interconnection with Netflix and does not carry Netflix content over Cogent interconnects.

A related phenomenon occurred with levels of packet loss. Figure 2 shows the spikes in packet loss that correspond to the declines in throughput speed. This simply means that consumers were not only getting slower downloads, a relatively high percentage of the traffic simply never reached their computers.

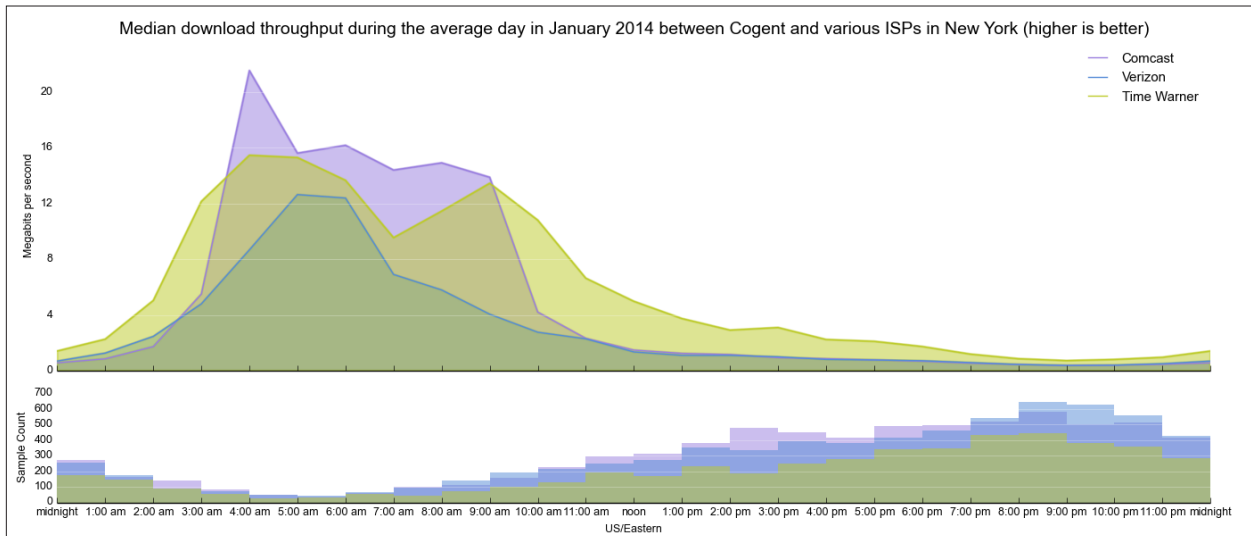


**[Figure 1]** Median download throughput achieved by customers of Comcast, Time Warner Cable, and Verizon in the New York City area when connecting across transit ISP Cogent, January 2013 to September 2014.



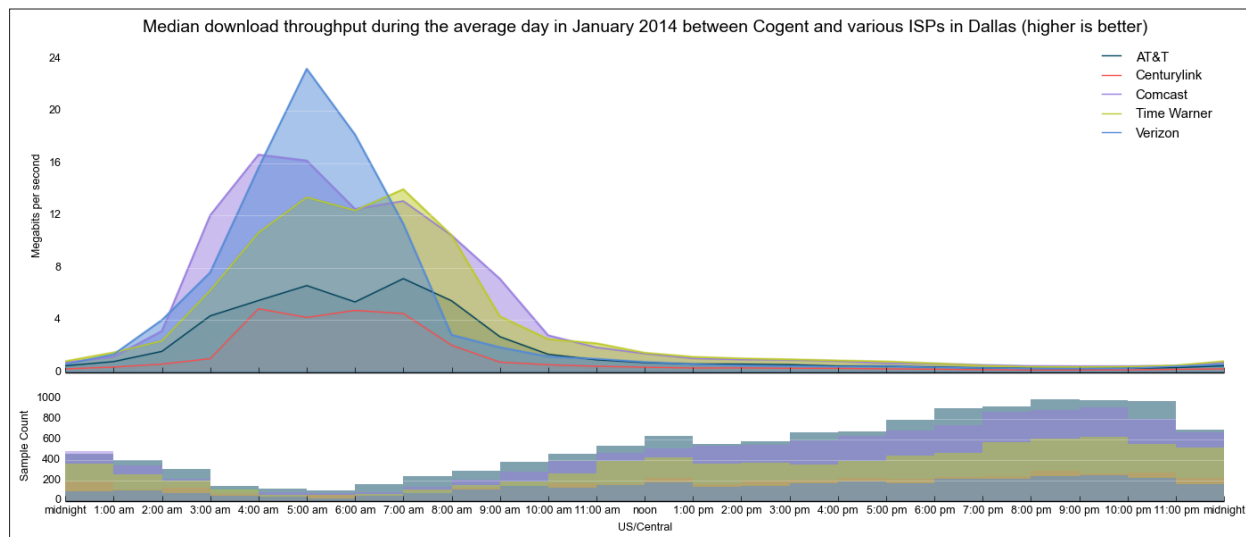
**[Figure 2]** Median packet retransmission rate experienced by customers of Comcast, Time Warner Cable, and Verizon in the New York City area when connecting across Transit ISP Cogent, January 2013 to September 2014. This view shows a clear correlation between increased packet retransmission rate and decreased download throughput (Figure 1).

The experiences of consumers in Dallas, Seattle, and Los Angeles were similar — both AT&T and CenturyLink also displayed the same pattern of “dramatic degradation” with the Cogent interconnection that appears so clearly in this chart. To underline what this means: for months, all across the country, the customers of five of the nation’s largest ISPs were experiencing Internet service with download speeds *below* the FCC’s minimum standard for broadband, regardless of what they paid for. Break down these charts into a day-by-day analysis, and the actual download speeds in the most important parts of the day (afternoon and evening) get even lower. Figure 3 shows the “median diurnal” measurements for the New York City market for several ISPs over the Cogent interconnect.



**[Figure 3]** Median download throughput achieved by customers of Comcast, Time Warner Cable, and Verizon in the New York City area, by hour of the day during an average day in January 2014, when connecting across Transit ISP Cogent. This view shows the extent of download throughput degradation during peak use hours. The FCC defines peak use hours as 7pm to 11pm, local time.

What this data shows is that congestion in the Cogent interconnect — quite logically — got worse as more and more people were using it. As long as people were only online between 2 AM and 10 AM, everything appeared fine. But anything in the afternoon or evening experienced slow-downs so serious that many applications were unusable. The situation was even worse in Dallas, shown in Figure 4 below.

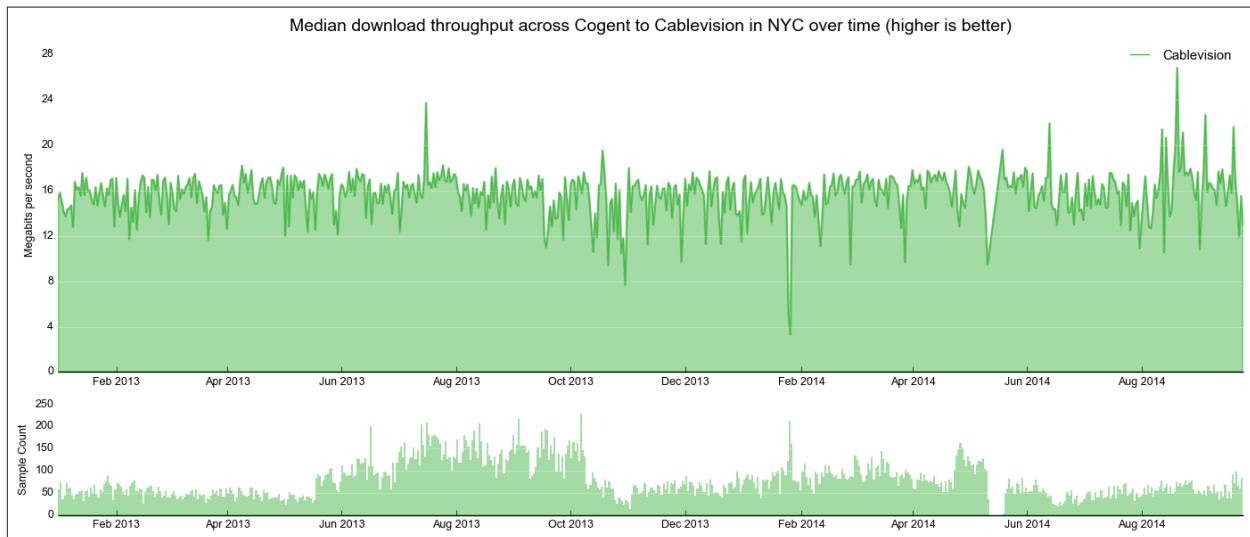


**[Figure 4]** Median download throughput achieved by customers of AT&T, CenturyLink, Comcast, Time Warner Cable, and Verizon in the Dallas area, by hour of the day during an average day in January 2014, when connecting across Transit ISP Cogent. This view shows the extent of download throughput degradation during peak use hours. The FCC defines peak use hours as 7pm to 11pm local time.

What each of these graphs reveals is not a technical problem. It was not an inability to arrange for increased capacity at the interconnection points that caused these disruptions. (Network operators could have augmented the physical infrastructure to increase bandwidth without great difficulty or major expense.) The problem was a market dispute over who should pay for what. And as the nine-month standoff wore on, millions of consumers suffered daily. Not only were download speeds reduced below the functional thresholds for high bandwidth applications; the latency times and packet loss percentages also rose precipitously. The combination of high latency, high packet loss, and low throughput resulted in an Internet service that was of little use to the consumer who bought it for the affected applications. In many areas in these markets, all of the available ISPs were providing the same degraded service. Only a handful of large ISPs, such as Cablevision in New York City and Cox in Dallas and Los Angeles, did not manifest these problems with Cogent.



Figure 5 shows the Cablevision/Cogent interconnection. It is the same chart as Figure 1 for the other ISPs in the New York City market. But for Cablevision, there was no decline in download speed. In short, Cablevision shows what broadband service could look like for consumers absent disputes with interconnection business partners.



[Figure 5] Median download throughput achieved by customers of Cablevision in the New York City area when connecting across Transit ISP Cogent, January 2013 to September 2014.

## February 2014 and the “Cogent Coda”

The serious consumer harms caused by these interconnection disputes between ISPs and the Cogent transit network (and by proxy, with Netflix), appear to change for the better in February 2014. Figures 1 and 2 clearly show that in February 2014, the major decline in quality of service reversed almost overnight. The timing coincided with the announcement of an interconnection agreement between Netflix and Comcast that sought to end the dispute that resulted in degraded service. This “bounce-back” in the M-Lab data leaves some unanswered questions. While it may be the case that Comcast consumers experienced a rapid return to normal quality of service after the deal with Netflix, it should not have been the case for other ISPs, such as Verizon and Time Warner Cable. These ISPs eventually made deals with Netflix, but not until some weeks or months after February 2014. So what explains the M-Lab data that shows a simultaneous rebound for all the ISP interconnections with Cogent?

The raw data are not conclusive on this point, but the M-Lab researchers discovered what appears to be the answer.<sup>52</sup> In February 2014, at the same time that Comcast and Netflix were finalizing a settlement, traffic to M-Lab measurement points on the Cogent network begin to show a special tag that indicates a priority delivery.<sup>53</sup> This means these packets may have been put at the front of the queue at any congested interconnection point. Cogent network engineers recently confirmed that they made just such a change to network management practices at this time.<sup>54</sup>

This is an interesting “coda” to the story of the previous nine months of feuds over interconnection and dramatic degradation in consumer services, but it was not itself the remediation of the degradation. It appears that right at the end of this long and unprecedented industry dispute, Cogent chose to make changes in network management to relieve the pressure on some of its consumers. Cogent engineers explained that they placed this priority tag on the traffic of retail enterprise customers only – leaving wholesale customers with the standard treatment

of traffic. Retail enterprise customers would include businesses with direct service from Cogent, including M-Lab. Wholesale customers would include any customer with content at a data center buying wholesale access to Cogent transit, including Netflix. It is therefore likely that in the time period after February 2014 the enterprise customers of Cogent services experienced a return to normal or near-normal quality of service. Meanwhile, this would have resulted in even greater congestion for wholesale customers – meaning services like Netflix would have become even worse on those ISPs yet to make a deal with Netflix. This explains why M-Lab data from the Cogent network showed a sharp uptick in February 2014 but consumer complaints about Netflix service persisted. However, unlike characterizations made by some observers after the announcement, this finding does not imply that the persistent degradation of Cogent traffic, or from any particular content provider, over the previous nine months was the result of network management practices by Cogent prior to this change.

The Cogent “coda” raises a number of important issues for policy-makers to consider. Transparency and the implementation of traffic management practices, such as prioritization, have historically played a role in the broader debate over network neutrality. However, this does not appear to be a case in which Cogent sought to sell prioritization and quality of service. On the contrary, this network management regime was implemented quietly at a time of extreme congestion in order to save some consumers from major levels of degradation, notable especially to those that use congestion-sensitive applications. And Cogent claims to have followed industry recommendations on the management of congestion. Such an episode demonstrates the effects of bandwidth scarcity. Questions remain about the precise nature of consumer impact, why Cogent did not make this change sooner, and what the appropriate degree of transparency for such practices should be. And of course there are deeper questions about the relationship of these interconnection disputes to the network neutrality debate and the market concentration in

this industry. These are beyond the scope of this paper but deserve a fuller treatment as the facts emerge.

## Consumer Harm — Real World Impact

The M-Lab charts paint an impressive picture, but they do not fully demonstrate the human costs in terms of wasted time, lost business, frustration and anger caused by the disruptions. The combination of degraded performance represented here, in the form of low throughput, high latency, and high packet loss, translates into major disruption for a wide range of applications and services that require minimum thresholds for bandwidth and delay. Recall that video applications for streaming, gaming, or video conferencing require a minimum of 1 Mbps for SD, 1-5 Mbps for HD, and up to 25 Mbps for Ultra HD.<sup>55</sup> In addition, if multiple family members or co-workers are online at the same over the same connection, the consequences could impact even low-bandwidth applications. Consider the daily pattern in the Dallas market represented in Figure 3. From 1 PM to midnight, consumers would be lucky to get 1 Mbps.

We can read about how these circumstances worked out in the real world in customer complaints. It is, of course, not possible to connect any one complaint with the exact interconnection congestion documented in the M-Lab data, but the sheer number, locations, and similarity of the complaints makes the correlation probable for individual cases and extremely likely on the whole.

In May 2013, a Comcast business customer in Utah reported problems with its VoIP phone system: “This is a recent problem (last week or two), but I am seeing it with multiple Comcast circuits at this time...I have a few VoIP Phones connected to a Comcast Circuit in our offices in Utah....The service seems to work fine in the morning, and then degrades as the day moves on.”<sup>56</sup> It is quite likely that what this company was experiencing was diurnal degradation of latency over interconnection points to the Comcast network to a level that by afternoon, VoIP calls were not possible.

A frustrated Netflix viewer in August of 2013 reported this experience on the Verizon user forum: “So, ever since I moved from one part of Pittsburgh to another, my Netflix streams have suffered from extremely diminished speeds during peak hours...Furthermore, if I try to watch something on another streaming video platform, like Amazon Instant or HBO GO, it’ll go into HD picture within seconds. I’ve called Verizon about this six times now, and Netflix three times. Both blame the other, and I’m both baffled and irritated. I’ve power cycled the router more times than I can count. The Netflix engineers told me that my network’s consistency was to blame, and when I asked the Verizon tech about it, he said he had no way of measuring it, so I was basically out of options. Is there some way to fix this? For the love of god, please tell me there is.”<sup>57</sup>

A Comcast customer in November 2013 expressed frustration with a wide variety of online services: “No, you’re not the only one. I’ve been having League of Legends issues, VPN issues to work, Avaya Softphone issues, VOIP.ms issues.... all because Comcast/Cogent have this congestion issue. Everything sucks because of this one issue.”<sup>58</sup>

In early December, a Verizon customer in the Los Angeles market reported problems with secure FTP services that have the hallmarks of the Cogent interconnect problem: “When I run a speed test, I get 15ms latency, 39.76 Mbps down, and 38.84 Mbps up. But a site from which I download regularly (using FTPS) has recently (end of November/beginning of December) dramatically dropped in speed. Instead of my old >1 MBps per connection average, I began seeing 50 KBps, then 40 KBps, and today 30-32 KBps...Like I said, the Verizon Speed Test still says everything is hunky-dory. That said, I’m not paying for FIOS in order to get 256 Kbps downloads.”<sup>59</sup>

A group of Comcast business customers were united in a common complaint thread in January of 2014. They discovered that corporate VPNs handling business

communications from Chicago to Salt Lake City to Seattle were reduced to sub-1 Mbps speeds, high latency and 10 percent packet loss. One business reported that despite the fact that this was a well-known problem, Comcast was still insisting on sending technicians for a truck roll. “This issue is also happening in Connecticut using a business class line getting to some servers on Cogent in Chicago. I have opened tickets again. They are sending a “tech” to my house to check the line and modem. That is the only way to start getting things escalated to the next level. If they want to waste time and money I will have them send techs everyday until I get a logical answer. I will also see if some of my users at my company will join in on this and flood their techs. I have contacted Cogent about the issue too but I want Comcast to respond to this problem. Comcast has not responded to the issue from the business class or residential other than will send a tech to your service address.”<sup>60</sup> Another customer on the same thread pleaded: “Comcast I am begging you. Please help. I am losing customers over this.”<sup>61</sup>

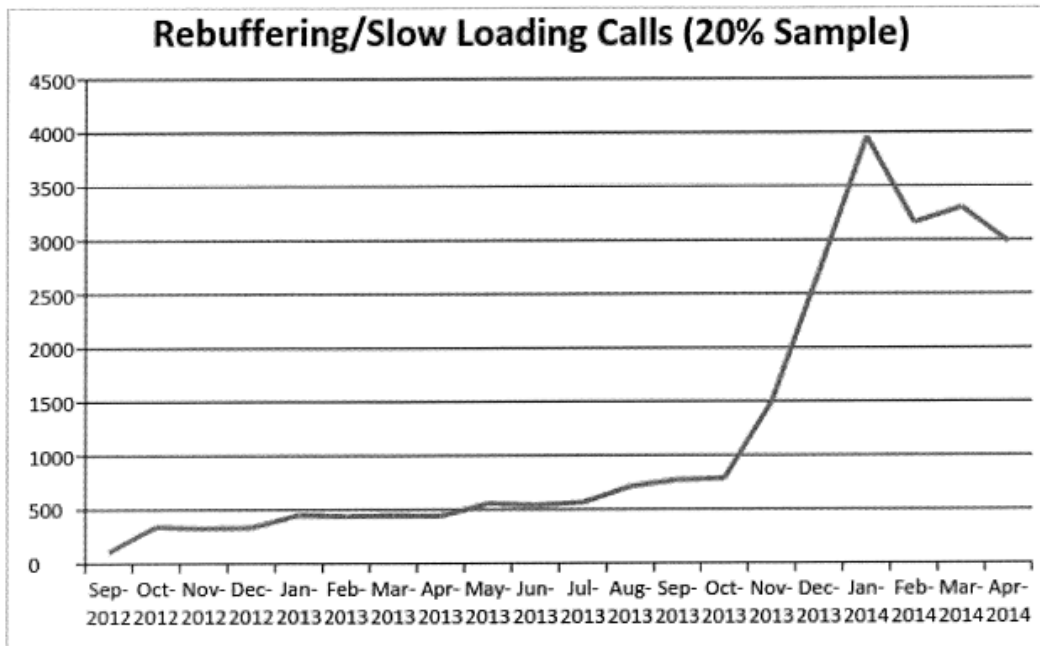
---

### **“Comcast I am begging you. Please help. I am losing customers over this.”**

---

Finally, in early February 2014, a company that provides software solutions for online radio stations reported Cogent related problems over AT&T’s network: “We are seeing lots of problems with our audio streaming traffic dropping lots of packets where our transit provider Cogent hands off to ATT & Verizon. Right now, I’m seeing 43% packet loss. Cogent is blaming ATT/Verizon and says there is nothing they can do about it. We’re the collateral damage. I threaten to cancel my service, Cogent says, “sorry to lose you as a customer”, and go on their merry way. Are other transit providers having issues peering / getting to ATT/Verizon? I need to know who to avoid.”<sup>62</sup>

Netflix provided this chart of their customer complaint calls during this period. It shows the scale of the problem and the quantity of complaints directed at Netflix for the poor performance of their service. And Netflix and Cogent



[Figure 6] This chart tracks the volume of consumer calls to Netflix complaining about slow speeds. It was submitted by Netflix in their filing opposing the merger of Comcast and TWC.<sup>63</sup>

do share some of the responsibility for looking after their customers in this situation. They engaged reluctantly in business negotiations with the ISPs for far too long and left not only their own customers (Netflix) but many others (Cogent) with terrible service and not a lot of explanation. The scale of harm was simply too large for this strategy to work without serious consequences.

Comments from Netflix consumer forums indicate that even late into the months of outages — after the press had already broken the story of the Cogent interconnection dispute — many consumers were not getting straight answers from Netflix customer service.

In January of 2014, one customer reported a problem that looks a lot like the Cogent interconnection issue: “In my case I find that during the day everything is fine but at night I have problems streaming content from netflix to my computer---- the picture is blurry and stops to reload every few minutes. Since my upload and download speeds are exactly the same whether day or night and since I have no trouble streaming on Amazon and other sites I know

this is a netflix issue. I think netflix has not been scaling up their server capacity to keep pace with their expanding customer base (especially with the imminent debut of the 2nd season of “House of Cards”) and that is why some of us are have difficulty especially at night when the vast majority of users are on the site---they just cannot handle all the traffic. *When I spoke to netflix customer service about this they tried to tell me it was a problem with my router or modem which obviously is not the case due to what I have described above.* I think they are hiding their heads in the sand on this issue and they are alienating customers.”<sup>64</sup>

The consumer complaints in this section are very representative of thousands more like them. They are drawn from the user forums of Netflix and the ISPs involved in this dispute (Cogent has no similar user forum). All of the companies involved in this dispute should be troubled by the outcome, especially considering the number of Cogent-hosted applications and services that were significantly degraded despite having no involvement in this pricing dispute. This dispute should either have been

settled by the companies quickly before consumer harm got out of hand, or it should have triggered a rapid and decisive regulatory intervention.

It is only the opacity of the interconnection market and the lack of consumer understanding about how it works that stopped this from becoming a bigger consumer protection scandal. Any similar incident of this scale and damages in a non-technology market would not have been tolerated by consumers or regulators.

## **Incident Type #2 — Incremental Degradation**

If the M-Lab technical report on interconnection disputes had documented only the dramatic degradation of the Cogent dispute, it would have presented troubling data about an incident of market failure that has now been resolved. But the data show much more than just the Cogent story. They document what is an even more troubling story of incremental degradation of Internet quality of service for millions of consumers. This phenomenon does not deliver the same obvious results as a categorical failure of whole suites of applications. It is not as obvious to the end-user because the degradation is not targeted at a particular high-bandwidth website or service. In other words, this is the degradation of millions of websites, not just one.

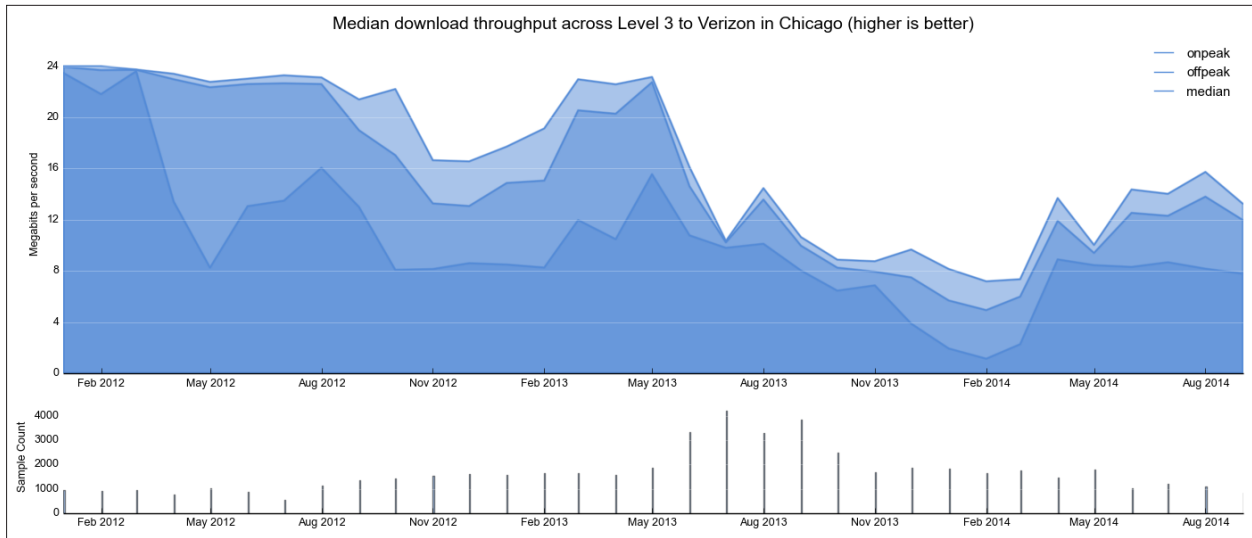
The story of incremental degradation shows up in the data as a persistent but gradual decline in the quality of service flowing from one transit provider into a particular ISP network. That means that over a period of months, traffic flowing to consumers along particular paths experience noticeable declines in throughput and increases in both latency and packet retransmission. These declines do not happen in a strictly linear fashion. They ebb and flow up and down, but gradually trend towards greater and greater degradation from the advertised product and the normative quality of service expected by the consumer. And of course, the patterns of congestion causing this downward pressure will manifest differently throughout

the day, with the strongest impact during hours of peak use (afternoon and evening). For the consumer, this results in a very frustrating experience with no obvious source of causality or redress. Sometimes services will work — and sometimes they won't, it is never clear why. This was everyday life for the majority of American Internet subscribers.

Once again, the data suggest that this is not a technical matter but the result of a business decision made by the ISPs. It appears that links between particular ISPs and transit networks are permitted to become congested well above levels that would normally trigger infrastructure upgrades. These patterns are consistent across multiple markets between the same pairings of ISPs and transit providers. Without proper oversight and the tools to address problems as they arise, these instances of incremental degradation based on delays or failures to maintain interconnections could result in a continual, low intensity form of consumer harm in which quality of service is persistently poor at particular times of day for particular types of applications. Two examples illustrate the point.

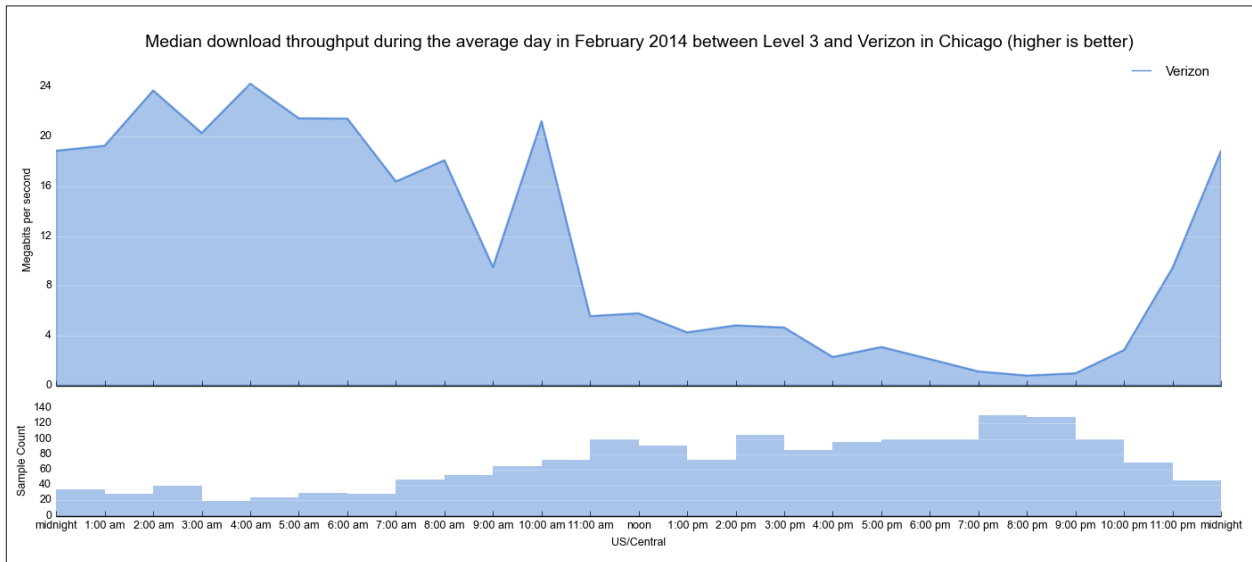
### **Example #1: Verizon over Level 3 (July 2013 - present)**

The patterns in the M-Lab data regarding Verizon and Level 3 interconnections are different from the Cogent dispute not only in degree (dramatic vs. incremental) but also in scope. That is, the Cogent dispute saw a similar pattern of degradation across all ISPs in a particular market. The incremental degradation patterns are not uniform for all incoming traffic from a specific transit network across all ISPs in a particular market. Rather, they are specific to a particular pairing of transit and ISP networks across all markets. In other words, what we see in the data about patterns of incremental degradation in Verizon and Level 3 links is common to all local Verizon markets where M-Lab has measurement points; but it is different than the patterns we see for Level 3 across other ISPs in the same markets.



**[Figure 7]** Median download throughput during peak use hours, off-peak hours, and overall achieved by customers of Verizon in the Chicago area connecting across Transit ISP Level 3, January 2012 to July 2014. The FCC defines peak use hours as 7pm to 11pm local time. This view shows clear variations between peak use and off-peak download throughput performance.

Figure 7 shows the pattern of download throughput for the Verizon/Level 3 pairing in the Chicago market over a period of 2.5 years. It represents the clearest picture in the M-Lab data of the incremental degradation phenomenon. Declines begin to accelerate in the second half of 2013 and drop to a low point in early 2014. And despite a recovery in more recent months, the quality of service remains significantly lower than it was two years before. Not only is there a clear decline in quality of service — that decline is most extreme during peak usage hours. Figure 8 shows the daily pattern in the Chicago market and a clear reduction in throughput rates below the 4 Mbps threshold for much of the afternoon and evening for months on end.

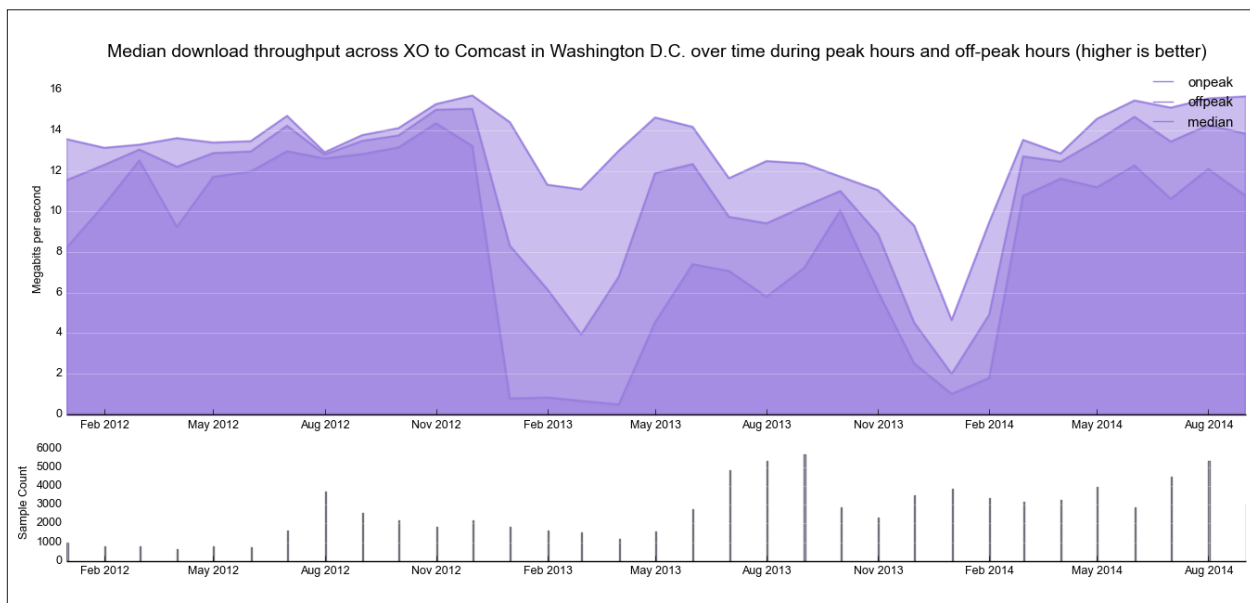


**[Figure 8]** Median download throughput achieved by customers of Verizon in the Chicago area, by hour of the day during an average day in February 2014, when connecting across Transit ISP Level 3. This view shows the extent of download throughput degradation during peak use hours. The FCC defines peak use hours as 7pm to 11pm local time.

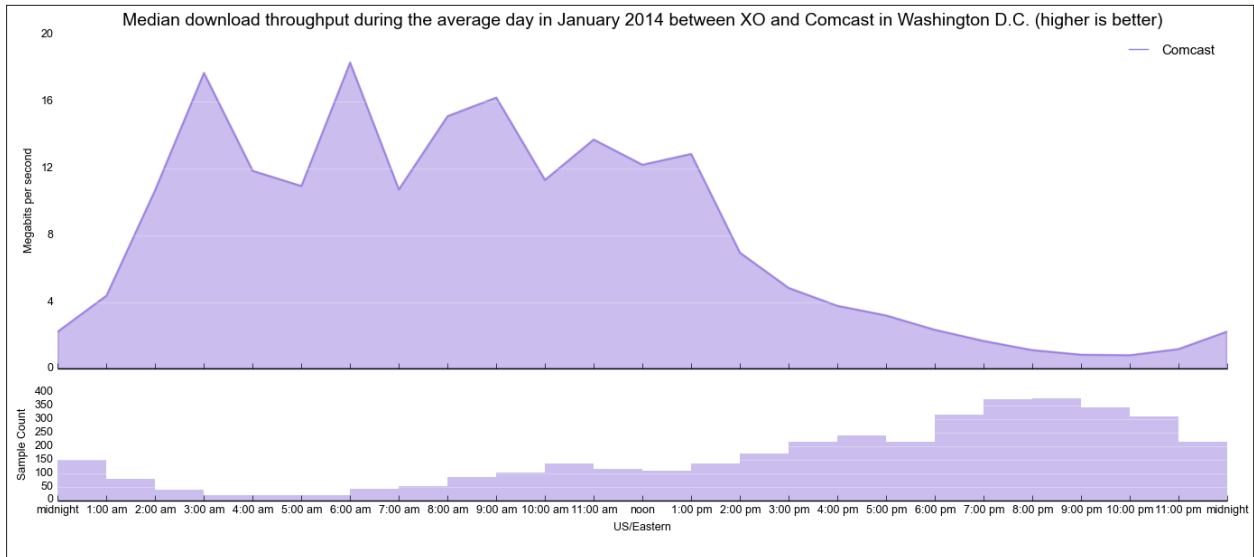
This level of degraded service occurring gradually over time will have a noticeable impact on the usability of a number of popular applications and services, including HD video, online-gaming, VPNs, and video-conferencing. At certain peak hours, this level of degradation is just as low as the Cogent/Verizon path described above. However, since the direct interconnection arrangement, Netflix is no longer in the center of this dispute. The press is not covering it. And consequently consumers have no way of knowing that the quality of service declines they are experiencing are attributable to congested interconnection points that are most likely the result of policy choices made by network operators, rather than unsolvable technical problems. The scope of potential impact on content and services delivered over Level 3 is significant. Level 3 is the largest transit provider in the world<sup>65</sup>, and its connections are upstream from 56 percent of IP addresses on the Internet.<sup>66</sup>

### Example #2: Comcast over XO (January 2012 - present)

Customers of the Comcast network in the Washington, D.C. market experienced an unusual pattern of service degradation over the course of the last 2.5 years. This pattern includes two major episodes of transit network to ISP interconnection congestion that lasted for a period of months. More recently, these problems appear to be remediated. This pattern is not seen for other ISPs with interconnection to XO in this market – it is unique to Comcast. During the periods of serious degradation (January/February of 2013 and January/February of 2014), Comcast subscribers experienced levels of throughput well below the 4 mbps standard for broadband. And when we look at an average day during one of these periods, the speeds and packet loss rates during peak usage hours reach levels that would interfere with a normal suite of applications.



**[Figure 9]** Median download throughput during peak use hours, off-peak hours, and overall achieved by customers of Comcast in the Washington, D.C. area connecting across Transit ISP XO, January 2012 to July 2014. The FCC defines peak use hours as 7pm to 11pm local time. This view shows clear variations between peak use and off-peak download throughput performance.



**[Figure 10]** Median download throughput achieved by customers of Comcast in the Washington, D.C. area, by hour of the day during an average day in January 2014, when connecting across Transit ISP XO. This view shows the extent of download throughput degradation during peak use hours. The FCC defines peak use hours as 7pm to 11pm local time.



# PART IV: REMEDY

The remedy to protect consumers against the service degradation from these types of interconnection disputes will require a set of new policies and ongoing oversight. The events described in this report represent widespread and systemic consumer harm resulting from a market failure in the operation of America's information infrastructure. Regardless of the party at fault, consumers endured significant collateral damage during an extended dispute between commercial parties. For the most part, none of the parties fully informed consumers about the cause of service deterioration until the source of the problem was identified by others. A repeat of the dramatic degradation incident that occurred during the Cogent dispute is clearly an unacceptable outcome; but the policy solution must also deter current trends of incremental degradation incidents affecting consumer's quality of service. These new policies should encourage operators to avoid these disputes or to resolve them very quickly. Or more simply, the FCC could choose to implement certain additional requirements to ensure that the quality of service promised to paying customers is delivered. Finally, these rules must be paired with clear penalties and procedures for rapid and decisive intervention in the event that interconnection problems lead to consumer harm.

Any strong solution must begin with effective oversight. We cannot address problems that we do not measure. The M-Lab platform, which the FCC already uses, offers one attractive option, and it is an open platform with transparency built into its design. Running on open source operating software and testing suites, M-Lab publishes both raw data and the methodology of its analyses. This is data science structured for a participatory research community with replicable results and high degrees of accountability. Whatever system the FCC chooses for oversight, it should be premised on these same principles

of openness and reproducibility. And, of course, the Commission need not choose just one solution. Different Internet measurement tools measure different things and afford the ability to present different cross-sections of complex networks. A mix of approaches unified by a common commitment to openness will yield more data for review. All of the examples cited in this report — dramatic and incremental degradation as well as the Cogent quality of service episode — are clear cases for immediate implementation of a more effective system of oversight at the FCC. President Obama made exactly this point in his recent statement about network neutrality: “The connection between consumers and ISPs — the so-called ‘last mile’ — is not the only place some sites might get special treatment. So, I am also asking the FCC to make full use of the transparency authorities the court recently upheld, and if necessary to apply net neutrality rules to points of interconnection between the ISP and the rest of the Internet.”<sup>67</sup>

Using this oversight system, the FCC should continuously monitor congestion at interconnection points between large transit carriers and large ISPs (those with sufficient consumer base to leverage those end-users as collateral in business dispute). Greater transparency and vigilant monitoring will spot the artificial congestion created by business disputes — as opposed to normal technical patterns of load — well before they become months-long consumer harms. It will also have a disciplining effect on all parties involved in interconnection, as those parties will all be aware that disputes that produce consumer harms will be spotted quickly and communicated publicly. One possibility is for the FCC to set a threshold of congestion in its monitoring regime. If that threshold is reached, it should trigger a warning from regulators to all parties involved that the situation must be resolved within days or else the agency will intervene. If that date passes

without resolution, the FCC would either apply a pre-existing default rule for settlement free interconnection, or it could initiate an arbitration proceeding. It is worth noting that all ISPs are under rule already obliged to disclose their network management practice.<sup>68</sup>

---

**“The connection between consumers and ISPs — the so-called ‘last mile’ — is not the only place some sites might get special treatment. So, I am also asking the FCC to make full use of the transparency authorities the court recently upheld, and if necessary to apply net neutrality rules to the point of interconnection between the ISP and the rest of the Internet.”**

*-President Barack Obama*

---

Based on current evidence and the history of the interconnection market’s success with “settlement free interconnection” (SFI), a policy framework that preserves the no-cost exchange of traffic appears to be an appropriate default. The SFI arrangement should take place at the interconnection point nearest to the consumer requesting the content. And both the ISP and the transit provider should be prepared for private negotiations to cover the (relatively modest) costs of adding switches, power, rack-space, and physical infrastructure inside the exchange points. In general, however, the FCC should seek to preserve traditional arrangements governing Internet traffic to the extent practical.

This system has worked effectively for many years despite enormous increases in data flow. And it encourages all parties to structure business relationships to maximize capacity and grow the infrastructure over time. In brief, these economics allocate costs accordingly in the value chain: (1) content companies pay to store, process and

upload data requested by end-user customers to transit networks (and they are compensated by consumers or advertisers); (2) transit providers (compensated by content/services companies) pay to deliver traffic from the data centers to the point of interconnection with ISPs nearest to the end-user customer; and (3) ISPs pay to maintain the network that delivers the content that end-users have requested (and are compensated by those consumers for the access service). These are all profitable businesses, and in this market structure they have successfully grown the Internet to its current form.

Not surprisingly, this principle of “presumption of SFI” is shared by the transit network operators, many of whom have articulated similar positions in recent regulatory filings.<sup>69</sup> ISPs argue, however, that they bear a disproportionate share of the cost of upgrades at the interconnection point. And more importantly, they argue that interconnection pricing should move away from SFI entirely if the ratios of inbound/outbound traffic are not symmetrical. Verizon has made the case<sup>70</sup> that all interconnection agreements should be priced based on ratios and balance, and accused transit operators of seeking to free ride when it suits them. Transit operators counter that a traffic ratio basis of pricing makes no sense given the inherent asymmetry of contemporary Internet usage and the fact that all traffic downloading was requested by ISP consumers.<sup>71</sup> They maintain they have covered the costs to deliver traffic to the ISP’s front door, and the consumers who requested the content have paid for the last mile — and therefore further fees are “double-dipping.”

The FCC should review these arguments and evaluate specific cost-based evidence in a deliberate fashion. But given the importance of the SFI system for the global Internet and the troubling implications of market concentration among U.S. ISPs, the FCC should begin with a presumption for SFI. Of course, the agency will also need to evaluate possibilities for private contracts for some forms of transit (e.g. long-haul, trans-ocean,

and transit-to-transit network interconnection) as well as cost-sharing for infrastructure augmentation at the interconnection points. However, regulators should view with a high degree of skepticism any system in which fees are assessed by ISPs to deliver traffic that their own subscribers have requested and paid for down their own terminating networks.

Make no mistake: this is a major inflection point in the history of the Internet. The FCC should treat this problem as a high priority with far-reaching impact on the national and global market. There are good reasons why these disputes are popping up right now. The most important one is that ISPs have become very large through mergers and consolidation over the last decade. These terminating access monopolies have enough end-user customers to use them as pawns in business disputes with content and transit companies. Merger opponents have predicted this behavior for years, and now it is happening. Whether any of these extra fees are legitimate is a question worth debating, but the fact that ISPs have grown large enough to distort adjacent markets is no longer a hypothetical concern. It is a reality.

Eventually, regulators all over the world will have to address the policy problem the FCC currently faces. The central question is whether the current system is a fair distribution of the costs among all of those actors paying into (and extracting from) the Internet value chain. And if this historically common arrangement is not, for whom is it unfair? And who decides? To date, this problem has been left to sort itself out in what has been considered a competitive backbone and ISP market. That theory collapsed in the market failure of the Cogent dispute and continues to burn in the ongoing interconnection disputes beyond Cogent, impacting the Internet experience of millions of Americans. Given the longstanding history and success of the practice, SFI appears to be the most appropriate default in most scenarios, and the FCC should take necessary steps to ensure that ISPs do not leverage their gatekeeper status and disrupt that traditional model.

The goal of any regulatory regime in this market must be to shape an outcome that leads to provisioning networks with abundant capacity to serve the explosive growth of the technology industry. This approach is important to drive US economic growth and to strengthen our global economic advantage in the information technology sector, and beyond. To that end, the interconnection dispute is directly connected with the broader debate over network neutrality. It would not be wise policy to permit business models that are premised on selling priority access to scarce bandwidth. That approach is a path toward incentivizing scarcity rather than growing capacity. A network lacks incentives to add capacity to service consumer demand if there are better revenue opportunities in maintaining significant congestion. Moreover, the alarming divergence between the promises of the ISPs in the network neutrality debate (i.e. that they would never do anything to degrade consumer quality of service) and their behavior in the interconnection disputes should demonstrate the stakes of the game and the intentions of the players. Dramatic and sustained impairment to the user experience of millions of consumers did not appear to alter the ISPs' behavior in the slightest. Regardless of whether the FCC believes a transport price or SFI interconnection agreements are an appropriate resolution to the business disputes, under no circumstances can it be acceptable to hold consumers hostage during these negotiations ever again.

# ENDNOTES

1. Verizon Forums, “Netflix is slow lately on FiOS,” Verizon.com, <https://forums.verizon.com/t5/FiOS-Internet/Netflix-is-slow-lately-on-FIOS/m-p/584577/highlight/true#M38667> (accessed November 5, 2014).
2. Comcast Forums, “is Netflix throttling thier [sic] own customers?,” Comcast.com, <http://forums.comcast.com/t5/Basic-Internet-Connectivity-And/Is-comcast-working-on-the-Netflix-issue/m-p/2005843/highlight/true#M194292> (accessed November 5, 2014).
3. Verizon Forums, “Netflix streaming has become unusable, is Verizon intentionally degrading it?,” Verizon.com, <https://forums.verizon.com/t5/FiOS-Internet/Netflix-streaming-has-become-unusable-is-Verizon-intentionally/m-p/676145/highlight/true#M45135> (accessed November 6, 2014).
4. These events were widely reported in tech blogs, though the scope was not well known at the time and most consumers never heard about it. For a good account of this dispute, see: Stacey Higginbotham, “Peering Pressure,” *GigaOm*, June 19, 2013, <https://gigaom.com/2013/06/19/peering-pressure-the-secret-battle-to-control-the-future-of-the-internet/> (accessed November 6, 2014). The basic facts of the dispute are not contested and are described by the companies themselves in regulatory filings. See endnote #5.
5. Both Comcast and Netflix have offered the Commission detailed explanations of these events. See Petition to Deny of Netflix, Inc, Applications of Comcast Corp. and Time Warner Cable Inc. for Consent to Assign or Transfer Control of Licenses and Authorizations, Docket No. 14-57, PP. 52-60, August 27, 2014, available at <https://pr.netflix.com/WebClient/fileDownload.do?newsAssetId=8638&fileType=PDF&fileName=PUBLIC-Netflix%20Amended%20PTD%2027Aug2014.pdf&newsId=1471&downloadType=NEWS>; Opposition to Petitions to Deny and Response to Comments of Comcast Corporation and Time Warner Cable Inc., Applications of Comcast Corp. and Time Warner Cable Inc. for Consent to Assign or Transfer Control of Licenses and Authorizations, Docket No. 14-57, PP. 208-211, 217-223, Sept. 23, 2014, available at <http://corporate.comcast.com/images/2014-09-23-REDACTED-Comcast-TWC-Opposition-and-Response.pdf>.
6. Note that this congestion phenomenon — identified here as a part of an example of business disputes between Netflix, Cogent and Comcast — was widespread. As noted elsewhere in this report, it was not just a problem with Comcast, but with most major ISPs, and not just with Cogent, but with other major transit providers.
7. Declaration of Henry (Hank) Kilmer, Vice President of IP Engineering, Cogent Communications Holdings, Inc., MB Docket No. 14-57, <http://apps.fcc.gov/ecfs/document/view?id=7521817735> (accessed November 6, 2014) at 10 (“Cogent Communications Declaration”).
8. Comcast Forums, “is Netflix throttling thier [sic] own customers?,” Comcast.com, <http://forums.comcast.com/t5/Basic-Internet-Connectivity-And/Is-comcast-working-on-the-Netflix-issue/m-p/2001119/highlight/true#M193973> (accessed November 6, 2014).
9. Verizon Forums, “Not Getting Even 2 Mbps from Netflix,” Verizon.com, <https://forums.verizon.com/t5/FiOS-Internet/Not-Getting-Even-2-Mbps-from-Netflix/m-p/669341/highlight/true#M44414> (accessed November 6, 2014).
10. “ISP Interconnection and its Impact on Consumer Internet Performance,” *Measurement Lab*, [http://www.measurementlab.net/blog/2014\\_interconnection\\_report](http://www.measurementlab.net/blog/2014_interconnection_report) (accessed November 6, 2014). Measurement Lab is a research consortium of which OTI is a partner.
11. Federal Communications Commission, “Broadband Speed Guide,” *Federal Communications Commission*, <https://www.fcc.gov/guides/broadband-speed-guide> (accessed November 6, 2014).
12. Mark Claypool and Kajal Claypool, “Latency Can Kill: Precision and Deadline in Online Games,” (Worcester, MA: Computer Science, 2010), <http://web.cs.wpi.edu/~claypool/papers/precision-deadline-mmsys/> (accessed November 6, 2014) at 7. A latency of 100 milliseconds is approximately the tolerable threshold measured for some first person shooter games.
13. Xbox Support, “Xbox Live Lag Problem and Solutions,” Xbox.com, <http://support.xbox.com/en-US/xbox-360/networking/slow-performance-solution> (accessed November 6, 2014).
14. Comments of the Entertainment Software Association, GN Docket No. 14-28, <http://apps.fcc.gov/ecfs/document/view?id=7521731696> (accessed November 6, 2014) at 2.
15. Statista, “World of Warcraft subscriber numbers 2014,” Statista.com, <http://www.statista.com/statistics/276601/number-of-world-of-warcraft-subscribers-by-quarter/> (accessed November 6, 2014).
16. Gamespot, “Final Fantasy 14 has attracted 2 million players,” Gamespot.com, <http://www.gamespot.com/articles/final-fantasy-14-has-attracted-2-million-players/1100-6419072/> (accessed November 6, 2014).
17. Paul Tassi, “Riot’s ‘League of Legends’ Reveals Astonishing 27 Million Daily Players, 67 Million Monthly,” *Forbes*, January 27, 2014, <http://www.forbes.com/sites/insertcoin/2014/01/27/riots-league-of-legends-reveals-astonishing-27-million-daily-players-67-million-monthly/> (accessed November 6, 2014).
18. Julia Adler-Milstein, et al., Telehealth Among US Hospitals: Several Factors, Including State Reimbursement And Licensure Policies, Influence Adoption (Bethesda, MD: Health Affairs, 2014) <http://content.healthaffairs.org/>

- content/33/2/207.abstract (accessed November 6, 2014).
19. Mary Butler, "Telemedicine Set for a Boom; Barriers to Adoption Emerge," *Journal of Ahima*, August 23, 2014 <http://journal.ahima.org/2014/04/30/telemedicine-set-for-a-boom-barriers-to-adoption-emerge/> (accessed November 6, 2014).
  20. Federal Communications Commission, Connect America Fund, WC Docket No. 10-90, Report and Order, [https://apps.fcc.gov/edocs\\_public/attachmatch/DA-13-2115A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DA-13-2115A1.pdf) (accessed on November 6, 2014) at paras. 20-23; Federal Communications Commission, Wireline Competition Bureau Seeks Further Comment on Issues Regarding Service Obligations for Connect America Phase II And Determining Who Is An Unsubsidized Competitor, WC Docket No. 10-90, [https://apps.fcc.gov/edocs\\_public/attachmatch/DA-13-284A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DA-13-284A1.pdf) (accessed November 6, 2014) at paras. 25-26.
  21. Federal Communications Commission, "Health Care Broadband In America: Early Analysis and a Path Forward," OBI Technical Working Paper No. 5, <http://transition.fcc.gov/national-broadband-plan/health-care-broadband-in-america-paper.pdf> (accessed November 6, 2014).
  22. See, e.g., Greg Glinden, "Geeking with Greg: Marissa Mayer at Web 2.0," *Geeking With Greg*, <http://glinden.blogspot.com/2006/11/marissa-mayer-at-web-20.html> (accessed November 6, 2014).
  23. Chris Lewis and Steve Pickavance, "Implementing Quality of Service Over Cisco MPLS VPNs," (Cisco Press, 2006), <http://www.ciscopress.com/articles/article.asp?p=471096&seqNum=6> (accessed November 6, 2014).
  24. Yang Xu et al., "Video Telephony for End-Consumers: Measurement Study of Google+, iChat, and Skype," (Evanston, IL: Northwestern University), <http://aqualab.cs.northwestern.edu/component/attachments/download/341> (accessed November 6, 2014) at 18; Cisco, Cisco Visual Networking Index (VNI) Mobile Infographic: FaceTime Study (Slideshare.net), <http://www.slideshare.net/CiscoSP360/cisco-facetime-infographic> (accessed November 6, 2014).
  25. Richweb, "IPSEC Site to Site VPN Requirements," Richweb.com, <http://www.richweb.com/node/100/> (accessed November 6, 2015).
  26. Adobe, "Adobe Connect Selected in Expanded U.S. DoD Contract," *Adobe and Public Sector Blog*, <https://blogs.adobe.com/adobeingovernment/adobe-connect-selected-in-expanded-u-s-dod-contract-2/> (accessed November 6, 2014); Adobe, "Defense Connect Online: over 1 MILLION served," *Adobe and Public Sector Blog*, <https://blogs.adobe.com/adobeconnect/2014/02/defense-connect-online-over-1-million-served.html> (accessed November 6, 2014).
  27. Verizon Forums, "Re: Latency with Level3," Verizon.com, <https://forums.verizon.com/t5/FiOS-Internet/Latency-via-Level3/m-p/726171#M49579> (accessed November 6, 2014). See also: <https://www.linkedin.com/in/jamiekiechlin>.
  28. *Id.*
  29. Rebecca Carroll, "More Federal Employees Are Teleworking More Often," *Nextgov*, <http://www.nextgov.com/cio-briefing/wired-workplace/2014/10/more-federal-employees-are-teleworking-more-often/97382/> (accessed November 6, 2014).
  30. Google, "Google Video Quality Report," Google.com, <https://www.google.com/get/videoqualityreport/#methodology> (accessed November 6, 2014).
  31. James O'Toole, "Netflix now has 50 million subscribers," *CNN Money*, July 22, 2014, <http://money.cnn.com/2014/07/21/technology/netflix-subscribers/> (accessed November 6, 2014).
  32. Parks Associates, "More than 50% of US households use paid OTT video services," ParksAssociates.com, <http://www.parksassociates.com/blog/article/more-than-50-of-us-households-use-paid-ott-video-services> (accessed November 6, 2014).
  33. Leichtman Research Group, "About 385,000 Add Broadband in the Second Quarter of 2014," LeichtmanResearch.com, <http://www.leichtmanresearch.com/press/081514release.html> (accessed November 6, 2014).
  34. Cogent Communications Declaration at 10.
  35. NCTA comments, July 15, 2014, at 14. <http://apps.fcc.gov/ecfs/document/view?id=7521479748>
  36. AT&T comments, July 15, 2014, at 31. <http://apps.fcc.gov/ecfs/document/view?id=7521679206>
  37. Comcast comments, July 15, 2014 at 22. <http://apps.fcc.gov/ecfs/document/view?id=7521479245>
  38. Verizon comments, July 15, 2014, at 26. <http://apps.fcc.gov/ecfs/document/view?id=7521507614>
  39. Time Warner Cable comments, July 15, 2014, at 24. <http://apps.fcc.gov/ecfs/document/view?id=7521480407>
  40. United States Telecom Association comments, July 16, 2014, at 11. <http://apps.fcc.gov/ecfs/document/view?id=7521592793>
  41. Ruth Milkman, "Remarks of Ruth Milkman, Chief of Staff," public remarks, Progressive Policy Institute, Washington, DC, May 27, 2014, [https://apps.fcc.gov/edocs\\_public/attachmatch/DOC-327292A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DOC-327292A1.pdf) (accessed November 6, 2014) at 5.
  42. Julie Knapp and Walter Johnston, "Internet Traffic Exchange: Time to Look Under the Hood," *Official FCC Blog*, June 18, 2014, <http://www.fcc.gov/blog/internet-traffic-exchange-time-look-under-hood> (accessed November 11, 2014).
  43. Jon Brodtkin, "FCC asked six more ISPs, content providers to reveal paid peering deals," *Ars Technica*, August 1, 2014, <http://arstechnica.com/business/2014/08/fcc-asked-six-more-isps-and-content-providers-to-reveal-paid-peering-deals/> (accessed November 6, 2014).
  44. European Telecommunications Network Operators' Association, "ITRs Proposal to Address New Internet

- Ecosystem,” ETNO.eu, <https://www.etno.eu/datas/itu-matters/etno-ip-interconnection.pdf> (accessed November 6, 2014).
45. *Id.*; Jemima Kiss, “ITU and Google Face Off at Dubai conference over the future of the internet,” *The Guardian*, December 3, 2012, <http://www.theguardian.com/technology/2012/dec/03/telecoms-unitednations> (accessed November 11, 2014).
  46. Lawrence Strickling, “Remarks of Assistant Secretary Strickling at Columbia Institute for Tele-Information,” public remarks, Columbia Institute for Tele-Information, New York, NY, September 24, 2012, <http://www.ntia.doc.gov/speechtestimony/2012/remarks-assistant-secretary-strickling-columbia-institute-tele-information> (accessed November 6, 2014).
  47. William E. Kennard, “Today’s Internet Model Works: If it ain’t broke, don’t fix it,” public remarks, FT-ETNO Summit, Brussels, Belgium, October 2, 2012, <http://useu.usmission.gov/etno2.html>
  48. Ambassador Gross is now a partner with Wiley Rein LLP, which currently represents a range of Internet-related companies, including telecom giants like AT&T and Verizon.
  49. Andrew Couts, “Interview: US Ambassador David Gross Explains UN ‘Takeover’ of the Internet,” *Digital Trends*, August 9, 2012, <http://www.digitaltrends.com/web/fmr-us-ambassador-david-gross-explains-un-takeover-of-the-internet/2/> (accessed November 6, 2014).
  50. Measurement Lab, “ISP Interconnection and its Impact on Consumer Internet Performance.”
  51. See e.g. Comcast and Time Warner Cable Inc. Opposition to Petitions to Deny and Response to Comments, MB Docket No. 14-57, Exhibit 4, pp. 24-25, Sept. 23, 2014, available at <http://corporate.comcast.com/images/2014-09-23-REDACTED-Comcast-TWC-Opposition-and-Response-Exhibit-4-McElearney.pdf>; Cogent Communications Group, Inc, Petition to Deny, MB Docket 14-57, Declaration of Joseph Farrell, p. 13, Aug. 25, 2014, available at <http://apps.fcc.gov/ecfs/document/view?id=7521817745>; Comments of the Ad Hoc Telecommunications Users Committee, GN Docket No. 12-353, p. 10, Jan. 28, 2012, available at <http://apps.fcc.gov/ecfs/document/view?id=7022113716>.
  52. Collin Anderson, “Research Updates: Beginning to Observe Network Management Practices as a Third Party,” Measurement Lab, October 31, 2014, [http://www.measurementlab.net/blog/research\\_update1](http://www.measurementlab.net/blog/research_update1) (accessed November 11, 2014).
  53. K. Nichols et al., “Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers,” *Internet Engineering Task Force*, December 1998, <https://tools.ietf.org/html/rfc2474> (accessed November 11, 2014); “Real-Time Network Management of Internet Congestion,” *Broadband Internet Technical Advisory Group*, October 2013, [http://www.bitag.org/documents/BITAG\\_-\\_Congestion\\_Management\\_Report.pdf](http://www.bitag.org/documents/BITAG_-_Congestion_Management_Report.pdf) (accessed November 11, 2014).
  54. “M-Labs data and Cogent DSCP markings,” November 5, 2014, <https://groups.google.com/a/measurementlab.net/forum/#!topic/discuss/vcQnaZJO6nQ> (accessed November 11, 2014).
  55. See, e.g. the requirements recommended by Netflix, Skype, Apple, and Google: “Internet Connection Speed Recommendations,” Netflix, <https://help.netflix.com/en/node/306>; “How Much Bandwidth Does Skype Need?” Skype Support, <https://support.skype.com/en/faq/fa1417/how-much-bandwidth-does-skype-need>; “FaceTime for Mac: About HD video calling,” Apple, <http://support.apple.com/kb/ht4534>; “Video Quality Report: The Methodology,” Google, <https://www.google.com/get/videoqualityreport/#methodology> (accessed November 11, 2014).
  56. Comcast Business Forums, “VoIP/RTP Traffic Shaping or Congestion Management?,” Comcast.com, <http://forums.businesshelp.comcast.com/t5/Connectivity/VoIP-RTP-Traffic-Shaping-or-Congestion-Management/m-p/9657/highlight/true#M1024> (accessed November 6, 2014).
  57. Verizon Forums, “Netflix won’t display in HD during peak hours,” Verizon.com, <https://forums.verizon.com/t5/FIOS-Internet/Netflix-won-t-display-in-HD-during-peak-hours/m-p/614526/highlight/true#M40654> (accessed November 6, 2014). Another example occurred in August 2013, when a Comcast broadband subscriber reported problems with different services. His traceroutes - verified by several other users in the thread experiencing same problems - pointed to major packet loss in the Cogent/Comcast interconnection point. He wrote: “Is anyone else having issues with comcast routing/peering through Cogent? Its so bad for me that I can’t play a single online game and even netflix constantly rebuffers and closes saying unable to play due to connectivity issues. What can i do to get comcast to remove cogent from my routes? can i? if so how? who do i talk to because this is getting nuts.” See Comcast Forums, “Cogent and Comcast issues,” Comcast.com, <http://forums.comcast.com/t5/Basic-Internet-Connectivity-And/Cogent-and-Comcast-issues/td-p/1805678> (accessed November 6, 2014).
  58. See Comcast Forums, “Cogent and Comcast issues.”
  59. Verizon Forums, “Is Verizon throttling speed to certain sites?,” Verizon.com, <https://forums.verizon.com/t5/FIOS-Internet/Is-Verizon-throttling-speed-to-certain-sites/td-p/656487> (accessed November 6, 2014).
  60. Comcast Forums, “Terrible speeds 10% packet loss to and fromCogent (my office VPN),” Comcast.com, <http://forums.comcast.com/t5/Basic-Internet-Connectivity-And/Terrible-speeds-10-packet-loss-to-and-fromCogent-my-office-VPN/td-p/1991001> (accessed November 6, 2014).
  61. *Id.*; The customer continued: “People simply cannot telecommute into or out of our network via Cogent using your internet service....This is the email I got in response to this thread. “Thanks for sharing your concern with us. The Forums team has been made aware of your issue.” You think? I am already sure top engineers and CEOs are aware of this issue. My frustration is that it is not getting more press or attention Just look at the titles of the threads in this forum. They are mostly, “I cannot get Netflix to work”, or “I am getting packet loss”, or “I am not getting my advertised speed”. They are all related and connected the

- peering war between comcast and Cogent. But nobody is doing anything about it.”
62. Gossamer Threads, “Cogent /ATT and Verizon Peering alternatives,” Gossamer-Threads.com, <http://www.gossamer-threads.com/lists/nsp/outages/49696> (accessed November 6, 2014).
  63. Peter Kafka, “The Netflix Case Against Comcast, in One Chart,” *re/code*, August 27, 2014, <http://recode.net/2014/08/27/the-netflix-case-against-comcast-in-one-chart/> (accessed November 6, 2014).
  64. Netflix Users, “Netflix just too unreliable?,” NetflixUsers.com, <http://www.netflixusers.com/forum/f19/netflix-just-too-unreliable-1063/> (accessed November 6, 2014) (emphasis added).
  65. Earl Zmijewski, “A Baker’s Dozen, 2013 Edition,” Dyn Research, January 9, 2014, <http://www.renesys.com/2014/01/bakers-dozen-2013-edition/> (accessed November 6, 2014); see also: Center for Applied Internet Data Analysis, “AS Rank: Information for a single Org: Org Member ASes,” AS-Rank.caida.org, <http://as-rank.caida.org/?modeo=org-info&mode1=member-ases&org=LVLT-ARIN> (accessed November 6, 2014).
  66. TeleGeography, “Global Internet Geography,” TeleGeography.com, [http://www.telegeography.com/page\\_attachments/products/website/research-services/global-internet-geography/0005/1382/GIG\\_Executive\\_Summary.pdf](http://www.telegeography.com/page_attachments/products/website/research-services/global-internet-geography/0005/1382/GIG_Executive_Summary.pdf) (accessed November 6, 2014).
  67. “Net Neutrality: President Obama’s Plan for a Free and Open Internet,” *The White House*, November 10, 2014, <http://www.whitehouse.gov/net-neutrality> (accessed November 11, 2014).
  68. See, e.g., Federal Communications Commission, Public Notice - New Docket Established to Address Open Internet Remand, GN Docket No. 14-28, [https://apps.fcc.gov/edocs\\_public/attachmatch/DA-14-211A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DA-14-211A1.pdf) (accessed November 6, 2014) and Federal Communications Commission, Public Notice - FCC Enforcement Bureau and Office of General Counsel Issue Advisory Guidance for Compliance With Open Internet Transparency Rule, GN Docket No. 09-191 and WC Docket No. 07-52, [https://apps.fcc.gov/edocs\\_public/attachmatch/DA-11-1148A1.pdf](https://apps.fcc.gov/edocs_public/attachmatch/DA-11-1148A1.pdf) (accessed November 6, 2014).
  69. See, e.g., Reply Comments of Level 3 Communications, Inc., GN Docket No. 14-28, <http://apps.fcc.gov/ecfs/document/view?id=7522620642> (accessed November 6, 2014); Comments of COMPTTEL, GN Docket No. 14-28, <http://apps.fcc.gov/ecfs/document/view?id=7521480266> (accessed November 6, 2014); Declaration of Randolph Nicklas, IB Docket No. 11-78, <http://apps.fcc.gov/ecfs/document/view?id=7021692073> (accessed November 6, 2014).
  70. David Young, “Level 3’s Selective Amnesia on Peering,” Verizon Policy Blog, July 21, 2014, <http://publicpolicy.verizon.com/blog/entry/level-3s-selective-amnesia-on-peering> (accessed November 6, 2014).
  71. Moreover, most access ISPs provision consumer access options at drastically asymmetric rates, making parity in traffic nearly impossible when a user’s upload rate is a fraction of his or her download rate.



This report carries a Creative Commons license, which permits non-commercial re-use of New America content when proper attribution is provided. This means you are free to copy, display and distribute New America’s work, or include our content in derivative works, under the following conditions:

- ▶ **Attribution.** You must clearly attribute the work to the New America Foundation, and provide a link back to [www.newamerica.org](http://www.newamerica.org).
- ▶ **Noncommercial.** You may not use this work for commercial purposes without explicit prior permission from New America.
- ▶ **Share Alike.** If you alter, transform, or build upon this work, you may distribute the resulting work only under a license identical to this one.

For the full legal code of this Creative Commons license, please visit [creativecommons.org](http://creativecommons.org). If you have any questions about citing or reusing New America content, please contact us.

© 2014 New America



