February 9, 2008
Re: WC Docket No. 07-52

To: Marlene H. Dortch
Office of the Secretary
Federal Communications Commission
445 12th Street, SW, Suite TW-A325
Washington, DC 20554.

From: Richard Bennett
Livermore, CA 94550

Dear Chairman Martin and Commissioners,

This is a comment on the two items in WC Docket 07-52, the Petition for Declaratory Ruling by
Free Press, et. al., and the Petition for Rulemaking by Vuze. Inc.

The petitioners allege that Comcast unreasonably discriminates against BitTorrent and similar
peer-to-peer file bartering applications, and request penalties, injunctions, and clarifications of
the "reasonable network management" exception to the four prongs of the Broadband Policy
Statement. As I fail to see in the petitions any clear evidence of wrongdoing on Comcast's part, I
believe there is insufficient evidence for chastisement, but I agree that the exception warrants
clarification.

I've sought to explain my reasons at length in a variety of published articles (attached) and public
presentations[1] and will attempt to explain them here again only in summary form. For the record,
I'm a Comcast customer, a user of the Vuze product, and a network engineer, and my interest in
this matter is solely that of a good citizen seeking to guide public policy in the right direction.

Overview

The advent of peer-to-peer file bartering applications such as BitTorrent coupled with an
explosion of interest in HDTV and digital movies has created a traffic crisis on Internet access
networks. Networks designed to provide responsive web-browsing have been hit with traffic
loads that violate their basic deployment assumptions, and network operators have been forced
to react.

Something similar happened within the Internet's core in the early 90s, when the advent of HTTP
and web-browsing caused radical increases in the load presented to core links. The solution to
the problem of the 90s was increased provisioning and a redesign of HTTP to increase its
network efficiency. The solution to today's problem will be deployment of faster and more
symmetrical networks (where upload speeds are closer to download speeds), other technical
enhancements, and quite possibly a reduction in illegal file sharing.

Residential broadband providers are in various states of redeployment at the moment, and
advocates complain about the lack of uniformity in this always messy business. A common
complaint concerns the fact that packet networks don't work the way that circuit-switched
network do. A year from now the advocates will probably have much less to complain about, but
at the moment the Commission has a pair of petitions to adjudicate.

The Factual Basis of the Petitions is Thin

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1 *Harold and Kumar go to Comcastle: Save the Internet contests Laws of Physics,*
http://www.theregister.co.uk/2007/11/06/richard_bennett_comcastle/; *Dismantling a Religion: The EFF's Faith-Based
Internet,* http://www.theregister.co.uk/2007/12/13/bennett_eff_neutrality_analysis/; *Hogging the Trough: The EFF Strikes
Back,* http://www.theregister.co.uk/2008/01/23/benett_eff_neutrality_response/; and *Killing with Kindness,*
http://bennett.com/blog/index.php/archives/2008/01/27/net-neutrality-2008-presentation/, a presentation at the *Toll Roads*
Symposium at the University of San Francisco Law School on January 26th, 2008.

The sole factual basis of the petitions is a pair of news articles[2] and a series of advocacy pieces[3] published by the Electronic Frontier Foundation, an organization not a party to the complaints. These articles document the fact that Comcast reduces the amount of traffic that BitTorrent and similar file-bartering applications (such as Gnutella) may offer to the Comcast residential broadband network in the upstream direction (from the consumer's connection to the Internet) while not actively engaged in file downloading. What they fail to do is to put Comcast's actions into any context other than petitioners' fundamentally unreasonable wish to enjoy unlimited bandwidth at all hours of the day. It is as if petitioners believe that the Commission can judge the validity of Comcast's actions as Platonic essences rather than as pragmatic reactions to empirical conditions. According this logic, self-defense is murder.

In order to establish that these management actions are unreasonable or "discriminatory", it would be necessary, at a minimum, to show that they're deployed regardless of traffic load on relevant Comcast network segments. This can be difficult to determine with high precision on a DOCSIS network because the upstream traffic channel is by its very nature directly visible only at the provider's CMTS and not to the consumer. Nonetheless, the petitioners should have been able to show whether the network was heavily loaded at the time of the alleged infractions by presenting the inferential picture of upstream data traffic that can be gleaned from downstream responses such as TCP ACKs and RTP responses coupled with response time measurements obtained from ICMP "ping" packets. They have not supplied these measures, hence the petition for declaratory ruling fails to meet any reasonable burden of proof.

The four prongs of the Policy Statement do not include a "right to be free of delay" or a "right to infinite bandwidth", and in the real world someones ox must be gored when the load offered to a network segment exceeds its capacity. Hence, the petition for declaratory ruling must be rejected. The remainder of these remarks deals with the petition for rulemaking.

Network Management Reacts to Load

The reasonableness of any network management action depends largely on four factors: 1) the load on the network; 2) the nature of the network's Medium Access Control protocol and other available management tools; and 3) congruence between the network operator's policies and the services he sells; and 4) the legal framework that applies to networks of this type.

Over the course of a day, network load varies wildly on any residential broadband network; in the typical multi-user packet network, it may indeed vary greatly over the range of any given minute. Networks are provisioned to meet peak loads with minimal degradation in performance, but new applications often increase load and invalidate provisioning assumptions. BitTorrent has had this effect, as the World-Wide Web protocol, HTTP, did at its inception.

Medium Access Control protocols are designed to provide efficient and equitable sharing of network resources, but each tends to favor particular forms of traffic. The isochronous DOCSIS 1.0 and 1.1 protocol deployed in the Comcast network tries to provide a range of time-sensitive and time-insensitive services with varying degrees of success, and is therefore not tuned to favor Internet Protocol traffic over voice traffic, for example. Newer versions are more suited to Internet Protocol traffic.

The Consensus on Traffic Management

Traffic management policies are ultimately guided by customer expectations, psychological factors, and competitive pressures, but aren't radically different from one carrier to another. It's

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2 Peter Svensson, *Comcast Activity Hinders Subscribers' File-Sharing Traffic, AP Testing Shows*, Associated Press, Oct. 19, 2007

3 Seth Schoen, *Comcast and BitTorrent*, Electronic Frontier Foundation Blog, September 13, 2007, http://www.eff.org/deeplinks/2007/09/comcast-and-bittorrent.

generally considered good network management practice to prioritize[4] in some or all of the following ways when offered load approaches or exceeds network capacity:

1) Highly interactive applications should have priority over non-interactive ones;
2) Applications with modest bandwidth requirements should have priority over those with larger appetites;
3) Each user of a given account type should have the ability to use a roughly equal share of available bandwidth, measured over various spans of time;
4) Legal and responsible network uses should have priority over illegal and harmful network applications such as spam, viruses, and malware.

One partial implementation of this system of priorities is the traffic management system in the subset of the IEEE 802.11e protocol popularly known as WiFi WMM, in which traffic is classified into Voice, Video, Best Effort, and Background priorities. Each user of this system has an equal opportunity to present traffic of each type to the network, and traffic type determines the probability that a given packet will successfully transit at any given time. 802.11e doesn't *a priori* lower the priority of large bandwidth users over modest bandwidth users, but many implementations add this feature[5]. The academic literature as well as commercial product documentation abound with systems and methods such as Weighted Round-Robin Queuing, Weighted Fair Queuing, and Class-Based Weighted Fair Queuing which implement various combinations of these policies.

Note that these systems of prioritization are employed in private Local Area Networks where bandwidth is essentially free. Free in this sense doesn't equate to "infinite", the only context in which prioritization can be considered unnecessary.

In order to understand whether Comcast's traffic management systems and policies are reasonable, it is therefore necessary to understand the nature of the traffic mix on their network that triggers them. If Comcast is reacting to high traffic load with a reasonable method of bandwidth allocation, its actions are vindicated; and if it's willy-nilly stifling modest traffic streams during low-load periods, the petitioners would have a point.

Network Operators Must Manage Overload

One way to establish the reasonableness of the Comcast approach is to compare the state of affairs it creates with the state of affairs that would exist on the network in its absence. Professor Jim Martin of Clemson University has done this for us in an excellent academic paper which shows the impact that BitTorrent users have on their neighbors[6]:

> The web response time statistic increased from a value of 0.25 seconds when no BitTorrent users were active to 0.65 seconds when 15 BitTorrent users were active. This suggests that 15 BitTorrent users can cause a drop in performance by a factor of 2.5. When the number of BitTorrent users exceeds 30 performance degrades beyond the 1 second metric threshold.

The one second threshold is the desired response time for interactive applications such as web browsing, and the state of affairs where most users don't enjoy it is obviously to be avoided. Voice-over-IP demands much better response time than web-browsing, typically under 100 milliseconds, so it's severely affected in the fifteen BitTorrent user scenario.

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4   Some Utopian activists (David Isenberg, Susan Crawford, et. al.) assert that all forms of prioritization are harmful, the only fair rule being "first come, first served." This is not a credible position. While the ideal broadband network has sufficient bandwidth to carry full offered load the vast majority of the time, peak loads typically cause increased delay on copper-based and wireless packet networks which require active management according to more equitable means. The activists represent "The Tragedy of the Commons" as a desirable state of affairs.

5 *Campus Bandwidth Management: Approaches and Tradeoffs, Matrix of Approaches and Tradeoffs,* http://qos.internet2.edu/wg/cbm/cbm-matrix.html

6 *Assessing the Impact of BitTorrent on DOCSIS Networks*, James J. Martin and James M. Westall, http://people.clemson.edu/~jmarty/papers/bittorrentBroadnets.pdf.

So this is the choice that Comcast has on its network of today: should it allow a handful of BitTorrent users to degrade the performance of VoIP and web users to the point of distraction, or should it limit the bandwidth that BitTorrent users can consume? This is not a hard choice to make, and the only interesting implications it has concern methods employed and obligations for disclosure owing to the customer. The implications of failing to manage shared lines are vividly portrayed in the classic "web hog" commercial[7] aired by Pac Bell a few years ago.

Rational Ends Define Rational Practices

There is, of course, more than one reasonable method of network traffic management, just are there are many reasonable policies and reasonable people. But it is easily established that management practices which serve to protect a rational end (such as enhancing interactive user experience, allocating bandwidth among users in some equitable fashion, or preserving network stability) are reasonable, and such determination suffices to answer the substance of the petition.

The means by which we bring about rational ends are also relevant, but perhaps less so in the technical context than in the human one. There have been a number of complaints that one specific technique employed by Comcast violates various unwritten rules of Internet conduct; both petitions push this button multiple times, in inflammatory terms:

> Comcast does this by hacking into its own network and using a clandestine "man in the middle" tactic whereby each party is sent a communication "RST" (reset) message which falsely tells the other party to shut down the connection. (Vuze petition, pg. 10)

and:

> Forged reset packets are normally the kind of thing that would only be present if a hacker was attacking your computer, but in this case, it's the ISP you pay money to each month that is sending them. (Free Press petition, pg. 12)

The *clandestine forgery* consists of sending TCP control packets with the *Reset* bit set, which has the effect of causing an immediate shutdown of data traffic offered to the upstream side of the Comcast network; it's effective because it's defined by the TCP standard to bring about the result that Comcast seeks. The alternative would be to employ a rigorous campaign of packet-dropping when the network was well below peak load, reducing interactive response and bringing about the same end more slowly.

Vuze argues that its application is immune to the temporary loss of connection this method brings about:

> [BitTorrent] uploads and downloads [can] be resumed mid-way rather than restarted, and transmission errors can easily be fixed without resending an entire file (Vuze, pg. 7)

but Free Press worries nonetheless about the dozens of imaginary applications:

> While it may be true that some software automatically tries again, there is no guarantee that this is true of the many dozens of programs that communicate using protocols that are affected by Comcast's packet forgery. (Free Press, pg. 13-14)

Vuze is the more authoritative source: they say peer-to-peer applications aren't harmed by Comcast's actions, and this much is to believed.

Comcast Terms of Use

Comcast has recently revised its terms of use, but the statement in place at the time of the Vuze

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7   Viewable on YouTube: http://www.youtube.com/v/ubc7zFSyEbg

petition (and indeed at Vuze's founding) forbidding the the operation of file servers on residential accounts has not been modified:

> [P]rohibited uses and activities include, but are not limited to...servers from the Premises that provide network content or any other services to anyone outside of your Premises local area network ("Premises LAN"), also commonly referred to as public services or servers. Examples of prohibited equipment and servers include, but are not limited to, e-mail, Web hosting, file sharing, and proxy services and servers[8];

There is no doubt that this restriction applies to BitTorrent in the pure seeding mode regardless of the nature of network load. Comcast may choose not to enforce this restriction at their discretion, but it clearly belies the argument that Comcast management is "deceptive" or "secretive."

This provision directly conflicts with the Policy Statement, because it says that seeder and server applications may not be run on residential accounts regardless of network conditions. The Commission can resolve this contradiction in two ways, of course: either modify the policy statement regarding "applications of choice" or strike down the Comcast TOU. The network management exception is insufficiently specific to resolve this conflict.

Petitioners Have Failed to Make Their Case

Pending a smoking gun yet to be presented, the petitioners haven't made their case. They probably know this, and have simply entered their petitions hoping that an evidentiary fishing expedition would shore them up. Their petitions are littered with off-topic laments about the state of broadband in America and dubious assertions about free speech on the cellular telephone network which serve no purpose but rank emotional manipulation.

Lingering Policy Concerns

Despite the fact that petitioners have failed to make a case, there may still be important policy questions to be decided about network traffic management. Is it proper or desirable, for example, for ISPs to address network overload by any or all of the following means:

1. Cap traffic per account and discard the excess.
2. Set billing tiers and charge for excess traffic.
3. De-prioritize excess traffic per account.
4. De-prioritize excess traffic per traffic class.
5. Ban applications that are likely to offer excess traffic preemptively.
6. Allow users to tag traffic according to a pre-defined set of priorities that guide ISP behavior with respect to delay and discard policies.
7. Add bandwidth faster than anyone can use it.

Each approach has its advantages and disadvantages, and none is perfect (number 7 isn't even possible.) The fundamental problem that these policies address is a nexus between user behavior and the state of the network at any given moment. Network conditions are highly dynamic, but user behavior is not. The more effective a technique is at addressing network overload, the more difficult it is to communicate to the customer. I have a preference (number 6), but I don't believe ISPs should be required to do business the way I think I would if I were in their shoes.

If ISPs have the freedom to experiment with different methods and business models, and consumers have reasonably broad choices, the market will sort this matter out. Hence the policy priority should be the promotion of market-based competition between Fiber, DOCSIS, DSL, and wireless.

The Limits of Over-Provisioning

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[8]*Comcast Acceptable Use Policy For High-Speed Internet Services*, http://www6.comcast.net/terms/use/.

Network engineering is not immune to rigid doctrinal disputes, and there are those in my profession who reject prioritization and traffic shaping on philosophical grounds. According to their point of view, network operators should accept any degree of load offered by any user, and simply supply enough bandwidth that no user ever experiences delayed service. This viewpoint is often driven by the fear that carriers can't be trusted to manage their networks properly because of conflicts of interest and a generally untrustworthy nature. In Congressional hearings on Network Neutrality this point of view was advanced by lobbyists connected with the Internet2 consortium of universities.

It's worthwhile to point out that Internet2 schools practice traffic shaping and policing on their campus networks, for the same reasons that public carriers such as Comcast do: it's not economically feasible to build networks around the excessive bandwidth appetites of a few users. For detailed descriptions of traffic shaping tools and policies at Internet2 schools, see the proceedings of the Internet2 Campus Bandwidth Management Working Group (http://qos.internet2.edu/wg/cbm/.)

Conclusion

The Comcast network was designed to carry interactive web traffic optimally. This kind of traffic is characterized by large volumes moving downstream and small volumes moving upstream, on an episodic basis (one reads a web page for some period of seconds, and then clicks a link.) BitTorrent presents a completely different mix of traffic, characterized by slightly more upstream than downstream traffic, with constant requests for service. Traffic management forces the BitTorrent mix toward the network's operating assumptions.

Comcast has announced a redeployment and update of its network that will increase available bandwidth and make nearly equal allocations for upstream and downstream paths. This update will reduce the need for traffic management of the sort the petitioners bemoan, but it won't eliminate it.

The fundamental design goal of BitTorrent is to use up all available bandwidth; network operators have no choice but the limit the bandwidth **seen** by such applications if they're to provide stability and satisfaction to the bulk of their customers. As far as we know, this is exactly what Comcast does.

There are alternative methods and policies that may be employed by ISPs to address problems of network congestion and overload; the market should decide among these, not the government.

Thank you for entertaining my comments.

Richard Bennett

/s/

Attachments:

Three articles published in The Register

1. *Harold and Kumar go to Comcastle*, published Tuesday 6th November 2007.
2. *Dismantling a Religion: The EFF's Faith-Based Internet*, published Thursday 13th December 2007.
2. *Hogging the Trough: The EFF Strikes Back*, published Wednesday 23rd January 2008

Original URL: http://www.theregister.co.uk/2007/11/06/richard_bennett_comcastle/

Harold and Kumar go to Comcastle

By Richard Bennett
Published Tuesday 6th November 2007 00:18 GMT

Comment The coalition of the frustrated who comprise *Save the Internet!* have filed a multi-trillion dollar complaint with the FCC regarding Comcast's blatant exercise of, um, reasonable network management. The key fact seems to be this: if you live in a dream world of secret manipulative forces, evil wizards, fire-breathing dragons, scary ghosts and freaky monsters, the actions of ordinary businesses seem peculiar.

The complaint (http://www.freepress.net/docs/fp_pk_comcast_complaint.pdf) is a combination of science fiction and group therapy, with generous doses of pure paranoia thrown in.

The highlight (http://www.freepress.net/docs/fp_et_al_nn_declaratory_ruling.pdf):

> The FCC should act immediately to enjoin Comcast's secret discrimination and, even before deciding the merits, issue a temporary injunction requiring Comcast to stop degrading any applications.

Secret discrimination? However, the same complaint describes Comcast's network management practices as *blatantly violating the FCC's Internet Policy Statement.* So which is it, secret or blatant?

And it gets better. The basis of the complaint is the claim that Comcast discriminates against BitTorrent in particular and Peer-to-Peer file swapping applications in general. The FCC's principles say that customers can run any application they want, and BitTorrent is an application. Hence, limiting the bandwidth P2P can use is breaking the law.

There are only two problems with this line of reasoning:

1) P2P applications aren't the only ones that Comcast throttles. The complaint itself admits that classic ftp has problems when trying to act as a server on the Comcast network, and further charges that Comcast's management has much wider effects:

> While only Comcast knows the algorithm they use to decide when to forge RST packets, it is unlikely that they ever tested the plethora of applications that are potentially broken by that algorithm.

2) BitTorrent isn't disabled on the Comcast network, not even the seeding mode where it acts as a file server. I'm a Comcast customer, and as I write this I'm seeding several video files from the current season of a certain murder mystery series set in the most dangerous county in England. The key fact about BitTorrent that the reporters have missed is that it typically takes hours for large file or set of files to transfer, so a five to ten minute test doesn't say anything.

It's a nonsense complaint.

Shoot first, ask questions later?

So we have to ask if the FCC should be issuing injunctions before deciding on the merits of completely meritless complaints?

In a way I wish they would, so that Comcast's customers could see what their network would look like without any traffic management. I'll predict an outcome: people swapping illegal videos would be thrilled, everybody else would be super-pissed. And if that harms Comcast's business, then it would certainly be reasonable for the complainants to be required to compensate them.

And finally, how is Comcast to manage those situations that arrive in the course of operating a network millions of times a day when the traffic bound for a certain path exceeds the capacity of the path without *degrading any applications?* Surely some applications are going to be degraded, assuming the network's capacity is, you know, finite.

And this brings us to the funniest part of the complaint, the helpful suggestions about how to manage the Comcast network:

> ...if Comcast is concerned that the collective set of users running P2P applications are affecting quality of service for other users on a cable loop, they could readily set dynamic quotas for each user on the loop, so as to ensure that there is always bandwidth available for users who are not running P2P applications – and they could do so without interfering in protocol choice

As far as we know, this is exactly what Comcast is doing, setting dynamic upload quotas and enforcing them by preventing excessive numbers of upload streams from starting inside their private network.

The angels apparently believe there's a magic "quota" knob inside each cable modem owned or rented by each Comcast subscriber, but that's not the case. These modems can take a hard cap at boot time, but after that they lack a mechanism to prevent them from issuing excessive numbers of upstream transfer requests. That's undoubtedly a flaw in the definition of the DOCSIS protocol, but it's one that isn't going away simply because we may earnestly wish it would.

Who passed these Laws of Physics? Let's sue 'em

So what we have here is a demand that the FCC and Comcast repeal the laws of physics and provide unlimited non-delayed uploads to everybody everywhere on the Comcast network all the time. That's not going to happen no matter who's in charge of the agency.

The FCC should clarify the nature of "reasonable network management", and do so with sufficient force that the coalition is motivated to take its regulatory zeal elsewhere. In particular, that would mean saying that the following are presumed reasonable unless proved otherwise:

- Any network management practice whose effect is to limit traffic load to the capacity of the network.
- Any network management practice whose effect is to prevent a small number of users from dominating limited network resources and increasing delay for others.
- Any network management practice necessary to keep the network operating within its stability parameters, which depend on the technology itself. E.g., Wi-Fi, DOCSIS, and Ethernet are all stable in different ranges of load.
- All that virus and security stuff is also clearly fine.

I believe that we need to ignore the methods and concentrate on the effects because network equipment doesn't always allow multiple choices of the methods that manage traffic. The regulation advocates suggest, for example, that Comcast use "dynamic caps" to manage BitTorrent traffic rather than busy signals (TCP Reset is a digital busy signal). Dynamic caps aren't available in all DOCSIS modems, but the busy signal at the network portal clearly is.

In other words, Comcast manages its network according to what works, not what some weird coalition of angry lawyers and sweaty advocates think will work.

And I'd seriously like for the FCC to consider referring the complaint to the Justice Department for consideration of perjury charges. Some of the signatories have filled out "penalty of perjury" declarations after making irresponsible charges and claiming to be subject matter experts. I know this is pro forma, but some of their charges are so extreme that it would be wise to make examples of them. I don't expect that to happen, of course, because there's a wide latitude for lying in advocacy, but it would thrill me if it did.

Playing the politics game with the net

The bottom line here is that the Internet, which has succeeded largely because of its lack of regulation, has become the lust-object of a whole slew of regulators. Its existence and success are an affront to the livelihood and reputation of regulators everywhere, and they can't allow such a rebuke to stand. And sooner or later, the 535 regulators who make up the Congress will side with them. The Internet is too juicy a plum for them not to get their grubby little paws on it.

Net neutrality's father, Tim Wu, committed a gaffe recently and admitted that his movement is a [power struggle for control of the Internet](http://www.news.com/Thanks-to-BitTorrrent%2C-Net-neutrality-debate-reignites---page-2/2100-1034_3-6216750-2.html?tag=st.num) (http://www.news.com/Thanks-to-BitTorrrent%2C-Net-neutrality-debate-reignites---page-2/2100-1034_3-6216750-2.html?tag=st.num). Indeed it is. We can either allow the Internet to continue operating as it always has, under the control of engineers and users, or we can transfer control to lawyers, bureaucrats, and appliance testers. There are disturbing signs that the bureaucratization of the Internet is well underway. ICANN, the group that oversees domain name registrars and other sundry details, recently [elected a lawyer to lead it](http://www.news.com/ICANN-taps-New-Zealand-lawyer-to-replace-Cerf/2100-1030_3-6216997.html?tag=st_lh) (http://www.news.com/ICANN-taps-New-Zealand-lawyer-to-replace-Cerf/2100-1030_3-6216997.html?tag=st_lh) in place of a former network engineer.

So enjoy it while it lasts.®

Richard Bennett is a network architect and occasional activist in Silicon Valley. He wrote the first standard for Ethernet over twisted-pair wiring and contributed to the standards for WiFi and the Ultra-Wideband wireless networks. His eleven-year old blog is on his personal website, at bennett.com (http://www.bennett.com/blog), where this article first appeared.

Dismantling a Religion: The EFF's Faith-Based Internet

By Richard Bennett
Published Thursday 13th December 2007 17:05 GMT

The Electronic Frontier Foundation likes to portray the internet as under attack. But the activist group is doing more to imperil its future than any of its favourite targets.

The latest salvo in the utopians' war is a report on Comcast's traffic management policies. It's an amazingly conflicted piece of work, bristling with fierce language (the term "forgery" is used 33 times in ten pages), but very light on substance.

At least the authors - attorney Fred von Lohmann, copyright specialist Peter Eckersley, and computer guy Seth Schoen - concede that Comcast has a legitimate interest in controlling bandwidth hogs.

"It is true that some broadband users send and receive a lot more traffic than others, and that interfering with their traffic can reduce congestion for an ISP," they write. Which leaves them, ultimately, only quibbling over the methods the cable giant uses.

Their complaint consists of a laundry list of suggested alternative mechanisms for dealing with congestion, that are either unworkable or only trivially different from the "Reset Spoofing" technique Comcast uses.

(Reset spoofing merely rations the number of Bittorrent seeding sessions a user can offer to the internet at a given time. It doesn't affect BitTorrent downloads, and in fact improves them for most users.)

Among the EFF's suggestions we find:

> [Comcast] can set a limit on the amount of data per second that any user can transmit on the network. They can also set these limits on a dynamic basis, so that (1) the limits are gradually relaxed as the network becomes less congested and vice-versa and (2) so that the limits primarily slow the traffic of users who are downloading large to very large files that take minutes to transfer.

Here, the EFF confuses upload and download issues, erroneously assuming that cable modem (DOCSIS) networks have the same capabilities for managing upstream flows that they have for downstream ones - a serious error.

DOCSIS networks are grafted onto systems that were built to deliver analog television programs. They employ separate frequency channels for upstream and downstream traffic, and manage them very differently. In the downstream direction, where the cable company's CMTS controller is the only transmitter, traffic can indeed be managed dynamically and usage-sensitive limits used. This is the cable company's equipment and they can manage it as they see fit. Upstream traffic is completely different, however; it comes from multiple transmitters using equipment they may either own outright or lease from the cable company.

The multiple transmitter problem is thorny. While computers operating on other shared-cable systems such as co-ax Ethernet could see whether anyone else was transmitting before jumping on the cable, DOCSIS transmitters are unable to do so because of the separation of transmit and receive channels. The best they can do is wait for a time synchronisation message, take a random guess, and pray that their message (initially a request for bandwidth to the CMTS) will be transmitted successfully. If their prayer is answered, they're given a reserved time slot and everybody's happy. If their request for bandwidth collides with another computer's request for bandwidth, nothing happens and both have to

try again, after a suitable delay.

The issue that destabilises cable modem networks is not strictly related to bandwidth: a lot of short packets are worse for the network than a smaller number of large packets consuming more bandwidth.

That's why the EFF's suggestion about dynamic bandwidth caps, even if it were possible to implement, wouldn't solve the problem. But it's not possible to implement in any case: DOCSIS 1.1 cable modems accept a hard bandwidth limit when they boot up and attach to the network for the first time, but it remains in place until the next reboot. This limit has to be set reasonably high (384 kbit/s) in order to provide good performance for the short bursts of traffic that are characteristic of web browsing and gaming. It should probably be supplemented by more sophisticated controls, and will be someday.

But for now, DOCSIS is what it is and does what it does, and no amount of screaming "forgery" is going to change it. Besides, the customers who've purchased their own DOCSIS modems shouldn't be treated as badly as the people who bought last year's Mac.

The Cost of Technical Illiteracy

Comcast's challenge is to make their residential network stable and responsive for the majority of its users despite the desire of a few users of such peer-to-peer file-sharing software such as BitTorrent to consume unlimited bandwidth.

BitTorrent's basic approach to bandwidth consumption actually conflicts quite strongly with a key assumption of the internet's architects, that the relationship between users and traffic flows is essentially a constant. On networks where people browsing the web use four connections in short bursts while BitTorrent users consume 40 or 50 constantly, this is no longer the case.

In contrast to the EFF, serious network people are exploring ways to extend the internet's traditional traffic management methods - packet dropping and slow-start - into the new reality where fairness and congestion have to be managed together.

Bob Briscoe of BT and UCL presented a paper to the IETF (the Internet's technical advisory body) in March. Flow Rate Fairness: Dismantling a Religion [PDF (http://www.cs.ucl.ac.uk/staff/B.Briscoe/projects/2020comms/refb/fair_ccr.pdf)] attacking the problem head-on. In Briscoe's abstract we see that the problem afflicting the EFF has its roots in the internet design community's received wisdom:

> Resource allocation and accountability keep reappearing on every list of requirements for the Internet architecture. The reason we never resolve these issues is a broken idea of what the problem is. The applied research and standards communities are using completely unrealistic and impractical fairness criteria. The resulting mechanisms don't even allocate the right thing and they don't allocate it between the right entities. We explain as bluntly as we can that thinking about fairness mechanisms like TCP in terms of sharing out flow rates has no intellectual heritage from any concept of fairness in philosophy or social science, or indeed real life. Comparing flow rates should never again be used for claims of fairness in production networks. Instead, we should judge fairness mechanisms on how they share out the 'cost' of each user's actions on others.

In other words, the internet's traditional method of ensuring fairness doesn't work any more - not for Comcast, not for BT, not for any network that hosts peer-to-peer file-sharing applications designed to grab all the bandwidth they can get. Internet routers can randomly drop packets all the way to the Restaurant at the End of the Universe, and peer-to-peer users will still consume most of the bandwidth on the internet's first and last hops.

The EFF's quibble with Comcast is therefore bankrupt. Home network providers have to provide some measure of fair access to each user they serve, and they can only do so with mechanisms that actually produce a result. The internet's traffic toolkit is nearly barren, so it's no wonder that Comcast and its peers would use mechanisms such as Reset Spoofing to accomplish an end that all rational people agree is worthwhile.

Truth or dare?

So why does the EFF complain? They're aware that file-sharing is troublesome for cable networks, but remain fully committed to the religious view that the internet's protocols were born fully-formed and inviolate in the mind of a virgin engineer in Bethlehem some 40 years ago, IETF discussions to the contrary notwithstanding.

Like many advocacy groups dealing with technical subjects, the EFF represents the view that technologies are meant to liberate the human spirit from the chains of exploitation, hence it's bewildered by the sight of people using the internet for such mundane purposes as downloading porn, bullying, and stealing music.

So it manufactures a fake crisis of network management to avoid the truth about the inanities of the internet. Problem solved. ®

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Original URL: http://www.theregister.co.uk/2008/01/23/benett_eff_neutrality_response/

Hogging the Trough: The EFF Strikes Back

By Richard Bennett
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The FCC is to investigate Comcast's network management practices. Last month here I gave an expert view (http://www.theregister.co.uk/2007/12/13/bennett_eff_neutrality_analysis/) on how the EFF, and other campaigners who called for an inquiry, don't understand the problems. Now Peter Eckserley, a copyright academic at the EFF, has responded to my article. Let's recap the story first.

To avoid congestion on its cable network, Comcast uses a technique to throttle uploads for BitTorrent users; BitTorrent downloads continue to proceed smoothly. Net Neutrality campaigners leapt onto the issue, insisting that Comcast's methods are illegitimate.

Comcast has little choice but to do what they're doing, given the three problems BitTorrent causes for their network - and their customers who *don't* use BitTorrent.

The first is the nature of BitTorrent itself. BitTorrent's behavior on the Comcast network is like a glutton at an all-you-can-eat buffet who insists on planting himself at the trough, preventing others from getting to the food. This causes multiple problems for DOCSIS cable networks, which caused Comcast's network managers to throttle uploads under high-load conditions (but not prohibit them outright) using a technique called Reset Spoofing.

The EFF has a preferred way of dealing with this, random packet drop. For EFF this is the One True Method of traffic management. But as I've explained to Eckersley both in print and over the phone, the problems BitTorrent causes can't be healed by random packet drop.

Packet drop would work with the regular diner who takes a plateful and moves on, but not with this super-hungry dude.

(I don't attribute malicious intent to BitTorrent's designer Bram Cohen; software often has bugs, even when it wasn't born in Redmond.)

But the EFF soldiers on, its honor now at stake.

Hogging the pipe

The EFF simply dismisses the Denial-of-Service-like effects of BitTorrent handshakes, in which a given Comcast customer's PC can become quite attractive to BitTorrent downloaders because of its favored position in the Tracker's list.

Eckersley correctly noticed that I gave an incorrect reason for this positioning: it's not because of response time, as I said, it's because of the Comcast-resident system's possession of rare file parts, which is even worse. Watch BitTorrent in operation and you'll see cycles of high popularity come and go. It's immune to packet dropping; a connect request comes into the Comcast network, and the user's system responds immediately, regardless of congestion, TCP window sizes, or load.

This highlights a design flaw in the Internet's reliance on TCP packet drop to control congestion generally; packet drop only slows traffic on established streams, not on sessions in the process of becoming established or on non-TCP streams.

Another, more persistent problem that the EFF dodges has been explained by Professor Jim Martin of Clemson University, the world's leading expert on TCP/BitTorrent interaction, and it's simple enough

that a copyright expert can certainly grasp it if he wants to.

Residential networks, Comcast's being no exception, are designed on the assumption that users do more downloading than uploading. BitTorrent strives for a symmetric interchange of data, offering as much (or slightly more) in the upload direction as in the download direction. Hence, a small number of BitTorrent sessions will exhaust the network's upload capacity long before it's stressed in the download path. Professor Martin's paper, *Assessing the Impact of BitTorrent on DOCSIS Networks* [PDF (http://people.clemson.edu/~jmarty/papers/bittorrentBroadnets.pdf), 450kb] predicts that fifteen BitTorrent sessions significantly slow down web browsing for the neighbors.

> The web response time statistic increased from a value of 0.25 seconds when no BitTorrent users were active to 0.65 seconds when 15 BitTorrent users were active. This suggests that 15 BitTorrent users can cause a drop in performance by a factor of 2.5. When the number of BitTorrent users exceeds 30 performance degrades beyond the 1 second metric threshold.

Eckersley is certainly familiar with Martin's work, as he cites him in his original "research" on BitTorrent and Comcast.

An additional problem arises from BitTorrent's tendency to punish users on fast connections with greater traffic loads. Even though Comcast limits upstream traffic to 384kbit/s, a small fraction of its basic 4Mbit/s download rate, upstream traffic moves considerably faster on its network than it does on a standard DSL connection.

Consequently, BitTorrent downloaders will gravitate to peers on Comcast over those on DSL through their own performance assessment.

So let's recap the argument. I say BitTorrent causes problems for Comcast's DOCSIS network that can't be healed economically by randomly dropping packets. Packet drop applies back-pressure to conventional TCP sessions, but it does nothing to the data queued inside Comcast users' cable modems, where it contends for scarce upstream bandwidth with other users.

Packet-drop also does nothing to affect the rate at which new connect requests come into the Comcast network from BitTorrent users across the Internet. Random packet-drop has profound effects on conventional applications, but very little on BitTorrent, and the routers to do packet-drop in real-time are more expensive than the aynchronous Sandvine system.

Therefore, it's acceptable for Comcast, as a matter of reasonable network management, to employ TCP Resets to prevent BitTorrent doing harm to the web browsing, standard file downloading, and VoIP sessions that are the typical behavior of the Comcast customer.

My claim is borne out by Professor Martin's analysis of TCP's interaction with the DOCSIS Medium Access Control protocol, and by his analysis of BitTorrent's side effects on web browsing. It's further borne out by observations of BitTorrent's cycling behavior, and the well-known weakness in packet drop in terms of cycling and fairness which I addressed on the last article.

Confronted with all this evidence, the EFF and Eckersley would be wise to admit their confusion and vow to devote further study to the topic, in particular to wait for the FCC's analysis of the complaint.

To the cable company's credit, it has announced plans to begin a major network upgrade (http://www.lightreading.com/document.asp?doc_id=140143&site=cdn&f_src=lightreading_default) starting in the fourth quarter, resulting in a nearly symmetric 130/100 Mbit/s network with the kind of traffic controls that the EFF dreams about.

(When it's not lobbying for usage-based pricing. Eckersley cites Australian ISP Whirlpool's pricing plans (http://bc.whirlpool.net.au/bc-plan.cfm) as exemplary.)

With such a system on the drawing board, it's not hard to fathom why Comcast doesn't want to lay in the collection of the expensive routers (Sandvine runs on PC hardware and processes packets out-of-band) the EFF would have them buy to patch their current network into EFF-approved shape; all it takes is a willingness to see reality as it is and an ability to put the holy books aside. That may be a hard slog for a Net-Utopian advocacy group harboring delusions of conspiratorial persecution, but it's the right thing to do.

Conclusion

Everyone who's argued with religious fanatics has seen them dig in their heels and flail when confronted with challenges to their belief systems. Point out the inconsistencies in the Genesis account of creation or the implausibility of Noah's Ark and you'll get some creative sputtering followed by affirmations of faith at a high volume level.

The EFF's response is over-heated religious rhetoric that ignores both the economic constraints that bind network operators, and the ineffectiveness of the Internet's inherited methods at dealing with challenges created by new protocols and applications. The literature on packet-drop in particular suggests a dozen variations, none of which applies across the scope of a single BitTorrent user's communications.

While the Internet's end-to-end architecture makes it a fertile testbed for the implementation of new protocols, each brings with it new traffic patterns that must be dealt with in ways that prevent others from starving. Hogging the trough is simply not acceptable network behavior.®

Richard Bennett is a network architect and occasional activist in Silicon Valley. He wrote the first standard for Ethernet over twisted-pair wiring and contributed to the standards for WiFi and the Ultra-Wideband wireless networks. His eleven-year old blog is at bennett.com (http://bennett.com/blog/). He will debate these issues on a panel (http://www.netneutrality2008.org/Schedule.html) at the Toll Roads Symposium (http://www.netneutrality2008.org/About.html) in San Francisco on Saturday.