Technical Paper

sandvine
Intelligent Broadband Networks

Contents

Transparent and Reasonable Network Management in DOCSIS 3.0

The high-speed data industry is in a state of flux due to maturing markets, increased regulation, public policy pressure, transparency requirements and DOCSIS 3.0 speeds. With the wide-spread adoption of broadband, and its evolution into wideband, we are seeing the relentless destruction of information-based business models as information shifts to Internet-based delivery. Newspaper media giants are going bankrupt, broadcasters are cutting out their affiliates to deliver directly to the consumer, and the music and movie industry are challenged. Delivery models are shifting to the Internet because of the low cost to the content provider. At the same time, top-line subscriber growth on high-speed data is declining and peak bandwidth is not able to command a proportional premium in price.

This paper will discuss the technical means to achieve the goals of: providing continued and profitable high-speed data service with transparency and reasonable network management, while transitioning consumer experience and expectations to the broadband of tomorrow made possible with the speeds created with DOCSIS 3.0.

Network Management Forces

No aspect of the evolution of the Internet has ever been slow and quiet. This is as true today as it was in 1969 with the first ARPANET nodes in UCLA and Stanford. However, there is a sea-change happening in that the evolution is now being driven not by common-shared interests amongst a small community, but by divergent interests driven by business, government, and content owners versus content consumers. In "Tussle in cyberspace: defining tomorrow's internet" [1], Clark et al discussed the thesis that the Internet will be increasingly defined by tussles that arise among the varying parties with divergent interests, rather than the common shared interest that drove its initial design and evolution, and this in turn drives one of the major set of forces.

Technology forces also play strongly in network management. DOCSIS 3.0 provides wideband access speeds of up to 160Mbps to hybrid-fibre-coax cable networks. As DOCSIS 3.0 is adopted, this in turn changes the oversubscription ratios and 'fairness' concepts between users of DOCSIS 1.0, 1.1, 2.0, and 3.0 (as all may share some portion of the RF spectrum). It also drives an increasing disparity between upstream and downstream speed in the short term.

Media and content companies have a dichotomy of approach towards network capacity and network management. From a copyright-infringement and digital rights standpoint, they would prefer network management to pro-actively block certain content. From a distribution standpoint, they would prefer for infinite capacity for zero cost (to them) to exist. As a consequence, they lobby both for and against, network management. For an MSO deploying DOCSIS 3.0, this direct distribution of content (e.g. Hulu) in turn reduces revenue, shifting it from low-cost switched digital video towards high-cost packet-switched infrastructures, while at the same time reducing both subscription and advertising revenue.

The Internet has always resisted regulation and censorship. "Neo-luddism and the demonisation of technology: cultural collision on the information superhighway" [2] suggests that "Just as society did not cry for an end or regulation of the printing press, so too should we not regulate the Internet", and so too here should we not call for regulation to arbitrate these forces.

Transparency Helps Define Reasonableness

A 'reasonableness' test helps define the acceptability of network management. This test stems from the common-law concept of 'what would a typical person agree is reasonable'. It is by consequence a subjective fine-line test.

In the opinion of this author, the best means of defining reasonable network management is by a combination of transparency and contract. If a network management policy is disclosed in such a way that a typical consumer can understand it, and if that same typical consumer then purchases access to that same network, they have de facto defined the practice as reasonable.

Transparency is a challenging concept. The subtle technical nuances of DOCSIS networks (latency, loss, jitter, shared-access, etc.) are difficult to describe in simple enough terms that the layman can understand. Analogies, although helpful to form a basis, rapidly become inappropriate as they diverge from the original problem. Network management practices evolve over time and should not be hampered by overly detailed disclosure and discussion. Thus it becomes important to disclose what is material to understanding a network management policy. Since we are relying on transparency as a means of supporting reasonableness, material becomes any aspect that would affect the actions of the typical consumer.

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[1] Clark, D. D., Wroclawski, J., Sollins, K. R., and Braden, R. 2005. Tussle in cyberspace: defining tomorrow's internet. IEEE/ACM Trans. Netw. 13, 3 (Jun. 2005), 462-475. DOI= http://dx.doi.org/10.1109/TNET.2005.850224

[2] Bowman, D. 2009. Neo-luddism and the demonisation of technology: cultural collision on the information superhighway. SIGCOMM Computer Communications Review. 39, 3 (Jun. 2009), 19-21. DOI= http://doi.acm.org/10.1145/1568613.1568618

It is also important to not overly pander to the least-technical nor the most-technical user of the network. The typical consumer is a concept which has evolved throughout the history of residential Internet access from the earliest days of the enthusiast to today's mass-market penetration. The typical consumer is the one that an MSO targets with television and print advertising.

If typical users, understanding the disclosed network management policies in use, contract for the service, the policy must be reasonable by definition. Reasonable is defined entirely in the frame of reference of the end-user, the customer of the MSO.

Success Criteria

In order to be successful, a reasonable network management plan must maximize the user experience of the maximum number of users for the maximum amount of time for a given capital investment. It must do so without sacrificing subscriber growth due to competitive forces. It must do so without falling afoul of public policy and regulation. This is a tough set of bounds to operate within, but it is possible.

An acceptable and successful network management plan will take into account the following focus areas.

Narrowly-Tailored

All networks have variation in usage patterns, whether by time of day, by geography, by user demographics, or by other factors. As a consequence, oversubscription and quality of experience are non-uniform across the network. A properly constructed network management plan takes this into account, and focuses as narrowly as possible on the problem to be solved. It does not try to force a one-size-fits-all solution into all areas at all times.

In a DOCSIS 3.0 environment, there are several areas of 'narrowly-tailored' that might be technically considered for addressing subscribers who are causing disproportionate congestion in times of congestion. These include:

1. Channel bonding and how channels are shared with un-bonded users
2. Mixed DOCSIS 1.0, 1.1, 2.0, and 3.0 usage within the same shared spectrum
3. Subscriber density per node
4. Subscriber demographics per node
5. CMTS backhaul network capacity
6. Unforeseeable events

A reasonable network management practice takes these factors, and more, into account. It applies itself differently, or not at all, depending on the conditions that are currently present. For example, a network management practice might be self-tuning, and disable itself when no congestion is present. It might operate differently when congestion is present on a single user, versus a single RF channel, versus a bonded set of RF channels, versus the CMTS backhaul uplink.

A successful network management practice will narrowly-tailor itself to the situation at hand at the time it is needed. It will not apply in a broad fashion across the broad average of a network.

Proportional and reasonable effect

The impact of a reasonable network management policy must be proportionate to the problem being solved. It would be considered unreasonable by most to take a subscriber causing 15% of the congestion on a network, and manage their bandwidth to 1% of peak rate. It might, however, be considered reasonable to reduce the priority of traffic of the top twenty-percentile of bandwidth users, which as a

group might be only 5%, but consume more than half the bandwidth at a given point in time. In reducing their scheduling priority they do not affect the latency and throughput of the other 95%. The network management policy needs to take into account the concept of proportional effect and response.

Legitimate and demonstrable technical need

The operator must have a legitimate and demonstrable technical need for the network management practice. The architectural strengths and weakness of DOCSIS provide the majority of the technical needs for network management, and these are discussed in detail in "An Overview of the DOCSIS (Cable Internet) Platform"[3]. Additional technical needs arise due to network architecture outside the scope of DOCSIS, for example, implementation-specific details of various CMTS vendors of backhaul and core network architecture.

To be successful, a network management practice must be described in such a way that both the technical need and the practice are clear and the network management practice seeks only to address this need and nothing more.

Transparent disclosure

The operator must make the material information publicly available to allow understanding of the network management policy by those impacted by it. The disclosure should be sufficient for a consumer to form an informed opinion on whether the practice will affect them, which applications might be affected, when they might be affected, and what the impact might be, including impact to speed, latency and general experience.

Disclosure might take many concurrent forms. The most popular include network management FAQ Web pages, notices included in billing material, acceptable use policies, terms of service, etc. In "Virgin Media Broadband: Traffic Mangement"[4], Virgin Media describes their network management practices in very explicit form. In "Cox Communications – Congestion Management FAQs"[5], Cox Communications describes theirs in more general terms. Both provide an end-user with information to understand how the practice will affect them, and both provided pro-active notification to their users in addition to the FAQ web page.

Auditable and demonstrable

Owing to the public scrutiny of capital investment in networks, and network management policies, it becomes important for an MSO to be able to demonstrate that the above criteria were indeed met.

On audit, an MSO should be able to provide:

1. What was the technical need that caused the creation of the network management policy
2. What affect the policy had on the user experience
3. How they have disclosed their policy to the end-user
4. How the policy took into account network and time variances

In addition, the audit should be able to demonstrate the above were met using technical results. These results might include information on the user experience for the typical user for typical locations in the network.

[3] Tooley, M., Bowman, D. 2008. An Overview of the DOCSIS (Cable Internet) Platform. http://www.tiaonline.org/gov_affairs/fcc_filings/documents/Cable_Architecture_Declaration_01.14.10.pdf

[4] "Virgin Media Broadband: Traffic Mangement", http://allyours.virginmedia.com/html/internet/traffic.html

[5] "Cox Communications – Congestion Management FAQs", http://www.cox.com/policy/congestionmanagement/

DOCSIS 3.0 Challenges

DOCSIS 3.0 has enjoyed a rapid rollout, giving a large number of consumers access to a wideband experience. It has also created specific challenges for network management policies. Specific network policy management challenges include:

1. Mixed use of RF spectrum between DOCSIS 2.0 and 3.0 users
2. Availability of downstream channel bonding in advance of upstream channel bonding
3. Lack of DOCSIS 3.0 IPDR availability from CMTS vendors
4. Dynamic channel bonding groups and external signaling of change events
5. Higher oversubscription rates stemming from increased offerings
6. Lack of ability to prioritize traffic in downstream in all CMTS with PacketCable Multimedia
7. Increased burden on backhaul network

As a consequence, this has increased the complexity of network management technology.

In a mixed DOCSIS 2.0 and DOCSIS 3.0 environment, a successful network management implementation needs to be able to:

1. Prioritize per user per RF channel and per bonded channel group in the downstream above the CMTS
2. Prioritize per user per RF channel and per bonded channel group in the upstream in the cable modem and DOCSIS scheduler
3. Detect near-congestion state in near- real-time
4. Detect the users and applications causing the disproportionate congestion in near-real-time
5. Interact correctly with temporary speed changes such as PowerBoost™, edge-QAM resource management
6. Provide strong reporting and business intelligence to be able to provide accurate capacity planning and auditable results
7. Provide strong subscriber experience measurements

Many MSO are now also using non- DOCSIS access technologies such as WiFi, 3GPP HSPA, fibre PON, WiMax, so network management may also need to operate in an access-agnostic fashion.

Conclusions

Despite its higher speeds (in fact, because of them), active network management is required in DOCSIS 3.0 to maximize the experience of the maximum number of users for the maximum amount of time.

Network management policies must be narrowly tailored, must be proportional and reasonable, must be designed to address a legitimate technical need, must be transparently disclosed and must be auditable.

Reasonable network management requires disclosure of the policy in such a way that the typical user can understand the impact to them, and reasonableness is framed entirely from the end-user perspective.

Access-agnostic network policy control is required to create a network management practice that spans multiple devices, and multiple access technologies.

Strong reporting and business intelligence is required to be coupled to the network management practice to understand demand, capacity, and user experience.

As an MSO deploying DOCSIS 3.0, this may seem like a minefield of requirements, but a few simple up front planning activities can make for a highly successful network management practice.