The Internet Market For Quality

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Abstract: The market for the exchange of traffic among networks on the Internet has proved to be remarkably efficient and adaptable.While the issue of network neutrality has dominated policy debates in recent years, the evolution of this market has begun to provide answers to many of the questions raised in these debates.It is establishing the terms under which content will be exchanged among networks and delivered to end users, how traffic will be routed and resources will be deployed to ensure quality of service, and by whom. Underlying changes in consumer demand and industry structure are driving this evolution in the market for Internet traffic exchange, forcing each of the players in the system - including content providers, content delivery networks, and local access networks - to adapt. Even as the terms of peering and transit agreements have become so well understood and accepted that the vast majority of such agreements can be adopted on a handshake basis, without even a written document, parties have also produced new variations on this model to establish terms for the delivery of large volumes of video traffic. While this process may be messy at times, as indicated by the disputes that have arisen over the last year, the performance of this market has so far been quite good. It may therefore be wise for regulatory authorities, having established broad parameters for policy toward net neutrality, to allow the development of the market to continue without intervention, while monitoring its progress.

Key words: Internet, peering, network neutrality, traffic exchange, CDN.

Debates on the subject of network neutrality have occupied policy makers in markets around the world, including both sides of the Atlantic. Over the last two years authorities in Europe and in the United States have adopted broad policy frameworks with respect to network neutrality, although it remains to be seen how the implementation of these policies will affect market outcomes.

While these debates have been under way, the Internet has continued to evolve, as it has done since it began. The use that consumers and businesses make of the Internet, the structure of the market, and the business models of the participants, have all been changing rapidly over the last five years, while the volume of traffic exchanged has grown eightfold. The market for the exchange of IP traffic among networks, which was

already highly developed and efficient, has also evolved in response to these trends. In the process, it has begun to establish the terms under which content will be exchanged among networks on the Internet and delivered to broadband users. In short, while parties have been arguing questions of network neutrality before policy makers, their actions in the marketplace have begun to fill in some of the answers to those questions. These include the business models and the physical routing used to deliver content, the resources that will be deployed to ensure quality, who will provide those resources, and at what terms.

■ Performance of the market for IP traffic exchange

Since the Internet was privatized in the early 1990s. a robust market for the exchange of IP traffic has developed, based on voluntary commercial agreements. This market has produced very low prices. For a large volume commitment at an Internet Exchange Point (IXP) transit service can be obtained for USD 2 to 3 per megabit per month. [1] Yet the market has also been able to generate investment to support the explosive growth of the Internet from a relatively limited research community to a global phenomenon connecting two billion users. Twenty households with average broadband usage in 2010 generated as much traffic as the entire Internet carried in 1995. [2]

■ Market structure evolution

The Internet has always been in a perpetual process of reinvention and transition. Even as the basic model of peering and transit has become so well understood that written agreements are often unnecessary, the universe to which those agreements apply has been evolving rapidly.

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[1] This is at least five orders of magnitude lower than an equivalent service for circuit-switched voice traffic. Some very large volume transactions are thought to be priced at less than one USD per megabit. See, for example, http://drpeering.net/AskDrPeering/blog/articles; Peering_vs_Transit___The_Business_Case_for_Peering.html

[2] For a general review of the development of this market see WELLER & WOODCOCK, 2011.

Global extension

As the Internet has expanded globally, Internet resources such as IXPs have been deployed in more countries and regions. The availability of exchange points within region has reduced costs, increased service quality, and freed up long-haul facilities such as undersea cables to be used for out-of-region traffic (KENDE, 2011).

Disintermediation of backbones

Rapid growth of peering has led to the disintermediation of the large global backbone networks that the Internet once depended on for transit service. This has allowed the majority of Internet traffic to be delivered without ever touching one of the large backbone networks.

The substitution of peering for transit has been facilitated by the development of well-known and readily accepted terms and conditions for peering agreements, which in turn has minimized transaction costs. In a recent survey of peering which drew responses from 86% of the world's Internet carriers, 99.51% of the 144,210 agreements reported were "handshake" agreements in which parties agreed to informal or commonly understood terms without creating a written document (WOODCOCK & ADHIKARI, 2011). Transaction costs have been further reduced by the widespread use of multilateral agreements, in which many carriers at an IXP join a single agreement, rather than negotiating bilateral agreements with the other parties.

Just as the availability of transit acts as a constraint on the ability of Internet networks to charge for termination, by providing an alternative way to deliver traffic, so too does the availability of other alternatives, such as CDN services (discussed below) and peering, constrain the price of transit.

New patterns of demand

The shifting structure of the industry is being driven by evolution of user demands, just as that evolution is in turn enabled by the new structure of the industry.

Among the top ten global applications (by percentage of Internet traffic) identified in a 2009 study by Atlas Internet Observatory, streaming and direct

download of video was the fastest growing between 2007 and 2009. Peer-to-peer (P2P) applications, the category that had raised the most concern about straining Internet capacity, declined the most. According to the annual survey published by Sandvine, in North America, 45.7% of the downstream traffic on fixed networks is generated by what they categorize as Real-Time Entertainment. The largest single contributor to this is Netflix, which by itself accounts for more than 20% of downstream traffic during peak hours (8 to 10 pm.) P2P is still the largest driver of upstream traffic on North American fixed networks, accounting for 53.3% of total bytes.

It appears likely that the shifts in usage patterns will continue as age cohorts with different habits move through the age distribution, as consumers who had previously watched linear television programming view more video online, and as applications move from the desktop into the cloud.

The growth of CDNs

Content delivery networks (CDNs) serve as aggregators of content, systems for delivery of traffic directly to the terminating network, and providers of quality-enhancing inputs, such as caching of content close to the end user. This market segment has grown rapidly. A 2009 study by Atlas Internet Observatory estimated that the top five "pure play" CDNs - LimeLight, Akamai, Panther, BitGravity, and Highwinds - represented close to 10% of Internet traffic. Akamai's revenues have quadrupled in the past five years. Online service providers purchase inputs from CDNs, but in many cases they also self-supply. Google, for example, has built or acquired substantial backbone capacity, and carried about 6% of Internet traffic in 2009, according to Atlas (LABOVITZ *et al*., 2009, pp. 22-24). Google and Comcast, neither of which appeared on Atlas's list of the top ten Internet networks by volume in 2007, just two years later had risen to number three and number six on that list, respectively.

As the mix of services has shifted, the distinctions among backbone networks, access networks, and media companies have blurred. Rather than speak of CDN networks, it may be more useful to think in terms of CDN functions. All of the trends reviewed in this section - the disintermediation of transit, the creation of more exchange points, the increase in peering, and the growth of CDN functions - are ways in which the market for the exchange of IP traffic has brought new resources to bear to accommodate the increase in traffic, and to improve quality.

■ Challenges for market participants

The new developments in demand and market structure have created new challenges for market participants to adapt their business models and establish new relationships with one another.

Content providers

While the Internet has created a powerful conduit for new forms of content, the growth of online delivery also offers both opportunities and challenges for established providers of content, such as movie studios and broadcasters. They must decide how to fit online delivery alongside their existing forms of distribution, such as theaters, DVDs, and linear television. They have historically been slow to adopt new distribution technology, as have music companies, and are naturally concerned about cannibalization.

But the potential for new revenue is too large to ignore. In the second quarter of 2011, Viacom and CBS each added at least USD 60 million in pretax profit from online streaming deals with companies like Netflix, while NBC Universal added about USD 80 million. In the last few months, Netflix has announced a series of new deals for the rights to stream programs, most recently an agreement with Time Warner and CBS said to be worth one billion USD. [3]

Online aggregators

While content creators may be able to reach some online customers through their own sites, much of this new online demand comes through aggregators such Google, Netflix, Apple,and Hulu. On the purchasing side of their business, these intermediaries face demands for better terms from content companies. Netflix, for example, recently raised its rates significantly, provoking sharp complaints from their customers, in part to cover higher payments to content companies.

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[3] "Netflix digs deep for 'Gossip Girl'," *Wall Street Journal*, 14 October 2011. http://online.wsj.com/article/SB10001424052970204002304576628983215283342.html?mod=WSJ_business_whatsNews

On the distribution side of their business, these companies must arrange for efficient, high-quality delivery of content to the access networks that serve their consumers. This involves CDN functions, either self-supplied or from providers like Akamai, and agreements to terminate traffic on local access networks.

Local access networks

Local access networks that offer proprietary linear television may have concerns about cannibalization as more content is viewed online. Cable operators have seen gradual erosion of their residential video subscribers over the last two years. Time Warner Cable, for example, lost 124,000 video customers in the second quarter of 2011, or about 1% of the total. We may be at the beginning of a major trend toward cord-cutting of linear video services, just as consumers have dropped landlines over the last decade, but it is difficult at present to find hard evidence of this.

However, many of these companies are no longer the single-play video businesses they once were. Broadband revenues are now the source of most of their growth. Glenn Britt, CEO of Time Warner, said in a recent interview "I think broadband clearly is becoming the anchor service." [4] Most also own content providers, have substantial online services of their own, and derive significant revenues from online distributors such as Netflix. For example Comcast also owns NBC Universal, a major creator of content, which in turn is a part owner of Hulu. In 2007 it was primarily a local cable operator, lacking its own backbone facilities, mainly focused on residential video and broadband services and highly dependent on upstream transit suppliers. By 2009 it had become a major provider of voice services, a net exporter of traffic, the sixth largest network by traffic volume, and the largest user of IPv6 addresses on the Internet (LABOVITZ *et al*., p. 19).

As these trends continue, the incentives of these operators will become more complex, and their ability to negotiate terms of interconnection may change as well. Since broadband customers typically download more material than they upload, in the past local access networks have often found it difficult to peer, and have thus had to pay transit to receive traffic.

4 "Time Warner Cable Sees Its Balance Shifting to Web", *Wall Street Journal*, August 16, 2011. http://online.wsj.com/article/SB10001424053111903392904576510713535434984.html?mod=WSJ_hp_LEFTWhatsNewsCollection

Peering with one another, with content providers, and with CDNs, offers both parties the opportunity to reduce their transit expenses.

Local access networks may also face challenges in adapting their networks to deal with the traffic created by online content delivery. While most fixed networks already have last-mile facilities capable of supporting video delivery [5], an increase in the aggregate volume of traffic does create a need to augment the capacity of middle mile, or regional subnet, facilities to carry traffic between the gateways where traffic is exchanged with other networks and the last mile.

Many wireline access networks already have relatively efficient infrastructure in place to deliver linear video services to their end users. This is particularly true for cable systems, whose networks were originally designed to broadcast videos channels, simultaneously distributing a single copy of a given program to all of their subscribers. The number of those subscribers who choose to watch a particular program has no effect on the resource requirements placed on the system. However, online distribution from a service like Netflix or Hulu causes the local network to transmit a separate copy of the content for each individual user who requests it. The amount of investment required to adapt the regional subnet of the local access network will depend on how and where this traffic is delivered, and whether the content is cached locally (BENNETT, 2011).

As the structural changes described in this section have developed, the various participants - content providers, online distributors of content, backbone networks, CDNs, and local access networks - must realign their business models, their prices, and their arrangements with other parties. This process has led to some conflicts when parties have disagreed over contract terms.

■ Commercial agreements - and disagreements

In December, 2010, stories began to appear in the trade press reporting that broadband customers of Orange in France were having difficulty downloading content from Megaupload, a P2P video hosting service based

[5] Ken Florence, Director of Content Delivery, Netflix, "Netflix Performance on Top ISP Networks", January 27, 2011.
http://techblog.netflix.com/2011/01/netflix-performance-on-top-isp-networks.html.

in Hong Kong. It soon became clear that Orange was engaged in a peering dispute with Cogent, the backbone provider carrying traffic for Megaupload. As this dispute played out in the press, the rhetoric escalated. Megaupload accused Orange of "throttling" its traffic, and urged Orange customers to switch to other broadband providers. [6] Orange attributed the problem to Megaupload's choice of an "unreliable" provider, and announced its intention to sue Cogent. [7] The French national regulatory agency, ARCEP, after meeting with the parties, has chosen not to intervene. No public announcement has yet been made of a settlement of this dispute.

In December 2010, stories began to appear in the trade press reporting that an American broadband provider, Comcast, was refusing to accept video traffic originated by Netflix and delivered to Comcast by Level 3, provider of CDN services to Netflix. As with the dispute in France, this issue was played out in the press. Level 3 accused Comcast of violating network neutrality by demanding payment from Level 3, with whom it had a peering agreement. Comcast portrayed the matter as a peering dispute, claiming that the Netflix traffic did not fall within the parameters of the peering agreement. The national regulatory authority, the FCC, after meeting with the parties, has chosen not to intervene. No public announcement has yet been made of a settlement of this dispute.

Distance and direction

In both of these disputes, the local access network receiving the video traffic complained that the traffic flows were too far out of balance to allow for peering. Traffic balance is listed as a relevant criterion in the peering practices of most Internet networks. How should traffic balance affect the negotiation of IP interconnection agreements?

If parties have agreed (on whatever basis) that one network should be a customer of the other, then the direction of the payment flow has already been determined. The customer network buys ports on the network of the transit provider, and pays for traffic exchanged through those ports in both

6 "French ISP Throttles Direct Download Website Megaupload", ITProPortal, 15 January 2011. http://www.itproportal.com/2011/01/15/french-isp-throttles-direct-download-website-megaupload

7 "Orange to sue Cogent, seeks fair peering deal." 26 January 2011. www.telecompaper.com/news/orange-to-sue-cogent-seeks-fair-peering-deal

directions. Neither the costs incurred by either network, or the amount of payment, varies as a function of the balance of traffic.

If parties have agreed to a peering arrangement, then in many cases traffic is not exchanged in both directions at a single point. Each network seeks to drop off its originating traffic at the closest possible point, thus minimizing its transport costs - the classic "hot potato" routing. If traffic is roughly balanced (and if suitable exchange points are available) the result is a roughly equitable division of the transport costs. In this context, a change in the relative balance of traffic (perhaps because of an influx of video) could increase the share of the overall cost of transport that is borne by the receiving network.

However, when the interconnecting carrier is a CDN whose service to its customer (the video service provider) includes transporting the traffic to a point close to the end user, then the CDN is covering transport costs that might otherwise be borne by the receiving carrier in a standard peering arrangement. The local access network may still incur additional costs if it must handle a greater volume of traffic on its side of the exchange point, but that would be the case regardless of the direction of traffic.

Since IP interconnection agreements are voluntary, it is up to each party to decide what factors are relevant, and what value to assign to each factor. To some parties, traffic balance may be seen as correlated with a network's "interest" in the traffic or ability to realize some revenue from its end users. But these are subjective assessments at best. In terms of cost, the direction of traffic is important only in "hot potato" configurations, where it affects the division of transport costs. In the case where a CDN brings traffic to a local access network, it's not clear why the direction of the flow of funds should be determined by the direction of traffic.

Level 3 recently announced a revised peering policy which looks beyond traffic balance to consider other factors which might affect the balance of costs borne by the parties. It calls for parties to "work together to implement routing practices and adjust location of interconnection points such that each party bears a reasonably equal share of backbone burdens - taking into account the amount of traffic carried by each party and the distance over which that traffic is carried." [8]

[8] "Level 3 Announces new Policy for Internet Protocol Interconnection", *Telecom Ramblings*, 12 October 2011. http://newswire.telecomramblings.com/2011/10/level-3-announces-new-policy-for-internet-protocol-interconnection/

Forging new agreements

As online video service providers and the CDNs who support them look for ways to deliver their product to broadband users efficiently, and local access providers seek ways to accommodate the influx of video traffic, these "frenemies" have been negotiating new forms for IP interconnection agreements (CLARK *et al*., 2011). In effect, these new arrangements have begun to address the need for upgrading the regional subnets of the local access providers to accommodate growth in video traffic. If it locates the exchange point deep within the local access network, the CDN provider contributes in kind to this upgrade. [9] Caching content close to the end user reduces latency and improves quality, but it also moves the point at which it becomes necessary to transmit multiple copies of the content through the subnet. Upstream of the cache, it is necessary to transmit only one copy of the file to "seed" the cache. Carried to some limit, the caching process begins to approximate the older cable model where a single copy of the content resides at a head end.

The CDN thus brings substantial new resources to the table when it negotiates such an arrangement. At issue would be how deep into the local network the CDN will transport the content, whether the cache will be located at some third-party exchange point, or colocated within an office in the local network, and whether the CDN will make some cash payment to the local access provider. [10]

The outcome of these negotiations has been mixed. Firms like Google and Akamai have been able to negotiate settlement-free peering agreements with many local access networks; Google is said to have been able to do this with more than 70% of all providers around the world. [11] At the same time, a few of the major local access networks have put in place service offers in which they provide access arrangements for CDNs, in return for payment. These include telcos like AT&T and Verizon, as well as cable networks like Time Warner Cable and Comcast. These are referred to as CDN access agreements, or simply paid peering. It's not clear what

9 See, for example, John TIMMER, "Google backing off net neutrality with ISP deal? Not Really", ars technica. http://arstechnica.com/old/content/2008/12/google-backing-off-net-neutrality-with-isp-deal-not-really.ars

10 Another possibility, discussed below, might actually include a payment in the form of revenue sharing to the CDN or content aggregator.

11 See LABOVITZ (2010): "In fact, the only remaining major group of ISPs without direct Google peering are several of the tier1s and national PTTs."
http://asert.arbornetworks.com/2010/10/google-breaks-traffic-record/

proportion of the interconnection arrangements between these networks and CDNs have made use of these offers.

The prices reported for paid peering have been relatively low - at the low end of the range of transit rates (NORTON, 2009). Level 3, even as it continued its disagreement with Comcast, in July 2011 signed a multiyear agreement with Cox cable that covered a package of different business matters, including terms and conditions for IP traffic exchange as well as resale of Level 3 services by Cox. This illustrates the familiar result that there is more scope for agreement when there are more dimensions to the exchange. For online video providers that lack Google's scale, CDNs and/or paid peering provide a means to match the improved quality that Google has obtained through its investments in facilities, and to avoid transit, at a price at or below what it would have paid for transit.

Facts of the case

While the Cogent/Orange dispute and the Level 3/Comcast case are parallel in some respects, many of the underlying facts are quite different.

In the French case, it is not clear from the press reports whether Cogent is providing CDN functions to Megaupload, or simply acting as a transit provider. Cogent has a history of brinksmanship in its negotiations with other networks, and has depeered other networks, and been depeered, many times. Orange has used the press coverage of the dispute as an opportunity to express its view that peering "no longer works" and that an Internet termination charge should be considered. It appears that some of the more extreme statements initially made by the parties have been withdrawn, and that the relationship has continued with unresolved issues concerning the number of ports made available by Orange, and the location of points where traffic is exchanged.

In the case of Level 3 and Comcast, prior to the dispute, the two companies had two separate agreements for the exchange of IP traffic. One was a peering agreement for the exchange of traffic between the two networks. The other was a transit agreement in which Comcast paid Level 3 to reach other networks with which it lacked any other arrangement. Comcast also had paid peering agreements with a number of CDNs, including Akamai, which had also invested to extend its transport deep into Comcast's network. Akamai, in turn, had a contract to provide CDN services to Netflix.

In October 2011, Netflix transferred this business from Akamai to Level 3. Level 3, in order to fulfill its commitment to Netflix, asked Comcast to make a large amount of new capacity - 300 Gigabits/second - available for its use. This was the capacity needed to accommodate the same traffic that Akamai had previously handled. Comcast argued that, when Level 3 assumed the role of CDN provider, it was stepping outside the scope of its peering agreement. It therefore declined to provide the requested capacity, proposing instead that the two companies should negotiate a third agreement, a paid peering arrangement for the delivery of the Netflix traffic.

The current state of play

What conclusions might one draw from these two recent disputes? Perhaps the most important is that, pushed by shifting consumer demand and structural changes, a wholesale market for the improvement of quality is being developed. It is not the market envisioned by local access network operators when the debate over network neutrality began. Quality is being improved, not primarily through prioritization, as those operators had expected, but through the deployment of additional network resources. However, rather than simply augmenting capacity, this market is directing resources to produce quality enhancements more efficiently, through more direct routing and the use of local caching.

Which party is in the right in each of these disputes? It doesn't really matter. Ultimately each voluntary agreement must be based on what each party is willing to accept. Despite the abundance of religious beliefs that have been expressed by many observers of this process, there really is nothing in the economics of two-sided markets that dictates what the terms of trade should be in any particular case. So far, no party, or category of parties, has been able to impose a particular outcome in all cases.

In considering whether any policy intervention might be necessary, what is more important is that the different outcomes observed so far appear to fall within a range that is reasonable. Local access networks as a group, for example, have not been able to impose termination charges, or some equivalent, in all, or even most, cases. In the few cases where paid peering has been agreed, the level of the rate is generally lower than what the same party would have paid for transit. New options for indirect routing of traffic, such as "single hop" or ‘backplane" access, provide CDNs with additional alternatives, and thus improve their bargaining positions (CLARK *et al*.,

2011, p. 15). In a recent report to investors, James Crowe, the CEO of Level 3 said that its dispute with Comcast had not been resolved, but that in the meantime Level 3 was paying the charge proposed by Comcast. He also characterized the charge as "not material" to Level 3, adding that "if for whatever reason those charges remain in place, we'll adjust." (SPANGLER, 2011). Certainly if the objective of the local access networks was to prevent the rapid growth of the CDNs, or of online video, or the decline of their own linear TV businesses, they have failed.

Some analysts have suggested that the concern over market power should really be on the other side, given the increased concentration among large online service providers such as Google. However, while these networks have had considerable success in concluding peering agreements with local access networks, they have not been able to impose them at will, and have in some cases wound up agreeing to pay. It has also been suggested that when a local access network agrees to peering with a CDN, this must always cause a net loss to the access network, related primarily to the loss of transit revenue. [12] Since these are voluntary agreements, one wonders why an access network would accept an arrangement that was not in its interest. The Comcast example would appear to demonstrate that large CDNs have not been able to impose unfavorable terms on local access networks.

In fact, there appear to be potential gains from trade for both parties. Through the details of an agreement, parties are able to establish an acceptable division of these gains, by adjusting the relative contribution that each makes in terms of transport, caching, other physical inputs, or money. For this reason, any arbitrary restriction on the ability of local access networks to provide CDN functions could sharply limit the range of possible arrangements for sharing these responsibilities. Absent some strong showing of harm from anticompetitive behavior, NRAs should allow local access networks to participate in the CDN market.

The outcomes of negotiations between local access networks and CDNs are part of the larger process of adjustment that is taking place up and down the value chain. Level 3 is testing the price structure that Comcast has

[12] See, for example, KROGROSS, WELDON & SOFMAN, 2011. The authors present a numerical example in which the effect on the access network of peering with a CDN is negative, but this is not a proof that this would always be the case. The example also is based on extremely narrow assumptions. For example, it completely neglects the cost side, and looks only at the division of revenues, thus ignoring any resources the CDN might contribute.

sought to establish. It's widely believed that Level 3 was able to outbid Akamai for the Netflix contract because it assumed that it could terminate the traffic under its peering arrangements. That assumption is now being tested. In much the same way, the content companies are testing the limits of what they can charge Netflix. This experimentation is likely to continue until some new pattern is established. Perhaps over time a new set of norms will develop which will make this market more efficient. At the same time, the existing low cost, no-frills universe of standardized peering agreements, so highly developed that most agreements are not even written down, provides a competitive alternative that puts limits on any attempt to create more elaborate arrangements.

The market for the exchange of IP traffic through peering and transit has performed remarkably well over the last fifteen years. No market is perfect, and there is no guarantee that this one will be free from failure in the future. Now that some broad outlines of policy toward network neutrality have been adopted, some outer limits of behavior have perhaps been established, and NRAs have some tools at their disposal should intervention be necessary. However, given the success of this market to date, it would be reasonable for NRAs to set the threshold for intervention very high.

In most situations, the alternative means for delivering traffic to a local access network, should an agreement not be reached, would be through transit. As explained above, both sides have an incentive to avoid unnecessary transit expense. It has been suggested that a local access network might seek to degrade the quality of this alternative by deliberately ordering insufficient transit capacity (ROTHSCHILD, 2011). This would seem to be a risky strategy to bring off, as it would also degrade the quality of the local network's connections to all of the networks outside the group of its peers. Nonetheless, if the NRA is to monitor behavior in the market, this is one aspect of behavior that might bear watching.

In the two prominent cases reviewed here, neither NRA has chosen to intervene. In February 2011, in response to a question at a congressional hearing, the chairman of the FCC, Mr. Genachowski, expressed the view that the FCC's recent order on network neutrality was focused on protecting broadband consumers, not on peering disputes. The network neutrality rules "don't change anything with existing peering agreements," he said. Some analysts, however, have expressed concern that any non-discrimination rule adopted by the FCC could be interpreted to prohibit arrangements such as paid peering. This illustrates the difficulty of drawing a non-discrimination rule in such a way as to bound its application, and limit unintended

consequences. In August, 2011, Cogent filed a complaint against Orange with the French competition law authority, the 'Authorité de la Concurrence'. [13]

In another recent case, a different European NRA, the Polish regulator UKE, adopted a draft decision in 2006 that would have imposed on the Polish incumbent Telekomunikia Polska (TP) an obligation of nondiscrimination and transparency as regards transit of IP traffic. A second order, in 2007, added a much longer list of additional regulatory measures. UKE's action was based on a concern that TP would selectively degrade traffic arriving via third-party transit providers in order to force transit customers to purchase more expensive services directly from TP (in other words, something very close to what some have suspected Comcast of doing.) The European Commission responded in 2010 by expressing serious doubts as to the compatibility of the notified draft measure with Community law. The Commission raised doubts as to whether the markets the UKE sought to designate - peering and transit - were separate markets, finding them to be effective substitutes for one another, and also questioned whether, even if they were separate, TP could exercise significant market power.[14]

In the announcement of the Commission's decision, Digital Agenda Commissioner Neelie Kroes said:

> "The Commission fully shares the objectives of the Polish regulator in seeking competitive markets, but our assessment is that regulation of these particular markets for Internet traffic exchange services is not necessary to protect consumers or competition. If the market itself is able to provide for fair competition, don't disturb it with unnecessary regulations."

13 See http://www.telecompaper.com/news/cogent-files-competition-complaint-against-orange-france. See also http://www.latribune.fr/technos-medias/internet/20110829trib000645165/orange-veut-nous-faire-payer-pour-atteindre-ses-clients.html

14 http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/240&format=HTML&aged=0&language=EN&guiLanguage=en. Commission letter at: http://circa.europa.eu/Public/irc/infso/ecctf/library?l=/commissionsdecisions&vm=detailed&sb=Title.

■ Business options for local access networks

The authors of a recent A. T. Kearney study have suggested that the current model of Internet traffic exchange does not provide sufficient revenue for access networks to fund the investments needed to build high-speed local broadband networks. It is also argued that the model does not give online service providers the correct market incentives to optimize their use of network resources (A. T. Kearney, 2011).

While local access networks certainly do require large investments, the discussion in this paper suggests that the market for IP traffic exchange has in fact produced efficient results. As new agreements are negotiated between CDNs and local access networks, a new division of effort is being created in which CDNs and their clients do contribute, in money and/or in kind, to the improvement in the regional subnets of local exchange carriers needed to handle increasing volumes of traffic. They and their clients therefore do have an incentive to make efficient use of those resources.

For example, it has been reported that some European incumbents, such as France Telecom, have been in discussion with Google over a possible agreement to cooperate on measures, such as local caching and the design of mobile apps, to moderate the volume of data presented to mobile networks. [15] A voluntary industry group called P4P, comprising peer-to-peer application developers as well as local access networks, has published recommendations for data sharing among parties to allow P2P applications to respond to user requests using the closest copy of the desired content, thus minimizing network costs while improving the quality of service. [16] The AT Kearney authors offer four pricing models that might, in their view, offer the operator of an access network the opportunity to maintain a sustainable business model while making investments necessary to cope with Internet traffic growth.

One option is for the access network owner to adopt a range of pricing models, perhaps, as already occurs in several countries, incorporating variable usage pricing or a series of nonlinear offers to accommodate different levels of demand. This appears to be a reasonable approach -

15 http://www.rethink-wireless.com/2011/06/08/google-deal-orange-data-congestion-comes-closer.htm

16 http://www.pandonetworks.com/p4p. The group's work is based on research by authors at Yale and the University of Washington. See H. XIE, A. KRISHNAMURTHY, A. SIBERSCHATZ & R. YANG, "P4P: Explicit Communications for Cooperative Control Between P2P and Network Providers".

subject, of course, to the presence of sufficient competition to constrain rates to be reasonable and to the normal application of competition law. A possible concern here is the relationship between the options available to end users and the terms agreed with interconnecting networks. Today, for example, when a broadcaster or cable channel negotiates with a cable operator for carriage, it would be interested not only in the compensation it might receive from the operator, but also whether the channel would be included in the basic service package, or would be available only if the end user pays an additional charge to subscribe to a premium tier, since this would affect the size of its audience, and hence the viability of an advertising-based business model. Similarly, a CDN would seek settlement-free peering, but would also care whether broadband end-users had to pay extra for high-quality delivery of its content (CLARK *et al*., p. 18). In the cable example, where end users do pay something to access a premium channel, the result of the negotiation may include sharing between the cable operator and the cable channel of any revenue that may result. Similarly, it has been reported that one of the possible features of an agreement between European incumbents and Google might be some form of revenue sharing of incremental subscription fees paid by end users in higher-priced broadband tiers. [17]

A second option is to introduce what are termed "traffic-dependent charges for all traffic." It is presumed that this termination charge would be uniformly applied to all interconnecting carriers and to all traffic. This would require enforcement, either by the government or by a coalition of the access networks.

This second approach raises a number of concerns. It would recreate on the Internet the pricing models of the traditional telephone network, models that have generally not performed nearly as well as the Internet market. At a time when the market is experimenting with different arrangements to share costs and improve quality, this proposal would impose a rigid payment rule. This would deprive the Internet of the ability to adapt and evolve as it has always done, and substitute an arbitrary valuation of the connectivity provided by each network for a market value. Generating adequate investment for local networks is a worthwhile objective, but those networks should have to earn their revenue by providing value that other parties, whether they are end users or interconnecting networks, are willing to pay

17 http://ipcommunications.tmcnet.com/topics/ip-communications/articles/181643-france-telecom-google-deal-would-be-breakthrough.htm

for. If a local access network can negotiate a voluntary agreement that involves the payment of a charge, such as the paid peering agreements discussed above, then they should be allowed to pursue that business. But governments should not support the establishment of a uniform, mandatory termination charge, and they should prevent any collusive action to impose such a system.

A third option is to implement QoS over the public Internet. This would involve an end-to-end coordination of QoS across all, or at least a critical mass, of networks across the entire Internet. The possibility of this "inter-provider QoS" has been discussed for many years but has failed each time implementation has been attempted, so it seems unlikely that the necessary coordination could be brought about now. Further, for revenue from this approach to reach the terminating carrier, a cascading system of charges is envisioned, which again sounds dangerously close to a legacy settlement system. Even if such a system could be created, it would impose tremendous costs, and it is doubtful that it could promote the kind of experimentation and evolution that have made the Internet so efficient.

The final option is that access networks could offer CDN services based on voluntary commercial agreements. For the reasons discussed above, NRAs should allow access networks to pursue this opportunity, while monitoring the outcomes of this market, with particular attention to the possible interaction with pricing of tiered broadband services to end users.

Conclusion

Even as governments have wrestled with the issue of network neutrality, markets for IP traffic exchange have begun to generate answers to some of the questions raised in that debate. Driven by powerful structural changes in the Internet market, agreements between networks are directing resources needed to improve quality and cope with rapidly increasing traffic volumes. While this process may be messy at times, as indicated by the disputes that have arisen over the last year, the performance of this market has so far been quite good. It may therefore be wise for regulatory authorities, having established broad parameters for policy toward network neutrality, to allow the development of the market to continue without intervention, while monitoring its progress.

References

A. T. Kearney (2011): *A Viable Future Model for the Internet*. http://www.atkearney.com/index.php/Publications/a-viable-future-model-for-the-internet.html

BENNETT R. (2011): "Now Playing: Video over the Internet", Information Technology and Innovation Foundation (ITIF), December 10. http://www.innovationpolicy.org/now-playing-video-over-the-internet

CLARK David, LEHR W. & BAUER S. (2011): "Interconnection in the Internet: the Policy Challenge", Massachusetts Institute of Technology, August 9. Presented at the Telecommunications Policy Research Conference, September 2011. www.tprcweb.com

KENDE M. (2011): "Overview of recent changes in the IP interconnection ecosystem," Analysys Mason, 23 January.

KROGROSS B., WELDON M. & SOFMAN L. (2011): *Internet Architecture Evolution and the Complex Economies of Content Peering*, Alcatel-Lucent 2011.

LABOVITZ C. (2010): "Google Sets New Internet Traffic Record", Arbor Networks, 25 October 2010. http://asert.arbornetworks.com/2010/10/google-breaks-traffic-record/

LABOVITZ C. IEKEL-JOHNSON S., McPHERSON D., OBERHEIDE J., JAHANIAN F. & KARIR M. (2009): *Atlas Internet Observatory*, 2009 Annual Report. http://www.nanog.org/meetings/nanog47/presentations/Monday/Labovitz_ObserveReport_N47_Mon.pdf

NORTON W. (2009): "Paid Peering and Net Neutrality", 5 November, DrPeering. http://drpeering.net/AskDrPeering/blog/articles/Ask_DrPeering/Entries/2009/11/5_Paid_Peering_and_Net_Neutrality.html

ROTHSCHILD A. (2011): "Peering Disputes: Comcast, Level 3, and You," Voxel, 2 December. http://www.voxel.net/blog/2010/12/peering-disputes-comcast-level-3-and-you

SPANGLER T. (2011): "Comcast, Level 3 Still At Impasse Over Internet Connection Fees", Multichannel News, 27 July 2011. http://www.multichannel.com/article/471614-Comcast_Level_3_Still_At_Impasse_Over_Internet_Connection_Fees.php

WELLER D. & WOODCOCK B. (2011): "Internet Traffic Exchange: Market Developments and Policy Challenges," and the accompanying Annex, OECD, November 2011.

WOODCOCK B. & ADHIKARI V. (2011): "Survey of Characteristics of Internet Carrier Interconnection Agreements, Packet Clearing House, May 2, 2011. http://pch.net/resources/papers/peering-survey