



## *When Want & Freedom Collide Finding a Fair Internet Capacity Sharing Solution*

### *Executive Summary*

Problems with the way the Internet shares capacity are surfacing. Net neutrality is high on the political agenda in the US and the Internet technical community recently accepted that the traditional way the Internet shares out capacity is not a way forward. A radical new approach called 'congestion exposure' or 'cost transparency' is building a head of steam for Internet standardization. But this issue is not just a matter for technical committees to decide; it impacts global business and public policy too.

When chief executives of the world's ICT firms met at the GIIC annual commissioner meeting in April '09, they were briefed on the new approach, proposed by researchers in BT. Intuitively they liked the idea, but they wanted to hear experts assess its potential impact, in depth, before putting their support behind it.

On 30 September 09, experts from around the world converged on the GIIC-organized workshop in London to assess the proposal, from the three perspectives: commercial, public policy and technical. The workshop was hosted by BT, with CTOs and CEOs of GIIC member companies or their expert representatives also attending, plus a few joining over video or audio links.

There were positive and often deeply considered comments about the proposal from all those who attended, included assessment of it in their talks: Dr David Clark (MIT and former IETF Chief Protocol Architect), Rich Woundy (Comcast office of the CTO), Prof Christopher Yoo (Penn Law), Leslie Daigle (CITO of ISOC), Kevin Mason (Telecom NZ), Don Bowman (CTO Sandvine), Eric Klinker (CTO BitTorrent) and Falk von Bornstaedt (Head of Peering Strategy, DT). KK Ramakrishnan (AT&T Research) who has been involved in this area since the early Internet added a much-needed dose of realism about the chances of deployment. No one had anything negative to say about the proposal, though some potential obstacles to adoption were raised. Bob Briscoe (BT) presented the proposal and Robert Pepper gave a background talk on Cisco's predictions for future Internet traffic.

At the end there was a general show of hands supporting the proposal. The GIIC is now considering the actions it will ask its commissioners to commit to, in order to help this proposal progress.

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The main purpose of the workshop was for interactive discussion around and about BT's Cost Transparency proposal, with an end result to decide "what should the GIIC do about it?"

The workshop was hosted by **Paul Excell, GIIC Commissioner & Chief Customer Innovation Office** at BT Centre. Other GIIC commissioners in attendance at the workshop were Matt Bross, Don Rippert and Alfie Kane, with overall about 30 attendees including commission members and invited experts.

These notes are intended to capture some of the most salient discussion at the workshop and are not intended to represent the full content of the program. A copy of the workshop agenda, the slides presented at the workshop as well as the list of participants have been attached.

## **The Problem**

**Matt Bross, GIIC Vice Chairman**, made the first presentation to the workshop (via video conference from St. Louis, MO) on the **Internet Capacity Sharing Problems**. Matt stated that the main notion of the Cost Transparency proposal is to introduce a “unit of cost” – as a building block for simpler access to infrastructure, for investment in the Internet, removing innovation barriers to new apps etc; but not as a new way of the operator controlling things.

BT's proposed protocol to implement cost transparency (called re-feedback of Explicit Congestion Notification or re-ECN) is currently being considered for addition to the Internet standardization agenda at the IETF, where it is called Congestion Exposure or ConEx.

Matt urged a temporary suspension of disbelief about any concerns of how to make the change, relying on the technical experts to consider this at the end.

Matt's presentation was followed **Rich Woundy, Senior VP Software & Applications, Office of the CTO, Comcast**. Rich discussed **Comcast's FairShare solution** to capacity sharing, and how it compares with BT's cost transparency proposal. Comcast rapidly deployed FairShare in response to the FCC's criticism of their previous traffic management solution.

FairShare operates at congestion times only, traffic from the heaviest users (in the previous 15 minute period) is put into a lower priority class; <1% customers are impacted. Measurements have shown that a period of 5-15 minutes is best, as it maximizes the chances that the current measurement is an accurate prediction of demand in the next period (70% accuracy).

Rich emphasized that Comcast avoids trying to detect specific application protocols – to avoid the ‘cat and mouse’ of ‘bad’ applications trying to disguise themselves as ‘good’ ones.

He also highlighted that FairShare's algorithm is publicly disclosed – this intentionally meets the FCC's additional principle about transparency of network management practices.

FairShare & Cost Transparency have similarities: both aim to provide the best possible network experience for broadest set of customers; both are “protocol agnostic” and “application agnostic”, both act based on current network conditions and a user's recent traffic, and both are compatible with Internet standards and supportive of Internet innovation.

Cost Transparency appears to offer some extra advantages: it gives customers greater control of their own network experience; it adds transparency between network and user, it takes into account end-to-end congestion (not just local) and, by revealing the presence of congestion to user applications and to all devices on the network path, it enables new possible responses by the network, user and application. It also allows an operator to know where and when to target capacity growth by being able to distinguish real demand from incidental desires.

Rich's conclusion was that their current approach, FairShare, meets the immediate needs of their customers, the FCC and Comcast. It is a step on a new path compatible with BT's proposal, which Comcast is interested in because of its additional positive properties. Comcast is supportive of the re-ECN proposal and actively assessing the likely deployment costs and the commercial stance Comcast would adopt, if re-ECN were standardized.

**David Clark, Senior Research Scientist, MIT**, talked about the role of the ISP in the value chain – especially how to find a happy midpoint between the two unwelcome extremes of the ISP as a commoditized packet carrier and a vertically integrated, closed system.

Does Cost Transparency help? David gave the answer Yes, having analyzed the proposal in considerable depth. Firstly, it provides a consistent, well-defined (assuming it is standardized) ‘platform’ that application designers can use - ‘platform’ refers to the cost information that it moves from where the congestion occurs to where it can be dealt with. Secondly it meets the important requirement that it works solely with bi-lateral (and not multilateral) business negotiations.

David has estimated the incremental cost of Internet usage, ignoring ‘outside plant’, as roughly \$0.1 per GB. This is significant (especially with the growth of video) and therefore “reasonable network management” is required – rather than just adding capacity until there’s no congestion. “Reasonable” has to make sense to application designers, investors, networks - both the retail ISPs and the (monopoly?) wholesale operator – and so on.

## **A Proposed Solution**

This session was led by **Bob Briscoe, Chief Researcher, BT**.

Bob said that BT has reached a solution very similar to Comcast’s – it identifies those that send most at peak times. However, BT has found it is not viable to limit all the traffic from the heavier users at peak times, because this unnecessarily degrades the light interactive *usage* of heavy users. Possibly because competitive cost pressures are more intense in the UK, BT has chosen to spare the light applications it guesses these customers value most. BT has also decided to openly publish these practices in its fair use policy. BT would rather not make choices for its customers, but the current state of Internet technology leaves little alternative.

Bob outlined the proposal from BT research. The problem is a tension between i) standardized capacity sharing protocols that allow the few to take from the many, and ii) ad hoc blocks and throttles introduced by ISPs to better satisfy more users. Not only do these obstruct new applications, they also work against emerging protocols (BitTorrent) that work through co-operation to enable light usage to go much faster without affecting heavy usage.

The proposal enables such cooperation by revealing the incremental cost of a customer’s usage of the Internet – the amount of congestion they cause to others. By revealing cost (ie congestion) information, BT’s proposal enables accountability models to be built over it that would encourage cooperation towards much faster capacity sharing. It would be open to the market to decide what models worked.

The proposal requires a change to the Internet protocol (IP), which could be justified to shift the Internet from a fruitless arms-race towards a cooperative future. The examples of Diffserv and CATV QoS show that major changes to standards can sometimes be done quickly – in 1-2 years.

A questioner was concerned that content providers would not like a shift to sender accountability. Bob explained that the solution allowed the receiver to accept accountability when requesting a session, but that sender accountability had to be the default, given Internet technology does not allow receivers to refuse incoming data.

## **Expert Assessment**

### **Expert Assessment – Public Policy Aspects**

In the first afternoon session, the focus was on **Internet Public Policy Issues & Alternative Solutions**.

The discussion was led off by **Professor Christopher Yoo, Director, Center for Technology, Innovation, & Competition, Penn Law**, who talked about public policy and net neutrality with respect to Cost Transparency.

He liked the proposal as it provides an existence proof that traffic management in the broad interests of all the users of a network is feasible as an alternative to capacity expansion. He said the FCC has recently proposed additional principles: still involving non-discrimination against particular content or applications, but allowing reasonable traffic management; where a major test of reasonableness will be transparency in what exactly traffic management entails. The Cost Transparency proposal appears a good fit, as it's an informational foundation for markets and also it supports multiple forms of congestion management.

Christopher identified obstacles that the proposal would need to show it has surmounted, in particular that congestion suffers from joint causation.

Christopher explained that “net neutrality” encompasses a range of views, including some that are considered untenable even by fellow proponents of neutrality. Some might object to re-ECN in that it facilitates differentiated services based on willingness to pay, and in that it could be used for what some people define as degradation. However few would consider these objections reasonable.

Christopher thought there was a role for GIIC to define Best Practices for traffic management. This might help alleviate worries about liability, which can kill experiments in new business practices, especially when acting alone.

**Leslie Daigle, Chief Internet Technology Officer, ISOC**, talked about ISOC's global role in supporting the user-centric Internet, and its role in fostering the growth of Internet usage in developing countries. Policy should not be written in terms of technology, and the network should not be optimized for a particular application or for particular assumptions about where bandwidth is constrained.

On the Cost Transparency proposal, Leslie commented that it puts more information in the packet stream to enable a different set of “natural” traffic management choices; there is no telling what might be built with it.

Finally **Robert Pepper, Vice President, Global Advanced Technology Policy, Cisco Systems**, talked about the growth of Internet traffic. This has been much faster than was predicted in 1996, and again than in 2001. Video is currently the big source of traffic growth. In 2013 it's predicted that the average UK household will download 500 GB/month.

Robert's assertion that traffic management is an issue whether there is congestion or not prompted protests from the floor. It was pointed out that if there's no congestion, there's nothing to stop someone who wants more from having it. And no congestion means no queuing so no delay or jitter issues either. One admittedly obscure exception to this rule was pointed out concerning routing to minimize speed of light delays. A more significant exception is where carriers might artificially limit customers in order

to sell gradual easing of limits. But consensus was reached that traffic management is largely synonymous with management of congestion.

## **Expert Assessment – Commercial Viability**

In the second afternoon session, the focus turned to “**Is the Internet Value Chain Broken?**” The discussion was led off by **Kevin Mason, Principal Solutions Architect, Telecom New Zealand.**

Kevin gave his perspective on the Cost Transparency proposal, implying that it would be unquestionably better to manage traffic in this way. He stated the importance of early education of consumers about congestion (not volume) as the metric to manage; user empowerment, so each chooses the applications that respond best on their behalf – thus improving the user experience without a corresponding rise in provider costs; and network enablement, especially to reliably identify when congestion occurs and who are the contributors to it.

In terms of consumer education, one possibility is that alongside the current ISP offer of a monthly volume usage, there’s a congestion alternative – which offers a better experience for the same money. It was pointed out that it shouldn’t matter if customers don’t understand what congestion-volume means – today many customers don’t understand what a volume cap means, they just select the option that is marketed as suitable for their needs.

The next presentation was made by **Falk von Bornstädt, Head of IP-Transit and Peering, Deutsche Telekom.** Falk discussed DT’s experiences. They offer an open pipe, without volume capping etc restrictions on users. Falk has been experimenting with offering quality of service based on Internet differentiated services technology. He said the common factor between his approach and the BT proposal was an understanding that neutral traffic management can be more fruitful than blindly continuing to expand capacity. He has found that, because peering is unpaid, QoS can be difficult to introduce across multiple networks. And Hollywood may pay for quality, but most CDNs won’t.

An issue was raised about the robustness of the information (about Cost Transparency), especially at the boundary between ISPs – eg can an ISP cheat by inserting false information? David Clark said that an ISP could check whether a customer or another ISP is cheating.

Another issue discussed was whether all congestion bits cost the same? Might one have to weight congestion signals from African networks higher, given the relative cost of capacity is higher in Africa. The response was that, in theory, higher cost should be reflected by marking more bits as congested, not African congested bits priced higher than American. Then a content provider would naturally react by going slower or sending less bits to places with restricted or costly capacity.

Another discussion was around the difference between a ‘subscriber’ and a ‘user’, eg on a home network with several users. The ‘administrator’ of the home network may be able to assign different application priorities to each user.

## **Expert Assessment – Technical Feasibility**

The last expert panel of the afternoon discussed whether the Cost Transparency concept is ***Technically Feasible?***

**Don Bowman, CTO, Sandvine** talked about the history of managing capacity from traditional telephony to data communications leading to the arms race with p2p protocols and recent attempts to circumvent the latest controls. Sandvine is Comcast's main traffic management supplier, both for FairShare and the system it replaced. Consumption billing is ineffective at congestion alleviation – hence the key insight of FairShare was to look at peak time usage. Note also that daily/monthly top users do not particularly over-contribute to peak usage.

Don also gave Sandvine's recommendations that usage management should align the cost of a subscriber with their revenue, but the operator should allocate bandwidth without regard to the application. Sandvine's vision is a constant-quality network – and it supports standardization of congestion signaling to enable this.

**Eric Klinker, CTO, BitTorrent** talked about “uTP” – a replacement for TCP for background transfers; essentially it creates a scavenger service that only utilizes idle capacity, solely through new end-system behaviour without altering the network. uTP is beta testing in close to 1 million clients and is already 2% traffic. Operators could encourage the deployment of uTP by making non-congestive bytes “free” to users as well (ie not count against the volume cap - like the nights and weekend minutes of your cellular plan).

BitTorrent originally thought uTP would be its “secret sauce” to compete against other file-sharing systems, but they realized it was too valuable for the Internet as a whole to be kept proprietary. Therefore BitTorrent offered the specification for IETF standardization. BitTorrent and Microsoft now co-chair the working group standardizing low extra delay background transports (LEDBAT) at the IETF.

The main question from the floor was whether ISPs should give uTP a free pass because it *labels* itself as uTP, or because its *behaves* like uTP – very high volume but causing very low congestion. The former would encourage hostile data to falsely label itself as uTP.

Eric was also gave an emphatic Yes, when asked whether he wants uTP to use ECN and re-ECN. Re-ECN can be seen as necessary to allow ISPs to reciprocate the favor BitTorrent has offered with uTP, by being able to measure how little congestion it causes and reward it appropriately.

The last speaker on the technical feasibility panel was **KK Ramakrishnan, AT&T Labs-Research**.

KK gave a historical perspective on how Internet transport protocols have evolved. For example, ECN (Explicit Congestion Notification) was standardized in 1999 and carefully crafted for backwards compatibility - yet is not used despite offering performance benefits. But in the meantime several new versions of TCP have been deployed successfully. Lesson: changing multiple components in the network to achieve performance improvements is not easy, especially when they have no clear common shared economic incentive.

KK compared ECN and uTP. uTP uses end-to-end delay as an indicator of congestion. ECN is more robust and can be more aggressive in using bandwidth. But uTP is easy to deploy (only a change at end user's computer); its main benefit is to reduce self-congestion on your local link. We discussed how ECN might get deployed – perhaps in wireless, where the operator has some control over the terminal as well as the network. But mobile networks hide IP traffic in GTP-u tunnels, so equipment wouldn't ECN mark packets without an upgrade.

One question for the Congestion Transparency proposal is whether it has to wait for ECN to be deployed. It doesn't, but it makes an operator want to deploy ECN in order to be able to share capacity robustly, not just for incremental performance gains.

KK also talked about the difficulty of including policy within a transport protocol (such as 'what is a fair allocation of resource?') – this is better layered on top. Also, it is important to think about non-cooperation and collusion from the start.

It was left open whether these points amounted to praise or criticism for the cost transparency proposal. The implication was that deployment will be fraught. But re-ECN certainly meets the requirements to separate policy from mechanism, and has addressed non-cooperation from the start (whether successfully: remains to be seen).

## **Next Steps**

At the conclusion of the workshop, **Don Rippert** led a discussion on "Next Steps for GIIC".

Don gave his personal summary of the meeting. It is clear that there is broad support for the cost transparency proposal, to the extent it isn't necessary to ask who doesn't support it. But the Cost Transparency 'philosophy' needs to be articulated clearly for the GIIC commissioners not present –

- What precise problem makes it necessary?
- Since many will view this proposal with suspicion – with concern it is about more money for telcos -- the case needs to be made that it's about a fairer deal for all users, which answers the first question: the problem to solve is that today's Internet is unfair for the average user.

**Matt Bross** joined the discussion – now as Huawei's new global CTO. In his mind, there are two questions:

- Is there a problem that needs addressing?
- Can the GIIC develop a manifesto to address the problem?

We discussed developing stories about what the problem is – perhaps by analogy with the way VPNs today use traffic management (prioritization) to give better QoS for the same size pipe – similarly congestion management is an alternative to extra capital expenditure. Also, video traffic will continue to grow very rapidly, so we can expect that usage management issues will get more pressing. Also, examples of what it makes better than today – for instance, the consumer experience could be more like a corporate LAN but with current capacity.

We discussed how to avoid the comment that 'it just opens the door to higher prices'. The point is that it reveals actual costs; pricing is an issue to avoid, but making the incremental cost transparent should be a good thing. GIIC could have a role here in terms of facilitating the creation of markets that use this information, perhaps through identifying and recognizing best practices.

It was suggested that a trial would be worthwhile. Find a small number of ISPs and their application providers to turn on Congestion Transparency – or perhaps on an academic or test network. This would give others confidence that it gave benefit and nothing untoward happened. This leads to the question of how to make this happen.

It was questioned whether this issue requires a big public show of support, or quiet diplomacy between the captains of industry. The current Internet capacity sharing mechanisms (whether TCP or the ISP's

alternatives) didn't wait for public support – decisions were made by experts under the covers in technical committees. There was no definite conclusion to this discussion – so the question remains open about the best way to proceed in terms of the approach on the issue.

It was decided that key players will need to put energy, action and investment into this for it to be successful. It was agreed it offers the greatest promise to tackle capacity sharing, thereby improving the average consumer experience, lowering barriers to innovation and investment.

Bross called for a manifesto about our common intent to work together, and work out what each can contribute to it. A show of hands was requested for who would support the GIIC taking the cost transparency proposal forward. Nearly all hands went up.