

Content Delivery Networks 3.0

CDNs have improved in leaps and bounds, but are mainstream suppliers now struggling to deliver the next big improvement?

Could there be a window of opportunity for network operators to get into the game?

Could live OTT streaming be part of this opportunity?



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Sponsored by Broadpeak

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White Paper contents

What this paper is about	3
Historical CDN perspective	3
An introduction to CDN 1.0	3
Figure 1. Internet Transit prices have plummeted	4
Extending CDN 1.0 requirements	4
The emergence of global OTT players	5
The emergence of Video and CDN 2.0.....	5
For “traditional” RTSP based streaming, caches don’t really help.....	5
Adaptive Bit-Rate has brought a new lease of life to caching and CDNs	6
Using a Google cache: the kiss of death?	6
The response from existing Telcos	6
Global Telcos have a different perspective.....	7
Figure 2. Distribution of traffic on the backbone	8
CDN 2.0 is now reaching its limits	8
Intrinsic limitations in the architecture for live content	9
Figure 3. Scalability to channel audience levels is an issue	9
Business and eggs	10
Is “Live CDN” an oxymoron?	10
Why more and more operators are building their own CDNs	10
Dumb pipe syndrome.....	11
Figure 4. OTT Content is hurting Egyptian incumbent.....	11
Telecom infrastructure, chickens and eggs	12
Figure 5. Nasdaq Telecommunications index (^IXUT) 1996-2004	12
Figure 6. Unites States: Capacity utilization rate of the communications equipment suppliers	13
Figure 7. Market structure of fixed networks in the OECD area	13
Figure 8. The Olympic effect on the demand for Live OTT streaming OTT Live Vs. on Demand (Source BBC Q3-2012) 14	14
OTT is coming, but is now the time?	14
Figure 9. When is OTT cheaper than Satellite? (Source Nagra)	15
The true importance of “live OTT streaming”	16
Why local operators will always retain an important role	17
So where’s the money?	17
Resistance to change	17
Capping and net neutrality.....	18
Regulation and content rights	18
The next era for CDNs.....	19
What CDN 3.0 might look like	19

What this paper is about

As the London Olympics showed, streaming live content over IP is becoming more central for many service providers, whether over their own networks or over-the-top (OTT). The BBC went as far as calling the 2012 London Olympics the first truly digital games and streamed over 2.8 petabytes of data in a single day.

We will briefly look into where Content Delivery Networks (CDNs) came from and how they have evolved to solve the new challenges of live streaming over IP networks. We will consider how several operators around the world are addressing these new challenges and what further barriers are still ahead.

The chicken and egg question arises in telecoms when you look at whether demand comes first or infrastructure. We'll see that some of the biggest changes in the industry have been led by service offers, not demand and we'll see how that relates to live OTT streaming.

We are certainly not alone in predicting a new era for live OTT streaming, but our contention here is that traditional telecoms operators may yet get back into the game if they seize the opportunities that new technologies are offering to re-invigorate their strategies and their network infrastructure.

In researching this paper we spoke to a dozen operators including PCCW, SFR, Time Warner Cable, KPN, OSN, GVT, Bouygues Telecom, and a few anonymous ones including a major European player. We also interviewed several suppliers and analysts.

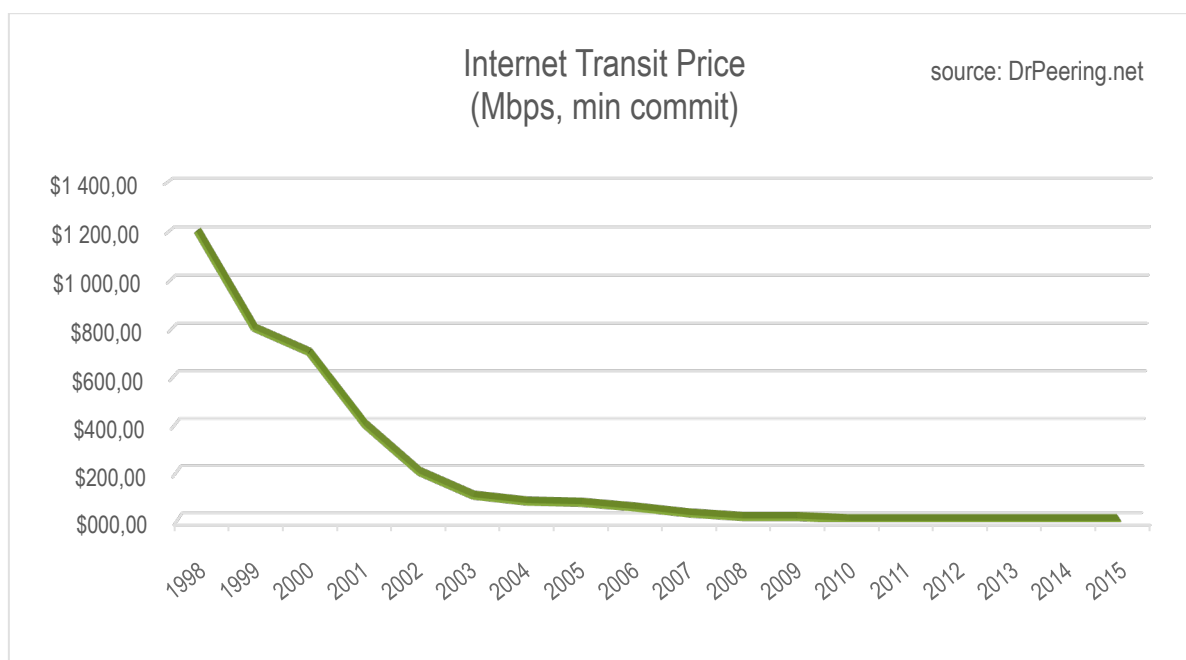
Historical CDN perspective

An introduction to CDN 1.0

The first generation of CDNs emerged over a decade ago to enable web sites to keep pace with proliferating Internet usage and higher access bandwidth. This led to development of “web acceleration” CDNs that cached frequently requested content in servers distributed closer to the points of consumption, to spread demand and reduce latency. It involved deployment of intelligent routing and edge computation, and led to the growth of the big global CDN players such as Akamai and Limelight. At this stage though, the CDN was largely a US phenomenon driven by that country's leadership in Internet growth, with some of the biggest customers being newspapers such as the New York Times meeting increasing demand for fast access to graphics via caches provided by Akamai in particular.

As opposed to mere caching, CDN 1.0 really introduced the ability to handle dynamic, rapidly changing content alongside traditional static material by “pushing” heavy data objects out to the caches in real time. Prior to CDN 1.0, in the very early days of public Internet access from the mid 1990s onwards, web content was almost entirely static, and ISPs would identify elements on their sites that rarely changed and cache them out in servers. They used then emerging techniques such as the Linux based Squid, which is a caching proxy automating the process of offloading frequently accessed web pages to distributed servers, which were much less sophisticated than today. Dialup connexions over PSTNs required even the smallest of optimisations to be carried out.

Figure 1. Internet Transit prices have plummeted



The DrPeering web site the above diagram comes from goes on to explain that ISPs and CDNs will have to morph or otherwise die. « There is simply no margin in Internet Transit services. There had better be some form of premium or bundled services to offer on top of transit services to provide some profit margins. ISPs then act like a convenience store that offers milk below cost so that customers buy the other items in the store while you are there. »

Utilities such as Squid had with very limited intelligence, merely reacting to repeated requests by deciding to store some of the content so that the next request could be served more locally from the hard disk...

The main motivation then was to reduce peering costs in those early days of the Internet, and that is still the case today for geographically isolated and relatively undeveloped "island" territories with expensive connections to the web. Such techniques come under the banner of transparent caching.

CDNs are more sophisticated in that the propagation of content through the network of servers is determined by more advanced algorithms, some of which can now adapt their methods in real time to match changing network conditions, such as congestion at a given router or link.

Cache and CDN based products and technologies have therefore emerged from different stables, but with a lot of crossover and interaction.

Extending CDN 1.0 requirements

In the early years of the new Millennium, as storage capacity and network bandwidth increased, web sites wanted to embed video, but this added two or three more zeroes to the amount of data they had to handle, and at the same time reduced the time available to deliver the content. File sizes increased from kilobytes to megabytes, and maximum time for packet delivery was reduced from seconds to milliseconds.

The emergence of global OTT players

Global OTT players emerged gradually during the noughties, either from major content companies, as Hulu did in 2007, or from DVD rental businesses like Netflix and to an extent LoveFilm in the UK, which was subsequently acquired by Amazon. However, these players provided on-demand content rather than live streaming, which has only emerged quite recently and created demand for yet further improvements in CDN delivery, leading towards CDN 3.0.

Google and Apple joined the fray more recently but already appear as formidable contenders for world OTT domination.

The emergence of Video and CDN 2.0

As video started to be embedded in web sites, CDNs emerged to distribute it, but initially the content was all pre-recorded and delivered on demand. In one sense this meant that video was just a large file of data. An important difference from, say, a chunk of text is that the user may not want to download a video file in its entirety, but may want to stop watching at some point. Therefore even on-demand video requires streaming, and this spurred development of CDNs optimized to deliver it.

Some big players such as Netflix are still building their own CDN, but most OTT players used infrastructure provided by a specialist CDN supplier. Such services fitted the needs of content owners, who paid the CDN to deliver video files bit by bit, and therefore only for the chunks actually watched by the user.

But then came increasing demand for live video streaming, and initially it looked like this would be the end of the road for caching. It appeared that live video could not be cached like previously recorded content, and that therefore, the infrastructure of the CDN must be modified to accommodate high-bandwidth point to point transfers between the source and user. The problem was that the cost involved in building and maintaining live streaming feeds for popular events would be extremely expensive as well as technically demanding.

For “traditional” RTSP based streaming, caches don’t really help

In the early days of video on the Internet, RTSP (Real Time Streaming Protocol) allied with RTP (Real Time Protocol) emerged as the most prevalent protocol for streaming video from web sites, and worked reasonably well, exploiting caching to support distribution of fragments to improve reliability and performance. Sometimes multiple bit rates were used to optimize the user experience for the receiving device.

But RTSP/RTP turned out to have some serious flaws, some of which were first identified by Apple as it developed its streaming protocol. One of the main issues was that RTSP tends to be blocked by routers or firewall settings, preventing a device from accessing the stream. On the other hand HTTP, having been developed specifically as the standard protocol for the Web, is generally accessible. HTTP has other advantages, such as requiring just a standard HTTP server, and involving readily available expertise and a much greater simplicity of client-side development. HTTP is also an open standard unlike Flash video, which was given a boulevard in which to dominate when RTSP showed its limitations. But now even Adobe recognizes that HTTP is an important step forward and after having developed its own HTTP Dynamic Streaming protocol, Adobe is staunchly backing the DASH industry initiative.

In this context HTTP Live Streaming has caught on like wildfire among CDN providers. MPEG DASH is emerging as a strong candidate to unify standards with the support of Microsoft & Adobe. Apple’s attitude is still unclear but it looks likely that their own HLS standard will still be around for a while.

All flavours of HTTP streaming involve server software that breaks MPEG transport streams into small chunks saved as separate files, along with a playlist called a manifest file to tell the Media player client software where to get the files that make up the complete stream. The Media player client merely downloads and plays the

small chunks in the order specified in the playlist. In the case of a live stream, the client periodically refreshes the playlist to see if there have been any new chunks added to the stream.

The protocol also supports adaptive bitrates and automatically switches to the optimal bitrate according to prevailing network conditions for a smooth quality playback experience. In this way the end user always experiences, at least in theory, the best possible quality that the network and the device together can produce, subject to varying bandwidth conditions.

Adaptive Bit-Rate has brought a new lease of life to caching and CDNs

Adaptive Bit-Rate (ABR) has reinvigorated caching and put it back on the centre of the stage for Quality of Experience. It enables a CDN to deliver media streaming, including live content, scalably by replicating the content across multiple Edge cache servers. An end user requesting the stream is then directed to the "closest" Edge server.

There is also an important cost advantage. The use of HTTP adaptive streaming allows the Edge server to run straightforward HTTP server software, whose licence cost is either free or at least inexpensive, compared with costly media server licences for the likes of Adobe's Flash Media Streaming Server. The CDN cost for HTTP streaming media then becomes similar to traditional HTTP web caching. The rise of the data-hungry iPhone that Steve Jobs insisted wouldn't support Flash has also contributed to the demise of Adobe's standard and the rise of HTTP streaming.

Using a Google cache: the kiss of death?

One option for network operators to lower the cost of delivering video content effectively is to allow Google to deploy a cache in your network. After all Google has come as close to perfecting on demand video access for YouTube as anybody, and its network has in effect become a global CDN bigger even than Akamai's.

Before YouTube, with finite content catalogues, caching strategy was relatively easy to define because it could be readily aligned with the most popular content. But YouTube and other effectively infinite content sources make such strategies much harder to elaborate.

Google is experienced in caching through having deployed caches in ISP networks to shorten transit paths and offload traffic, and so putting them into video delivery networks is a natural extension of that. When it comes to YouTube traffic in particular, Google can of course go deeper into proprietary formats and architectures to achieve better results than an operator could alone.

But such deployment carries risks relating to loss of control and ownership, with the possibility that Google may open the cache to other services that the operator had not intended to cater for. Nonetheless some Network operators have deployed Google caches successfully, such as Dhiraagu, the Maldives Telco.

The response from existing Telcos

Telcos need to put in CDNs so as to relieve the stress on service delivery platforms. But this doesn't relieve the pressure on last mile bandwidth.

Therefore Telcos are adopting separate measures to increase bandwidth in the last mile, where at least there is not the issue of contention to deal with since each user has a dedicated access circuit. This usually involves building out fiber, either all the way to the home as in FTTH (Fiber To The Home), or more usually closer to it, as in FTTC (Fiber To The Curb). It is worth noting that despite the claims of fiber advocacy groups such as the FTTH Council, only a minority of homes will have direct access to fiber for the foreseeable future. It will be

many years before FTTH gets anywhere near 100%, except in a few small densely populated regions such as Hong Kong, Singapore or the UAE.

Therefore Telcos will be adopting deep fiber strategies that include technologies that exploit shorter copper loop lengths to increase bandwidth to 100 Mbps and higher, enabling delivery of multichannel HD services, even at 1080p and perhaps the higher resolutions envisaged over the next decade. Alcatel Lucent is one of the key movers here with its vectoring technology that boosts copper performance by cancelling cross talk interference between neighbouring copper pairs.

Such brute-force approaches to the live streaming challenge are limited to densely populated urban areas and are cost-prohibitive elsewhere.

Global Telcos have a different perspective

We spoke to a few global IP operators that were only willing to share some detailed information if they remained anonymous. Their perspective on these issues was not uniform.

Telcos with global operations have different issues. For example much of their CDN “pain” is in mobile networks and not just in the fixed line area.

They note that in less developed markets 3G is only taking off now, but is already in advance of fixed broadband. Unlike in more mature markets like France - where incidentally 75% of the traffic generated by mobile devices is via Wifi on the Home network - usage is driving the rollouts, not technology as it did during the Telecom bubble (see below).

With their longer-term perspective, global operators don't see caching as delivering OPEX savings like small operators do. Over time, only 15% of overall traffic on the network ends up being saved, as content shelf life shortens.

Counter-intuitively, the average traffic per subscriber in peak hours is 1.5 times higher in many developing markets compared to Europe where it's currently 130 Kb/s/client for a 4mb/s connection. So easing content distribution with CDNs would actually be more cost effective in developing markets despite the fact that most of the focus is on developed markets. Clearly peak traffic is the issue as current average backhaul load is about 35 Kb/s/client and expected to move up to 41 Kb/s in 2015¹.

One large-scale operator has also found that although their catch-up TV services are consumed as anticipated overall by their marketers, OTT consumption is higher than expected. On the other hand usage on the TV screen connected to the managed network is slightly lower. CDNs exist to resolve this kind of issue, and there is a growing sense of urgency to deploy something here.

In early IPTV deployments or “TV over DSL” as it was sometimes called, all channels were brought to every DSLAM, but after several years of operation, operators managed to optimise stream delivery by having only the most viewed channels multicast at all times. Others are dynamically added or removed from the list, enabling more and more channels to be made available, including community based channels or UGC. FastWeb (now part of Swisscom) presented this as “intelligent multicast” at a trade show as far back as 2005. We will see at the end of this white paper that the future of CDNs may well borrow from this idea.

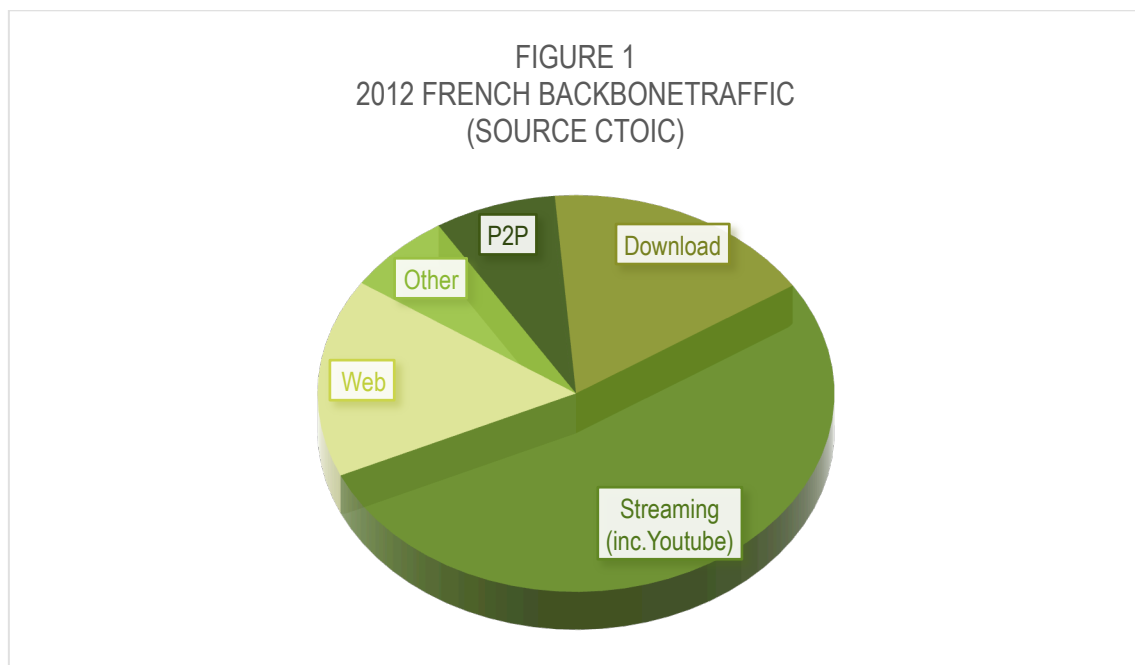
From a global perspective, regulation and scenarios à la Megaupload, where the FBI close down file sharing web sites, increase streaming on legal sites as people shy away from illegal P2P. The urgency for operators to get a scalable CDN in place seems ever more apparent.

¹ All un-attributed figures are CTOiC

Slim Kachkachi, who has been working on [Content Delivery Networks](#) for SFR, France's second largest Telco, told us that in the medium term, Telcos would be going much deeper into the network with their offerings. SFR's current [CDN offering](#) already has 12 points of presence (PoPs) in France, which he believes already puts them in a different league to global providers, most of which have at best one PoP in France. And SFR's 12 CDN PoPs will eventually spread much deeper in the network and grow in number as traffic increases. This poses specific challenges if content is to be cached very far out in the network. Uploading the same piece of content to many thousands of caching servers in real-time requires sophisticated technology.

Most operators agree on a "Moore's Video law" which states that video traffic doubles every 18 months (in some cases every 12). However on the really big backbones of fixed networks over the last 5 years overall traffic growth is closer to 25%. Mobile traffic has grown a bit faster on the backbone at about 33%, but these mobile trends are still too young to interpret meaningfully. 2012 national backbone traffic for a typical major Telco in Europe is 700 Gbps with upstream/downstream splitting on a 1/8 ratio. Looking at these volumes, the 2012 Olympics games had less impact than a new version of iOS does. But this was because CDNs already in place took the strain for the games.

Figure 2. Distribution of traffic on the backbone



Note that the biggest Telcos have been seeing flat CAPEX in their Backbone over nearly a decade now as costs decrease in line with required infrastructure investment.

CDN 2.0 is now reaching its limits

Over time it has become clear that CDN 2.0 architecture has limitations, as the London Olympics demonstrated. The main problem is end-to-end latency and over exposure to events within the transmission path such as congestion, which is even a problem for a CDN network.

Intrinsic limitations in the architecture for live content

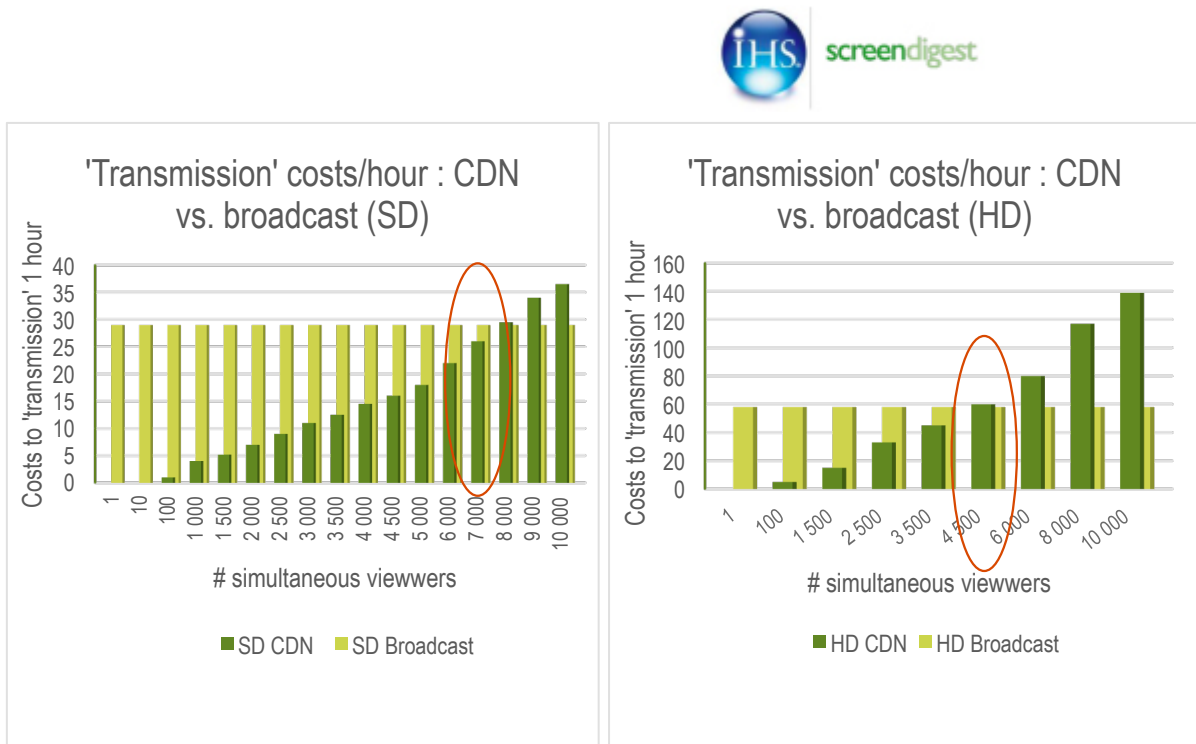
Both NBC and BBC streaming were widely criticized by those who suffered from unwatchable streams. Despite the fact that there were some very happy viewers, the Olympic Games therefore highlighted the shortcomings of CDN 2.0 for guaranteeing the delivery of live video.

Many stories can be found on the web of frustrated fans, like [this one on a Yahoo! Blog](#).

The BBC had a four screens strategy for content streaming during the games, addressing connected TVs, tablets, PCs and mobiles as target platforms receiving the same content but with some differences in presentation and organization. For the BBC the majority of issues related to connected TVs, largely because consumer expectations were higher on big screens, which also make glitches more noticeable. The main problems related to buffering and drifting off live, although the latter affected all screens.

In an IHS Screen Digest presentation dating from October 2012, the following slide shows the relatively low cut-off point where traditional CDN based streaming is more expensive than broadcast. Indeed, from about 4 000 HD viewers or 8 000 SD viewers, in IHS Screen Digest's calculation, CDN costs surpass those of broadcast.

Figure 3. Scalability to channel audience levels is an issue



IHS went on to explain that extending the calculation to all of the UK's live TV viewing, CDNs would cost €1,2Bn which is in turn enough OPEX to provision 5,000 channels via satellite. As we do at the end of this White paper, IHS Screen Digest's Guy Bisson concluded that the solution for OTT providers to reach mass audience affordably is to partner with wired operators.

Business and eggs

Is “Live CDN” an oxymoron?

Without any specific technological solution in place, live OTT behaves like VoD on a network. It is unicast with as many streams being required as there are viewers throughout the network. This imposes an insurmountable scalability limit.

As we have seen CDNs are no longer just about caching large files. We now sometimes talk of “repeaters” that propagate small chunks through the network. Typically any single repeater need only store a few chunks of any video stream.

With a CDN in place, content is only sent to those PoPs in the network where there is an active user. Once a second person starts watching the same live content most of the advantages of Broadcast are delivered almost as if IP multi-Cast were being used.

Another reason why the words “live” and “CDN” go so well together is the unpredictability of live content usage compared to on-demand content. Live content usage also suffers much worse peak consumption issues than on-demand does. Denying access to on-demand content or merely delaying the fulfilment of the request is not as critical as with live content for which there is less tolerance from viewers.

Why more and more operators are building their own CDNs

Slim Kachkachi explained to me that SFR started working on its own CDN technology so as to speed up the operator’s own web portal SFR.fr. In parallel with the evolution of CDN globally, SFR then went from caching images, text and HTML frameworks to caching live TV and Video on Demand for their own TV services both on the STB and mobile and retail devices. Slim was adamant that to deliver the best CDN experience to clients, you first have to build it for your own use as an operator. “Our whole operations team is a finely tuned machine that. I don’t see how a global operator run out of the US can be as reactive on the ground as we are, if a problem occurs say here in France”. But beyond developing business and staying above the mere bit-pipe model, operators like SFR build CDNs because they know that they can do the best possible job at serving their own customers.

Time Warner Cable is in a similar mind-set with its own operator CDN, the difference here being that – for now at least – the TWC CDN is for their own internal use only.

Beyond these strategic or almost philosophical reasons, the balance sheet is a call to action for network operators. Peering & network edge costs have always been a critical issue and CDNs are an invaluable way of lowering costs and becoming more agile.

[The Orange & Akamai strategic alliance](#) is another recent example of an operator and a global CDN provider joining forces to deliver the best possible CDN service.

The OSN example in the Gulf.

Bas Wijne is Director of IS-IT for OSN, the leading DTH operator in the Gulf. He oversees the integration of OTT delivery including hook-up with CDN provider Level 3.

After launching an OTT platform in March, the OSN live streaming went up to 10 live channels during the London Olympics, but has now gone back to a single sports channel. OSN saw a lot more usage than expected during the Olympics with 50% above already aggressive estimates. The OTT service is currently free for existing customers, so the return on investment is in reduced subscriber churn.

Bas told me that his current CDN setup is performing well. He did acknowledge though that OSN is serving a

closed group of people (OSN subs only), and that if OTT were to be available beyond the DTH customer base, the OTT streaming may not be cost effective. “The current business model is going to be way too expensive for content providers like us. One of our main issues is in peering relationships between regional Telcos, so a Multicast solution could potentially overcome this.”

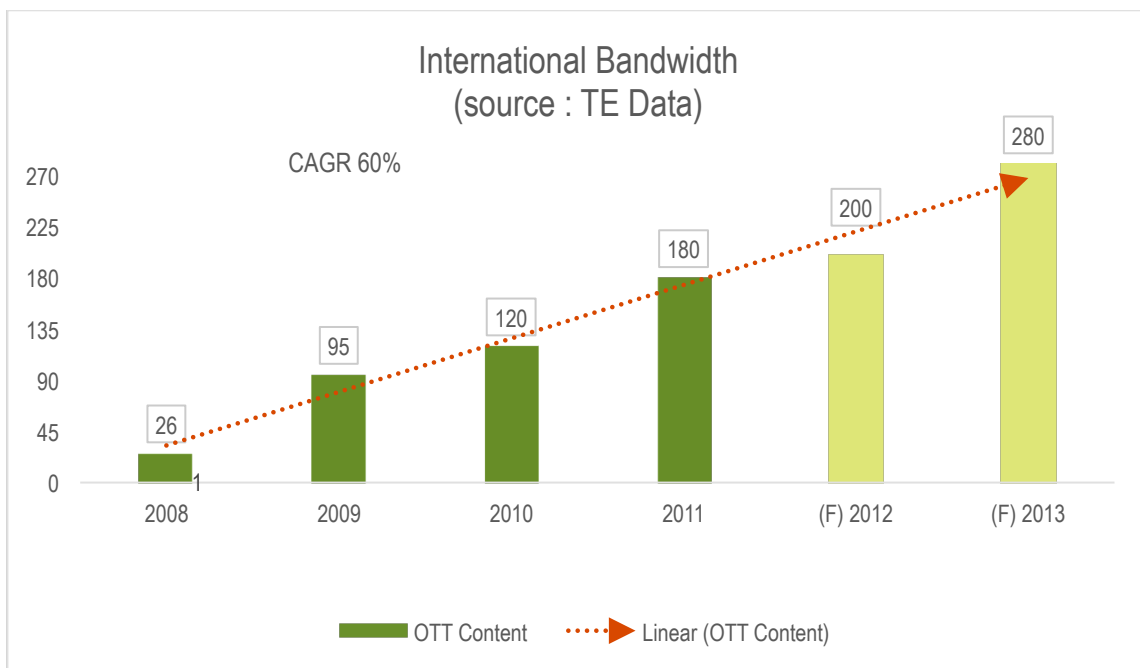
Dumb pipe syndrome

So as we’ve just seen, the need to climb back out of the dumb pipe hole they’ve dug themselves into is a key motivator for operators to build a CDN. The figures below, which Egyptian incumbent TE Data recently made public, show that operators must react and that the dumb-pipe model is not sustainable.

Egyptian incumbent TE Data showed some interesting trends during the TV Connect summit in Dubai this year:

- ✓ 60% Growth in broadband traffic in the coming 5 years
- ✓ 90% CAGR in international Bandwidth 2008-2011
- ✓ 60% CAGR in international Bandwidth 2008-2013
- ✓ Dumb Pipe model not sustainable

Figure 4. OTT Content is hurting Egyptian incumbent



Like most operators, Bouygues Telecom’s primary CDN focus has so far been to improve their own content catch-up and VoD services where security and conditional access pose issues, primarily on the STB. The second motive for Bouygues Telecom to build its own CDNs is the “transparent caching to manage external content providers that fill our pipes.” The goal here is to use this operator-CDN to deliver new billable services for content owners and thus avoid being squeezed out of the value chain. What makes this particularly hard is that Bouygues still want to recruit fixed ISP clients so must offer good YouTube and other similar services. One way forward out of this conundrum would be to review the whole peering landscape at an

international level.

However François Gette, Program Director of Fixed Line Service Architecture told me that it would take less than 8 months to deploy their own operator-CDN “so we can react if needed later ... i.e. if Netflix were to become a threat in France”.

It will be interesting to watch the effect on French operator Free of their on-going dispute with Google, which means that YouTube videos are less fluid for the subscribers of that operator. For a year now both Free and Google have been claiming the other party was responsible for upgrading the insufficient link between them.

On a side issue, although no Telco will openly admit it, building their own CDN can also be a strategy to keep prices of existing CDN vendors under control.

Telecom infrastructure, chickens and eggs

Intuitively one expects innovation to arise to answer a specific market or user need. But more often, in the telecoms space at least, new use cases and innovative services arise after the infrastructure has already been deployed. Both mobile telephony and broadband Internet access are good examples of such services where infrastructure has preceded and - some might say - created demand. This section focuses on this phenomenon, showing how it might apply to OTT. Later on in this paper we will explore how this relates to CDN technologies that are arising and may stimulate a new appetite for live OTT streaming.

During the telecoms bubble of 1997 to 2003, fibre was being laid down at breakneck speed in most cities in developed markets around the world.

Figure 5. Nasdaq Telecommunications index (^IXUT) 1996-2004



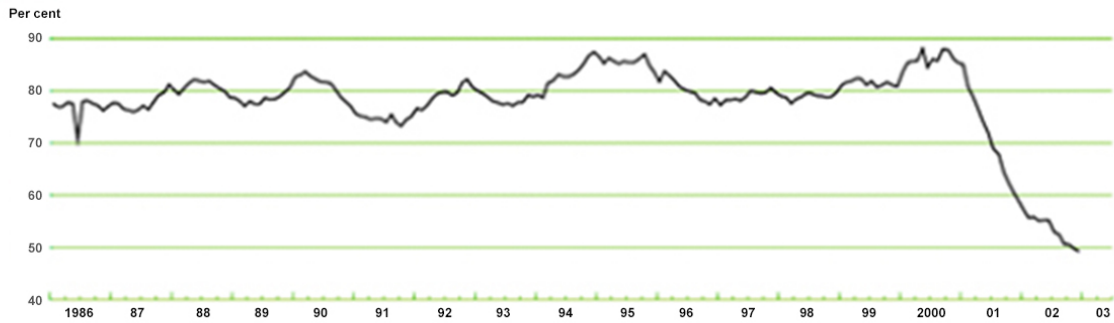
In its report “After the Telecommunications bubble” the OECD explains that the industry was so awash with cash that financing expensive fibre rollouts was never questioned, despite the fact that returns on investment were based solely on “hype”. The bubble finally burst and many companies went out of business. The global market cap of the telecommunications sector lost almost 3 trillion dollars during the dotcom crash.

Once the dust settled after the crash, the landscape had two fundamental differences from before.

- There was fibre capacity to be bought at rock-bottom prices from the remains of some of the companies that lost out.
- Regulatory evolution made the emergence of challenger ISPs viable.

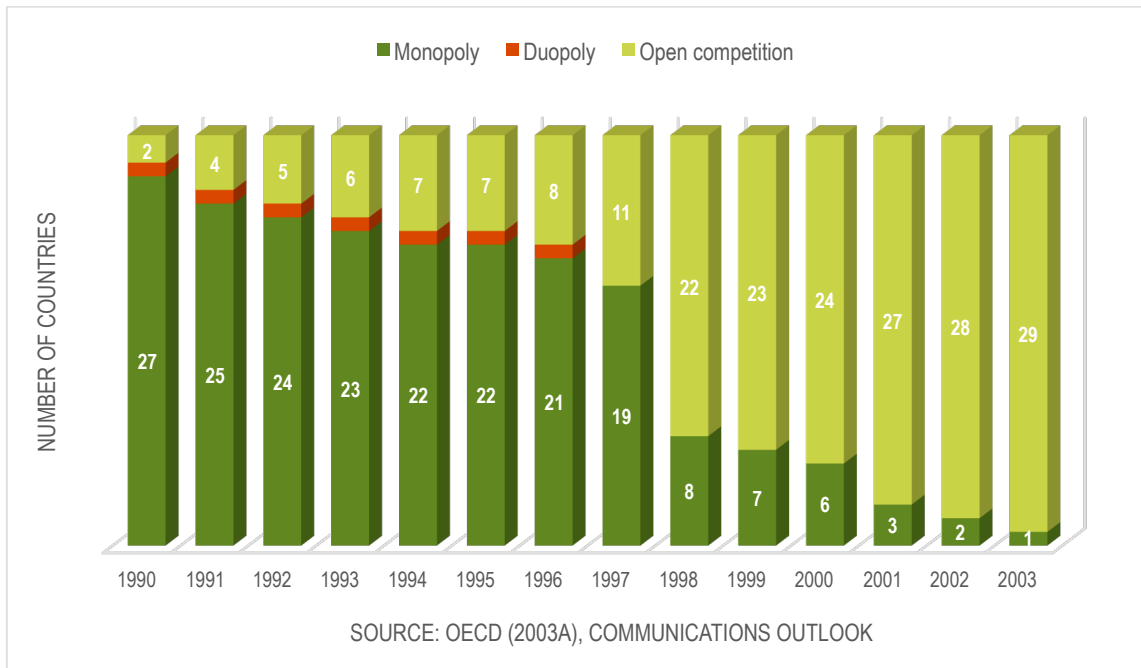
In its report “After the Telecommunications bubble” (<http://www.oecd.org/eco/economicoutlookanalysisandforecasts/2635431.pdf>), the OECD illustrates the over-capacity with the following graph:

Figure 6. Unites States: Capacity utilization rate of the communications equipment suppliers ²



and show the new regulatory situation with this one:

Figure 7. Market structure of fixed networks in the OECD area



². Refers to the NAJC classification 3342, which includes Telephone Apparatus Manufacturing (NAJCS 33421); Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing (NAICS 33422); and Other Communications Equipment Manufacturing (NAICS 33429). Source : US Federal Reserve.

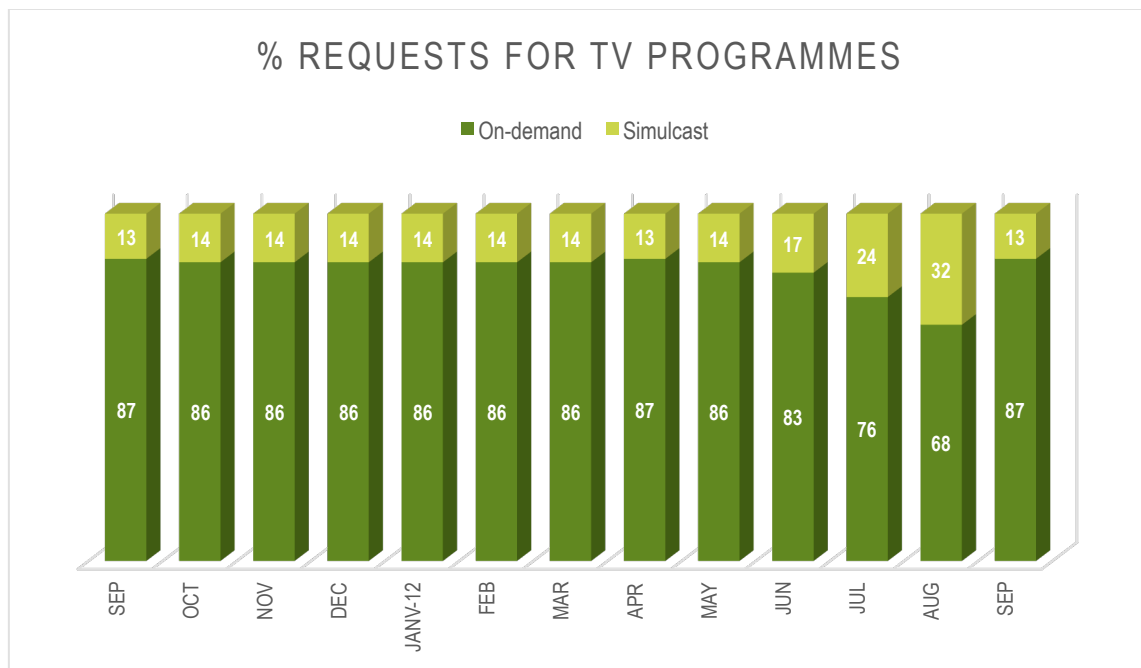
Although technically broadband could have taken off 5 years earlier than it did in several developed markets, service providers could not kick start the market until this excess capacity became available. But five years on, with this cheap infrastructure, the need all of a sudden became apparent.

Similarly in researching this white paper we have found surprisingly few signs that operators are “in pain” over the specific issue of unicast live streaming in 2012. But if we had asked them in 1998 if broadband deployment was a pain point, they would have listened politely and also been pretty cool as they didn’t perceive any associated customer need at the time beyond a few crazy geeks. The valves on data pipes were artificially kept closed. Demand only became apparent once the infrastructure was in place and affordable.

It is our contention that the need for much better and more affordable real time OTT streaming is not clearly perceived by service operators for the same reasons. Once the required infrastructure is in place, however, operators will again release the valves and a new market will take off.

However, content producers like the BBC already appreciate that demand for live content will grow inline with attractive offerings. This was perfectly illustrated by the doubling in demand for live as opposed to on-demand content within the iPlayer during the 2012 Olympics.

**Figure 8. The Olympic effect on the demand for Live OTT streaming
OTT Live Vs. on Demand (Source BBC Q3-2012)**



So while London represented a big advance on Beijing in 2008, the 2016 Olympics in Rio will tell a very different story in terms of live streaming.

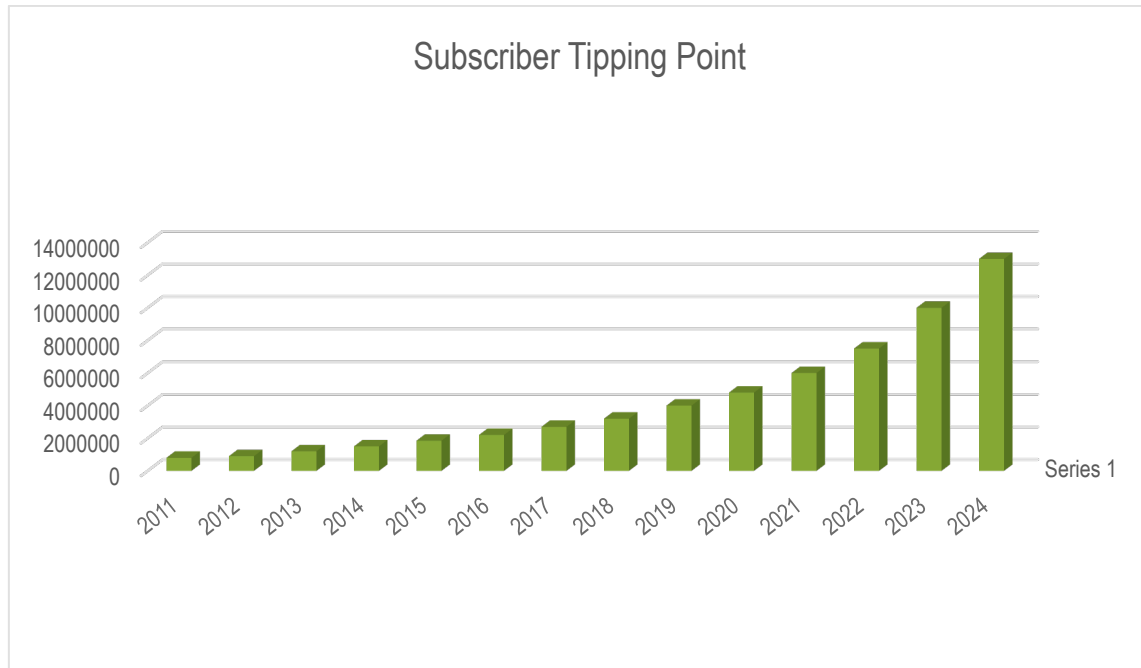
OTT is coming, but is now the time?

According to Simon Trudelle of Nagra, OTT feasibility economics required three things: broadband availability, Adaptive Bitrate Streaming (ABR) and CDNs.

Both broadband and ABR are now available, but for real time content, traditional CDNs cannot yet be scaled up without escalating costs. Nagra calculates that with a 20% annual drop in CDN costs, live streaming could

become cheaper than satellite transmission even for the larger operators with 12 million or more subscribers by 2024. Even today, Nagra calculates that it's already cheaper to stream with CDNs for operators with less than 500,000 subscribers, and also for the tail end of any bouquet. There is a huge gap between IHS Screen Digest's and Nagra's figures, but both show the same trend: CDN technology prices will drop much faster than broadcasting costs.

Figure 9. When is OTT cheaper than Satellite? (Source Nagra)



The main assumptions in this calculation are a 250 channel bouquet, 4 Mbps video, 6h 9m viewing per household, \$3m per transponder per year and \$0,034 per per GB CDN cost. Trudelle points out that this is an academic exercise using list prices. The cost can potentially be 30% to 40% lower for a large Telco that has built its own CDN. He goes on to point out that the opposite is true for smaller operators that don't reach the scale required to justify their own CDN. In this case use of a third party CDN is cheaper.

It is clear that in 2011 we hadn't reached the tipping point. History books may well cite 2012 and the first digital Olympics as that tipping point, but even if that isn't the case, OTT economics are still rapidly improving all the time. So even if 2012 turns out not to be the year, it is virtually certain that all the elements will be in place to ensure that the tipping point is reached in the next two years. Nagra goes as far as to predict that the tipping point will arrive in Q3 2013 and so we would add that that's when we can expect live OTT streaming to rise up on operator's agendas.

Felix Baumgartner's Youtube stunt in October 2012 showed that when the offer is there, the demand gets stimulated and appears.

The analogy of the Mobile telephony or VoIP, both swapping quality for other benefits, gives further arguments why live OTT will come now.

A blocking issue with OTT live streaming is the impossibility to absolutely guarantee service delivery. Currently it seems unthinkable to sell a TV service that could freeze during a penalty shoot-out.

Cast your minds back to the early 90s when fixed lined telephony in most developed countries represented the one service that always worked. It was reliable and consistent. When you got through to someone, the call stayed connected as long as you needed. The network was always available and audio quality was constant throughout the call.

What we have now falls far short with calls dropping, network outages, audio quality variation, ... Yet we are all happy, convinced that 2013 telephony is far better than 1990 telephony was.

That's because with mobility we've gained a new usage, i.e. on the go, and with VoIP we're paying a fraction of what we used to.

So in the same vein, OTT live streaming will become a key part of our video future. As with mobile telephony, users will still demand the best quality that is available, but will accept that there is a trade-off with convenience and ability to watch a wider variety of TV from anywhere. Key technologies enabling the OTT revolution are focussing on service continuity that must be assured as opposed to service quality that can vary more.

The true importance of "live OTT streaming"

Experts disagree over what balance will be reached between ad-funded, transaction-based, or subscription based business models. But all agree that advertising will remain a significant part of the equation. So far no operator has succeeded in making advertisements anything other than annoying with on demand content (having to click "skip ad" before watching a YouTube video was mildly frustrating, but having to watch it all without that possibility is positively infuriating), but somehow consumers have come to accept ads as part of the live TV experience. So if one of the key drivers of the TV business remains advertising, and if live TV is the place it most naturally fits, then if OTT streaming is to have a business model, a significant part of OTT will revolve around live content.

Does live OTT already provide a competitive advantage? Beyond an intuitive answer of « yes of course » it's quite hard to prove this point. It is at least viewed as a necessary "me too" offer to combat churn, and in some cases as a defence against the pure OTT players like Netflix.

When you speak to operators that only have their own controlled TV networks they are nonplussed by the issue. Others like KPN say why not make use of infrastructure that's there, although it's no big deal.

Of course the Pure-play OTT providers see it as critical.

The BBC aired thousands of hours of live content during the Olympics and rightly hails that as an incredible success, but it seems unclear how the Operator should handle the extra cost.

Paul Berriman, CTO of Hong Kong incumbent and IPTV pioneer PCCW, told me "OTT streaming has become merely another Pay TV source. All we are talking about is the delivery mechanism which forms only a part of the Pay TV ecosystem along with sales, marketing packaging, bundling etc. and yes live content/linear content would be considered part of an essential set of content genres if the Pay TV operator, whether with managed pipes or OTT, is to become more successful. Linear and Live TV is what gives Pay TV operators their bread and butter revenues. VOD is icing on the cake and this will be no different whether you are OTT or a managed Pay TV operator."

Here, Paul is providing further arguments in favour of CDN for Operators to differentiate services.

Why local operators will always retain an important role

I went on to ask PCCW's Berriman whether he saw live OTT streaming as a market driven issue, or one pushed by technology vendors, and this was his answer:

"Live OTT is the market taking a window of opportunity due to a low cost delivery technology. However, in going to market successfully, the OTT players will be best served by partnering with traditional, local operators in a hybrid mode because there are so many aspects of successful Pay TV that the OTT technology from some virtual place in the world does not bring. Content localization, dubbing, device installation and maintenance, local sales, market, locally focussed call centres, door to door selling, packaging, bundling with other content and services (broadband), beating local broadband data caps (in some places), local subscriber data for marketing and targeted advertising purposes (location, device, multi-screen), and the list goes on ..."

Another example of a locally strong TV operator comes from Latin America.

Luiz Felipe Taboada, a Telecom engineer from GVT, the Brazilian DTH platform, told me that they are already doing some multicast TV, but that it's limited for now to PiP feeds for subscribers.

GVT is looking into OTT service deployments and live content streams would be a key part of the solution. Indeed "live" content in general is still the biggest part of TV".

GVT is working on an initial use case to support current subs « on the move » on mobile devices. GVT's second use case is for pure OTT to deliver content to TV sets or games consoles without STBs. Here, cost reduction is key.

The threat from other OTT providers like Netflix is taken seriously at GVT, which is why GVT is preparing with CDN solutions to revert to the second use case.

"We're currently looking at a Cisco - Broadpeak solution to deploy our own CDN, as we don't want to depend on a big international supplier. We see our own CDN as a business opportunity to grow with the market in this area and to be able to support OTT services on our current environment. But just as important is to keep our OPEX under control."

So where's the money?

If the BBC's digital coverage of the games was heralded as a wild success in terms of user experience, questions have arisen over the business models. The Guardian's former editor Peter Preston put it pretty bluntly in that newspaper as early as August 12th: "BBC wins gold for Olympics coverage – but don't ask how much it cost".

That question will probably not be answered for a long time, but whatever the answer is, the 2012 Olympics did prove one thing. There was as much demand as there was available capacity. This probably illustrated how cheaper and more plentiful CDN capacity in the future will trigger more demand.

Resistance to change

In this white paper, we stick our necks out about how the future of CDNs will look. But just in case we are wrong, and in the interests of impartiality, here are some key counter-arguments.

As with anything as new and disruptive as live OTT streaming, there are forces that doggedly resist change. Pay TV operators naturally fear that the business model based on a combination of advertising and subscription revenue may be ending for good. At the same time big content owners are wary of letting their most valuable assets loose in the perceived jungle of OTT where predatory pirates are lurking.

It is a well-known law of broadcasting that rights have until now lagged behind technology, highlighted by the slow rate of adoption of network DVR even though the technology has been available for over five years. Pay TV operators may be relieved that rights holders will similarly drag their feet over OTT, but it will only delay the inevitable march towards IP delivery of all content. Meanwhile CDNs will evolve to the point at which the current distinction between managed and unmanaged networks becomes negligible or at least irrelevant.

Bouygues Telecom's François Gette confirmed what others have told us, i.e. that the network cost saving of CDNs is on a downward spiral with raw bandwidth costing less and less, making the CDN case not so compelling. As for the potential improved user experience, this too is losing traction as content providers are doing more and more of their own caching.

Elsewhere in the French market where IPTV operators have honed a walled garden VoD offering over the last decade, they are beginning to see the end of usage growth (network usage for any given operator peaks just below 100Gbps) with a small base of very active users. So one of the key problems plain vanilla transparent caching was designed to fix has stopped getting any worse.

Capping and net neutrality

Network operators that fail to see the potential in providing the best possible OTT experience to their customers may see the whole thing as a threat. If the pure-play OTT providers like Netflix don't find deals to make with network operators, the latter may be tempted to become defensive. This is typically achieved by capping broadband usage at a monthly quota.

You can already experience this in most markets with a mobile subscription where even the high-end options are limited to a few GB per month. For wired connections most caps are still high enough at a hundred GB per month not to limit fair usage of streaming, but their very existence means there is the threat they might be lowered at any time. In any case the bandwidth caps would prevent streaming taking over as the primary medium of distribution to connected TVs, because it would only allow up to two or three hours of HD viewing a day.

A few markets like Australia already have data caps that limit live streaming except with the operators' own streams. Here, net neutrality is no longer adhered to, just like in France where one operator has unilaterally decided to limit the bandwidth allocated to YouTube traffic.

Regulation and content rights

Regulation played a key role in enabling broadband penetration after the telecom bubble burst at the turn of the century. Regulated unbundling increased competitive pressures by letting new entrants in, bringing prices down to affordable levels.

In 2013 regulators are faced with a totally different challenge as the likes of Netflix, Apple or Google want to compete with TV operators. The TV broadcasters and even more the network operators are crying foul to the regulators. Indeed none of these new entrants are paying for the large amount of network bandwidth they consume.

Territorial rights are also hampering several initiatives around the world. Indeed traditionally rights owners like to carve the world up into as many small territories as possible. This maximises their revenue potential, but clearly makes life difficult for global or even regional providers.

The next era for CDNs

Many questions are still unanswered like for example whether some existing linear channels will migrate to a direct OTT only delivery?

But despite the uncertainty, we are now convinced a new era of CDN is upon us.

What CDN 3.0 might look like

Operators are moving away from the strong emphasis on closed network IPTV and there is a clear opportunity to reuse existing infrastructure in place.

Given the chicken and egg situation that we have discussed above, we believe that a major increase in CDN capacities will trigger much more OTT usage, while improvements are needed in both CDN technology and business models.

At present, live streaming has not created too many problems for Telcos because their multicast infrastructures have handled much of the load.

But as the pressure to add more and more channels is still growing along with TV-Everywhere (including mobility), so unicast traffic will inevitably increase as well. After the first CDNs we called CDN 1.0, their evolution to cope with video in 2.0, CDN 3.0 is not only a response to a shortage of resources as a way to prevent Google, Netflix and co from eating your lunch.

Some of the more advanced CableCos like Time Warner Cable (TWC) are already looking into “Multicast To The Home” which could give a preview of what the next generation of CDNs will look like. Charles Hasek who heads TWC’s CDN initiative told us during a conference in Berlin that as long as the home is equipped with a gateway device, “we can use ABR over SPTS (Single Program Transport Stream) to take advantage of our multicast infrastructure. The TWC Gateway device can then repackage the stream into fragmented format. Multicast SPTS reduces unicast traffic on the access network.”

Many industry pundits believe that standardisation is a way forward for operators to cooperate more effectively on CDNs. But as always, standards pose a challenge too: how can we differentiate if we’re all doing the same thing?

One important aspect of CDN 3.0 will be the rise of federated CDNs. Already operators are looking at ways to cooperate on this issue to meet the common threat from OTT players, creating a global CDN infrastructure that can be used to deliver to any platform anywhere. The 4th player in the French ISP market, Bouygues Telecom, told me they are open to CDN collaboration, even with their direct competitors SFR and Orange.

Choosing the best CDN can be based on multiple criteria including the costs, device, bearer (Wi-Fi, LTE, ...), ability to reuse streams already encoded and available in ABR thus limiting head-end CAPEX, ...

Whatever the technology employed, it is already apparent that a common factor here is in bringing the CDN further down the network or closer to its edge.

Whereas all the initiatives we’ve seen will help with on-demand content stored on servers, not many can handle the challenge of live OTT content.

An important development that answers these ideas is the nanoCDN concept pioneered by [Broadpeak](#). This concept was first demonstrated at IBC2012, extending CDN performance and scalability right to the end device by recruiting CPE equipment such as gateways that has storage in the customer’s home. In effect the

access circuit becomes part of the CDN network, which has the effect that end-to-end bandwidth consumption as far as the home remains constant irrespective of usage, even at peak times, and no matter how many devices are accessing the streams within the home. To make this work, Broadpeak modifies the streams at the point of ingest into the nanoCDN, and then within the home network a small piece of software undoes those changes so that the video can be viewed. The concept is easy to trial by putting just a single channel on a nanoCDN to leverage the multicast capacity. Then a single server transforms unicast to multicast for that stream.

A portal accessed by home devices lets subscribers choose content, pointing to a central server that in turn routes requests to the right streams. In bigger trials, if a live stream becomes one of the most popular channels, it automatically gets switched to multicast.

An application on the Home Gateway transforms multicast back to unicast so as to keep the final device (say an iPad) unchanged.

But for 2013 and beyond, operators who have nothing in place when the predicted demand picks up are putting themselves at risk. There were only a few disgruntled viewers of the 2012 Olympics; without Operator CDNs there will be many more by the time the Rio games are here.

For further information, visit the author's web site at www.ctoic.net or the sponsor's web site at www.broadpeak.tv.

