The Internet Video Explosion

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Online video is on the rise – and it's here to stay. Along with it, traffic requirements are continuing to grow as more and more consumers experience HD video content on the Internet. But we are rapidly approaching a point where the current method of distributing video on the Internet will no longer suffice. There are four powerful trends currently shaping the online video market:

> *Video content is moving to the Internet and IP-delivered platforms.*
> This comes as no major surprise with the advent of things like Youtube, Hulu and Netflix. Every day new content is available online that was traditionally limited to the realm of broadcast television or DVD distribution. But in addition, even private distribution networks are converting video content to digital files and streaming them via IP.
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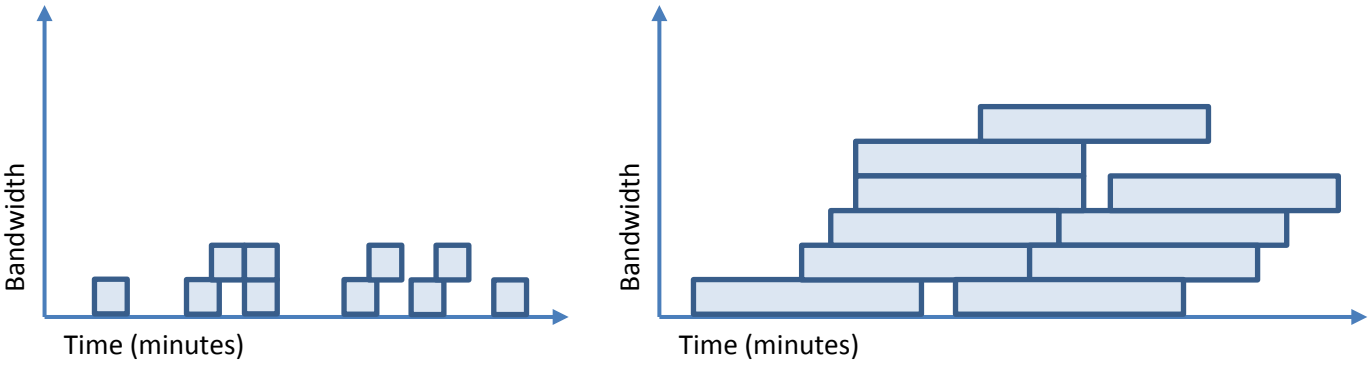
> *The quality of IP-delivered video is increasing.*
> A few years ago we were all quite happy to watch 90 seconds clip of grainy, pixelated video on Youtube. Now we expect full-screen, high-definition video. 3D is next.
>
> *Users demand an experience as good as, or better than traditional distribution formats.*
> Sitting and waiting for a video to buffer before you could start watching it used to be annoying, but acceptable. But as IP-delivered video is now displacing traditional video distribution systems, consumers expect a better experience.
>
> *Consumers of video are moving towards an on-demand rather than a broadcast model.*
> Users are no longer happy with seeing flipping through channels to see "what's on" … rather they want to watch what they want, when they want it.

These forces are converging on a reality where the methodologies we use to deliver video over IP networks and on the Internet will no longer be sufficient to meet the growing demand.

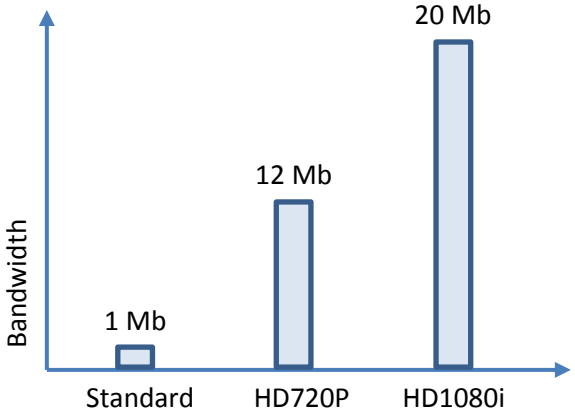
Video content uses exponentially more bandwidth than browsing even the most demanding website. The reason for this is simple: downloading data takes time – it takes a certain amount of time to download a high definition image. A single HD image contains more data than most entire web pages. But a high definition movie is a *stream* of images, usually 24 or 30 of them per second! Add in some audio, and you've got a lot of data to push down the pipe. Furthermore, a website is transactional, meaning that you request the page, and it downloads to your computer. It sits there, displayed on your

screen, until you go to another page. But with video, even if you're not actively doing anything, there's a continuous stream of that large image data. So not only does each user use more bandwidth, the number of users it takes to reach "peak" usage is actually decreased. Let's take a look at this graphically:



In this chart, we can see that 10 users are accessing a website during a particular time period. Because they're not all accessing it simultaneously, and it only takes a few seconds to download the data, the "effective" peak number of users accessing the content during this time period is 2. But then take a look at the same 10 users accessing a typical video file during the same period of time, requested at the same point in time over that same 5 minutes. They're still not all requesting it simultaneously, but because it's still streaming long after they've initially requested it, the "effective" peak number of users accessing the content during the same time period is now 6.

So video distribution platforms, simply because of the format of the medium, require the ability to handle more simultaneous users than if that same number of users were accessing other web content. But that's not all:



Not only do we have to handle more users (to handle the same number of users), but each user consumes more bandwidth by an order of magnitude! Going from Youtube-like video to high definition video doesn't just double bandwidth, it multiplies it back a factor of 20 times.

If you combine all these factors, you quickly find that the amount of bandwidth required for delivering high-definition, on-demand video bandwidth requirements scale to massive amounts with a relatively small number of users.

But wait… small number of users? Youtube gets a billion hits a day!!

It's true – today's video sites have enormous traffic and a fantastic number of users accessing their content. Youtube claims to serve 2 billion videos per day, and every minute, 24 hours of new content are uploaded.[1]

These numbers are impressive. But remember that Youtube, by way of Google, has one of the largest Internet backbone networks in the world at its disposal. It's estimated that Google operates 36 massive datacenters of its own[2], filled with multi-thousand server content distribution clusters[3]. Multiple terabits per second of traffic flow through these datacenters, and the infrastructure required to do this pushes the limits of current network technology. Very high capacity 100G Ethernet is just starting to become available, but if it were commonly deployed, this would give us a 10X capacity increase on where we are today.

According to Comscore's most recent report, all Google video sites combined, including Youtube served a total of nearly 145 million unique viewers in December 2010[4]. But relative to the numbers of users watching broadcast or pseudo on-demand video via traditional distribution methods, these are miniscule numbers indeed. Remember that this was the cumulative number of viewers through a month-long period, many viewing content no more than 30 seconds in duration. Apply this back to charts 1 and 2, and stretch that 5 minute period to a month-long period, and you can see how the short video vs. long video difference in "effective peak" looks remarkably similar to that of static vs. rich media content in those same charts. 145 million viewers of short duration content, spread over a month, might result in the same "effective peak" needed to handle 15 million simultaneous viewers.

Let me stop to say that the bandwidth required for 15 million viewers watching simultaneous video is staggering. A typical low-definition video stream of 1 Mbps would result in 15 terabits per second of traffic. That's 1,500 10G Ethernet connections, or 150 100G Ethernet connections. But make this high definition video – and depending on codec – you're talking about 15-20 Mbps per stream. That means

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[1] http://www.youtube.com/t/fact_sheet
[2] http://royal.pingdom.com/2008/04/11/map-of-all-google-data-center-locations/
[3] http://en.wikipedia.org/wiki/Google_platform
[4] http://www.comscore.com/Press_Events/Press_Releases/2011/1/comScore_Releases_December_2010_U.S._Online_Video_Rankings

potentially 30,000 10G Ethernet connections, or 3,000 100G Ethernet connections! Remember that 100G network links are still in trial and not yet in production in meaningful numbers[5].

So we've established that the bandwidth required to serve 145 million monthly viewers (effectively 15 million simultaneous in an arbitrary estimation) of short duration video content is enormous. Now remembering the short vs. long media content difference, and the need to have infrastructure capable of supporting the peak simultaneous viewership, if we assume that these 145 million viewers are instead watching feature-length HD films then the bandwidth required for these users increases by an order of magnitude. How much? If we assume that each of those 145 million users watches only a single hour-long program each week in the evening, and assume that the same number of people watch a program on Monday as on Friday, then we have over 19 million simultaneous viewers. We're already at 3,800 100G Ethernet connections – still not deployed in production.

But let's take this one step further. The latest Nielsen statistics estimate that the average American watches 31 hours of television per week. If we assumed that even 10% of this video was delivered via IP networks like the Internet, we're suddenly contemplating a different level of bandwidth requirement altogether. In the U.S. alone, this equates to 133 million hours of content viewed per evening, and given that the average household is viewing 2.4 programs simultaneously, this very conservatively equates to 1.33 Billion megabits per second, or 13,300 (yet-to-be-deployed) 100G Ethernet connections. Just for the United States, and just for 10% of the average nightly viewership.

These staggering numbers prompt what might perhaps be the most important question: will online video be a replacement for traditional video distribution mediums, or will it become a medium unto itself? Online video is certainly increasing, with the number of people watching video online increasing by double-digit percentages each year[6]. An analysis of Comscore reporting for the past few years also shows that the trend is towards higher-definition, longer-content video[7]. Hulu has become a television alternative for some viewers[8], and feature-length films are available on the likes of Netflix. While the content may be the same as on television and in the theater, the viewing habits of online video users are markedly different.

[5] http://www.datacenterdynamics.com/focus/archive/2011/02/ciena-and-renater-push-lhc-data-over-100gbps-network
http://www.lightreading.com/document.asp?doc_id=188835
[6] http://www.marketingcharts.com/television/online-video-growth-fueled-by-the-young-4523/
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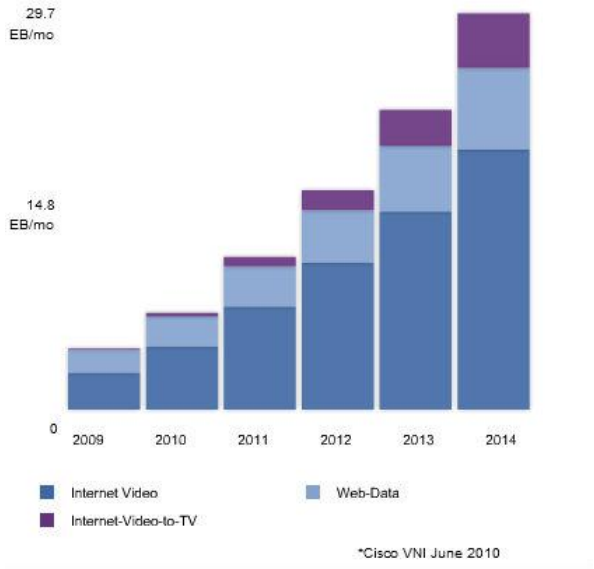

Cisco VNI gives us a forecast of predicted future traffic growth, based on historical data captured from users. The above chart shows standard Internet web traffic in light blue – traffic that just manages to double in 4 years. The dark blue reflects the growth of Internet video traffic, which by 2014 will represent the majority of overall traffic. But perhaps most interesting is the exponential growth in the third category – Internet Video to TV. This traffic grows by over 15X during the same period, which suggests serious implications for the future of online video. This data is echoed in the results of a recent survey, where 38% of online video users said they were interested in connecting their TV to the internet to watch online video[9].

Significant infrastructure challenges exist in the widespread adoption of HD video online. While thus far we've managed to keep up, if the Internet truly became a replacement distribution method for traditional HD content an entirely new model would be required. Perhaps the real answer is that the financial model will be the limiting factor – will traditional advertising revenue support the infrastructure requirements of online HD broadcast video? Or will video content be mirrored out to local distribution points in an effort to lessen the demands on the network?

[9] http://gigaom.com/video/half-of-internet-users-watch-online-video-every-week/
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