

# Double Double Toil and Trouble Bandwidth Grows and Congestion Bubbles

Will Law | Chief Architect - Media Division | Akamai

Friday 13<sup>th</sup> Dec 2013





2.6 TB

Content Delivered by NetStorage



849.7 GB

Content Uploaded to NetStorage



162.5 TB

Data Served to Users



5.7 Million

DNS Requests to Enhanced DNS



23.9 Million

DNS Requests to Global Traffic Management



3,200

Equivalent Number of Blu-Ray Discs Delivered



57 Million

Financial Services Page Views



2.2 Million

Gaming Page Views



7,600

Hours Of Video Streamed



63.7 Million

Live Streams Delivered



2.5 Billion

HTTP Requests Delivered



3.2 TB

Live HD Video for iPhone Delivered



16,472

Hours Saved by Akamai vs Public Internet



147.4 TB

HTTP Data Delivered



10.4 TB

Live Video Delivered



2.8 Million

NetSession Clients Online



4.6 Million

News Page Views



8,500

Objects Purged



2.2 Billion

Log Lines Written



2.8 Million

Mobile Page Views



2.6 Million

Public Sector Page Views



12 Million

Retail Page Views



13.5 TB

Secure HTTP Data Delivered



87.2 Million

Server Mapping Updates



26.3 Million

SSL Page Views



862.2 Million

SSL Requests



1.9 Million

SureRoute Traces

To accelerate innovation in the hyper-connected world by making the Internet fast, predictable, scalable and secure.



# The Explosion of Media over IP



Today

- 700 million video users
- 10 mins of video daily
- 1000 Kbps

↓  
5.4 Tbps

x3=

x12=

x7.5=

x270=

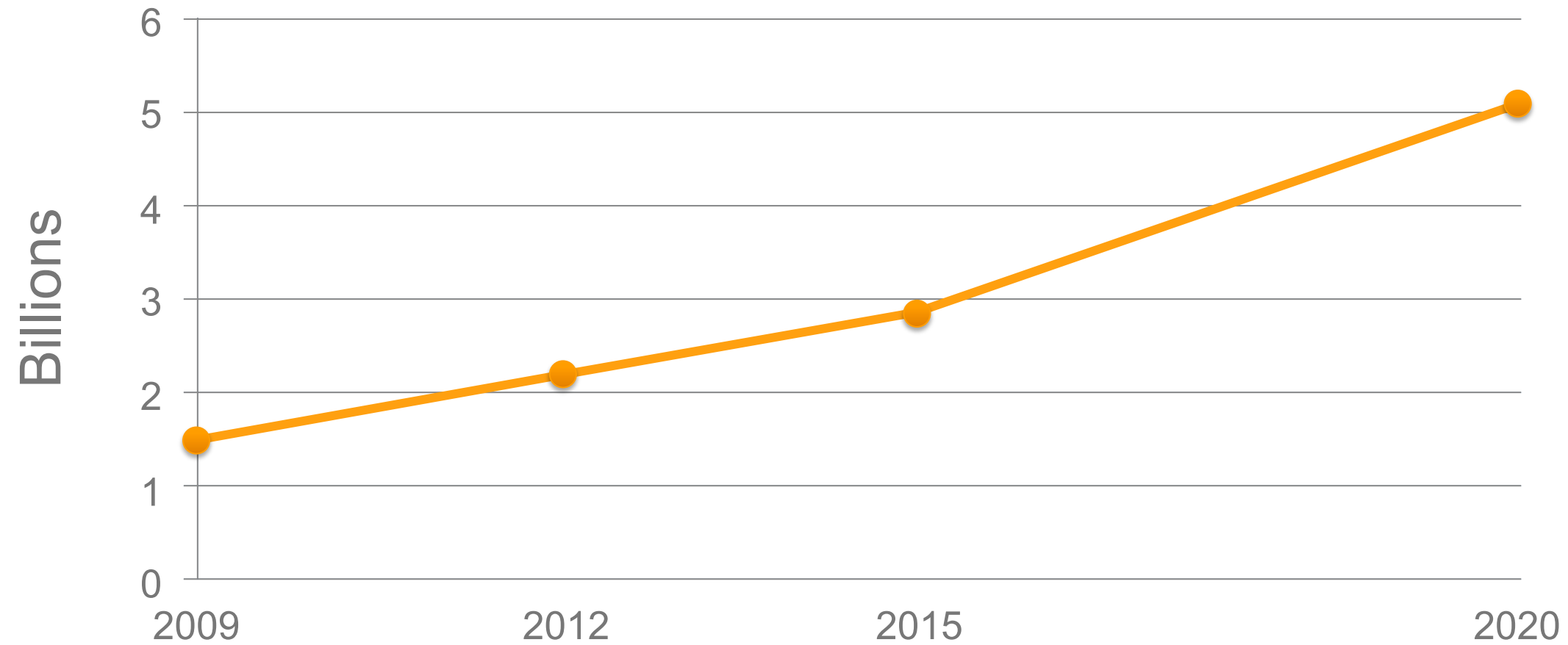
Future

- 2.1 billion video users
- 2 hrs of video daily
- 7.5 Mbps for hi-def content

↓  
1,296 Tbps



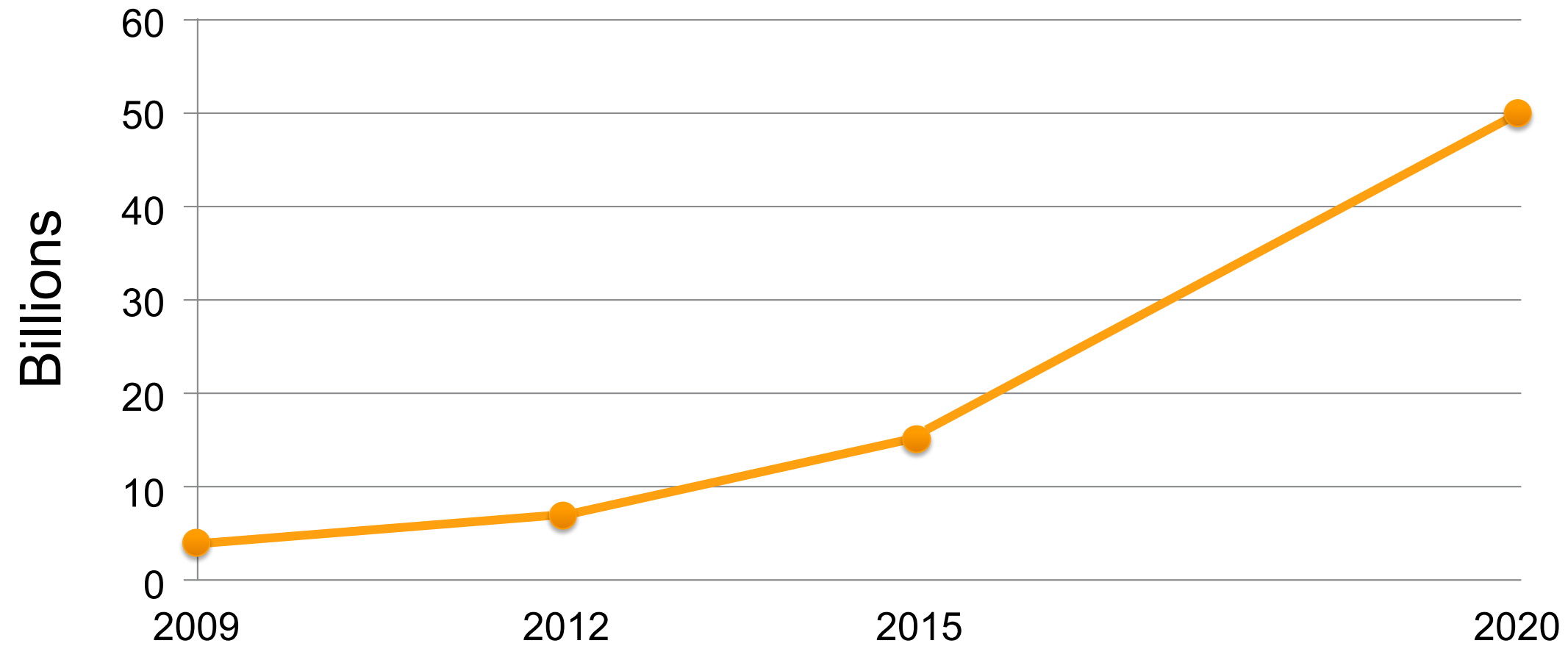
# More People online...



Sources: eTForecasts, Internet World Stats, National Science Foundation, Akamai Estimates

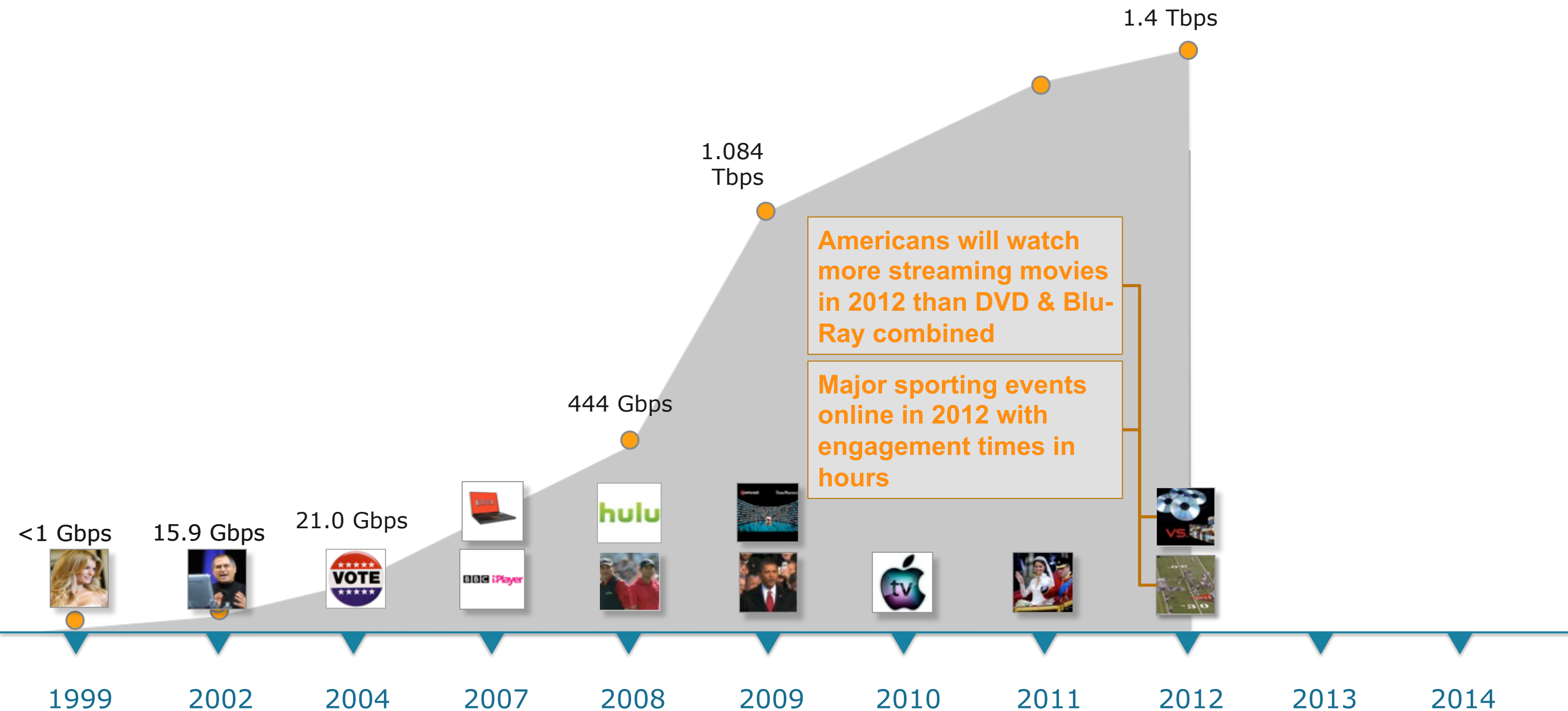


## ...On More Devices...





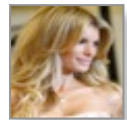
# Evolution of online video



# Revolution of TV Online



Continued  
Exponential Growth



1999



2002



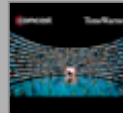
2004



2007



2008



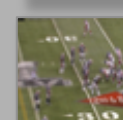
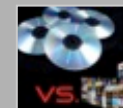
2009



2010



2011



2012

2013

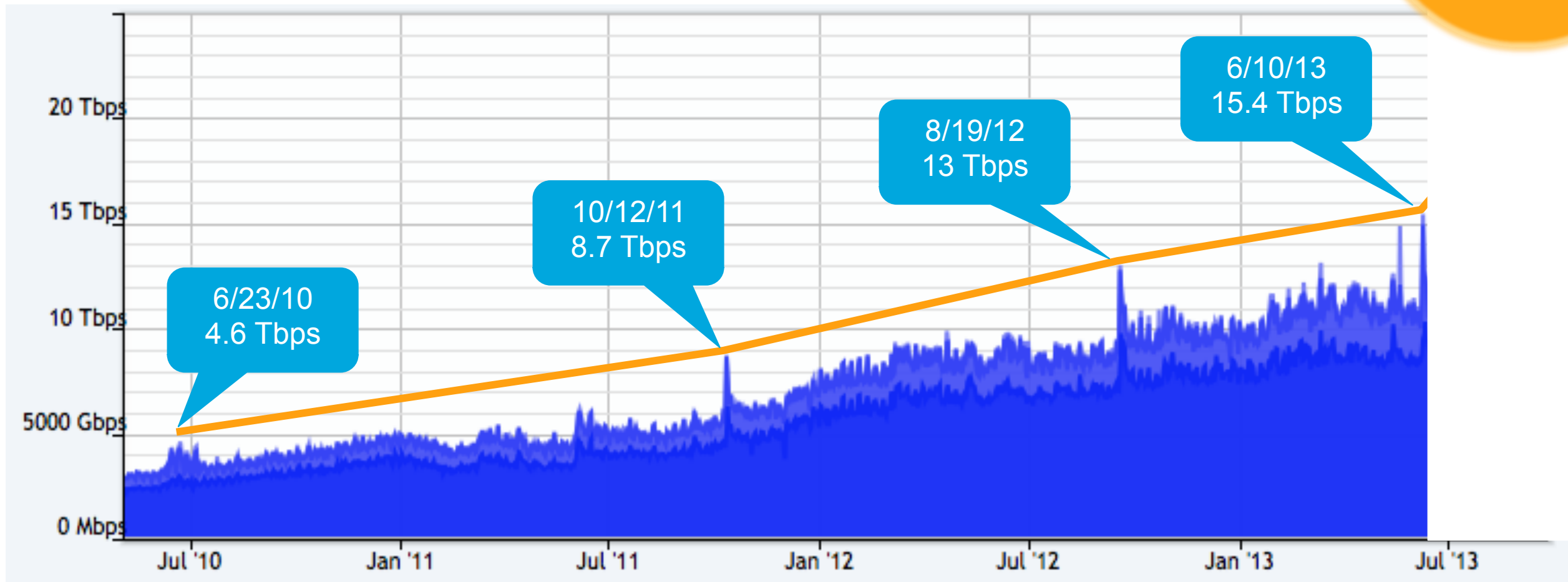
2014+



# Traffic growth



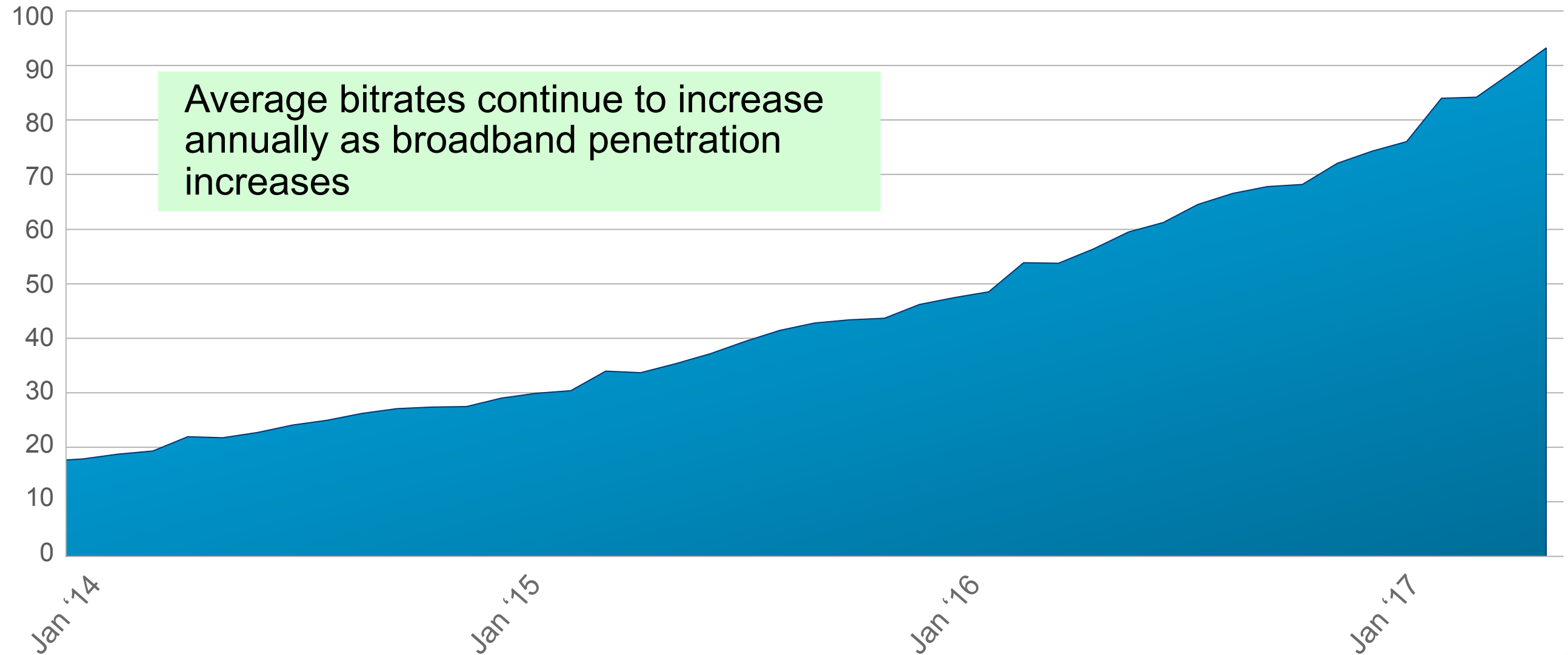
**9/18/13**  
**21.6**  
**Tbps**



# Preparing for Significant Delivery Growth



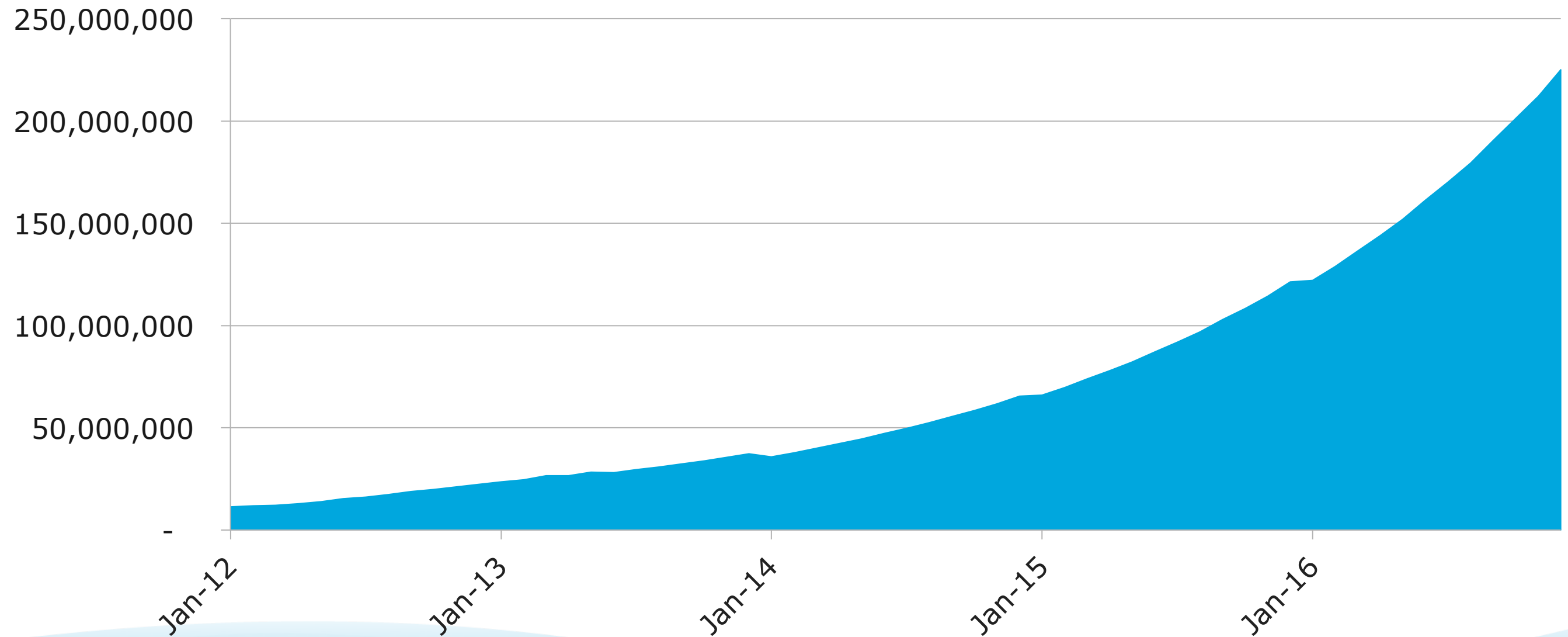
## Akamai Expected CDN Traffic Rate (Tbps)



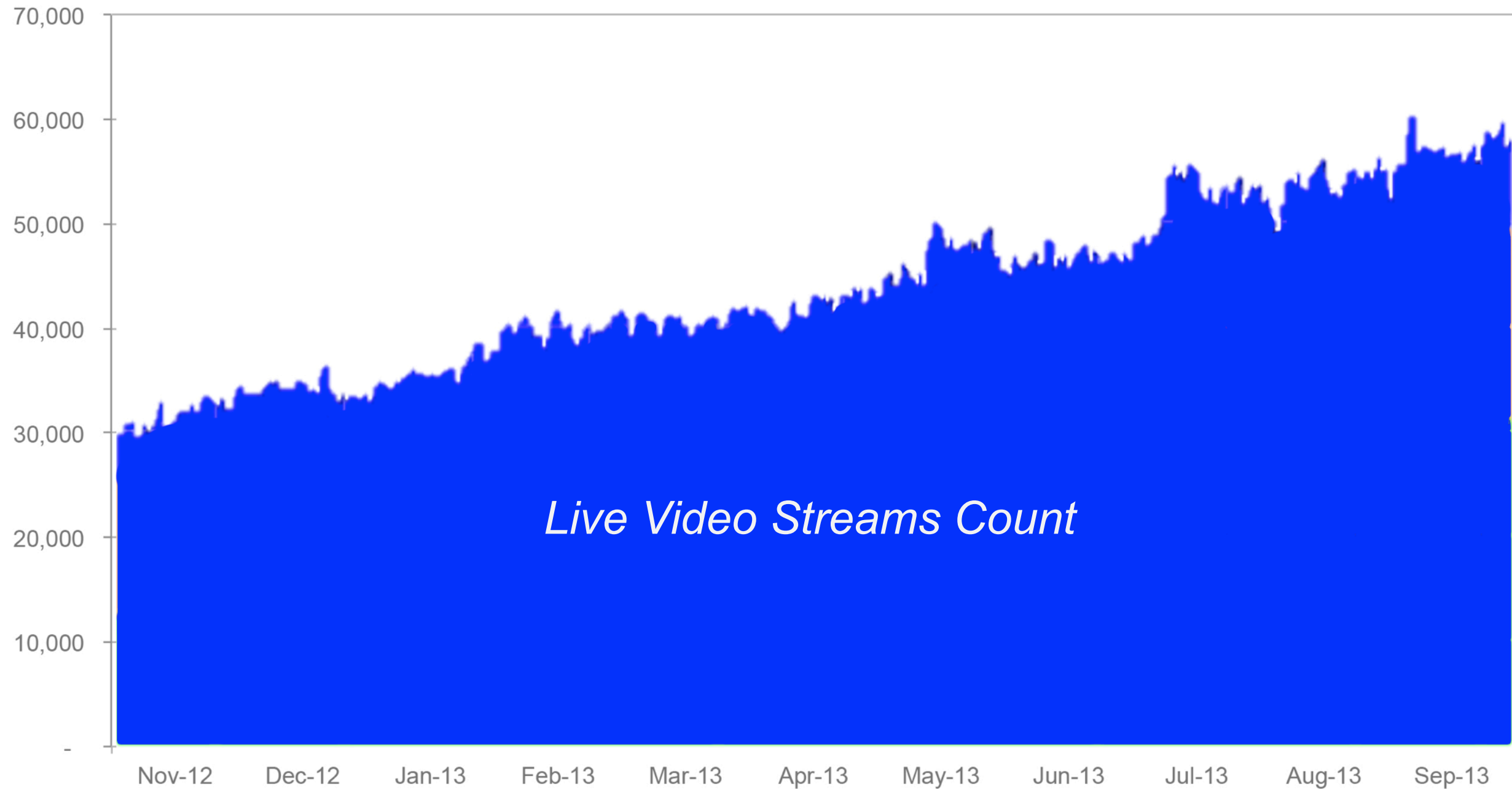
# Preparing for More Content To Come Online



**Akamai Projected Monthly GB Stored**



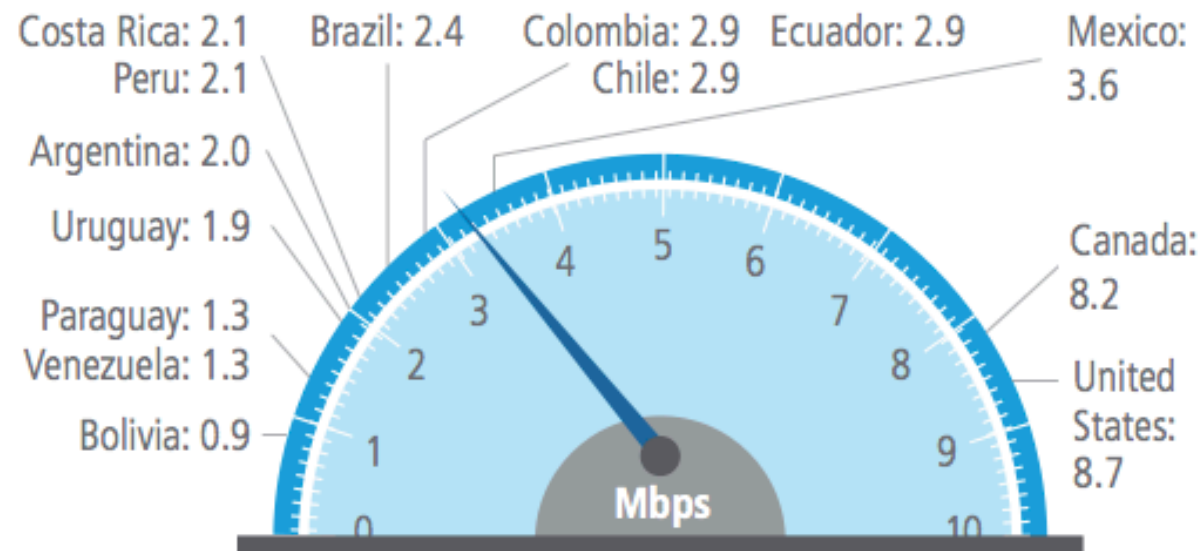
# Live Video Is Exploding Online



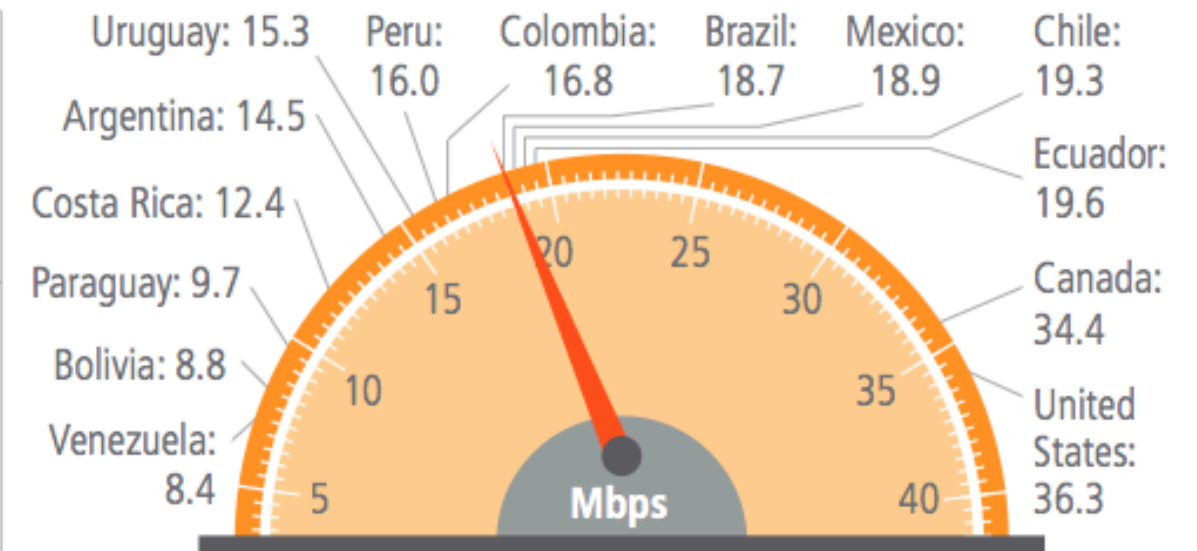
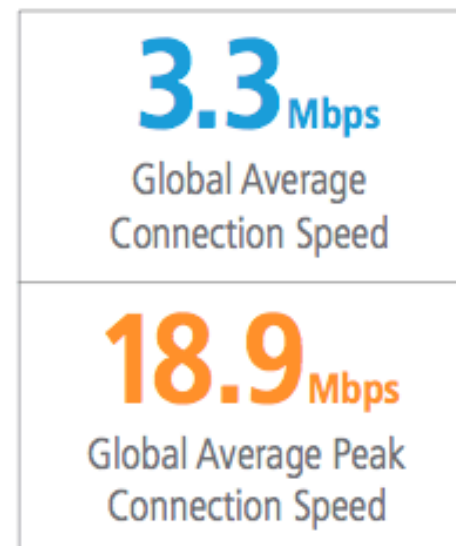
# Connection speed data – Q2 - 2013



In the second quarter, the global average connection speed increased 5.2% to 3.3 Mbps, and the global average peak connection speed increased 0.1% to 18.9 Mbps. Across countries in the Americas, quarterly changes across both metrics were generally positive.



Average Connection Speeds, Americas

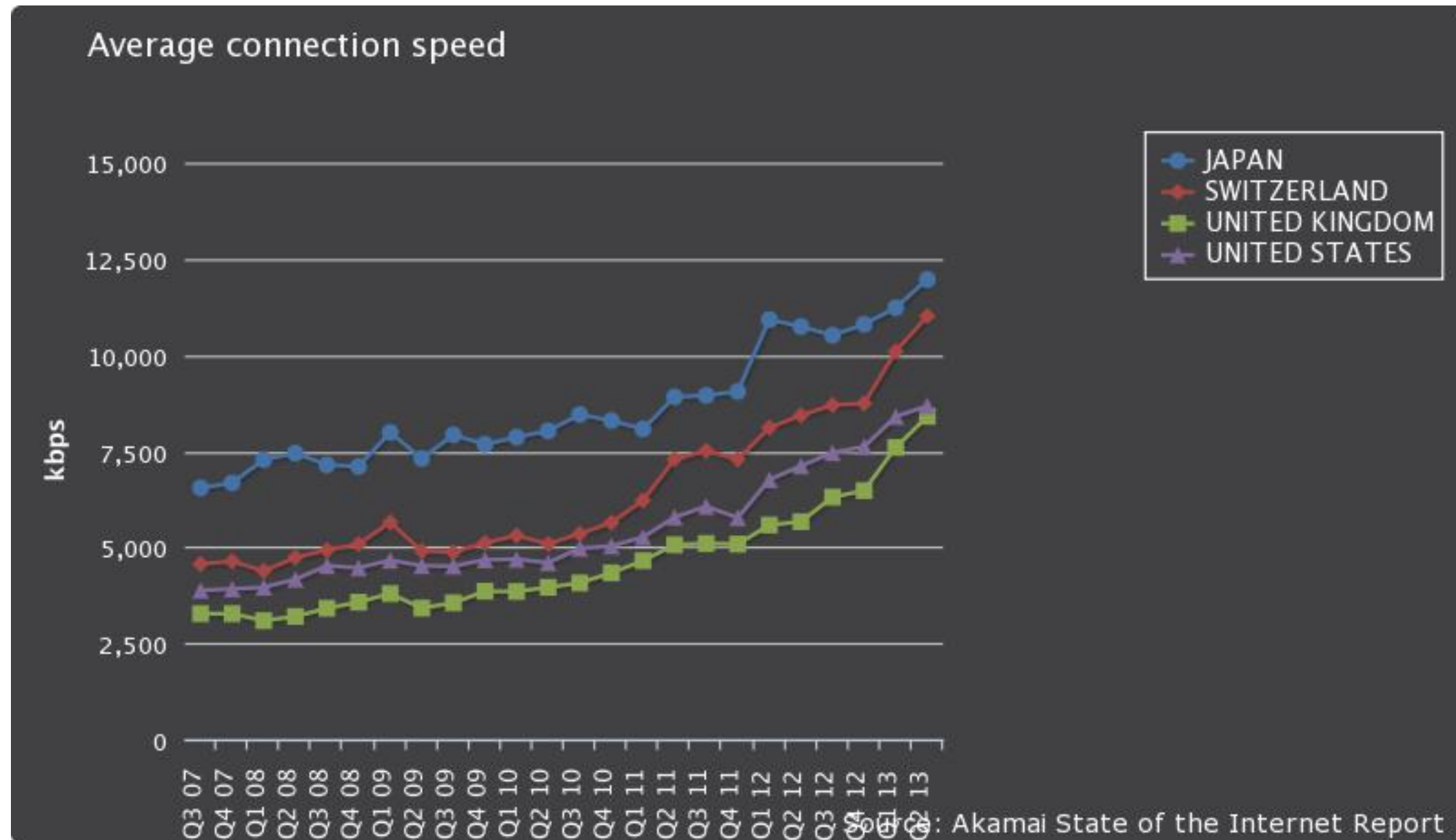


Average Peak Connection Speeds, Americas

<http://www.akamai.com/stateoftheinternet/soti-visualizations.html>

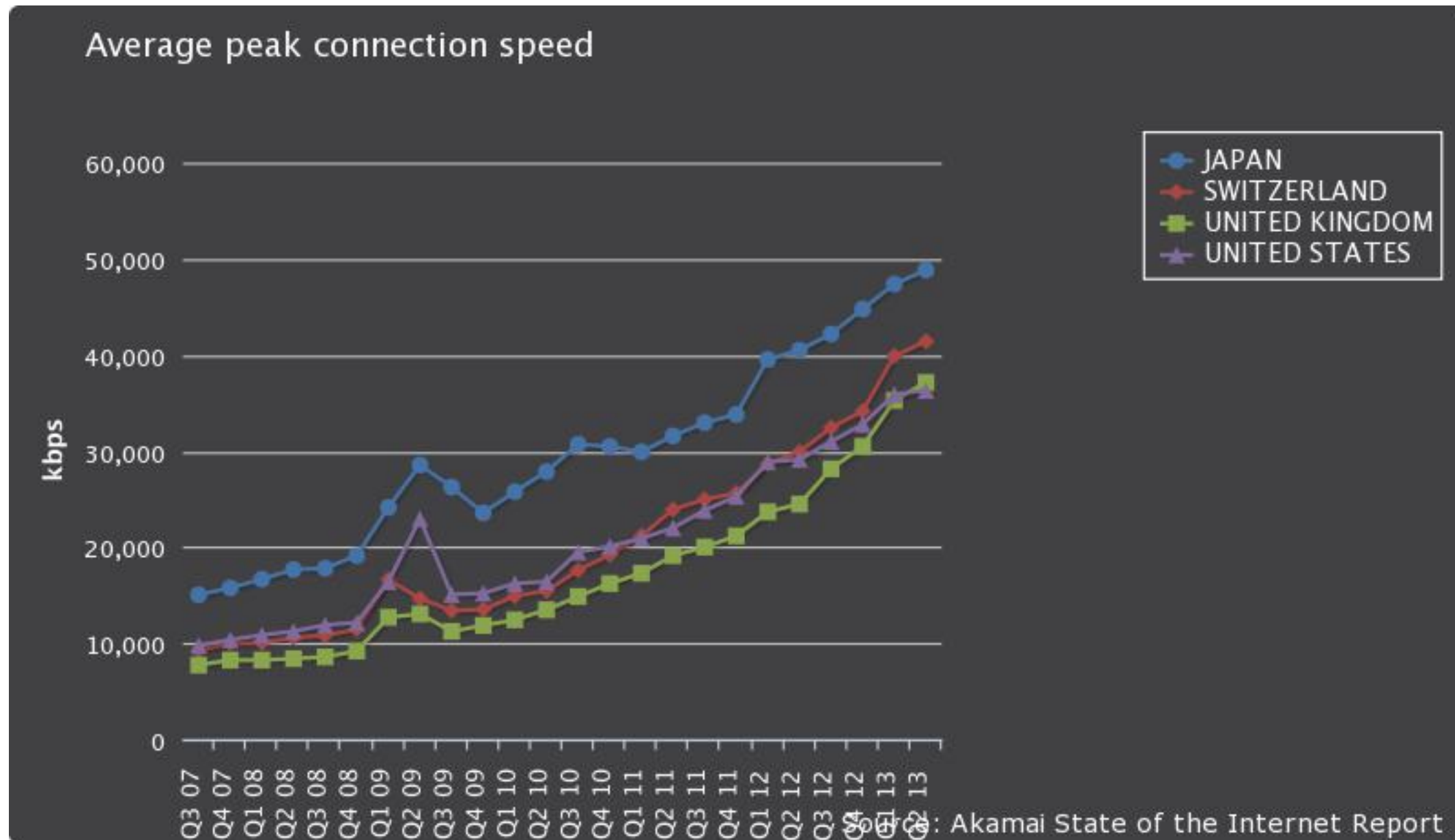


# Growth in average connection speed – last 7 years

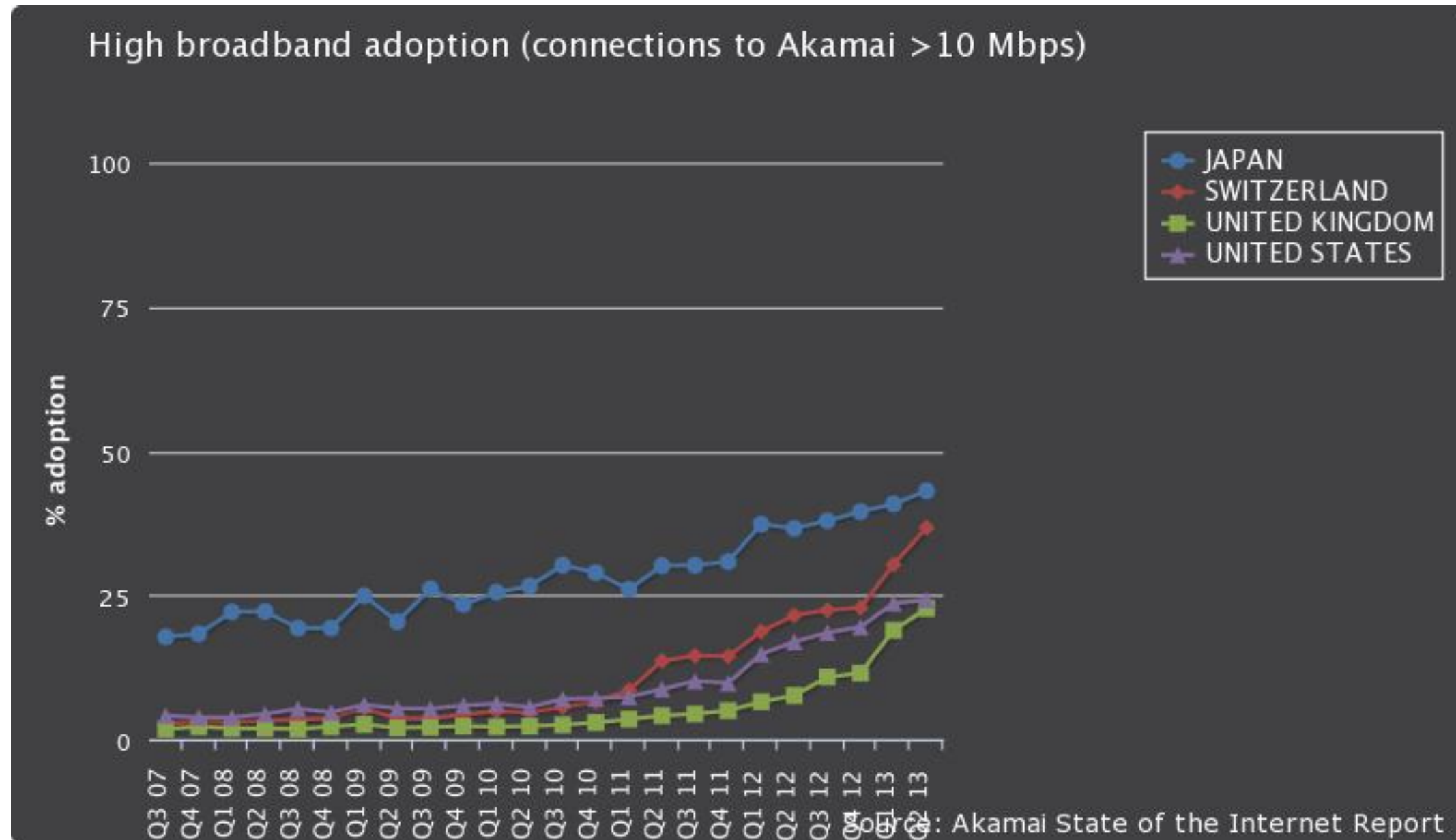




# Peak connection speed

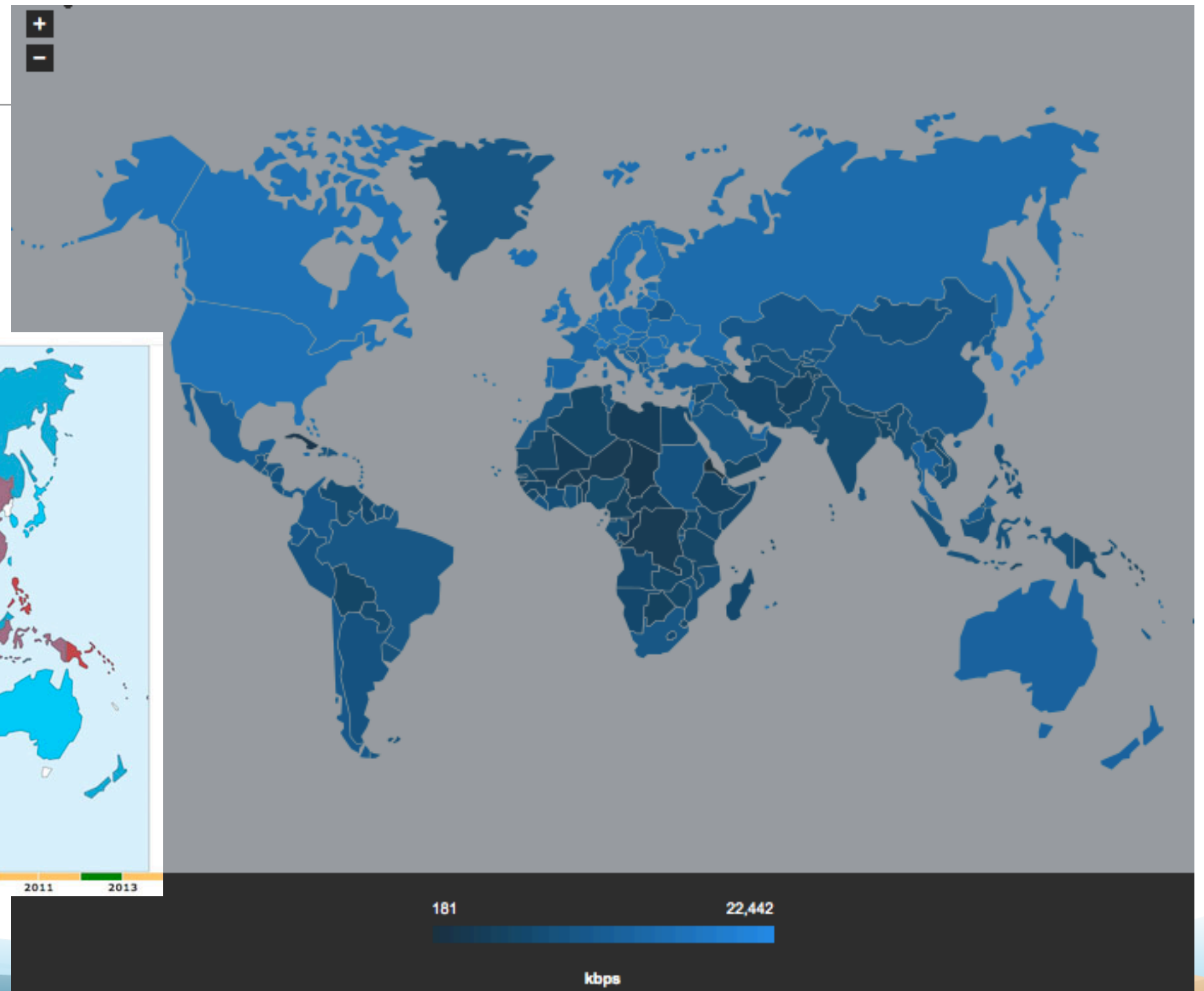
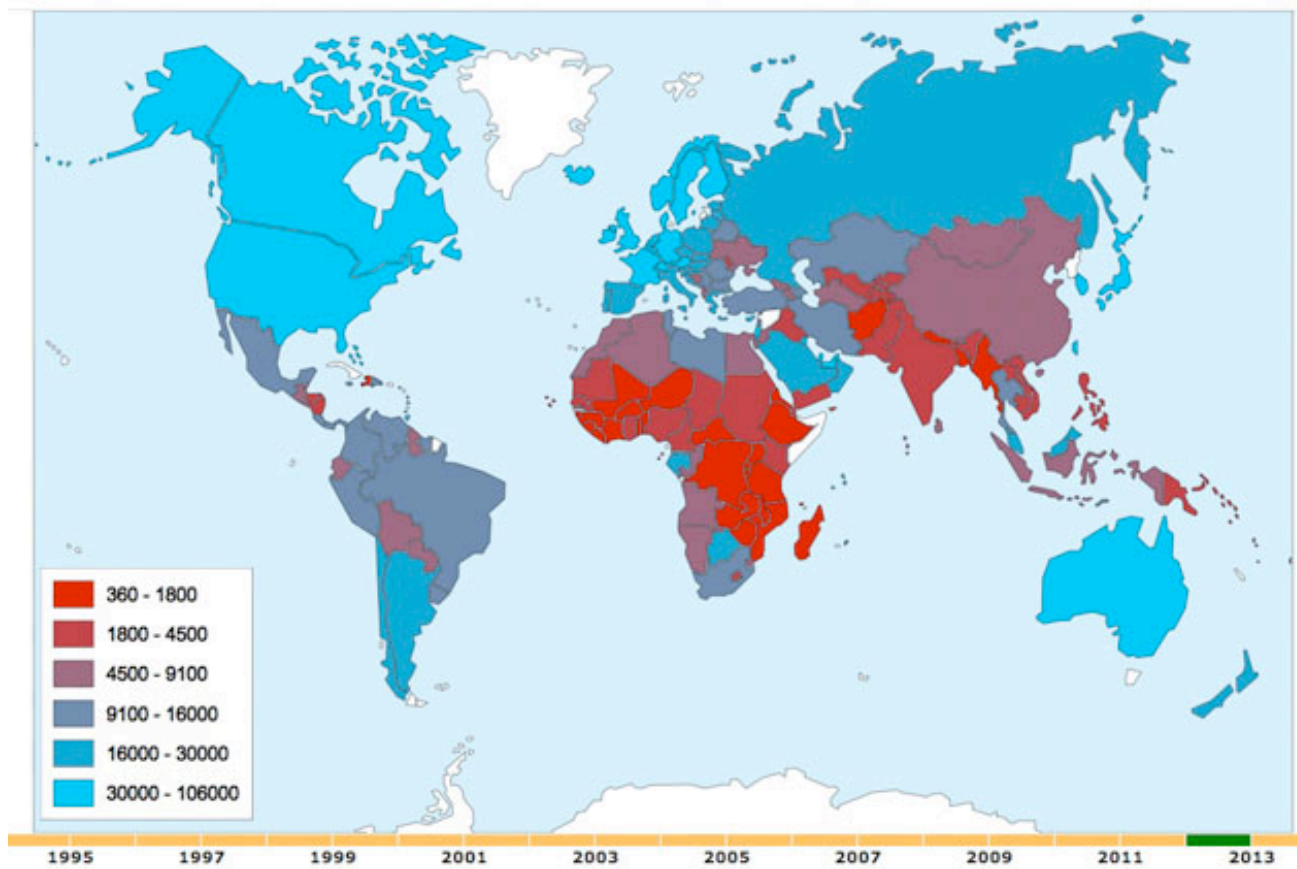


# Percentage of users with > 10Mbps connectivity

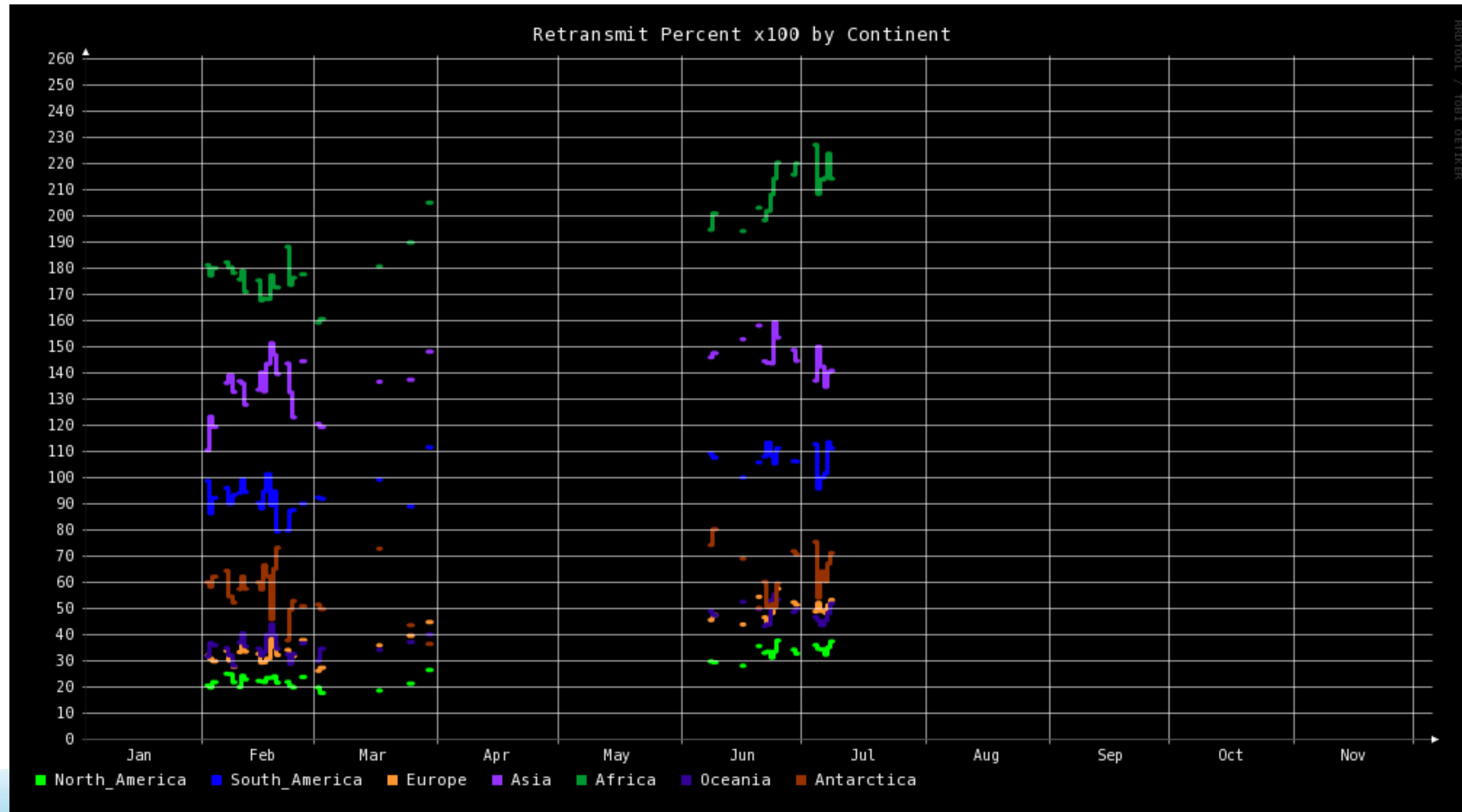


# Connection speed

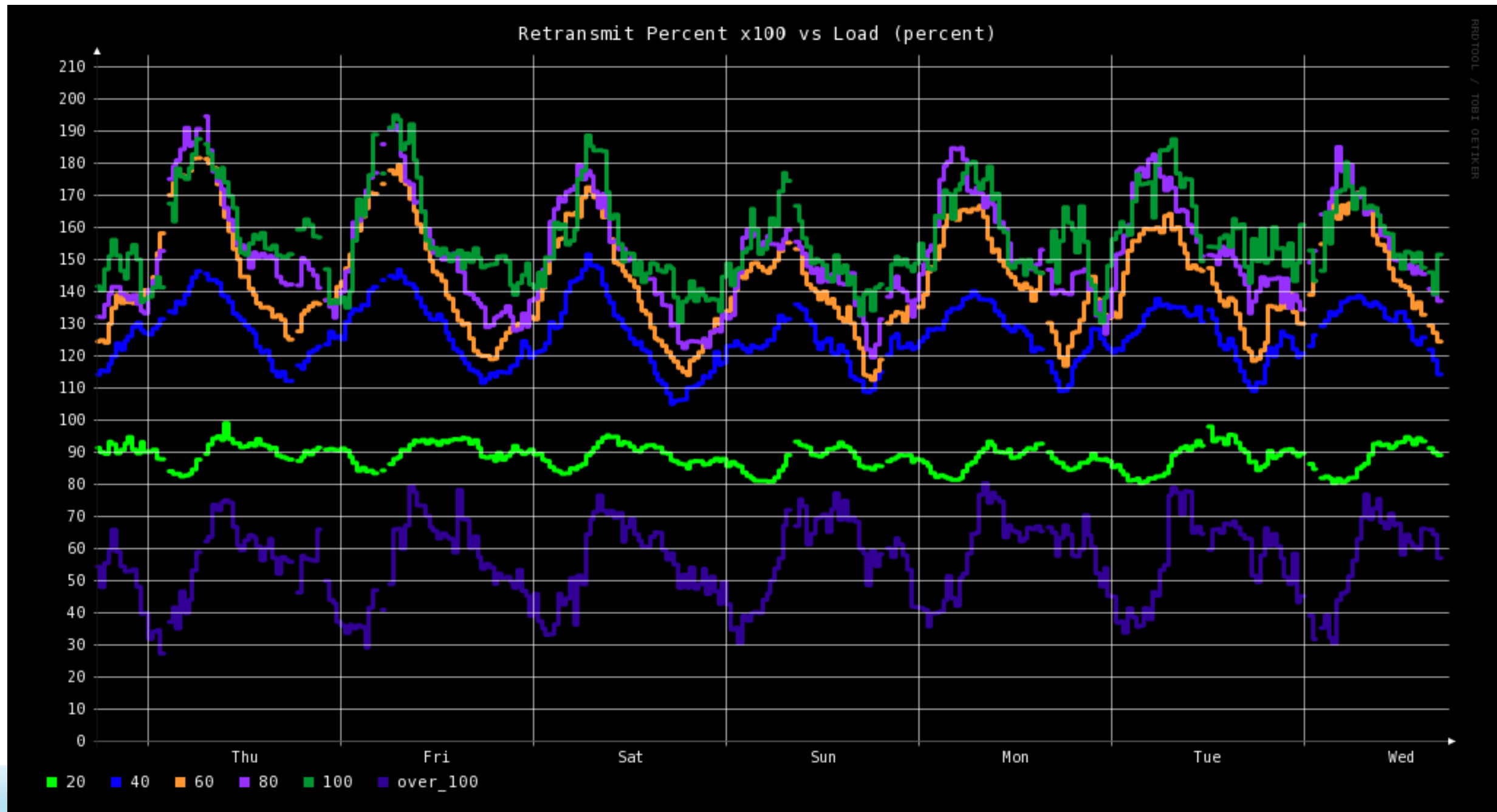
Averaged by country,  
over the whole world



# TCP retransmit rates by Continent



# TCP retransmit rates with Load, showing diurnal variation





# Simultaneous viewers - OTT still << broadcast TV

## TOP 10 LIST FOR

Prime Broadcast Network TV - United States

Week of Nov. 18, 2013

| RANK | PROGRAM                   | NETWORK | RATING | VIEWERS (000) |
|------|---------------------------|---------|--------|---------------|
| 1    | NBC SUNDAY NIGHT FOOTBALL | NBC     | 15.6   | 26,483        |
| 2    | NCIS                      | CBS     | 12.3   | 19,662        |
| 3    | SUNDAY NIGHT NFL PRE-KICK | NBC     | 11.4   | 19,614        |
| 4    | THE BIG BANG THEORY       | CBS     | 11.4   | 18,939        |
| 5    | OT, THE                   | FOX     | 9.4    | 16,017        |
| 6    | NCIS: LOS ANGELES         | CBS     | 9.4    | 14,993        |
| 7    | DANCING WITH THE STARS    | ABC     | 9.1    | 13,799        |
| 8    | FOOTBALL NT AMERICA PT 3  | NBC     | 8.1    | 13,713        |
| 9    | PERSON OF INTEREST        | CBS     | 7.8    | 12,278        |
| 10   | CRIMINAL MINDS            | CBS     | 7.7    | 12,398        |

Source: Nielsen. Primetime Broadcast Programs. Viewing estimates on this page include Live viewing and DVR playback on the Same Day, defined as 3am-3am. Ratings are the percentage of TV homes in the U.S. tuned into television.



# Video Quality Is Increasing - XBox One Reveal



## QUALITY

8.9 Mbps streams delivered to  
Xbox 360 viewers



## SCALE

More than 8.45 million people  
watched online in the first 24 hours



Greater volume + greater demand + more devices + more people + congestion = bandwidth crunch

There is no single solution to this problem

But there are an array of technologies which together can begin to attack this problem

**Let's take a look at 10 of them**  
(and demo 4 of them )



# 1. HEVC video codec



Successor to AVC (H.264) went to final draft in January 13

It requires 30-50% less bandwidth than AVC for the same perceived quality.

Decoding is complex although software decoding available in tablets/laptops/phones today

Can open up new markets for ADSL and mobile subscribers

Allows 720p at  $\leq 2$  Mbps which is sweet spot for 4G networks.

Makes OTT UHD (4K) feasible

Has legal issues with no clear license

**Will cut transport costs for OTT content only IF quality parity is maintained.**

**H.264 optimizations can achieve similar gains in the intermediate term. Firefox announces support for vp9 this week.**



## 2. Device compute capability is rising



The cell phone in your pocket has more computing power than all of NASA had in 1969 when it launched Apollo 13.

The Sony PS4 of today, which costs \$400, has the power of a military supercomputer of 1997, which cost millions of dollars.

Quad-core is the norm now, OctaCore came out with the S4, smarter multicore main processors are being fabbed with ridiculously small die sizes.

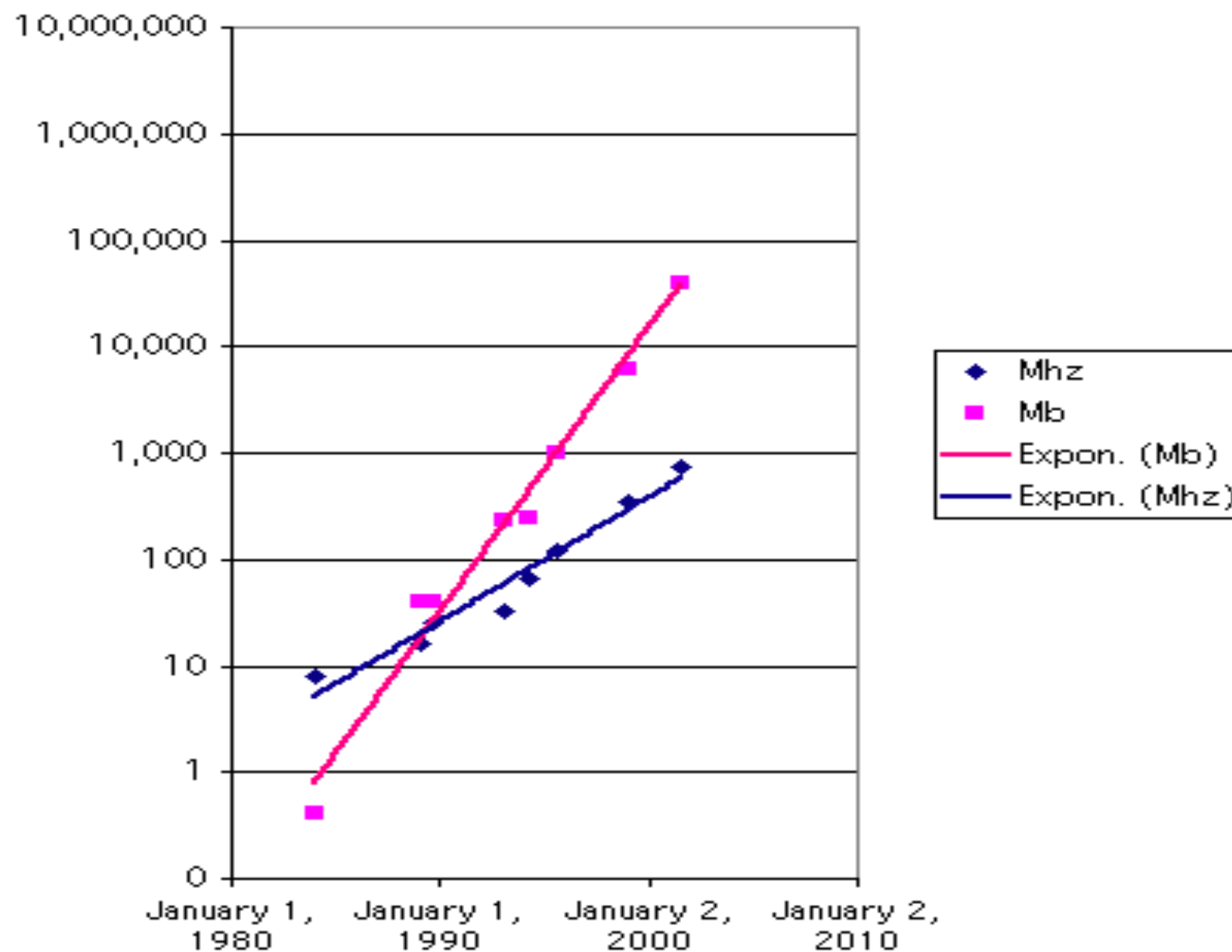
How does this effect media?

**Can decode ever more complex compression schemes.**



### 3. Storage density is growing faster than computeability

Why should  
Andreessen  
What if you



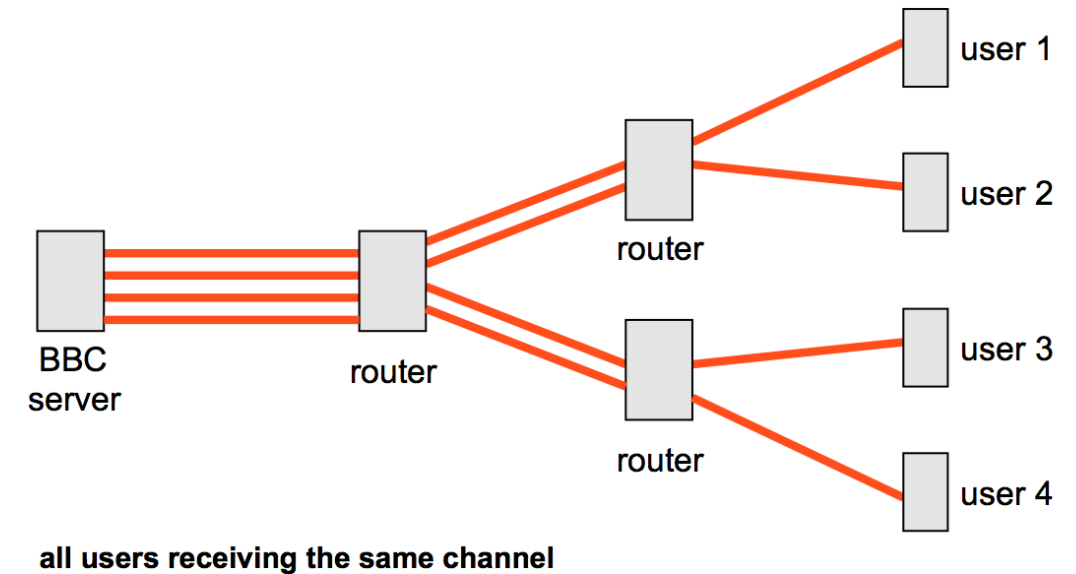
## 4. Multicast

Vast majority of OTT traffic today is unicast, IP Multicast is typically enabled within a network. No easy way for CDNs to ensure multicast transit to all end-users.

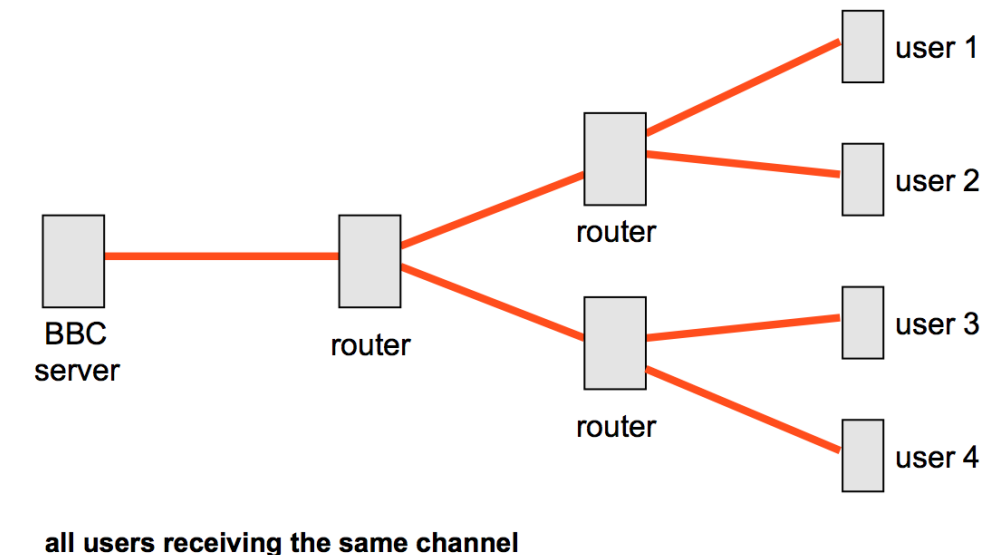
Multicasting longtail VOD traffic is inefficient  
But we could multicast

- Live sports events
- New events (Elections, royal weddings etc).
- OTT linear TV for marquee programming
- The top 100 Netflix titles?

### Unicast



### Multicast





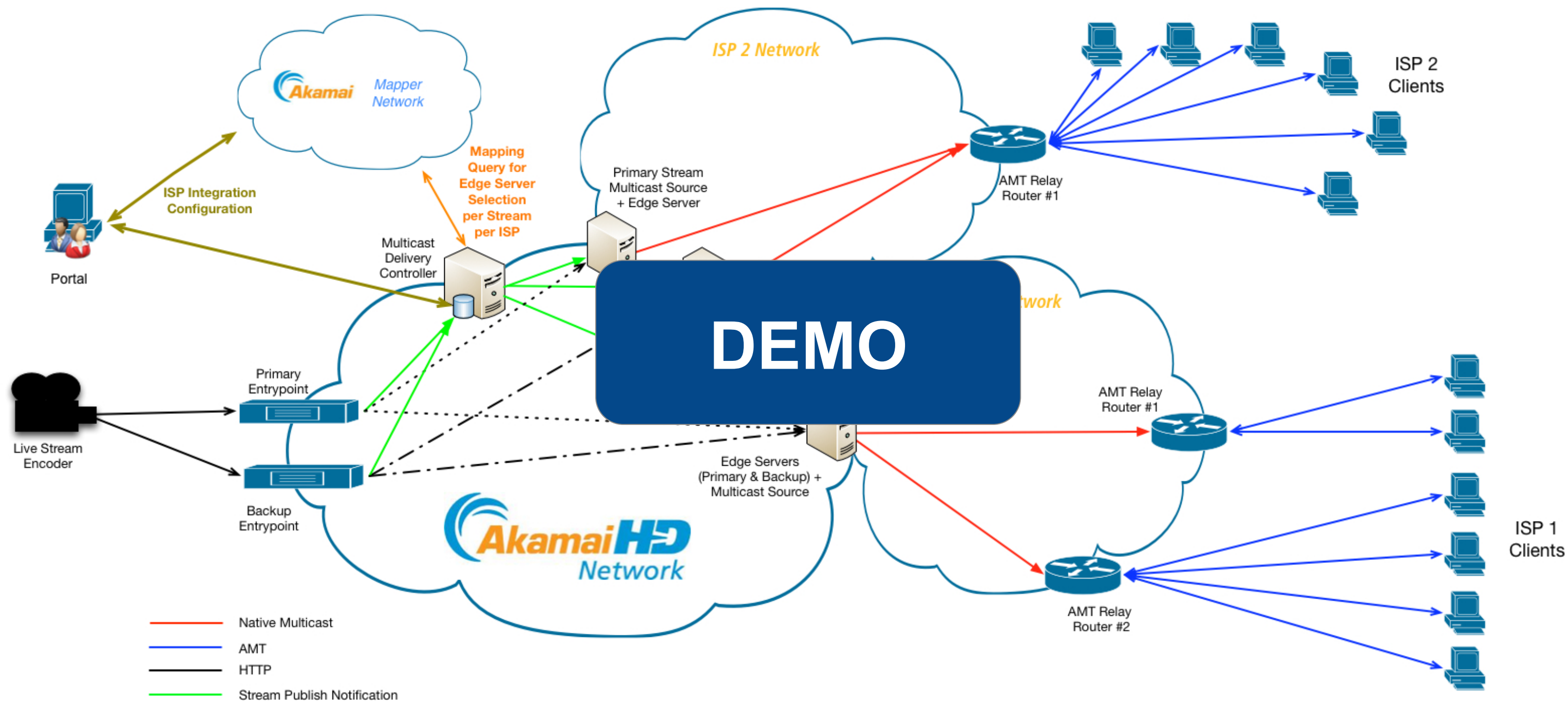
# Multicast at Akamai - requirements



- Keeps existing workflows intact:
  - Works with existing ingest, DRM, targeting & authentication.
- Uses existing player technology:
  - Supports existing players, ABR and advanced features like DVR.
- Format agnostic:
  - Supports HTTP chunked transport formats : HLS, HDS and DASH.



# Multicast Network Overview

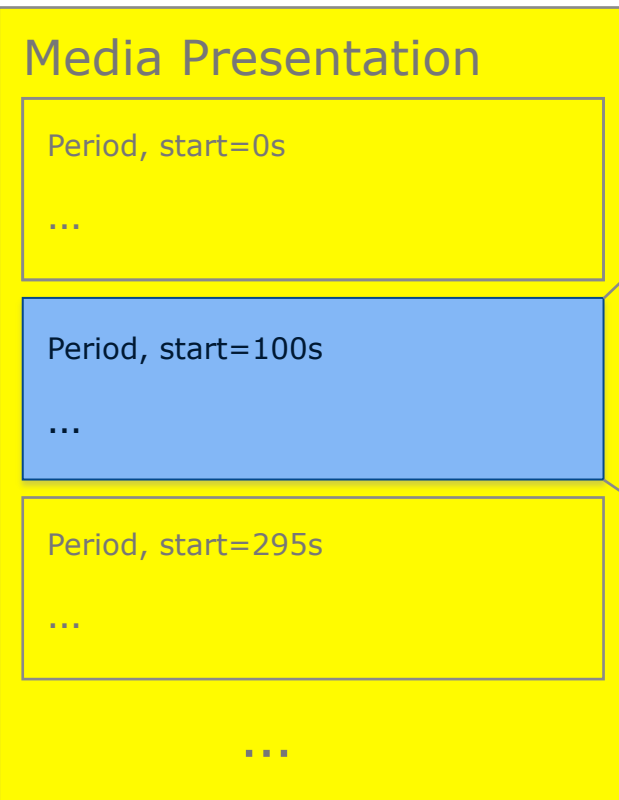


# 5. MPEG-DASH – unified delivery format

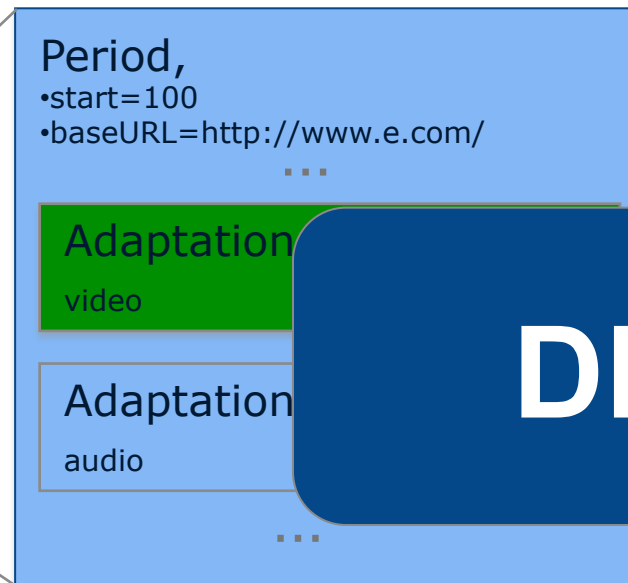
Focus == Improved Performance



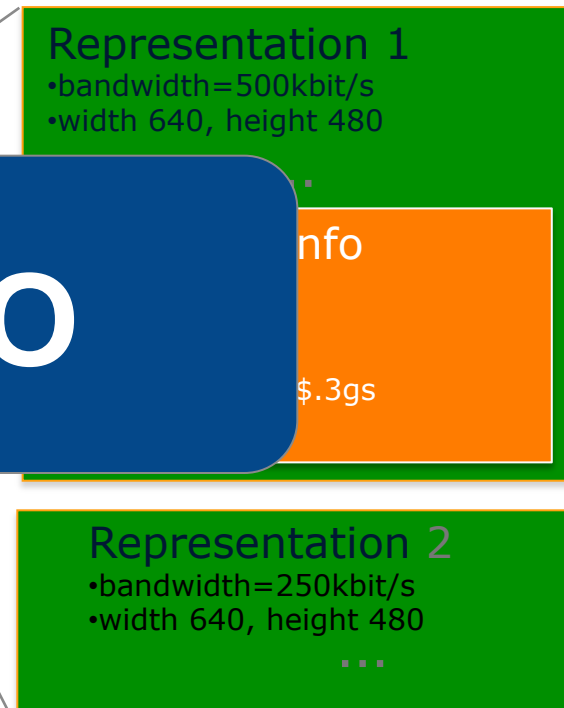
DEMO



Splicing of arbitrary content



Selection of Components



Select/Switch of Bandwidth



## 6. Improving existing TCP



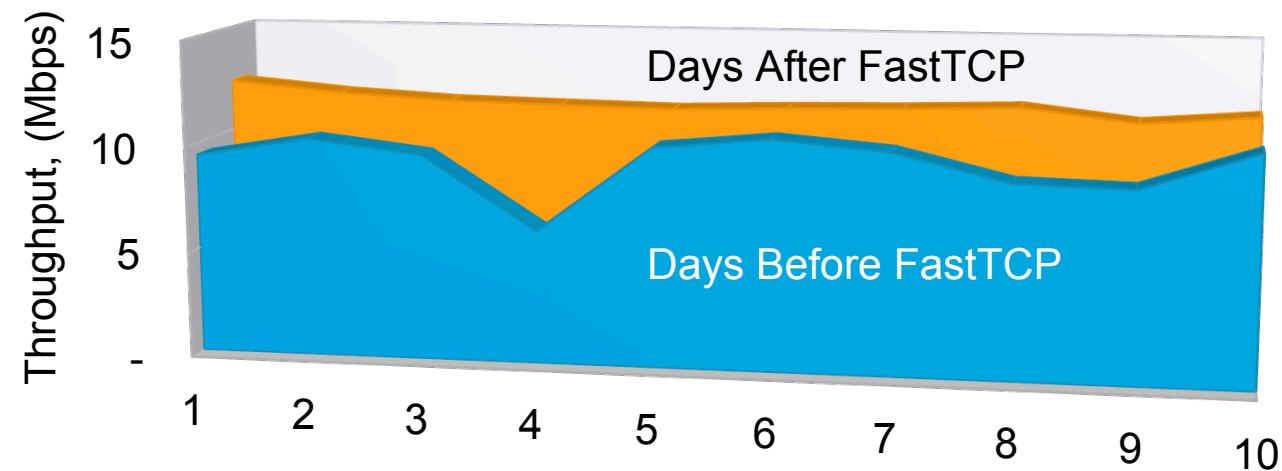
FAST TCP is a TCP congestion avoidance algorithm especially targeted at long-distance, high latency links.

Uses queueing delay instead of loss probability as a congestion signal.

Technology acquired September 2012, network integration completed in July 2013.

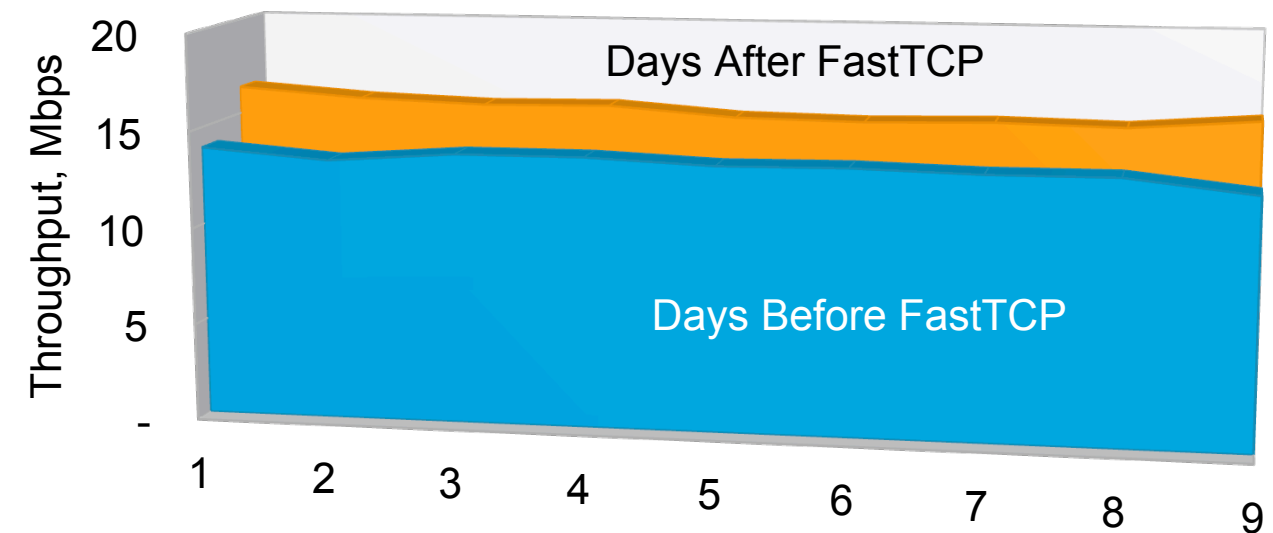


Throughput  
Before/After Akamai FastTCP  
European Service Provider



| Throughput (Mbps) | Before FastTCP | After FastTCP | Change (%) |
|-------------------|----------------|---------------|------------|
| Mean              | 9.6            | 11.7          | 22%        |
| Min               | 6.3            | 11.3          | 79%        |
| Max               | 10.9           | 12.4          | 14%        |

Throughput  
Before/After FastTCP Enabled  
North American Service Provider



| Throughput | Before FastTCP | After FastTCP | Change (%) |
|------------|----------------|---------------|------------|
| Mean       | 13.6           | 15.7          | 15%        |
| Min        | 12.9           | 15.3          | 18%        |
| Max        | 14.0           | 16.4          | 17%        |

## 7. Caching network

Imagine if all the content was  
away from you?

Think of caching as  
Used to only exist in

Now major telcos and carriers are building out transparent cache layers  
within their own networks. Verizon bought EdgeCast this week.

Federation of content between cache networks.

Caches are inching their way towards the cell tower, which is a non-IP  
environment.



at&t



in and midgress traffic



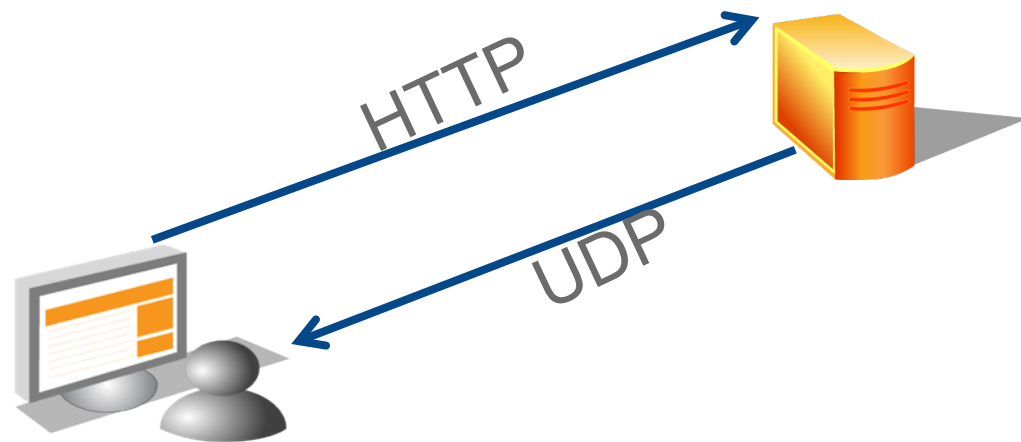


## 8. Hybrid UDP/TCP

95% of OTT content today is delivered via unicast HTTP over TCP.

UDP offers higher throughput, but it does not natively correct for packet loss or congestion.

How can we improve this????



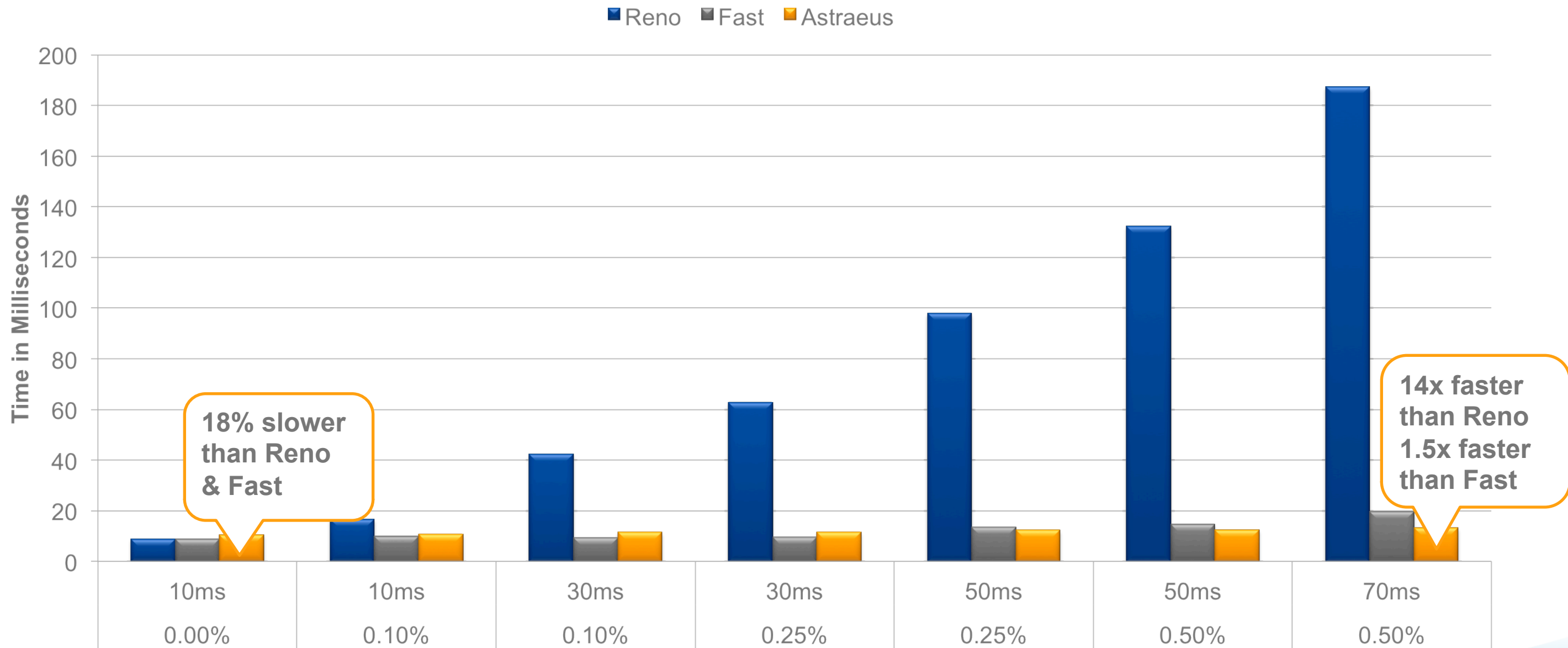
- **HTTP/UDP Hybrid Protocol**
  - Transparent, reuses existing infrastructure
- **Advanced Congestion Control**
  - Based on FastTCP, can provide further improvements due to flexibility of UDP
- **Forward Error Correction (FEC)**
  - Raptor10 FEC





# Download Time: Reno vs. Fast vs. Astraeus < 1% loss

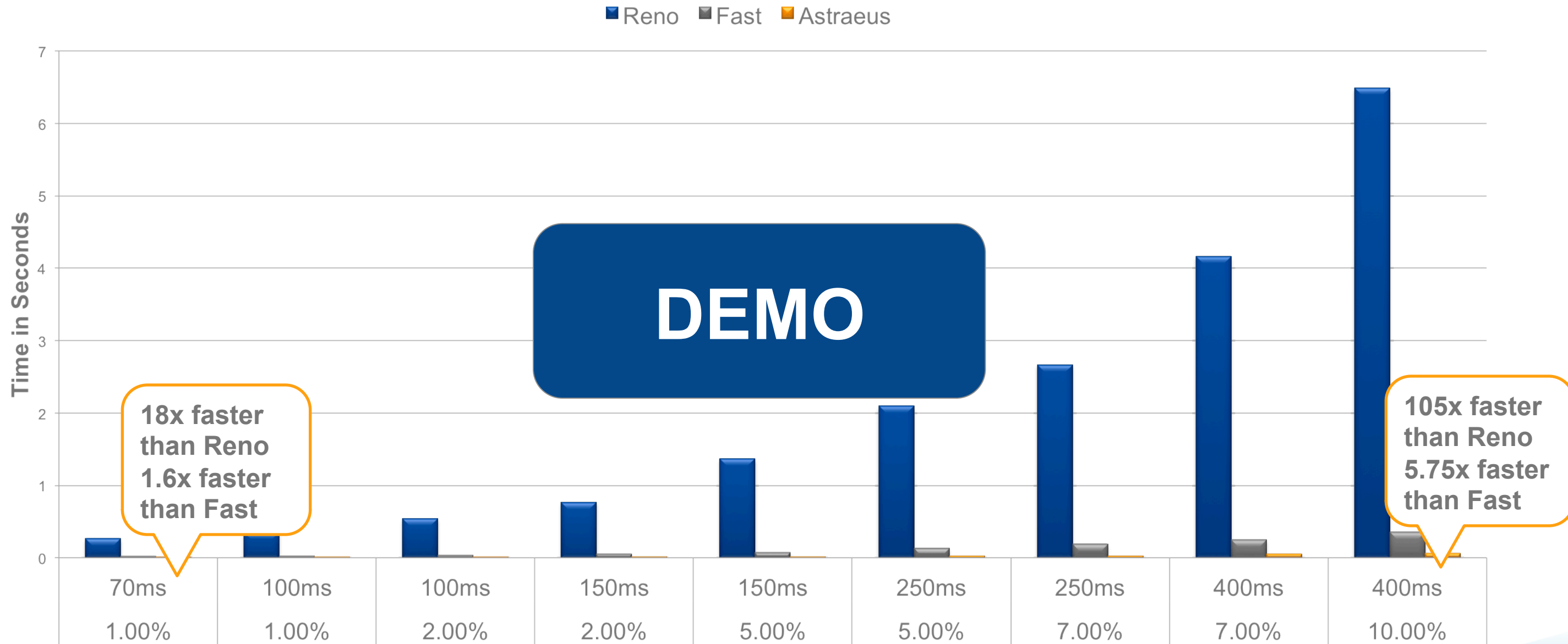
40MB Download



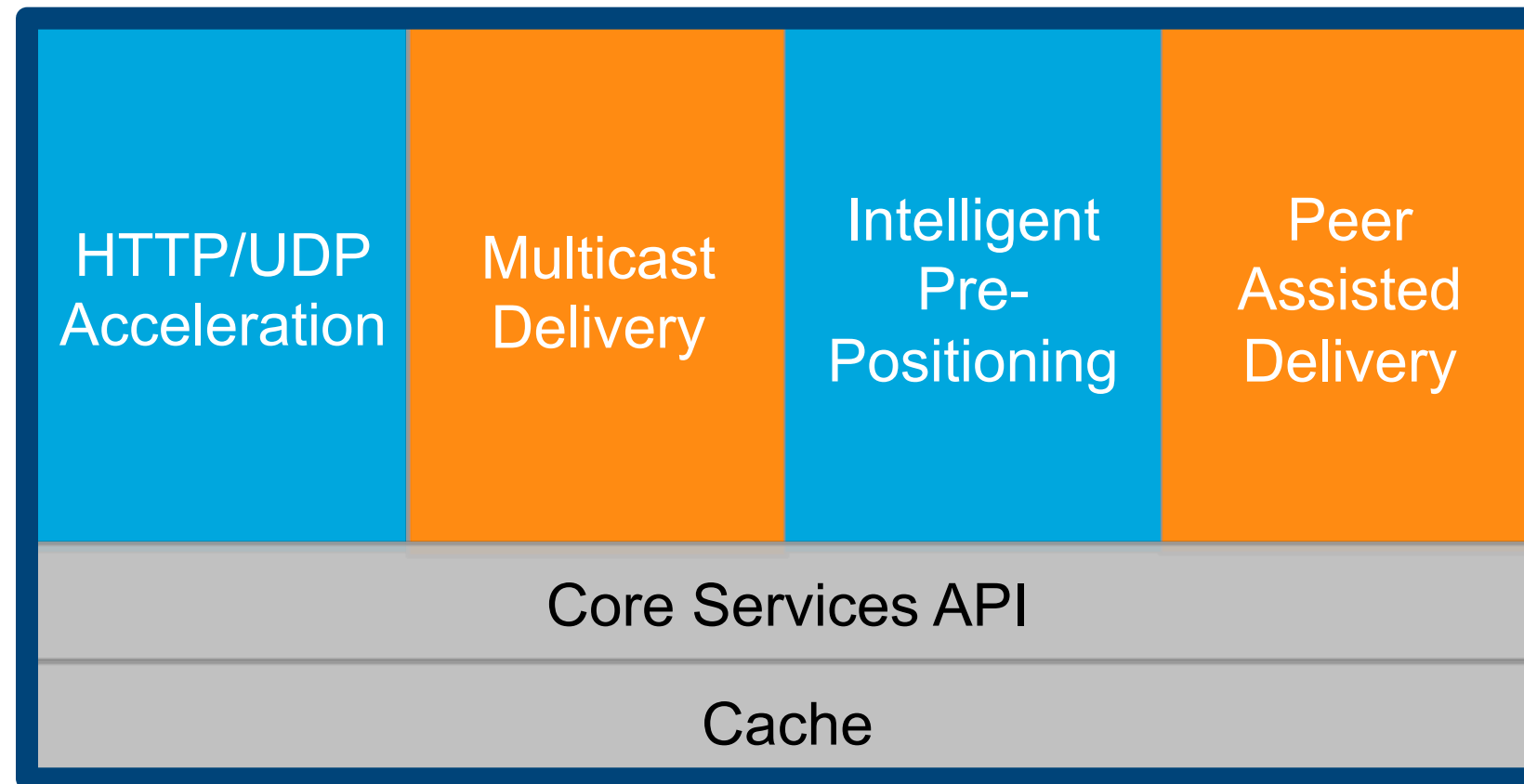
# Download Time: Reno vs. Fast vs. Astraeus $\geq 1\%$ loss



40MB Download



## Client Assisted Delivery



## 9. Fiber and transit capacity increasing



The last hop to your house or device is not where congestion is occurring – it is the peering and transit that has to occur between server and client.

Sustainable throughput on fiber increased 120% over past 5 years.

Dark fiber being activated and New fiber laid at increasing rates.

Sept 2012 NTT demonstrated ultra-large capacity transmission of 1 petabit (1000 terabit) per second over a 52.4 km length of optical fiber.

Note that 1 petabit is sufficiently fast enough to completely transfer 1388 2hr-10Mbps videos ***in a single second***.

July 2013 - Tests at Alcatel-Lucent's Innovation City campus in France result in data speeds of 31 Terabits per second over 7200 kilometers, the highest sub-sea capacity ever transmitted on a single optical fiber. That is more than 1.5 times the peak output of *all* of Akamai's servers.



## 10. Peer Assisted Delivery



Get video from your peers instead of a conventional server

Efficient architecture for live and popular VOD content.

File sharing gave p2p a bad name in the enterprise

Needs overlay security and control plane and is challenged by asymmetric last mile, which is not a problem for audio today.

Today's adaptive segmented (e.g. HLS, Smooth, DASH) lend themselves nice to peer assisted delivery.

**DEMO**

Barrier to deployment has been the installation of client executables.

- What if peers were TV's , home entertainment devices, home routers or refrigerators ?
- WebRTC opens up the ability for installation-free p2p solutions - good demo at [demo.streamroot.io](http://demo.streamroot.io)



# Many more beyond these 10



## Towards more congestion

- 4K video
- Device screen resolution increasing (S4 is 1080p)

## Towards better throughput

- HTTP 2.0 SPDY et al.
- Server bits/watt increasing
- Pre-caching
- Residential fiber
- Software Defined Networking
- WLAN/WiFi offload

**The bandwidth 'crunch' is an opportunity  
for those who choose to address it**





Thank you for your time this morning



QUESTIONS?

