

31st October 2016

# Moving the network with measurements

## World IPv6 Launch and beyond



Mat Ford  
Technology Program Manager  
[ford@isoc.org](mailto:ford@isoc.org)

# Moving the network with measurements



# Clear objective

- What is the obstacle on the path to deployment that is being overcome?



- IPv6 Day
  - Understand and minimise the number of users negatively impacted by making content dual-stack



- IPv6 Launch
  - Break the 'chicken-and-egg' logjam
  - Make content available (permanently)
  - Obtain (measurable) commitments from networks to permanently enable end-user IPv6

# Measurable result

- If the goal of the exercise isn't measurable, it's marketing
- What can you do that is externally measurable, reportable, and visible to everyone?
- For v6 day it was turning up IPv6 on your main website for 24 hours
  - Measurable around the globe via DNS
- For v6 launch, it was turning it up and leaving it on for websites, and turning up 1% of your users for networks
  - Networks measurable by aggregating data from major content providers



# A concrete publicly visible date helps

- Part of the purpose of a flag day is to give people a goal
  - feedback on both v6 events was that this greatly helped organizations internally
- This gave engineers something to show to managers as a deliverable date
- This gave companies a reason to do something a little sooner than they had already planned to do it



# I want to be like...

- Google, Facebook, and Yahoo!
- Heard this from a lot of people:
  - Having a headlining big brand standing up and saying they are making a commitment to a technology has a TON of pull in the industry (marketing)
  - Having a really big player do this makes it safe for others (engineering)
- What is the pull to drive others to want to do something?



# Who are the leaders?

- Small group of industry leaders who are committed to doing this together
- Can you identify them?
- Can they agree to
  - cooperate?
  - share risks?



# Clear result

- How is the Internet different after it's over?
- After v6 day it was clear that turning up v6 at scale didn't break the Internet, or v4 users
- Since v6 launch it is increasingly clear that v6 is part of the Internet as regular business





# Mutually Agreed Norms for Routing Security (MANRS)

MANRS defines four concrete actions that network operators should implement

- Technology-neutral baseline for global adoption

MANRS builds a visible community of security-minded operators

- Promotes culture of collaborative responsibility

<https://www.manrs.org/>



# Measuring IPv6

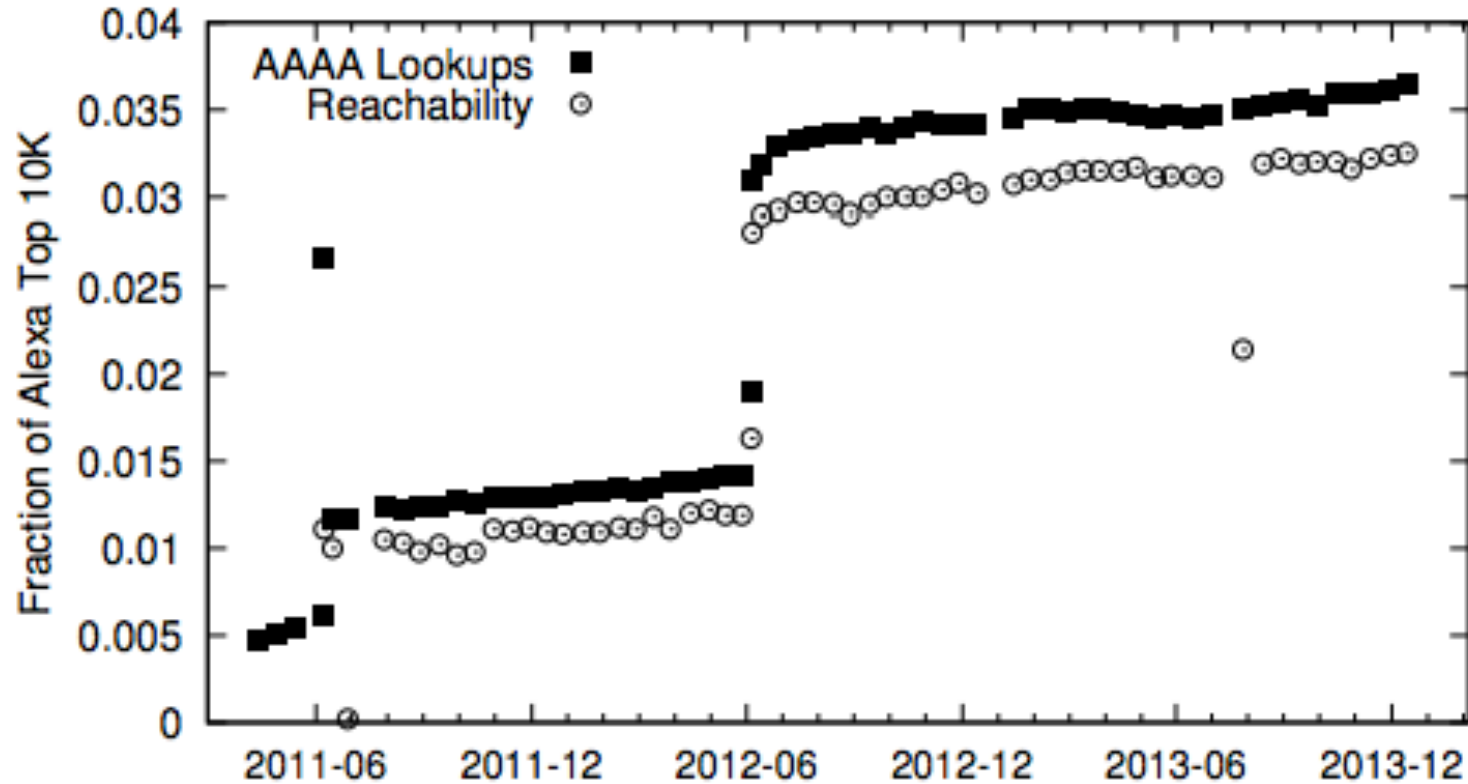


# Agenda – Measuring IPv6

- Measuring Web content
- Measuring network operators from the outside
- Measuring network operators from the inside
- Measuring countries
- Measuring the DNS
- Measuring performance
- Predicting the future

## Measuring IPv6

### Measuring Web content



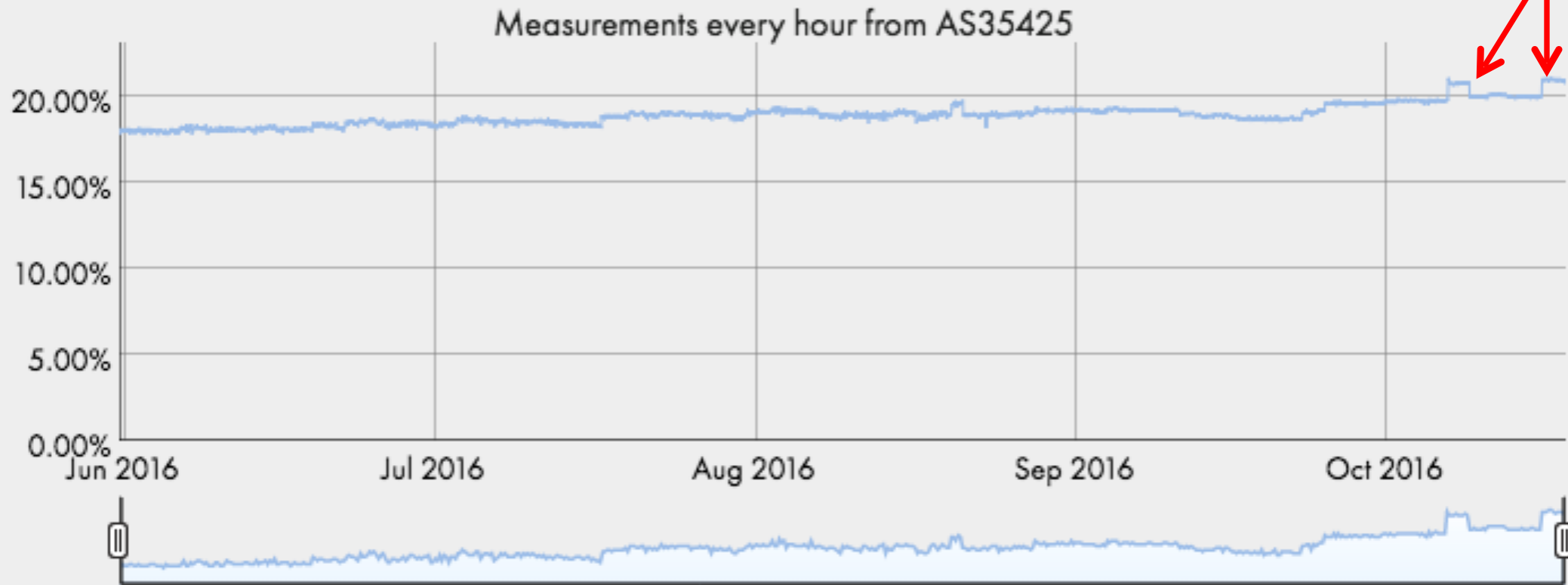
Measuring IPv6 adoption. By: Jakub Czyz, Mark Allman, Jing Zhang, Scott Iekel-Johnson, Eric Osterweil, Michael Bailey.  
Appears in: CCR August 2014.

## Measuring IPv6

### Measuring Web content

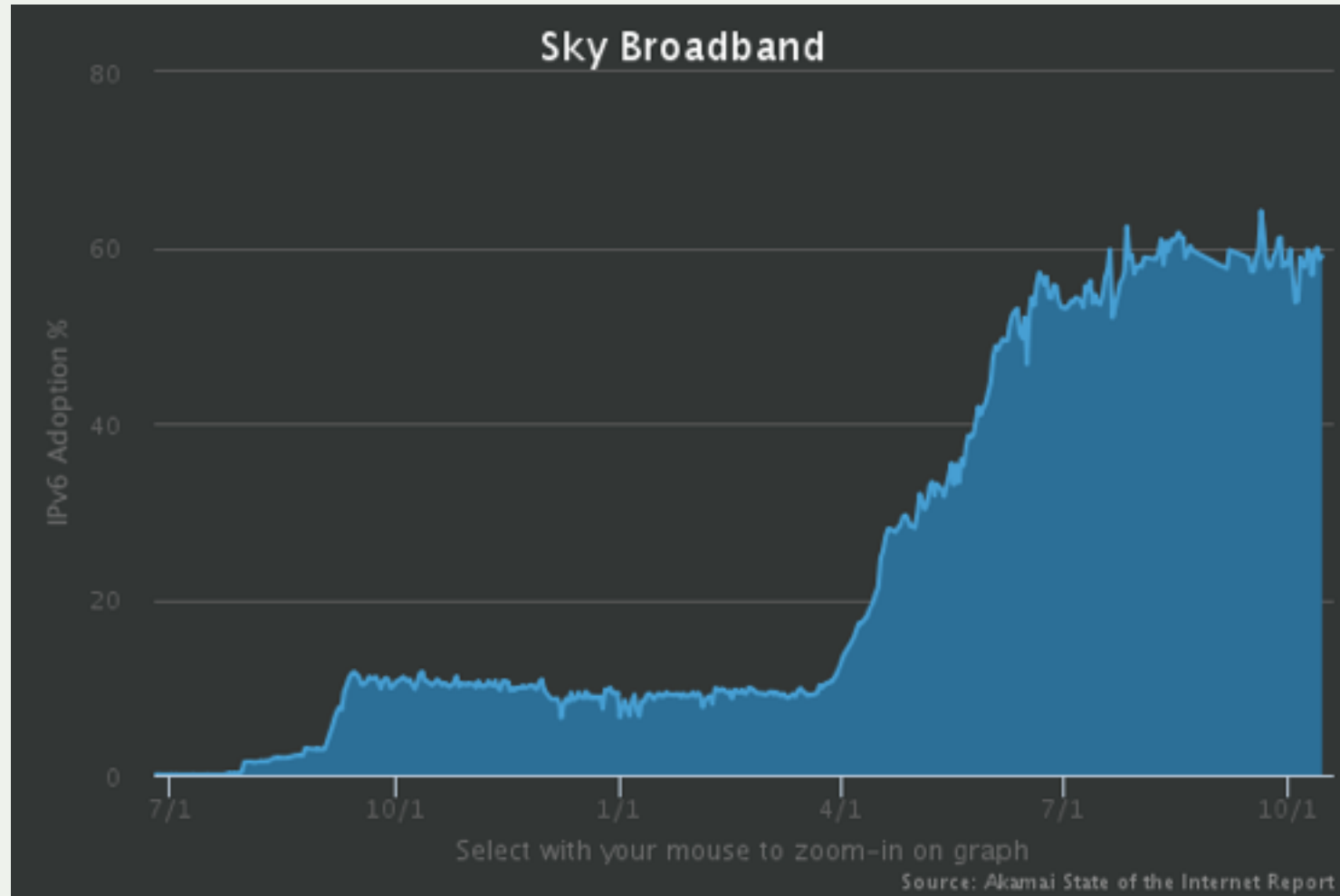
#### Percentage of Alexa Top 1000 websites currently reachable over IPv6

Cloudflare?



## Measuring IPv6

Measuring network operators from the outside – Akamai



# Measuring IPv6

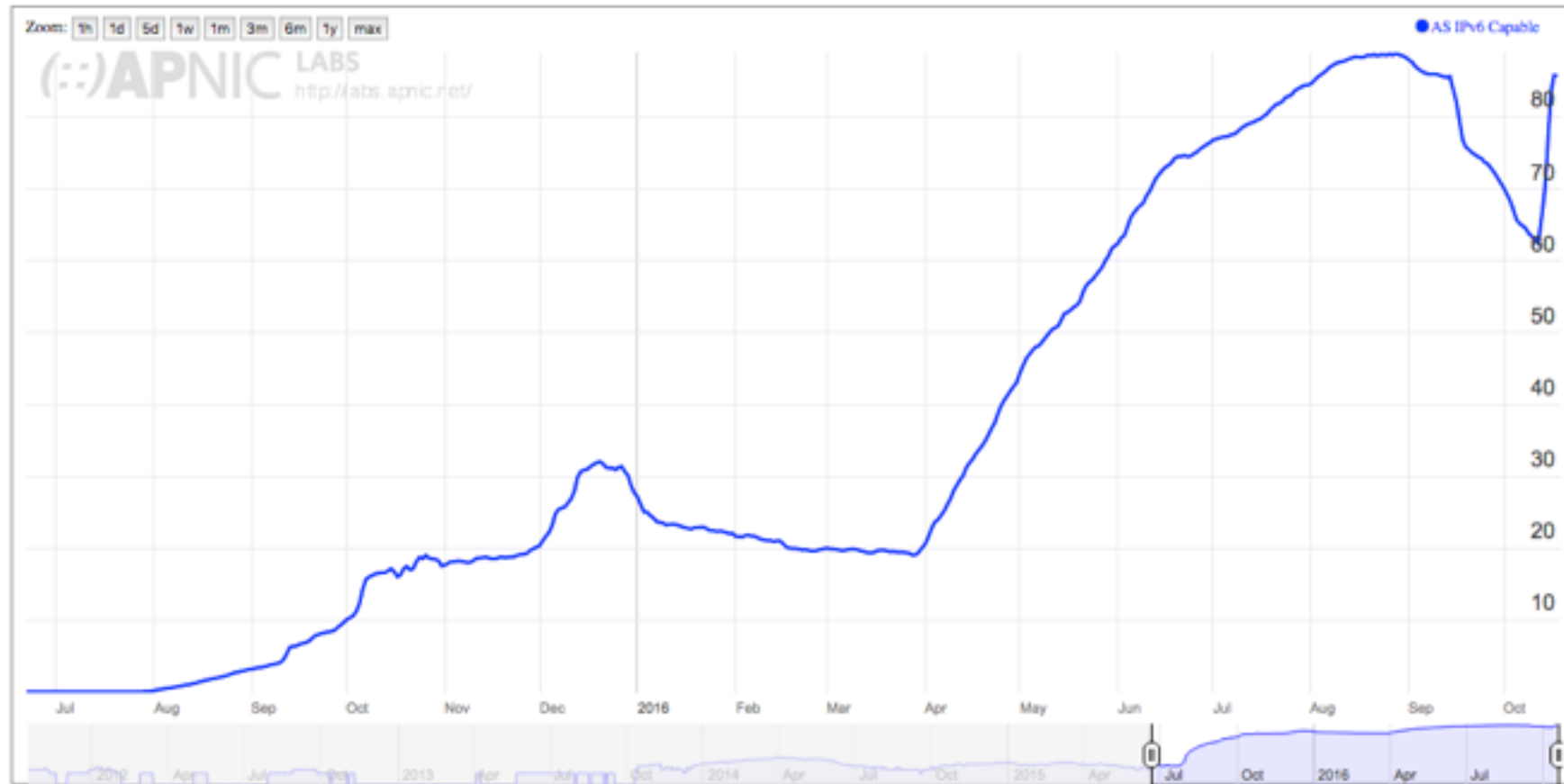
## Measuring network operators from the outside – Akamai



## Measuring IPv6

Measuring network operators from the outside – APNIC

### IPv6 Deployment for AS5607: BSKYB-BROADBAND-AS Sky UK Limited





# Measuring IPv6

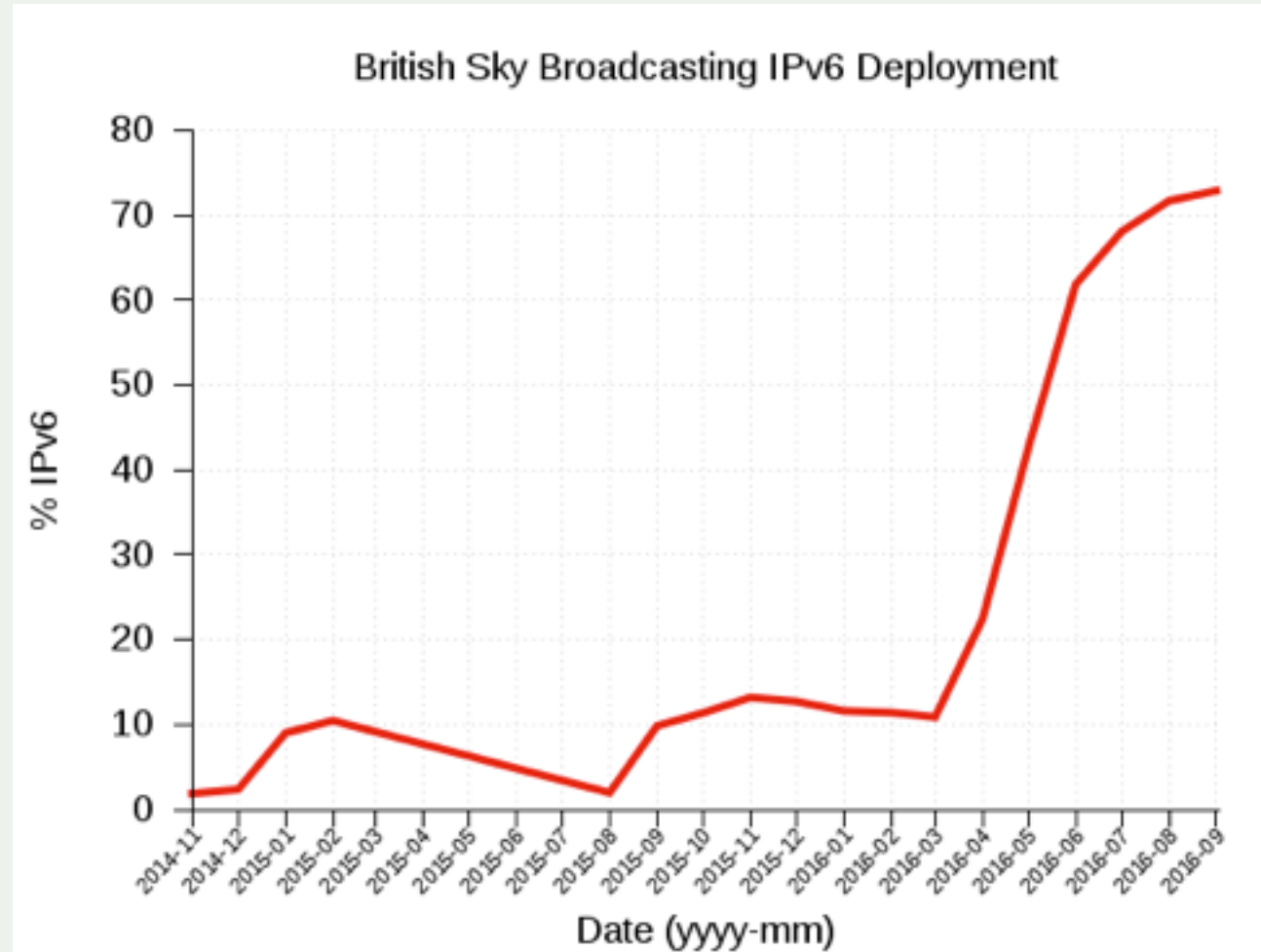
## Measuring network operators from the outside – World IPv6 Launch



Show 10 entries		Search: <input type="text"/>	
Rank	Participating Network	ASN(s)	IPv6 deployment
1	<a href="#">Comcast</a>	7015, 7016, 7725, 7922, 11025, 13367, 13385, 20214, 21508, 22258, 22909, 33287, 33489, 33490, 33491, 33650, 33651, 33652, 33653, 33654, 33655, 33656, 33657, 33659, 33660, 33661, 33662, 33664, 33665, 33666, 33667, 33668, 36732, 36733	48.90%
2	<a href="#">ATT</a>	6389, 7018, 7132	60.68%
3	<a href="#">KDDI</a>	2516	25.48%
4	<a href="#">Verizon Wireless</a>	6167, 22394	75.59%
5	<a href="#">Time Warner Cable</a>	7843, 10796, 11351, 11426, 11427, 12271, 20001	30.59%
6	<a href="#">SoftBank</a>	17676	15.32%
7	<a href="#">T-Mobile USA</a>	21928	72.08%
8	<a href="#">British Sky Broadcasting</a>	5607	72.87%
9	<a href="#">Deutsche Telekom AG</a>	3320	29.37%
10	<a href="#">Telefonica del Peru</a>	6147	13.87%
Showing 1 to 10 of 272 entries			
First Previous 1 2 3 4 5 Next Last			

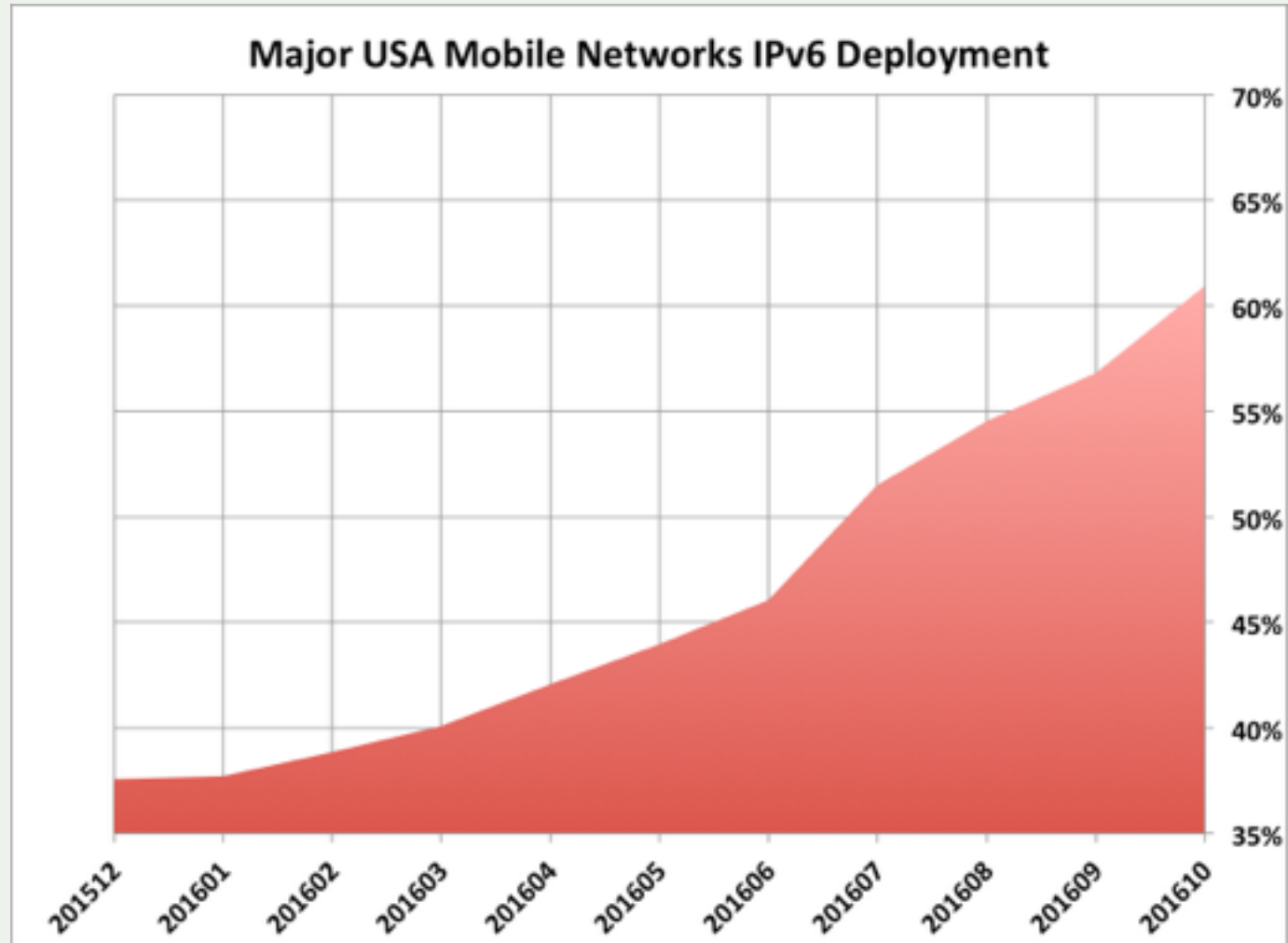
## Measuring IPv6

### Measuring network operators from the outside – World IPv6 Launch



## Measuring IPv6

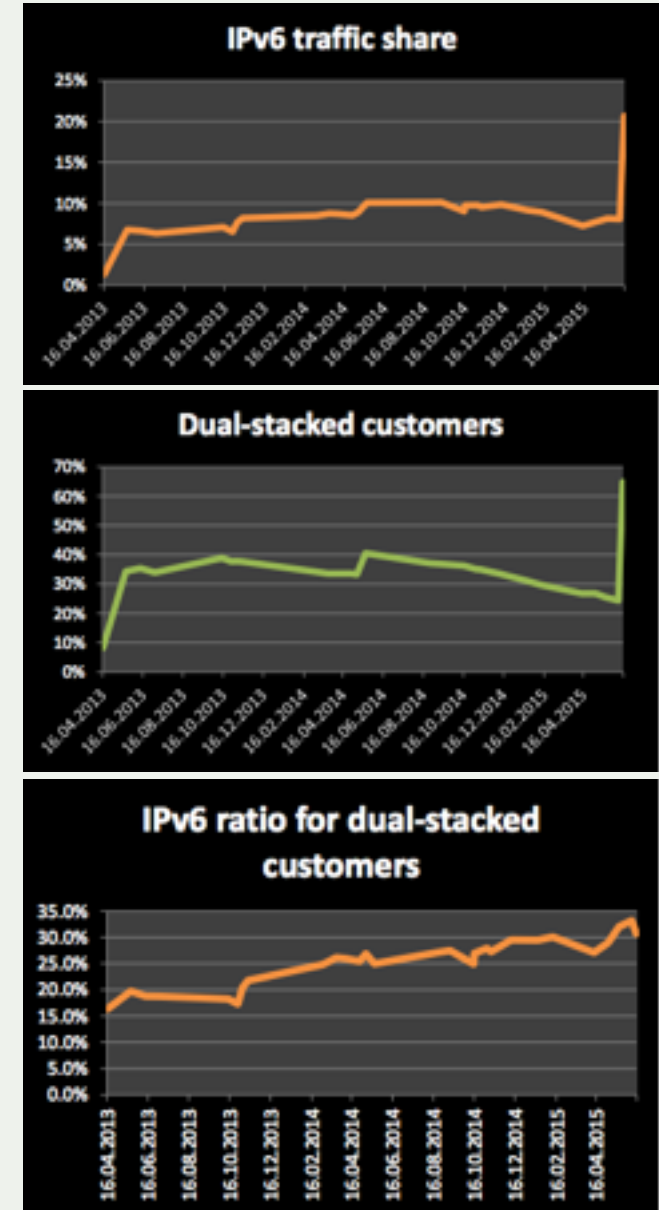
### Measuring network operators from the outside – World IPv6 Launch



# Measuring IPv6

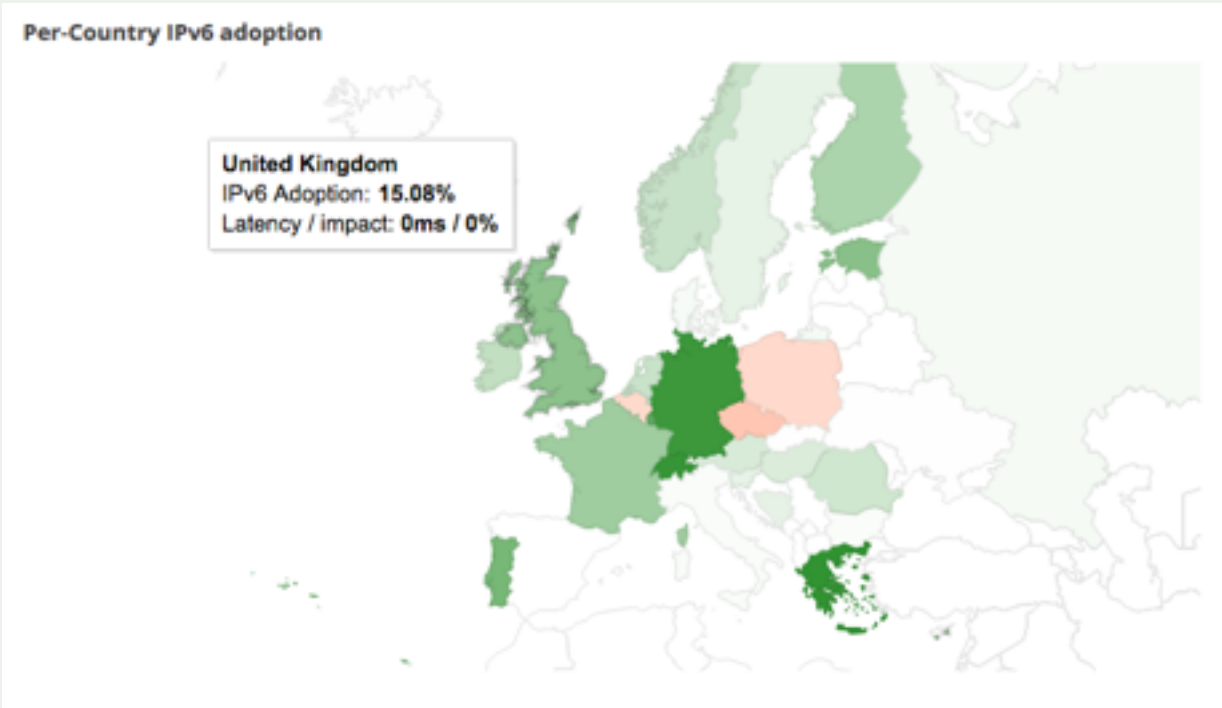
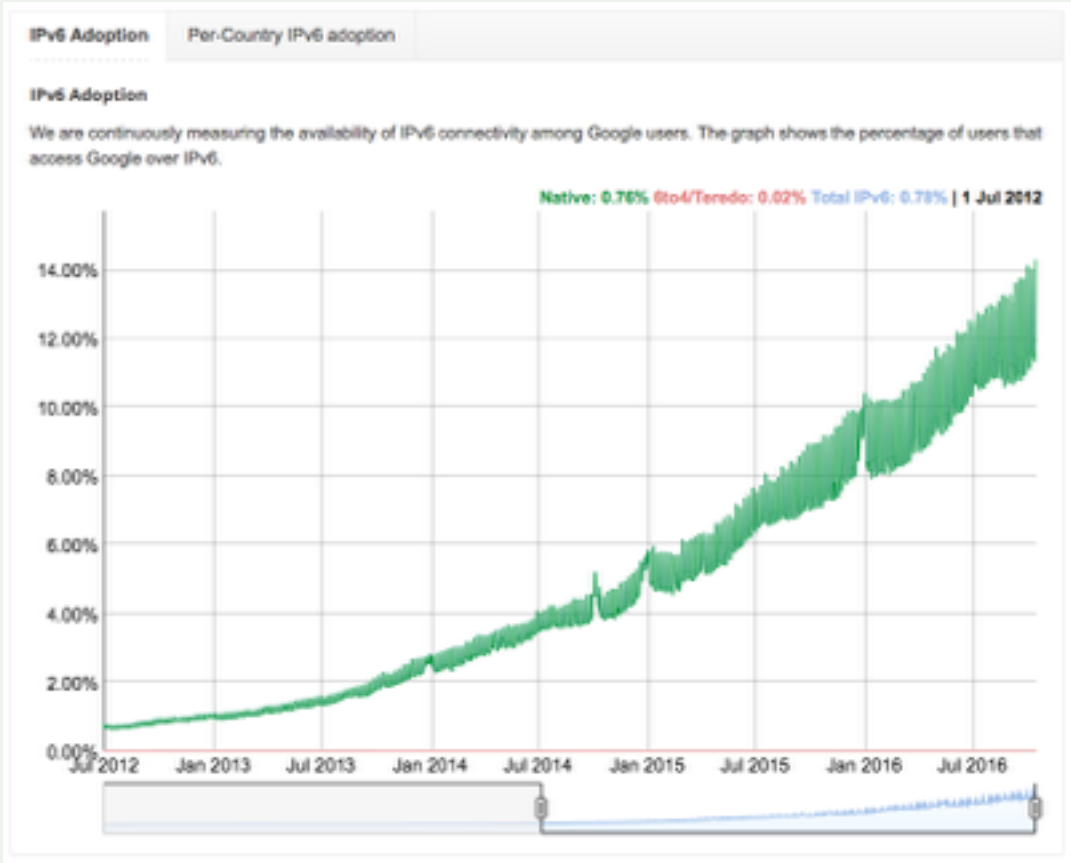
## Measuring network operators from the inside

- Martin Gysi of Swisscom wrote for us in 2014
  - At that time, 35% of subscribers were IPv6-capable
  - 8.5% of peak traffic was IPv6
- Presentation on IPv6 deployment at Swisscom in mid-2015
  - 67% of subs dual-stacked
  - >20% of traffic was IPv6
  - 31% of IPv6 user's traffic was IPv6 (mostly Google)



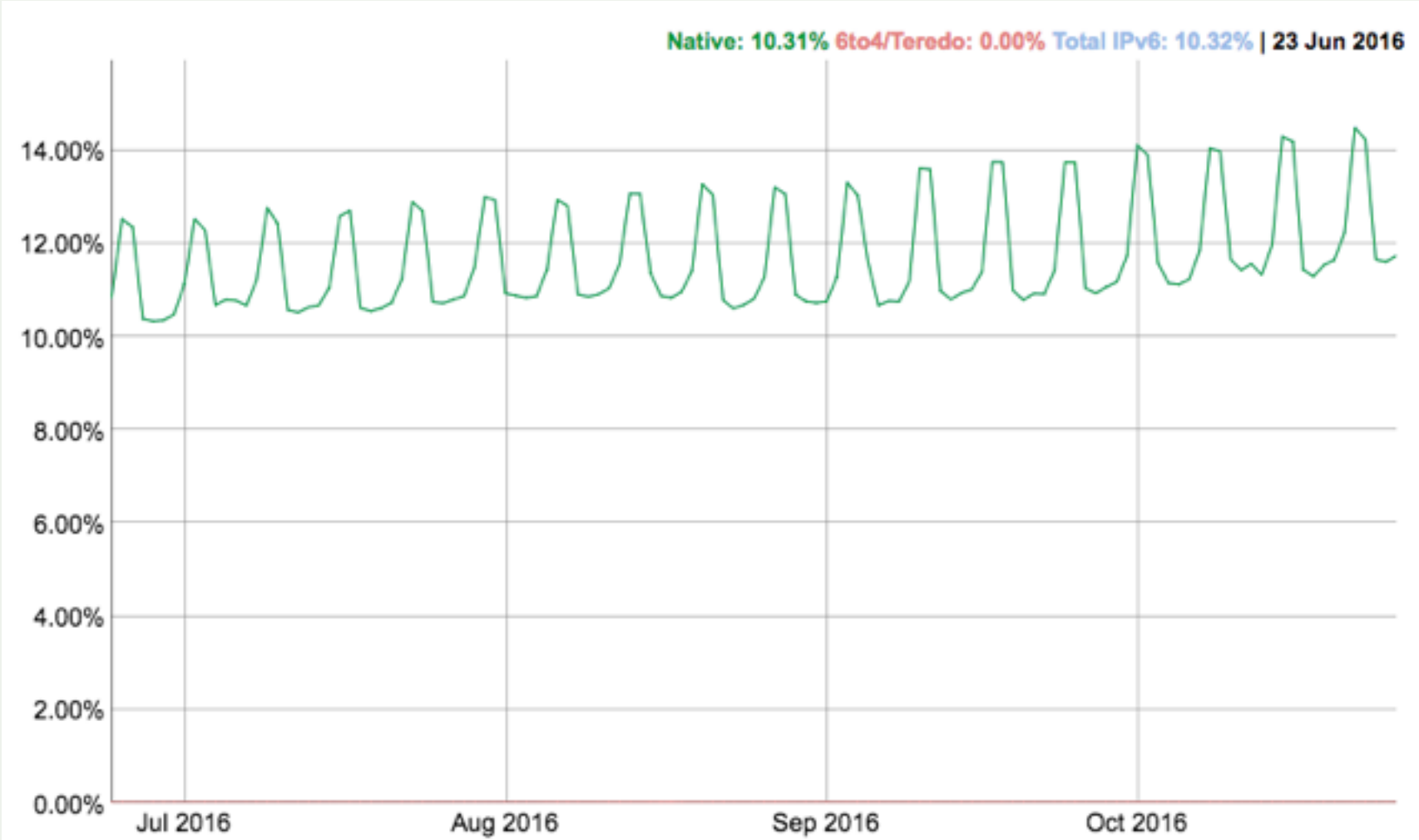
# Measuring IPv6

## Measuring countries – Google



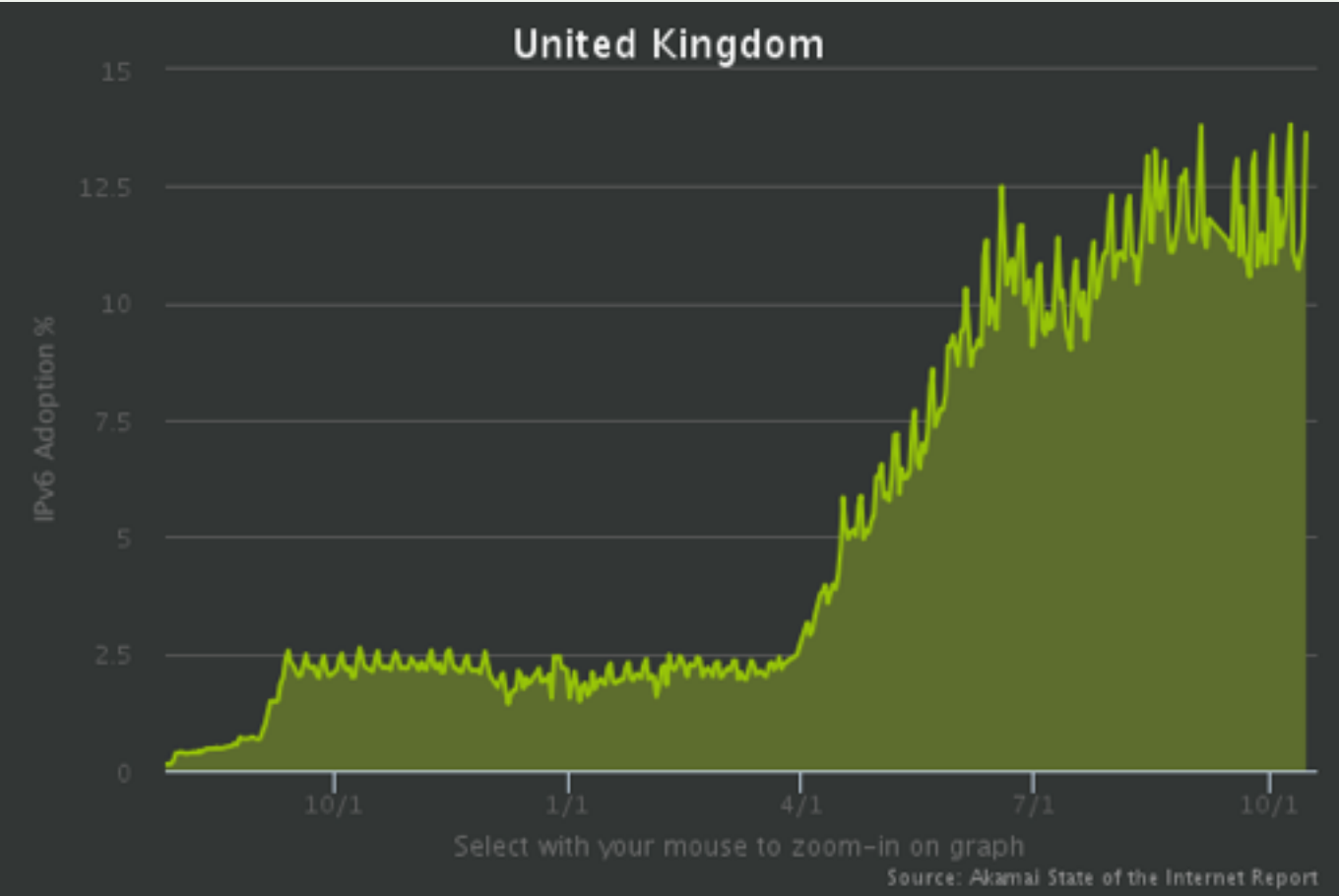
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## Measuring countries – Google



# Measuring IPv6

## Measuring countries – Akamai

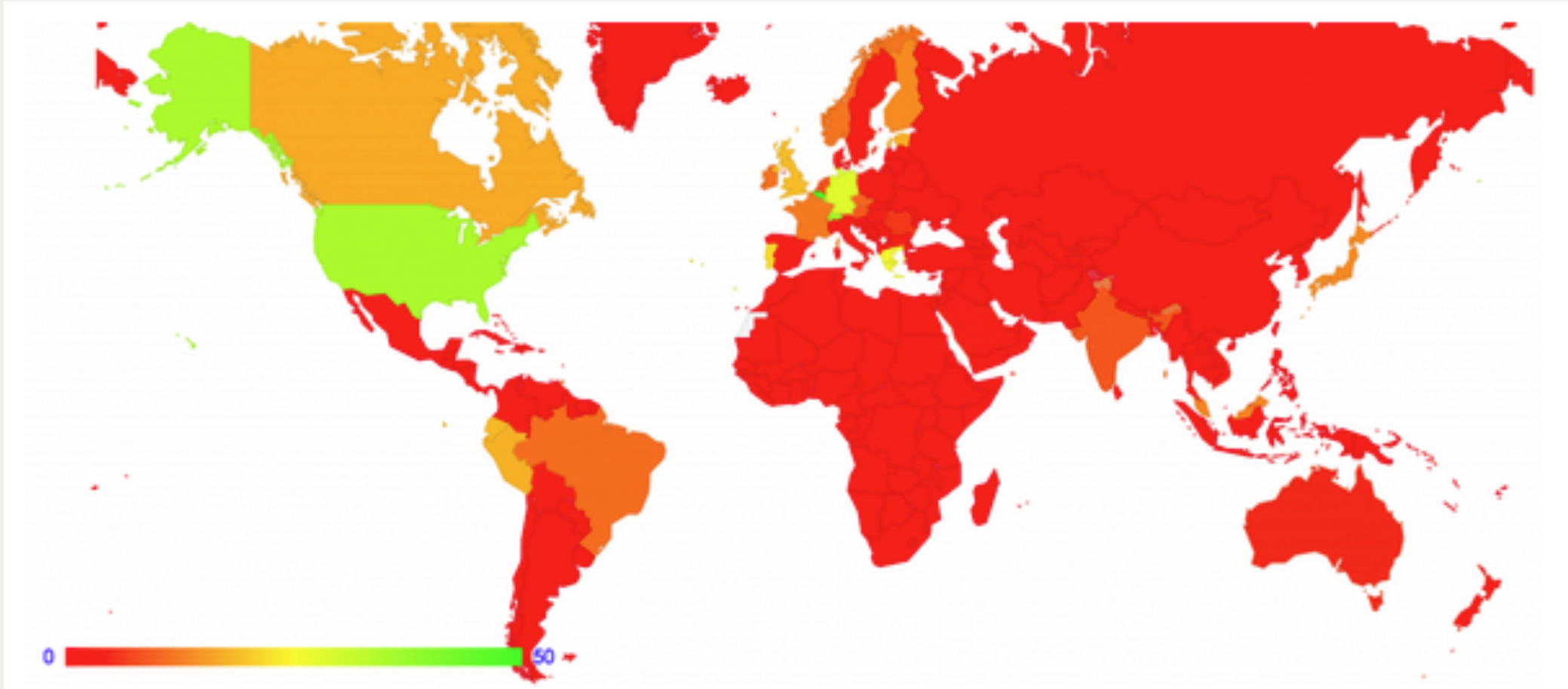


RANK	IPv6 %	COUNTRY
1	46.8%	Belgium
2	27.6%	Greece
3	26.1%	Germany
4	25.6%	Switzerland
5	25.4%	India
6	23.6%	United States of America
7	23.4%	Luxembourg
8	18.3%	Portugal
9	16.4%	Estonia
10	13.6%	United Kingdom
11	13.2%	Ecuador



## Measuring IPv6

### Measuring countries – APNIC

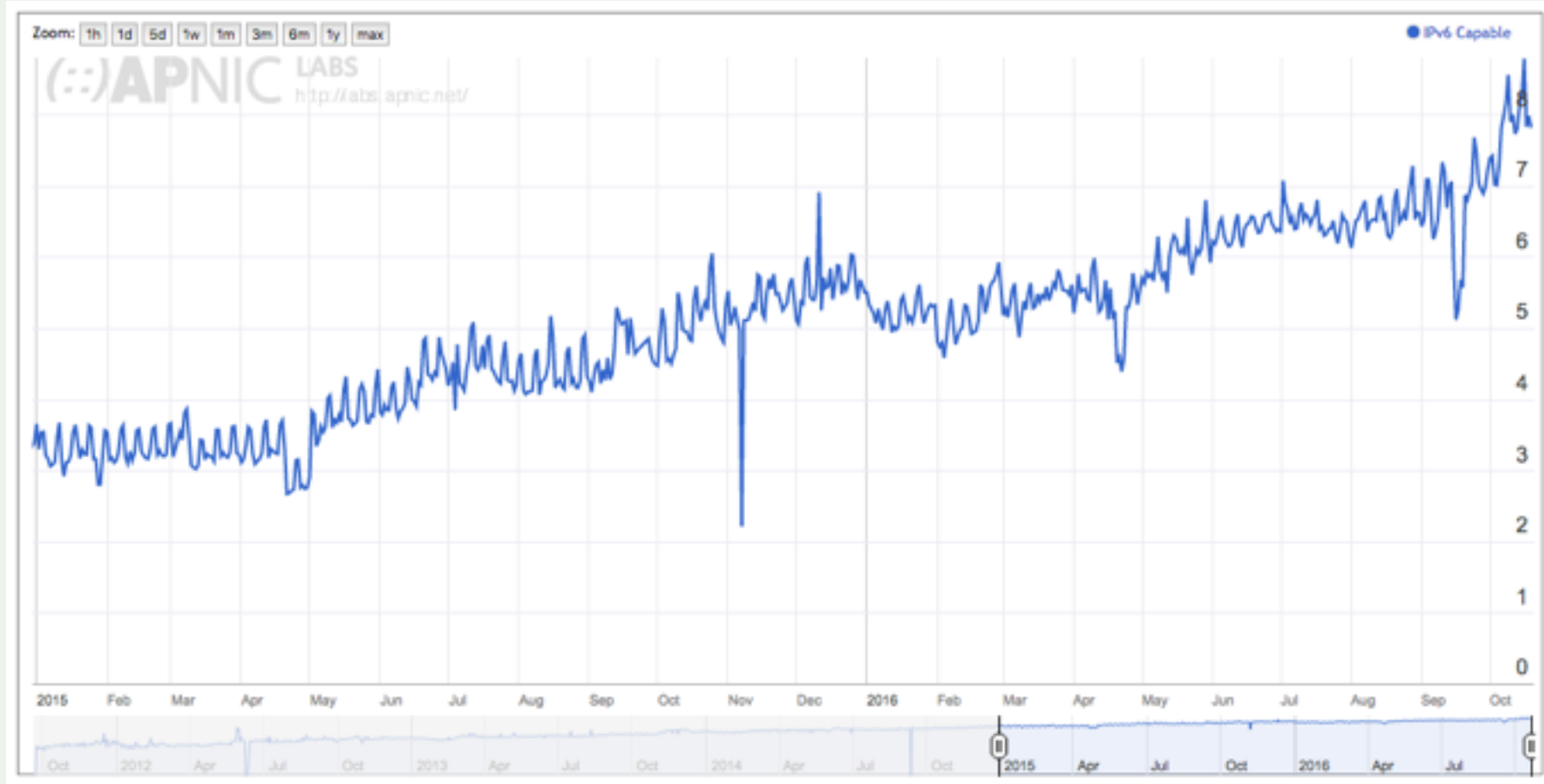


Global IPv6 deployment, as measured by the relative capability to use IPv6



# Measuring IPv6

## Measuring countries – APNIC

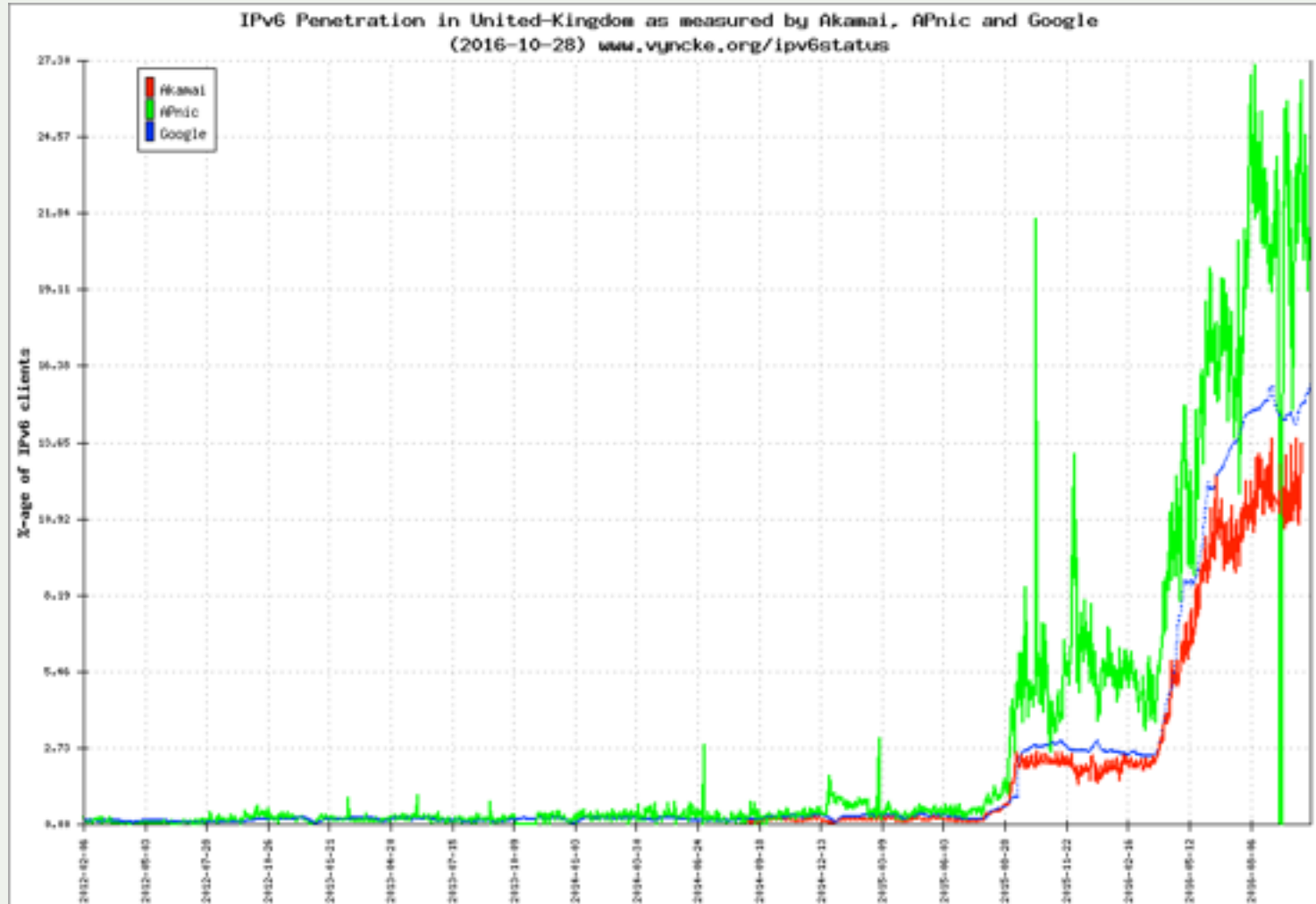


Use of IPv6 worldwide

<http://stats.labs.apnic.net/ipv6/XA>

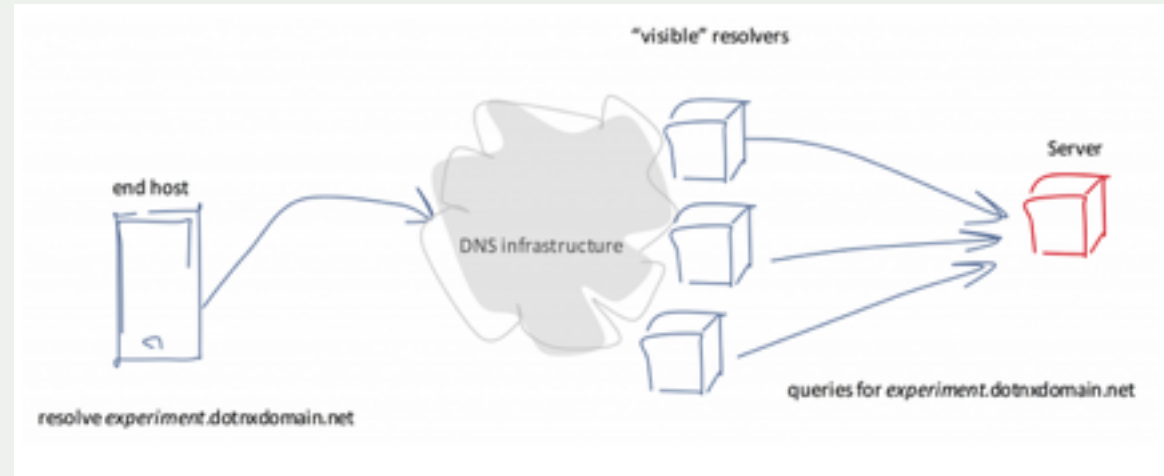
# Measuring IPv6

## Measuring countries – methodologies compared



## Measuring IPv6

### Measuring the DNS



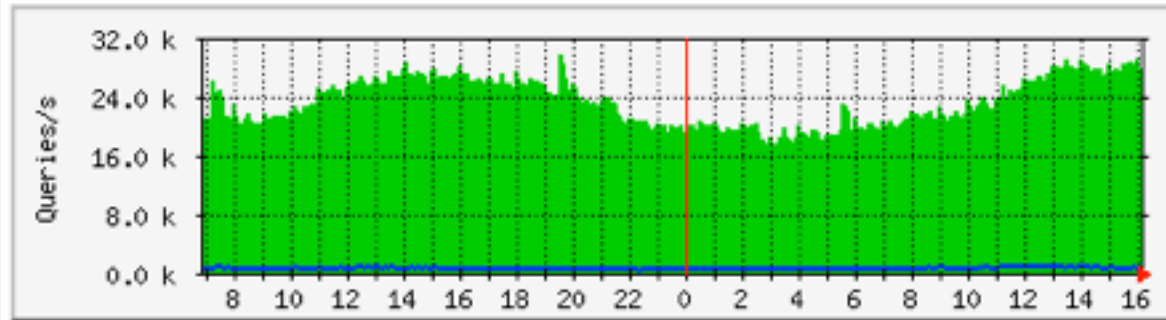
Geoff Huston, APNIC

- Around one third of the Internet's user population invoke DNS resolvers that are capable of using IPv6 to resolve a DNS name
- Half of those users are invoking Google, AT&T and Comcast
- “The DNS is well on the path of transition and perhaps further along this path than all the other elements of the Internet's infrastructure.” (<https://labs.ripe.net/Members/gih/ipv6-and-the-dns>)
- And as of earlier this month, all DNS root servers are IPv6-enabled

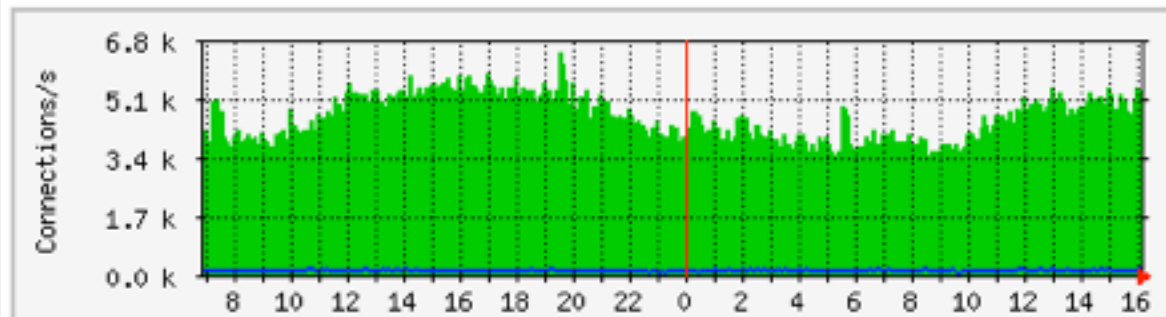
## Measuring IPv6

### Measuring the DNS – h.root-servers.net

#### IPv4 query rate



#### IPv6 query rate



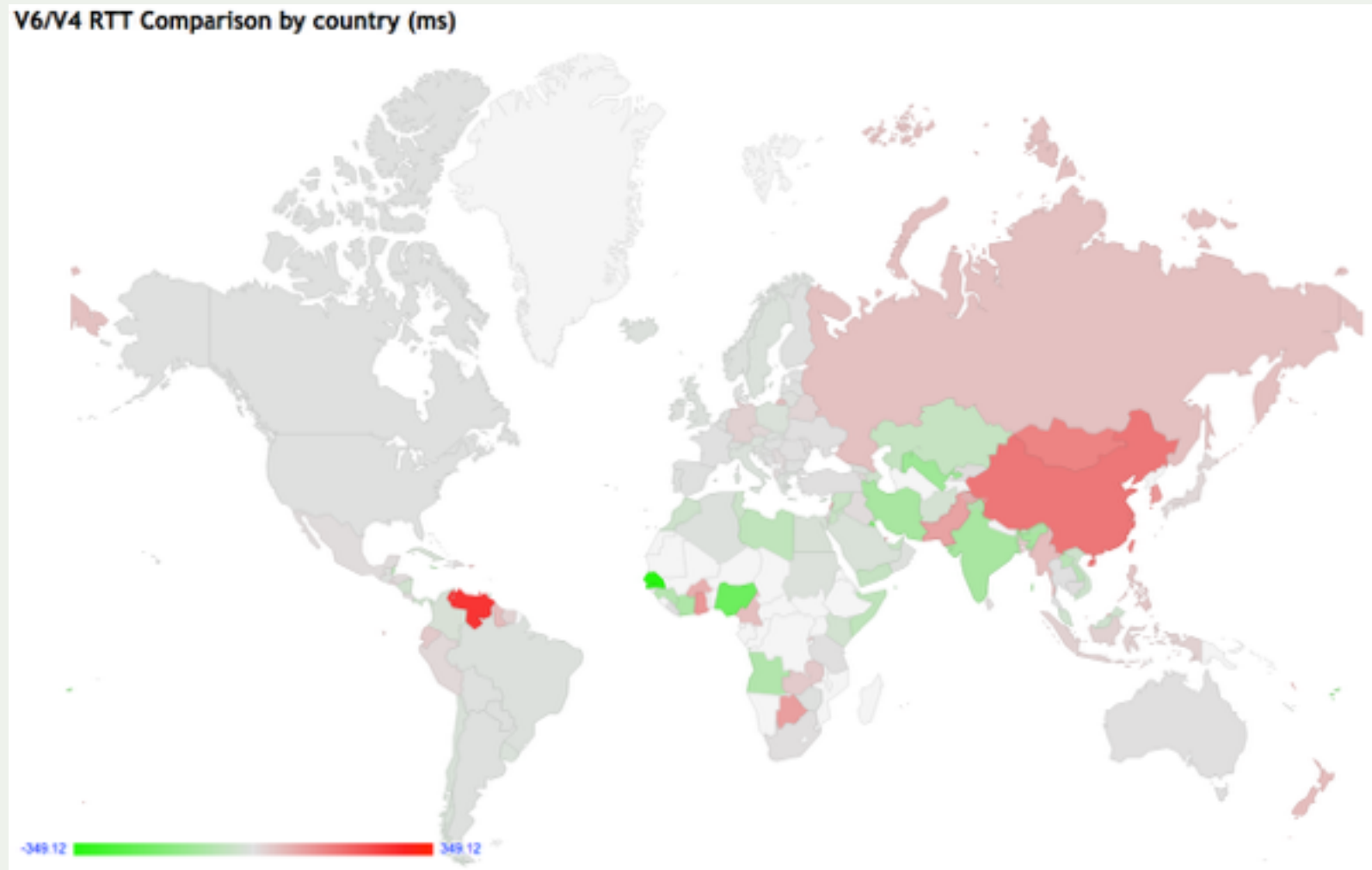
## Measuring IPv6

### Measuring performance

- Facebook have described controlled A/B tests that show IPv6 to be 15% faster on average for devices on mobile networks in the US, with some devices showing even better results.
- Measurements using Akamai's RUM system have also shown measurable performance improvements for IPv6 connections from US mobile networks.

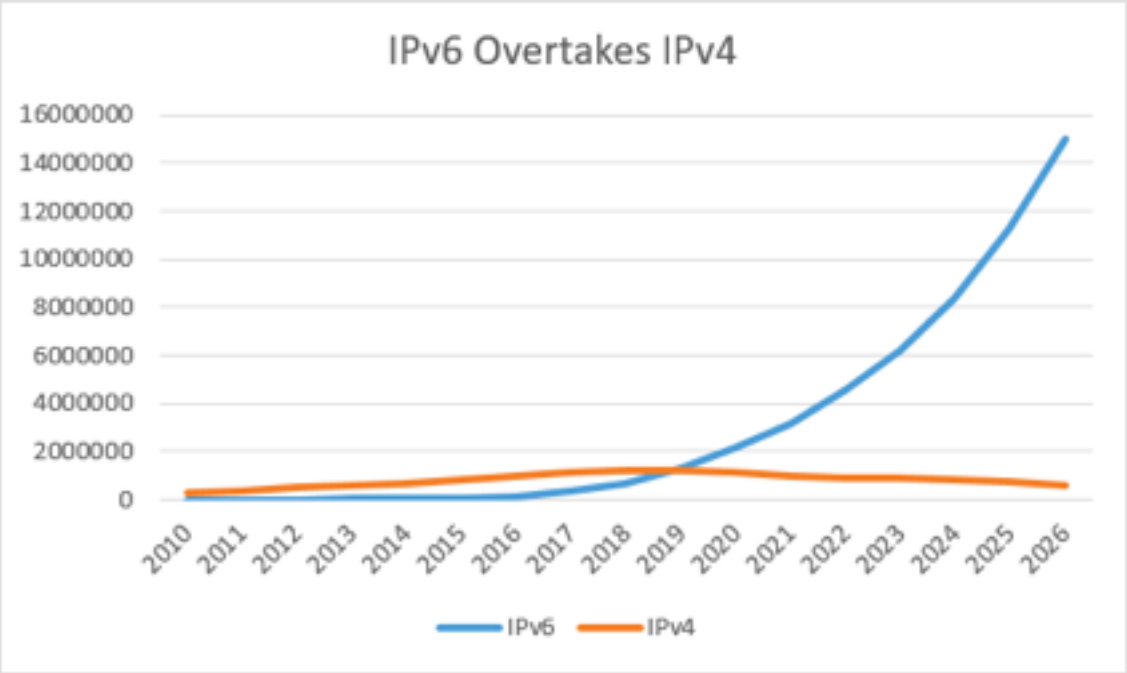
<https://blogs.akamai.com/2016/10/ipv6-at-edge-2016.html>

## Measuring performance – APNIC

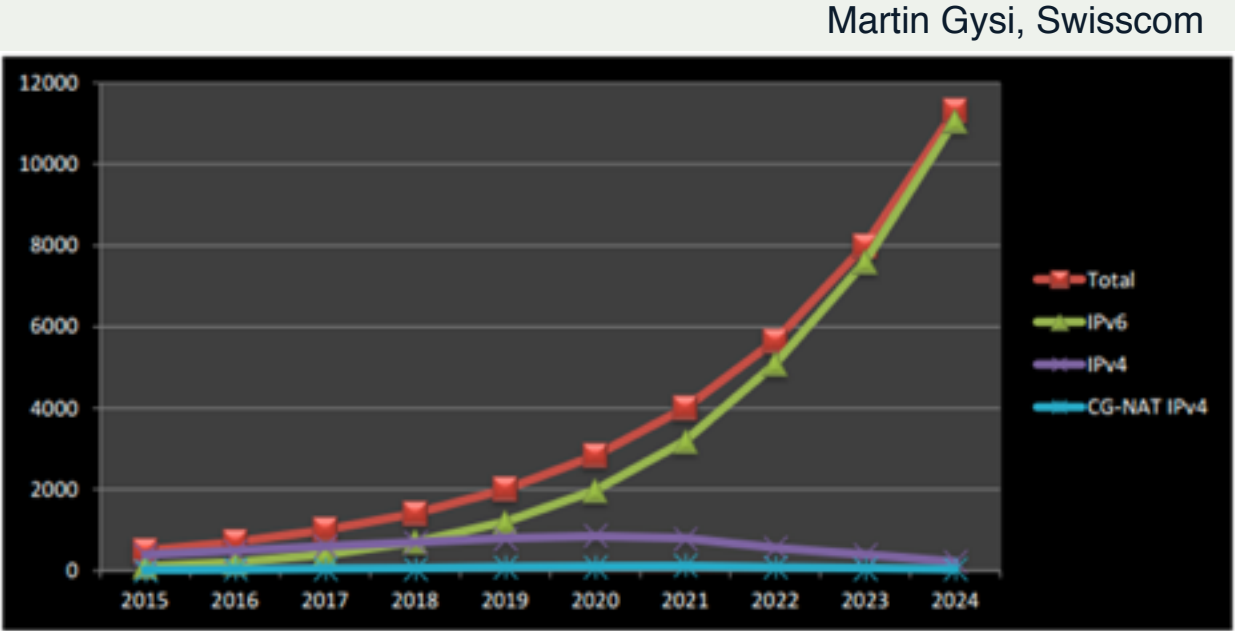


# Measuring IPv6

Projecting the future – when will IPv6 overtake IPv4?

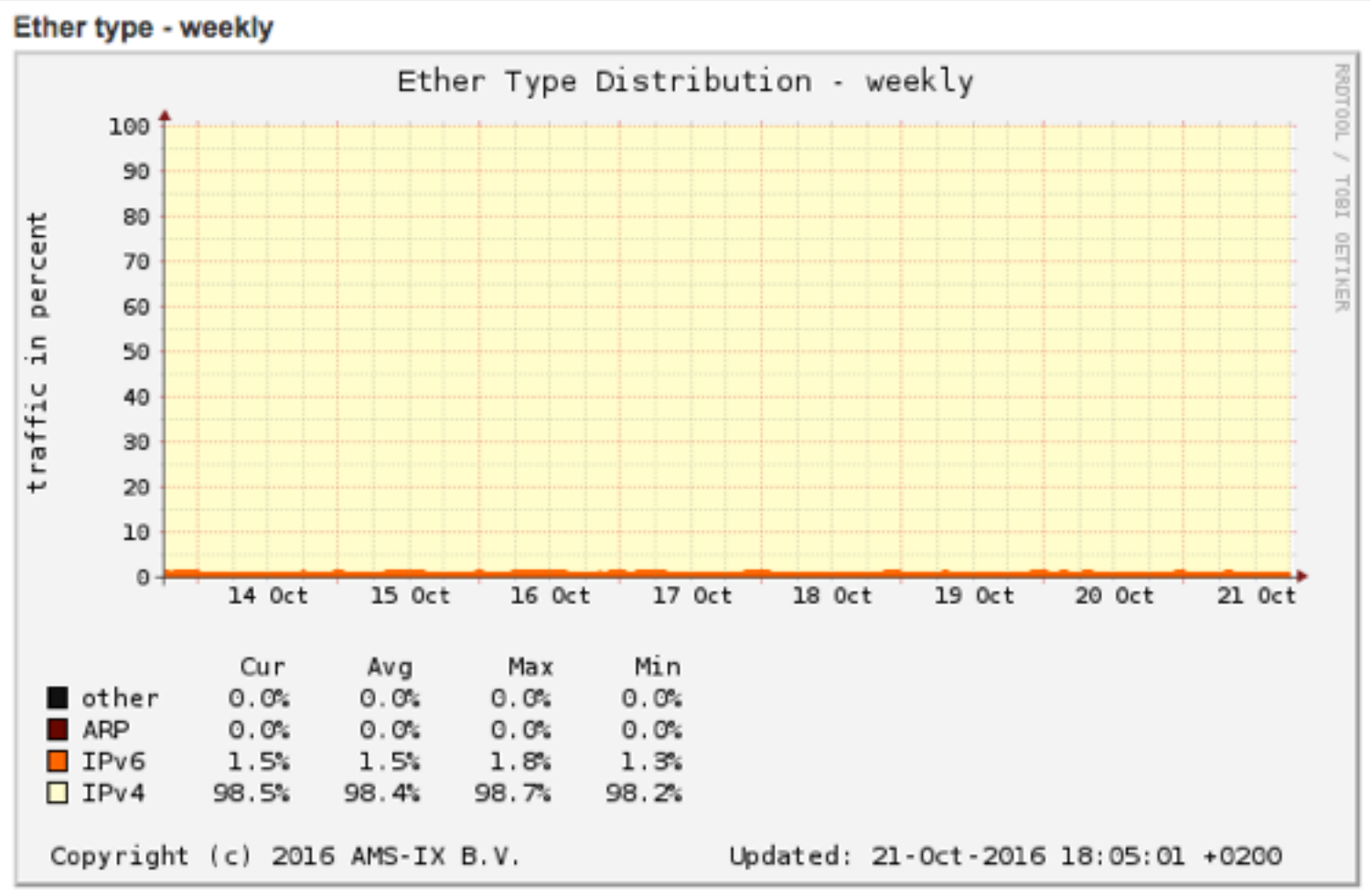


Scott Hogg, Infoblox



# Measuring IPv6

Another vantage point – AMS-IX





# Measuring IPv6

## Conclusions

- IPv6 is real
- IPv6 DNS is very real
- Centralisation of hosting/DNS is helping speed up deployment in some cases
- Web content is growing slowly -> needs to be much more pervasive
- When deployments happen, they can happen fast
- IPv6 is dominant protocol in some cases
- IPv6 is faster in some cases
- Interconnection and/or deployment quality is problematic in some cases
- Different vantage points and methodologies yield different results
- IPv6 will be dominant protocol for many operators in 2 – 3 years

# Sources

World IPv6 Launch: <http://www.worldipv6launch.org/measurements/>

Akamai: <https://www.akamai.com/uk/en/our-thinking/state-of-the-internet-report/state-of-the-internet-ipv6-adoption-visualization.jsp>

APNIC: <http://stats.labs.apnic.net/ipv6/> + <http://stats.labs.apnic.net/v6perf>

Google: <https://www.google.com/intl/en/ipv6/statistics.html>

Eric Vyncke: <http://www.vyncke.org/ipv6status/>

# Thank you.

Matthew Ford  
Technology Program Manager  
[ford@isoc.org](mailto:ford@isoc.org)

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Galerie Jean-Malbuisson 15,  
CH-1204 Geneva,  
Switzerland.  
+41 22 807 1444

1775 Wiehle Avenue,  
Suite 201, Reston, VA  
20190-5108 USA.  
+1 703 439 2120

