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We Secure the Internet.

IPv6

Past, Present, and Future

Bob Hinden

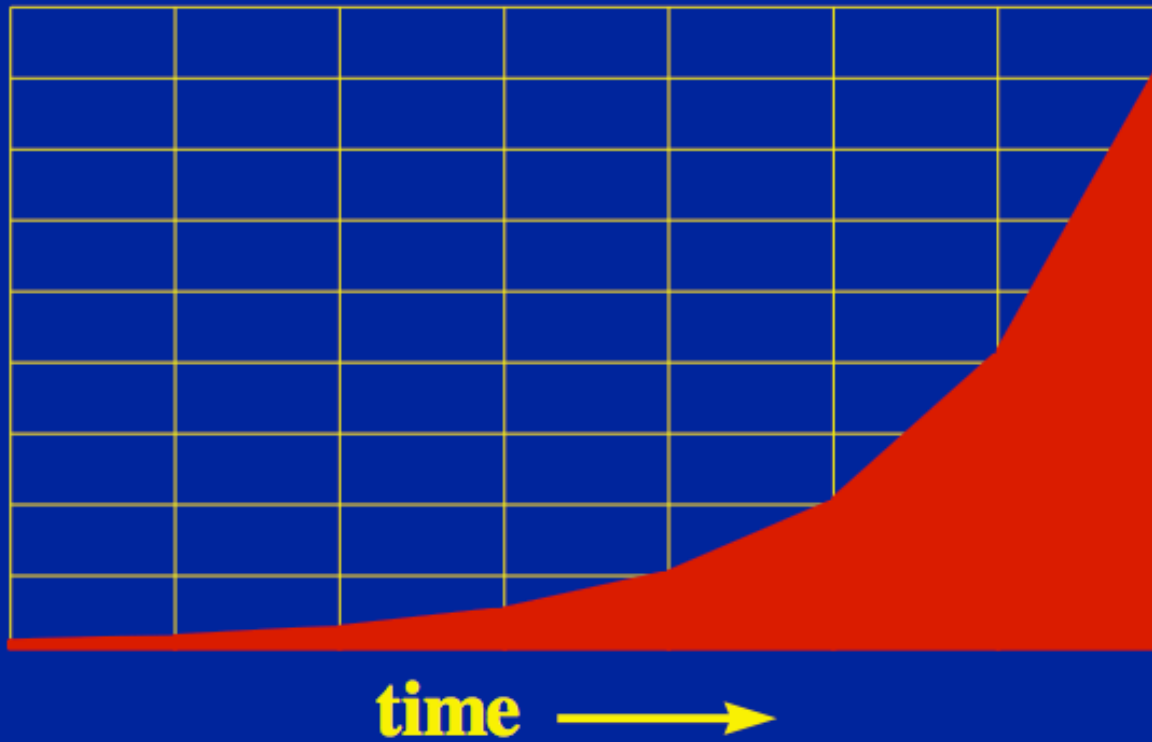Check Point Fellow

Outline

Background

- In the early 1990s it was not clear that TCP/IP was going to be successful

- There were many competitors
  - OSI CLNP, ATM, AT&T Business, etc.

- Predictions of Internet melt downs

- The IETF was not considered an official standards organization

- Not having a plan for what follows IPv4 was a real issue

Some Old Slides

INTERNET GROWTH

time ⟶

6

IPSILON

IETF IPng Time Line

- ~1990
  - Internet growing exponentially and started looking like running out of IP addresses
  - Projected exhaustion of Class B Address space

- 1991
  - Routing and Addressing (ROAD) group formed
    - Recommended implementing CIDR and develop IPng

- 1992
  - IAB issues "IP Version 7"
    - This came to be known as the "Kobe Incident"
      - Result was current IESG and IAB model
  - IETF issues call for IPng proposals
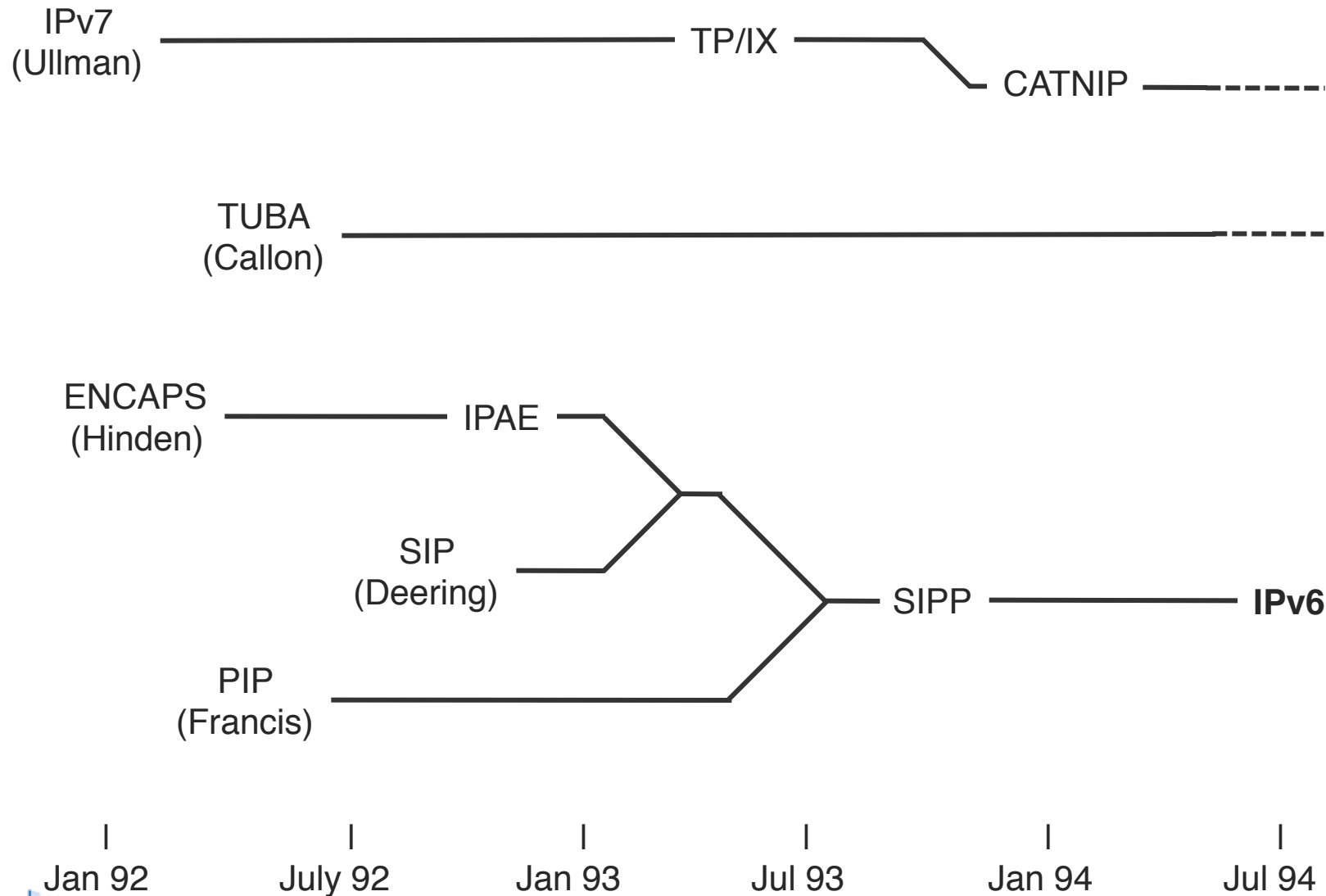
Time Line (continued)

- **1993**
  - IESG took on IPng responsibility
  - IPng Area formed
    - Scott Bradner & Allison Mankin area directors
  - RFC1550 Call for IPng Solicitation published

- **1994**
  - IPng Recommendation

IPng Candidates

IPv7
(Ullman) ——————————————— TP/IX ——————⌐
                                              └─ CATNIP ———— - - - - -

TUBA
(Callon) ————————————————————————— - - - - -

ENCAPS
(Hinden) ————————— IPAE ————⌐
                                    │
SIP   │
(Deering) ——————————————⌐
                             └─————┴———— SIPP ——————————— **IPv6**
PIP   ┌———————————┘
(Francis) ——————————————┘

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      |            |            |            |            |            |
   Jan 92      July 92      Jan 93       Jul 93       Jan 94       Jul 94
```

IP Version Numbers

Version	Name
0-3	Unassigned
4	Internet Protocol (current IPv4)
5	Stream Protocol (ST) (not an IPng)
6	SIP – SIPP – IPv6
7	IPv7 – TP/IX – CATNIP
8	Pip
9	TUBA
10-15	unassigned

The Address Size Debate

- Fixed length 64-bit addresses
  - Met requirements by 3 orders of magnitude, 10^{12} sites, 10^{15} nodes at .0001 allocation
  - Minimizes growth of packet
  - Efficient for software processing

- Variable length addresses, up to 160-bits
  - Compatible with OSI NSAP address plans
  - Large enough for auto-configuration using IEEE 802 addresses
  - Could start with short addresses and grow later

- Compromised on fixed length 128-bit addresses

IPng Recommendation

- IPng based on SIPP with 128-bit addresses

- IPng working group created to create specifications and standardize IPv6
  - Chairs: Steve Deering, Ross Callon
  - Document editor: Bob Hinden

- Goal to resolve remaing issues, complete unfinished work, move to Proposed Standard
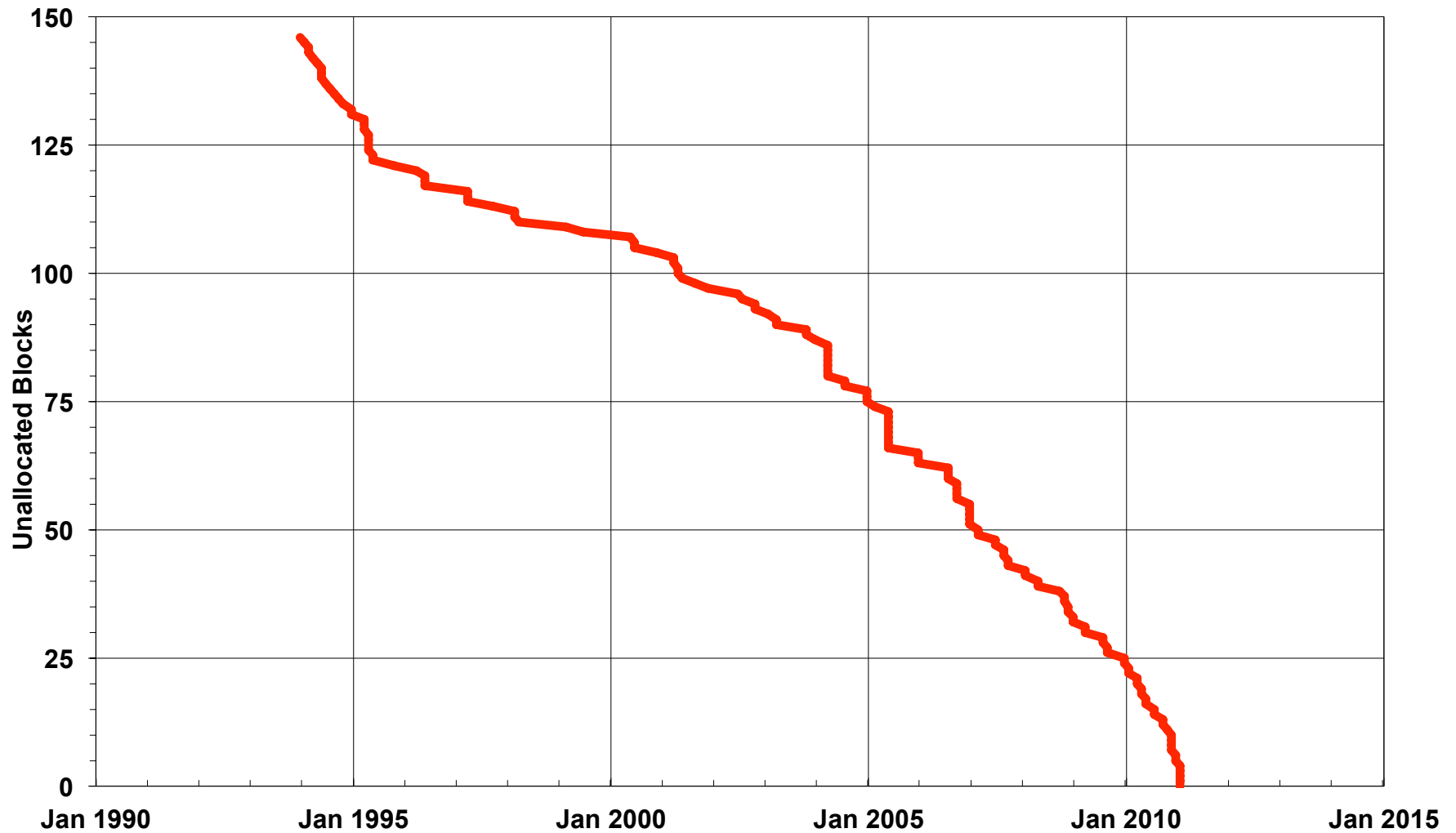 - IPv6 first published as RFC1883 December 1995

Outline

1 How IPv6 was invented

2 **Where we are now**

3 The next steps

We did run out of IPv4 Addresses

(Last allocation to RIRs from the IANA free pool 31 Jan 2011)

World IPv6 Launch

THE FUTURE IS FOREVER
6 JUNE 2012

Major Internet service providers (ISPs), home networking equipment manufacturers, and web companies around the world are coming together to permanently enable IPv6 for their products and services by 6 June 2012.

Organized by the Internet Society

http://www.worldipv6launch.org/

IPv6 Deployment Status

ISP's

- Backbone ISP's support IPv6 today
- Broadband ISPs are adding IPv6 support
- Wireless ISPs support underway

Products

- Routers, Switches
- Firewalls, IPS
- Load Balancers
- Win 7 / Vista
- MacOS X
- Linux / BSD
- IOS / Android

Content Providers

- Google
- Yahoo
- Facebook
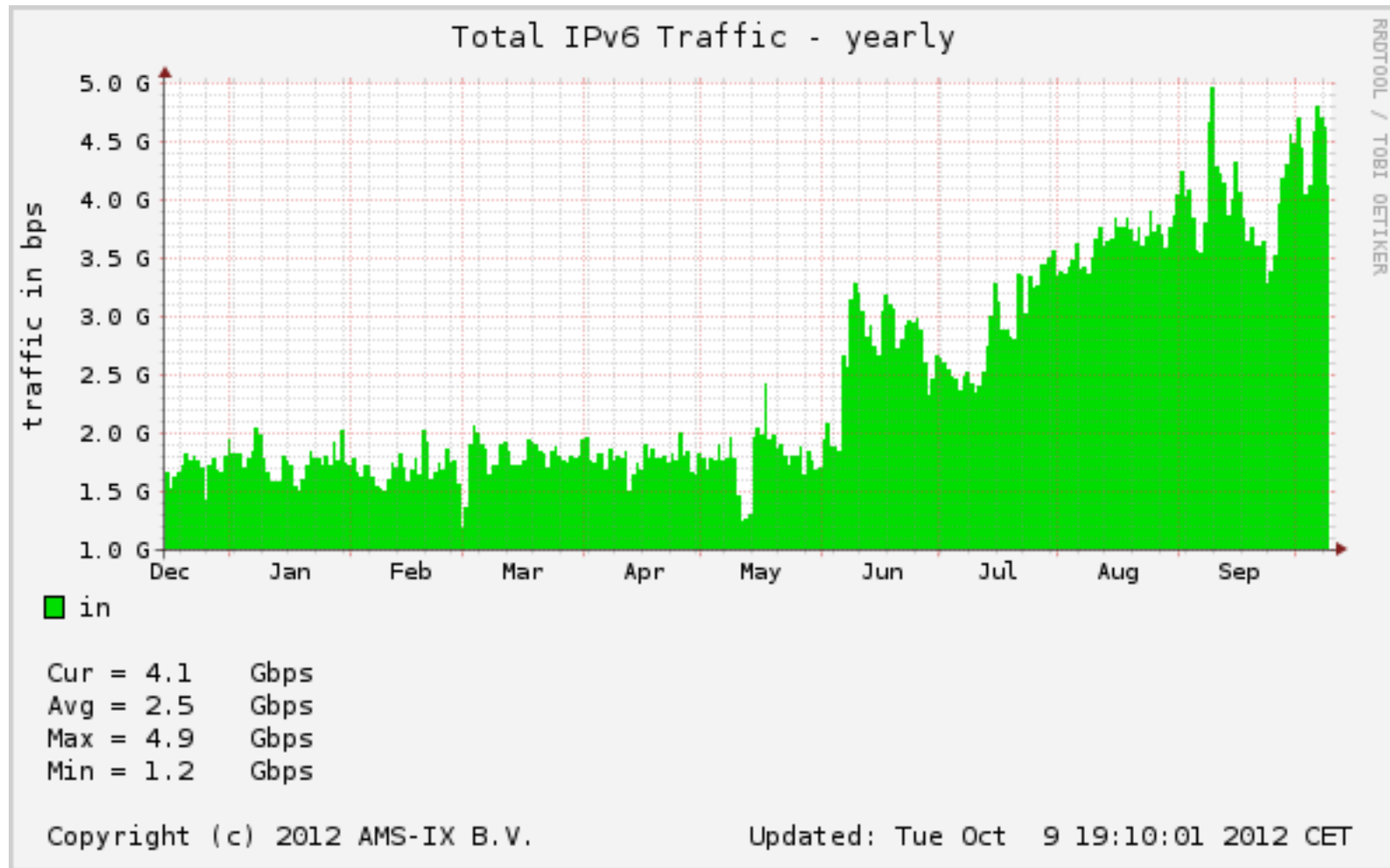- YouTube
- Netflix
- Microsoft Bing
- Akamai
- .....
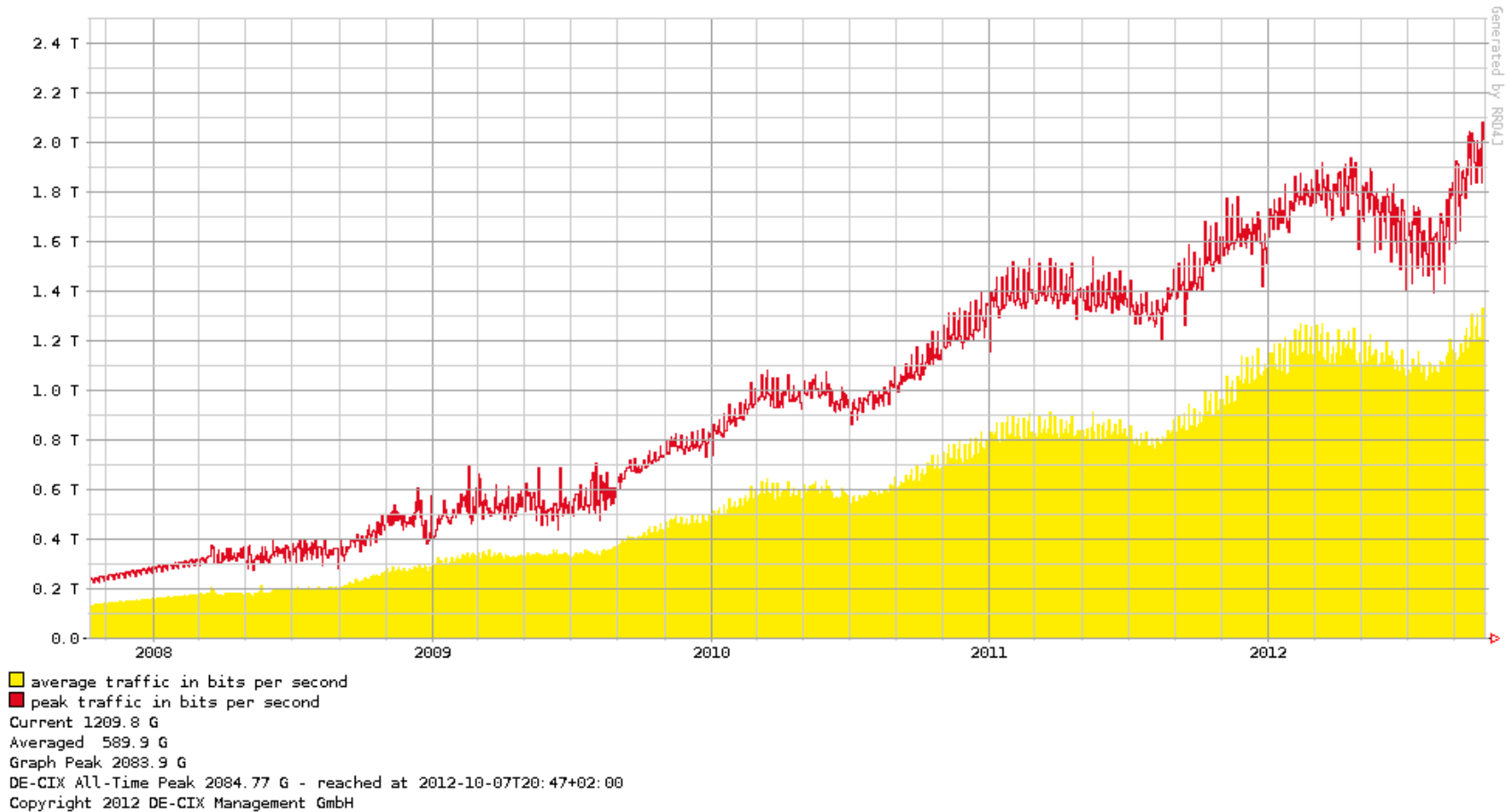
Slovenia highest % of IPv6 sites in Alexa Top 50 by Country

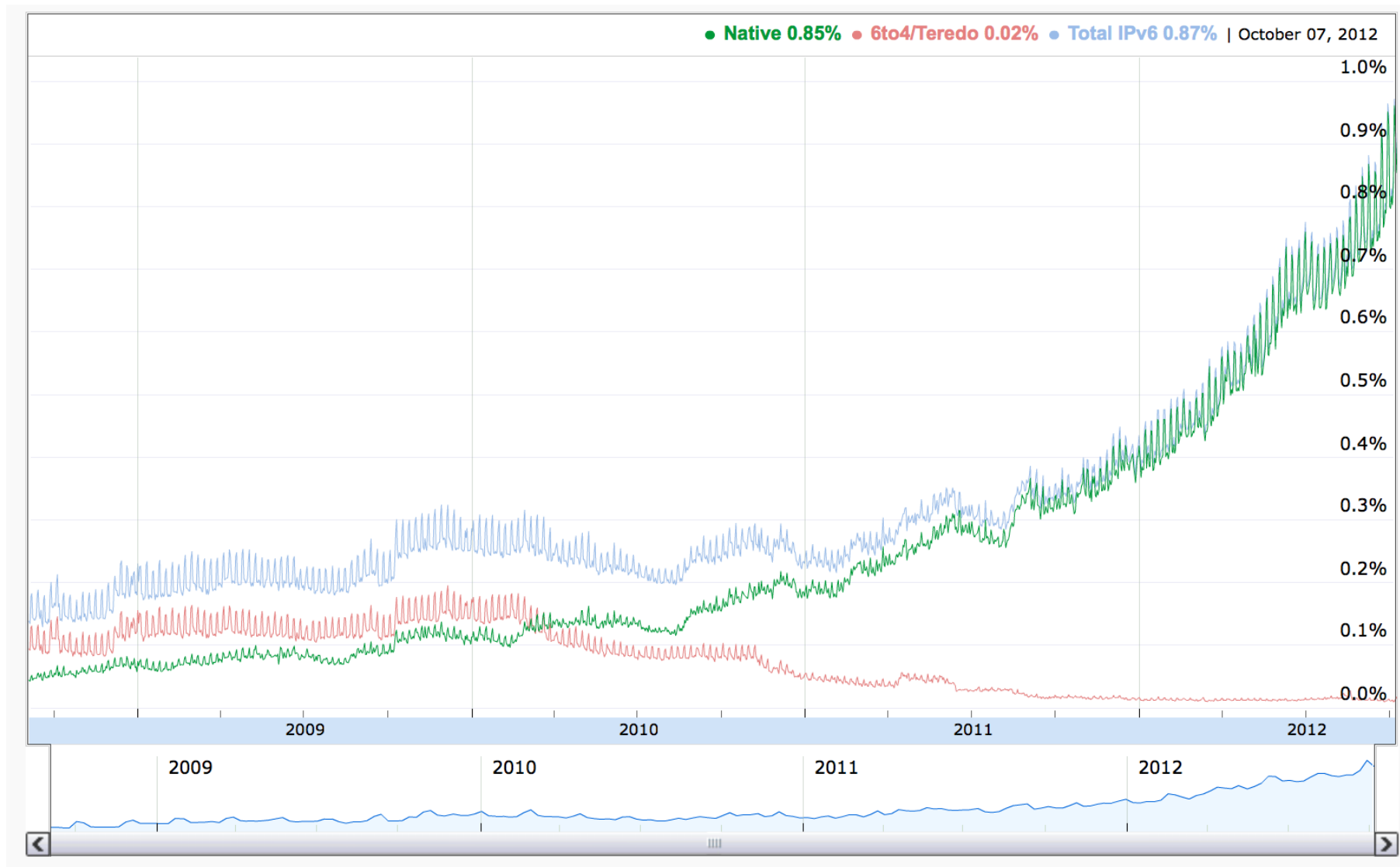http://www.vyncke.org/ipv6status/gmap.php?metric=W&region=150

IPv6 Traffic at Amsterdam IX

https://www.ams-ix.net/technical/statistics/sflow-stats/ipv6-traffic

DE-CIX IPv6 Traffic

http://www.de-cix.net/about/statistics/

Users accessing Google with IPv6

(http://www.google.com/ipv6/statistics.html)

% of AS's Announcing IPv6

% of ASes announcing an IPV6 prefix

| Zoom | 3m | 6m | 1Y | 2Y | 3Y | 5Y | 10Y | From: | Oct 1, 2007 | To: | Oct 1, 2012 |

ASes announcing an IPV6 prefix (%)

- Australia
- China
- India
- Japan
- Netherlands
- New Zealand
- OECD member states
- South Korea
- United States

40

30

20

10

0

−10

10. Mar   1. Sep   23. Feb   10. Aug   1. Feb   26. Jul   10. Jan   27. Jun   12. Dec   21. May   1. Oc

Sep '04   May '06   Jan '08   Sep '09   May '11

Source: RIPE

http://www.ipv6.org.nz/metrics/metric-1/
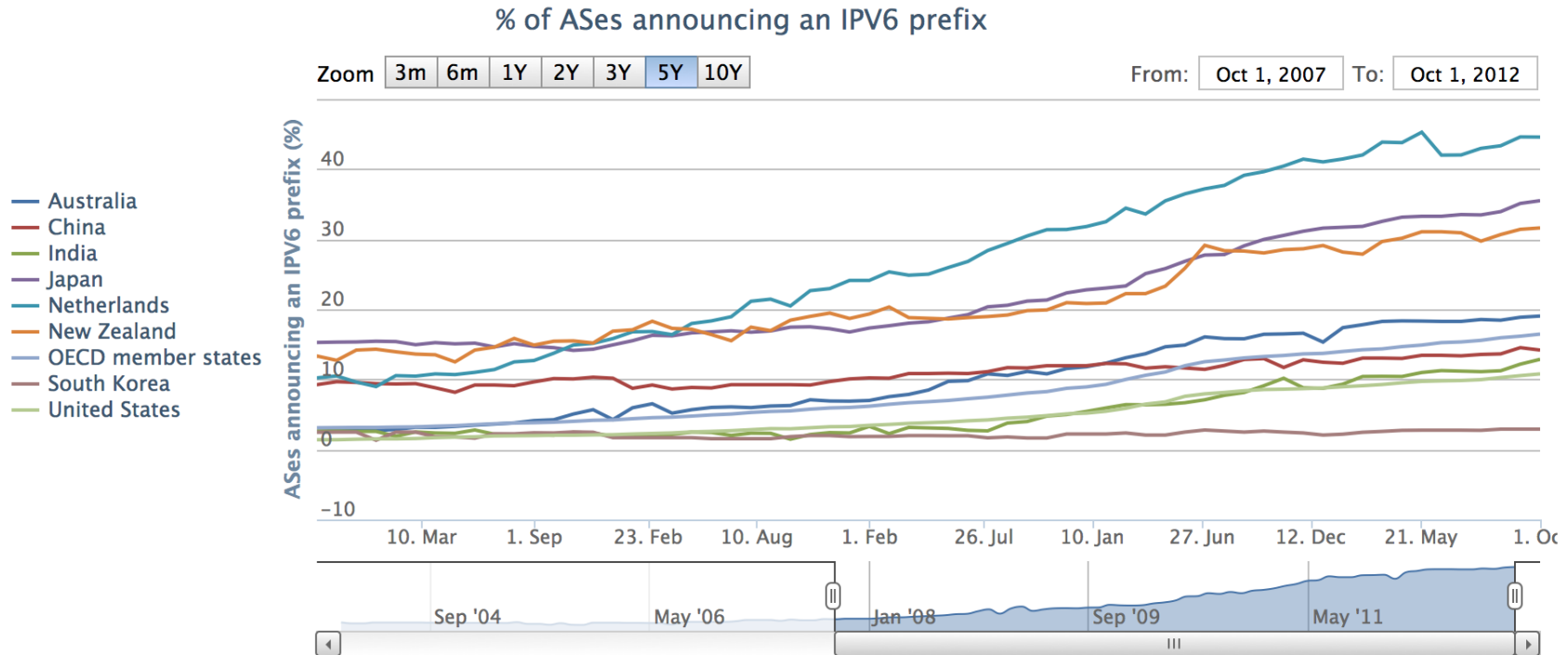
CAIDA AS Interconnection comparison

IPv4   IPv6

Peering: OutDegree
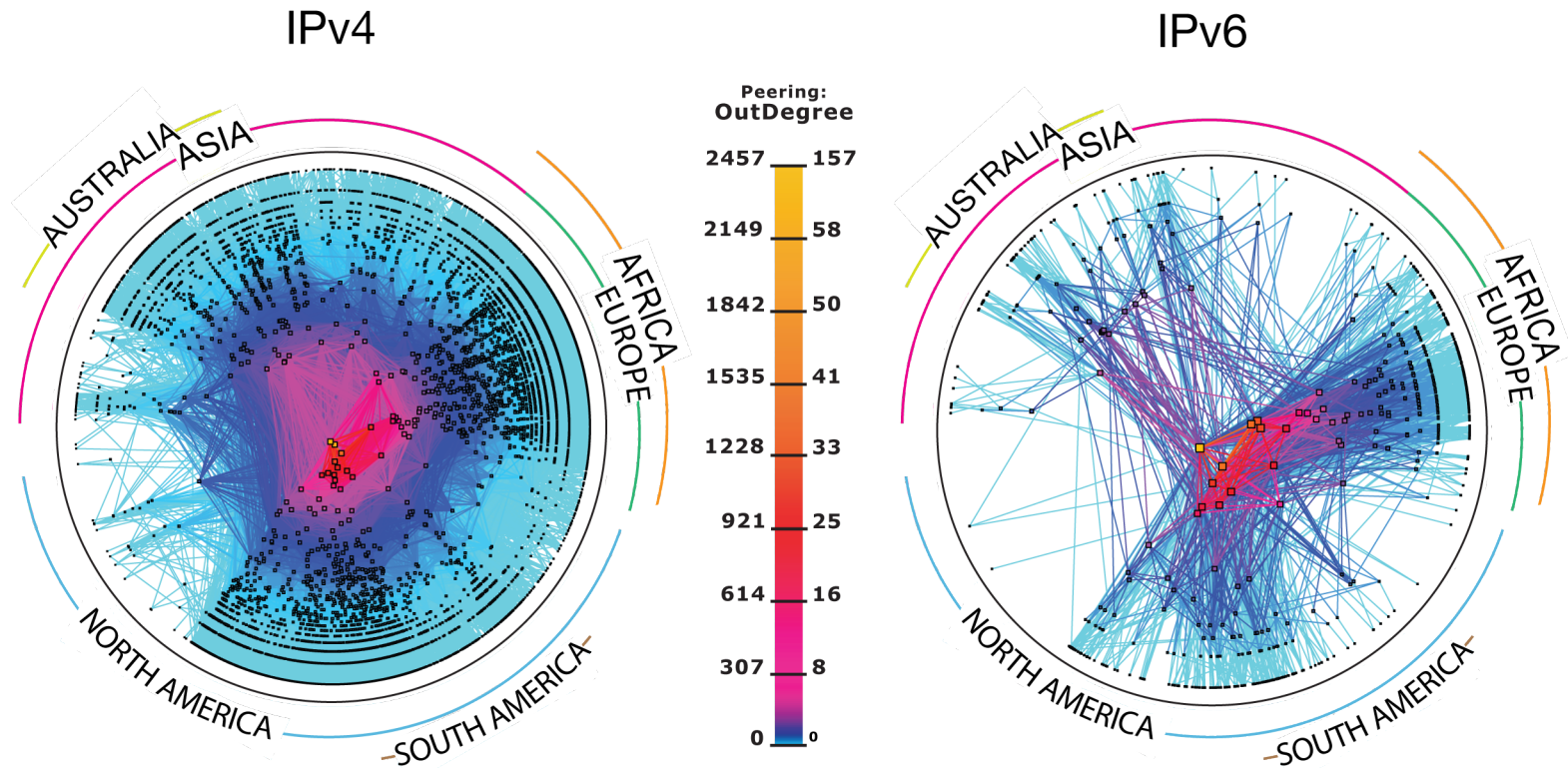
http://blog.caida.org/best_available_data/wp-content/uploads/2011/06/ascore-ipv4-ipv6.simple.2010.09.png

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(Short Demo)

Current Summary

Great progress in past few years

Many major deployment hurdles overcome

Question changed from:

"Why deploy IPv6" to "How do I deploy IPv6"

Outline

1 How IPv6 was invented

2 Where we are now

3 **The next steps**

What We Need To Do Next

Next Tier of Web content
- Governments
- News sites
- Banking
- Commerce

Access Networks
- WIFI in hotels, coffee shops, airports, ...
- LTE / 3G worldwide
- DSL/Cable worldwide

Enterprise Networks
- What is the business case?
- Is communicating with customers enough?
- Is this a Y2K like issue?

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The Good News

IPv6 Enabled Content

- About 80% of total Internet traffic comes from content providers who support IPv6

IPv6 Support

- Very good and broad IPv6 support in production products

As access providers enable IPv6 we will see IPv6 traffic increase quickly

Closing Thoughts

The transition to IPv6 is only a step in the Internet's evolution

The goal is a world where everyone and everything is connected on the Internet

IPv6 allows us to move toward the Goal

Thank You!

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