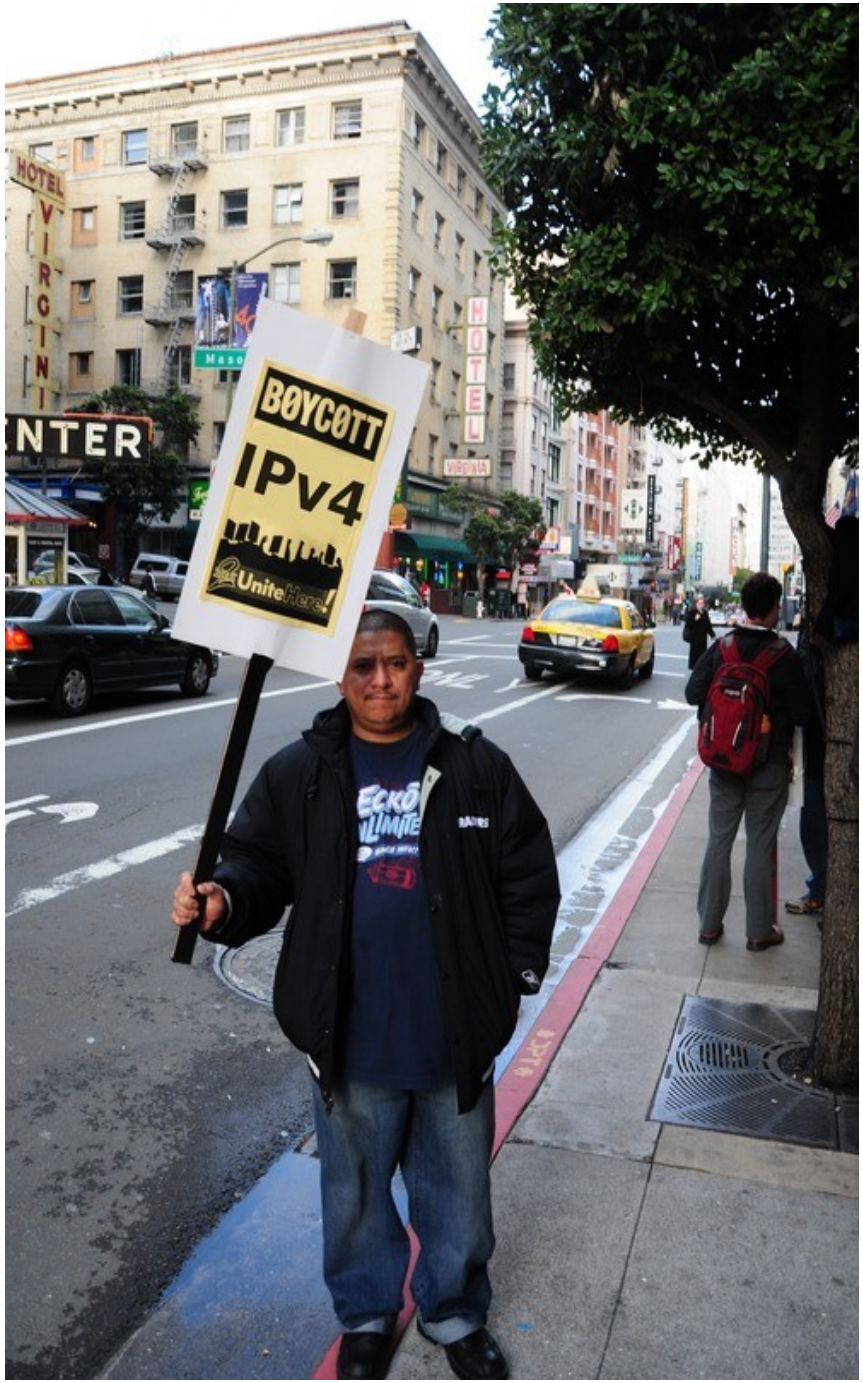


Experiences from an IPv6-Only World at Ericsson

What if there was no IPv4?

Jari Arkko and Ari Keränen
Ericsson

ERICSSON

Moving to an IPv6-Only Network

Our sites had been in dual stack for years

It all worked very well, so clearly we had to try something else

- At some point someone will move to this type of a network

We had several goals:

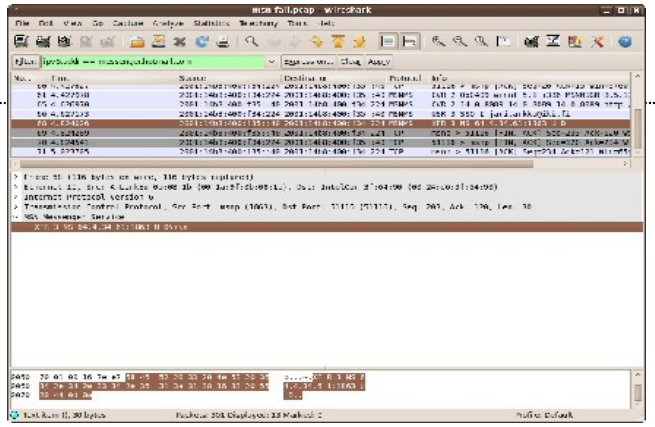
- Find out what works or breaks with IPv6-only
- Build an understanding to recommend dual stack and IPv6-only for the right situations
- Test our implementations

The IPv6-Only Experience

- Three sites, a small group of opt-in users
- IPv6-only network design
  - NAT64 + DNS64 in various configurations on the different sites
  - IPv6 was already in 24x7 use, dual stack retained as alternate
- Plenty of things work well
  - Browsing, e-mail, software updates, streaming, many chat systems
- On some handsets, 100% functionality
- Some issues in general environments
  - Host OS testing issues, usability, some applications fail, some appliances have no IPv6, some firewall issues

Example Issues in Messaging and Gaming

Messaging System	Works?
Facebook on the web (http)	Yes
Facebook via a client (xmpp)	Yes
Jabber.org chat service (xmpp)	Yes
Gmail chat on the web (http)	Yes
Gmail chat via a client (xmpp)	Yes
Gtalk client	No
AIM (AOL)	No
ICQ (AOL)	No
Skype	No
MSN	No

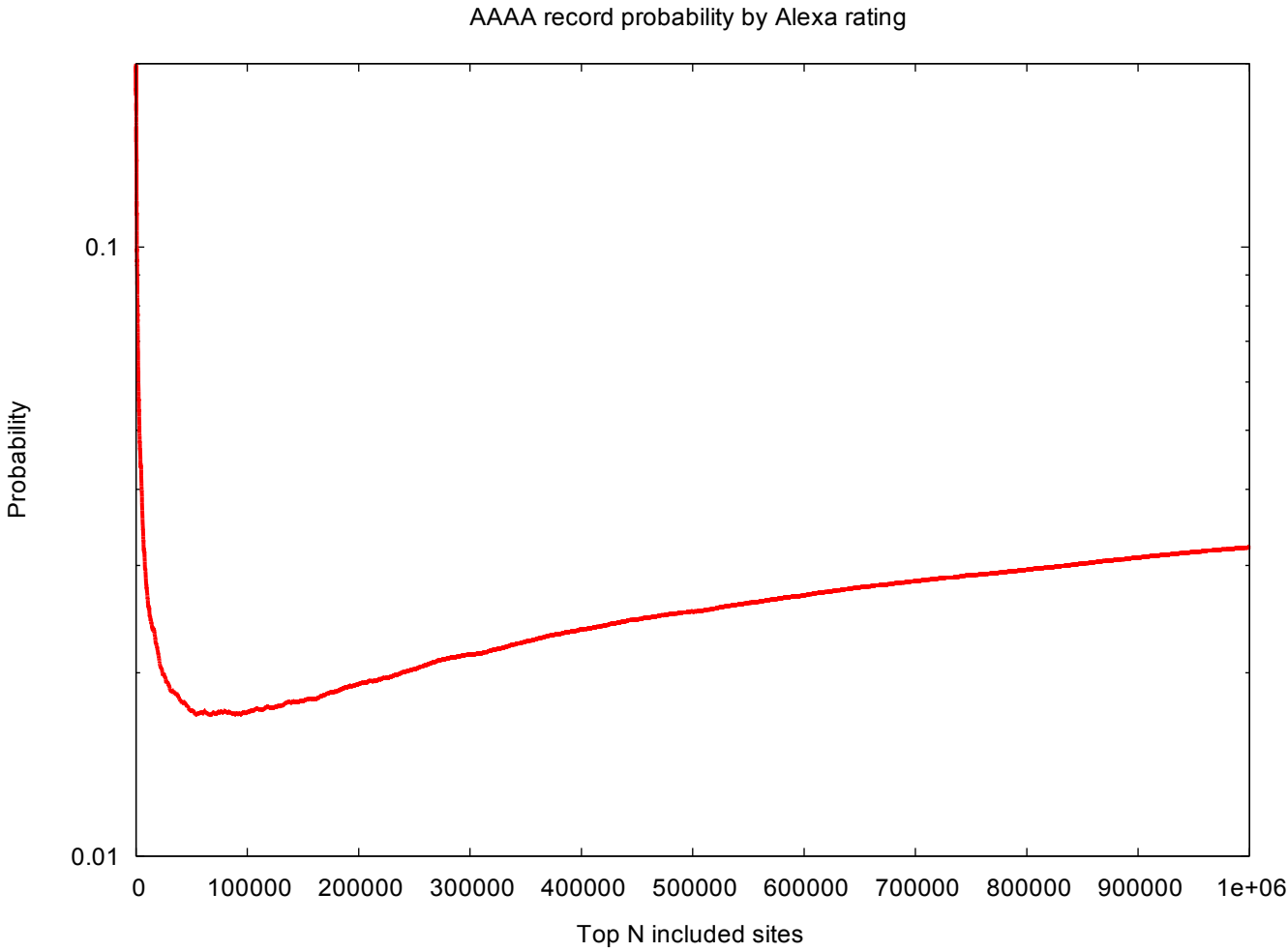


Unable to connect to Second Life.
DNS could not resolve the host name.
Please verify that you can connect to the www.secondlife
web site. If you can, but continue to receive this error,

Game	Works in LAN/NW mode?
Web-based (e.g. armorgames)	Yes
Runescape (on the web)	No
Flat out 2	No
Battlefield	No
Secondlife	No
Guild Wars	No
Age of Empires	No
Star Wars: Empire at War	No
Crysis	No
Lord of the Rings: Conquest	No
Rome Total War	No
Lord of the Rings: Battle for Middle Earth 2	No

Measurements – Basic Connectivity

- 3.2% of Alexa top 1M web site list has an AAAA record somewhere (www.example.com, ipv6.example.com, etc.)
- If we eliminate Google, this number drops to 1.1%
- IPv6-only alone is a very limited experience!
- NAT64 helps with this

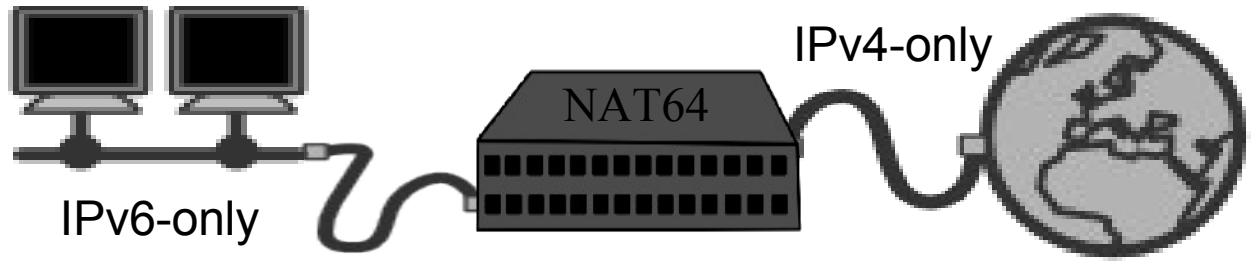


Measurements – Failures (IPv4 vs. IPv6)

- Measured failures with IPv4 and dual stack to Alexa sites
- Base IPv4 failure rates are relatively high – over 1%
  - Due to routing, server, temporary glitch, bankruptcy, authority intervention, ...
- With dual stack to destinations with both A and AAAA records, IPv6 failure rate was double that of IPv4
  - Likely a technical issue – DNS/server state mismatch, firewall blocks IPv6, etc.
- We've seen content providers reluctant to turn IPv6 on for fear of bad IPv6 connectivity at the end user side – but this seems to work the other way, too...

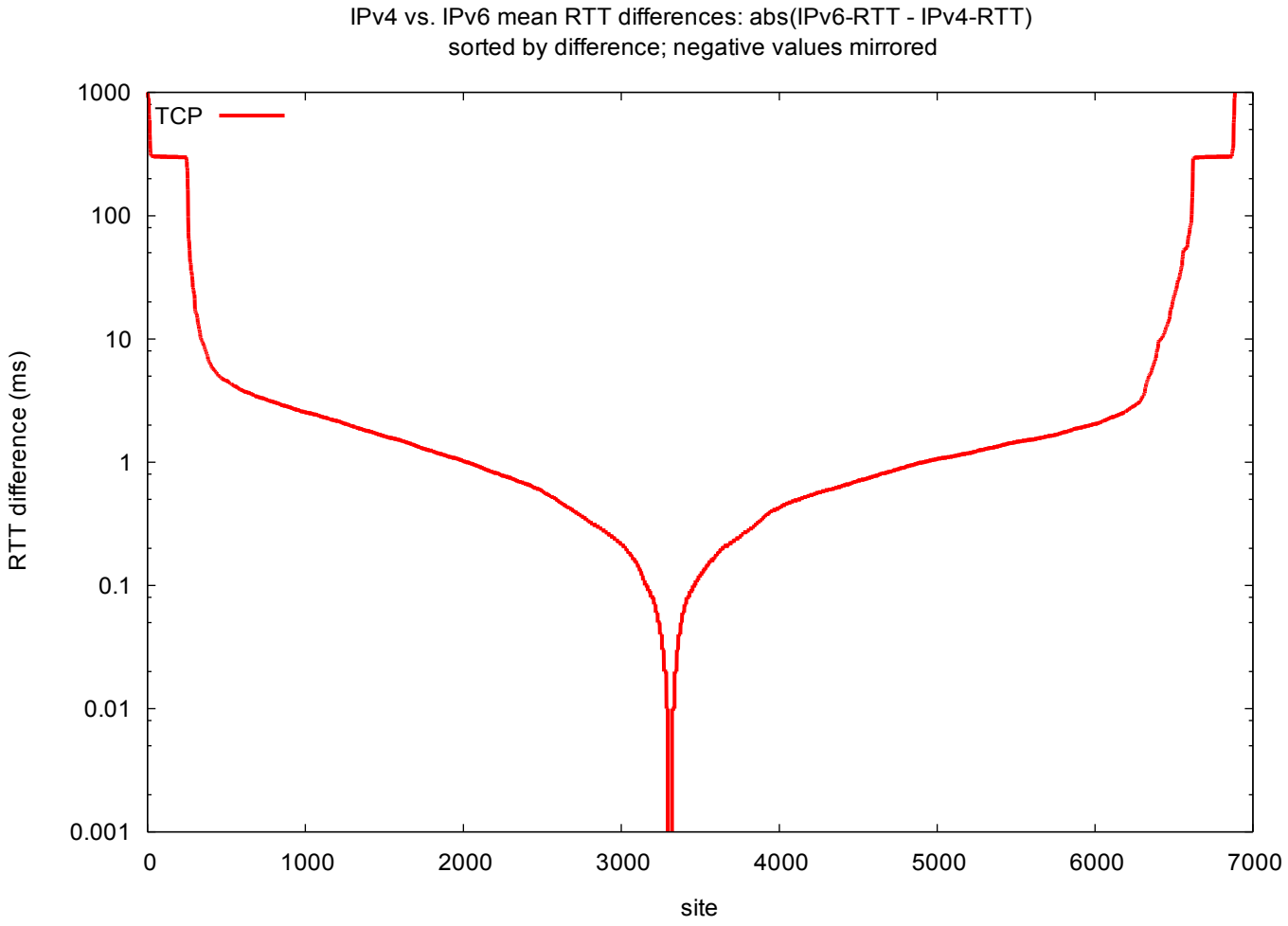
Measurements – Failures (NAT64)

- Failure rates through NAT64 are similar to those with dual stack (1% / 2% for IPv4/IPv6 destinations)
  - But unlike our measurement, real applications tend to allow for fallback, though not always with reasonable timeouts
  - There is no such fallback in IPv6-only through a NAT64 per RFC (but this could of course still be done)
- Interestingly, a NAT64 that always forces IPv4 is best!
  - DNS64 never asks for AAAA and lets NAT64 always translate
- This degenerate configuration has just 1% error rate



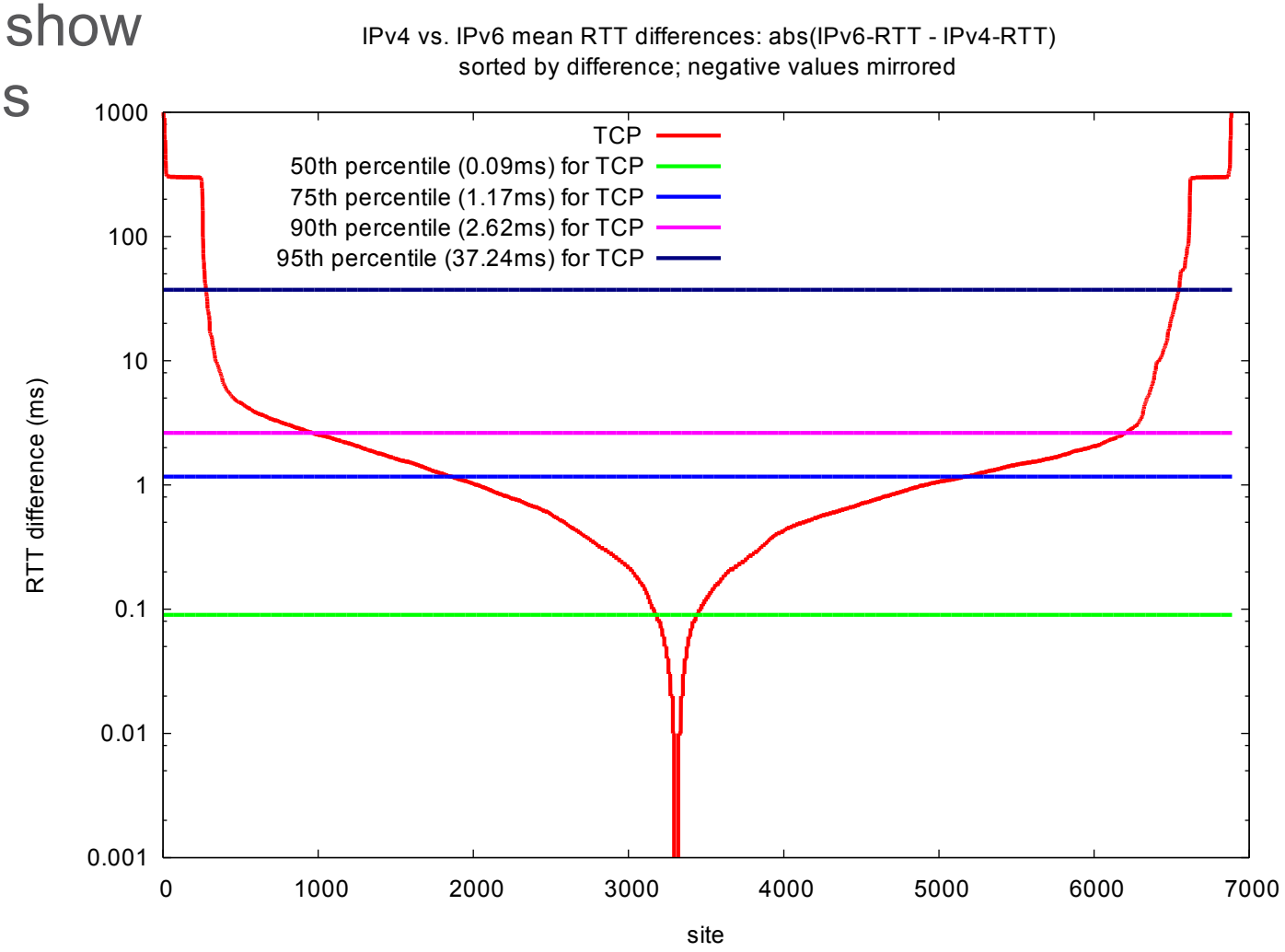
Measurements – Delays

- IPv4 and IPv6 delays in dual stack are very similar



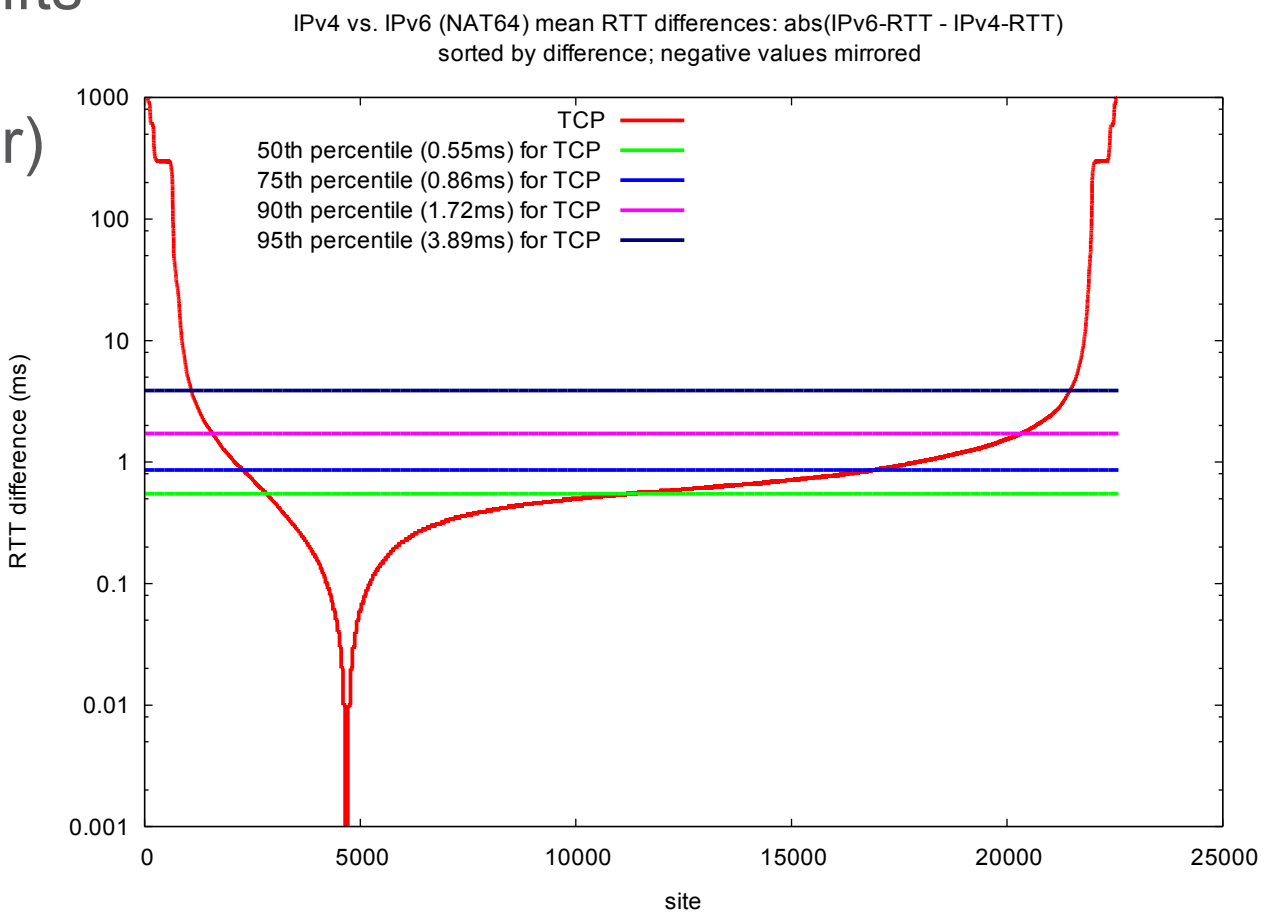
Measurements – Delays

- IPv4 and IPv6 delays in dual stack are very similar
- Percentiles show when IPv6 is slower
- Notice the 5% with a significant difference
- Could be packet loss or just bad IPv6 routing



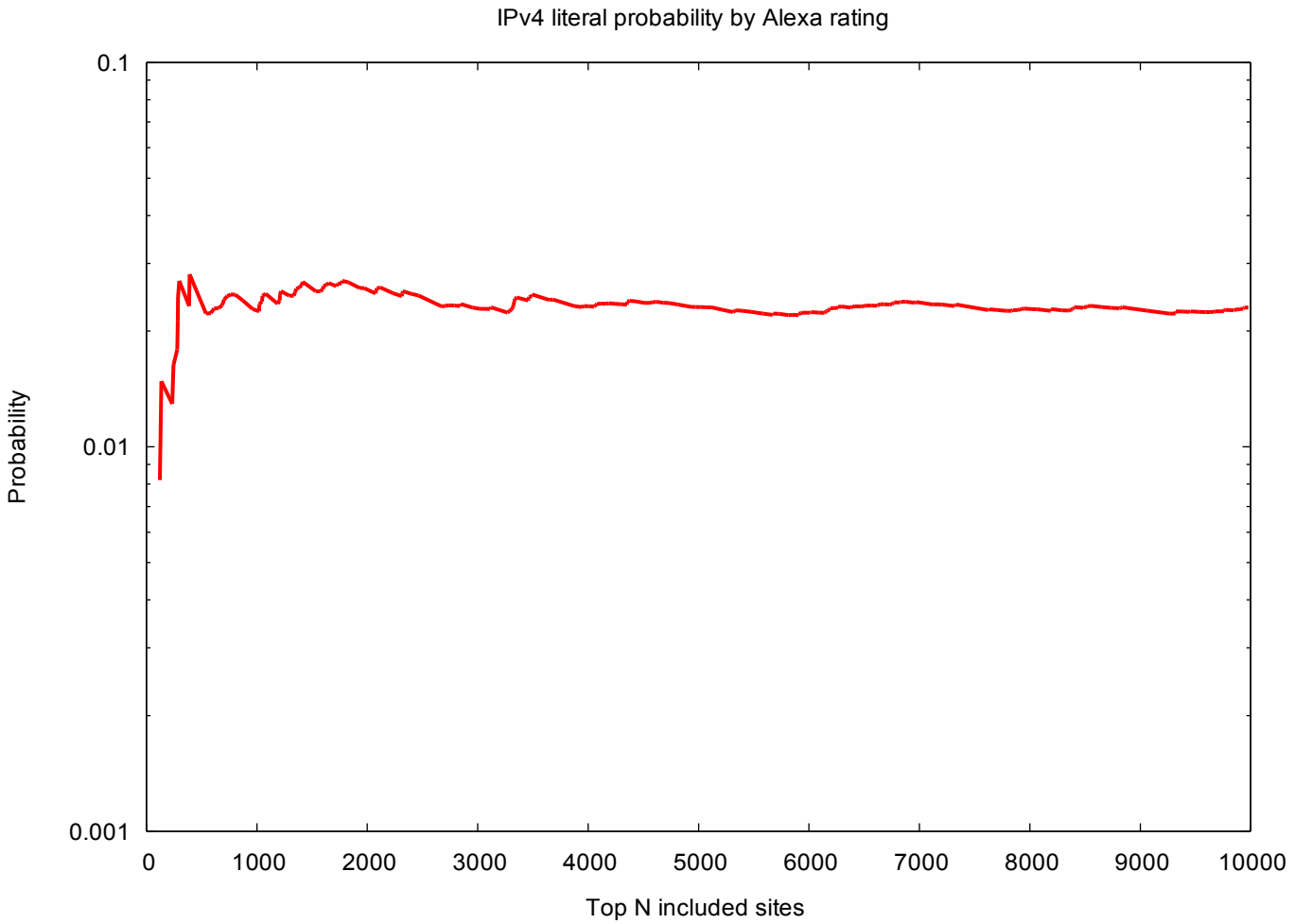
Measurements – Delays

- NAT64 introduces a small delay, comparable to router/NAT44 hop (note: absolute values not very interesting)
- Middle point shifts to left (but real change is minor)
- This test was done with the degenerate NAT64 config: notice the small variation



Measurements – IPv4 Literals

- With 100 top sites, 0% needed an IPv4 literal to render all components in their top page
- Beyond 100, this number increases to 2%
- Real effect unclear
- Personal experience is that the effect is neglible



Concluding Remarks

- We hope that this data helps better understanding of issues and performance in various network configurations
- Specific configurations have a significant effect on failure rates, for delays there does not seem to be a big impact
- In general, dual stack should still be our preferred mode
- IPv6-only can also be recommended today
  - Particularly for early adopters, mobile networks, …
  - The degenerate config would help problems with bad IPv6
- And tomorrow for everyone, but this needs some work
  - Fixing bugs, DNS discovery, cleaning IPv4 literals, Skype, messaging, gaming... and much of this is a one time-effort

More information: draft-arkko-ipv6-only-experience, Carpenter @ IEPG, Comcast IPv6 adoption monitor, IETF network IPv6-only experiment results, ...