Changing Perspectives on IPv6

The Exhaustion Risk

- Running out of IPv4 addresses was predicted to be as catastrophic as running out of telephone numbers
  - No more numbers, no more new users of the network
  - If the network cannot grow, then it dies
- We can’t let IPv4 run down to the last IPv4 address
- We need to design, build and deploy a new IP protocol before we get down to the last IPv4 address
- That was the thinking in 1990 or so when the IETF grappled with the news of imminent address failure in IPv4

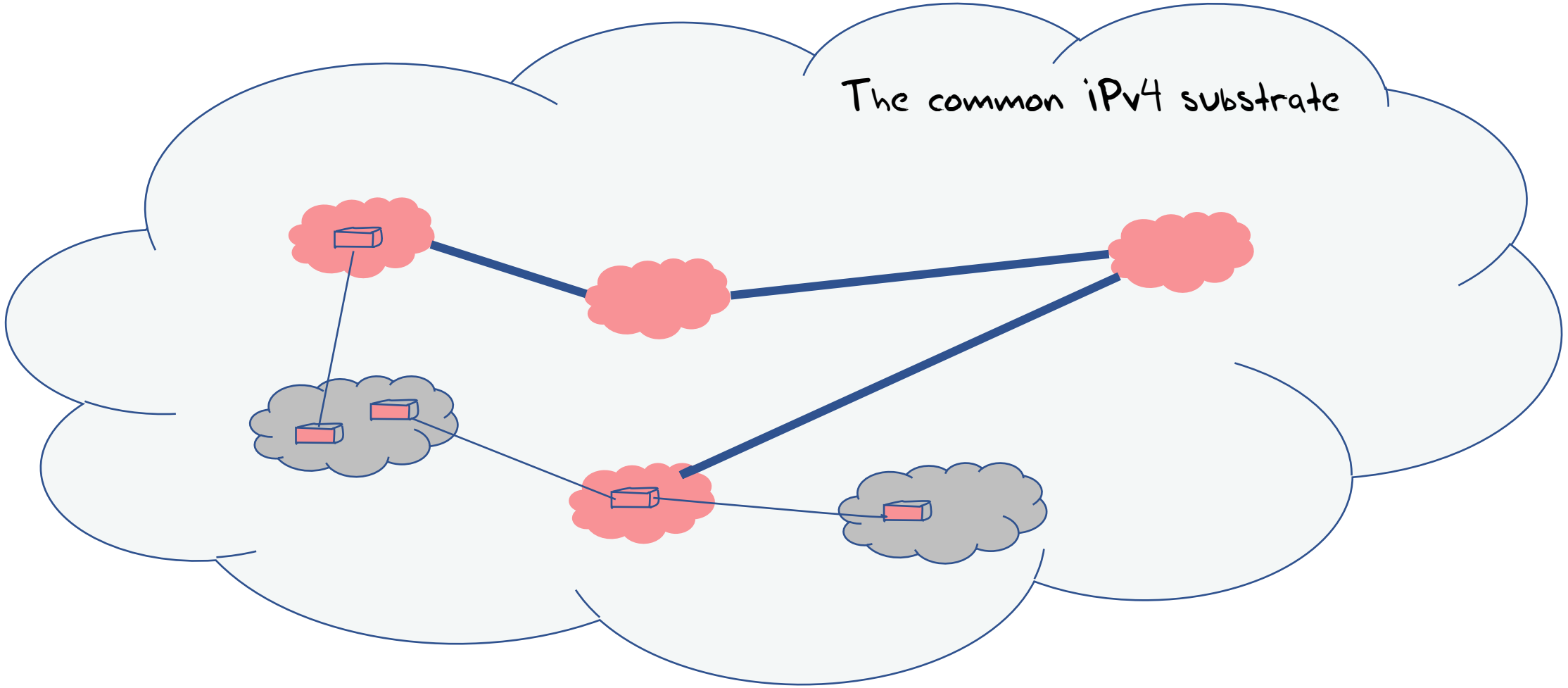
Enter IPv6

- IPv6 was intended to be the “minimal” change approach
- Keep most of IPv4 intact, but just recompile the protocol stack with 128 bit addresses
- But
  - This time we were not building in a greenfield location – we had to build in a space that was already populated with IPv4. We had to think about co-existence and transition as well.
  - We could not resist the temptation to address some of the niggling issues with the IPv4 design
  - And none of us were economists – we never looked at the acceptance of IPv6 in business and economic terms – it was just a technical question and only a technical question

IPv6 was as not “perfect”

- And some aspects were clearly inferior to IPv4 at the time

Tunnelling - IPv6 over IPv4



Tunnelling - IPv6 over IPv6

- Issues with managing MTU
- Issues with manual configuration of network-to-network tunnels
- Issues with auto-brokered tunnels (6to4)
- Issues with IPv4 and NAT traversal (Teredo)

- Despite the best of intentions tunnels were fragile and a significant performance hit

Dual Stack Hosts

- How does the host protocol stack manage ‘transparent’ connectivity when the host has IPv4 and IPv6?
- Try IPv6 and if the connect attempt fails then retry using IPv4?
- Try both at once at the same time and work with the first to complete
- Try IPv6 and then try IPv4 “soon” afterward

Multi-Addressing and Site Multi-homing

- How do IPv6 hosts select the “right” source address when the host has multiple IPv6 addresses on the same interface?
- How can a site use provider-based prefixes from multiple providers and use the “right” interface to the “right” provider (the SHIM6 problem)

IPv6 MTU handling and ICMPv6 Filtering

- Packet size mismatch requires the router to signal the source of the problem via ICMPv6 message
- But many networks filter ICMP messages as a security practice
- Which results in “black holes” where

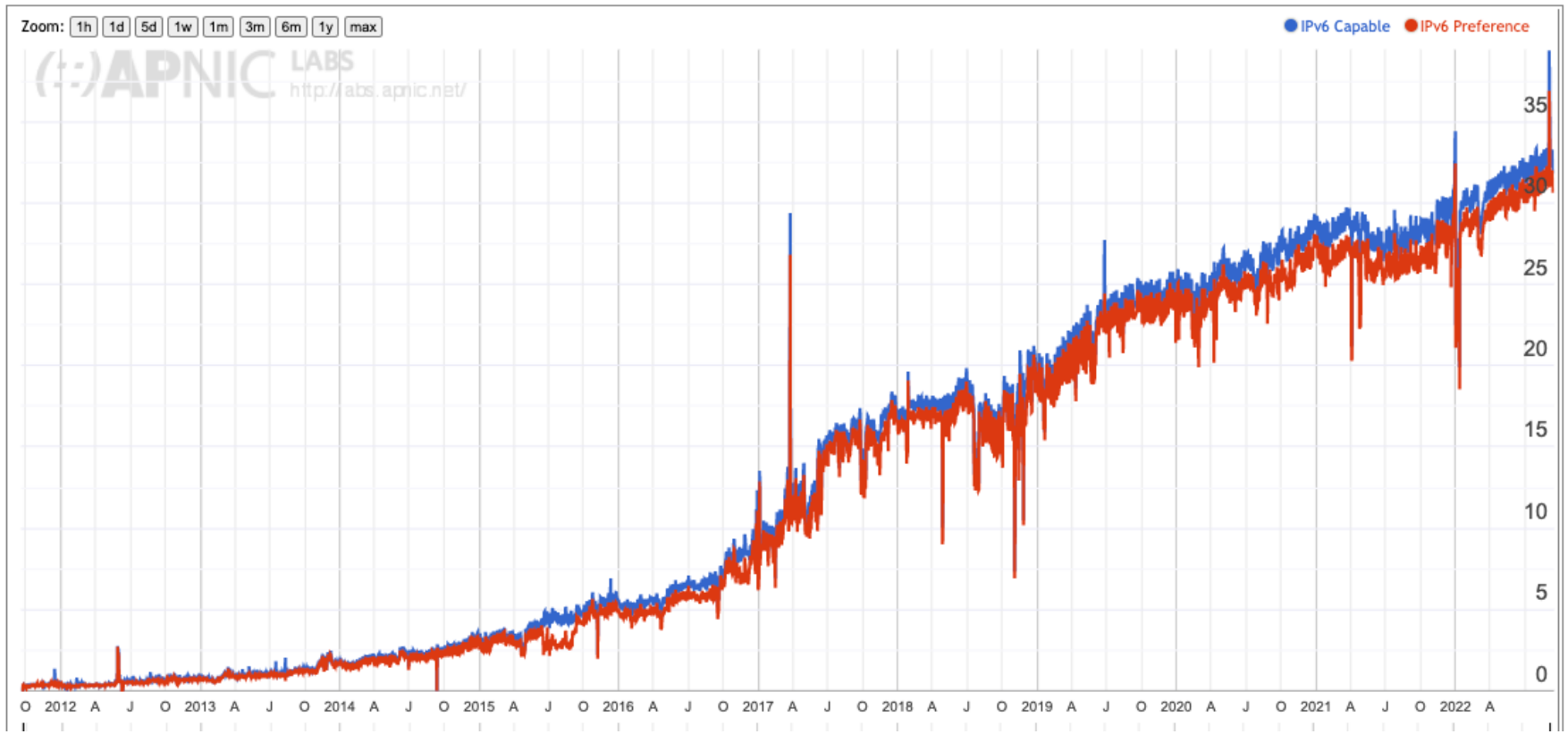
So the Industry was not confident about IPv6

- Remaining with IPv4 and increasing the use of NATs was a comfortable approach that did not stress out the support capabilities of the platform providers, access providers and service providers
- IPv6 ran the risk of creating additional operational fragility into the service environment that operators and support structures were ill-equipped to manage
- Better to just wait

How could we demonstrate that IPv6 was viable?

- By performing an objective measurement that showed the level of IPv6 adoption across the entire Internet all of the time, and at a level of granularity that showed the level of IPv6 support within each network

Use of IPv6 for World (XA)



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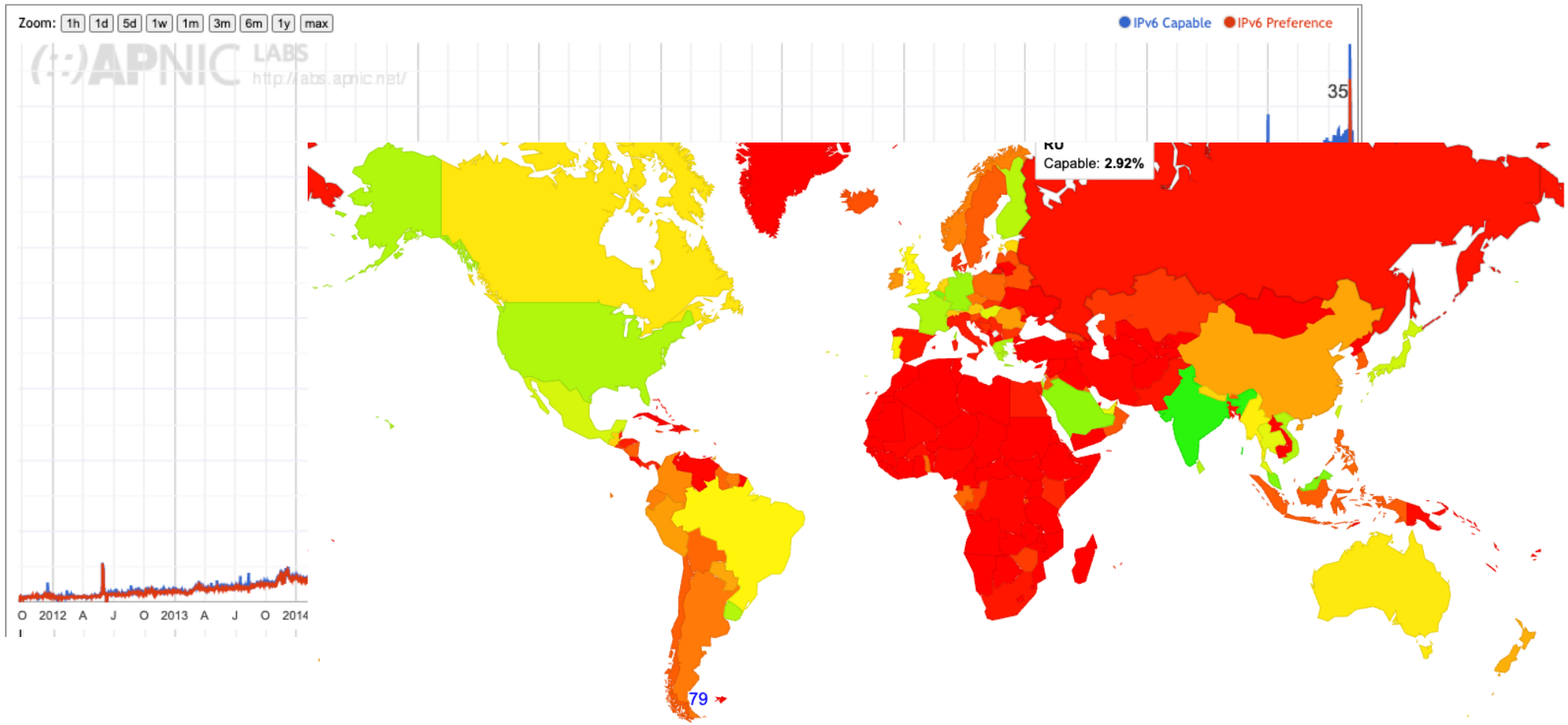

Where now?

Great question!

Where now?

Nobody knows

- But its clear that the Internet has changed a lot in the past decade or two
- Most network transactions are streamed from nearby datacentres
- There is little transit left, little in the way of routing, little residual need even for a global common network – we've taken the core of the network and passed it over to the interior of the CDNs
- If all the consumer money is used for accessing content relative to nearby datacentres then who pays for global transit? Who pays for routing? Who pays for a globally unique address system?
- Are we still building one network? Or many dedicated content-centric networks?
- Where does this leave IPv6?