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

The common IPv4 substrate
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)
Where now?

Great question!
Where now?

Nobody knows

• But it's 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?