Next Steps for IPv6 Standards

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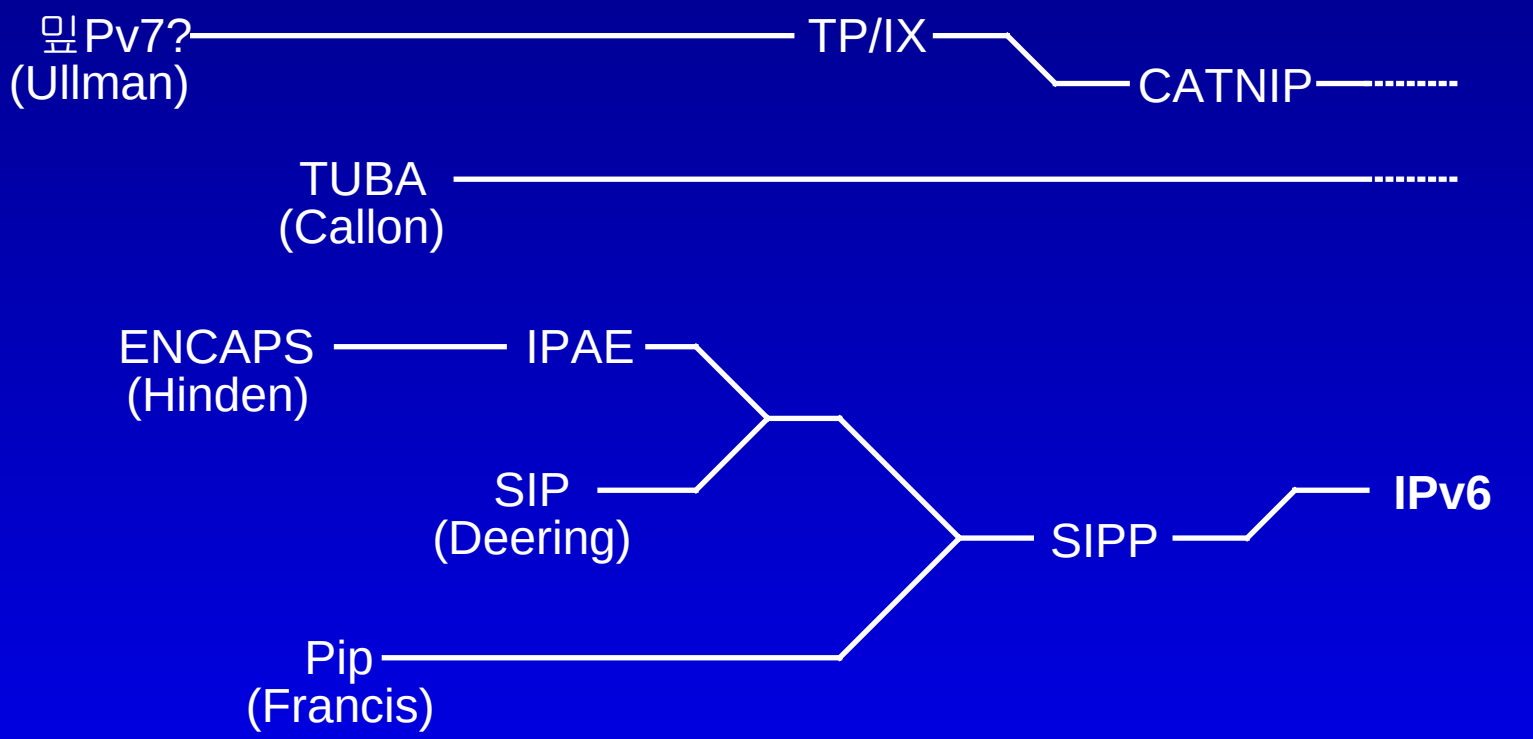
But First, A Little History…

IP Scaling Problems — the View from Early 1992

- running out of Class B addresses (near-term)
  - solution: CIDR (Classless Interdomain Routing) to allow addresses to be allocated and routed as blocks of any power-of-two size, not just Class A, B, and C
- running out of routing table space (near-term)
  - solution: provider-based delegation of address blocks, i.e., address hierarchy changed from organization:subnet:host to provider:subscriber:subnet:host
- running out of all IP addresses (long-term)
  - solution: a new version of IP with bigger addresses, dubbed IP Next Generation, or IPng

note: this was before the Web!

IPng Candidates



What's Been Happening Since Mid 1994?

- writing protocol specs, arguing about every detail, and progressing through the IETF Standards process
  - scores of documents, on IPv6 address formats and routing protocols (unicast & multicast), L2 encapsulations, auto-configuration, DNS changes, header compression, security extensions, IPv4/IPv6 co-existence & transition, MIBS,… (see playground.sun.com/ipv6 for list of documents)
- implementation by vendors, and interoperability testing
- building deployment testbeds
- shipping products
- deploying production services

IPv4 Address Allocation History

1981 - IPv4 protocol published
1985 ~ 1/16 of total space
1990 ~ 1/8 of total space
1995 ~ 1/4 of total space
2000 ~ 1/2 of total space

this despite increasingly intense conservation efforts!

- PPP / DHCP address sharing
- CIDR (classless inter-domain routing)
- NAT (network address translation)
- plus some address reclamation

Consequences of IPv4 Address Conservation

- loss of transparency
- loss of robustness
- loss of unique addresses
- loss of stable addresses
- loss of connectionless service
- loss of always-on service
- loss of peer-to-peer communication model
- loss of application independence
- but at least the email & web Internet kept growing!

i.e., many of the defining properties of the IP protocol architecture and original Internet have been lost

So, Where Is IPv6 Today?

- the core standards are stable and well-tested; some important auxilliary standards are less mature
  - e.g., mobile IPv6, MIBS, scoped addressing,…
- it is shipping as a standard feature on almost all major IP platforms (i.e., host OSs and routers)
- it is widely deployed in national and international testbeds and research & education networks
- commercial deployment is in the early stages, primarily in Japan and Korea

Much Still To Do

though IPv6 today has all the functional capability of IPv4,

- implementations are not as mature
  (e.g., with respect to performance, advanced features, compactness, instrumentation, etc.)
- commercial deployment has only just begun
- much work to be done moving applications, middleware, and management software to IPv6
- much training work to be done
  (application developers, network administrators, sales staff,…)
- many of the advanced features of IPv6 still need specification, implementation, and/or deployment work

What's Happening in the IETF IPv6 Working Group?

- some bureaucratic highlights:
  - Margaret Wasserman (WindRiver) appointed as 3rd co-chair, along with Bob Hinden (Nokia) and myself
  - making an effort to advance our many Proposed Standards to Draft Standard status (currently have 5 Draft Standards, 32 Proposed)

What's Happening with IPv6 WG (cont.)

- started to compile an IPv6 Node Requirements spec
  - triggered by appearance of several device requirements drafts ("cellular hosts", "low-cost network appliances")
  - to identify applicability and requirements level (MUST/ SHOULD/ MAY) of the many IPv6 RFCs and parts of RFCs
  - not to fix bugs/omissions from specification RFCs

- WG chairs propose to prioritize current and future work; to be discussed on WG mailing list and at meeting in Yokohama next week…

Prioritizing IPv6 WG Work (Rough Draft; Feedback Solicited!)

(1) finishing work-in-progress:

- default address selection
- address architecture
- basic & advanced APIs
- ICMPv6 update
- router preferences
- cellular hosts requirements
- node information queries
- DAD fixes to privacy addrs, autoconf and/or address architecuture
- other?

Prioritizing IPv6 WG Work (cont.)

(2) important and urgent for deployment:

- DNS Discovery (but may move out of IPv6 WG)
- prefix delegation
- IPv6 MIBs
- other?

(3) important but not quite so urgent:

- flow label specification
- scoped address architecture
- IPv6-over-3GPP-PDP-contexts spec
- IPv6 node requirements
- other?

Prioritizing IPv6 WG Work (cont.)

important but perhaps better handled in other WGs:

- secure, robust plug-and-play
- multi-link subnet spec
- anycast architecture
- routing protocol updates to handle IPv6 scoping
- other?

important and already handled in other WGs:

- site multihoming
- coexistence / interoperability / transition
- DHCPv6

Note Well

This list of ongoing work indicates the vitality, not the incompeteness, of IPv6!

Personal Conclusions

- if I knew it was going to take so long, I would have let one of the other IPng candidates “win”!
- I should have known it would take so long, given the nature of the undertaking
- the IETF was unusually far-sighted (lucky?) in starting this work when it did, instead of waiting till the Internet falls apart
- the Internet is now falling apart
- IPv6 is ready to put it back together again!