IPv6: Introduction, Background and Deployment Status

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Why a New IP?

Only *compelling* reason: more addresses!

- for billions of new devices,
  e.g., cell phones, PDAs, appliances, cars, etc.
- for billions of new users,
  e.g., in China, India, etc.
- for “always-on” access technologies,
  e.g., xDSL, cable, ethernet-to-the-home, PLC, etc.

But Isn't There Still Lots of IPv4 Address Space Left?

- ~ Half the IPv4 space is unallocated
  - if size of Internet is doubling each year, does this mean only one year's worth?!
- No, because today we deny unique IPv4 addresses to most new hosts
  - we make them use methods like NAT, PPP, etc. to share addresses
- But new types of applications and new types of access need unique addresses!

Why Are NAT's Not Adequate?

- They won't work for large numbers of "servers", i.e., devices that are "called" by others (e.g., IP phones)
- They inhibit deployment of new applications and services
- They compromise the performance, robustness, security, and manageability of the Internet

Incidental Benefits of Bigger Addresses

- Easy address auto-configuration
- Easier address management/delegation
- Room for more levels of hierarchy, for route aggregation
- Ability to do end-to-end IPsec (because NATs not needed)

Incidental Benefits of New Deployment

- Chance to eliminate some complexity, e.g., in IP header
- Chance to upgrade functionality, e.g., multicast, QoS, mobility
- Chance to include new enabling features, e.g., binding updates

Summary of Main IPv6 Benefits

- Expanded addressing capabilities
- Server-less auto-configuration (“plug-n-play”) and reconfiguration
- More efficient and robust mobility mechanisms
- Built-in, strong IP-layer encryption and authentication
- Streamlined header format and flow identification
- Improved support for options / extensions

Why Was 128 Bits Chosen as the IPv6 Address Size?

- Some wanted fixed-length, 64-bit addresses
  - easily good for 10^{12} sites, 10^{15} nodes, at .0001 allocation efficiency (3 orders of mag. more than IPng requirement)
  - minimizes growth of per-packet header overhead
  - efficient for software processing
- Some wanted variable-length, up to 160 bits
  - compatible with OSI NSAP addressing plans
  - big enough for autoconfiguration using IEEE 802 addresses
  - could start with addresses shorter than 64 bits & grow later
- Settled on fixed-length, 128-bit addresses
  - (340,282,366,920,938,463,463,374,607,431,768,211,456 in all!)

What Ever Happened to IPv5?

0–3		unassigned
4	IPv4	(today's widespread version of IP)
5	ST	(Stream Protocol, not a new IP)
6	IPv6	(formerly SIP, SIPP)
7	CATNIP	(formerly IPv7, TP/IX; deprecated)
8	PIP	(deprecated)
9	TUBA	(deprecated)
10-15		unassigned

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Standards

- Core IPv6 specifications are IETF Draft Standards => well-tested & stable
  - IPv6 base spec, ICMPv6, Neighbor Discovery, PMTU Discovery, IPv6-over-Ethernet, IPv6-over-PPP,...
- Other important specs are further behind on the standards track, but in good shape
  - mobile IPv6, header compression, …
  - for up-to-date status: http://playground.sun.com/ipng/html
- UMTS R5 cellular wireless standards mandate IPv6
  - March 2002 ?

Implementations

- Most IP stack vendors have an implementation at some stage of completeness
  - some are shipping supported product today, e.g., *BSD(KAME), Cisco, Compaq, Ericsson Telebit, Hitachi, IBM, Nortel, Sun, Trumpet, Linux
  - others have beta releases now, supported products soon, e.g., HP
  - others rumored to be implementing, e.g., Apple, Bull, Juniper, Mentat, Novell, SGI

- Interoperability test:
  - good attendance at frequent testing events

Much Still To Do

Though IPv6 today has all the functional capability of IPv4,

- Implementations are not as advanced
  (e.g., with respect to performance, multicast support, compactness, instrumentation, etc.)
- Deployment has only just begun
- Much work to be done moving application, 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 deployment work

Deployment Status

- Japan and Korea, targeted for 2005
  - Large investments in R&D, and deployment
- Europe follow up, same target (2005)
  - See IPv6 Task Force Recommendations
  - Adopted by the EC (Barcelona, March 2002)
  - Very high focus in FP6
- China, India, Latin America, others to follow
- US, most probably latest

Europe R&D Priorities

- Strong support to 3G and IPv6
- Large investments in R&D
- A few deployment activities
- Strong cooperation with ASEM
  - Co-Funding of links with Asia-Pacific
  - Strong cooperation with China and others
    - EuroChina Cooperation
  - Focus: IPv6, Wireless and Multimedia

IPv6 Forum

- A non-profit industrial association
- Mainly marketing activities to push the deployment
  - Lobby to industry, governments, …
- Several Working Groups
  - IPv6 Summits, Dissemination, Training, …
- No standards developed here
- Tech Directorate:
  - Technology, architecture, research and engineering center of expertise.