

# IPv6 (IP version 6) Essentials

## Ch1: IPv6 Versus IPv4



Louis Chuang  
Fu Jen Catholic University  
EE ENCL



# The History of IPv6 (1)

- The main Internet protocols & technologies were developed in the 1970s & 1980s.
- The effort to develop a successor protocol to IPv4 was started in the early 1990s by the IETF (Internet Engineering Task Force) → IPv6.
- Purpose: to solve the foreseen address space limitation, & provide additional functionality.
- IPv6 is sometimes called the Next Generation Internet Protocol or IPng.
- The IPng area directors of the IETF created IPv6 at the Toronto in 1994.
- The Directors formed an Address Lifetime Expectation working group (ALE WG) → to determine the expected lifetime of IPv4.
  - The ALE WG estimated the IPv4 address exhaustion between 2005 and 2011.
- The Internet Engineering Steering Group (IESG) approved the IPv6 recommendation and drafted a Proposed Standard on November 17, 1994.
- The core set of IPv6 protocols became an IETF Draft Standard on August 10, 1998.



## The History of IPv6 (2)

- Why is the new protocol **not IPv5**?
  - The version number 5 could not be used because it had been allocated to **an experimental stream protocol**.



# Overview of Functionality (1)

- IPv6 is a natural increment to IPv4, it can be installed as a normal software upgrade in most Internet devices, & **is interoperable with the current IPv4.**
- IPv6 includes **transition** & **interoperability** mechanisms.
  - IPv6 are designed to allow users to deploy IPv6 step by step as needed.
  - IPv6 provides direct interoperability between IPv4 and IPv6 hosts.
- The main changes from IPv4 to IPv6:
  - Expanded addressing capability and auto-configuration mechanisms.
    - ❖ IPv4: **unicast, multicast, broadcast.**
    - ❖ IPv6: **unicast, multicast, anycast.**
  - Simplification of the header format.
    - ❖ IPv4: **20~60 bytes header.**
    - ❖ IPv6: **fixed 40 bytes header.**



## Overview of Functionality (2)

- Improved support for extensions and options.
  - ❖ IPv4: **the options** were integrated into **the basic IPv4 header**.
  - ❖ IPv6: **the options** are put **in the extension headers**, they are optional and only inserted **between the IPv6 header & the payload**.
- Extensions for authentication and privacy.
  - ❖ IPv4: was not built in.
  - ❖ IPv6: was built in.
- Flow labeling capability.
  - ❖ IPv4: was not enabled.
  - ❖ IPv6: was enabled.



# Transition Aspects

- Is it worth migrating and upgrading from IPv4 to IPv6?
  - IPv4 has Network Address Translation (NAT) to solve address space problems.
  - IPv4 also has IPSEC (IPv4 security) to provide security.
- The 128-bit address space is the most obvious feature in IPv6.
  - IPv6 also includes other important features, such as:
    - ❖ Higher scalability, better data integrity, QoS features, auto-configuration mechanisms, improved routing aggregation in the backbone, & improved multicast routing.
- NAT should be regarded as a temporary solutions, & only for limited short-term scenario.



# IPv6 Alive (1)

- There are already a surprising number of global test networks and even commercial networks running over IPv6.
- Examples:
  - 6Bone:
    - ❖ The 6Bone started out as a network of **IPv6 islands working over the existing IPv4 Internet infrastructure**.
    - ❖ It uses **IPv6 tunneling technique** in IPv4 packets.
    - ❖ The **first tunnels** were established between the IPv6 laboratories of G6 in **France**, UNI-C in **Denmark**, & WIDE in **Japan** in early 1996.
    - ❖ The 6Bone structure:
      - 6Bone is structured as **a hierarchical network** of two or more layers.
      - **The top layer**: it consists of a set of backbone transit providers, called **pseudo Top Level Aggregators (pTLAs)**.
        - pTLAs use BGP4+ as a routing protocol.
        - It is **the 6Bone backbone network**.



## IPv6 Alive (2)

- **The intermediate layers:** they are called **pseudo Next Level Aggregators (pNLAs)**.
    - They interconnect **leaf sites** & the **pTLA backbone networks**.
  - **The bottom layer:** it is comprised of **leaf sites** connected via the 6Bone.
- ❖ Addressing:
- IPv6 **unicast addressing** of node interfaces is based on RFC 2374.
    - RFC2374 covers the **Aggregatable Global Unicast address format**.
  - 6Bone backbone networks is the pTLAs.
    - **pTLA** plays the role of an **top-level ISP**.
    - **pTLA assigns address space to pNLAs & leaf sites**.
    - **The assigned prefix** for IPv6 addresses of 6Bone is: **“3ffe::/16”** (RFC 2471).



# IPv6 Alive (3)

- The prefix currently allocated is 32-bit prefixes (previously, 24- and 28-bit prefixes were allocated).
- ❖ Growth:
  - The 6Bone is growing fast.
  - In December 1997, there were 43 backbone sites and 203 leaf sites registered.
  - In December 1998 there were 51 backbone sites and 332 leaf sites.
  - In January 2000 there were 67 backbone sites and 505 leaf sites.
  - In 2002, more than 505 leaf sites.....
  - Check link: <http://www.cs-ipv6.lancs.ac.uk/ipv6/6Bone/Whois/index.html#full>
  - In March 2003, the IETF decided that was the right time to start the phase-out of the IPv6 experimental network (6Bone), which started in 1996.



# IPv6 Alive (4)

## ❖ Joining the 6Bone:

- Membership in the 6Bone is open to anyone.
- 6Bone link: [http://www.6bone.net/6bone\\_hookup.html](http://www.6bone.net/6bone_hookup.html)
- There are different ways to connect to either the 6Bone or production IPv6 networks:
  - Become **an end site (leaf site)** of an existing 6Bone ISP: to **get 48-bit IPv6 external routing prefix** from **the ISP's TLA**.
  - **If you are an ISP:** to apply for your own 6Bone TLA.
  - To get your production IPv6 address: to find **a production IPv6 ISP**, & to get your prefix from the **IPS**.
  - Use the **"6to4" automatic tunneling mechanism**: address of this type has **the first 16 bits of 2002::/16**, with **the next 32 bits being the global IPv4 address** of a router.
- 3FFE::/16 is for 6Bone testing (RFC2471).



# IPv6 Alive (5)

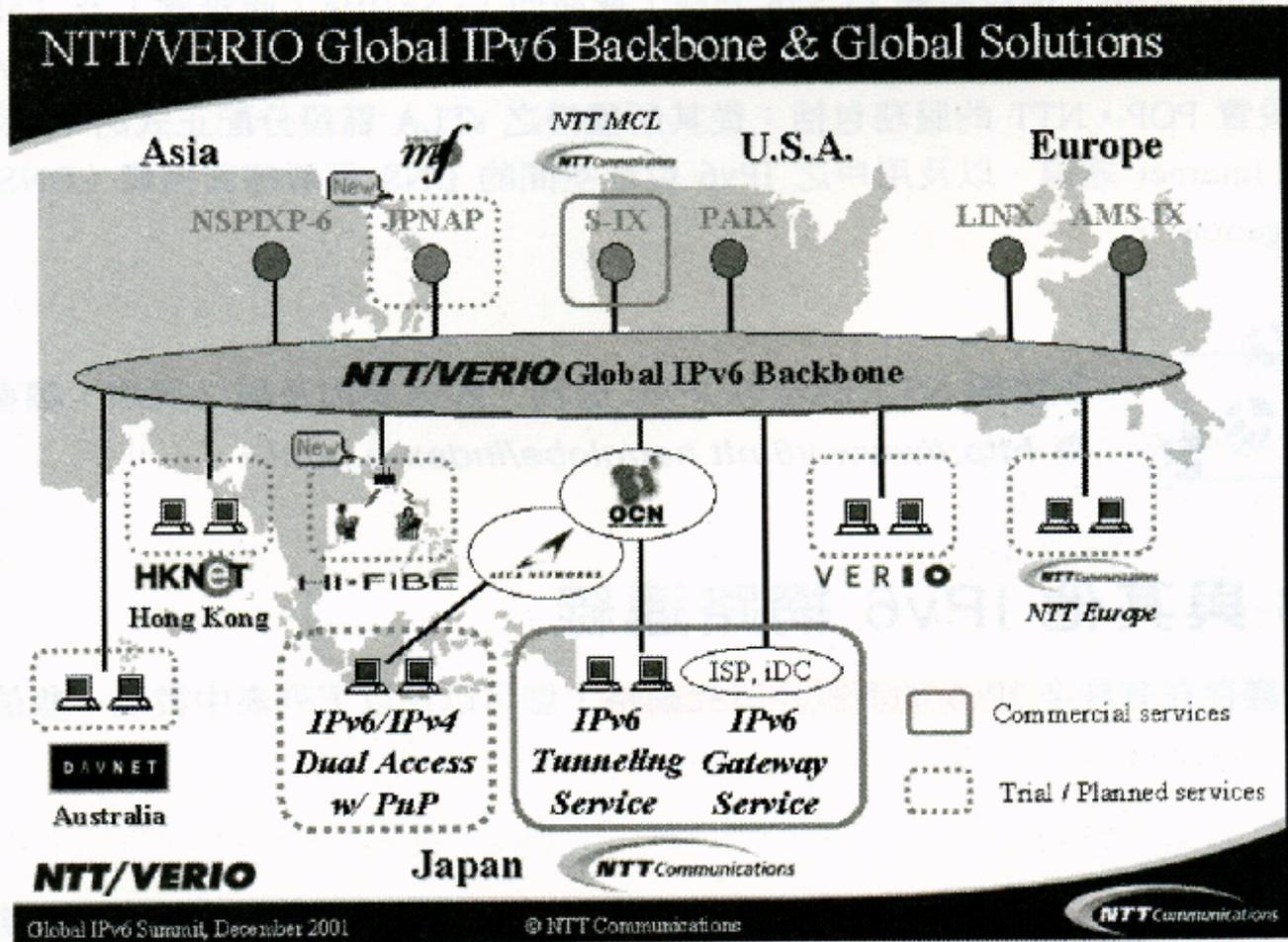
## ■ IPv6 Commercial Networks:

- ❖ There are many production networks worldwide that have already been assigned IPv6 address prefixes.
- ❖ Example:
  - vBNS+: in US.
  - Telia Sweden: in Sweden.
  - Internet Initiative Japan (IIJ): in Japan.
  - NTT Communications Corporation: in Japan. **NTT Laboratories started one of the largest global IPv6 research networks in 1996.** In April 2001 the company started their commercial IPv6 Gateway Service. **This native IPv6 backbone service connects sites in Japan to the NTT/VERIO Global Tier1 IPv6 backbone, which covers Asia, the U.S., and Europe.**
- ❖ The routing protocols used are BGP4+ and RIPng, IS-IS, & OSPFv3



# IPv6 Alive (6)

- NTT/VERIO's global IPv6 backbone (NTT Japan).





# IPv6 Alive (6)

## ■ Links to Other IPv6 Networks:

- ❖ There are a large number of international IPv6 test and research networks.
- ❖ Example:
  - **6Ren**: it is a voluntary coordination initiative of **research and education networks**.
  - **6Net**: it is a high-capacity IPv6 research network coordinated by **Cisco**.
  - **DREnv6**: it is the Defense Research and Engineering Network (DREN) v6 network. DREnv6 is also a major component of **the DoD (Department of Defense, USA) High Performance Computing Modernization Program (HPCMP)**.