

IP Version 6

ITL

Information Sources

- www.ipv6.org
- Christian Huitema, “IPv6, The New Internet Protocol”, Prentice Hall PTR, 1996.
- Lots of RFCs, 3513 describes the current address format
- Many others, see the web site

Why change IP

- Number of addresses
 - Routing Table Size
 - Client configuration
-
- Other stuff that could be done in IPv4 (but not as well)

New IP Header



Changes

- No fragmentation
- No options
 - Replaced by a chain of headers
- No checksum
- Hop count limit is still 255
- Packet size limit is still 64K

Address Notation

- 128 bits = 16 8-bit numbers; cumbersome!
- new notation uses 8 16-bit numbers, written in hexadecimal
- Example:
 - fedc:ba98:7654:3210:f5d9:1106:65fc:66d3
 - Omit leading zeroes, compress one zero run
 - fddc:8::78:f = fddc:
0008:0000:0000:0000:0000:0078:000f
 - Zone ID: fe80::ab:cd%3

Address Allocation Design

- Revisit the routing table issue
 - Address hierarchy
 - Geographic allocation?
 - Provider allocation
- Client Configuration
 - IPv6 includes auto/zero configuration
 - self-assigned addresses
 - router-based distribution of network information

Some Details

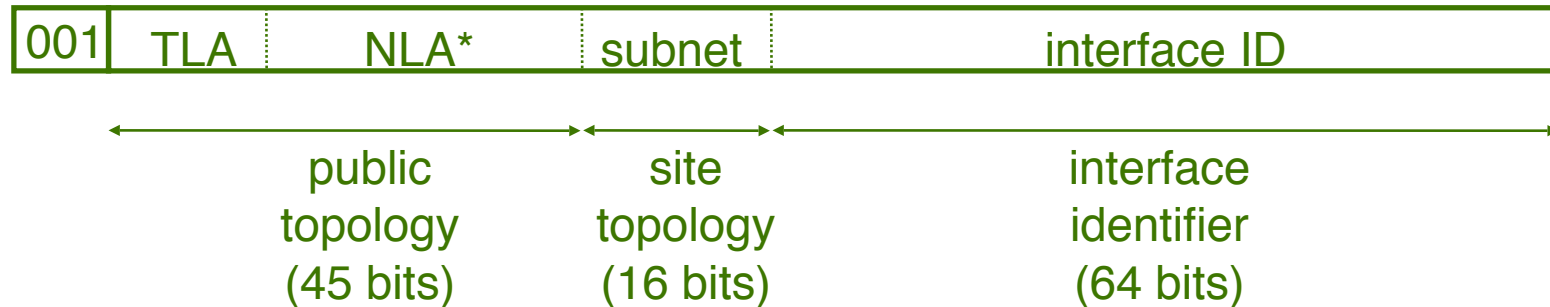
- Use the resources on the web to read up on this information
- “Classes” of addresses
- Configuration of hosts
- Transition from IPv4 to IPv6

Address allocation

Address type	Binary prefix	IPv6 notation
-----	-----	-----
Unspecified	00...0 (128 bits)	::/128
Loopback	00...1 (128 bits)	::1/128
Multicast	11111111	FF00::/8
Link-local unicast	1111111010	FE80::/10
Site-local unicast	1111111011	FEC0::/10 note 1
Local Addresses	11111110	FC00::/7 note 2
Global unicast	(everything else)	

- Currently global addresses start with 001, i.e. 2000::/3 (1/8 of the available space), about 70 billion usable addresses
- Note 1: Site Locals are being removed from the standard
- Note 2: These addresses are being standardized now

Global Address



Note that this precise structure is being deleted and assignments will be left to the RIRs.

The Interface ID should follow “modified EUI-64” format, it may be constructed to be globally unique, or created randomly for privacy reasons.

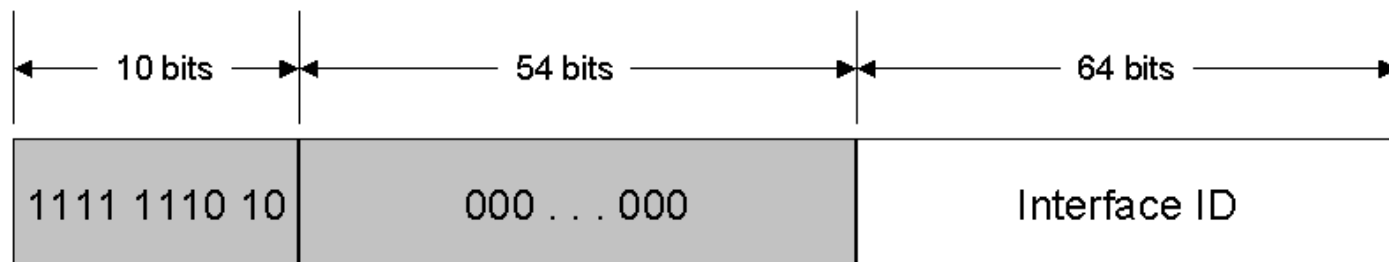
EUI = Extended Unique Identifier; IEEE Trademark

From Steve Deerings “IPv6 Master Class”

Example - OU

- 2001:468:b02::/48
 - 0010 0000 0000 0001
 - 0000 0100 0110 1000
 - 0000 1011 0000 0010
- TLA: “Generic TLA”
- Sub-TLA: “Temporary Allocation to OARNet”
- NLA: OARNet Assignment to OU

“Link Local” Address



Prefix `FE80::/64`

Other Addresses

- `::a.b.c.d` = “Compatibility Address”
 - Where `a.b.c.d` is the IPv4 address of the interface
- `::` = unassigned address
 - Equivalent to `0.0.0.0`
- `::1` = loopback
 - Equivalent to `127.0.0.1`

A Note on Multiple Addresses

- Hosts have
 - Loopback
 - Link-Local
 - Unique-Local (optional)
 - Global (optional, 1 or more)

Hosts also listen to

The node-local scope all-nodes multicast address (FF01::1)

The link-local scope all-nodes multicast address (FF02::1)

The solicited-node address for each unicast address

The multicast addresses of joined groups

Routers Have:

A link-local address for each interface

Unicast addresses for each interface (which could be a unique-local address and one or multiple routable global unicast addresses)

A Subnet-Router anycast address

Additional anycast addresses (optional)

A loopback address (::1)

Routers also listen to

The node-local scope all-nodes multicast address
(FF01::1)

The node-local scope all-routers multicast address
(FF01::2)

The link-local scope all-nodes multicast address
(FF02::1)

The link-local scope all-routers multicast address
(FF02::2)

The site-local scope all-routers multicast address
(FF05::2)

The solicited-node address for each unicast address

The multicast addresses of joined groups

Configuration

- Based on ICMP6
 - Automatic selection of link local address by the host, using the hardware address or another unique ID
 - Listen for router announcements (neighbor discovery) for site local and global prefixes

Address Types

- Unicast
- Multicast
- Anycast
 - IPv6 makes use of this for service discovery

Transition Issues

- Clients need
 - Operating system changes
 - Application changes
 - ISP support
- ISPs need
 - \$\$\$ for upgrades to the core infrastructure
- “Flashcut” is not possible
- How do IPv4 and IPv6 coexist?

Coexistence

- Dual protocol stacks
- “tunnels”
 - Carry IPv6 packets in IPv4 packets
 - Allows traversal of non-IPv6 capable infrastructure
 - Allows many IPv6-only devices to reach IPv6 destinations using a single IPv4 address
 - Useful mainly if all points of interest have IPv6 addresses

6to4 Tunnel

- One machine on a network must have an IPv4 address and becomes the gateway
- The local IPv6 network is
 - 2002:xxxx:yyyy::/48
 - xxxx:yyyy is the IPv4 address, e.g
 - 132.235.1.2 creates 2002:84EB:0102::/48
- IPv6 in IPv4 packets go to a tunnel end-point that has direct access to the IPv6 network

Domain Name Service

- IPv4 uses
 - A records to translate names to addresses
 - PTR records to translate addresses to names
- star.csm.ohiou.edu = 132.235.67.50
- 50.67.235.132.in-addr.arpa = star.csm.ohiou.edu

DNS continued

- IPv6 support
 - AAAA records translate names to IPv6 addresses
 - PTR records are used as before, but in a different “domain”
 - To find a name for fedc:ba98:7654:3210:f5d9:1106:65fc:66d3, look at the PTR record for
3.d.6.6.c.f.5.6.6.0.1.1.9.d.5.f.
0.1.2.3.4.5.6.7.8.9.a.b.c.d.e.f.ip6.int
 - Another record type, A6, is no longer supported

Example

```
> www.kame.net
```

```
Server:  boss.cs.ohiou.edu
```

```
Address: 132.235.1.1
```

```
www.kame.net      canonical name = apple.kame.net
```

```
apple.kame.net   canonical name = kame220.kame.net
```

```
kame220.kame.net      IPv6 address =
```

```
2001:200:0:4819:280:adff:fe71:81fc
```

```
kame220.kame.net      IPv6 address =
```

```
3ffe:501:4819:2000:280:adff:fe71:81fc
```