IPv6 Addressing

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Addressing scheme

- **RFC 3513** defines IPv6 addressing scheme
- **RFC 3587** defines IPv6 global unicast address format
- 128 bit long addresses
  - Allow hierarchy
  - Flexibility for network evolutions
- Use CIDR principles:
  - Prefix / prefix length
    - 2001:660:3003::/48
    - 2001:660:3003:2:a00:20ff:fe18:964c/64
  - Aggregation reduces routing table size
- Hexadecimal representation
- Interfaces have several IPv6 addresses
Textual Address Format

- Base format (a 16-byte Global IPv6 Address):

- Compact Format:
  2001:660:3003:1::6543:210F

- Literal representation
  [2001:660:3003:2:a00:20ff:fe18:964c]
IPv6 Address Space
(RFC 3513)

Aggregatable Global Unicast Addresses
001  2000::/3

Unique Local Unicast addresses
1111 1100  FC00::/7
[RFC-ietf-ipv6-unique-local-addr-09.txt]

Link-Local Unicast Addresses
1111 1110 10  FE80::/10

Multicast Addresses
1111 1111  FE80::/10

For  Future  Use
1/2  1/4  1/8  1/8

More info:  http://www.iana.org/assignments/ipv6-address-space
IPv6 Addresses

- **Loopback**: ::1
- **Link local**: FE80:....
- **Site local**: FEC0:....
- **Global**
  - 6bone: 3FFE:....
  - Official: 2001:....

- **IPv4 mapped**
- **6to4**: 2002:....

- **Unicast**
- **Multicast**
- **Anycast**

[specific to IPv4/IPv6 integration]
Local Addresses

**Link-local**

<table>
<thead>
<tr>
<th>10 bits</th>
<th>54 bits</th>
<th>64 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111111010</td>
<td>0 ............0</td>
<td>Interface ID</td>
</tr>
</tbody>
</table>

FE80

**Site-local** (in the process of being deprecated)

<table>
<thead>
<tr>
<th>10 bits</th>
<th>54 bits</th>
<th>64 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1111111011</td>
<td>Subnet ID</td>
<td>Interface ID</td>
</tr>
</tbody>
</table>

FEC0

*WALC 2006 (Quito, Ecuador – 26-28 July ’06)*
Interface Identifier

- 64 bits to be compatible with IEEE 1394 (FireWire)
- Eases auto-configuration
- IEEE defines the mechanism to create an EUI-64 from IEEE 802 MAC addresses (Ethernet, FDDI)
Interface Identifier (2)

- Links with non global identifier (e.g., the Localtalk 8 bit node identifier) → fill first left bits with 0
- For links without identifiers, there are different ways to proceed (e.g., tunnels, PPP):
  - Choose the identifier of another interface
  - Random number
  - Manual configuration

- **THEN**: Invert IEEE EUI-64 “u” bit to become an “interface identifier”
Interface Identifier (3)
(Privacy issues)

- IEEE 24 bit OUI can be used to identify HW:

- Interface Identifier can be used to trace a user:
  - The prefix changes, but the interface ID remains the same,
  - Psychological issue.

- Possibility to change Interface ID (RFC 3041 PS):
  - If local storage, use MD5 algorithm
  - Otherwise draw a random number
## Multicast Addresses

<table>
<thead>
<tr>
<th>Flag bits</th>
<th>Scope</th>
<th>Group ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 R P T</td>
<td>8 bits</td>
<td>4 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 bits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>112 bits</td>
</tr>
</tbody>
</table>

### Flag bits
- **R** = 1 permanent addresses (managed by IANA)
- **T** = 1 transient multicast addresses
  - **P** = 1 derived from unicast prefix (RFC3306)
  - **R** = 1 embedded RP addresses (RFC 3956)

### Scope
- **0**: Reserved
- **1**: Interface-local
- **2**: Link-local
- **3**: Subnet-local
- **4**: Admin-local
- **5**: Site-local
- **8**: Organization-local
- **E**: Global
- **F**: Reserved
Anycast Addresses (RFC 3513)

- « Anycast addresses allow a packet to be **routed to one of a number** of different nodes all responding to the same address »
- « (they) are allocated from the unicast address space, using any of the defined unicast address formats »
⇒ **It cannot be distinguished from a Unicast address**

- « it may be assigned to an IPv6 router only »
- Reserved anycast addresses are defined in RFC 2526
- Subnet anycast router address is:

```
<table>
<thead>
<tr>
<th>Subnet Prefix</th>
<th>00..00</th>
</tr>
</thead>
<tbody>
<tr>
<td>n bits</td>
<td>128 – n bits</td>
</tr>
</tbody>
</table>
```
## RFC 2471: Aggregatable Test Addresses

<table>
<thead>
<tr>
<th>3</th>
<th>13</th>
<th>x</th>
<th>32 - x</th>
<th>16</th>
<th>64</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>TLA</td>
<td>NLA</td>
<td>SLA</td>
<td>Interface ID</td>
<td></td>
</tr>
</tbody>
</table>

- Used in the 6bone
- TLA value is 0x1FFE => Prefix = 3FFE::/16
- pTLA in the NLA part assigned by ngtrans wg

[pTLA list](http://www.6bone.net/6bone_pTLA_list.html)

<table>
<thead>
<tr>
<th>49 x ::/24</th>
</tr>
</thead>
<tbody>
<tr>
<td>INNER/US-VA</td>
</tr>
<tr>
<td>TELEBIT/DK</td>
</tr>
<tr>
<td>SICS/SE</td>
</tr>
<tr>
<td>G6/FR</td>
</tr>
<tr>
<td>JOIN/DE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>45 x ::/28</th>
</tr>
</thead>
<tbody>
<tr>
<td>3FFE:8xyz::/28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>27 x ::/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>3FFE:4xyz::/32 (2003/11/21)</td>
</tr>
</tbody>
</table>
RFC 3587: Global Unicast address format

(obsoletes RFC 2374)
Production Addressing Scheme

IANA

RIR

Regional Internet Registries (ARIN, APNIC, RIPE NCC, plus possible future RIRs)

National Internet Registries (APNIC region)

Local Internet Registries (ISP's)

ISP/LIR

EU (ISP)

EU

EU

End Users

WALC 2006 (Quito, Ecuador – 26-28 July ’06)
### Production Addressing Scheme (2)

Source: [http://www.iana.org/assignments/ipv6-unicast-address-assignments](http://www.iana.org/assignments/ipv6-unicast-address-assignments)

<table>
<thead>
<tr>
<th>IPv6 Prefix</th>
<th>Binary Value</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000::/16</td>
<td>0010 0000 0000 0000</td>
<td>Reserved</td>
</tr>
<tr>
<td>2001::/16</td>
<td>0010 0000 0000 0001</td>
<td>Global Unicast Assignments [RFC3513]</td>
</tr>
<tr>
<td>2002::/16</td>
<td>0010 0000 0000 0010</td>
<td>6to4 [RFC3056 et 3068]</td>
</tr>
<tr>
<td>2003::/18</td>
<td>0010 0000 0000 0011</td>
<td>RIPE NCC Global Unicast Assignments [RFC3513]</td>
</tr>
<tr>
<td>2400::/x</td>
<td></td>
<td>APNIC</td>
</tr>
<tr>
<td>2600::/x</td>
<td></td>
<td>ARIN</td>
</tr>
<tr>
<td>2A00::/x</td>
<td></td>
<td>RIPE NCC</td>
</tr>
<tr>
<td>3FFE::/16</td>
<td>001 1 1111 1111 1110 0x1FFE</td>
<td>6bone Testing [RFC2471]</td>
</tr>
<tr>
<td>3FFF::/16</td>
<td>001 1 1111 1111 1111 0x1FFF</td>
<td>Reserved</td>
</tr>
</tbody>
</table>
### Production Addressing Scheme (3)

<table>
<thead>
<tr>
<th>IPv6 Prefix sub-TLA</th>
<th>Binary Values</th>
<th>Allocated to</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001:0000::/23</td>
<td>0000 000x xxxx x</td>
<td>IANA</td>
<td>Jul 99</td>
</tr>
<tr>
<td>2001:0200::/23</td>
<td>0000 001x xxxx x</td>
<td>APNIC</td>
<td>Jul 99</td>
</tr>
<tr>
<td>2001:0400::/23</td>
<td>0000 010x xxxx x</td>
<td>ARIN</td>
<td>Jul 99</td>
</tr>
<tr>
<td>2001:0600::/23</td>
<td>0000 011x xxxx x</td>
<td>RIPE NCC</td>
<td>Jul 99</td>
</tr>
<tr>
<td>2001:0800::/23</td>
<td>0000 100x xxxx x</td>
<td>RIPE NCC</td>
<td>May 02</td>
</tr>
<tr>
<td>2001:0A00::/23</td>
<td>0000 101x xxxx x</td>
<td>RIPE NCC</td>
<td>Nov 02</td>
</tr>
<tr>
<td>2001:0C00::/23</td>
<td>0000 110x xxxx x</td>
<td>APNIC</td>
<td>May 02</td>
</tr>
<tr>
<td>2001:0E00::/23</td>
<td>0000 111x xxxx x</td>
<td>APNIC</td>
<td>Jan 03</td>
</tr>
<tr>
<td>2001:1000::/23</td>
<td>0001 000x xxxx x</td>
<td>(future assignment)</td>
<td></td>
</tr>
<tr>
<td>2001:1200::/23</td>
<td>0001 001x xxxx x</td>
<td>LACNIC</td>
<td>Nov 02</td>
</tr>
<tr>
<td>2001:1400::/23</td>
<td>0001 010x xxxx x</td>
<td>RIPE NCC</td>
<td>Feb 03</td>
</tr>
<tr>
<td>2001:1600::/23</td>
<td>0001 011x xxxx x</td>
<td>RIPE NCC</td>
<td>Jul 03</td>
</tr>
<tr>
<td>2001:1800::/23</td>
<td>0001 100x xxxx x</td>
<td>ARIN</td>
<td>Apr 03</td>
</tr>
<tr>
<td>2001:FE00::/23</td>
<td>1111 111x xxxx x</td>
<td>(future assignment)</td>
<td></td>
</tr>
</tbody>
</table>

Where "x" indicates "0" or "1".
All other Sub-TLA ID values not listed above are reserved.
Production Addressing Scheme (4)

<table>
<thead>
<tr>
<th>3</th>
<th>45</th>
<th>16</th>
<th>64 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP</td>
<td>IANA/RIR/LIR</td>
<td>EU</td>
<td>Interface ID</td>
</tr>
</tbody>
</table>

- Public topology /48
- Site topology /80
- Network portion /64
- Host portion /64
RIR allocations

• Started July ’99
• New allocated prefix length since July 1\textsuperscript{st} 2002, ::/32 instead of ::/35
• Allocated prefixes (up to 10 September 2005) = 1301
  • [http://www.ripe.net/rs/ipv6/stats/](http://www.ripe.net/rs/ipv6/stats/)
    - APNIC
      • 398 prefixes
      • within 2001:{02, 0C, 0E, ...}00::/23
    - ARIN
      • 213 prefixes
      • within 2001:{04, 18, ...}00::/23
    - LACNIC
      • 33 prefixes
      • within 2001:1200::/23
    - RIPE-NCC
      • 647 prefixes
      • within 2001:{06, 08, 0A, 14, 16, ...}00::/23
Initial RIR allocation
Policy & Procedure

• Get the RIPE documents [246-250, 256, 261, 267, 274, 275, 280-282]
  – http://www.ripe.net/ripe/docs/ipv6.html
• Criteria: RIPE-267
  – http://www.ripe.net/ripe/docs/ipv6policy.html
• To qualify for an initial allocation of IPv6 address space, an organization must:
  – be an LIR: not be an end site
  – plan to provide IPv6 connectivity to organizations to which it will assign /48s, by advertising that connectivity through its single aggregated address allocation (/32 prefix)
  and
  – have a plan for making at least 200 x /48 assignments to other organizations within two years.
• For Latin America see:
  – http://lacnic.net/templates/ipv6-template-sp.txt