APNIC eLearning: IPv6 Addressing and Subnetting

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elP602_v1.0



Overview

- IPv6 Address Text Representation
- IPv6 Addressing Structure
- IPv6 Address Management Hierarchy
- Local Addresses
- Global Addresses
- Interface ID
- IPv6 Autoconfiguration
- Subnetting

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IPv6 Addressing

- An IPv6 address is 128 bits long
- So the number of addresses are 2^128 = 340282366920938463463374607431768211455
- In hex, 4 bits (also called a 'nibble') is represented by a hex digit
- So 128 bits is reduced down to 32 hex digits



IPv6 Addressing

- Hexadecimal values of eight 16 bit fields
 - X:X:X:X:X:X:X:X (X=16 bit number, ex: A2FE)
 - 16 bit number is converted to a 4 digit hexadecimal number
- Example:
 - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
 - Abbreviated form of address

4EED:0023:0000:0000:036E:1250:2B00

→4EED:23:0:0:0:36E:1250:2B00

→4EED:23::36E:1250:2B00

(Null value can be used only once)

Leading zeroes Groups of zeroes Double colons





IPv6 Addressing







IPv6 addressing structure



IPv6 Address Management Hierarchy



::*(::(*::)



IPv6 addressing model

- Unicast
 - Packet is sent to a single interface
- Anycast
 - Packet is sent to the nearest of group interfaces (in terms of routing distance)
- Multicast

API

- Packet is sent to multiple interfaces













Addresses Without a Network Prefix

- Loopback ::1/128
- Unspecified Address ::/128
- IPv4-mapped IPv6 address
- IPv4-compatible IPv6 address

::ffff/96 [a.b.c.d]

::/96 [a.b.c.d]





IPv6 Address Range

Unspecified Address ::/12
Loopback ::1/1
Global Unicast (0010) 200
Link Local (1111 1110 10) FE8
Multicast Address (1111 1111) FF0
Unique Local Address FC0

::/128
::1/128
2000::/3
FE80::/10
FF00::/8
FC00::/7





Local Addresses With Network Prefix

- Link Local Address
 - A special address used to communicate within the local link of an interface
 - i.e. anyone on the link as host or router
 - This address in packet destination that packet would never pass through a router
 - fe80::/10





Local Addresses With Network Prefix

- Unique Local IPv6 Unicast Address
 - Addresses similar to the RFC 1918 / private address like in IPv4 but will ensure uniqueness
 - A part of the prefix (40 bits) are generated using a pseudo-random algorithm and it's improbable that two generated ones are equal
 - fc00::/7
 - Example webtools to generate ULA prefix
 - http://www.sixxs.net/tools/grh/ula/
 - http://www.goebel-consult.de/ipv6/createLULA





Global Addresses With Network Prefix

- IPV6 Global Unicast Address
 - Global Unicast Range: 0010 2000::/3
 0011 3FFE:FFFE:...::/3

 All five RIRs are given a /12 from the /3 to further distribute within the RIR region

– APNIC	2400:0000::/12
– ARIN	2600:0000::/12
– AfriNIC	2C00:0000::/12
– LACNIC	2800:0000::/12
 Ripe NCC 	2A00:0000::/12

- 6to4 Addresses
 - 2002::/16
 - Designed for a special tunneling mechanism [RFC 3056] to connect IPv6 Domains via IPv4 Clouds
 - Need 6to4 relay routers in ISP network





Examples and Documentation Prefix

- Two address ranges are reserved for examples and documentation purpose by RFC 3849
 - For examples, use 3fff:ffff::/32
 - For documentation, use 2001:0DB8::/32





Interface ID

- The lowest-order 64-bit field addresses
- May be assigned in several different ways:
 - auto-configured from a 48-bit MAC address expanded into a 64-bit EUI-64
 - assigned via DHCP
 - manually configured
 - auto-generated pseudo-random number
 - possibly other methods in the future













Zone IDs for Local-use Addresses

- In Windows XP for example:
 - Host A: fe80::2abc:d0ff:fee9:4121%4
 - Host B: fe80::3123:e0ff:fe12:3001%3
- Ping from Host A to Host B
 - ping fe80::3123:e0ff:fe12:3001%4 (not %3)
- Identifies the interface zone ID on the host which is connected to that segment.





IPv6 Autoconfiguration



- Stateless mechanism
 - For a site not concerned with the exact addresses
 - No manual configuration required
 - Minimal configuration of routers
 - No additional servers
- Stateful mechanism
 - For a site that requires tighter control over exact address assignments
 - Needs a DHCP server
 - DHCPv6







Well-known link local prefix +Interface ID (EUI-64) Ex: FE80::310:BAFF:FE64:1D

- 1. A new host is turned on.
- 2. Tentative address will be assigned to the new host.
- Duplicate Address Detection (DAD) is performed. First the host transmit a Neighbor Solicitation (NS) message to the solicited node multicast address (FF02::1:FF64:1D) corresponding to its to be used address
- 5. If no Neighbor Advertisement (NA) message comes back then the address is unique.
- 6. FE80::310:BAFF:FE64:1D will be assigned to the new host.







- 1. The new host will send Router Solicitation (RS) request to the all-routers multicast group (FF02::2).
- 2. The router will reply Routing Advertisement (RA).
- 3. The new host will learn the network prefix. E.g, 2001:1234:1:1::/64
- 4. The new host will assigned a new address Network prefix+Interface ID
 - E.g, 2001:1234:1:1:310:BAFF:FE64:1D





Subnetting (Example)

- Provider A has been allocated an IPv6 block
 2001:DB8::/32
- Provider A will delegate /48 blocks to its customers
- Find the blocks provided to the first 4 customers





Subnetting (Example)

Original block: **2001:0DB8::/32**

Rewrite as a /48 block: 2001:0DB8:0000:/48

This is your network prefix!

How many /48 blocks are there in a /32?

$$\frac{/32}{/48} = \frac{2^{128-32}}{2^{128-48}} = \frac{2^{96}}{2^{80}} = 2^{16}$$

Find only the first 4 /48 blocks...





Subnetting (Example)

Start by manipulating the LSB of your network prefix – write in BITS

2001:0DB8:0000::/48



Then write back into hex digits





Appendix: IPv6 Addressing Exercise





Exercise 1.1: IPv6 subnetting

 Identify the first four /36 address blocks out of 2406:6400::/32







Exercise 1.2: IPv6 subnetting

 Identify the first four /35 address blocks out of 2406:6400::/32







Questions

- Please remember to fill out the feedback form
 - <survey-link>
- Slide handouts will be available after you fill out the survey







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APNIC Helpdesk Chat







Thank You!

End of Session



