Client IPv6 Addressing

ISP Workshops

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Acknowledgements

- This material originated from the Cisco ISP/IXP Workshop Programme developed by Philip Smith & Barry Greene
- Use of these materials is encouraged as long as the source is fully acknowledged and this notice remains in place
- Bug fixes and improvements are welcomed
  - Please email *workshop (at) bgp4all.com*

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Client IPv6 Addressing

IPv6 Addressing on LANs (fixed & wireless)

- StateLess Address AutoConfiguration (SLAAC)
  - Client learns IPv6 address, default gateway, and DNS resolver, from the router on the LAN
- Stateful DHCPv6
  - Client learns IPv6 address, default gateway, and DNS resolver, from a DHCP server
    - Can be on the same LAN (not advised)
    - Can be the router (usually limited feature set)
    - Standalone, via DHCP relay on the router (most common)
- Stateless DHCPv6
  - SLAAC for address information, DHCPv6 for everything else

SLAAC: Router side

- Router does not need any specific configuration
  - But there are some good practice suggestions to improve general behaviour
    - Setting router preference high (default is medium)
    - Make the RA interval 30 seconds
    - If supported, also supply DNS resolver using RA
    - Set Multicast Listener Discovery query interval to 30 seconds

```
interface FastEthernet0/0
 ipv6 address 2001:DB8:100::1/64
 ipv6 nd router-preference high
 ipv6 nd ra interval 30
 ipv6 nd ra dns server 2001:DB8:100:F::53
 ipv6 mld query-interval 30
!
```

SLAAC: Client side

- IPv6 client learns address "from the LAN"
  - IPv6 is enabled on most end-user devices today
    - Laptop, PC, tablet, smartphone
  - Device sends out "router solicit"
  - Router responds with "router advertisement" containing subnet and default gateway
  - Initial client state (eg macOS laptop):

```
Client:
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
          ether 68:5b:35:7d:3b:bd
          inet6 fe80::6a5b:35ff:fe7d:3bbd%en3 prefixlen 64 scopeid 0x8
```

SLAAC

- On receiving response from the router:

```
en3: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        ether 68:5b:35:7d:3b:bd
        inet6 fe80::6a5b:35ff:fe7d:3bbd%en3 prefixlen 64 scopeid 0x8
        inet6 2001:db8:100::6a5b:35ff:fe7d:3bbd prefixlen 64 autoconf
        inet6 2001:db8:100::18eb:2861:458e:862b prefixlen 64 autoconf temporary
        nd6 options=1<PERFORMNUD>

Internet6:
Destination        Gateway            Flags         Netif Expire
default            fe80::219:30ff:fee UGc             en3
```

  - Note the temporary address – this is the one used for all IPv6 connectivity, and has a lifetime determined by the client's operating system

Stateful DHCPv6

- Behaves like DHCP on IPv4 infrastructure:
  - DHCPv6 server distributes host address from a pool on request from client
  - DHCPv6 client configures IPv6 address, default gateway, and DNS resolver
  - Sample server configuration (Cisco IOS)

```
ipv6 dhcp pool LABNET
 dns-server 2001:DB8:100:F::53
 domain-name labnet
!
interface VLAN1
 ipv6 address 2001:DB8::1/64
 ipv6 nd managed-config-flag
 ipv6 nd other-config-flag
 ipv6 dhcp server LABNET
!
```

IPv6 address distributed by DHCPv6

DNS & other settings distributed by DHCPv6

Stateless DHCPv6

- Where DHCPv6 is used to distribute other information
  - But not IPv6 addresses (usually done by SLAAC)
  - Documented in RFC3736
- For example:
  - SLAAC is used to distribute IPv6 address and default gateway
  - DHCPv6 is used to provide DNS resolver and other network information
  - Compare this configuration with that from the earlier example

DNS & other settings distributed by DHCPv6

```
ipv6 dhcp pool LABNET
 dns-server 2001:DB8:100:F::53
 domain-name labnet
!
interface VLAN1
 ipv6 address 2001:DB8::1/64
 ipv6 nd other-config-flag
 ipv6 dhcp server LABNET
!
```

Distributing subnets to End-Users

- Static assignment (as in IPv4)
  - Tell the customer what subnet they have
    - Not dynamic!
    - Usually with Internet service documentation
- DHCPv6-PD
  - Use DHCPv6 Prefix Delegation feature to distribute subnets automatically
    - Prefix delegated can optionally be made persistent if desired

DHCPv6-PD

- New for IPv6, is Prefix-Delegation (PD)
  - Allows DHCP server to delegate subnets to clients
  - Especially useful for Broadband deployments
    - Also can be used for enterprise
  - Server example on BRAS (Cisco IOS)
    - Distribute /56 to client network out of /40 pool

```
ipv6 dhcp pool BB-CUST-1
 prefix-delegation pool BBCUST1 lifetime 1800 600
!
ipv6 local pool BBCUST1 2001:DB8:F00::/40 56
!
interface FastEthernet0/0
 ipv6 enable
 ipv6 dhcp server BB-CUST-1
!
```

DHCPv6-PD

- Client receives IPv6 subnet from the server
- Client then automatically assigns a /64 to each active interface on the router
- This means that the network operator can prepare a standard configuration for each client
  - No IPv6 address dependencies
  - Flexibility to change delegated prefix as required
- Many client side routers (CPE) support DHCPv6-PD

DHCPv6-PD – Cisco IOS example

- Cisco IOS uses a "general prefix" concept
  - The received subnet is stored in a user defined "variable"
  - This variable is then used on internal interfaces to give each a /64 subnet
  - For example:
    - Prefix received is 2001:DB8:C:80::/56 -> General Prefix
    - Final 72 bits are set by the user, taking the form ::<subnet>:0:0:0:1
    - Interfaces will be addressed 2001:DB8:C:80::1/64, 2001:DB8:C:81::1/64, 2001:DB8:C:82::1/64 etc, in sequence
- Receiving interface also configured automatically as the default gateway

DHCPv6-PD – Client Configuration

- Cisco IOS client configuration example:

```
interface Dialer0
 description ADSL link to MY ISP
 ipv6 address autoconfig default
 ipv6 dhcp client pd ADSL-PD rapid-commit
!
interface Vlan1
 description Home Network
 ipv6 address ADSL-PD ::0:0:0:0:1/64
!
interface Vlan2
 description Home IP/TV Network
 ipv6 address ADSL-PD ::1:0:0:0:1/64
!
interface Vlan3
 description Home Wireless Network
 ipv6 address ADSL-PD ::2:0:0:0:1/64
!
```

Signifies default interface, for default route

Speeds up DHCP configuration between client and server, using 2 messages rather than 4

DHCPv6-PD – Client Configuration

- Cisco IOS client interface status example:

```
router# sh ipv6 interface brief
Vlan1          [up/up]
    FE80::C800:E7FF:FE22:8
    2001:DB8:F00:3100::1
Vlan2          [up/up]
    FE80::C800:E7FF:FE22:6
    2001:DB8:F00:3101::1
Vlan3          [up/up]
    FE80::C800:E7FF:FE22:4
    2001:DB8:F00:3102::1
…etc…
```

DHCPv6-PD Servers ?

- Many vendor hardware products
  - Routers, firewalls, etc
- Example of standalone software (like IPv4 DHCP):
  - ISC's DHCP server
  - ISC's KEA (replaces ISC's DHCP server)
    - http://kea.isc.org
  - Jagornet DHCP server
    - http://www.jagornet.com
- Persistent address delegation
  - Available using DHCP Option 37 "remote hardware ID"
    - The client gets the same address block delegated each time

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