Plug and Play Using Prefix Delegation Mechanism

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Abstract

* **Issues to be Solved**

* **Prefix Delegation Using IPv6 DHCP**

* **Enhancement Issues in Prefix Delegation**
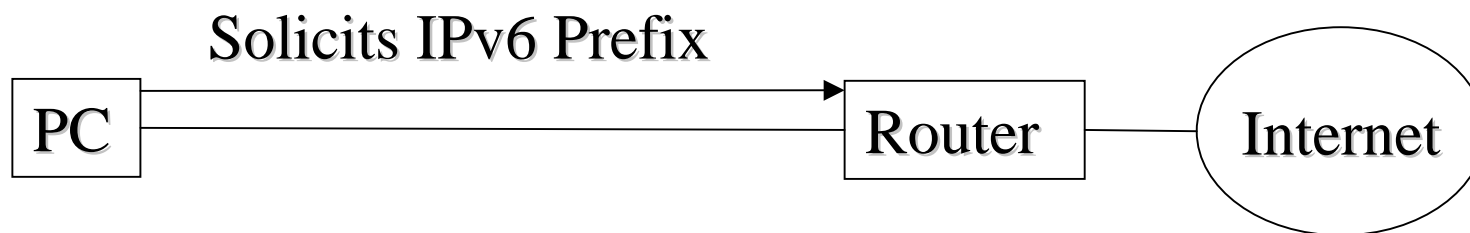 - Server Discovery
  - Multiple Prefix Delegation

IPv6 Plug and Play

* ## PC can get an IP address automatically via Router Advertisement (RA)
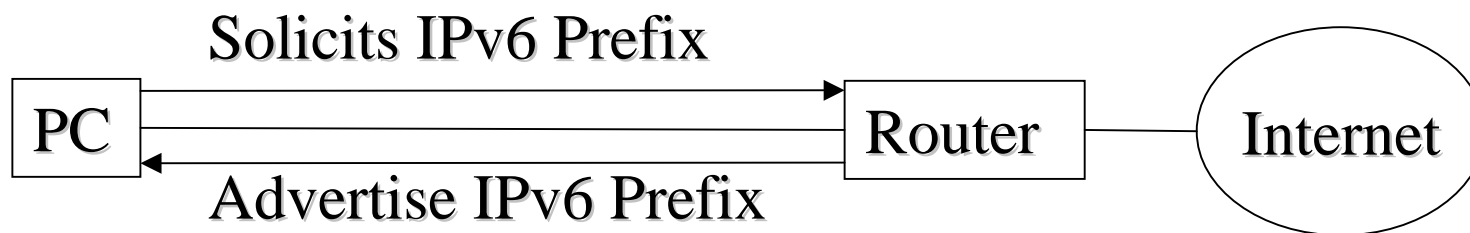
  →IPv6 Plug and Play

```
┌──────┐                          ┌──────────┐   ╭──────────╮
│  PC  │──────────────────────────│  Router  │───│ Internet │
└──────┘                          └──────────┘   ╰──────────╯
```

IPv6 Plug and Play

✴ **PC can get an IP address automatically via Router Advertisement (RA)**

→IPv6 Plug and Play

Solicits IPv6 Prefix

| PC | → | Router | Internet |

IPv6 Plug and Play

✳ PC can get an IP address automatically via Router Advertisement (RA)

→IPv6 Plug and Play

Solicits IPv6 Prefix

| PC | → | Router | — | Internet |

Advertise IPv6 Prefix
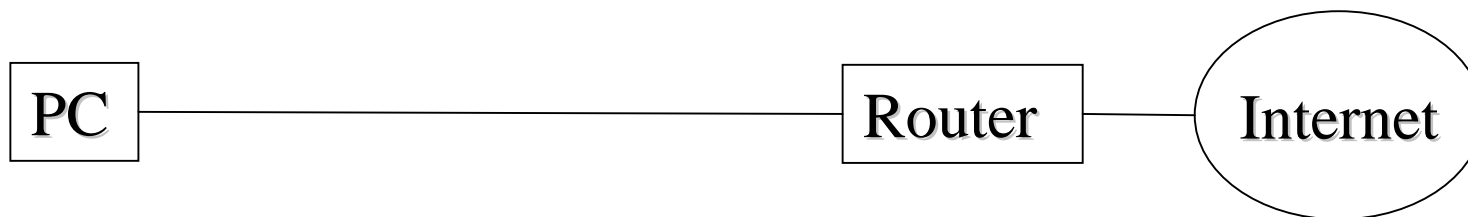
Issues in Current IPv6 Plug and Play (1)

* ## Routers have to be configured manually

  – otherwise, packet from PC cannot be routed properly

  – normal SOHO users cannot configure routers

Quite difficult to deploy IPv6 for ordinary Internet users!

Plug and Play
by RA

Requests Configuration
by paper

PC ← CPE Router ← PE Router ─ Internet
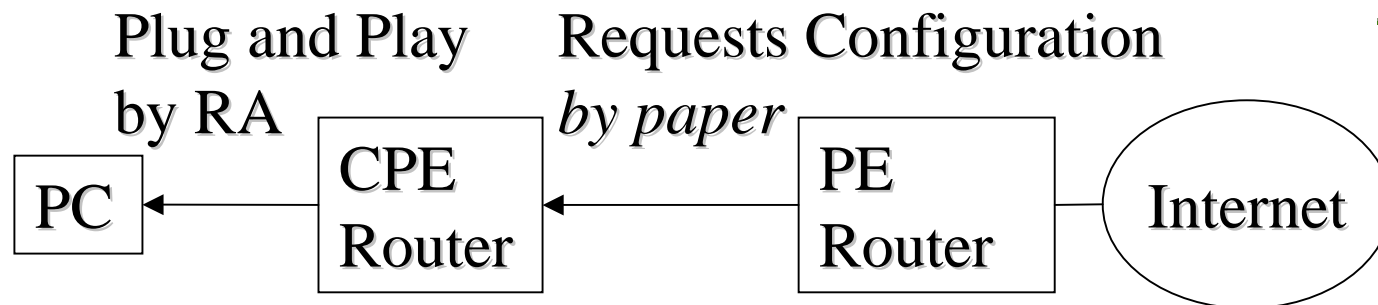
c.f.) IPv4 Plug and Play for CPE Routers

✳ CPE Routers can be configured automatically, but there is a NAT!

Plug & Play by IPv4 DHCP
(private IPv4 address)

Plug & Play by IPv4 DHCP
(global IPv4 address)
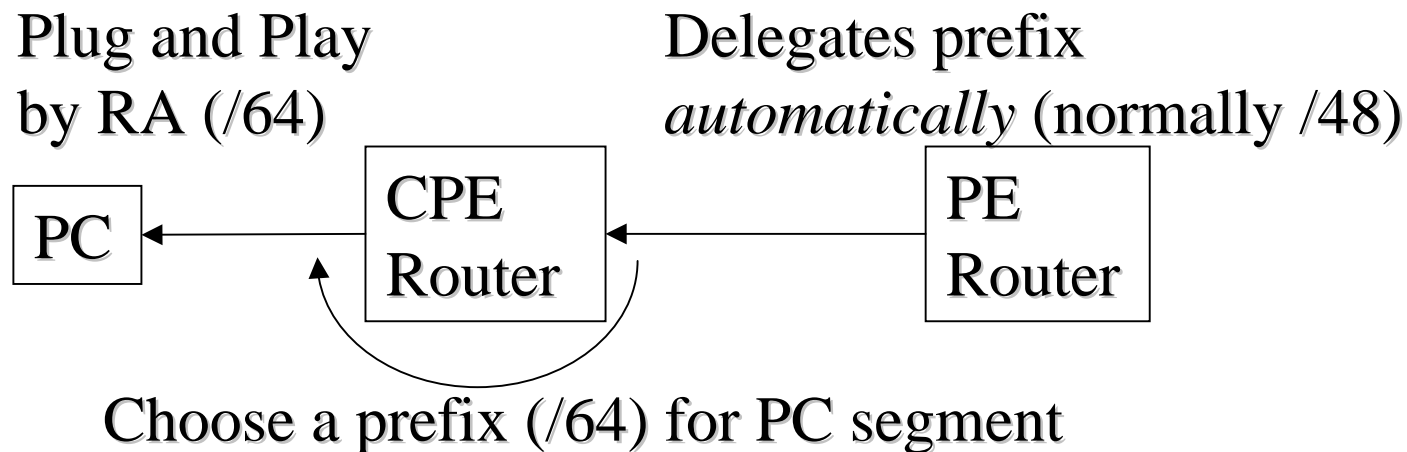
PC ← CPE Router ← PE Router — Internet

NAT
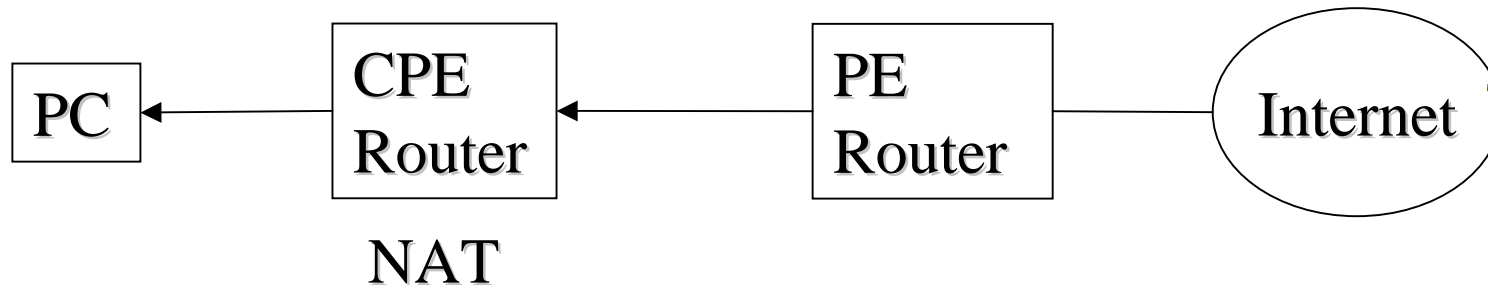
Issues in Current IPv6 Plug and Play (2)

✳ IP address is automatically configured, but other information still has to be configured manually:

- – DNS server
- – NTP server
- – Packet filter

Prefix Delegation (PD)

✴ PE router delegates IPv6 prefix(es) to CPE routers

– then CPE routers are automatically configured to generate RA toward PC

→Plug and Play for CPE Router!

Plug and Play
by RA (/64)
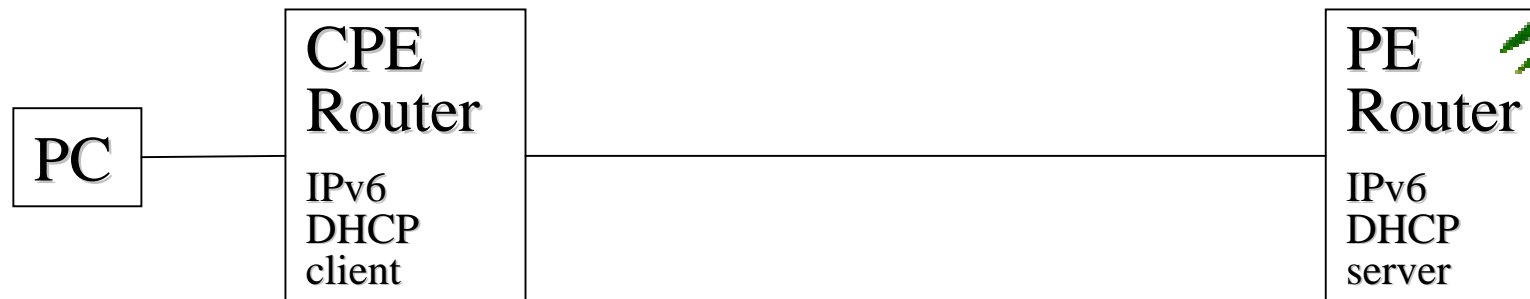
Delegates prefix
automatically (normally /48)

```
+------+     +----------+     +----------+
|  PC  | <-- |   CPE    | <-- |    PE    |
+------+     |  Router  |     |  Router  |
             +----------+     +----------+
```

Choose a prefix (/64) for PC segment

PD Mechanism (1)

✶ Use IPv6 DHCP framework to distribute IPv6 prefix

```
          CPE                        PE
          Router                     Router
+----+    +--------+       +--------+
| PC |----| IPv6   |-------| IPv6   |
+----+    | DHCP   |       | DHCP   |
          | client |       | server |
          +--------+       +--------+
```

PD Mechanism (1)

✳ Use IPv6 DHCP framework to distribute IPv6 prefix

```
           CPE                                    PE
           Router      Solicits Prefix Option     Router
  PC ─────
           IPv6     ───────────────────────▶     IPv6
           DHCP                                   DHCP
           client                                 server
```

PD Mechanism (1)

✴ Use IPv6 DHCP framework to distribute IPv6 prefix

PC	CPE Router IPv6 DHCP client	Advertise candidate prefix (2001:db8:a::/48) ←	PE Router IPv6 DHCP server

PD Mechanism (1)

★ Use IPv6 DHCP framework to distribute IPv6 prefix

PC — CPE Router (IPv6 DHCP client) — Request the prefix (2001:db8:a::/48) → PE Router (IPv6 DHCP server)

PD Mechanism (1)

* ✳ Use IPv6 DHCP framework to distribute IPv6 prefix

```
        ┌──────────┐   Reply with the prefix    ┌──────────┐
        │ CPE      │   (2001:db8:a::/48)        │ PE       │
┌────┐  │ Router   │ ◄──────────────────────────│ Router   │
│ PC │──│          │                            │          │
└────┘  │ IPv6     │                            │ IPv6     │
        │ DHCP     │                            │ DHCP     │
        │ client   │                            │ server   │
        └──────────┘                            └──────────┘
```

PD Mechanism (1)

✳ Use IPv6 DHCP framework to distribute IPv6 prefix

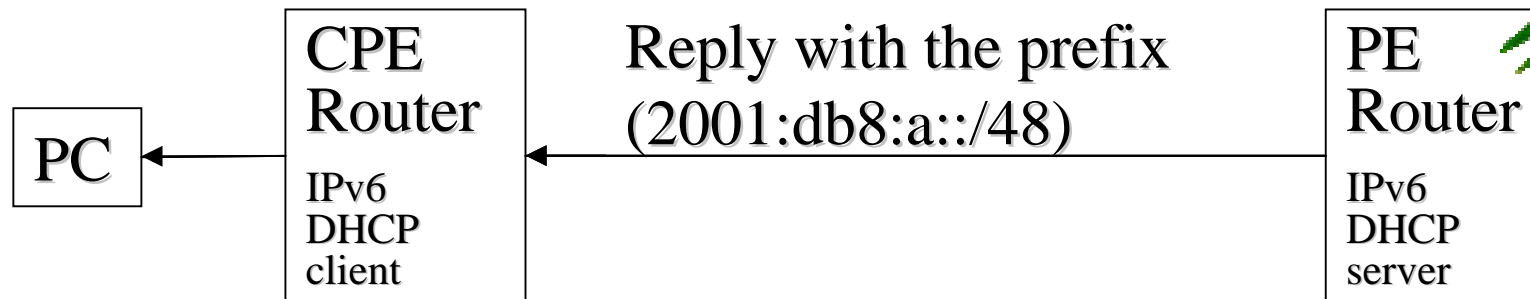| PC	CPE Router	Reply with the prefix (2001:db8:a::/48)	PE Router
	IPv6 DHCP client	←	IPv6 DHCP server
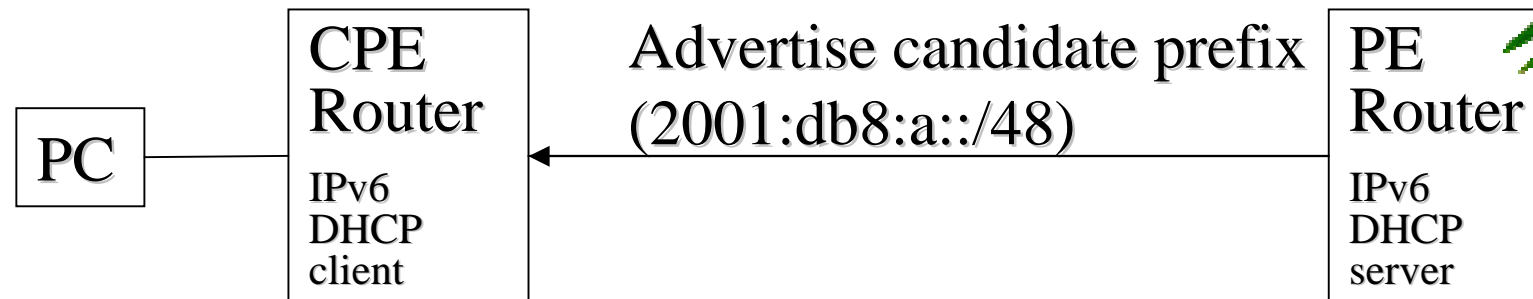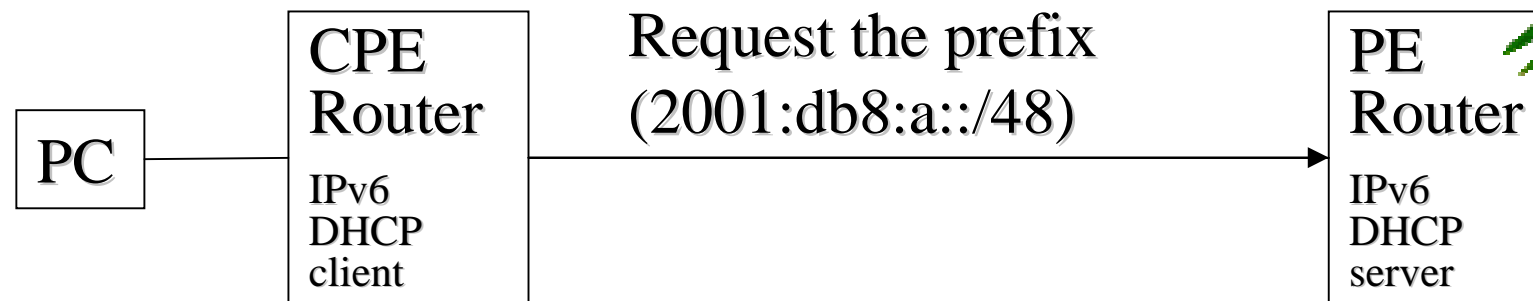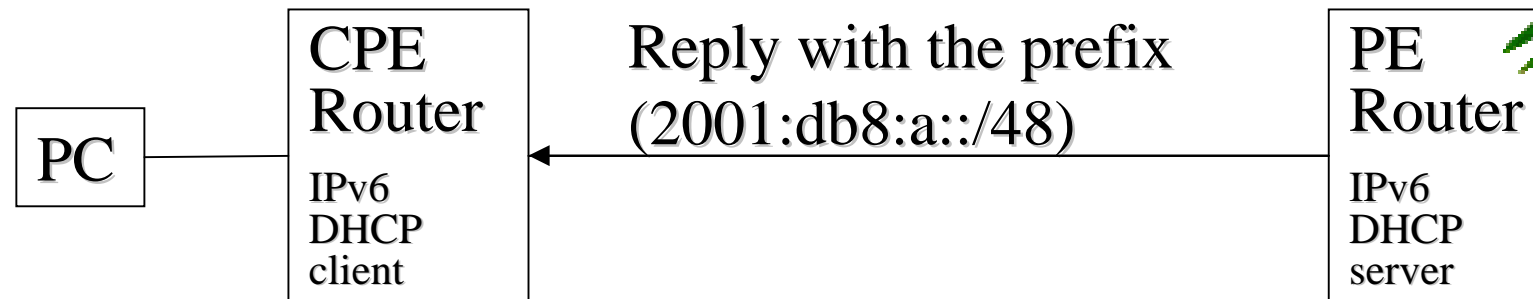
Choose 2001:db8:a:1::/64
for PC segment

PD Mechanism (1)

* Use IPv6 DHCP framework to distribute IPv6 prefix

Plug and Play by RA
(2001:db8:a:1::/64)

| PC | CPE Router
IPv6 DHCP client | Reply with the prefix
(2001:db8:a::/48) | PE Router
IPv6 DHCP server |

Choose 2001:db8:a:1::/64
for PC segment

PD Mechanism(2)

* Other DHCP options can be negotiated simultaneously

  →Server addresses (e.g. DNS, NTP) can be specified to CPE router

PD Status

* IETF Standardization
  - almost finished
  - waiting for RFC-editor's review...
* Implementations
  - PE Router
    * Cisco, Hitachi, KAME, NEC, USAGI
  - CPE Router
    * 6WIND, Allied-Telesyn, Cisco, IIJ, KAME, NEC, USAGI, Yamaha
  - interop'ed in lots of test events
    * IPv6 Showcase (Jul 2002), TAHI (Jan 2003)
  - Two Japanese ISPs have started PD service

PD Implementation Example

* P E (e.g. Hitachi)
  – can distribute these information:
    * DNS Server Address
    * DNS Domain Search List
    * NTP Server Address
    * IPv6 Prefix

* C P E (e.g. KAME)
  – can reflect these information to its configuration:
    * DNS Server Address
    * IPv6 Prefix

Enhancement Issues in PD
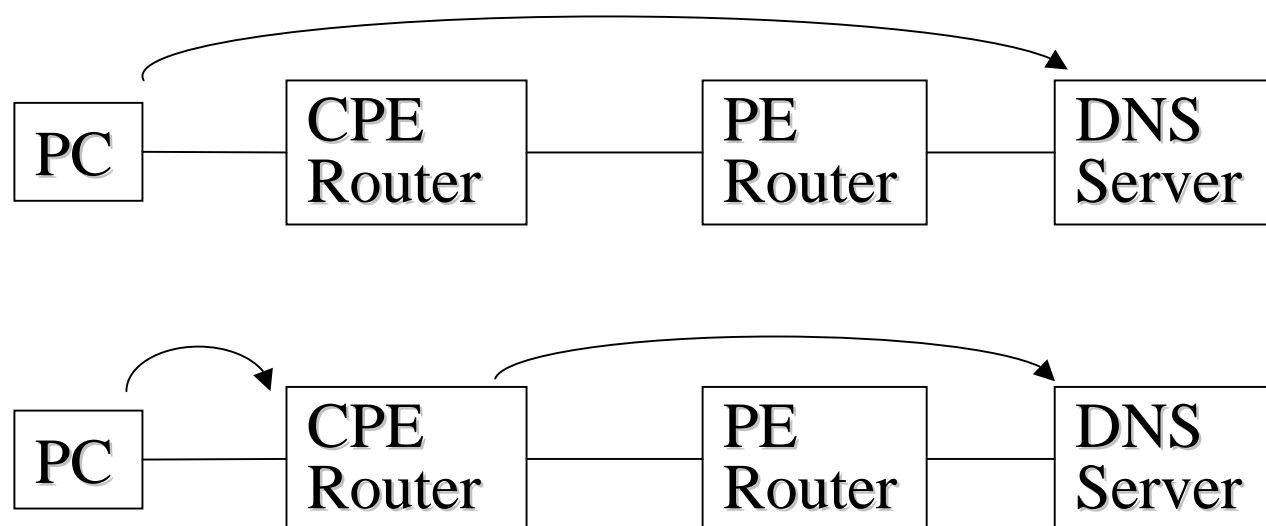
✳ **Server Discovery on PC**

   – Necessary for complete Plug and Play

✳ **Multiple Prefix Delegation**

   – A new service making use of the vast IPv6 address space

<div align="center">

IPv6-specific!

</div>

Server Discovery on PC(1)

* PC has to know the DNS/NTP server, but how? (only SOHO router knows…)
    – Inform the actual DNS/NTP server.
    – SOHO router behaves as a DNS/NTP relay
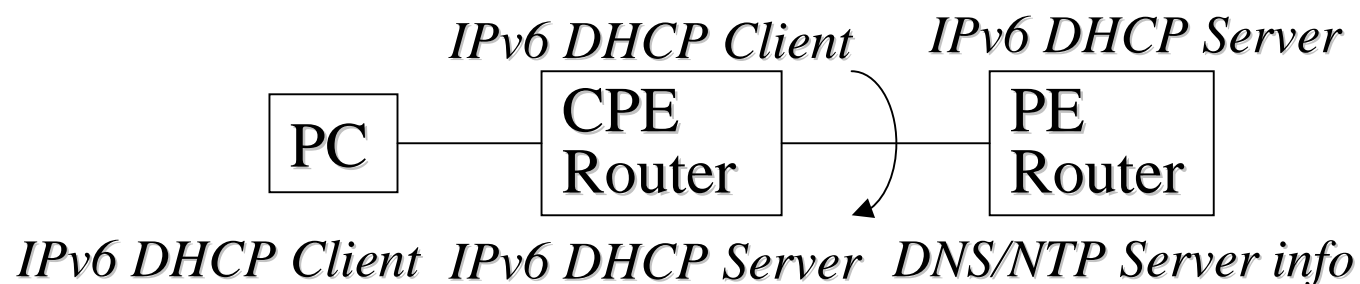
Server Discovery on PC(2)

✴ Inform the actual DNS/NTP Server

    – another IPv6 (stateless) DHCP on PC segment

        ✴ CPE Router has to inherit DNS/NTP server information from PE Router to its internal DHCP server

✴ CPE Router behaves as a DNS/NTP relay

    – Well-known site-local addresses (fec0:0:0:ffff::1~3)

        ✴ but site-local has been deprecated...

    – IPv4 DHCP (private-address) on PC segment

        ✴ have to manage IPv4 :-(

    – IPv6 (stateless) DHCP on PC segment

```
 ┌──────┐      ┌──────────┐      ┌──────────┐
 │  PC  │──────│   CPE    │──────│   PE     │
 │      │      │  Router  │      │  Router  │
 └──────┘      └──────────┘      └──────────┘
```
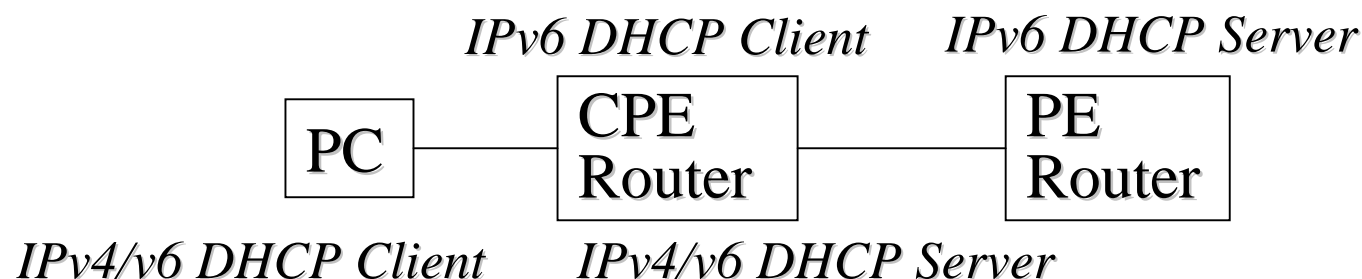
Server Discovery on PC(2)

✴ Inform the actual DNS/NTP Server
  – another IPv6 (stateless) DHCP on PC segment
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  – Well-known site-local addresses (fec0:0:0:ffff::1~3)
    ✴ but site-local has been deprecated...
  – IPv4 DHCP (private-address) on PC segment
    ✴ have to manage IPv4 :-(
  – IPv6 (stateless) DHCP on PC segment

IPv6 DHCP Client　　　*IPv6 DHCP Server*

| PC |　　| CPE Router |　　| PE Router |

IPv6 DHCP Client　*IPv6 DHCP Server*　*DNS/NTP Server info*

Server Discovery on PC(2)

✳ Inform the actual DNS/NTP Server
  – another IPv6 (stateless) DHCP on PC segment
    ✳ CPE Router has to inherit DNS/NTP server information from PE Router to its internal DHCP server

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  – Well-known site-local addresses (fec0:0:0:ffff::1~3)
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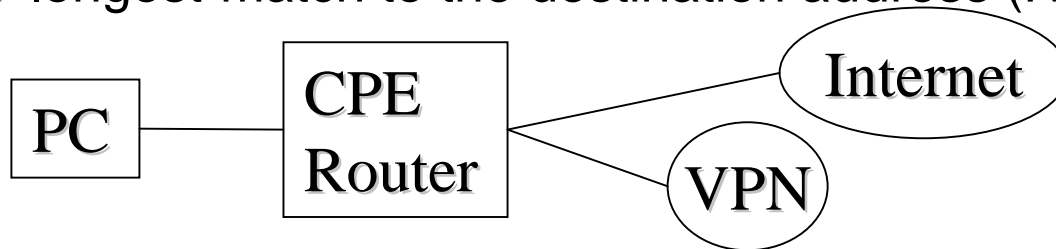   ✳ have to manage IPv4 :-(
  – IPv6 (stateless) DHCP on PC segment

IPv6 DHCP Client   *IPv6 DHCP Server*

| PC | —— | CPE Router | —— | PE Router |

IPv4/v6 DHCP Client   *IPv4/v6 DHCP Server*

Multiple Prefix Delegation (1)

✴ If multiple prefixes can be delegated properly, there are some benefits:

  – Redundancy

    ✴ multi-home

  – Seamlessly multiplexed services

    ✴ by assigning prefix per each service (e.g. VPN and Internet)

    ✴ Since each service is mapped to the corresponding prefix, administrator can easily control network by service (e.g. QoS policy, packet filter)

Multiple Prefix Delegation (2)

✴ Example: VPN and Internet for Home

  – PC must use a proper source address for each service to pass through ingress filtering:

    ✴ e.g. use VPN's prefix to connect to VPN

  – In case of IPv4, you have to press "VPN-on" button on PC when you use VPN.

  – If multiple IPv6 prefix are delegated from each services, PC can automatically select source address

    ✴ longest-match to the destination address (RFC3484)

```
              ┌──────────┐                ╭──────────╮
  ┌──────┐    │   CPE    │<──────────────│ Internet │
  │  PC  │────│  Router  │                ╰──────────╯
  └──────┘    └──────────┘<──────╮  ╭───────╮
                                  ──│  VPN  │
                                    ╰───────╯
```

Summary

* PD is a concept to configure CPE routers

* IPv6 DHCP framework is used in its implementation

* Proposed an enhancement guideline for better services:

  – Server Discovery on PC

  – Multiple Prefix Delegation

* Hitachi is now investigating these features to provide good services in IPv6!

Thanks for your attention!

Feel free to contact me, if you are interested in multiple-prefix-delegation!