Public IPv4 over Access IPv6 Network

draft-cui-softwire-host-4over6-04

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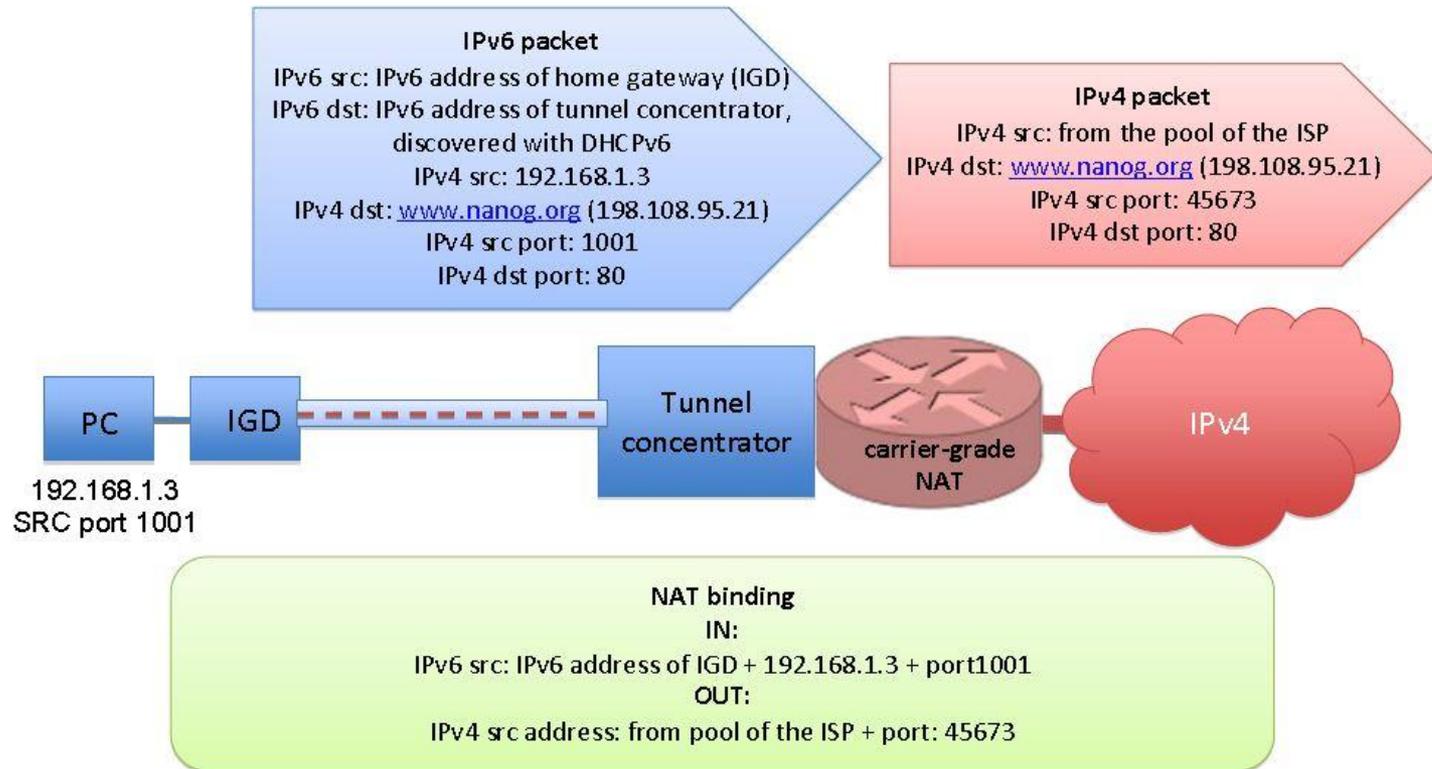O. Vautrin   Juniper Networks
Y. Lee   Comcast

Outline

- Introduction
- Basic idea & use cases
- Key issues & elements
- Example of public 4over6
- DHCPv4 over IPv6 tunnel
- Summary

Introduction

- When upgrading to IPv6, ISP needs to sustain IPv4 service for network users
  - CP/SP's lag on supporting IPv6 contents/apps
  - IPv6 User's demand to connect with IPv4
- IPv4 connectivity Requirement
  - Support all existing IPv4 apps
  - Ability to be visited by IPv4(e.g., app server)
  - Full bi-directional IPv4 connection
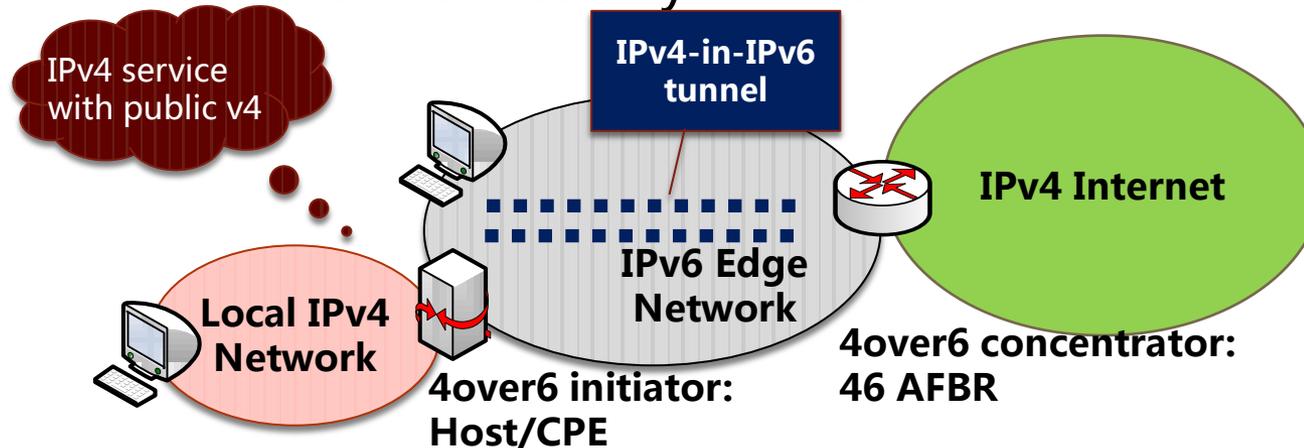- Leverage ISP's existing IPv4 address blocks

DS-lite: what we have now

IPv6 packet
IPv6 src: IPv6 address of home gateway (IGD)
IPv6 dst: IPv6 address of tunnel concentrator,
discovered with DHCPv6
IPv4 src: 192.168.1.3
IPv4 dst: www.nanog.org (198.108.95.21)
IPv4 src port: 1001
IPv4 dst port: 80

IPv4 packet
IPv4 src: from the pool of the ISP
IPv4 dst: www.nanog.org (198.108.95.21)
IPv4 src port: 45673
IPv4 dst port: 80

PC — IGD — Tunnel concentrator — carrier-grade NAT — IPv4

192.168.1.3
SRC port 1001

NAT binding
IN:
IPv6 src: IPv6 address of IGD + 192.168.1.3 + port1001
OUT:
IPv4 src address: from pool of the ISP + port: 45673

- User-side: private IPv4 address
- AFTR: CGN address+port translation
- What's missing?

Basic idea of Public 4over6

- Allocate public address to user side
  - host directly-connected to IPv6, or local IPv4 network
- IPv4-in-IPv6 tunnel between user and 46AFBR for data forwarding
- Address availability consideration
  - The more users switch to IPv6, the more IPv4 addresses we can collect & re-allocate to IPv6
  - Value-added service beyond DS-lite

IPv4 service with public v4

IPv4-in-IPv6 tunnel

IPv4 Internet

IPv6 Edge Network

Local IPv4 Network

4over6 initiator: Host/CPE

4over6 concentrator: 46 AFBR

Use cases

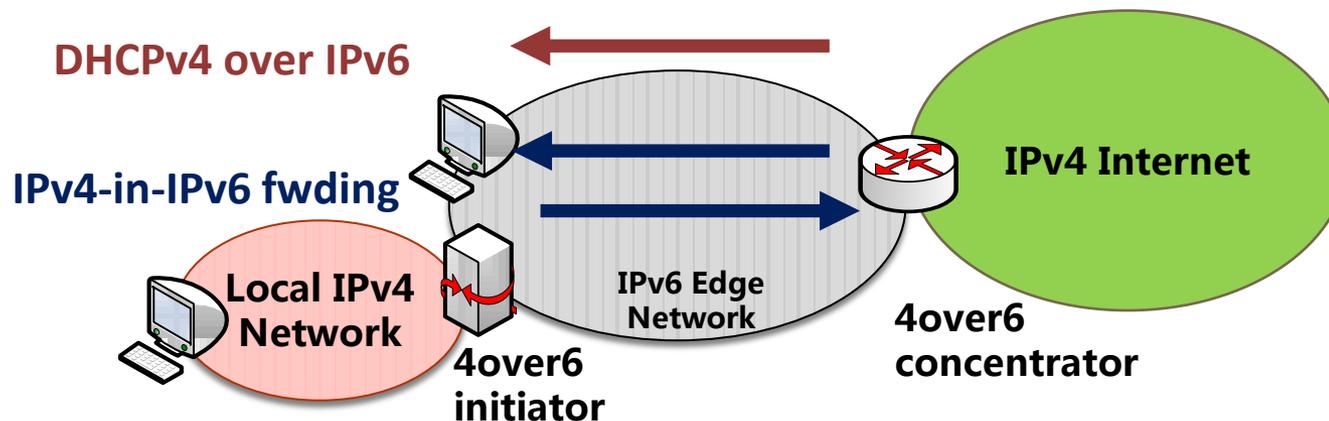- high-end user(host/local network): own global IPv4 address to support various apps
- Servers: Move IPv4 servers to IPv6 networks without loss of IPv4 clients
- Having global IPv4 addresses will be a Value-Added Service beyond basic DS-lite
- ISP with enough IPv4 addresses to support (part of) its users

IPv4 server

High-end host

Local IPv4 Network

CPE

IPv6 Edge Network

IPv4 Internet
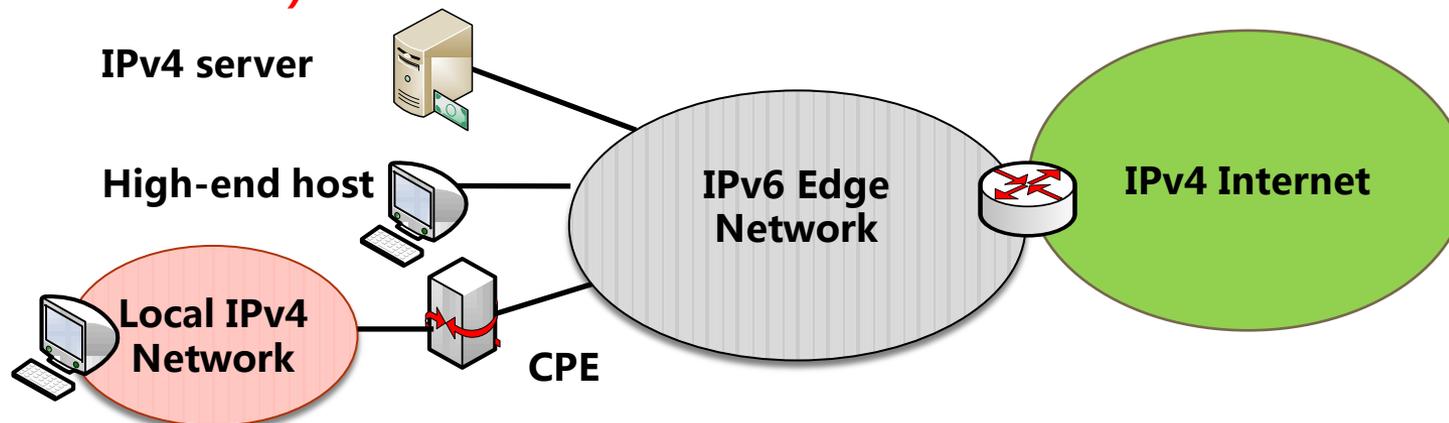
Key issues

- IPv4 address allocation over IPv6
  - Static/DHCP over IPv6 tunnel
- Data forwarding
  - IPv4-in-IPv6 encapsulation & decapsulation
  - Encapsulation of inbound packets on concentrator
  - (Allocated IPv4 addr, user IPv6 addr) mapping on the concentrator

DHCPv4 over IPv6

IPv4-in-IPv6 fwding

Local IPv4 Network

IPv6 Edge Network

IPv4 Internet

4over6 initiator

4over6 concentrator

Public 4over6 elements

- 4over6 initiator
  - 2 cases with slight differences
    - Direct-connected host
    - NATed CPE: private v4 in local network
  - DHCP client supporting tunneled DHCPv4
  - IPv4-in-IPv6 encap & decap
- 4over6 concentrator
  - DHCP server(relay) supporting tunneled DHCPv4
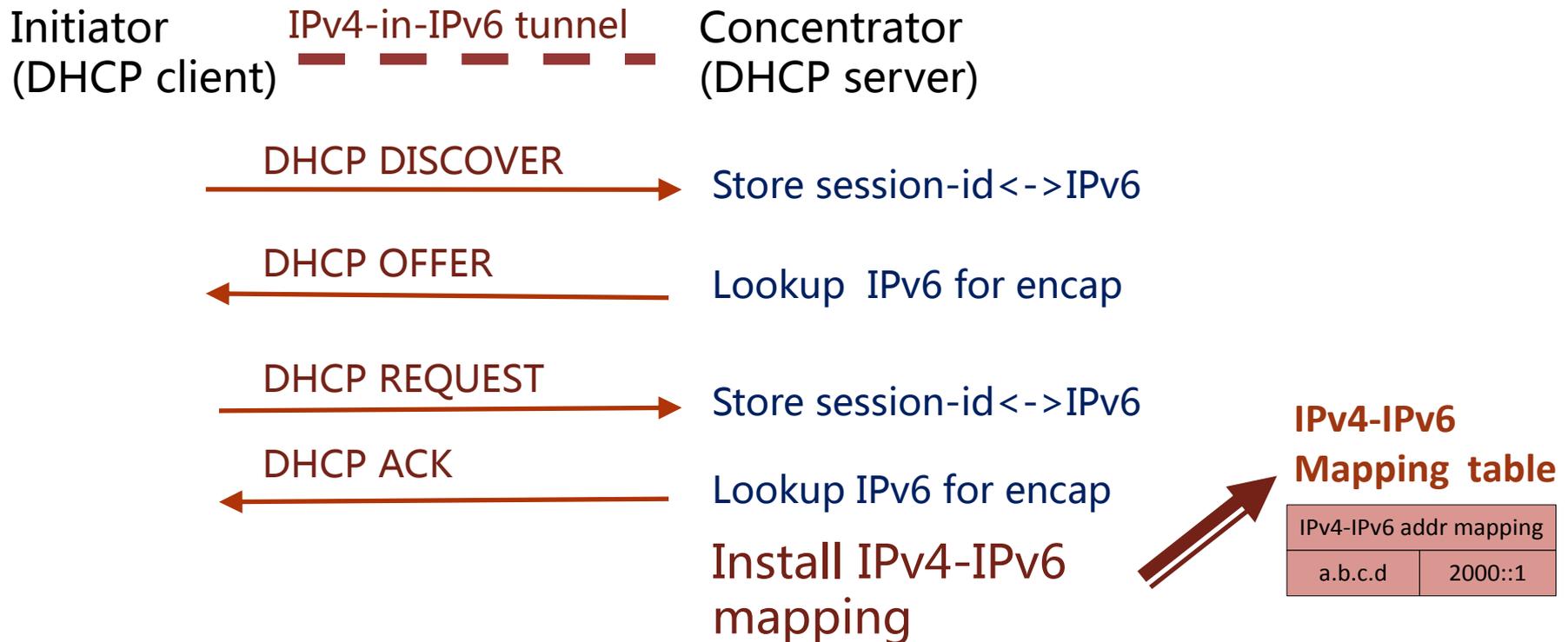 - IPv4-IPv6 address mapping
  - IPv4-in-IPv6 encap & decap

Concentrator discovery

- Leverage "Dynamic Host Configuration Protocol for IPv6 (DHCPv6) Option for Dual-Stack Lite"
  - Through initiator's DHCPv6 beforehand
  - draft-ietf-softwire-ds-lite-tunnel-option
  - Approved to be proposed standard on 3.29

Example of public 4over6

DHCPv4

DHCPDISCOVER-->   <--DHCPOFFER

DHCPREQUEST-->   <--DHCPACK a.b.c.d

IPv4-in-IPv6 Tunnel

Addr mapping table

IPv4-IPv6 addr mapping	
a.b.c.d	2000::1

Outbound fwding

Payload	
IPv4 SRC	a.b.c.d
IPv4 DST	DST in v4 Internet

Encap

Payload	
IPv4 SRC	a.b.c.d
IPv4 DST	DST in v4 Internet
IPv6 SRC	2000::1
IPv6 DST	2000::1001

Decap

Payload	
IPv4 SRC	a.b.c.d
IPv4 DST	DST in v4 Internet

Inbound fwding

Decap

Payload	
IPv4 SRC	a.b.c.d
IPv4 DST	DST in v4 Internet

Encap

Payload	
IPv4 SRC	SRC in v4 Internet
IPv4 DST	a.b.c.d
IPv6 SRC	2000::1001
IPv6 DST	2000::1

Payload	
IPv4 SRC	SRC in v4 Internet
IPv4 DST	a.b.c.d

host

Tunnel VIF a.b.c.d

2000::1

2000::1001

IPv4 Internet

4over6 initiator

4over6 concentrator

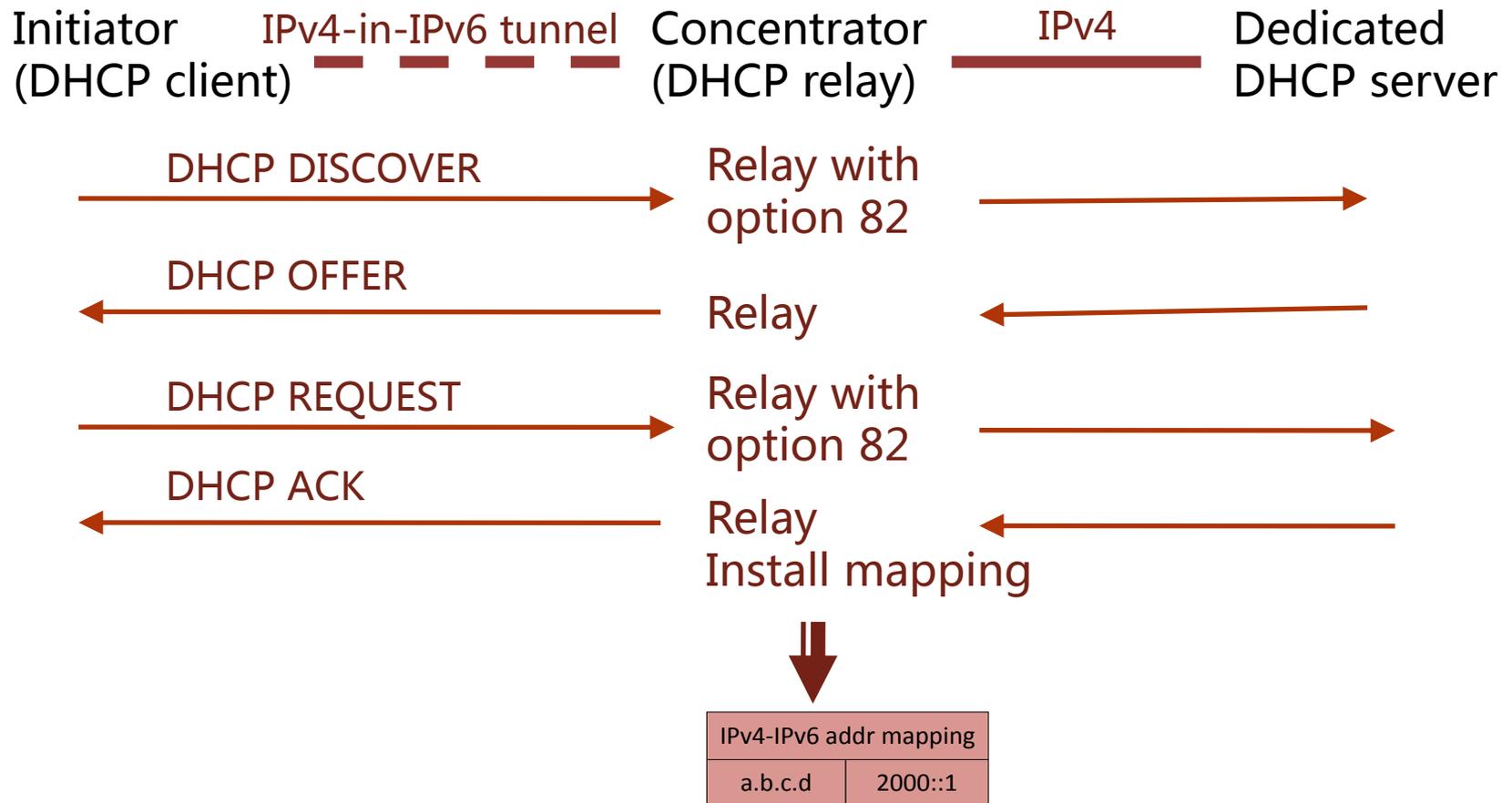|	
▬▬▬	**IPv6 Link**
▬▬▬	**IPv4 Link**

DHCPv4 over IPv6 tunnel

- Every DHCP packet between initiator & concentrator go through tunnel using IPv4-in-IPv6 encapsulation.
- Implementation issue: server->client encapsulation

Initiator
(DHCP client)

IPv4-in-IPv6 tunnel

Concentrator
(DHCP server)

DHCP DISCOVER → Store session-id<->IPv6

← DHCP OFFER   Lookup IPv6 for encap

DHCP REQUEST → Store session-id<->IPv6

← DHCP ACK   Lookup IPv6 for encap

Install IPv4-IPv6 mapping

IPv4-IPv6 Mapping table

IPv4-IPv6 addr mapping	
a.b.c.d	2000::1

DHCPv4 over IPv6 tunnel(cont')

- When DHCP server is run by a dedicated device in IPv4
- Concentrator as a DHCP relay with option 82

Initiator (DHCP client)	IPv4-in-IPv6 tunnel	Concentrator (DHCP relay)	IPv4	Dedicated DHCP server

DHCP DISCOVER → Relay with option 82 →

DHCP OFFER ← Relay ←

DHCP REQUEST → Relay with option 82 →

DHCP ACK ← Relay
Install mapping ←

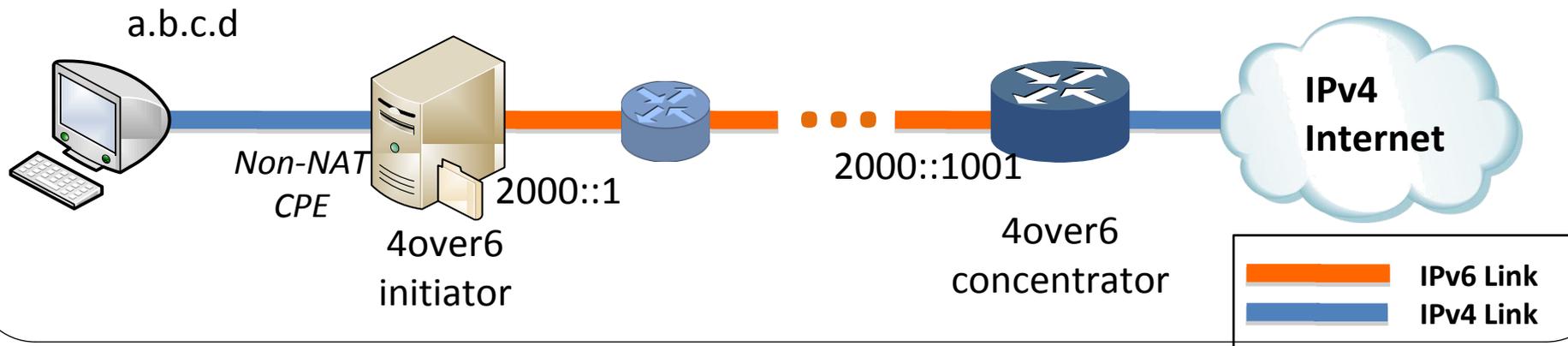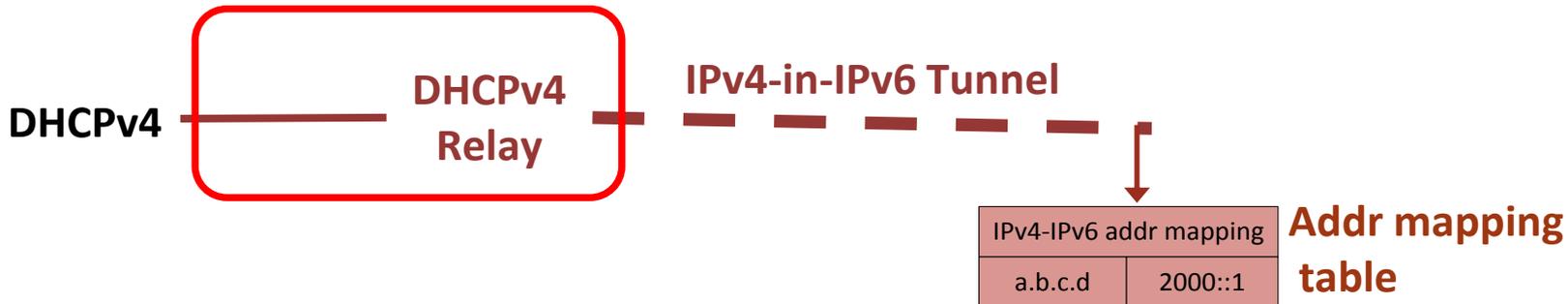| IPv4-IPv6 addr mapping	
a.b.c.d	2000::1

Summary

- Achievement of Public 4over6
  - Sustain IPv4 service when users switch to IPv6
  - Support bidirectional IPv4 communication
  - Avoid CGN and support all apps
  - Ensure high-priority host/network to have full access to IPv4
  - Encourage IPv4 servers move to IPv6 without loss of IPv4 users
- DHCP over IP tunnel between initiator & concentrator
- Address mapping triggered by DHCP allocation
- DHCP relay works for concentrator, too
- Comments?

Backups(1/2): Non-NAT CPE case

---Public address to host behind CPE

DHCPv4

DHCPv4 Relay

IPv4-in-IPv6 Tunnel

IPv4-IPv6 addr mapping	
a.b.c.d	2000::1

Addr mapping table

Outbound fwding → **Encap** → **Decap** →

Inbound fwding ← **Decap** ← **Encap** ←

a.b.c.d

Non-NAT CPE

4over6 initiator

2000::1

2000::1001

4over6 concentrator

IPv4 Internet

▬▬▬	**IPv6 Link**
▬▬▬	**IPv4 Link**

Backups(2/2): NATed CPE case

---Similar to Host initiator case, with a local NAT

IPv4-in-IPv6 Tunnel

DHCPv4 ━ ━ ━ ━ ━ ━ ↓

IPv4-IPv6 addr mapping	
a.b.c.d	2000::1

Addr mapping table

Outbound fwding → **Local NAT Xlate** → **Encap** ————————→ **Decap** ————————→

Inbound fwding ← **Local NAT Xlate** ← **Decap** ←———————— **Encap** ←————————

192.168.1.2

Tunnel VIF
a.b.c.d

CPE with NAT

2000::1

4over6 initiator

2000::1001

4over6 concentrator

IPv4 Internet

	IPv6 Link
	IPv4 Link