IPv6 Transition Techniques

APNIC

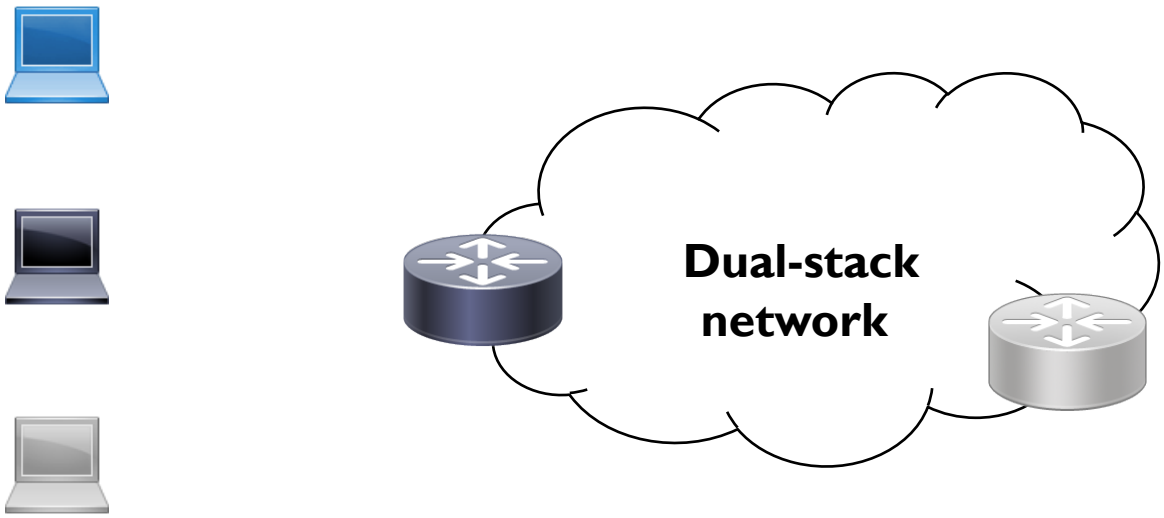
Agenda

- **IPv6 in Mobile Network**
- IPv6 in Broadband Network

IPv6 in Mobile Networks: Technology

Carrier	Economy	Deployment
Verizon Wireless	USA	Dual-stack (2011)
T-Mobile	USA	464XLAT (2012)
SK Telecom	Korea	464XLAT (2014)
Telstra	Australia	464XLAT (2016)
Reliance Jio	India	Dual-stack (2016)
AIS	Thailand	Dual-stack (2017)
Bhutan Telecom	Bhutan	Dual-stack (2018)
Chungwa Telecom	Taiwan	Dual-stack (2018)

Dual-stack



Dual-stack

- Does not solve IPv4 (public) depletion issue
  - Still need to use CG-NAT to access IPv4-only sites
- But effective, and the only viable/scalable way forward
  - IPv6 native access to most of the major content providers
  - None of the scalability issues of v4 CG-NAT

Dual-stack in mobile network

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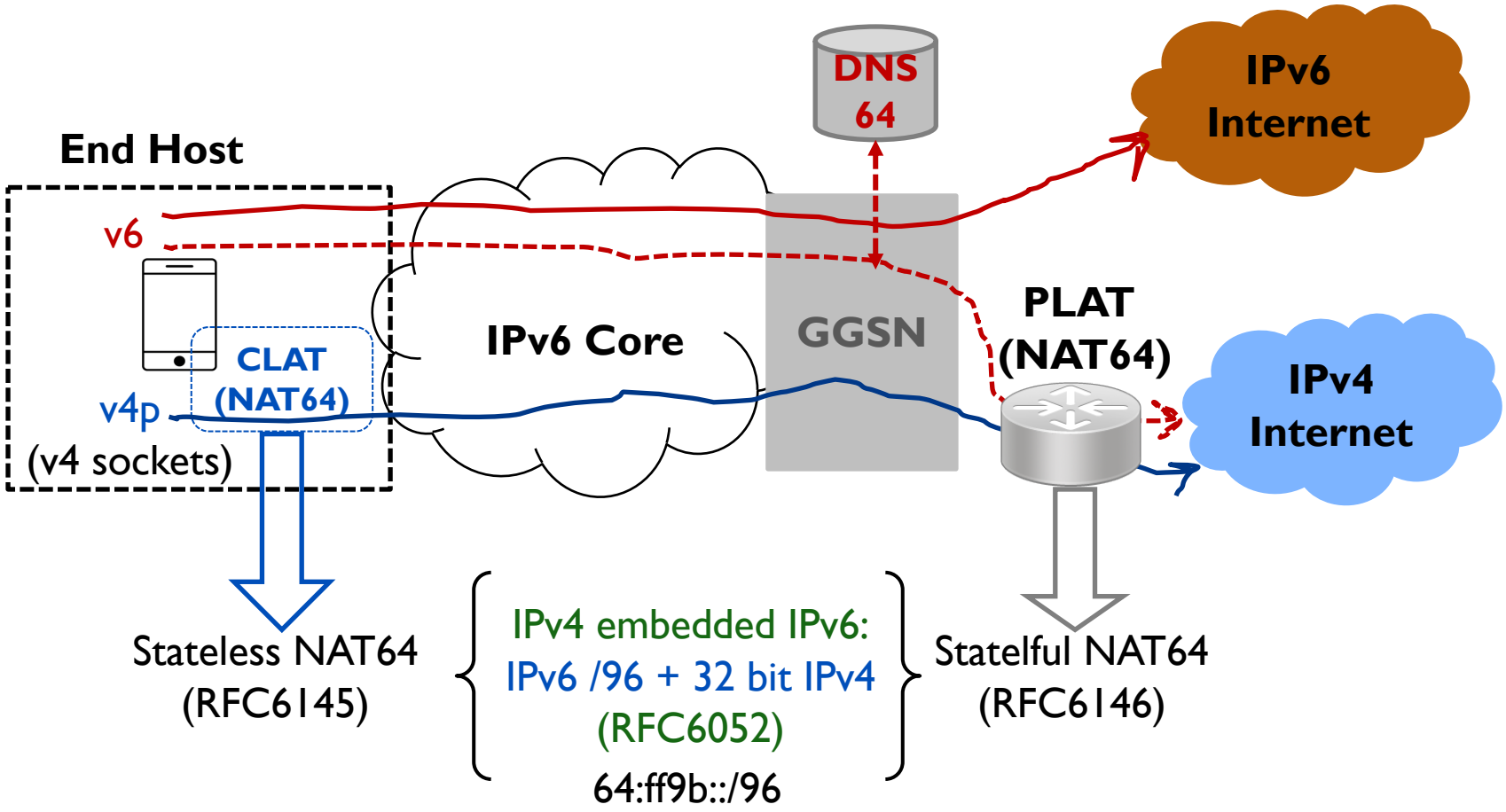
  - None of the scalability issues of v4 CG-NAT
  - And of course, no DNSSEC issues

464XLAT (RFC6877)



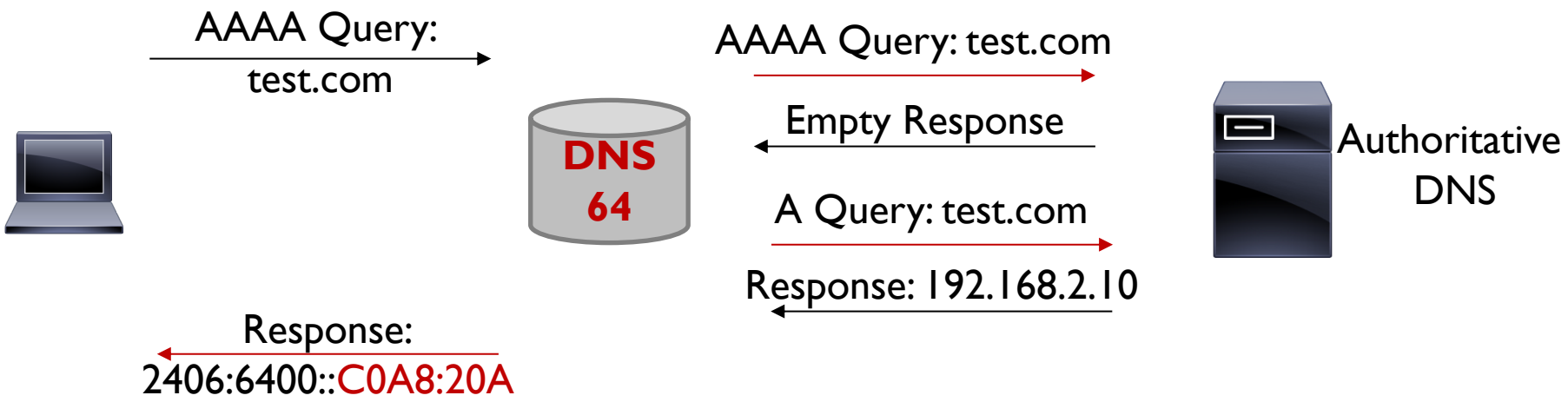
CLAT (Stateless NAT64) (RFC6145)

- When IPv4 connection is required (an IPv4 socket)
  - CLAT function provides private IPv4 address (and default route for applications to bind to)
  - a dedicated prefix (/64 or /96) for stateless translation (DHCPv6)
  - must know the PLAT side translation prefix
  - Route connections to the PLAT (stateful NAT64)
  - 1:1 mapping
  - **2406:6400::[v4p in HEX]** (RFC6052)

RFC6145 has been deprecated by RFC7915

DNS64(RFC6147)

- Generate **AAAA** records from **A** records
  - Allows IPv6-only client to talk to IPv4 hosts
  - If 'AAAA' records exists, no *synthesis*
  - If only 'A' record exist for the queried name (after recursive query), synthesize to AAAA record



DNS64 Example

- DNS64 **options** statement in BIND9.8

```
dns64 2406:6400::/96 {
        clients {any;};
        mapped {!rfc1918; any;};
        exclude {0::/3; 2001:DB8::/32;};
        break-dnssec yes;
};
```

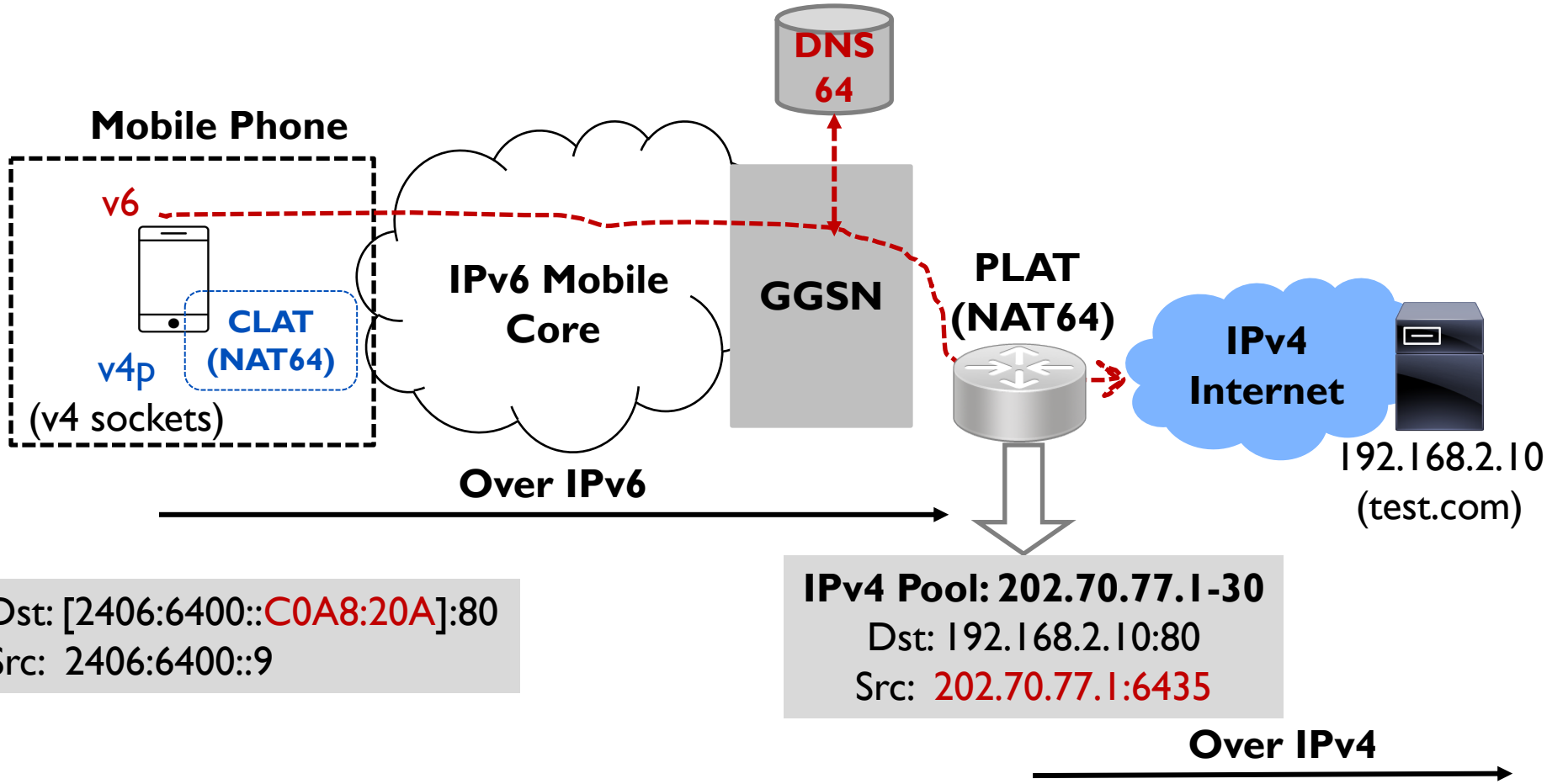
https://ftp.isc.org/isc/bind9/cur/9.9/doc/arm/Bv9ARM.ch06.html

  - *mapped*: which IPv4 addresses are to be mapped (A records)
  - *exclude*: list of IPv6 addresses to ignore if they appear in the domain's AAAA records (synthesize it from the ***NAT64 prefix+v4*** address)
  - *break-dnssec yes*: by default, DNS64 module does not process secure queries (DO = 1) or responses. The **break-dnssec yes** overrides this default.
    - However, the synthesized response will not have any DNSSEC records added and therefore cannot be verified by the client!

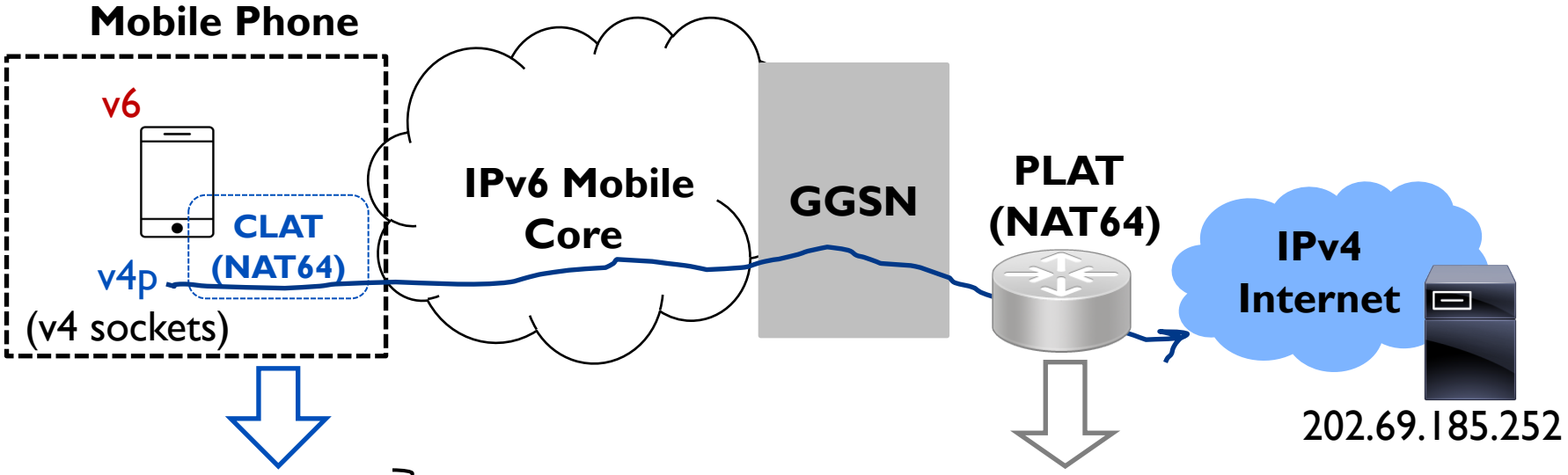
PLAT (Stateful NAT64) (RFC6146)

- IPv6 to IPv4 translation (public)
  - and vice versa
  - bindings for every translation maintained
    - need a return path
  - N:1 mapping (conserves IPv4)
  - **2400:6400::[v4p in HEX]** to **[v4]:port** (~PAT)

Stateful NAT64 (v6-only to v4-only 'Internet')



Stateless NAT64 (v4 to v4 – literal IPs)



v4p address (Src): 192.168.12.99
Dst: 202.69.185.252:80

Stateless XLATE prefix:
2406:6400:EEEE::/96

PLAT-side XLATE prefix:
2406:6400:AAAA::/96

IPv6 Src:
2406:6400:EEEE::C0A8:C63

IPv6 Dst:
[2406:6400:AAAA::CA45:B9FC]:80

IPv4 Pool: 202.70.77.1-30

PLAT-side XLATE prefix:
2406:6400:AAAA::/96

Src: 202.70.77.1:888
Dst: 202.69.185.252:80

IPv6 and Mobile devices

- Android supports 464XLAT (**4.4 - KitKat**)
- IPv6 supported over mobile interface since iOS 9 (supported IPv6 on WiFi for a long time!)
  - All apps submitted to App Store must support IPv6 (only) since June 2016
    - https://developer.apple.com/support/ipv6/

IPv6 Tethering

- **RFC6653**:DHCPv6-PD for Mobile Networks
  - 3GPP Rel-10

- **RFC7278**: Extending IPv6 /64 prefix from Mobile interface to LAN
  - "Flaky" support since Android 6.0 (Marshmallow)
  - Stop-gap until DHCPv6-PD

References

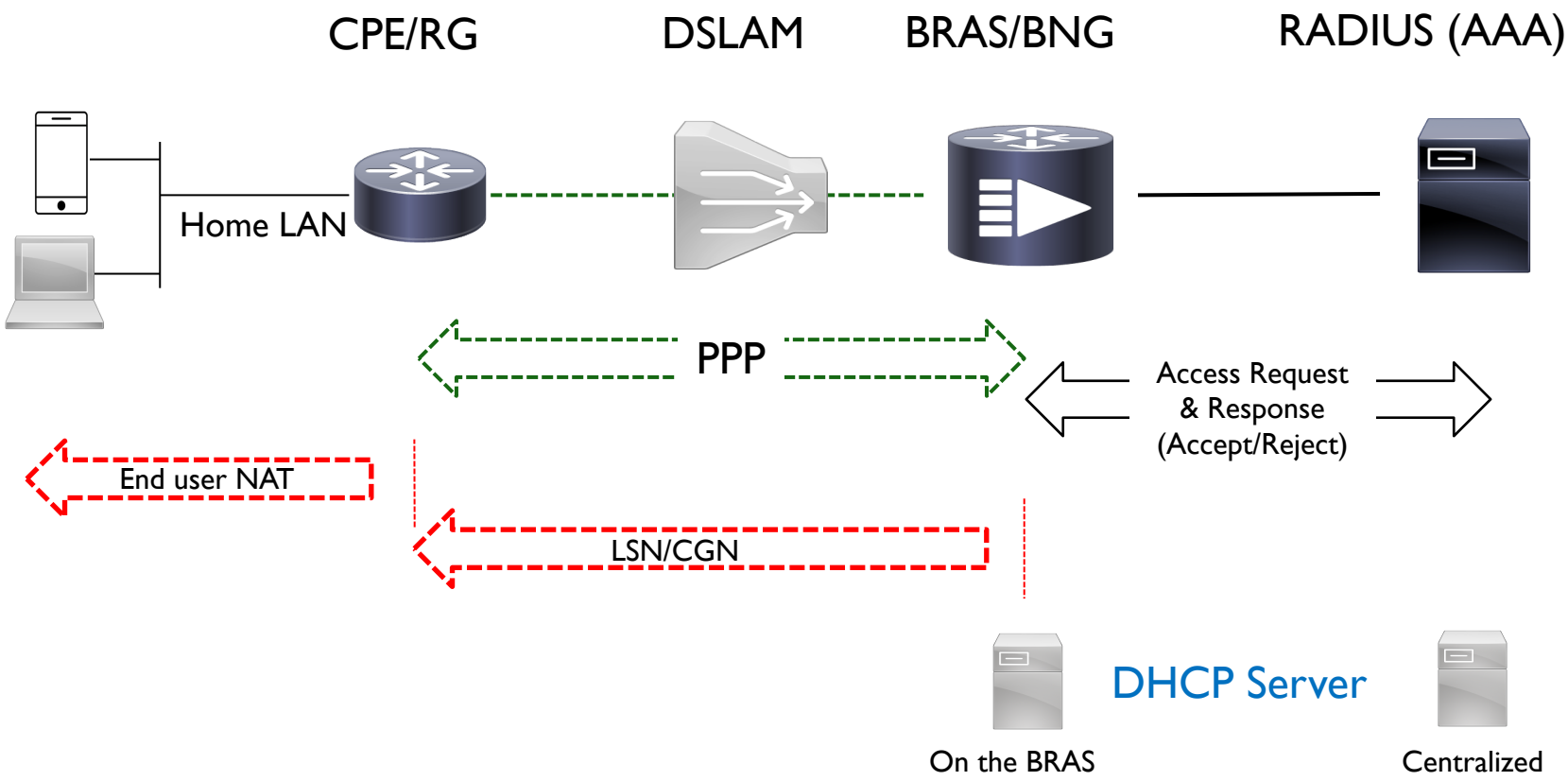
- IPv6 in Mobile Networks – Telstra
  - Sunny Yeung, Senior Technology Specialist
  - Presentation @APNIC41 (Feb 2016)
  - https://conference.apnic.net/data/41/yeung.-s-tutorial-apricot-2016_1455689286.pdf

- 464XLAT: Breaking free of IPv4 - TMobile
  - Cameron Byrne's presentation at SANOG23 (Jan 2014)
  - http://www.sanog.org/resources/sanog23/SANOG23_464XLAT.pdf

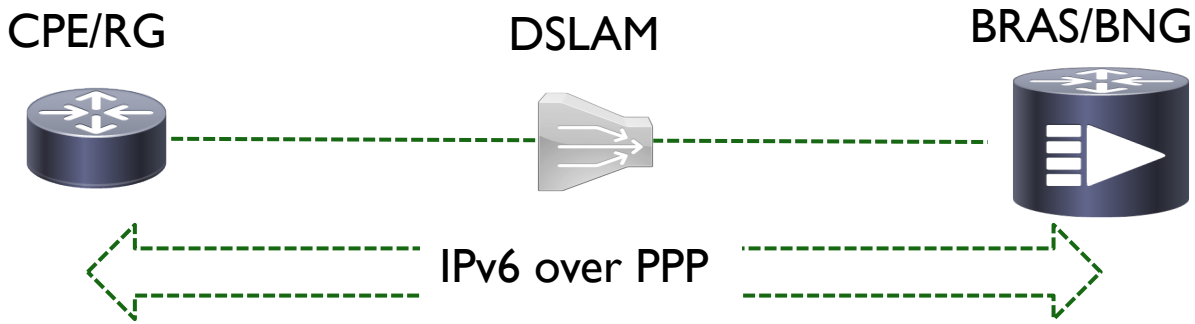
Agenda

- IPv6 in Mobile Network
- **IPv6 in Broadband Network**

Broadband Network (IPv4)

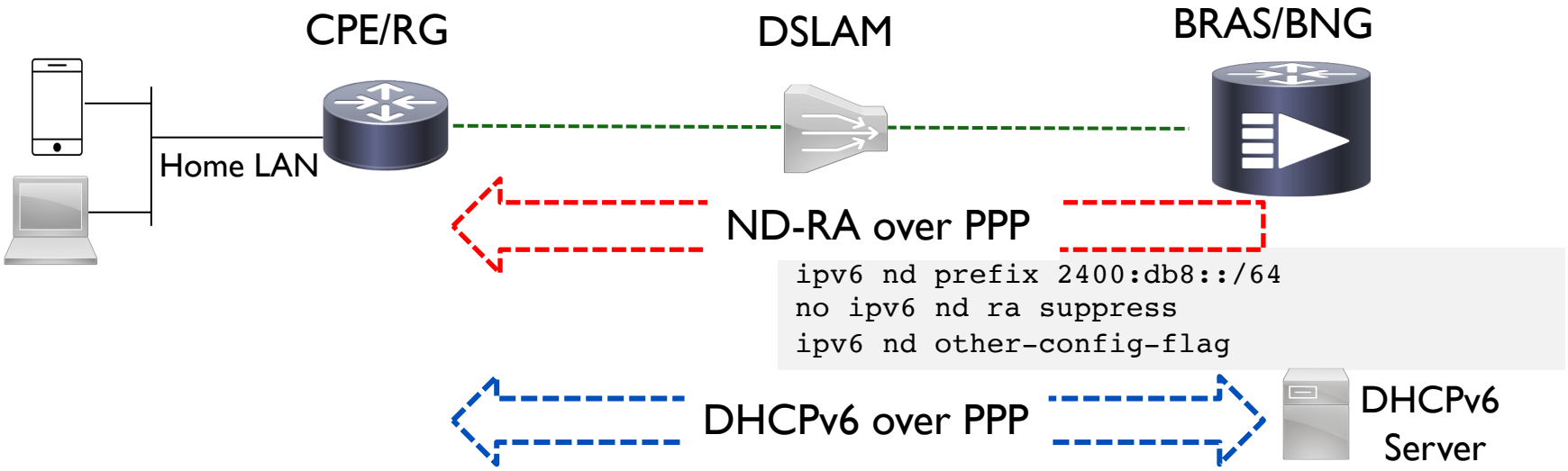


IPv6 over PPP



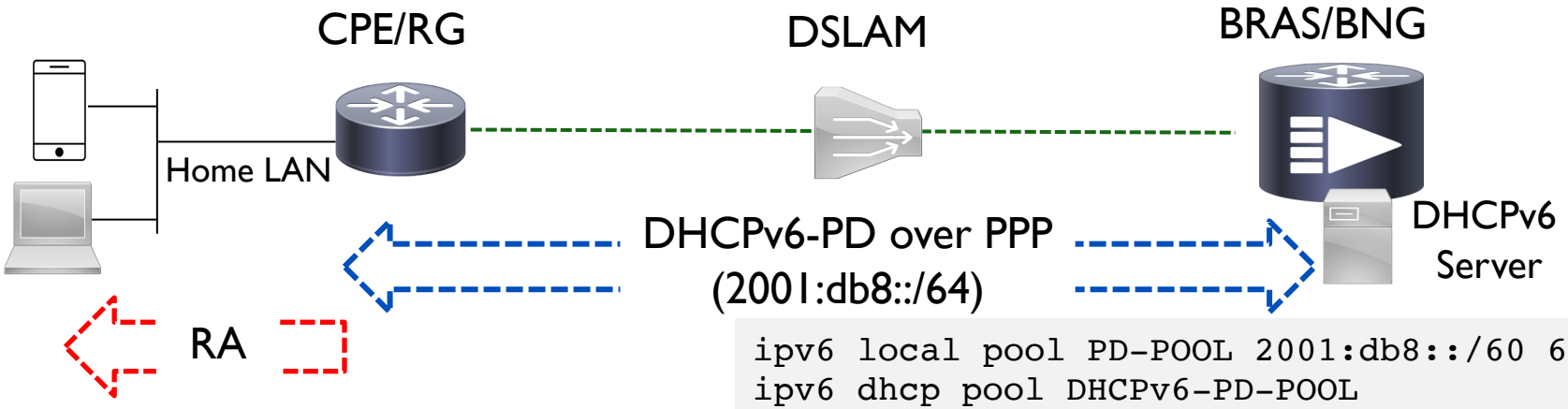
- Link Control Protocol (LCP) same as in IPv4
  - Establish the connection, agree packet sizes (MTU/MSS)
- Authentication same as IPv4
  - (PAP/CHAP)
- Network Control Protocol (NCP) for IPv6 is **IPV6CP**
  - Choose the network protocol (IPv6)
  - Options:
    - Interface Identifier (to negotiate the 64-bit int-id for SLAAC) – RFC 5072
    - Compression Protocol (ability to received compressed packets) – RFC 5172

IPv6 CPE WAN



- CPE IPv6 address
  - SLAAC based on the RA (and set 'O' flag for DNS), or
  - use the link-local, OR
- DHCPv6 over PPP
- How will home devices get IPv6 address?
  - Proxy RA?

IPv6 on Home LAN (DHCPv6-PD: RFC 8415)




```
ipv6 local pool PD-POOL 2001:db8::/60 64
ipv6 dhcp pool DHCPv6-PD-POOL
 prefix-delegation pool PD-POOL
 dns-server 2001:db8::1
```

- CPE requests prefix from BRAS (delegator)
  - DHCPv6 messages over PPP
  - BRAS delegates /64 prefix from the pool to CPE

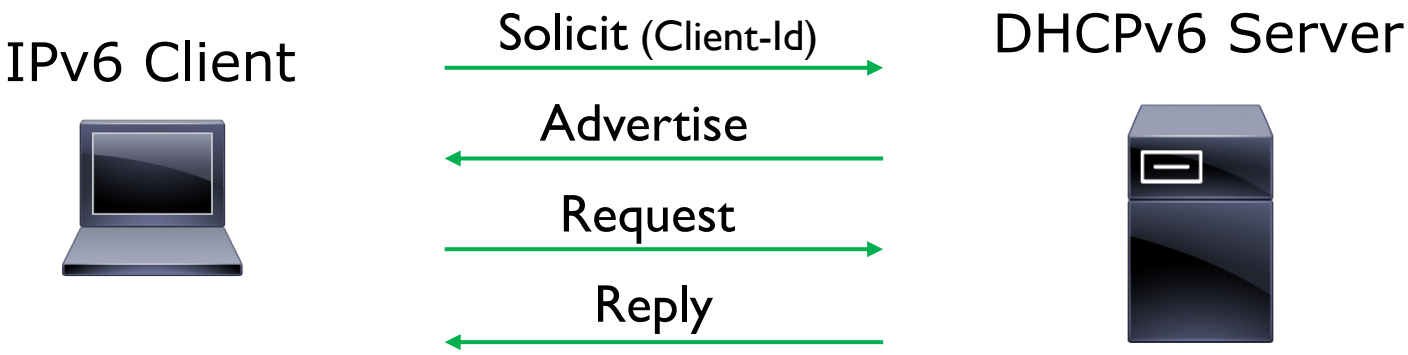
PD:
Prefix Delegation

- ND-RA to home devices by CPE
  - Auto-configure IPv6 address (SLAAC) using the delegated prefix

DHCPv6 (RFC8415)

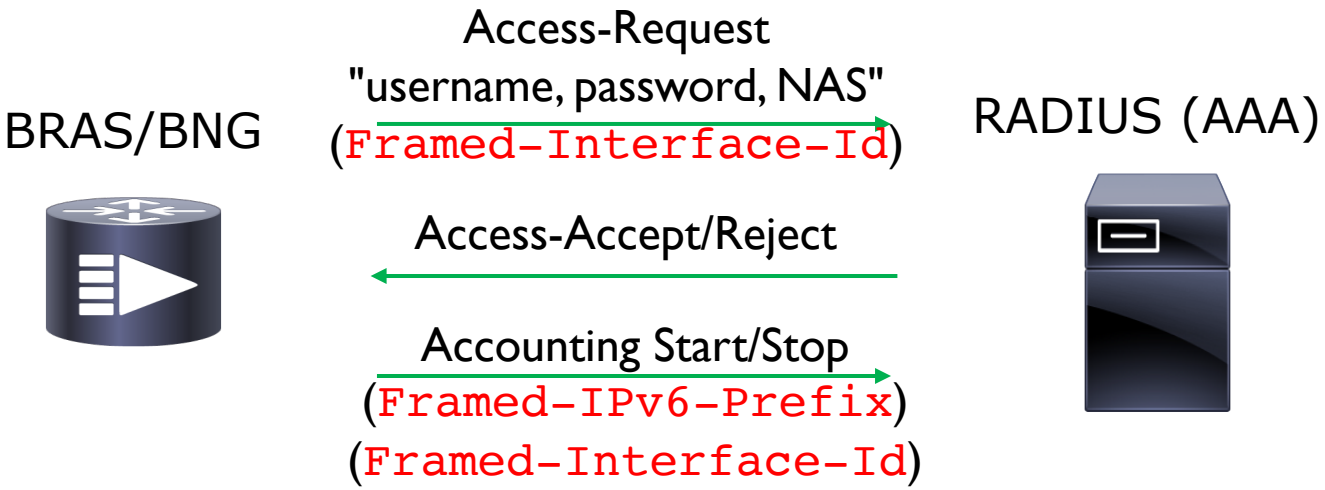
- RA message:
  - A (auto) flag set by default
    - SLAAC
  - If O (other) flag set: *stateless DHCPv6*
    - auto-generate IPv6 address (IPv6 prefix, prefix length in the RA)
    - obtain other information (DNS server, domain) via DHCPv6
  - If M (managed) flag set:
    - obtain all addressing information via DHCPv6
    - 'O' flag is redundant

DHCPv6 (RFC8415)



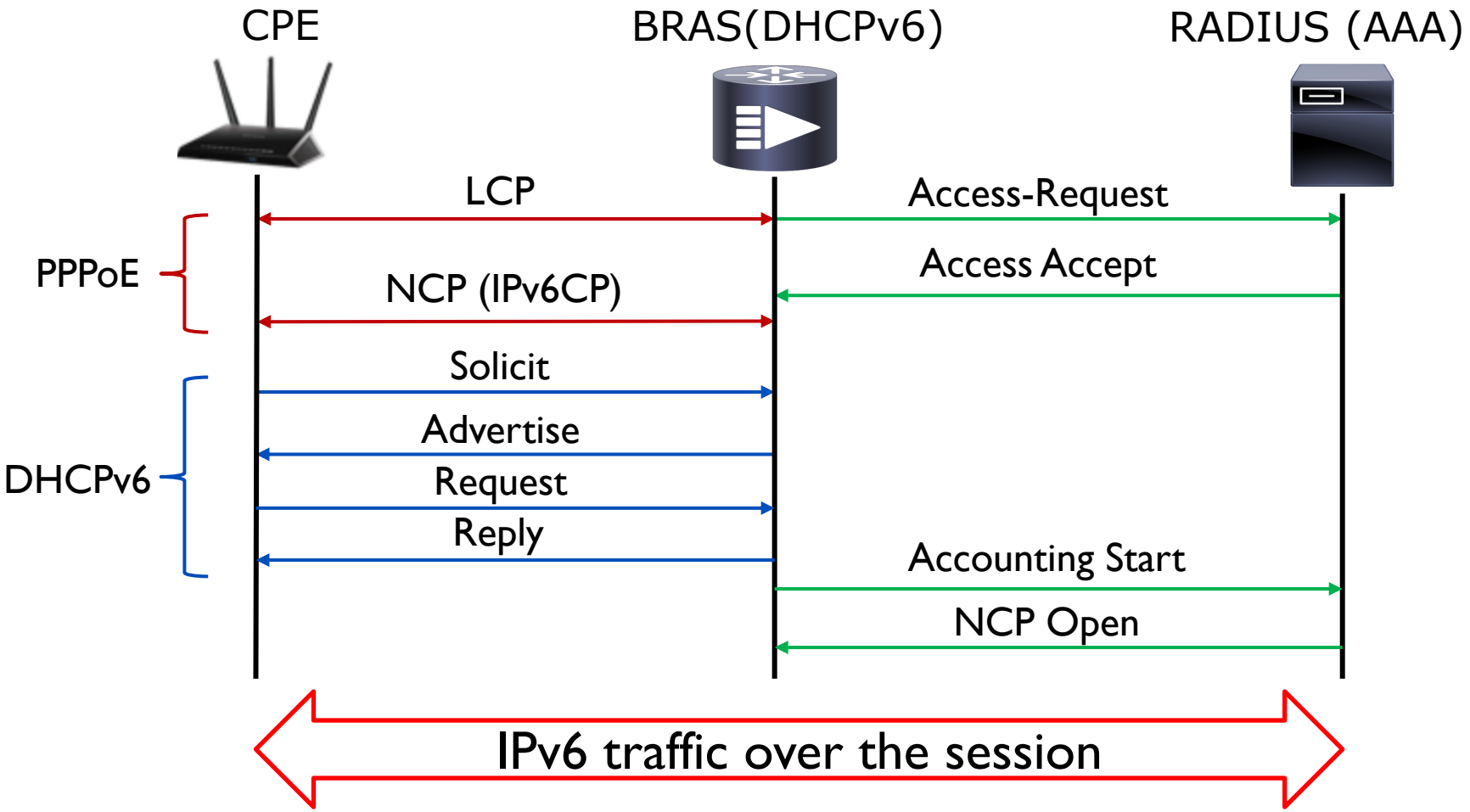
- DHCPv6 uses DUID + IAID as Client-Id
  - Servers will drop any Solicit message without Client-id
- Be wary of duplicate DUID!
  - to uniquely identify & associate (IA) IPv6 addresses with each interface on a host
  - IAIDs uniquely identifies the interface (one IA per interface)
  - Have a look at **"The Story of IPv6 at FPT Telecom" @APRICOT2017**
- DUID types:
  - Link-layer address, Link-layer+Time, Enterprise number (vendor)

RADIUS attributes for IPv6 (RFC6911)



- Framed-IPv6-Prefix:
  - Which prefix was delegated to the LAN side of the CPE
- Framed-Interface-Id:
  - Used for accounting and also indicates what address will be used on WAN side through RA

Putting it together



Deployment Planning

- Assess your network
  - Do the existing network nodes support IPv6?
    - What requires updating (hw/sw)?
    - What needs upgrading/replacing (hw)?
  - Talk to your vendor!
- Clean up your network
  - Remove unused configs/interfaces/BCPs/etc
    - Mistakes in v4 could get carried over to v6
- Get your IPv6 address – very easy ☺
- Address planning – not difficult ☺
- Do you have in-house skills or need consulting?
  - Talk to the community – many are willing to help!!

Deployment Planning -2

- Start from the backbone – not so complicated
  - Transit ready?
    - Dual stack or tunnel?
- Deploy for enterprise customers – not difficult
- Deploy in access Network
  - Both financial and technical assessment required!!
    - Vendors and ”IPv6 consultants” will tell you otherwise ☹
  - Mobile: IPv6 PDP license ☹
    - Either IPv6-only or dual-stack (IPv4v6)
  - Wired broadband:
    - MSANs, DSLAMS, OLTs should carry IPv6 ether-type (do not assume)
    - CPEs, wireless routers, APs: https://getipv6.info/display/IPv6/Broadband+CPE

Thank You!

END OF SESSION