



deploy

IPv6 and xDSL

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Outline

- Introduction on an xDSL Environment
- PPPv6 overview
- PPP over ATM/Ethernet
- Addressing
- IPv6 and Radius
- Scenarios & Configuration
- CPEs



Introduction in an xDSL Environments

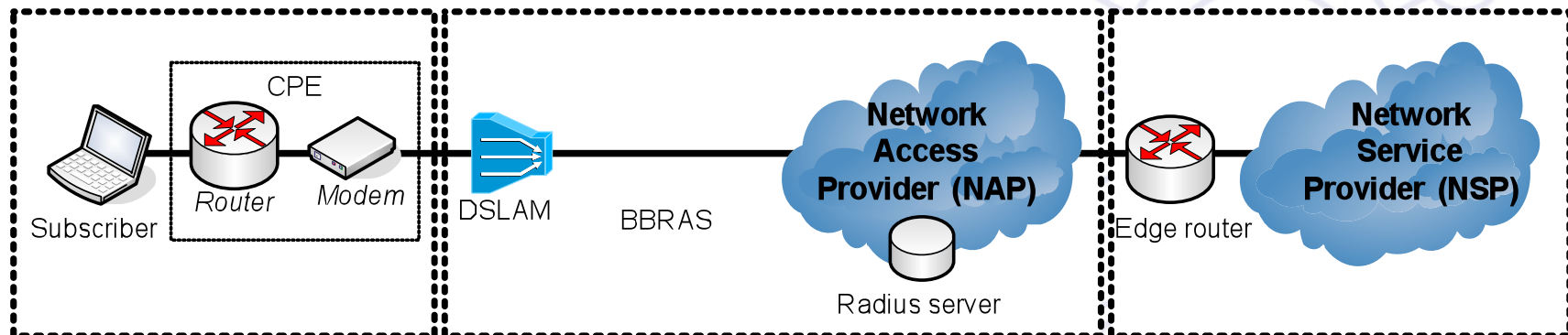


Entities in an xDSL Environment

- Subscriber – Residential (xDSL) User
 - Connecting PCs, and (possible) operating xDSL modem or bridge/router.
- Network Access Provider (NAP)
 - Manages the (copper) local loop and connects users to several service providers.
 - Responsible for DSLAM, BBRAS, radius server and (possible) CPE.
- Network Service Provider (NSP)
 - Responsible for providing user with interconnection services to the Internet. May also offer other added-value services.
 - Responsible for edge router, radius server.

Entities in an xDSL Environment (2)

- The NAP and the NSP may be part of the same organisation.



Implementation Details

- xDSL modem
 - Encapsulates subscribers' traffic to ATM cells, signal (de) modulation.
- DSL Access Multiplexer (DSLAM)
 - Signal (de)modulation, aggregates traffic over ATM links.
- Broadband Remote Access Concentrator (BBRAS)
 - Terminates the subscribers' ATM connections, authenticates incoming connections, terminates subscribers' PPP sessions.
 - Called *L2TP Access Concentrator (LAC)*, if protocols carried within incoming PPP sessions are tunnelled to the edge router.

Implementation Details

- Radius Server
 - Contains subscriber configuration templates.
- Edge router
 - Gateway to Internet.
 - Called *L2TP Network Server (LNS)*, if terminates PPP sessions.

PPP overview



IPv6 over PPP (RFC 5072)

- The Point-to-Point Protocol (PPP) provides a standard method of encapsulating multiple Network Layer protocol information over point-to-point links.
 - PPP: point to point connection between *two* peers
 - Carrying of IP traffic back and forth between peers
 - Non broadcast medium (contrast to Ethernet)
 - Maximum Receive Unit ==> IP Maximum Transfer Unit



IPv6 over PPP

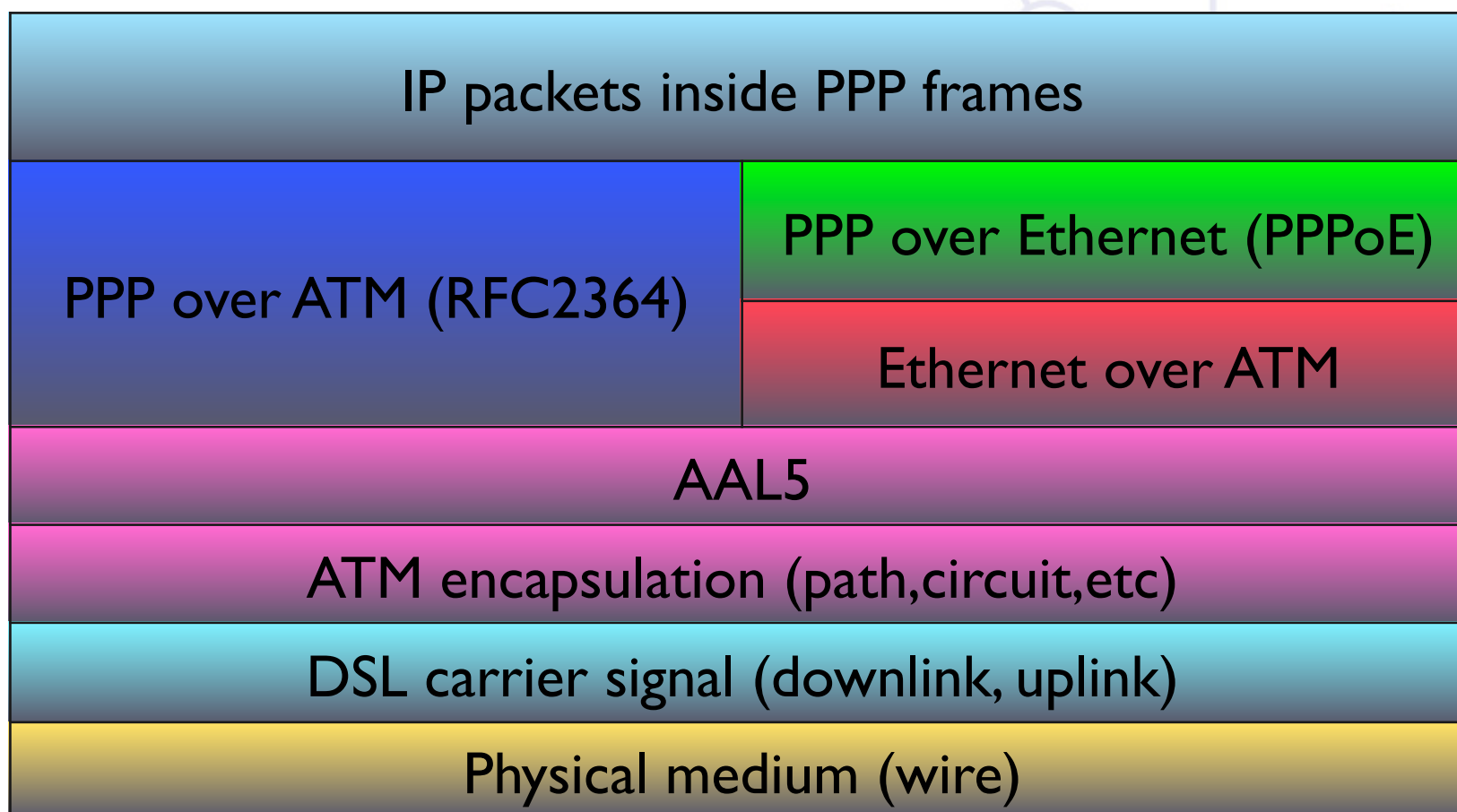
- PPP has three main components
 - A method for encapsulating datagrams over serial links;
 - a **Link Control Protocol (LCP)** for establishing, configuring, and testing the data-link connection;
 - a family of **Network Control Protocols (NCPs)** for establishing and configuring different network-layer protocols. The NCP for establishing and configuring the IPv6 over PPP is referred as the ***IPv6 Control Protocol (IPV6CP)***.

IPv6 over PPP

- PPP establishment sequence
 - Link Control Protocol (LCP)
 - Mutual Authentication, Negotiation of Maximum Receive Unit, Connection Keepalive packets (LCP echo)
 - Compression Control Protocol
 - IP Control Protocol (NCP)
 - Address Assignment, DNS etc, VJ (header) Compression etc



IPv6 over PPP



IPv6 over PPP

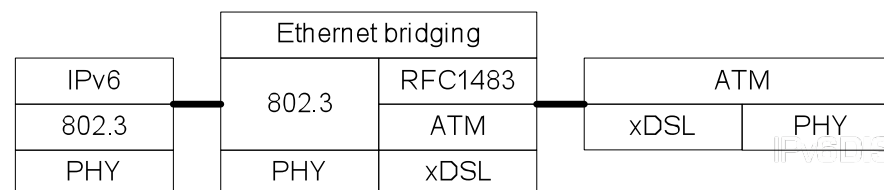
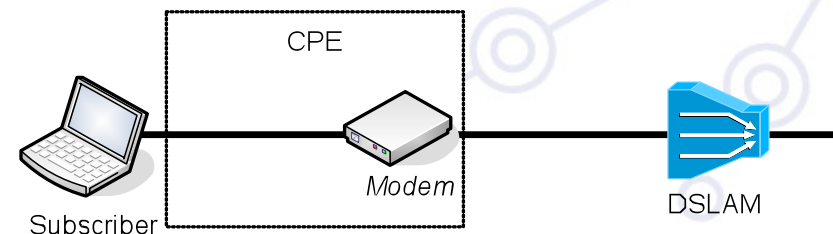
- Extra info
 - Over a single PPP session, IPv6 and IPv4 packets may be transmitted [provided that IPCPv6 and IPCP have reached *opened state*].
 - Separate PPP sessions for IPv4 and IPv6 traffic may be established between the CPE and the LNS. However, this approach increases overheads without any good reason, e.g. extra licenses are needed at LNS for supporting increased number of PPP sessions, control of PPP sessions per user may be necessary, etc.
- IPv6CP Options
 - *Interface-Identifier* : Provides a way to negotiate a unique 64-bit interface identifier to be used for the address auto-configuration at the local ends of the link.
- PPP Information field length
 - The maximum length of an IPv6 packet transmitted over a PPP is the same as the maximum length of the *information field* of a PPP frame. This should be at least 1280 bytes.

PPP over ATM/Ethernet



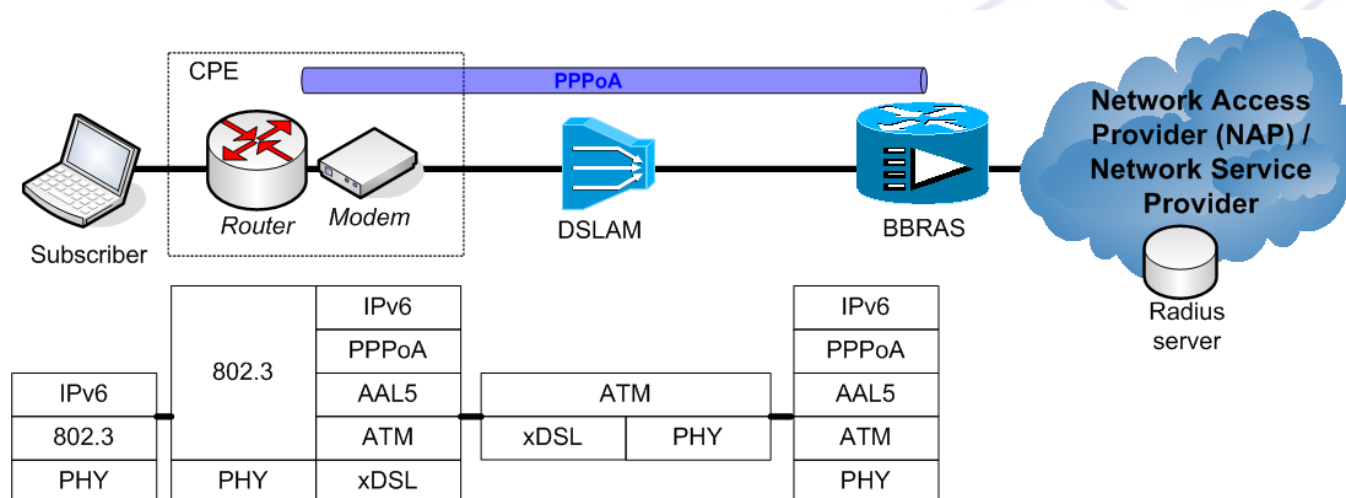
Ethernet Bridging over ATM

- The CPE forwards IP packets using multi-protocol encapsulation over ATM adaptation layer 5 (AAL5).
- Minimum functionality is required for CPE, aka xDSL modem (L3 unaware device).
- A single ATM PVC is used for IPv4/6 interconnection.
- Subscriber's PCs are configured with static IPv6 address, or via DHCPv6 or via auto-configuration.
- This method does not support authentication and authorization functionality. The NAP has to enable service selectively.



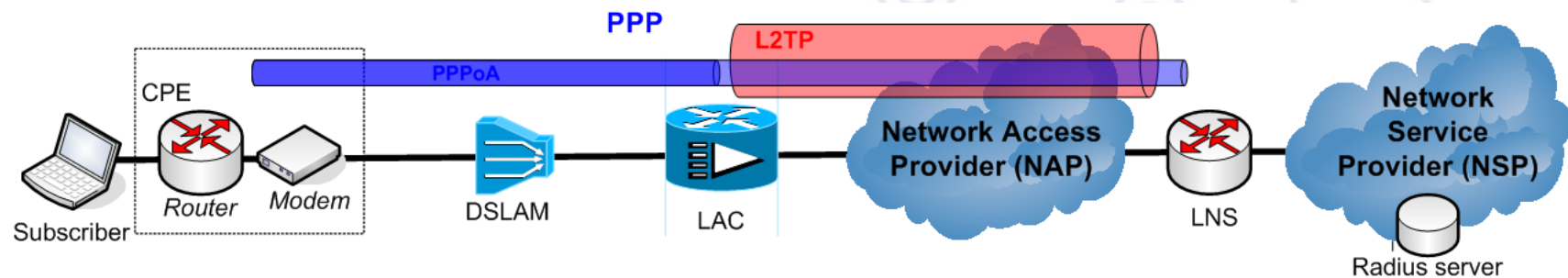
PPP over AAL5 (PPPoA) – PTA Model

- The CPE supports IPv6/4 packet forwarding and interconnects multiple systems in the *Subscriber's* local network.
- A single PPPoA link is established over an ATM PVC allowing the CPE to exchange IPv6 and IPv4 traffic.
- IPv6 addresses are assigned automatically using attributes stored in a centralised radius server or local database.
- The CPE may be authenticated –after LCP negotiation- using one of the multiple protocols, such as PAP, CHAP, MS-CHAP, EAP, etc.

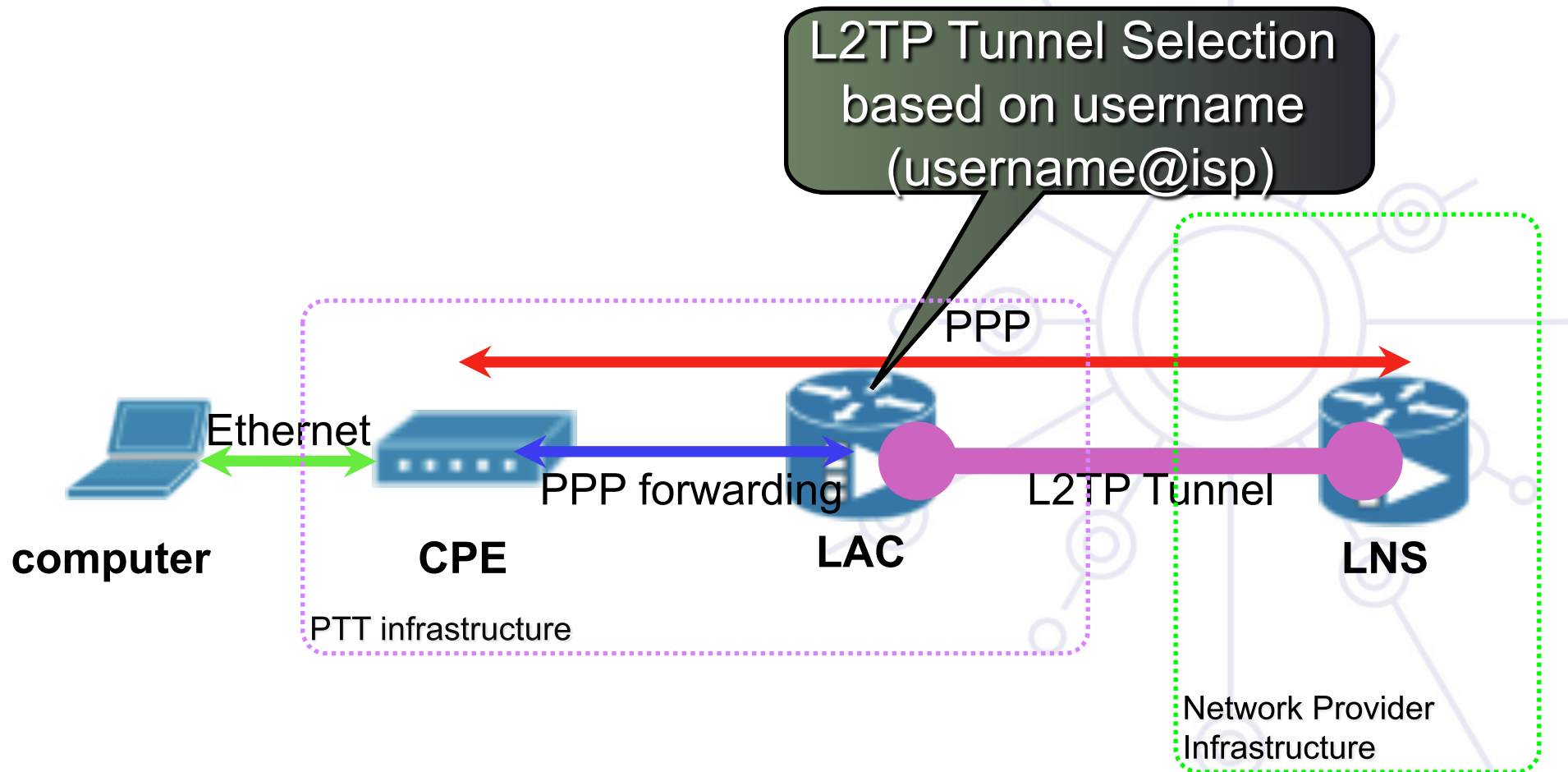


PPP over AAL5 (PPPoA) – LAA Model

- In case the *NAP* and the *NSP* are different, the subscribers' PPP sessions terminate at the *L2TP Network Server (LNS)* instead of the *L2TP Access Concentrator (LAC)*.
- The LAC uses the subscribers realm of incoming sessions to select the appropriate LNS.
- The LAC is IPv6-unaware, provided that no hardware acceleration is required.
- Address assignment and authentications methods are performed in the same way as previously but now the radius server is managed by the *NSP*.

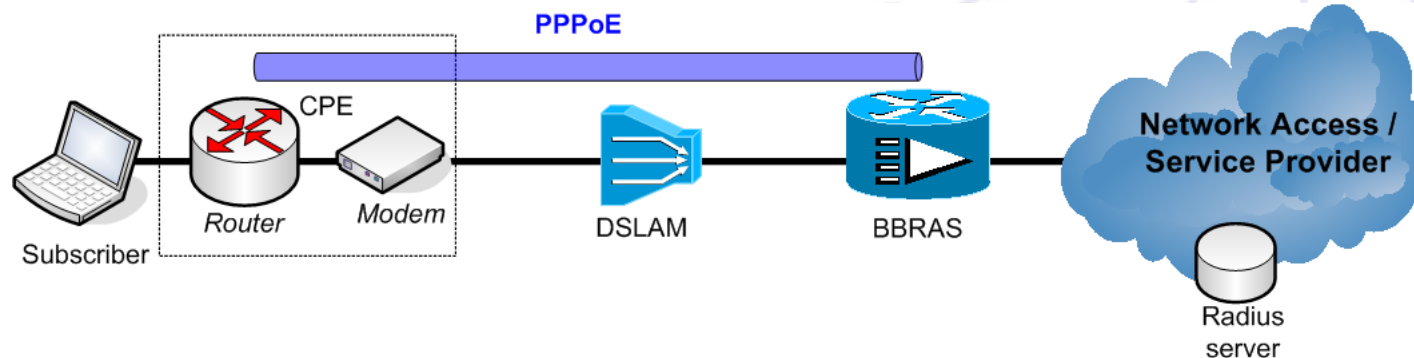


(Simplified) PPP over AAL5 (PPPoA) - LAA Model



PPP over Ethernet (PPPoE)

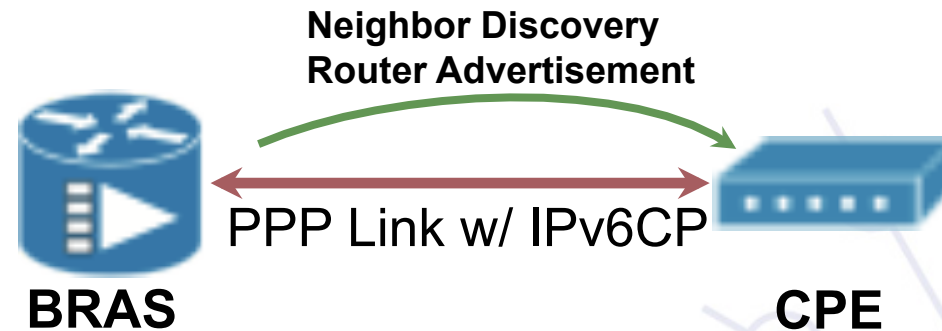
- A PPP session is established between the subscribers' systems (or CPE) and the BBRAS for IPv6 and IPv4 traffic.
 - Same IPv4/6 address allocation schema as in PPPoA
 - Sessions may terminate in the LNS in the NSP network (not shown).
 - If PPP sessions terminate at the *subscribers'* end systems, then the CPE may be L3 unaware. It requires, however, specific software to be installed in the *subscribers'* end systems. The advantage of this approach is that allows access control and service selection to be done on per-subscriber rather than on per-site basis.



Addressing

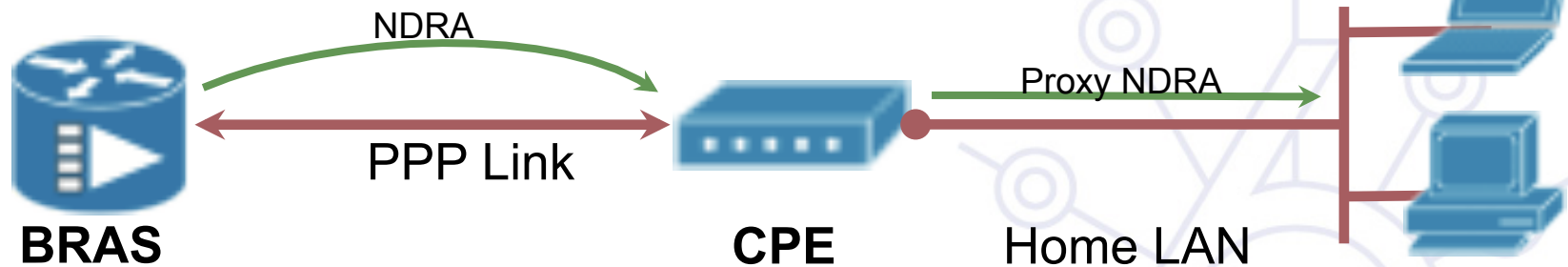


IPv6 address on WAN



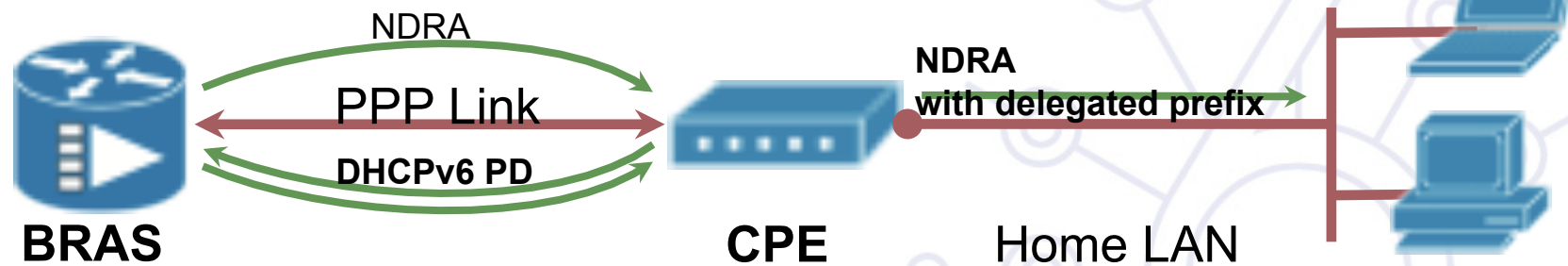
- RFC 2472
- LCP unchanged
- IPv6CP along with IPCP (**IPCP+IPv6CP** both in **one** PPP session)
 - Negotiated Interface ID - lower 64 bits (usually settable by the LNS)
- Stateless address autoconfiguration (SLAAC) over established link after PPP start
 - NDRA contains IPv6 prefix, lifetime
 - Usage of /64 prefixes

IPv6 address on Home LAN (Neighbor Discovery Proxies)



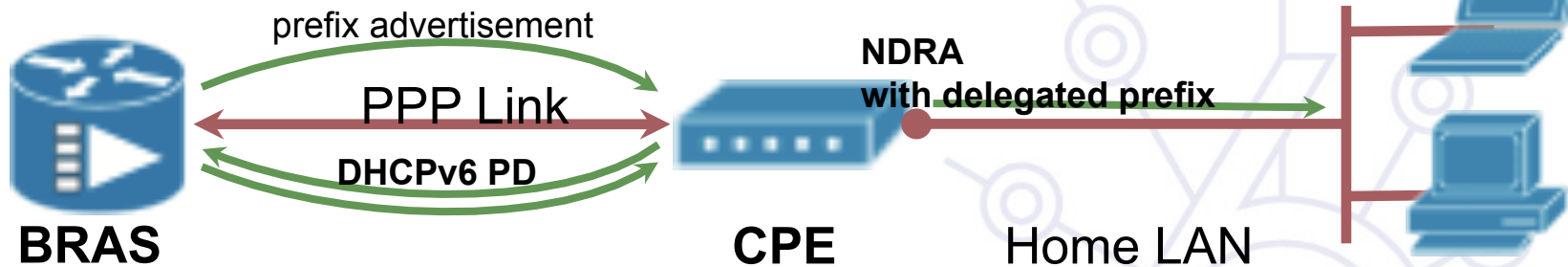
- RFC 4389
- Proxying of ICMPv6 NDRA messages to the Home LAN
- **Only one** /64 prefix needed per user for both PPP and Home LAN
- *No too many implementations at this point*

IPv6 on Home LAN (DHCPv6 Prefix Delegation)



- DHCPv6 IA_PD request from CPE, response from BRAS with delegated prefix and its lifetime
 - Delegated prefix length ≤ 64
 - Inclusion of DNS and other stateless parameters in DHCPv6 response

IPv6 on Home LAN (DHCPv6 Prefix Delegation)

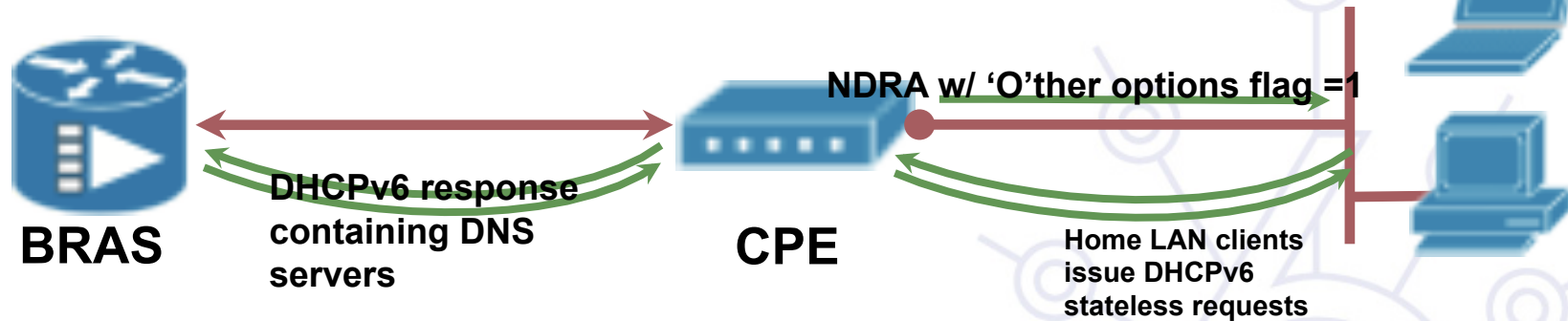


- CPE: Enumeration of Home LAN w/
Delegated Prefix
 - CPE sending NDRA (64 bit prefix) on Home LAN
 - Lifetime probably analogous to delegated lifetime
- Home LAN clients: Stateless Address
Autoconfiguration

Stateless DHCPv6

- If “Other” options flag in NDRA == 1
 - Response to DHCPv6 Informational Requests
- Options available:
 - DNS servers
 - SNTP servers
 - Domain search
- DHCPv6 IA_PD: stateless info included in responses

DNS and IPv6



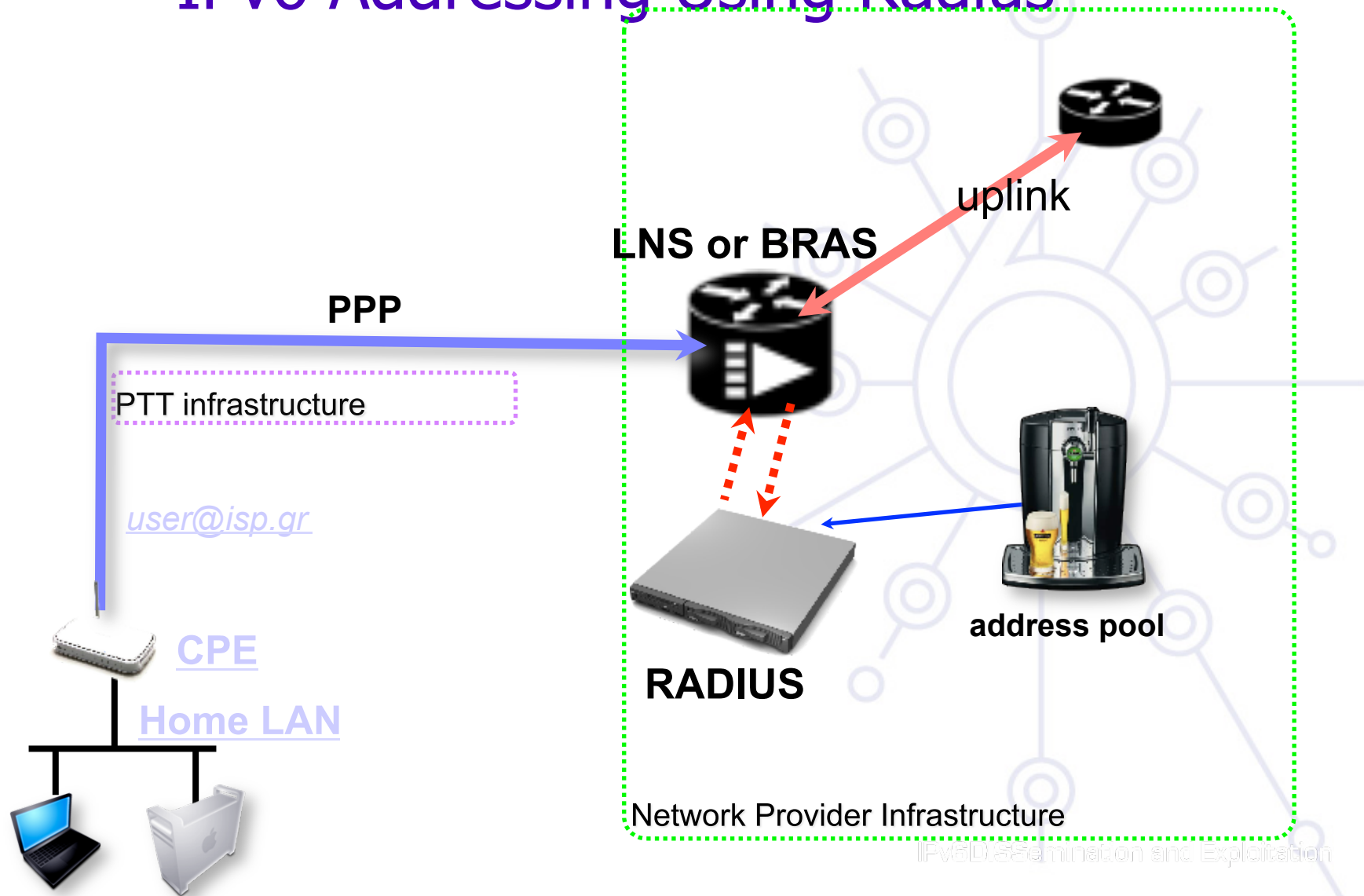
- PPP: DNS Servers transmitted using Stateless DHCPv6
 - independent from DHCPv6 PD
 - but: combination w/ PD possible and desirable
- Home LAN:
 - Most common: Stateless DHCPv6
 - Usage of *Other* options flag
 - and/or: RFC 5006 - IPv6 Router Advertisement Option for DNS Configuration (contained in NDRA)

IPv6 and Radius



IPv6 Dissemination and Exploitation

IPv6 Addressing Using Radius



IPv6 xDSL and Radius (1)

- Radius protocol
 - Provides authentication, authorisation and accounting services
 - Necessary in any xDSL deployments, e.g. stores large number of user information instead of keeping them in the LNS
 - Provides configuration data, e.g. IPv4/v6 address allocation, ACLs

IPv6 xDSL and Radius (2)

- Radius message exchange
 - A NAS sending a RADIUS *access-request* may not know a-priori whether the host will be using IPv4, IPv6, or both.
 - Within PPP, IPv6CP occurs after LCP, so that address assignment will not occur until after RADIUS authentication and authorization has completed.
 - The IPv4/IPv6 attributes may be sent within the same RADIUS message. The NAS will decide which attributes to use

IPv6 and Radius Attributes (RFC3162) (1)

- **NAS-IPv6-Address**
 - Indicates the IPv6 address of the NAS that requests authentication of a user
 - Only used in *Access-Request* packets
- **Framed-Interface-Id**
 - Specifies the interface to be configured, aka this attribute can be used to specify the *ppp* interface of the end user
 - If the Interface-Id IPv6CP option is successfully negotiated, this attribute must included in an *Access-Request* packet as a hint by the NAS to the server that it would prefer that value.

`Framed-Interface-Id = "fedc:ba98:7654:3210",`

IPv6 and Radius Attributes (2)

- **Framed-IPv6-Prefix**

- Specifies the IPv6 address prefix to be assigned to a user. In addition, the NAS configures the corresponding route to the user.
- It may be used in *Access-Accept* packets, and can appear multiple times
- It may be used in an *Access-Request* packet as a hint by the NAS to the server that it would prefer these prefix(es)
- Similar (proprietary) attribute: *cisco-avpair:ipv6:prefix*

```
Framed-IPv6-Prefix="ipv6:prefix#1=2001:648:2000:df::/  
64"
```

IPv6 and Radius Attributes (3)

- **Framed-IPv6-Route**

- Specifies the IPv6 routing information to be configured for the user on the NAS. It is intended to be human readable
- It contains a destination prefix (optionally followed by a slash and a decimal length specifier), a gateway address, and one or more metrics (encoded in decimal) separated by spaces.
- Whenever the gateway address is unspecified, the IP address of the user is used instead
- Similar (proprietary) attribute: *cisco-avpair:ipv6:route*

```
Framed-IPv6-Route =  
"2000:0:0:106::/64 2000::106:a00:20ff:fe99:a998 1"  
Framed-IPv6-Route = "2000:0:0:106::/64 :: 1"
```

IPv6 and Radius Attributes (4)

- **Framed-IPv6-Pool**

- Specifies the name of a RAS managed pool from which the RAS should assign an IPv6 prefix

```
Framed-IPv6-Pool = "ACCESS6"
```

- **Login-IPv6-Host**

- Indicates the system with which to connect the user, when the Login-Service Attribute is included.

- **cisco-avpair:ipv6:inacl(/outacl)**

- Proprietary attribute for setting inbound/outbound access lists

```
cisco-avpair = "ipv6:inacl#1=permit 2001:0DB8:cc00:1::/48"
```

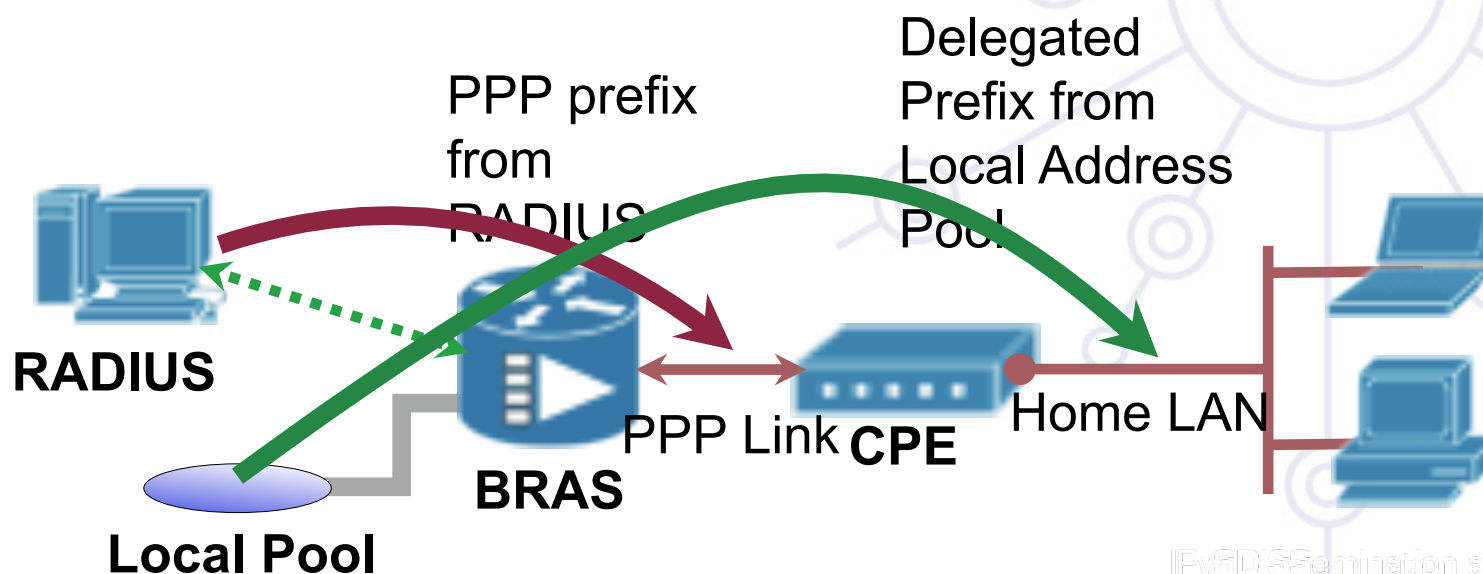
```
cisco-avpair = "ipv6:inacl#2=deny any"
```


Scenarios & Configuration



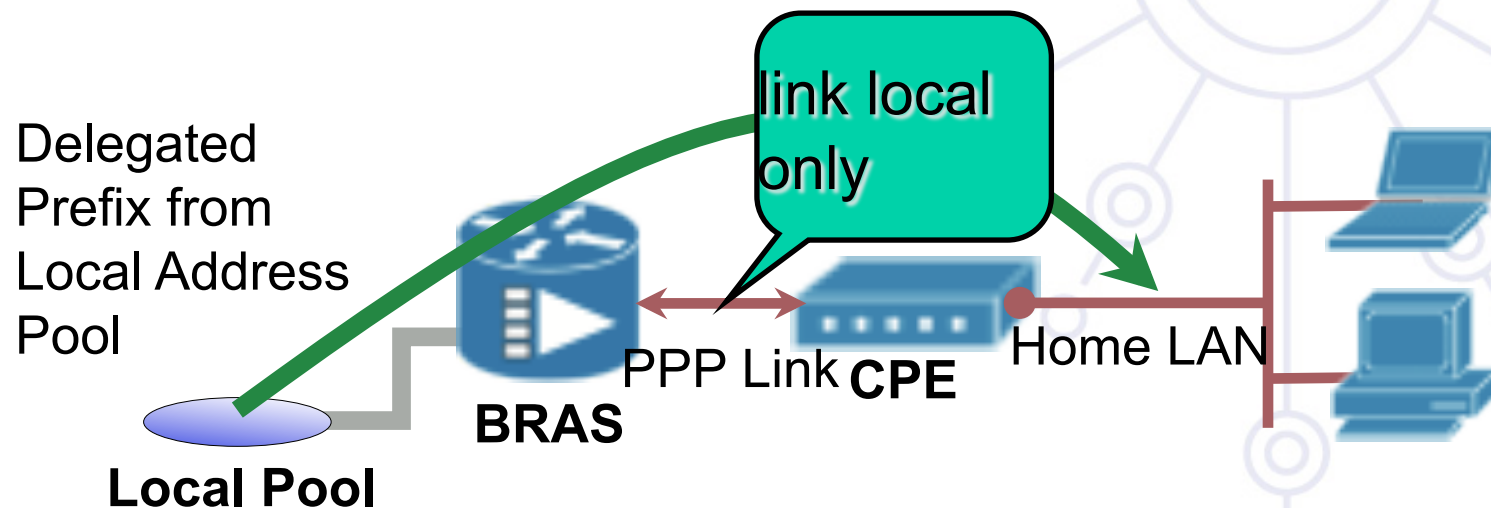
IPv6 Scenario #1

- Framed-IPv6-Prefix for PPP link.
- Framed-IPv6-Pool for DHCPv6 PD.
 - Example:
 - Framed-IPv6-Pool = 'ntuav6'
 - Framed-IPv6-Prefix = '2001:648:2001:0001::/64'
 - ntuav6 local address pool locally defined in the BRAS
- Need for **2** pools
 - 1 managed by RADIUS server, 1 managed by NAS
 - (For n NAS'es, n+1 pools)



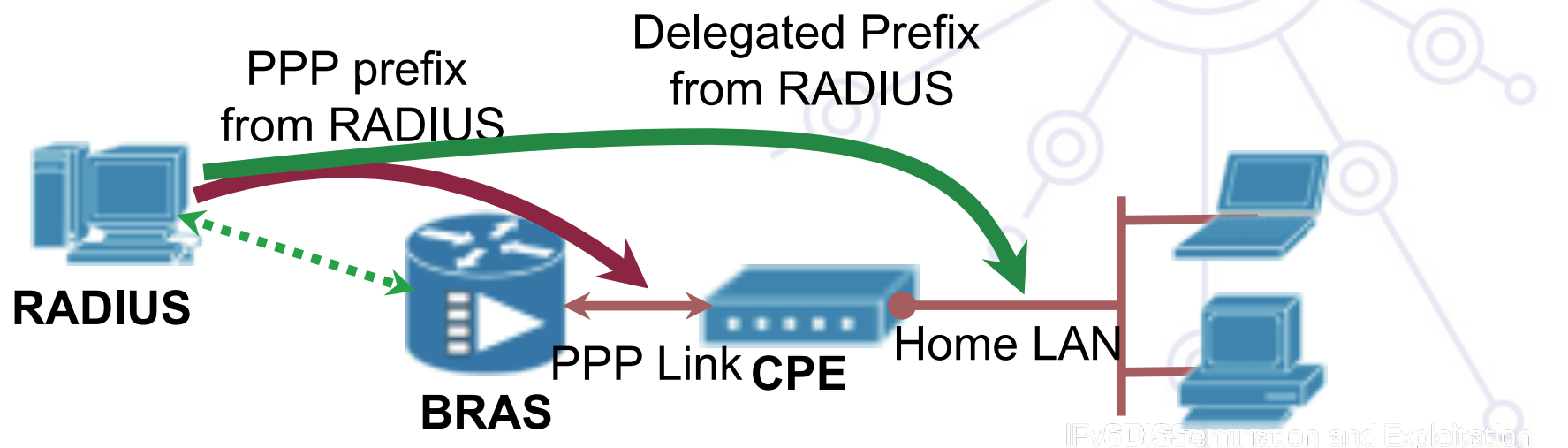
Scenario #2

- Framed-IPv6-Pool for DHCPv6 PD
- Just a link local for the PPP – **No** NDRA
 - Almost working
 - Installation of PD route on the link local link (JUNOSe)
 - Connectivity configurable for the CPE



Scenario #3

- Assignment of all prefixes by the RADIUS server
 - Framed-IPv6-Prefix, Delegated-IPv6-Prefix
 - Normal IPv6 access for CPE and Home LAN machines





IPv6 in CPEs & Operating Systems (PPP, DHCP, RAs, DNS, etc)



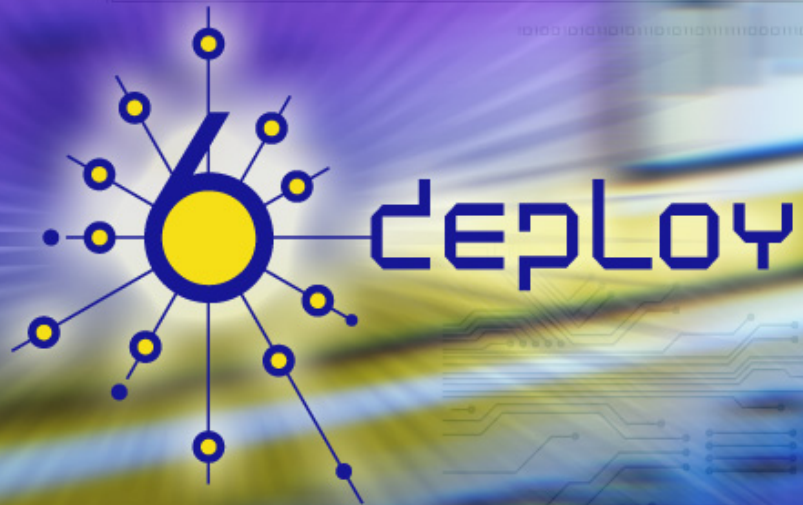
IPv6 in Operating Systems

- Microsoft
 - Windows 7: Usable, 1 Home LAN only, some ICS problems with DHCPv6
 - Windows Vista: Embedded support, without user control.
 - Windows XP (or earlier): PPPv6 is not supported due to lack of IPv6CP.
- MacOS
 - MacOSX 10.3: IPv6CP supported with user control
- Linux, FreeBSD
 - IPv6CP supported with user control
 - dhcp6c wide-client working good

(Some) IPv6 functionality in CPE's

- Cisco CPE 8xx (exc 85x,86x)
 - Very configurable, PPPv6, DHCPv6
- AVM: Fritz!Box 7270
 - NDRA, DHCPv6 PD, DNS via RA's (RFC 5006), DNS via DHCPv6 (using options flag in RA's, Internal DNS Server (RFC4193 Unique Local Address (example: fd00::21f:3fff:fe3a:752f)
- GENNET
 - ULAs (SLAAC), DHCP-PD+SLAAC/DHCP, firewall,
- Apple Airport Exteme (DHCP-PD (DHCP mode)), D-Link 8xx/6xx (DHCP-PD)

Check on RIPE CPE Survey for updated information



Questions?