IPv6 Deployment on Service Providers Networks

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Agenda

- Market overview
- IPv6 Core Network Enhancement
- Broadband Access Networks
  - IPv6 over broadband data link layers
  - IPv6 address allocation guidelines
  - IPv6 AAA Radius
  - IPv6 auto-configuration – Prefix Delegation & Stateless DHCP
- Case study

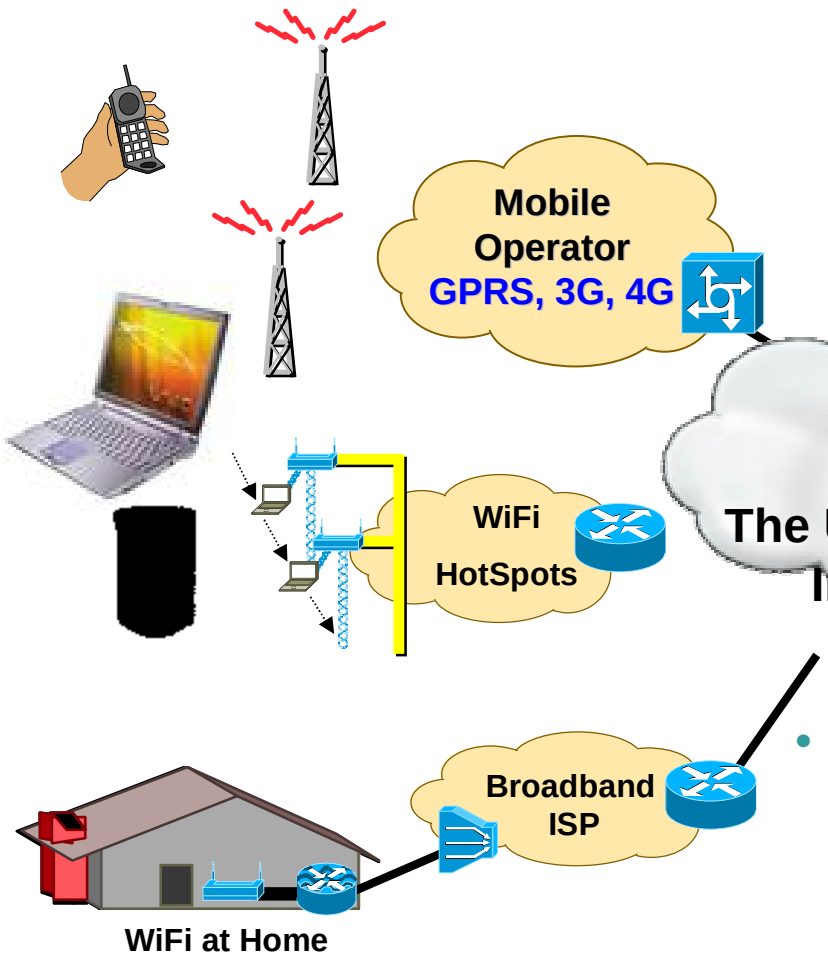
ISP Deployment Activities

- **Several Market segments**
  - **IX, Carriers, Regional ISP, Wireless**
- **ISP have to get an IPv6 prefix from their Regional Registry**
  - **http://www.ripe.net/ripencc/mem-services/registration/ipv6/ipv6allocs.html**
- **Large carriers are running trial networks but**
  - **Plans are largely driven by customer's demand**
- **Regional ISP focus on their specific markets**
  - **Japan is leading the worldwide deployment**
  - **Target is Home Networking services (dial, DSL, Cable, Ethernet-to-the-Home,…)**
- **No easy Return on Investment (RoI) computation**

Broadband Home – A necessity for IPv6 !

Cisco.com

Mobile Wireless Networking – an IPv6 Must

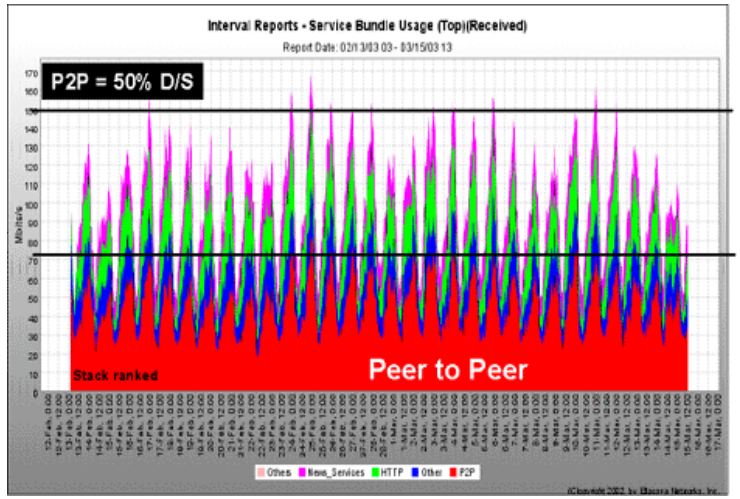


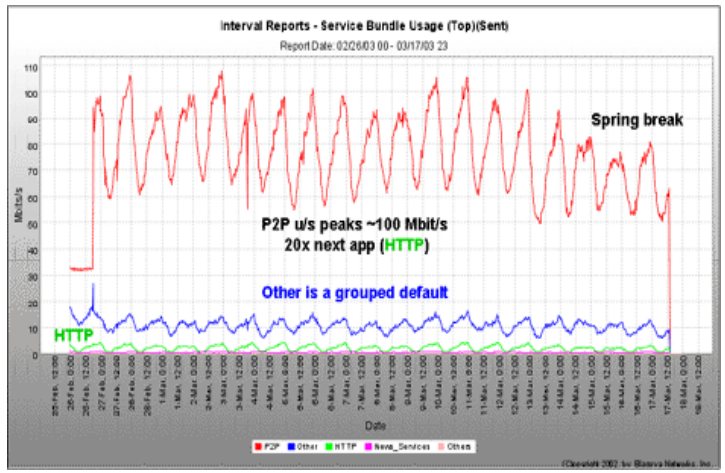
- Unlicensed Band (WiFi,…)
  - Personal mobility
  - high data rate
  - incremental infrastructure
- Licensed Band (GPRS, 3G, DVB-T,…)
  - Full mobility
  - Modest data rate
  - New infrastructure

- **Mobile Wireless Networking challenges**
  - Manage the growth of subscribers
    - CY04, 1.5B Mobile Phone's users
  - Address this large number of "Always-reachable" devices
  - Support a Multimedia environment
    - ***The IPv6 Benefits***

Traffic Evolution

- **Applications – Server/Client, P2P, GRID – generate different traffic patterns than Client/Server**
  - **Symmetrical – as much upstream as downstream traffic (users become servers)**
  - **Very long sessions – Always-on devices may be left unattended. Streaming applications can run for a long period of time. Often 24/7.**
  - **Sustained high bandwidth – many devices can now use all bandwidth available. Multiple video sessions require high bandwidth capacity**
  - **Non-local – Traffic travels globally, and between ISP networks, hence putting load on the peering points (est. 60% of traffic) and expensive long haul links.**





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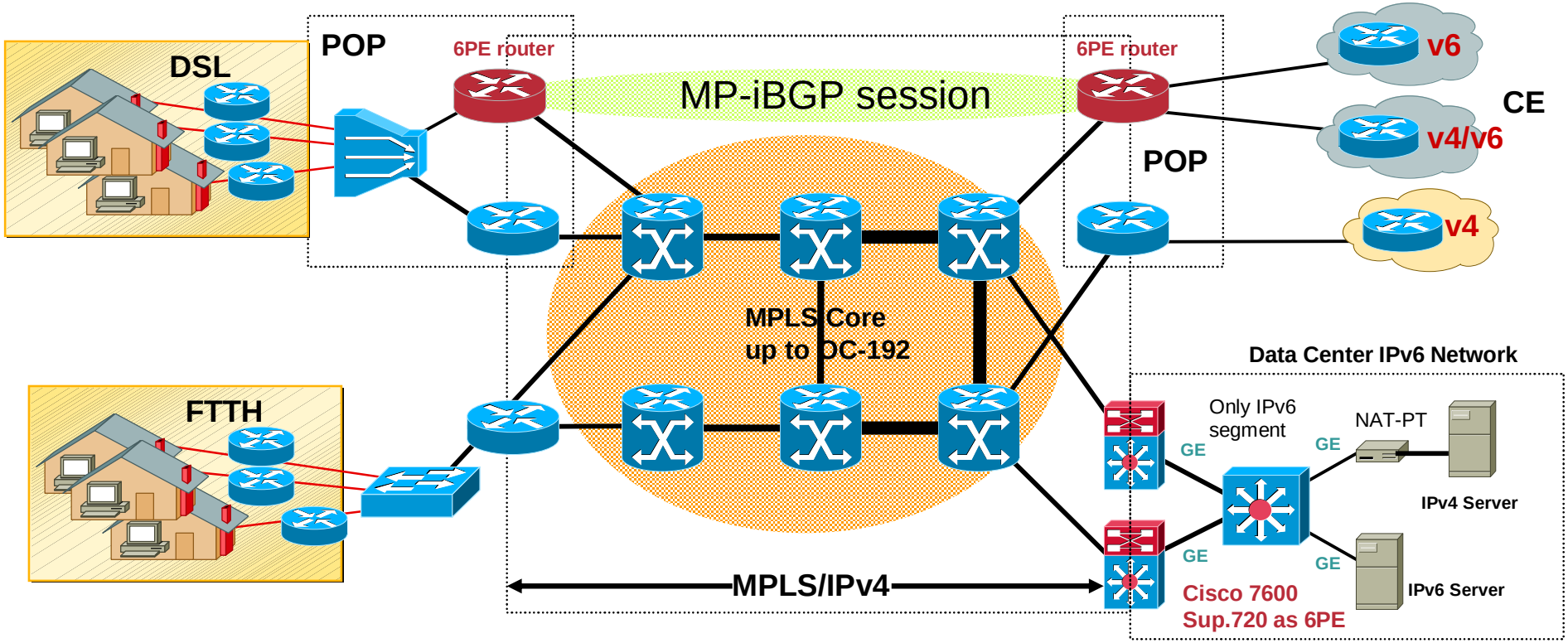
Pre-existing MPLS infrastructure

- **If MPLS being already deployed for IPv4 services, 6PE is the preferred scenario**
  - **IPv6 POPs can be installed one by one (software upgrade or new PE router) – Cost of deployment is under control**
  - **IPv6 prefix ::/48 can be assigned from ::/32**
  - **draft-ooms-v6ops-bgp-tunnel-04 in last call**

Minimum Infrastructure Upgrade for 6PE

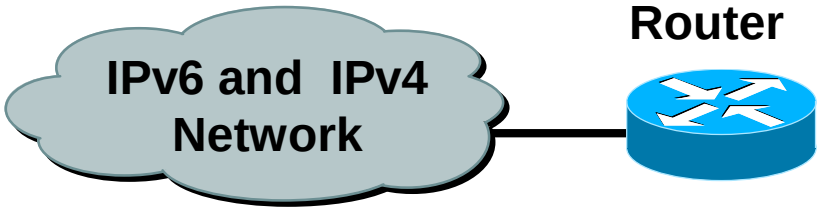


- **MPLS/IPv4 Core Infrastructure is IPv6-unaware**
- **PEs are updated to support Dual Stack/6PE**
- **IPv6 reachability exchanged among 6PEs via iBGP (MP-BGP)**
- **IPv6 packets transported from 6PE to 6PE inside MPLS**

Dual Stack IPv4-IPv6 Infrastructure

- It is generally the goal when IPv6 traffic and users will be rapidly increasing
- May not necessarily apply to the overall infrastructure. One may begin on network's portion such as Campus or Access or core networks
- Network design must be well planned
  - Memory size to handle the growth for both IPv4 & IPv6 routing tables
  - IGP options & its management: Integrated versus "Ships in the Night"
  - Full network upgrade impact
- IPv4 and IPv6 Control & Data planes should not impact each other
  - Feedback, requirements & experiments are welcome

Cisco IOS Dual Stack Configuration



Dual-Stack
Router

```
router#
ipv6 unicast-routing

interface Ethernet0
 ip address 192.168.99.1 255.255.255.0
 ipv6 address 2001:db8:1::/64 eui-64
```

IPv4: 192.168.99.1

IPv6: 2001:410:213:1::/64 eui-64

- **Cisco IOS is IPv6-enable:**

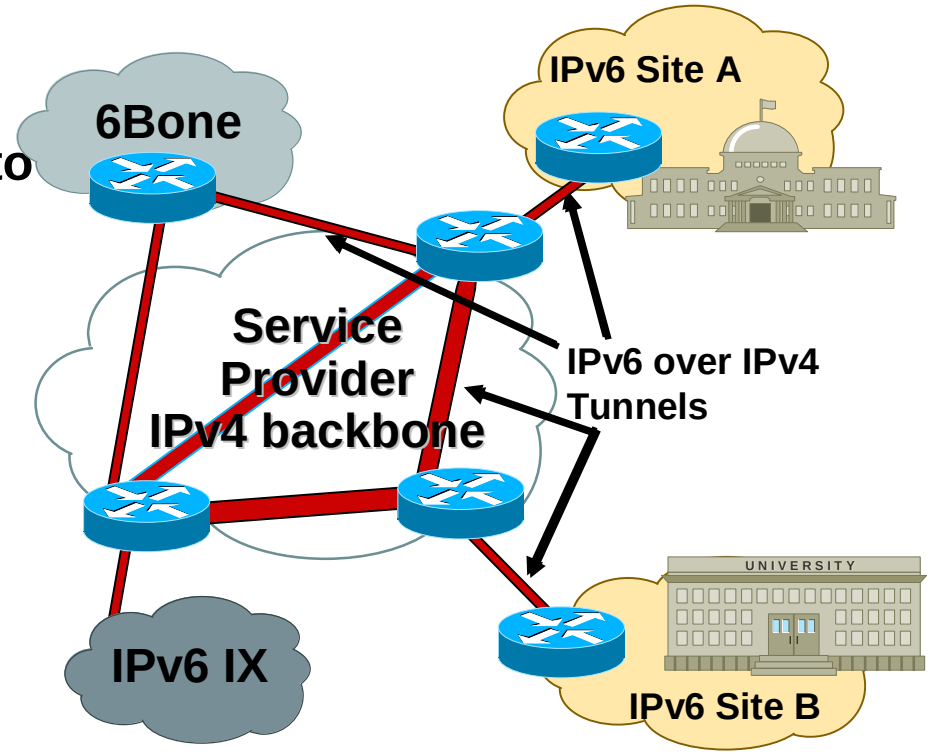
  If IPv4 and IPv6 are configured on one interface, the router is dual-stacked

  Telnet, Ping, Traceroute, SSH, DNS client, TFTP,…

IPv6 Tunnels & Native Case Study

- **ISP scenario**
  - **Configured Tunnels or Native IPv6 between IPv6 Core Routers**
  - **Configured Tunnels or Native IPv6 to IPv6 Enterprise's Customers**
  - **Tunnels for specific access technologies, eg. Cable**
  - **MP-BGP4 Peering with other 6Bone users**
  - **Connection to an IPv6 IX**
  - **6to4 relay service**

Use the most appropriate



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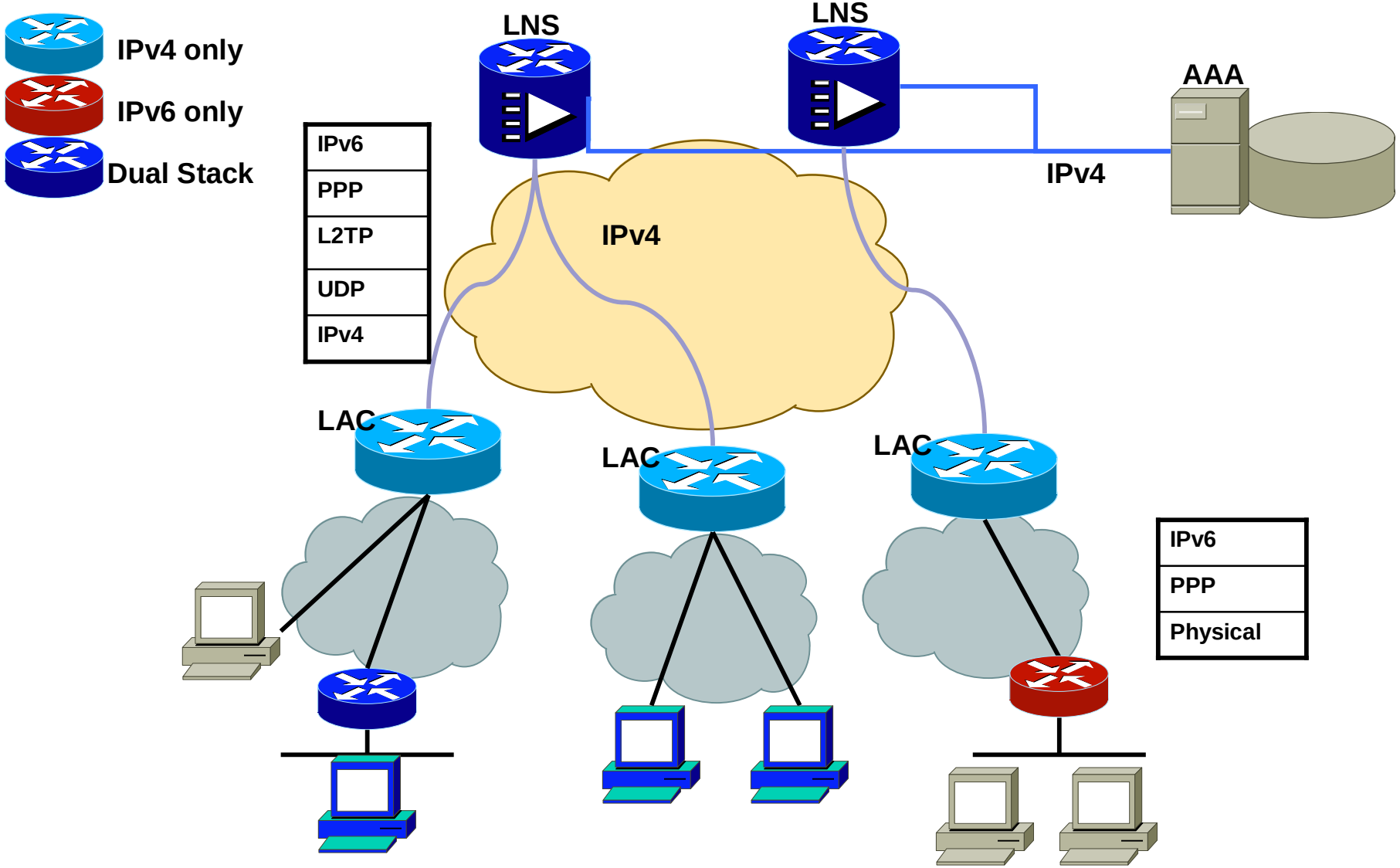
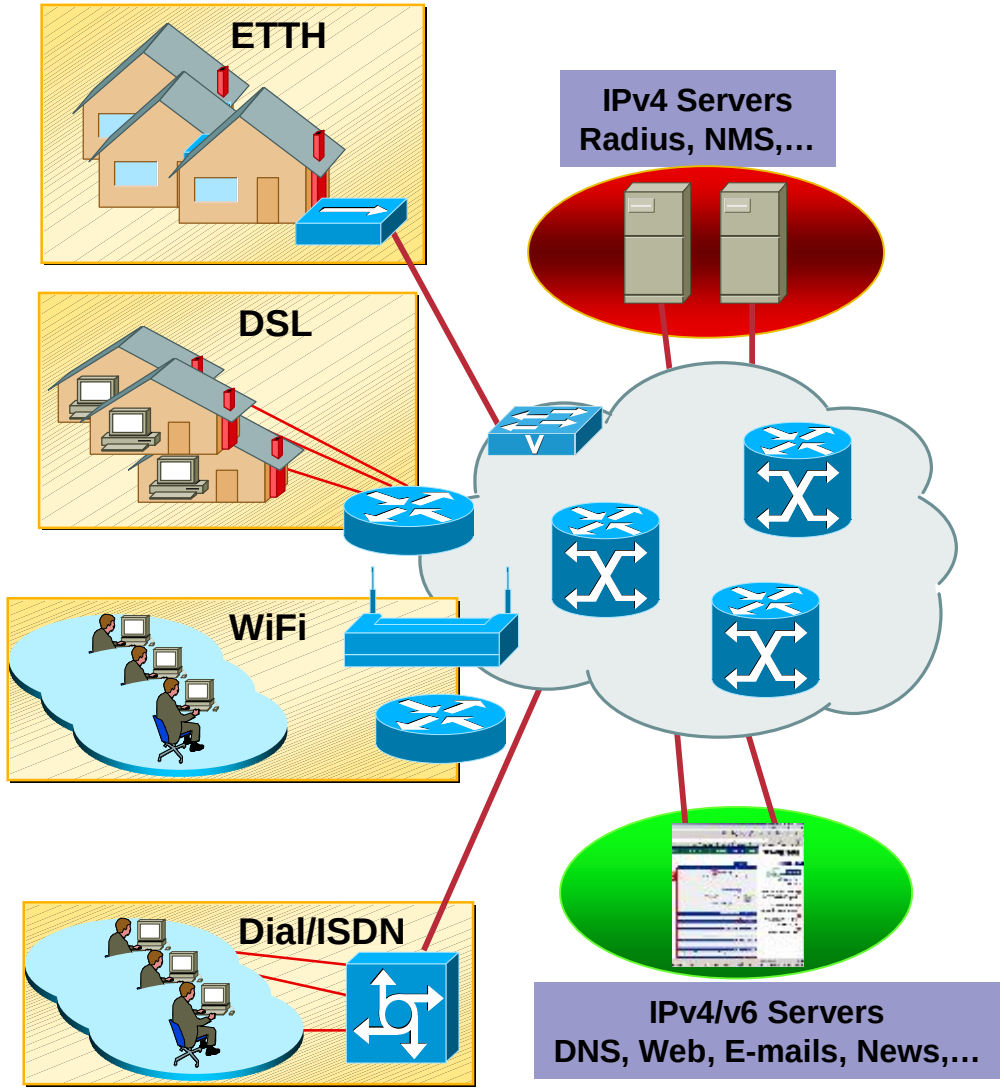
Topology

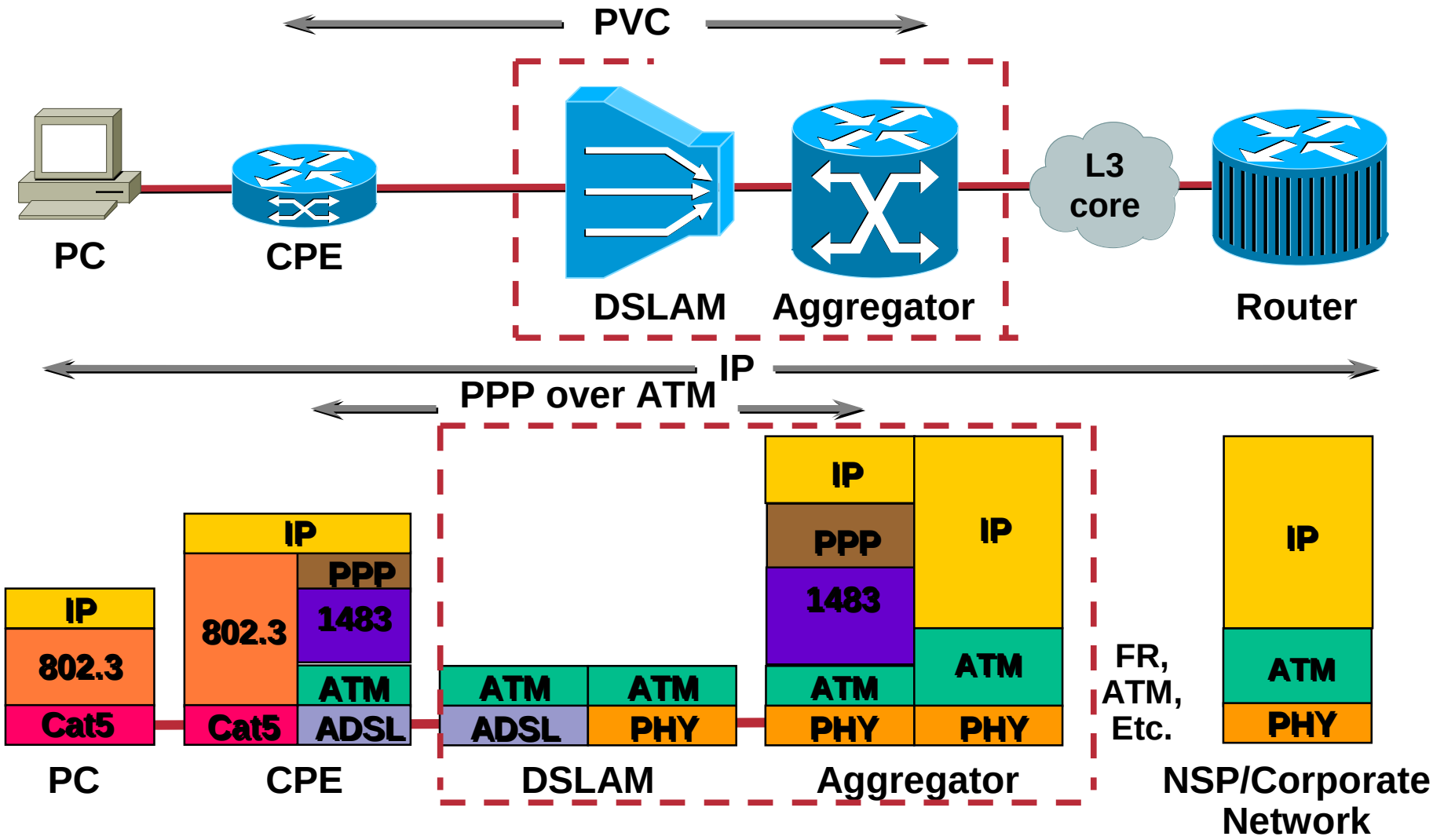


Data Link Layers

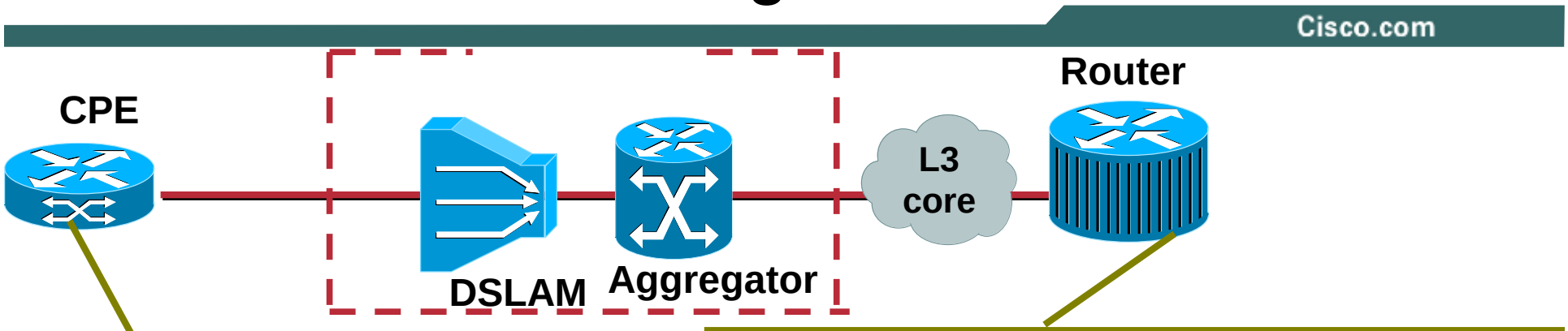
- **Dial/ISDN**
  - **PPP**
- **Ethernet-To-The-Home**
  - **Ethernet**
- **802.11 (WiFi) Hot Spots**
  - **Ethernet like**
- **ADSL**
  - **ATM RFC 1483 Routed**
  - **ATM RFC 1483 Bridged (RBE)**
  - **PPPoA**
  - **PPPoE**
- **Available from Cisco IOS routers running 12.3M and 12.3B releases**



Protocol Stack - PPP over ATM



PPP over ATM configuration




```
interface FastEthernet0
 ipv6 address 2001:db8:1::/64
!
interface Atm 0
pvc 1/23
 encapsulation aal5mux ppp dialer
dialer pool-member 1
!
interface dialer1
 encapsulation ppp
 dialer pool 1
 ipv6 address autoconfig
 ppp authentication chap foo
 ppp chap hostname user@domain.net
 ppp chap password 7 1111111111
!
ipv6 route ::/0 Dialer1
!
```

```
!
vpdn enable
!
vpdn-group 1
accept dialin l2tp virtual-template 1 remote sp_lac
local name lns
!
interface Loopback0
ipv6  address 2001:db8:2::1/64
!
interface Virtual-Template1
 ipv6 enable
 ipv6 mtu 1480
 no ipv6 nd suppress-ra
 ppp authentication chap default
 !
radius-server host 172.22.66.16
!
```

AAA/RADIUS

- **Cisco Vendor Specific Attributes**
  - **IPv6 Prefix, IPv6 Route, IPv6 ACL (Input & Output)**
- **RADIUS and IPv6 (RFC3162)**
  - **Framed-IPv6-Prefix**
  - **Framed-IPv6-Route**
  - **Framed-IPv6-Pool**
  - **NAS-IPv6-Address**
  - **Login-IPv6-Host**
  - **Framed-Interface-Id**
- **On Cisco IOS, RADIUS transport is IPv4 as today most Radius server are used for both protocols**
  - **IPv6 should be added later**
- **IPv6 AAA available on Cisco IOS**
  - **Cisco VSA available now from Cisco IOS 12.3M and 12.3B**
  - **RFC 3162 available from upcoming Cisco IOS 12.3T**

AAA per-user attributes

- **Route#**

  Installs a per-user static route in the RIB
  cisco-avpair="ipv6:route=3ffe:c00:1::/48"

- **Prefix#**

  Adds the prefix to RA's sent out the interface, and adds a route in the RIB.
  cisco-avpair="ipv6:prefix=3ffe:c00:2::/64"

- **ACL**

  cisco-avpair="ipv6:inacl=permit 3ffe:c00:2::/64"

- **Framed-Interface-Id**

  Framed-Interface-Id=0:0:0:0:0:0:1
  Included in accounting records

IPv6 Address Allocation Guidelines

"…recommends the assignment of /48 in the general case, /64 when it is known that one and only one subnet is needed…"

RFC3177
IAB/IESG Recommendations on IPv6 Address Allocations to Sites

Policy Implementation

- Give Home/SOHO a permanent /64 – single link
- Give Home/SOHO a permanent /48
- Short-lived /64 from a prefix-pool

  A Separate /64 is assigned each user/interface. The prefix is advertised in RA's and a route is installed in the RIB.

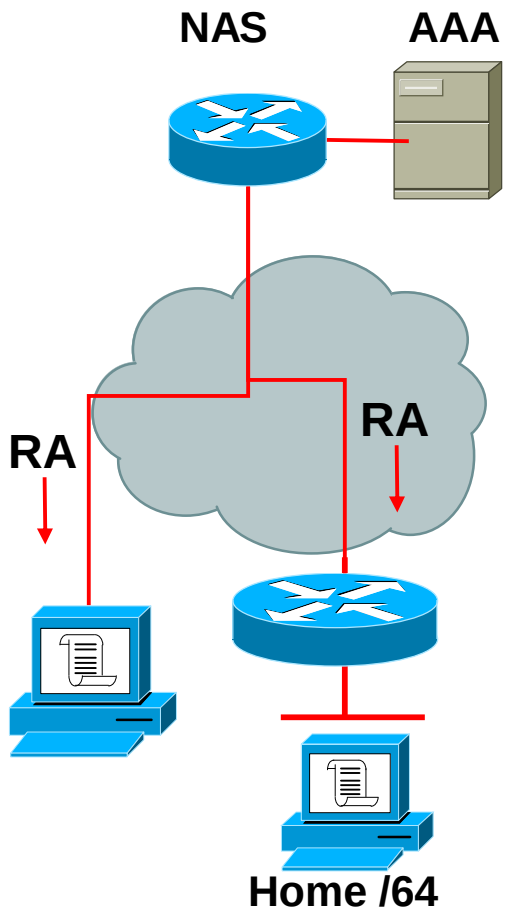
- Short-lived /128 from a shared prefix-pool

  /64 prefix is shared between all users of the pool. The same /64 prefix is advertised in RA's out all interfaces. The user gets an /128 based on the prefix and his Interface-Identifier. A route in the RIB is installed only for the /128.

- For some users set the Interface-ID explicitly

Give home users a permanent /64 – single link

- **Use: for single PC or network with only one link**
- **AAA static prefix attribute. Interface-Id attribute to specify the complete address**
- **CPE: single PC, proxy RA, or configured router**

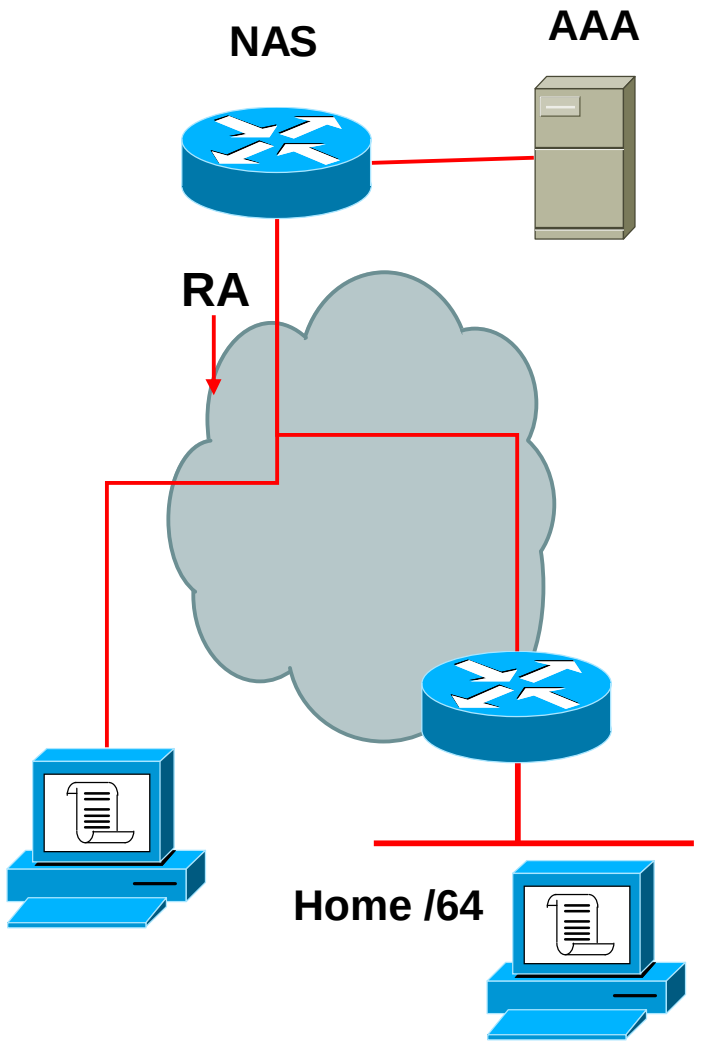


AAA config:
Auth-Type = Local, Password = “foo”
User-Service-Type = Framed-User,
Framed-Protocol = PPP,
cisco-avpair = “ipv6:prefix=3ffe:c00::/64
Framed-Interface-Id = 0:0:0:1

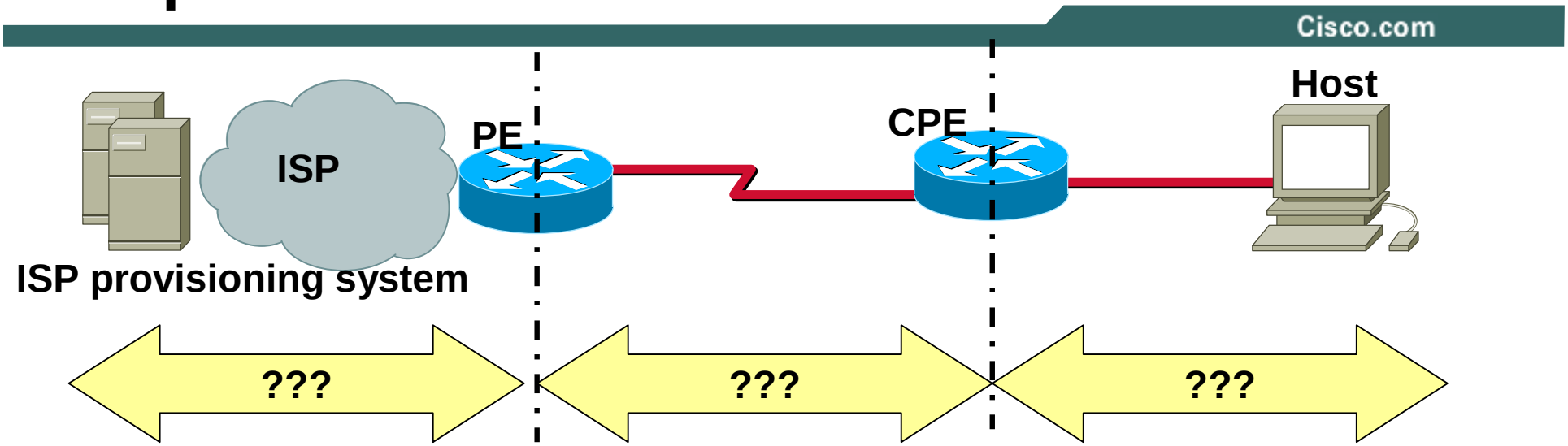
Address Assignment – short-lived /64

- **Use: for single PC or very simple network**
- **NAS: IPv6 prefix pool**
- **CPE: Proxy-RA/multi-link subnet/bridging Renumbering issues**

AAA config:
Auth-Type = Local, Password = “foo”
User-Service-Type = Framed-User,
Framed-Protocol = PPP,
cisco-avpair = “addr-pool=“foo”



IPv6 on Broadband Infrastructure Requirements



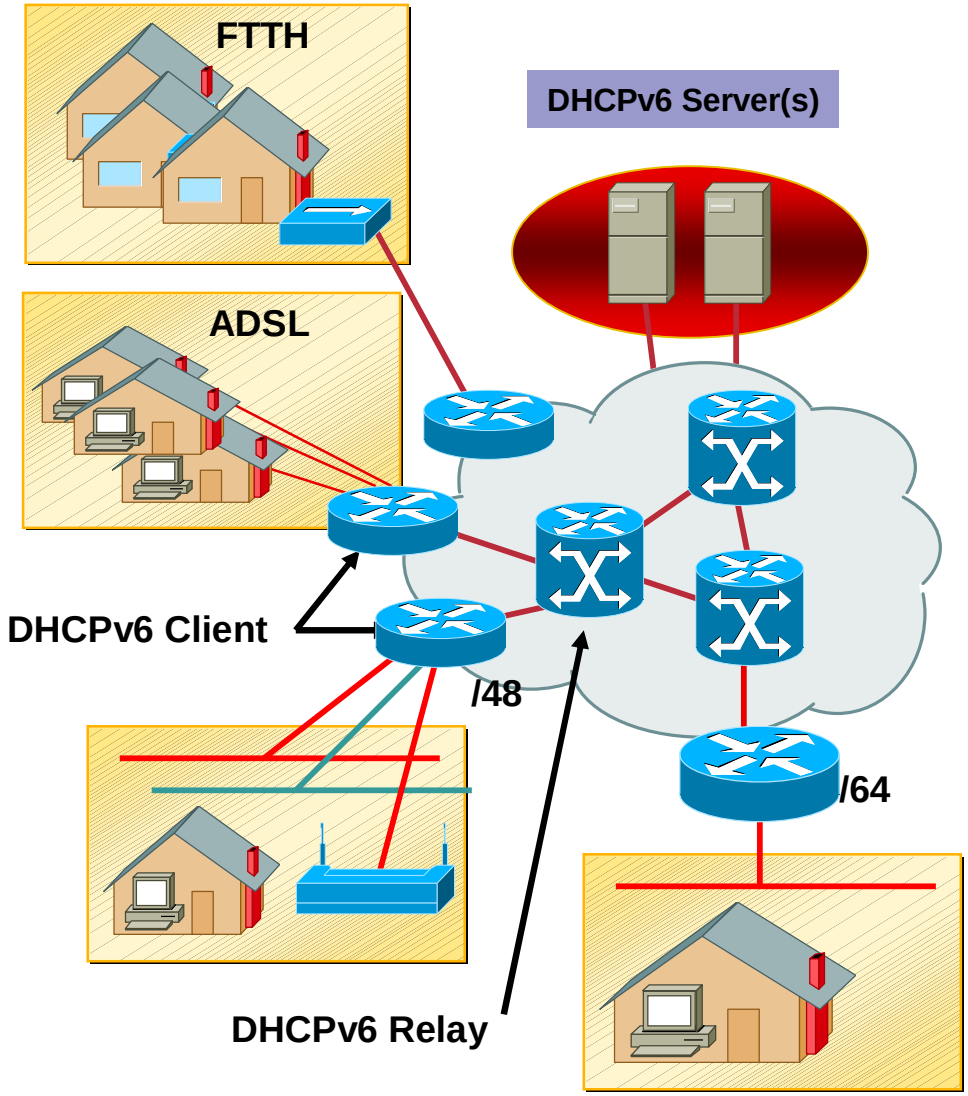
How do we get the configuration information and prefixes from the ISP provisioning system, to the PE, from the PE to the user CPE, and from the CPE to the end user hosts?
Routes for delegated prefixes/addresses also need to be injected into the ISP's routing system.

Prefix Delegation

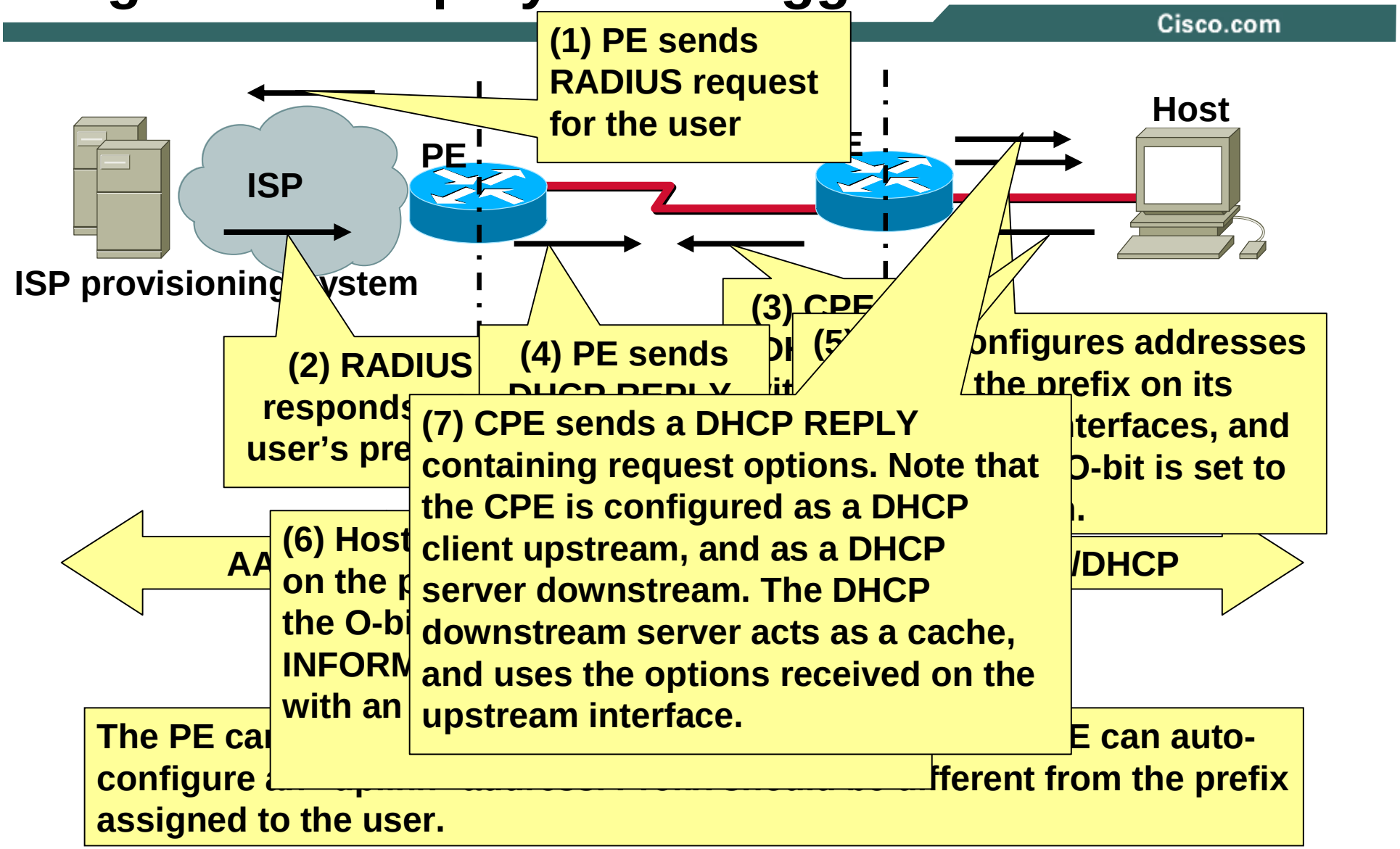
- Assignment of variable length prefixes
- Independent of end user topology
- Media independent
- Additional Informations (DNS, NTP, SMTP, POP, etc)

DHCPv6 PD (RFC 3633)

- **Media independence**
  - **e.g. ADSL, FTTH**
  - **Only knows identity of requesting router**
- **Leases for prefixes**
- **Flexible deployments**
  - **Client/Relay/Server model**
- ***Requesting router* includes request for prefixes in DHCP configuration request**
- ***Delegating router* assigns prefixes in response along with other DHCP configuration information**



Large Scale Deployment Suggested solution

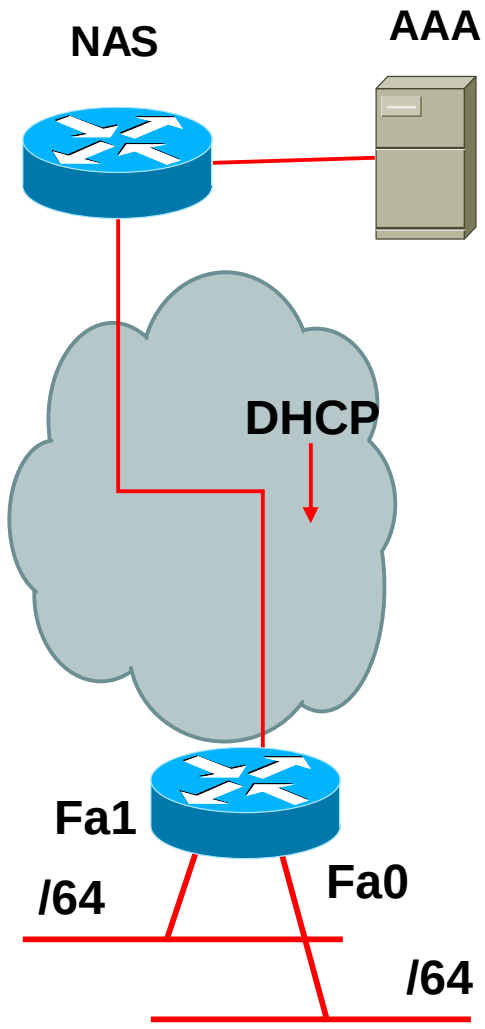


Address Assignment – permanent /48

- **Use: whole site -supports multiple links**
- **AAA prefix-attribute**
- **Use DHCP-PD to configure the CPE**

```
interface Atm 0
pvc 1/23
 encapsulation aal5mux ppp dialer
dialer pool-member 1
!
interface dialer1
 ipv6 dhcp client pd DH-PREFIX
!
interface FastEthernet0
   ipv6 address DH-PREFIX 0:0:0:1::/64 eui-64
!
```

Auth-Type = Local, Password = “foo2”
User-Service-Type = Framed-User,
Framed-Protocol = PPP,
cisco-avpair = “ipv6:prefix=2001:db8:1::/48



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IP in Schools – Today

- **School's business is Education**
  - **Read, Write, Maths, Foreign Languages as foundations to Knowledge**
    - **The above are minimum end-users requirements to access the Internet**
  - **Analytic mind is key to value the data retrieved from the Internet**
- **Schools are part of the Information Society**
  - **Today, more and more schools get an Internet connection – a Must**
    - **Lease lines, Broadband Access,…**
    - **Linked to NRN or local government**
- **Today, Applications and Services**
  - **Client-Server: e-mails, web browsing**
  - **Servers generally hosted externally**
    - **Most of the time using PAT (a single global IPv4 address)**

IPv6 in Schools - Tomorrow

- **Developing new Class of Applications and Services**
  - Class to Class collaboration – internal to the school, between schools (national & international)
    - Sharing Database, creating server's,…
  - Teachers-Students collaboration
    - "After-time" support, digital pupil desk, foreign languages class,…
  - Content delivery between schools or Information Providers – Multimedia streaming
  - IP Telephony between schools
  - Remote-surveillance – Physical security
  - Secure Information – Transfer between schools-academy, teachers-school
- **Integrating those services over IPv6**
  - IPv6 could easily be configured on (Cisco J) routers connecting the schools
  - NRN or Local Government can delegate production IPv6 prefixes to the schools.
- **It can be done Today**
  - IPv4 applications must not get disturbed
  - Keep IPv4 as it is, even using PAT

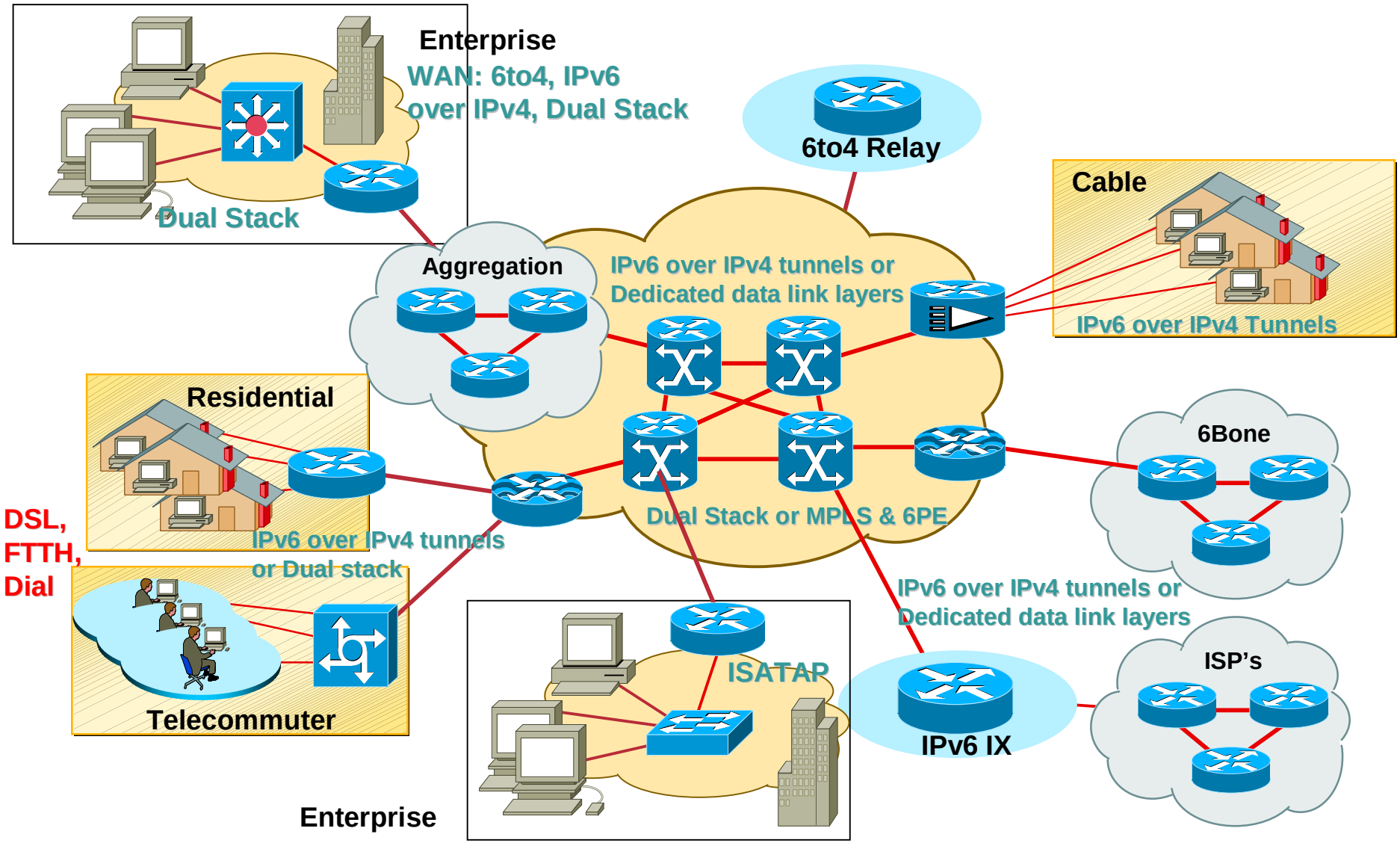
Adding IPv6 Services to the Schools

- **IPv6 can easily be added to Cisco routers attaching the schools as well as any OS runs by the Educative community**
  - **Key feature: IPv6 production and permanent prefix through Native or configured tunnels**
- **IPv4 applications must not get disturbed**
  - **Keep IPv4 as it is, even using PAT**
- **Configure IPv6 on the Router**
- **Start adding new applications/services over an IPv6 transport**
- **Adding new services**
  - **Securing the IPv6 connection through Cisco IOS IPv6 Firewall**
  - **Multimedia distribution through IPv6 Multicast**

Choice of Applications

- **No need to wait, applications are available today!!!**
- **Class to Class collaboration**
  - **Isabel**
- **Teachers-Students collaboration**
  - **3Degrees – www.3degrees.com**
- **Content delivery between schools or Information Providers**
  - **Windows Media Player 9.0, DVTS, Videolan – www.videolan.org**
- **Tele-surveillance**
  - **Panasonic appliances, Geovision,…**
- **Secure Information**
  - **IPv6 IPsec between Servers**

Moving IPv6 to Production, running Cisco IOS



Questions?

More Information

- **CCO IPv6 - http://www.cisco.com/ipv6**
- **The ABC of IPv6**

  http://www.cisco.com/en/US/products/sw/iosswrel/ios_abcs_ios_the_abcs_ip_version_6_listing.html
- **IPv6 Application Notes**

  http://www.cisco.com/warp/public/732/Tech/ipv6/ipv6_techdoc.shtml
- **Cisco IOS IPv6 manuals**

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios123/123cgcr/ipv6_vcg.htm
- **Cisco IOS IPv6 Product Manager – pgrosset@cisco.com**