APNIC eLearning:
IPv4 to IPv6 Transition

Contact: training@apnic.net

APNIC

Overview

- Transition Concept
- IPv4 to IPv6 Transition and Co-existence
- Dual-Stack Configuration
- Dual-Stack Challenges
- Tunneling Concept
- 6to4 and 6RD
- Transition Strategies

Transition overview

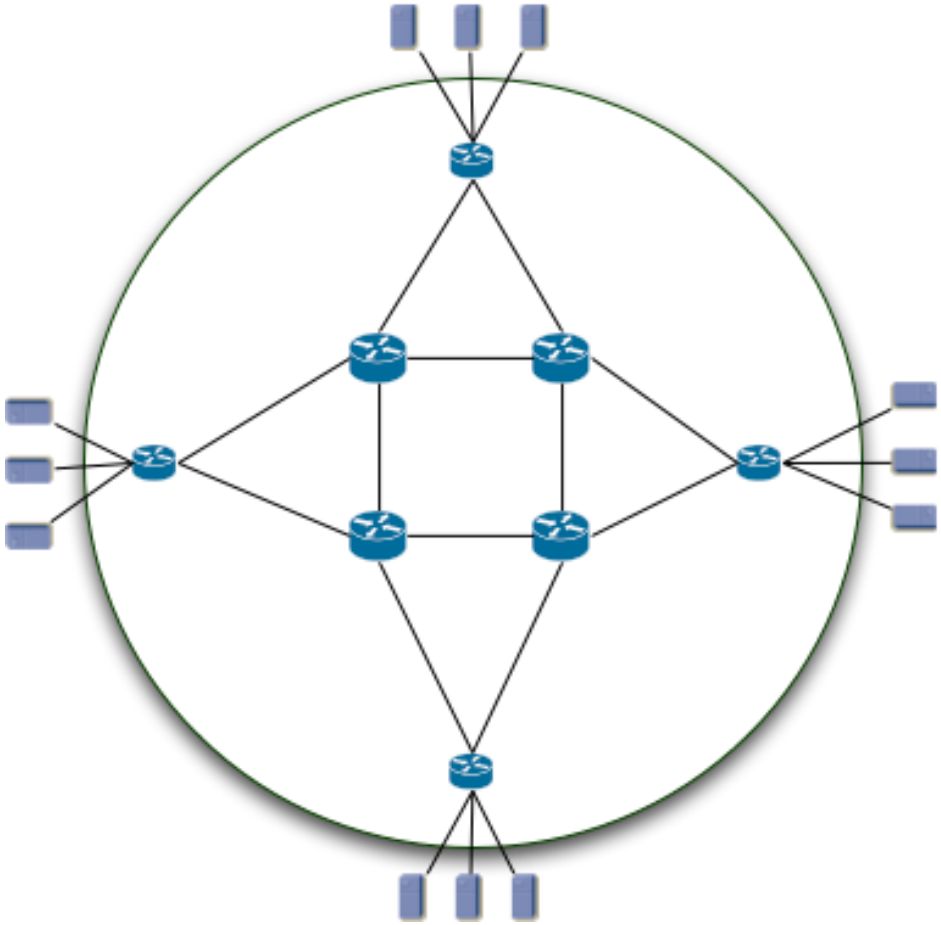
- How to get connectivity from an IPv6 host to the global IPv6 Internet?
  - Via native connectivity
  - Via IPv6-in-IPv4 tunnelling techniques
- IPv6-only deployments are rare
- Practical reality
  - Sites deploying IPv6 will not transit to IPv6-only, but transit to a state where they support both IPv4 and IPv6 (dual-stack)

http://www.6net.org/book/deployment-guide.pdf p59

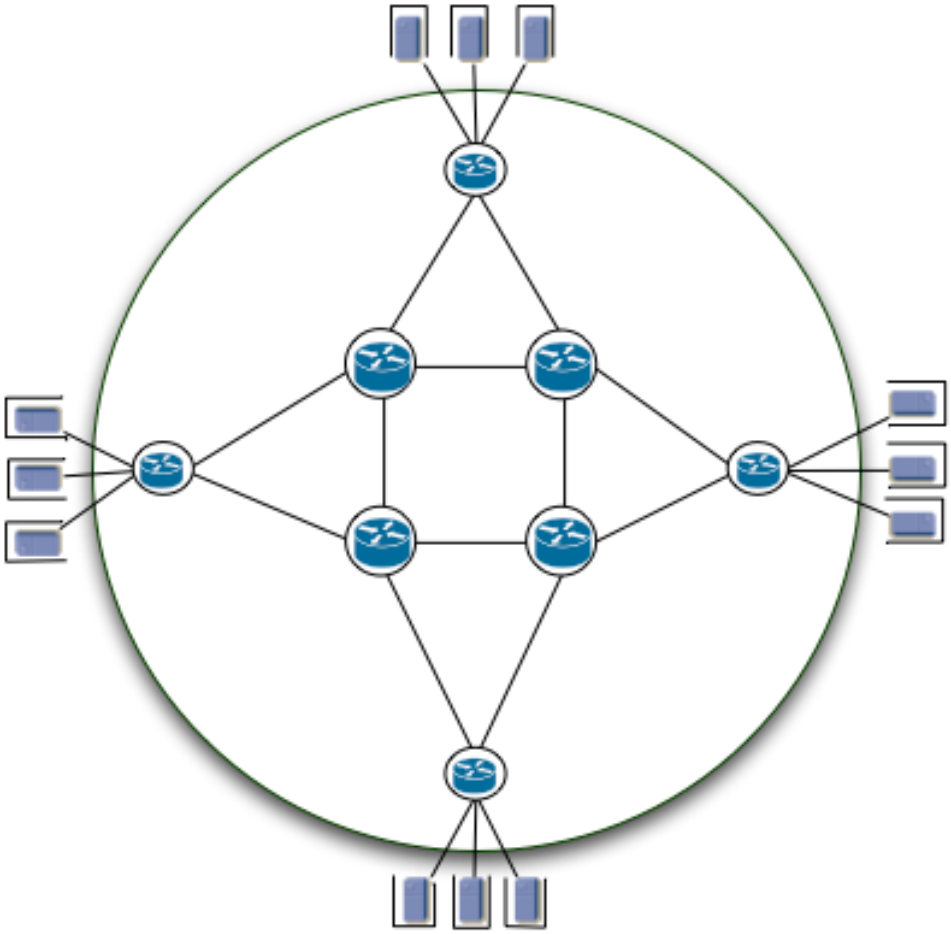
IETF Working Groups

- “v6ops”
  - Define the processes by which networks can be transitioned from IPv4 to IPv6
  - www.ietf.org/dyn/wg/charter/v6ops-charter.html
- “behave”
  - Designs solutions for the IPv4 to IPv6 translations scenarios
  - www.ietf.org/dyn/wg/charter/behave-charter.html
- “softwires”
  - Specifies the standardisation of discovery, control and encapsulation methods for connecting IPv4 networks across IPv6 networks and IPv6 networks across IPv4 networks in a way that will encourage multiple, inter-operable implementations
  - www.ietf.org/dyn/wg/charter/softwire-charter.html

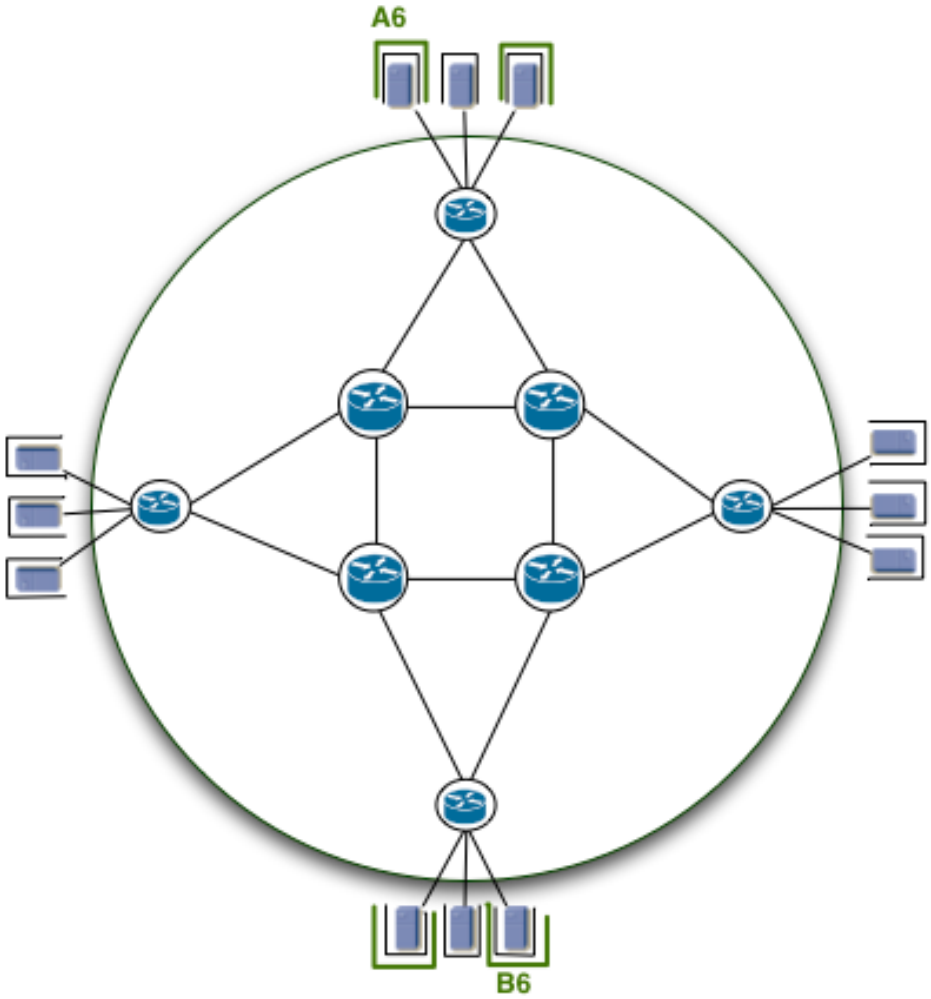
Transition Concept



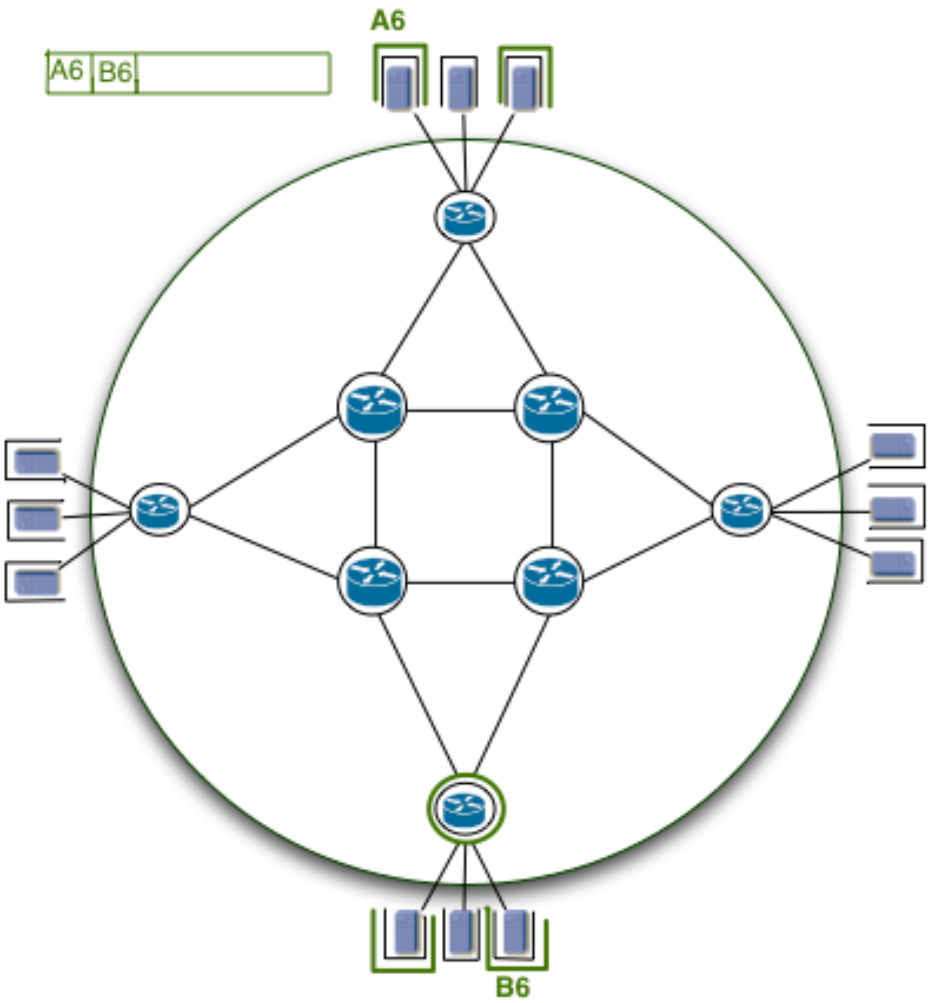
Transition Concept



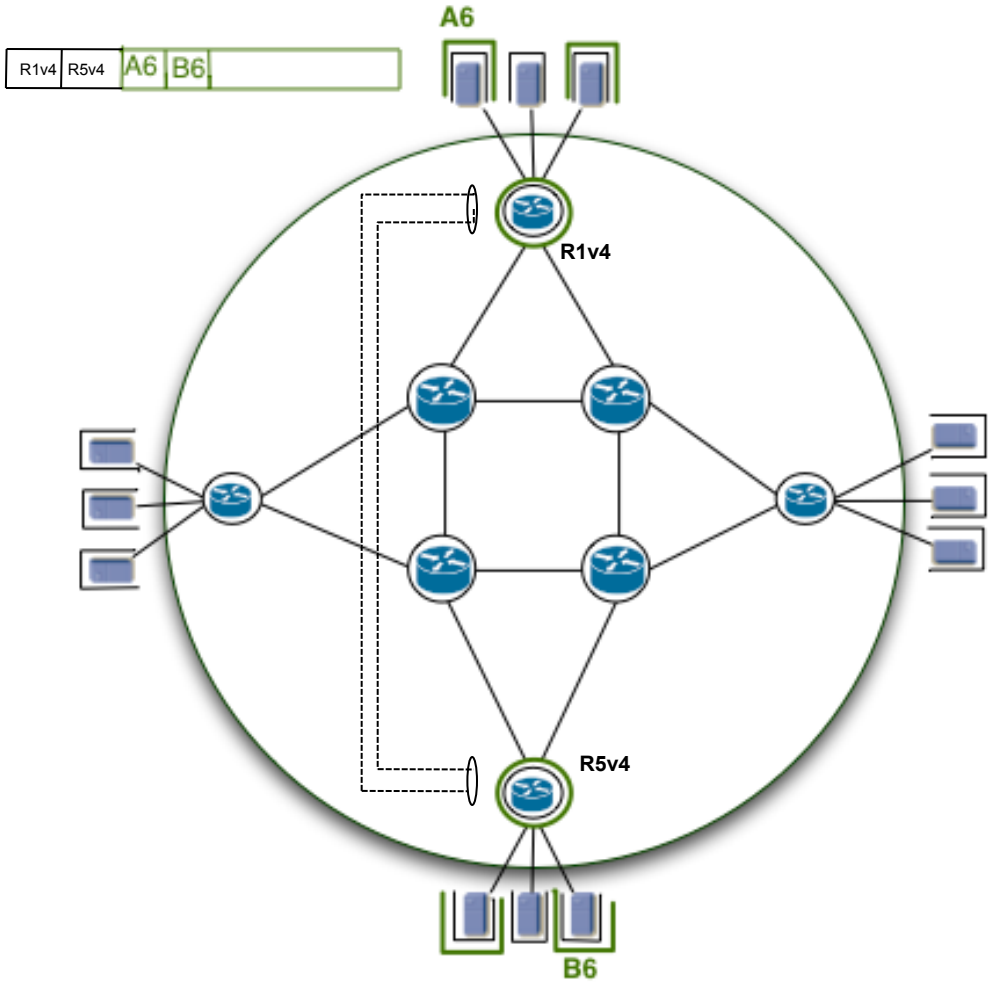
Transition Concept



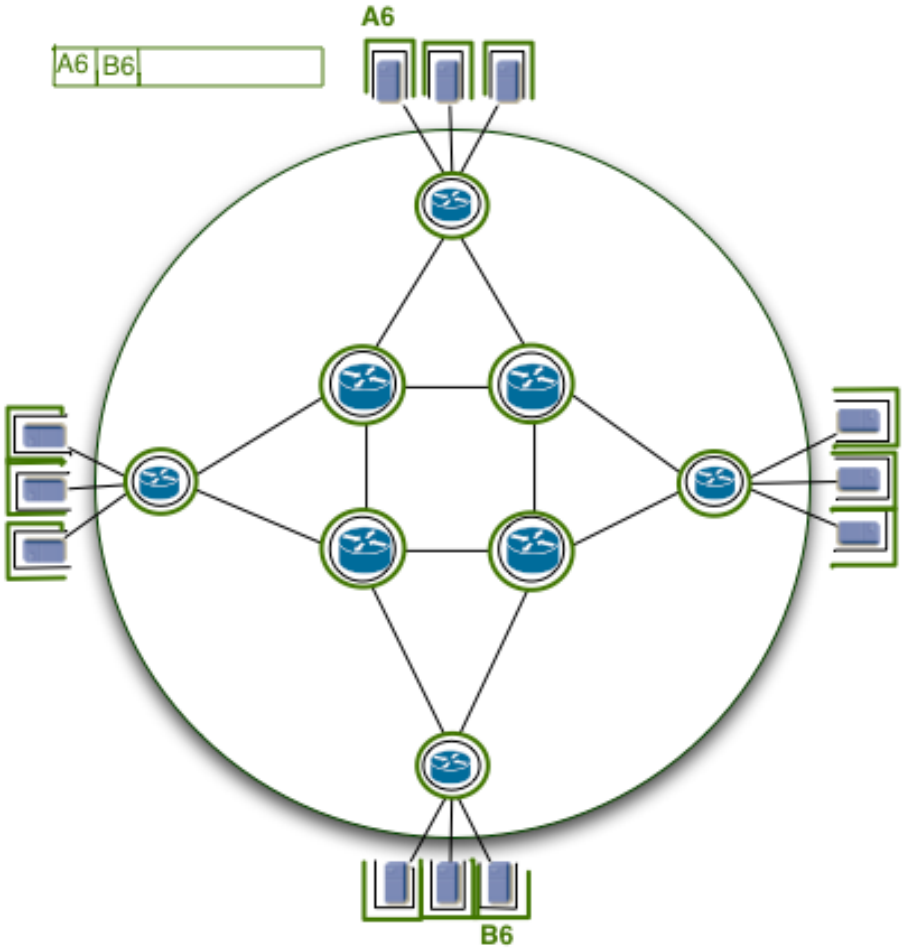
Transition Concept



Transition Concept



Transition Concept



IPv4 to IPv6 Transition

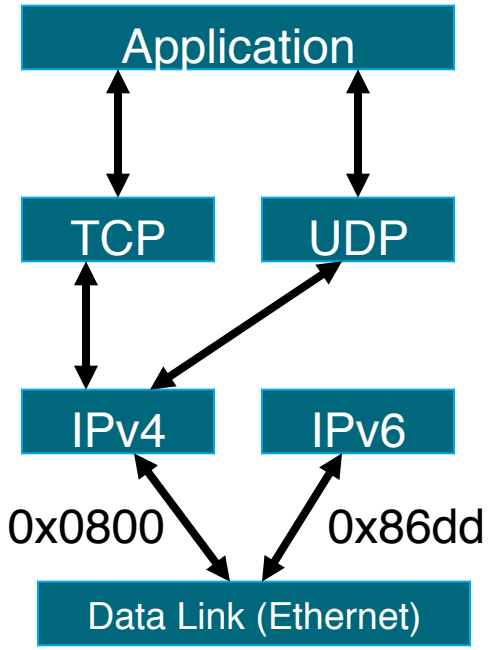
- Implementation rather than transition
  - No fixed day to convert
- The key to successful IPv6 transition
  - Maintaining compatibility with IPv4 hosts and routers while deploying IPv6
    - Millions of IPv4 nodes already exist
    - Upgrading every IPv4 nodes to IPv6 is not feasible
      - No need to convert all at once
    - Transition process will be gradual

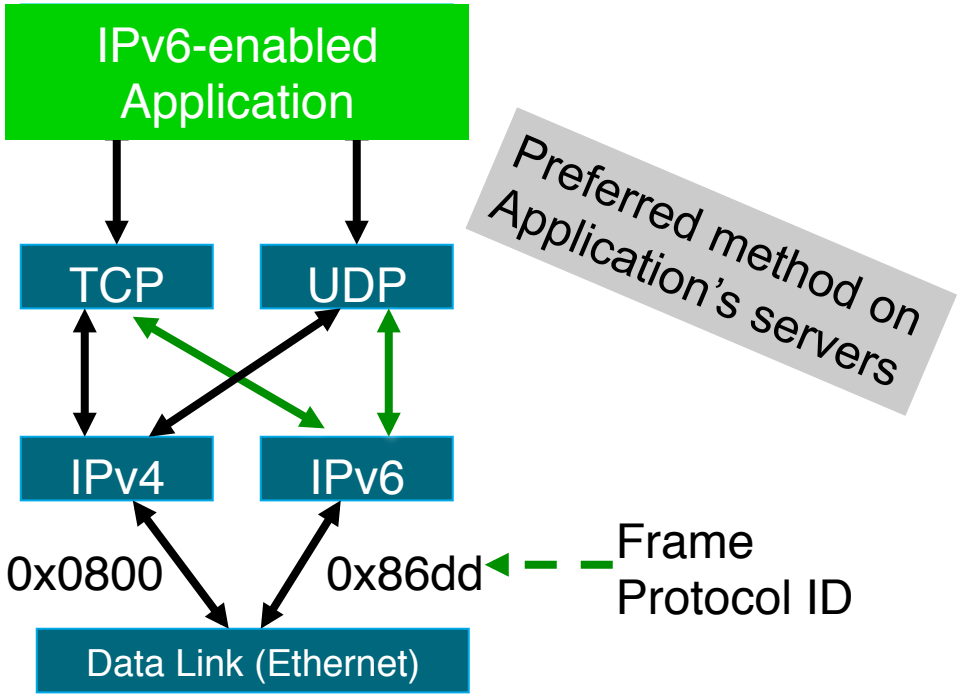
IPv4-IPv6 Co-existence/Transition

- A wide range of techniques have been identified and implemented, basically falling into three categories:
  - Dual-stack techniques, to allow IPv4 and IPv6 to co-exist in the same devices and networks
  - Tunneling techniques, to avoid order dependencies when upgrading hosts, routers, or regions
  - Translation techniques, to allow IPv6-only devices to communicate with IPv4-only devices
- Expect all of these to be used, in combination

Dual Stack Approach

RFC 4213



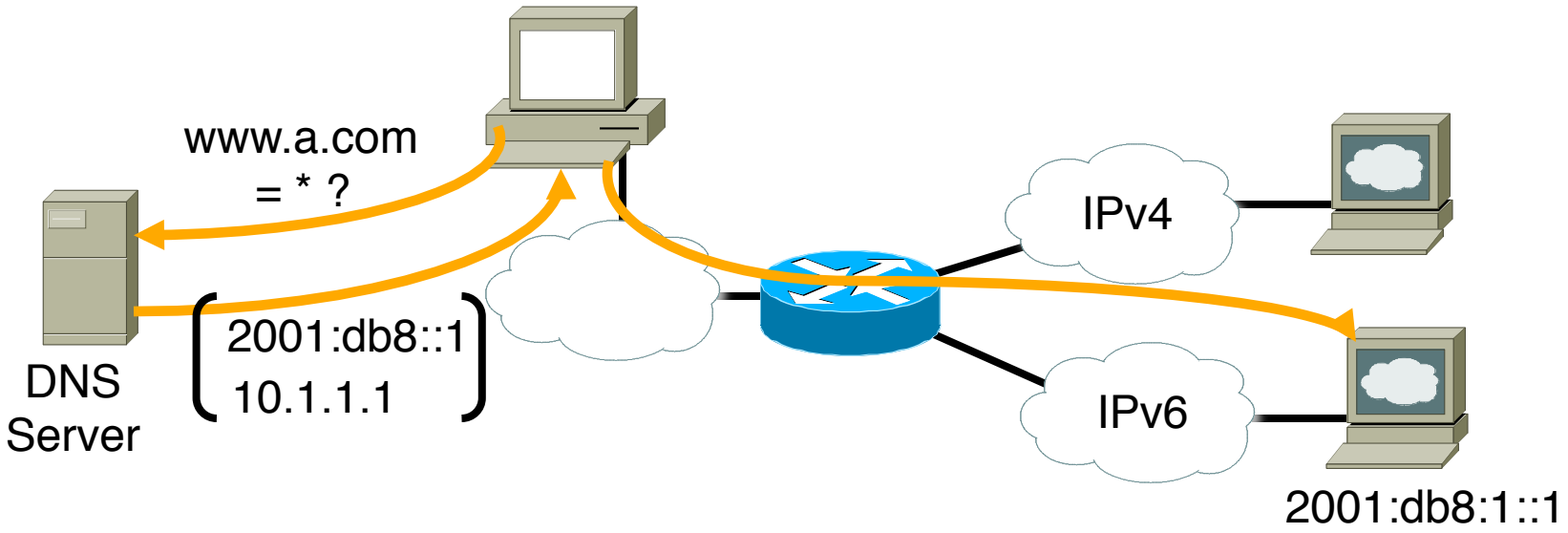


- Dual stack node means:
  - Both IPv4 and IPv6 stacks enabled
  - Applications can talk to both
  - Choice of the IP version is based on name lookup and application preference

Dual Stack Challenges

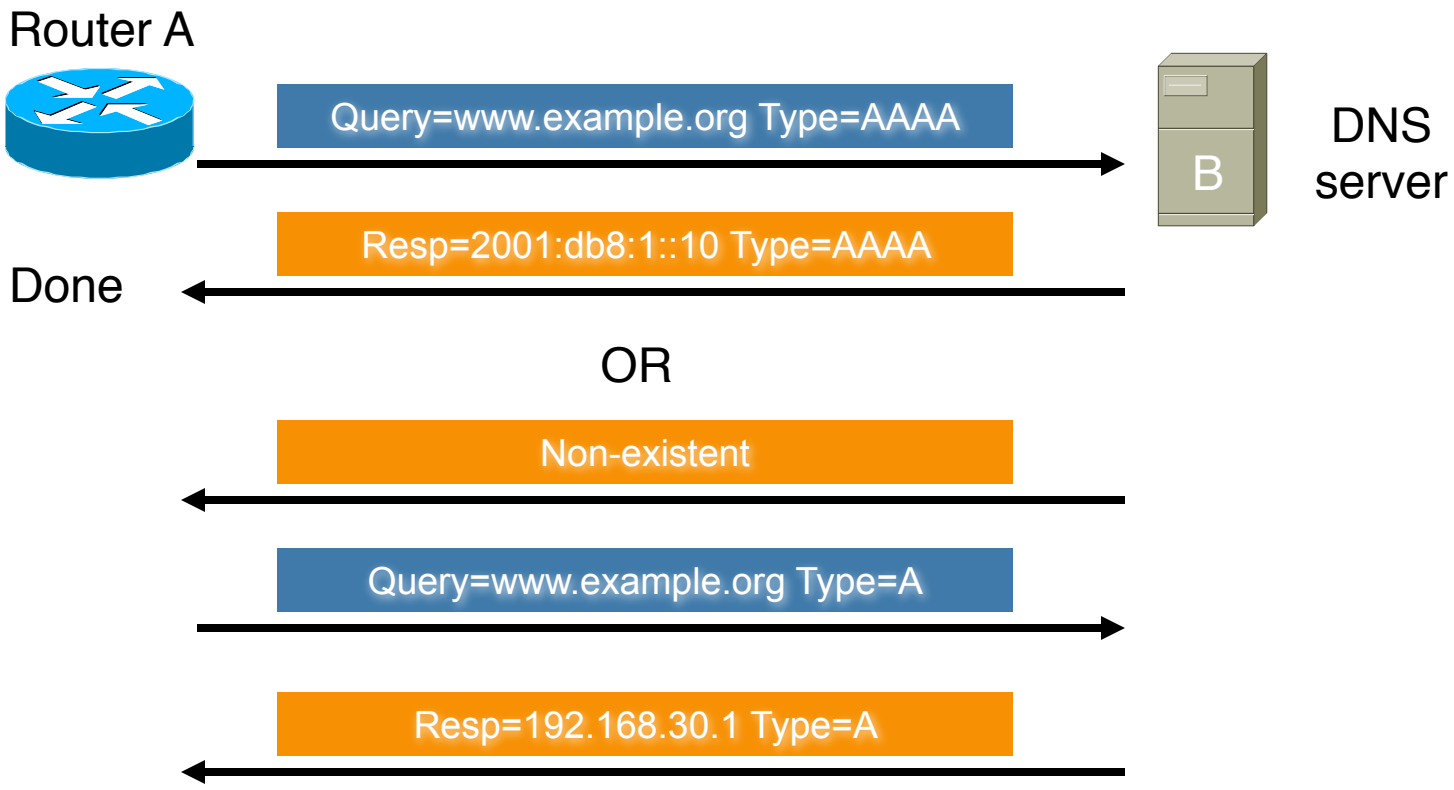
- Compatible software
  - Eg. If you use OSPFv2 for your IPv4 network you need to run OSPFv3 in addition to OPSFv2
- Transparent availability of services
- Deployment of servers and services
- Content provision
- Business processes
- Traffic monitoring
- End user deployment

Dual Stack Approach & DNS



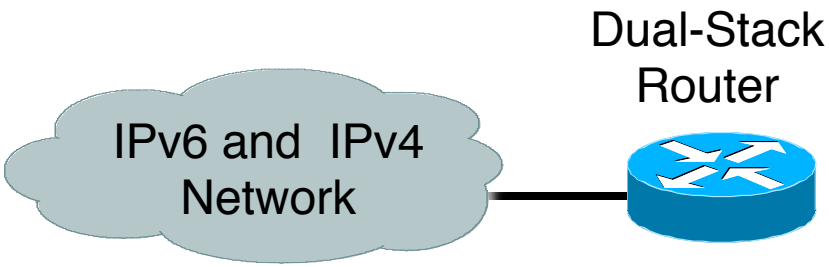
- In a dual stack case, an application that:
  - Is IPv4 and IPv6-enabled
  - Asks the DNS for all types of addresses
  - Chooses one address and, for example, connects to the IPv6 address

Example of DNS query



- DNS resolver picks IPv6 AAAA record first

A Dual Stack Configuration




```
router#
ipv6 unicast-routing

interface Ethernet0
 ip address 192.168.99.1 255.255.255.0
 ipv6 address 2001:db8:213:1::1/64
```

- IPv6-enabled router
  - If IPv4 and IPv6 are configured on one interface, the router is dual-stacked
  - Telnet, Ping, Traceroute, SSH, DNS client, TFTP,…

Using Tunnels for IPv6 Deployment

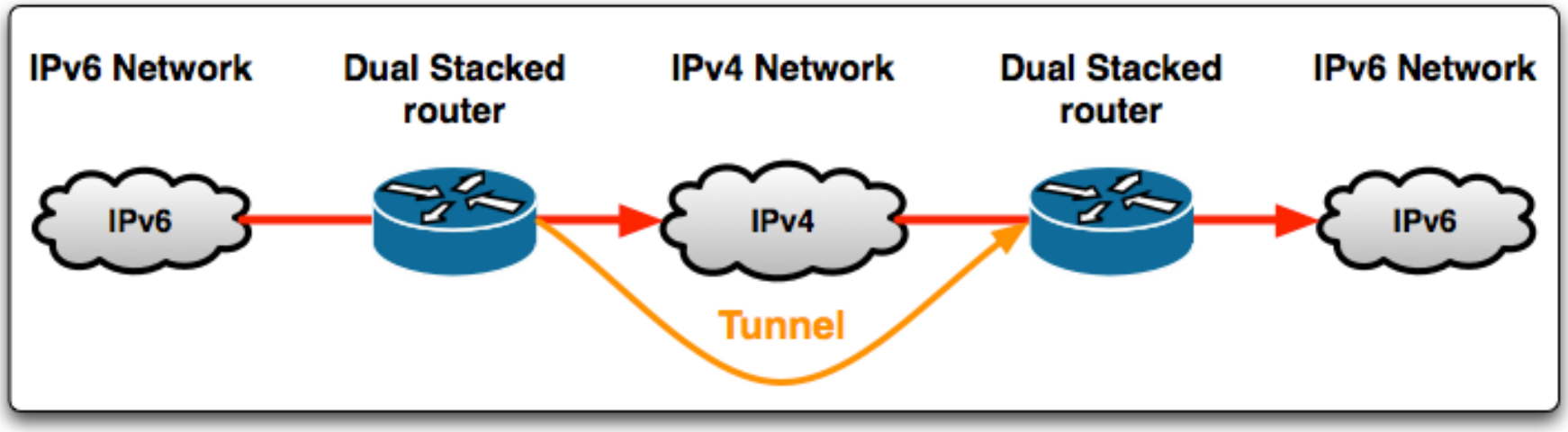
- Many techniques are available to establish a tunnel:
  - Manually configured
    - Manual Tunnel (RFC 2893)
    - GRE (RFC 2473)
  - Semi-automated
    - Tunnel broker
  - Automatic
    - 6to4 (RFC 3056)
    - 6rd

Tunnels

- Part of a network is IPv6 enabled
  - Tunnelling techniques are used on top of an existing IPv4 infrastructure and uses IPv4 to route the IPv6 packets between IPv6 networks by transporting these encapsulated in IPv4
  - Tunnelling is used by networks not yet capable of offering native IPv6 functionality
  - It is the main mechanism currently being deployed to create global IPv6 connectivity
- Manual, automatic, semi-automatic configured tunnels are available

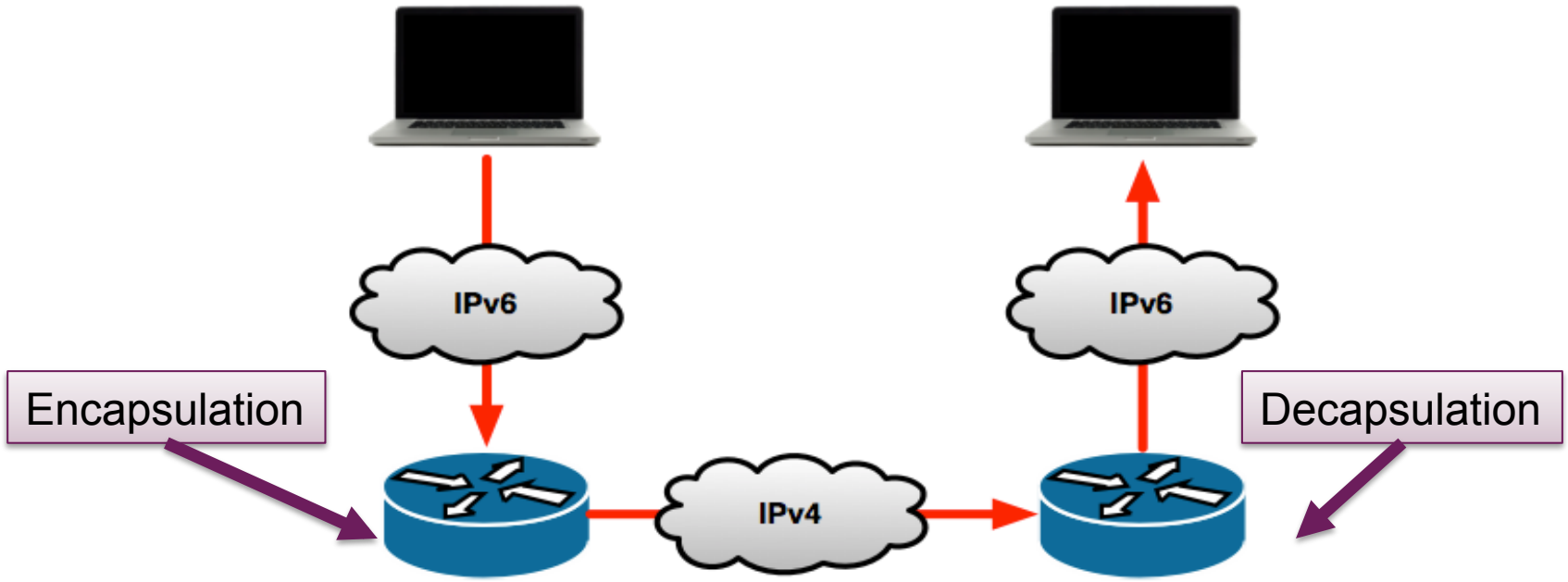
Tunneling – General Concept

- Tunneling can be used by routers and hosts
  - Tunneling is a technique by which one transport protocol is encapsulated as the payload of another.

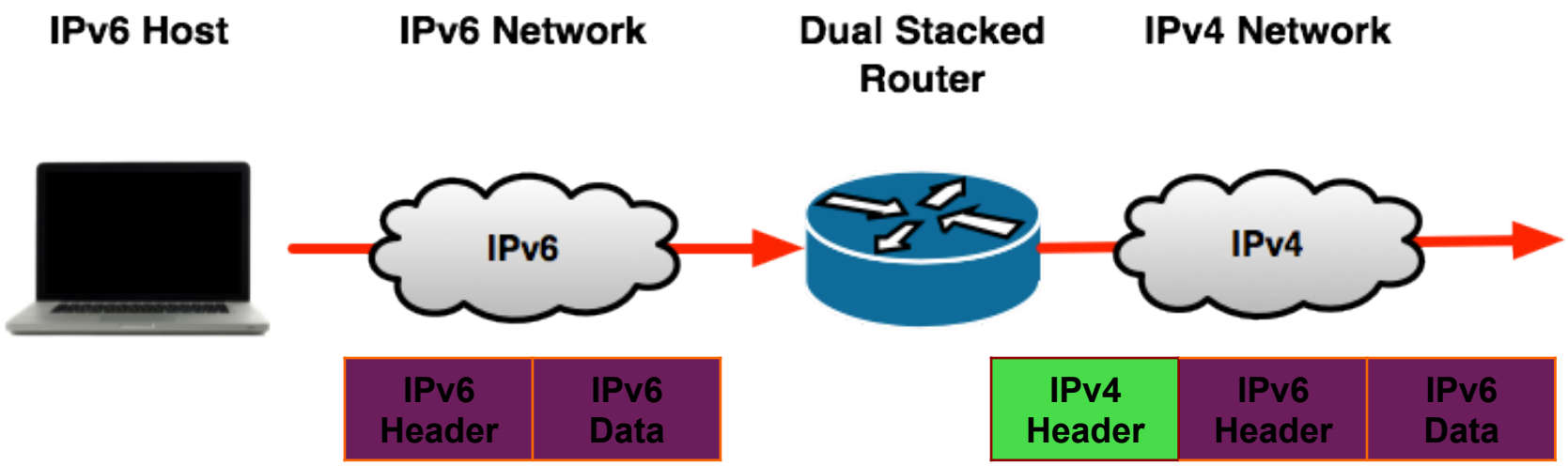


Tunneling – General Concept

- Two stepped process
  - Encapsulation of IPv6 packets to IPv4 packets
  - Decapsulation of IPv4 packets to IPv6 packets

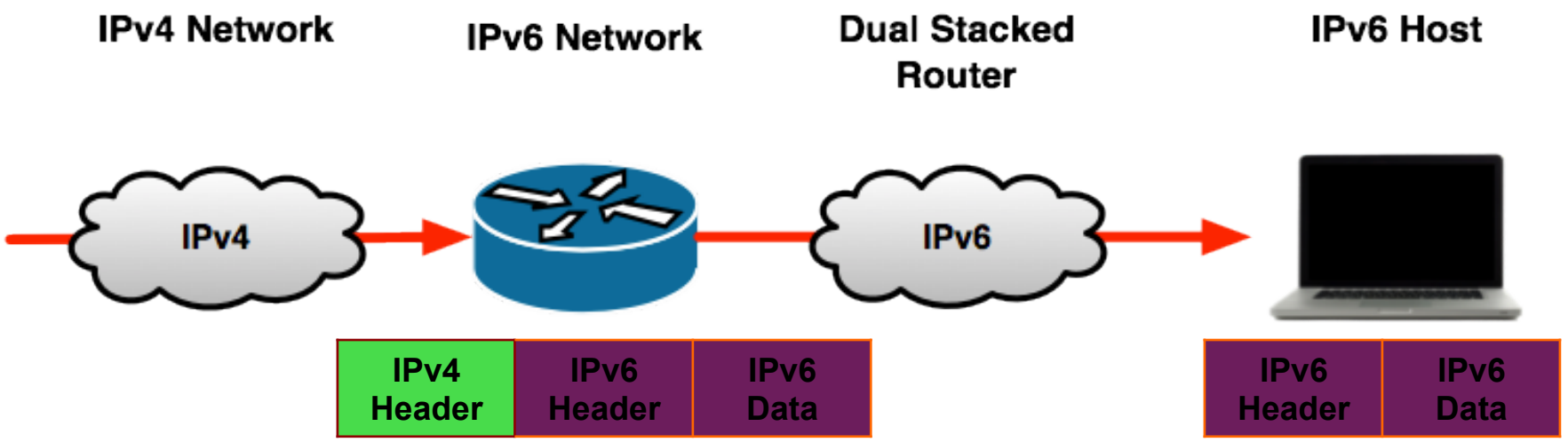


Tunnel Encapsulation



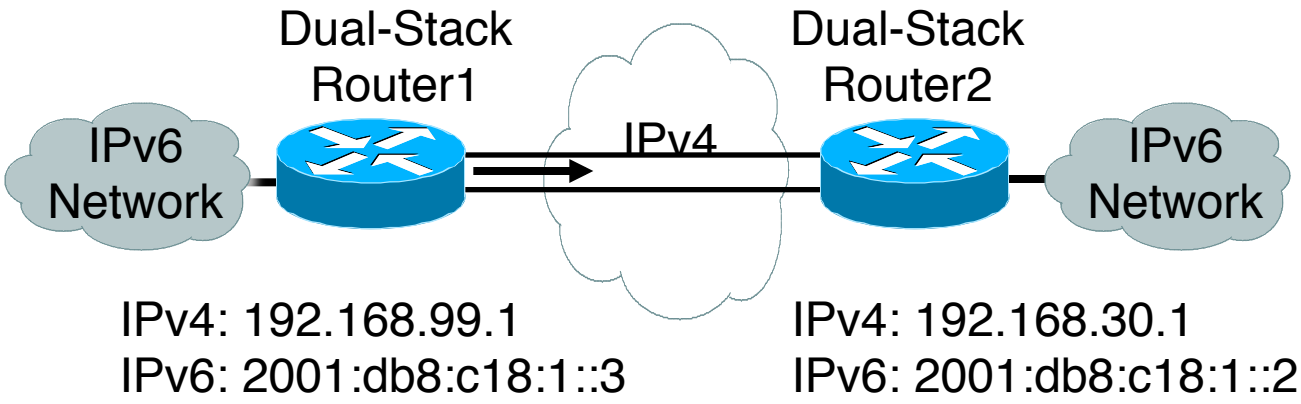
IPv6 essentials by Silvia Hagen, p258

Tunnel Decapsulation



IPv6 essentials by Silvia Hagen, p258

Manually Configured Tunnel (RFC4213)

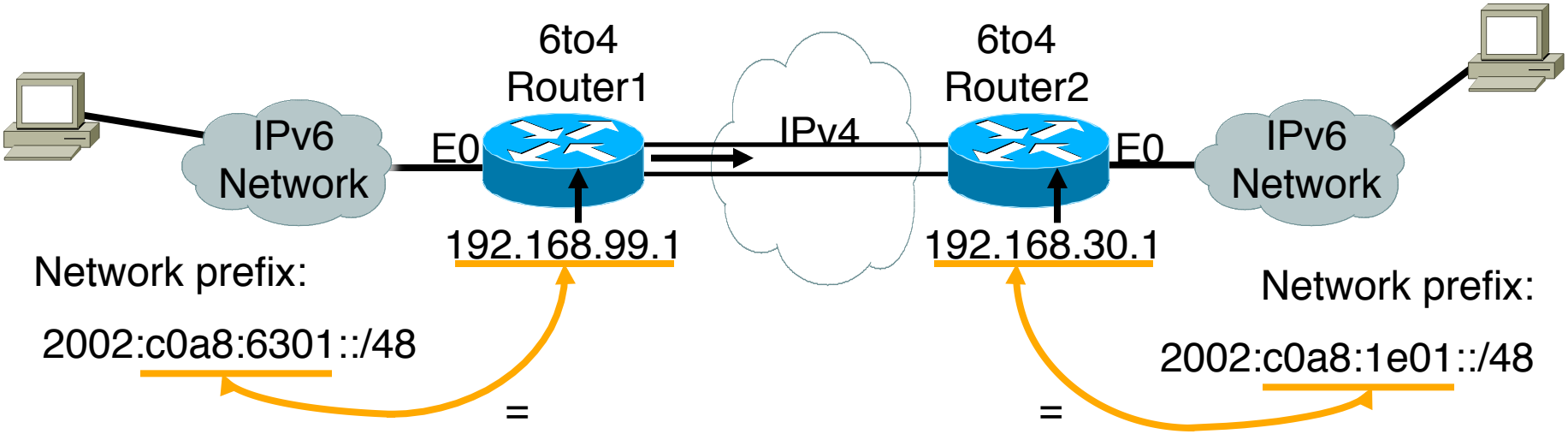



```
router1#

interface Tunnel0
 ipv6 address 2001:db8:c18:1::3/64
 tunnel source 192.168.99.1
 tunnel destination 192.168.30.1
 tunnel mode ipv6ip
```

```
router2#

interface Tunnel0
 ipv6 address 2001:db8:c18:1::2/64
 tunnel source 192.168.30.1
 tunnel destination 192.168.99.1
 tunnel mode ipv6ip
```

- Manually Configured tunnels require:
  - Dual stack end points
  - Both IPv4 and IPv6 addresses configured at each end

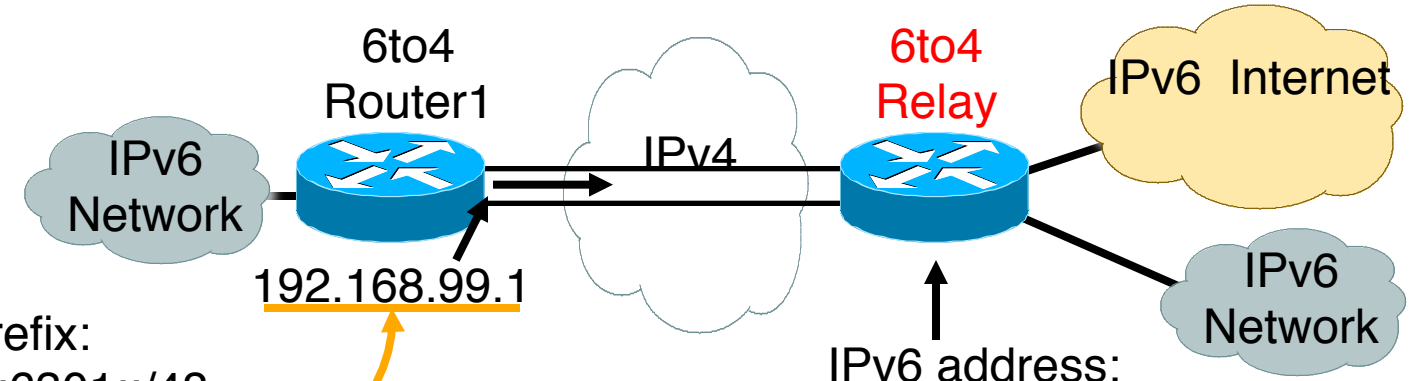
6to4 Tunnel (RFC 3056)



- 6to4 Tunnel:
  - Is an automatic tunnel method
  - Gives a prefix to the attached IPv6 network
  - 2002::/16 assigned to 6to4
  - Requires one global IPv4 address on each Ingress/Egress site

```
router2#
interface Loopback0
 ip address 192.168.30.1 255.255.255.0
 ipv6 address 2002:c0a8:1e01:1::/64 eui-64
interface Tunnel0
 no ip address
 ipv6 unnumbered Ethernet0
 tunnel source Loopback0
 tunnel mode ipv6ip 6to4

ipv6 route 2002::/16 Tunnel0
```

6to4 Relay




```
router1#
interface Loopback0
 ip address 192.168.99.1 255.255.255.0
 ipv6 address 2002:c0a8:6301:1::/64 eui-64
interface Tunnel0
 no ip address
 ipv6 unnumbered Ethernet0
 tunnel source Loopback0
 tunnel mode ipv6ip 6to4

ipv6 route 2002::/16 Tunnel0
ipv6 route ::/0 2002:c0a8:1e01::1
```

- 6to4 relay:
  - Is a gateway to the rest of the IPv6 Internet
  - Default router
  - Anycast address (RFC 3068) for multiple 6to4 Relay

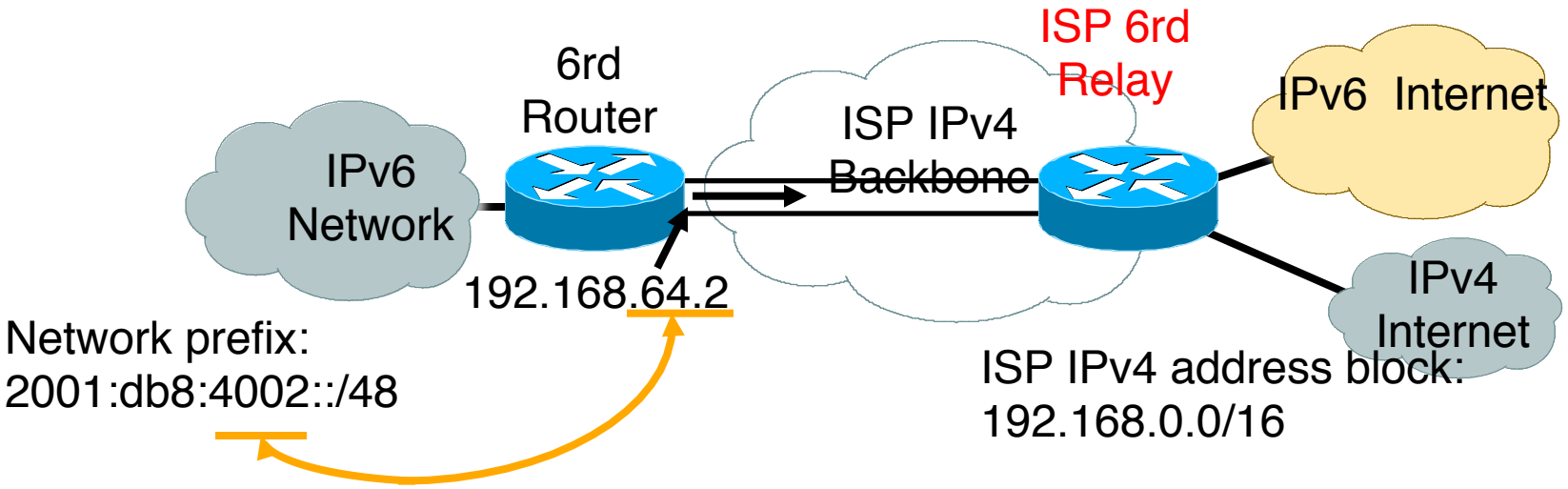
6to4 in the Internet

- 6to4 prefix is 2002::/16
- 192.88.99.0/24 is the IPv4 anycast network for 6to4 routers
- 6to4 relay service
  - An ISP who provides a facility to provide connectivity over the IPv4 Internet between IPv6 islands
    - Is connected to the IPv6 Internet and announces 2002::/16 by BGP to the IPv6 Internet
    - Is connected to the IPv4 Internet and announces 192.88.99.0/24 by BGP to the IPv4 Internet
  - Their router is configured with local IPv4 address of 192.88.99.1 and local IPv6 address of 2002:c058:6301::1

6to4 in the Internet
Relay Router Configuration

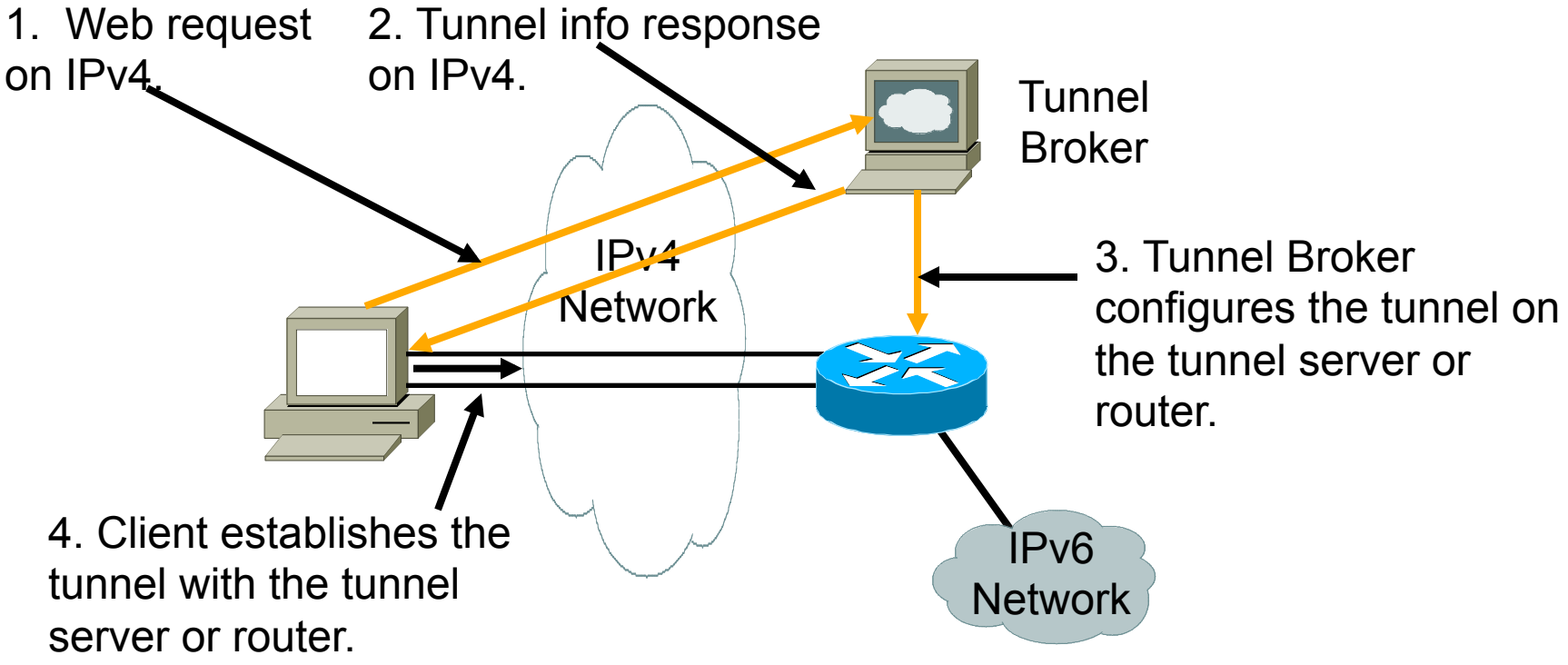
```
interface loopback0
 ip address 192.88.99.1
   255.255.255.255
 ipv6 address 2002:c058:6301::1/128
!
interface tunnel 2002
 no ip address
 ipv6 unnumbered Loopback0
 tunnel source Loopback0
 tunnel mode ipv6ip 6to4
 tunnel path-mtu-discovery
!
interface FastEthernet0/0
 ip address 105.3.37.1 255.255.255.0
 ipv6 address 2001:db8::1/64
!
router bgp 100
 address-family ipv4
  neighbor <v4-transit> remote-as 101
  network 192.88.99.0 mask
   255.255.255.0.
 address-family ipv6
  neighbor <v6-transit> remote-as 102
  network 2002::/16
!
ip route 192.88.99.0 255.255.255.0
   null0 254
ipv6 route 2002::/16 tunnel2002
```

6rd Tunnel



- 6rd (example):
  - ISP has 192.168.0.0/16 IPv4 address block
  - ISP has 2001:db8::/32 IPv6 address block
  - Final 16 bits of IPv4 address used on customer point-to-point link to create customer /48 → customer uses 2001:db8:4002::/48 address space
  - IPv6 tunnel to ISP 6rd relay bypasses infrastructure which cannot handle IPv6

Tunnel Broker



- Tunnel broker:
  - Tunnel information is sent via http-ipv4

Transition Strategies

- Do nothing
  - Wait for IPv4 to run out
- Extend the life of the IPv4 network
  - Use Network Address Translation (NAT)
  - Customers and SP infrastructure moved to RFC 1918 address space (private addreses)
  - Acquire more IPv4 addresses
- IPv4/IPv6 Coexistence
  - Dual stack network
  - 6rd (rapid deploy)
  - Large Scale NATs (LSN) – NAT444, Dual-Stack Lite, NAT64, IVI

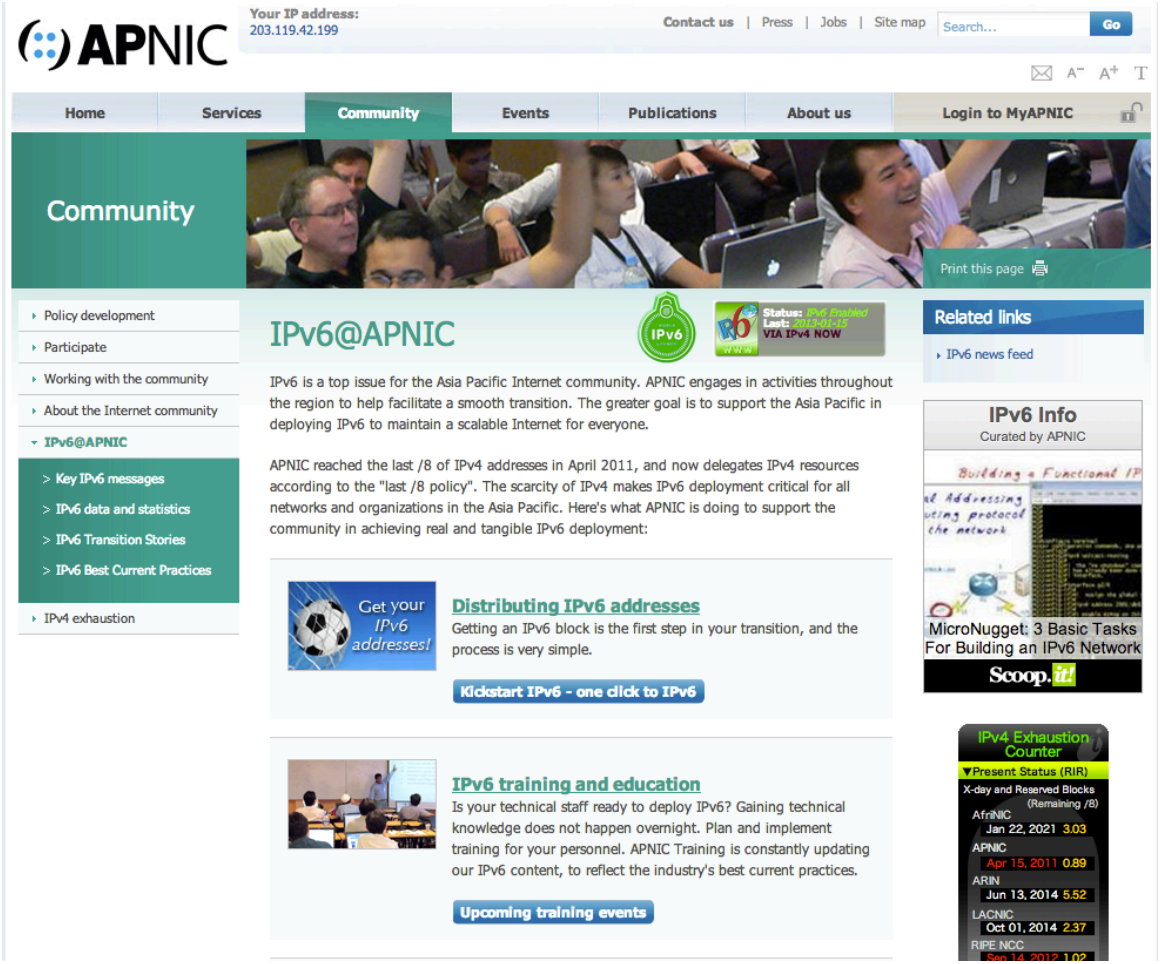
Transition Technology Terms

- Dual-stack
  - when IPv4 and IPv6 are fully deployed on the infrastructure
- IP in IP Tunnels
  - Mechanism whereby an IP packet from one address family is encapsulated in an IP packet
  - Ex. IPinIP, GRE, 6to4, Teredo, ISATAP, 6rd
- Address Family Translation (AFT)
  - Translation of IP address from one address family into another address family
  - Ex: NAT64, NAT46
- Network Address Translation (NAT)
  - Translation of IP address into another IP address (within the same address family)
  - Ex: NAPT, NAT-PT
- Carrier-Grade NAT (CGN)
  - ISP version of a subscriber NAT

Questions

- Please remember to fill out the feedback form
  - <survey-link>
- Slide handouts will be available after completing the survey

IPv6@APNIC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IPv6@APNIC
IPv6 is a top issue for the Asia Pacific Internet community. APNIC engages in activities throughout the region to help facilitate a smooth transition. The greater goal is to support the Asia Pacific in deploying IPv6 to maintain a scalable Internet for everyone.
APNIC reached the last /8 of IPv4 addresses in April 2011, and now delegates IPv4 resources according to the "last /8 policy". The scarcity of IPv4 makes IPv6 deployment critical for all networks and organizations in the Asia Pacific. Here's what APNIC is doing to support the community in achieving real and tangible IPv6 deployment:
Get your IPv6 addresses!
Distributing IPv6 addresses
Getting an IPv6 block is the first step in your transition, and the process is very simple.
Kickstart IPv6 - one click to IPv6
IPv6 training and education
Is your technical staff ready to deploy IPv6? Gaining technical knowledge does not happen overnight. Plan and implement training for your personnel. APNIC Training is constantly updating our IPv6 content, to reflect the industry's best current practices.
Upcoming training events
Related links
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ARIN
Jun 13, 2014 5.52
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Oct 01, 2014 2.37
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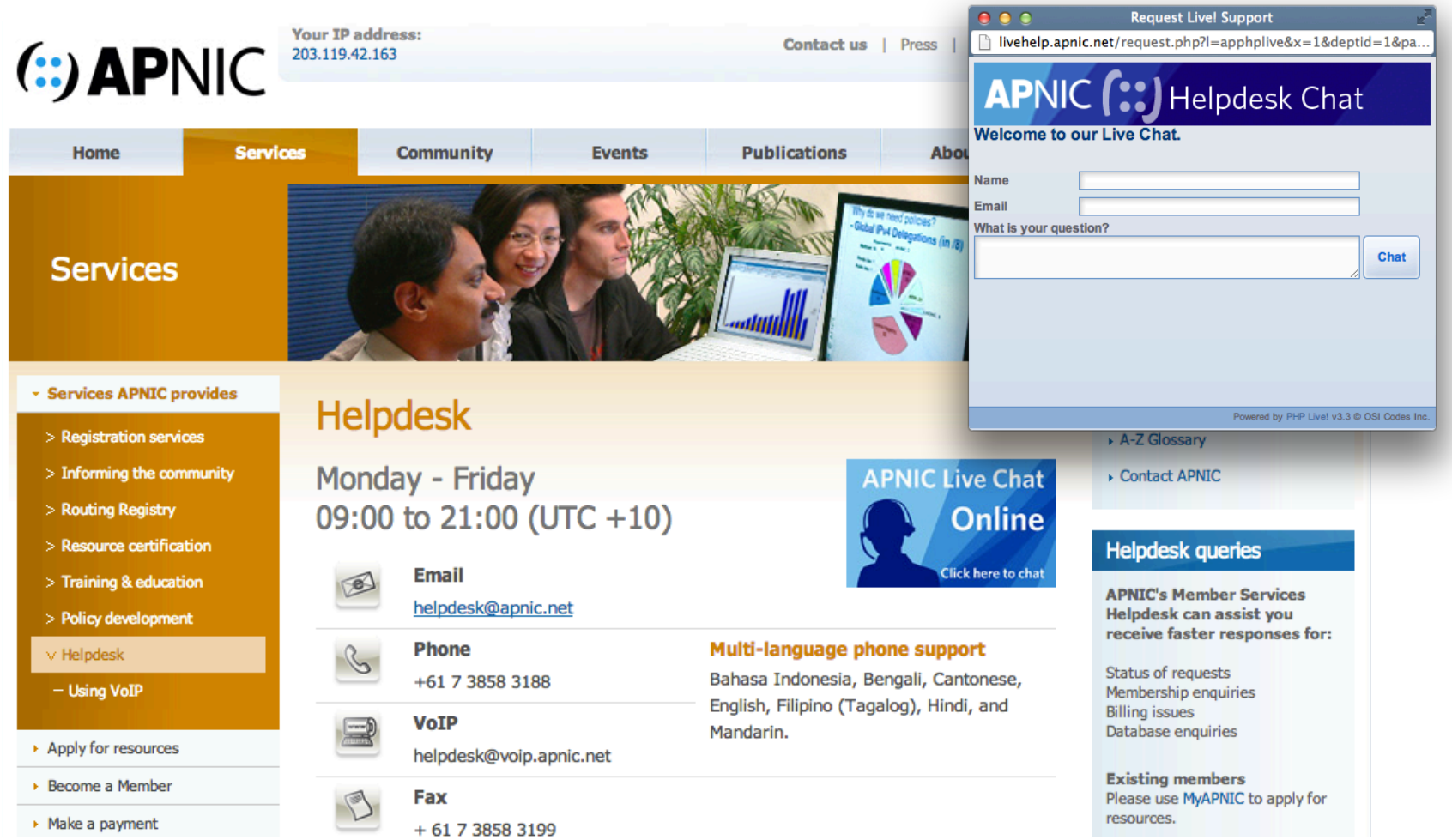
APNIC Helpdesk Chat



Thank You!

End of Session

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