APNIC

Asia Pacific Network Information Centre

Introduction to IPv6 and IPv6 Deployment

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In conjunction with

SANOG

Presenter

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Agenda

- IPv6 Overview
- IPv6 Addressing
- IPv6 Address Management
- IPv6 Subnetting
- IPv6 Host Configuration
- IPv4 to IPv6 Transition Technologies
- IPv6 DNS
- APNIC Training ISP Network Topology Overview

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- **IPv6 Overview**
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What Is IPv6?

- IP stands for **I**nternet **P**rotocol which is one of the main pillars that supports the Internet today
- Current version of IP protocol is IPv4
- The new version of IP protocol is IPv6
- There is a version of IPv5 but it was assigned for excremental use [RFC1190]
- IPv6 was also called IPng in the early days of IPv6 protocol development stage

Background Of IPv6 Protocol

- During the late 1980s (88-89) Internet has started to grow exponentially
- The ability to scale Internet for future demands requires a limitless supply of IP addresses and improved mobility
- In 1991 IETF decided that the current version of IP (IPv4) had outlived its design and need to develop a new protocol for Internet
- In 1994 IETF gave a clear direction of IPng or IPv6 after a long process of discussion

Background Of IPv6 Protocol

- August 1990
  - First wakeup call by Solensky in IETF on IPv4 address exhaustion
- December 1994
  - IPng area were formed within IETF to manage IPng effort [RFC1719]
- December 1994
  - List of technical criteria was defined to choose IPng [RFC1726]
- January 1995
  - IPng director recommendation to use 128 bit address [RFC1752]
- December 1995
  - First version of IPv6 address specification [RFC1883]
- December 1998
  - Updated version changing header format from 1st version [RFC2460]

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Motivation Behind IPv6 Protocol

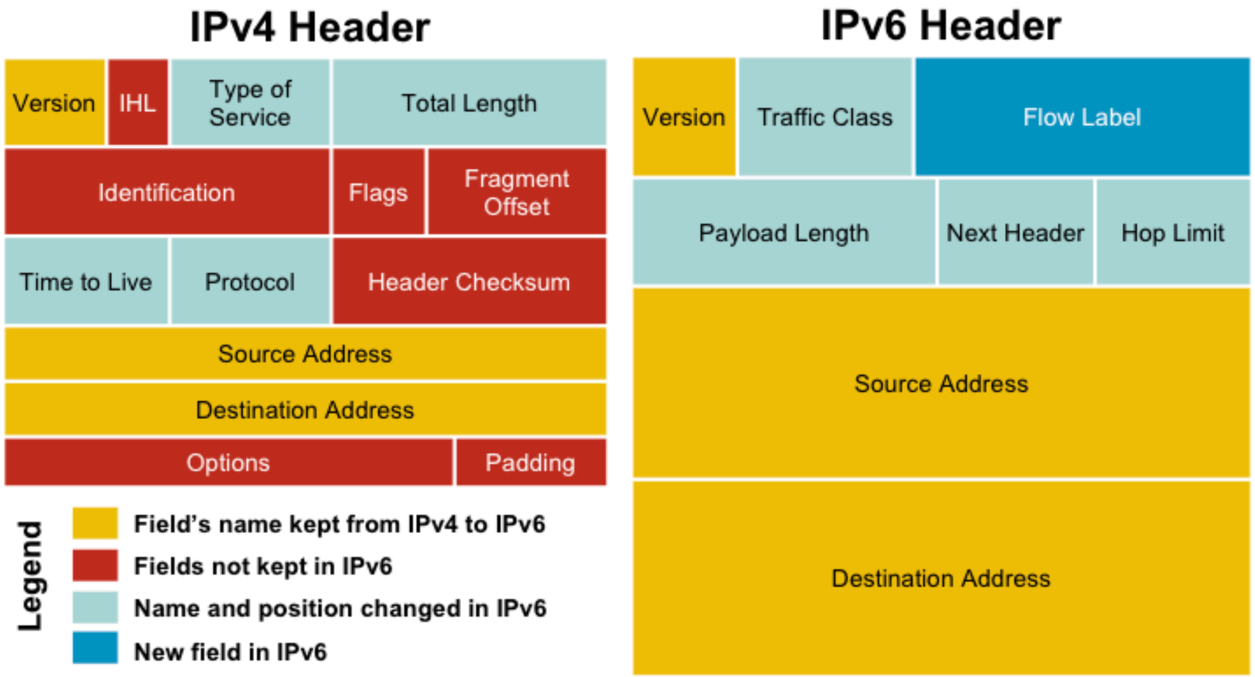
- New generation Internet need:
  - Plenty of address space (PDA, Mobile Phones, Tablet PC, Car, TV etc etc ☺)
  - Solution of very complex hierarchical addressing need, which IPv4 is unable provide
  - End to end communication without the need of NAT for some real time application i.e online transaction
  - Ensure security, reliability of data and faster processing of protocol overhead
  - Stable service for mobile network i.e Internet in airline

New Functional Improvement In IPv6

- Address Space
  - Increase from 32-bit to 128-bit address space
- Management
  - Stateless autoconfiguration means no more need to configure IP addresses for end systems, even via DHCP
- Performance
  - Fixed header sizes (40 byte) and 64-bit header alignment mean better performance from routers and bridges/switches

Source: http://www.opus1.com/ipv6/whatisipv6.html

Protocol Header Comparison



- IPv4 contain 10 basic header field
- IPv6 contain 6 basic header field
- IPv6 header has 40 octets in contrast to the 20 octets in IPv4
- So a smaller number of header fields and the header is 64-bit aligned to enable fast processing by current processors

Diagram Source: www.cisco.com

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Size of the IPv6 address space

- An IPv6 address is 16 octets (128 bits)
- This would allow every person on the planet to have their own internet as large as the current Internet
- It is difficult to foresee running out of IPv6 addresses

IPv6 addressing

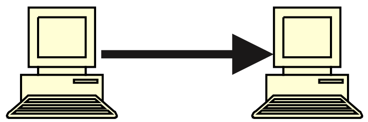
- 128 bits of address space
- Hexadecimal values of eight 16 bit fields
  - X:X:X:X:X:X:X:X (X=16 bit number, ex: A2FE)
  - 16 bit number is converted to a 4 digit hexadecimal number
- Example:
  - FE38:DCE3:124C:C1A2:BA03:6735:EF1C:683D
- Abbreviated form of address
  - 4EED:0023:0000:0000:0000:036E:1250:2B00
  - →4EED:23:0:0:0:36E:1250:2B00
  - →4EED:23::36E:1250:2B00
  - (Null value can be used only once)

IPv6 addressing model

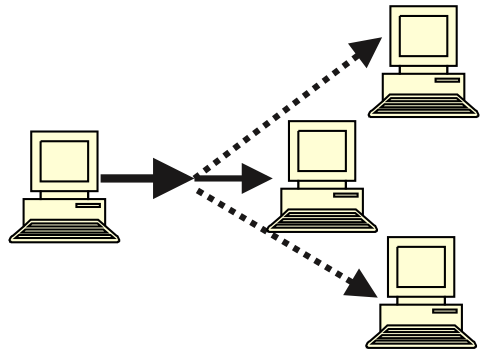
- **IPv6 Address type**

RFC 4291

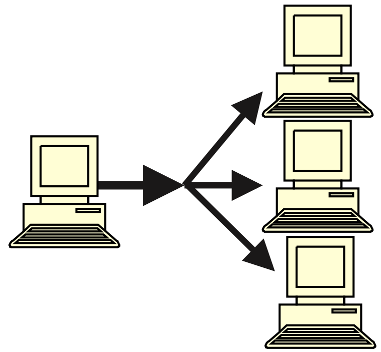
  - Unicast
    - An identifier for a single interface



  - Anycast
    - An identifier for a set of interfaces



  - Multicast
    - An identifier for a group of nodes



IPv6 Address Range

• Unspecified Address	::/128
• Loopback	::1/128
• Global Unicast 0010	2000::/3
• Link Local 1111 1110 10	FE80::/10
• Multicast Address 1111 1111	FF00::/8

Unicast address

- Address given to interface for communication between host and router
  - Global unicast address currently delegated by IANA

001 FP 3bits	Global routing prefix 45 bits	Subnet ID 16 bits	I nterface ID 64 bits

  - Local use unicast address
    - Link-local address (starting with FE80::)

1111111010 10 bits	000…….0000 54 bits	Interface ID 64 bits

Special addresses

- The unspecified address
  - A value of 0:0:0:0:0:0:0:0 (::)
  - It is comparable to 0.0.0.0 in IPv4
- The loopback address
  - It is represented as 0:0:0:0:0:0:0:1 (::1)
  - Similar to 127.0.0.1 in IPv4

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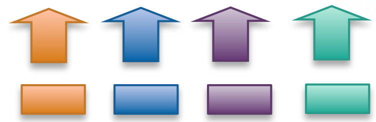
Allocation And Assignment

- Allocation
  - "A block of address space held by an IR (or downstream ISP) for subsequent allocation or assignment"
    - Not yet used to address any networks
- Assignment
  - "A block of address space used to address an operational network"
    - May be provided to ISP customers, or used for an ISP's infrastructure ('self-assignment')

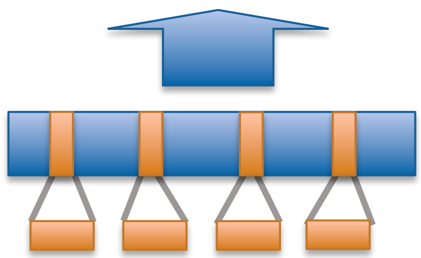
Portable And Non-portable

Portable Assignments



- Customer addresses independent from ISP
  - Keeps addresses when changing ISP
- Bad for size of routing tables

Non-portable Assignments



- Customer uses ISP's address space
  - Must renumber if changing ISP
- Only way to effectively scale the Internet

Initial IPv6 Allocation

- To qualify for an initial allocation of IPv6 address space, an organization must:
  - Not be an end site (must provide downstream services)
  - Plan to provide IPv6 connectivity to organizations to which it will make assignments

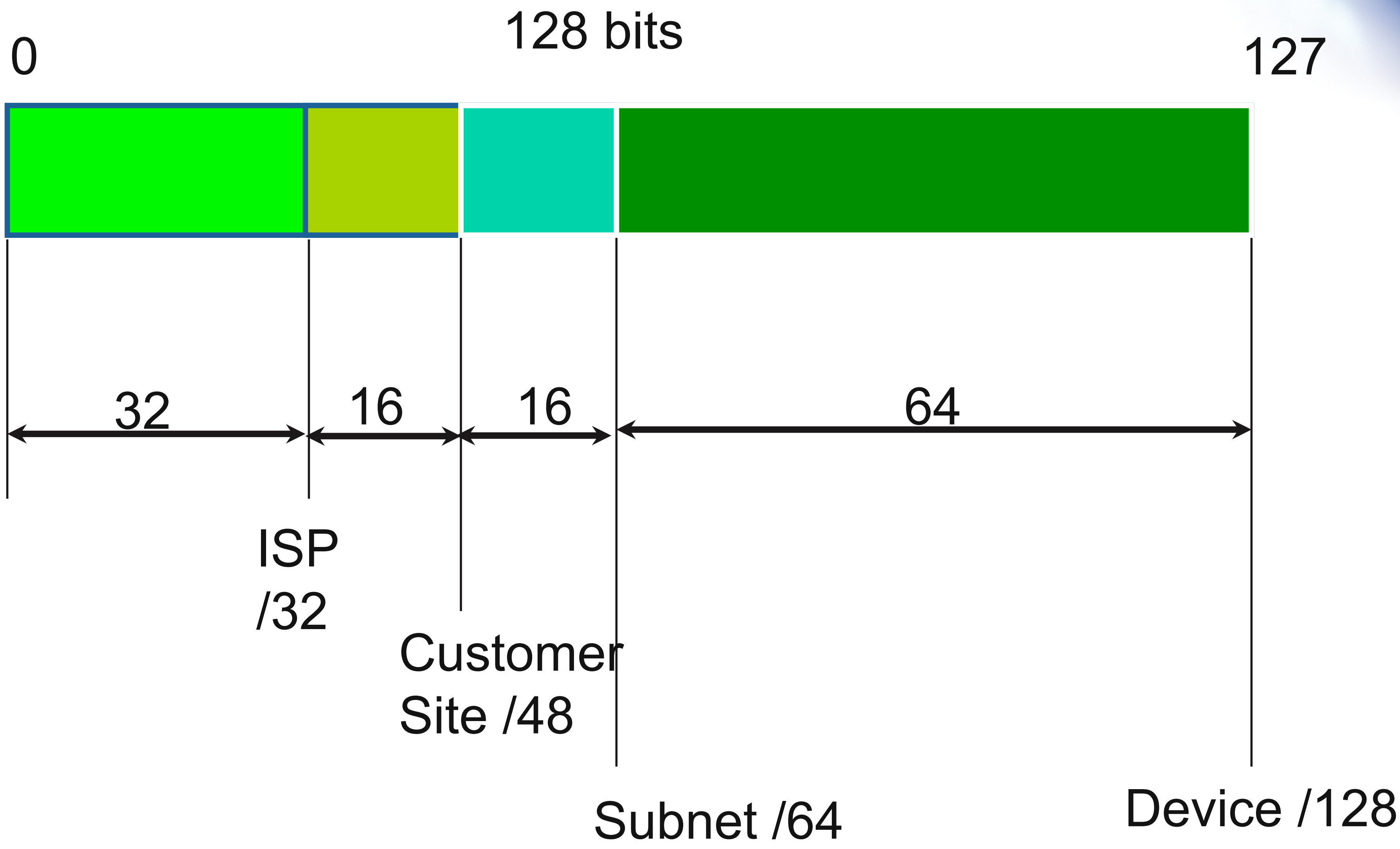
IPv6 Initial Allocation (cont.)

- Meet one of the two following criteria:
  - Have a plan for making at least 200 assignments to other organizations within two years OR
  - Be an existing ISP with IPv4 allocations from an APNIC or an NIR, which will make IPv6 assignments or sub-allocations to other organizations and announce the allocation in the inter-domain routing system within two years

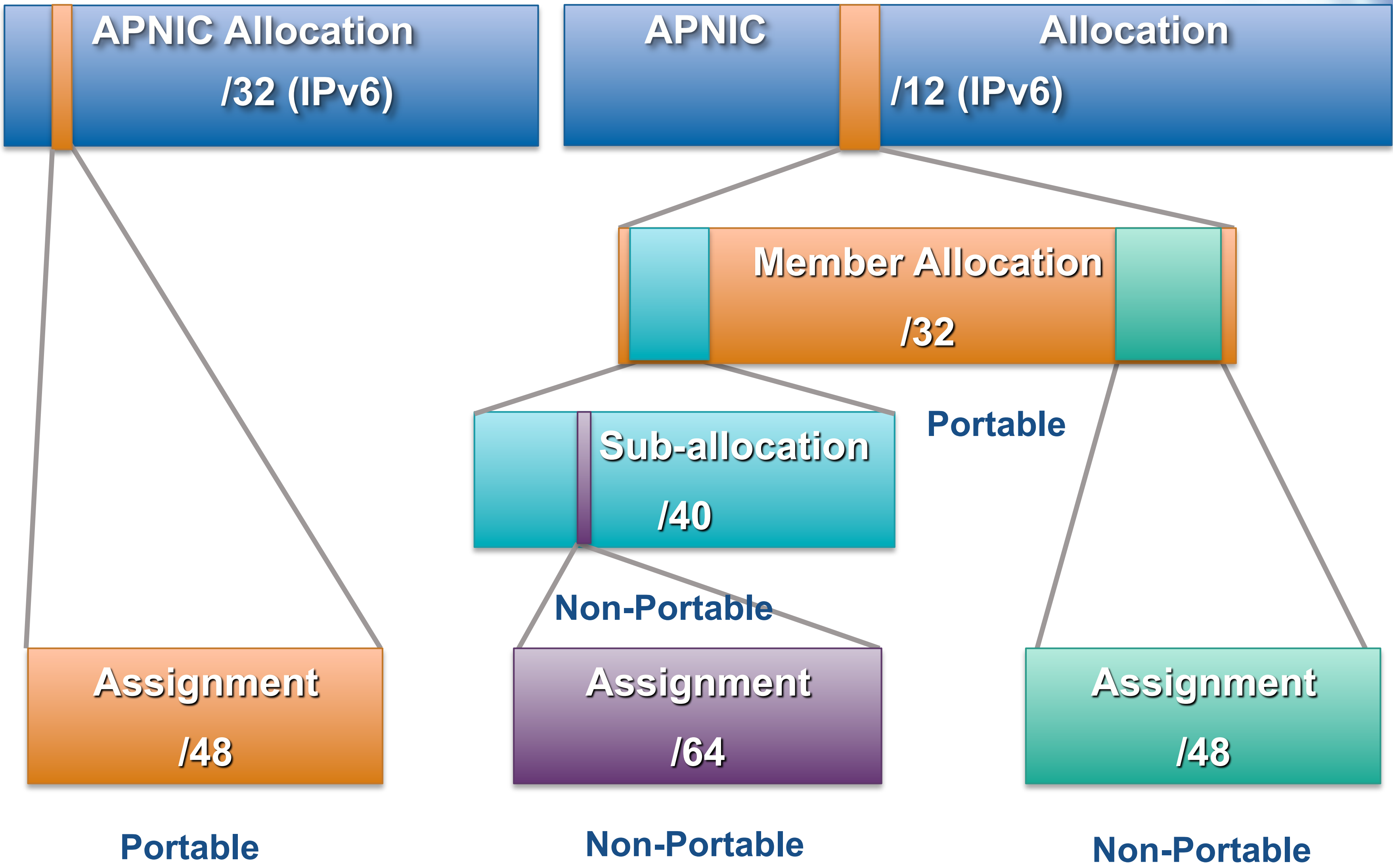
“One Click” IPv6 Policy

- Members with IPv4 holdings can click the button in MyAPNIC to instantly receive their IPv6 block
  - No forms to fill out!
- A Member that has an IPv4 allocation is eligible for a /32
- A Member that has an IPv4 assignment is eligible for a /48

IPv6 addressing structure

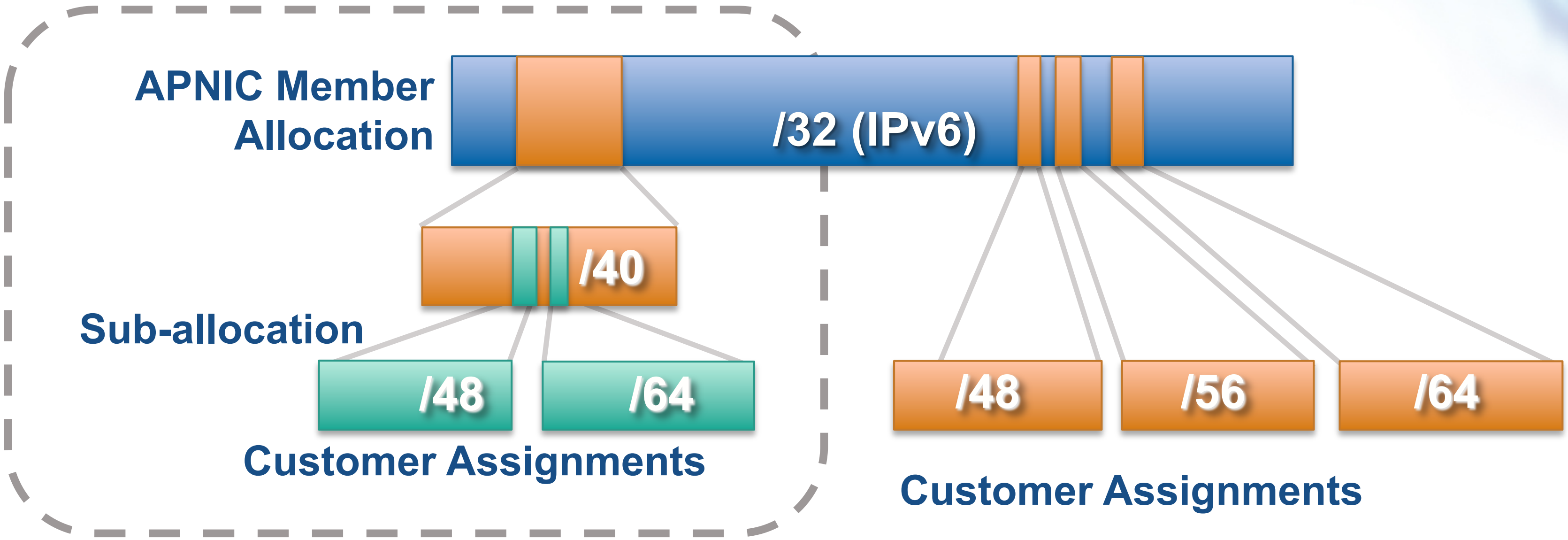


Address Management Hierarchy



- Describes "portability" of the address space

Sub-allocations

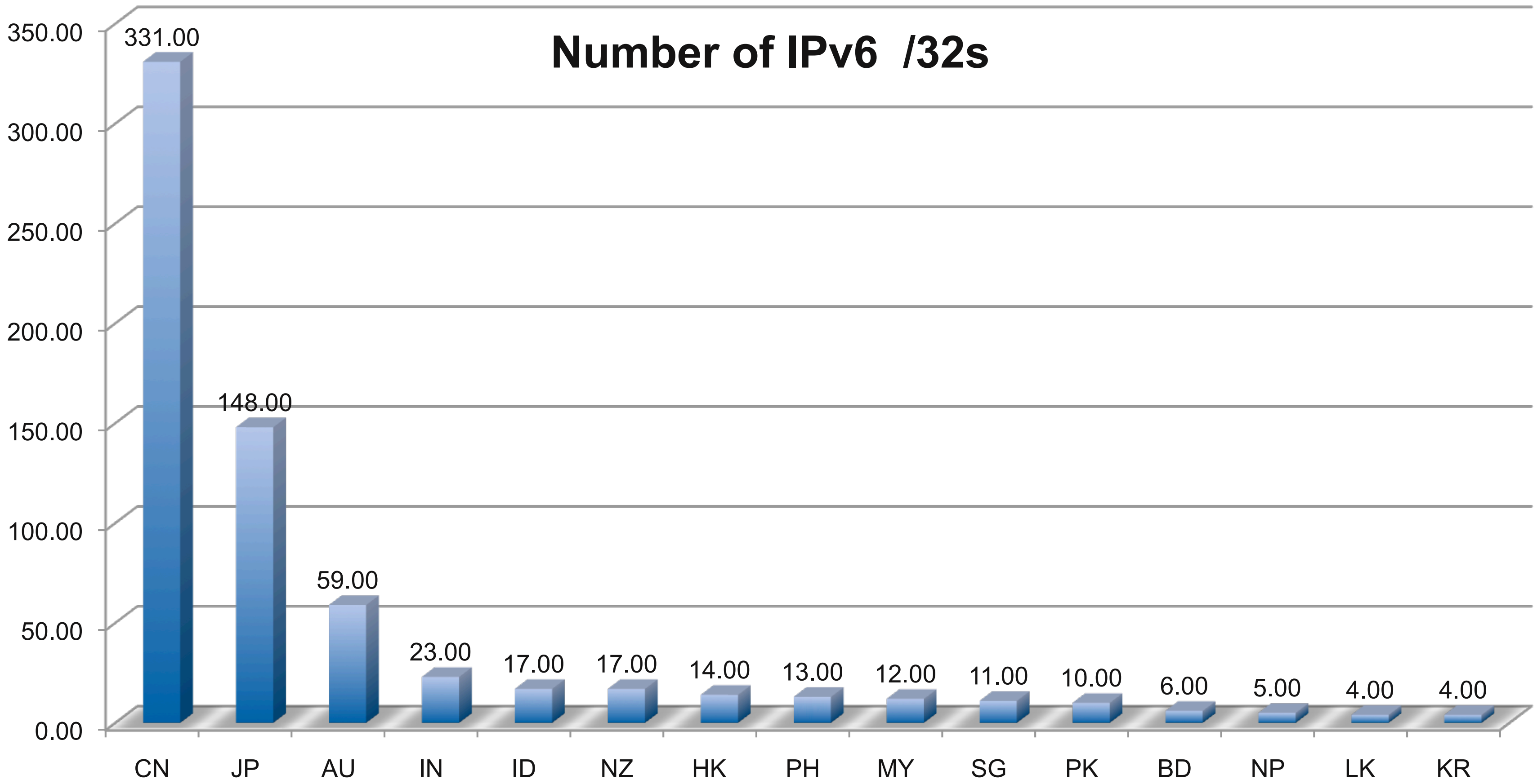


- **No max or min size**
  - Max 2 year requirement
- **Assignment Window & 2nd Opinion applies**
  - to both sub-allocation & assignments
    - Sub-allocation holders don't need to send in 2nd opinions

Sub-allocation Guidelines

- Sub-allocate cautiously
  - Only allocate or assign what the customer has demonstrated a need for
  - Seek APNIC advice if in doubt
- Efficient assignments
  - Member is responsible for overall utilisation
- Database registration (WHOIS Db)
  - Sub-allocations & assignments must be registered in the whois db

APNIC IPv6 Allocations By Economy



http://www.apnic.net/stats/o3/

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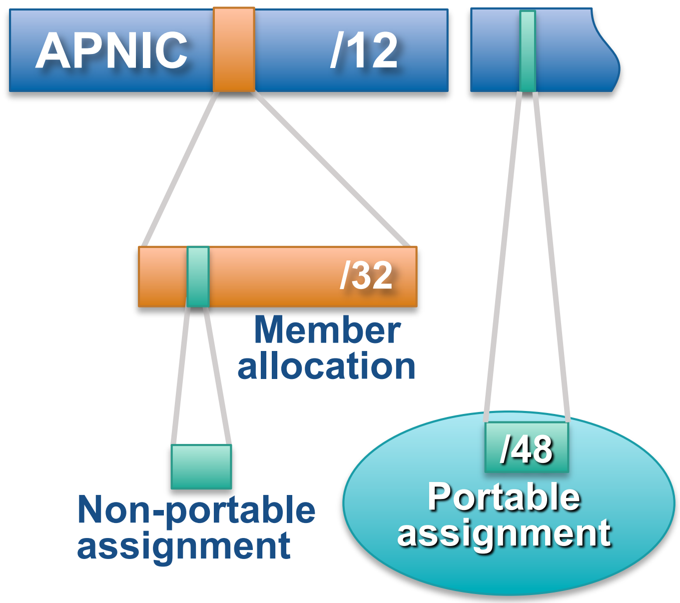
Portable Assignments for IPv6

- For (small) organisations who require a portable assignment for multi-homing purposes
  - The current policy allows for IPv6 portable assignment to end-sites
  - Size: /48, or a shorter prefix if the end site can justify it
  - To be multihomed within 3 months



IXP IPv6 Assignment Policy

- Criteria
  - Demonstrate ‘open peering policy’
  - 3 or more peers
- Portable assignment size: /48
  - All other needs should be met through normal processes
  - /64 holders can “upgrade” to /48
    - Through NIRs/ APNIC
    - Need to return /64

Portable Critical Infrastructure Assignments

- What is Critical Internet Infrastructure?
  - Domain Registry Infrastructure
    - Operators of Root DNS, gTLD, and ccTLD
  - Address Registry Infrastructure
    - IANA, RIRs & NIRs
- Why a specific policy ?
  - Protect stability of core Internet function
- Assignment sizes:
  - IPv6: /32

IPv6 utilisation

- Utilisation determined from end site assignments
  - ISP responsible for registration of all /48 assignments
  - Intermediate allocation hierarchy not considered
- Utilisation of IPv6 address space is measured differently from IPv4
  - Use HD ratio to measure
- Subsequent allocation may be requested when IPv6 utilisation requirement is met

Subsequent allocation

- Must meet HD = 0.94 utilisation requirement of previous allocation (subject to change)
- Other criteria to be met
  - Correct registrations (all /48s registered)
  - Correct assignment practices etc
- Subsequent allocation results in a doubling of the address space allocated to it
  - Resulting in total IPv6 prefix is 1 bit shorter
  - Or sufficient for 2 years requirement

HD Ratio

- The HD ratio threshold is
  - HD=log(/56 units assigned) / log (16,777,216)
  - 0.94 = 6,183,533 x /56 units
- Calculation of the HD ratio
  - Convert the assignment size into equivalent /56 units
    - Each /48 end site = 256 x /56 units
    - Each /52 end site = 16 x /56 units
    - Each /56 end site = 1 x /56 units
    - Each /60 end site = 1/16 x /56 units
    - Each /64 end site = 1/256 x /56 units

IPv6 utilisation (HD = 0.94)

- Percentage utilisation calculation

IPv6 Prefix	Site Address Bits	Total site address in /56s	Threshold (HD ratio 0.94)	Utilisation %
/42	14	16,384	9,153	55.9%
/36	20	1,048,576	456,419	43.5%
/35	21	2,097,152	875,653	41.8 %
/32	24	16,777,216	6,185,533	36.9%
/29	27	134,217,728	43,665,787	32.5 %
/24	32	4,294,967,296	1,134,964,479	26.4 %
/16	40	1,099,511,627,776	208,318,498,661	18.9 %

RFC 3194

"In a hierarchical address plan, as the size of the allocation increases, the density of assignments will decrease."

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Exercise

IPv6 Subnetting

Exercise 1.1: IPv6 subnetting

1. Identify the first four /64 address blocks out of 2001:AA:2000::/48
   1. ______________________
   2. ______________________
   3. ______________________
   4. ______________________

Exercise 1.2: IPv6 subnetting

1. Identify the fist four /36 address blocks out of 2001:ABC::/32
    1. ________________________
    2. ________________________
    3. ________________________
    4. ________________________

Exercise 1.3: IPv6 subnetting

3. Identify the first six /37 address blocks out of 2001:AA::/32
   1. ____________________________
   2. ____________________________
   3. ____________________________
   4. ____________________________
   5. ____________________________
   6. ____________________________

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Configuration of IPv6 Node Address

- There are 3 ways to configure IPv6 address on an IPv6 node:
  - Static address configuration
  - DHCPv6 assigned node address
  - Auto-configuration [New feature in IPv6]

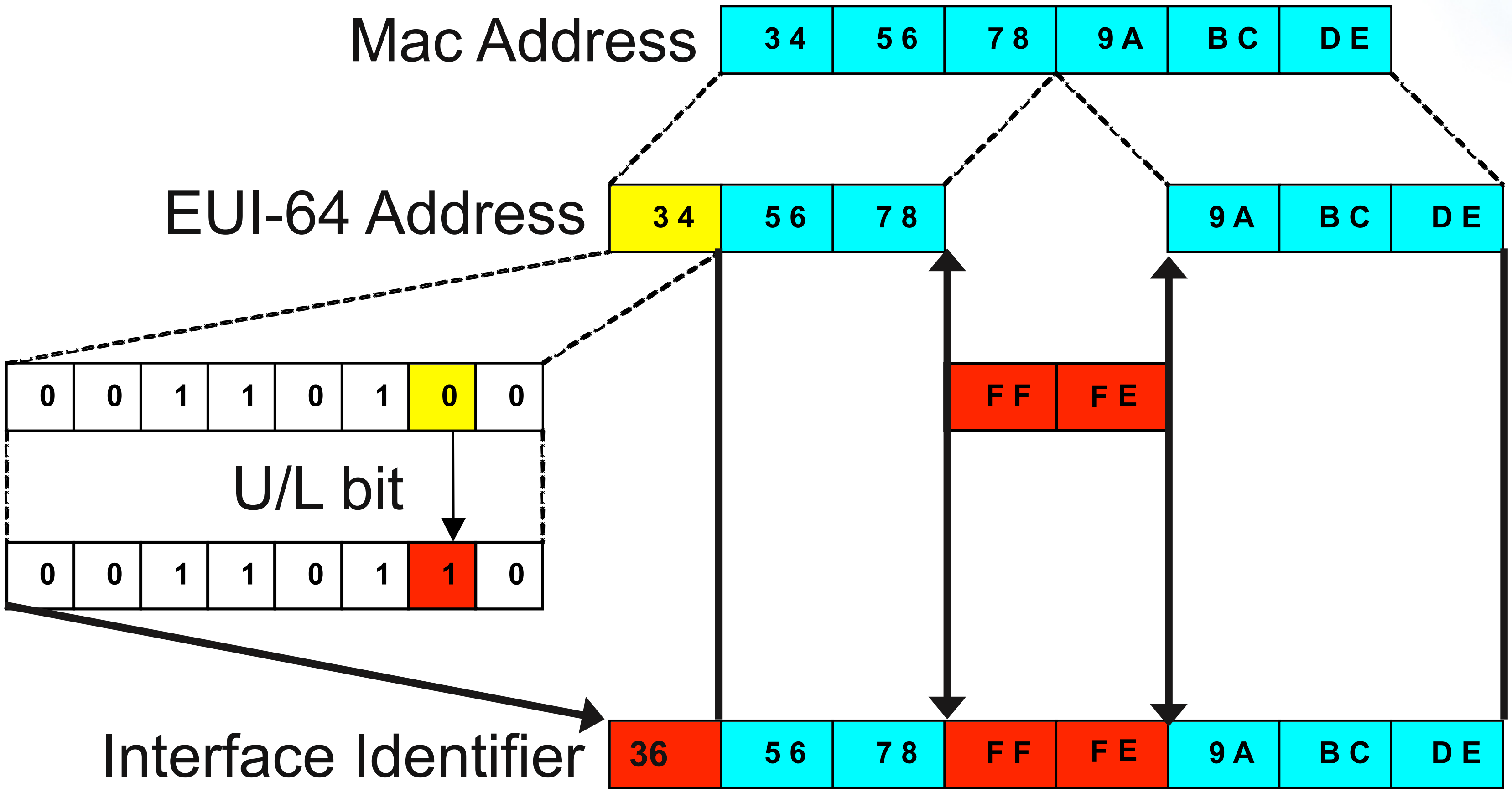
IPv6 Plug and Play

- IPv6 link local address
  - Even if no servers/routers exist to assign an IP address to a device, the device can still auto-generate an IP address
    - Allows interfaces on the same link to communicate with each other
- Stateless mechanism
  - For a site not concerned with the exact addresses
  - No manual configuration required
  - Minimal configuration of routers
  - No additional servers

Interface ID

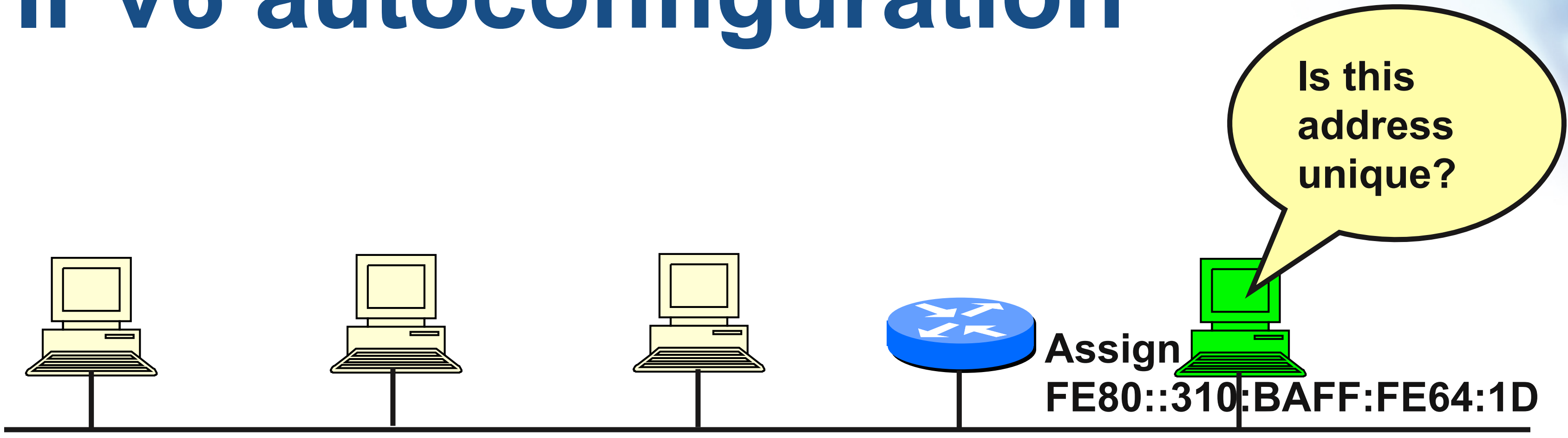
- The lowest-order 64-bit field addresses may be assigned in several different ways:
  - auto-configured from a 48-bit MAC address expanded into a 64-bit EUI-64
  - assigned via DHCP
  - manually configured
  - auto-generated pseudo-random number
  - possibly other methods in the future

EUI-64



Mac Address
34
56
78
9A
BC
DE
EUI-64 Address
34
56
78
9A
BC
DE
0 0 1 1 0 1 0 0
U/L bit
0 0 1 1 0 1 1 0
FF
FE
Interface Identifier
36
56
78
FF
FE
9A
BC
DE

IPv6 autoconfiguration

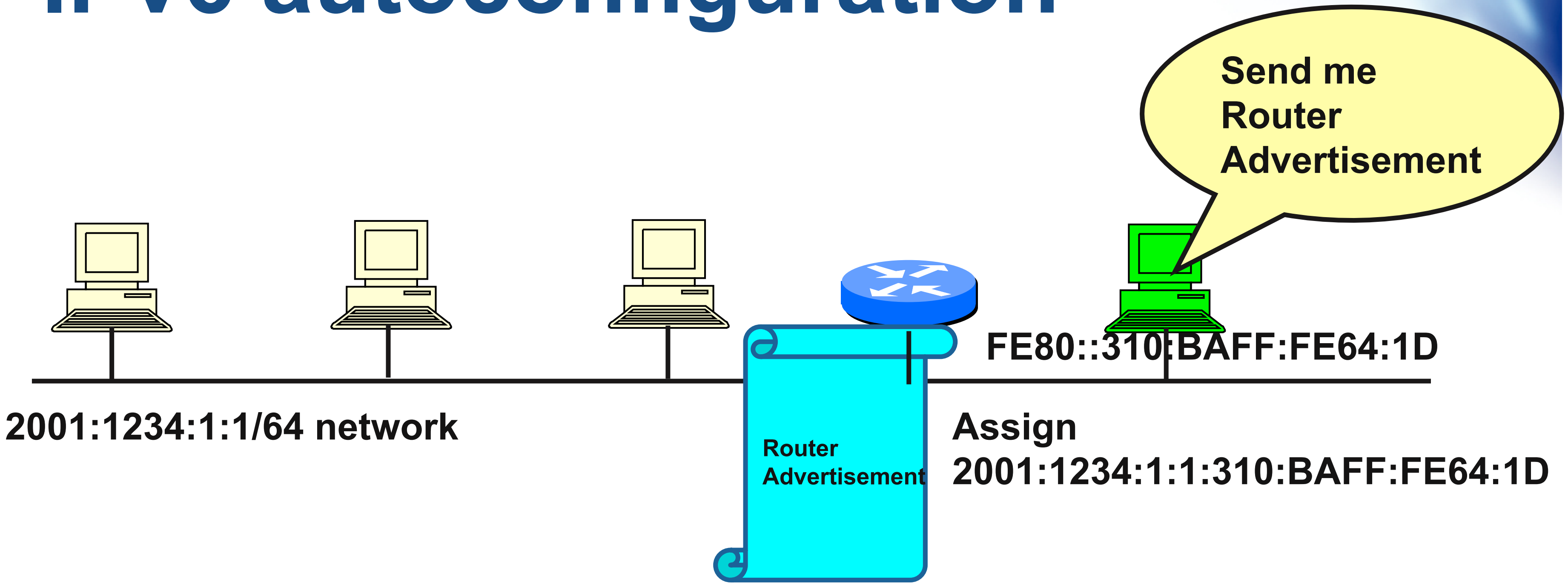


2001:1234:1:1/64 network

Tentative address (link-local address)
Well-known link local prefix +Interface ID (EUI-64)
Ex: FE80::310:BAFF:FE64:1D

1. A new host is turned on.
2. Tentative address will be assigned to the new host.
3. Duplicate Address Detection (DAD) is performed. First the host transmit a Neighbor Solicitation (NS) message to all-nodes multicast address (FF02::1)
5. If no Neighbor Advertisement (NA) message comes back then the address is unique.
6. FE80::310:BAFF:FE64:1D will be assigned to the new host.

IPv6 autoconfiguration



1. The new host will send Router Solicitation (RS) request to the all-routers multicast group (FF02::2).
2. The router will reply Routing Advertisement (RA).
3. The new host will learn the network prefix. E.g, 2001:1234:1:1/64
4. The new host will assigned a new address Network prefix+Interface ID E.g, 2001:1234:1:1:310:BAFF:FE64:1D

Exercise 1: IPv6 Host Configuration

- Windows XP SP2
- *netsh interface ipv6 install*

- Windows XP
- *ipv6 install*

Exercise 1: IPv6 Host Configuration

- Configuring an interface
  - *netsh interface ipv6 add address "Local Area Connection" 2406:6400::1*

- Prefix length is not specified with address which will force a /64 on the interface

Exercise 1: IPv6 Host Configuration

Verify your Configuration

- c:\>ipconfig

Exercise 1: IPv6 Host Configuration

Testing your configuration

- *ping fe80::260:97ff:fe02:6ea5%4*

Note: the Zone id is YOUR interface index

Exercise 1: IPv6 Host Configuration

- Enabling IPv6 on Linux
  - Set the NETWORKING_IPV6 variable to yes in /etc/sysconfig/network

```
# vi /etc/sysconfig/network
NETWORKING_IPV6=yes
# service network restart
```

- Adding IPv6 address on an interface

```
# ifconfig eth0 add inet6 2406:6400::1/64
```

Exercise 1: IPv6 Host Configuration

- Configuring RA on Linux
  - Set IPv6 address forwarding on

echo “1” /proc/sys/net/ipv6/conf/all/forward

  - Need radvd-0.7.1-3.i386.rpm installed
  - On the demon conf file /etc/radvd.conf

```
# vi /etc/radvd.conf
Interface eth1 {
advSendAdvert on;
prefix 2406:6400::/64 {
AdvOnLink on;
};
};
```

Exercise 1: IPv6 Host Configuration

- Enabling IPv6 on FreeBSD
  - Set the ipv6_enable variable to yes in the /etc/rc.conf

  # vi /etc/rc.conf

  Ipv6_enable=yes
- Adding IPv6 address on an interface

  # ifconfig fxp0 inet6 2406:6400::1/64

Zone IDs for local-use addresses

- In Windows XP for example:
- Host A:
  - fe80::2abc:d0ff:fee9:4121%4
- Host B:
  - fe80::3123:e0ff:fe12:3001%3
- Ping from Host A to Host B
  - ping fe80::3123:e0ff:fe12:3001%4 (not %3)
    - identifies the interface zone ID on the host which is connected to that segment.

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Transition overview

- How to get connectivity from an IPv6 host to the global IPv6 Internet?
  - Via an 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

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

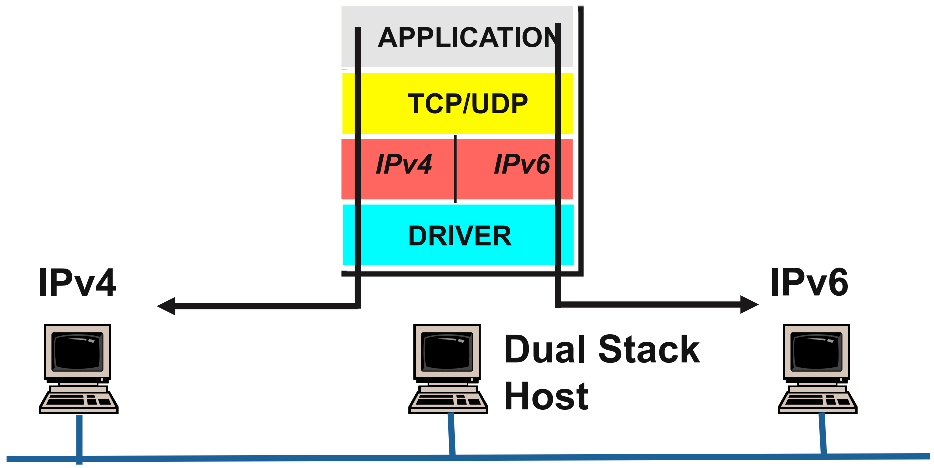
Transition overview

- Three basic ways of transition
  - Dual stack
  - Deploying IPv6 and then implementing IPv6-in-IPv4 tunnelling
  - IPv6 only networking
- Different demands of hosts and networks to be connected to IPv6 networks will determine the best way of transition

Dual stack transition

RFC 4213

- Dual stack = TCP/IP protocol stack running both IPv4 and IPv6 protocol stacks simultaneously
  - Application can talk to both
- Useful at the early phase of transition



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 and DNS

- DNS is used with both protocol versions to resolve names and IP addresses
  - An dual stack node needs a DNS resolver that is capable of resolving both types of DNS address records
    - DSN A record to resolve IPv4 addresses
    - DNS AAAA record to resolve IPv6 addresses
- Dual stack network
  - Is an infrastructure in which both IPv4 and Ipv6 forwarding is enabled on routers

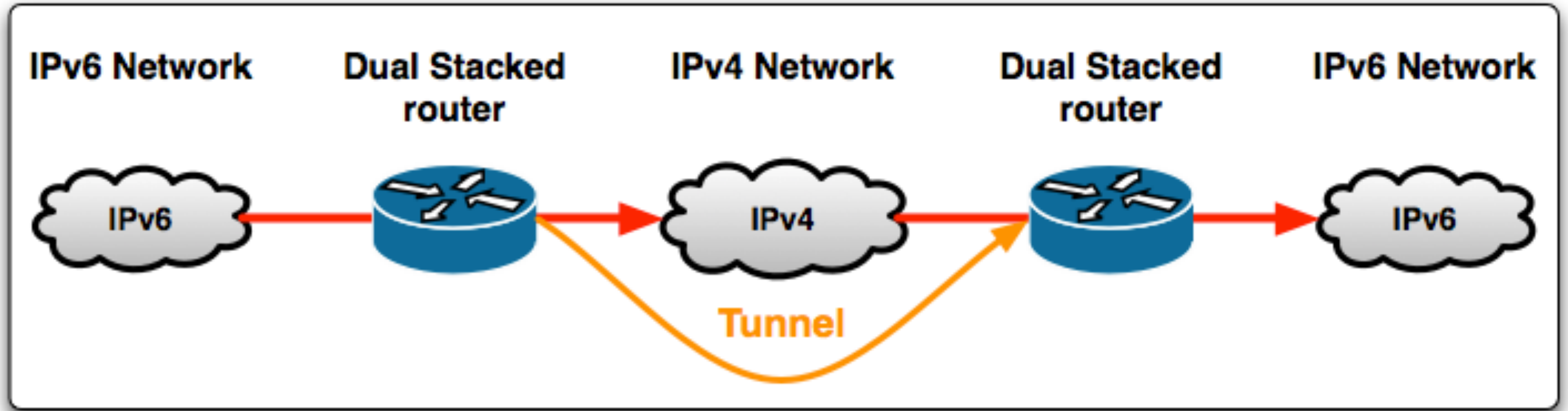
IPv6 essentials by Silvia Hagen, p256

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

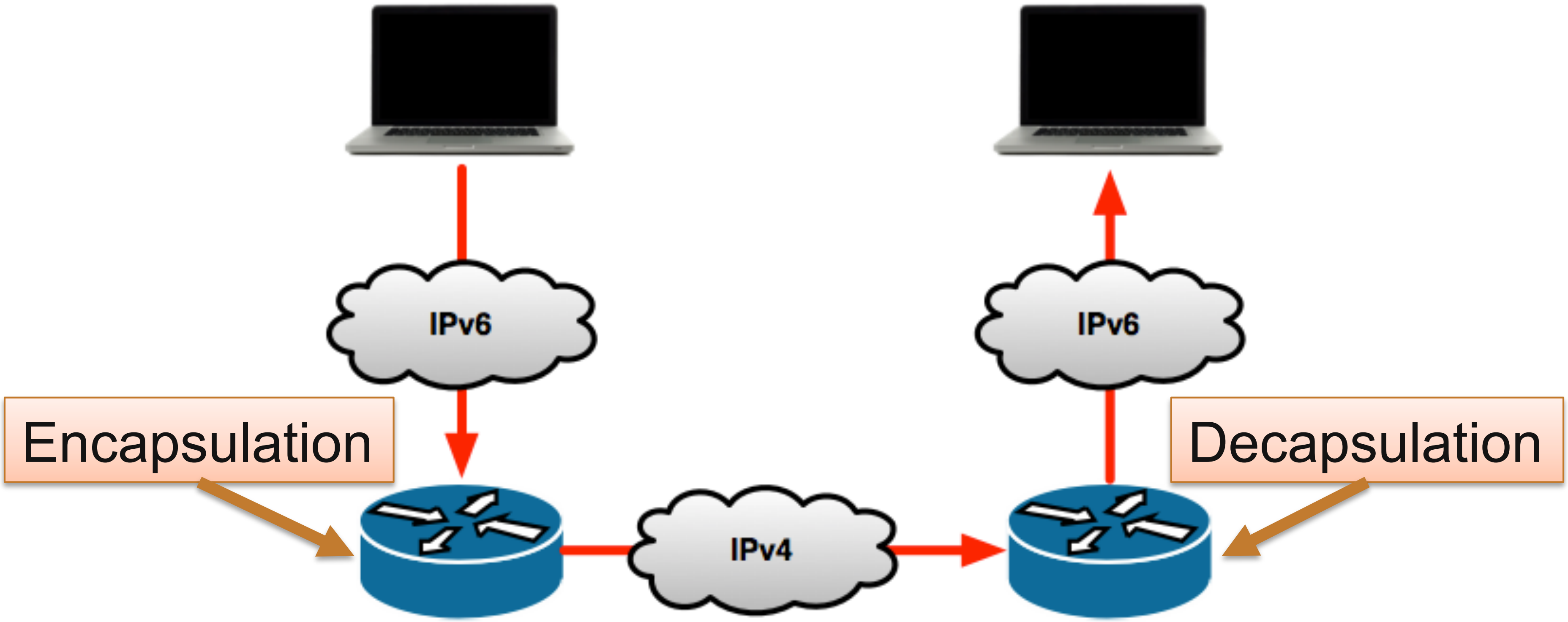
Tunneling – general concept

- 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
  1. Encapsulation of IPv6 packets to IPv4 packets
  2. Decapsulation of IPv4 packets to IPv6 packets

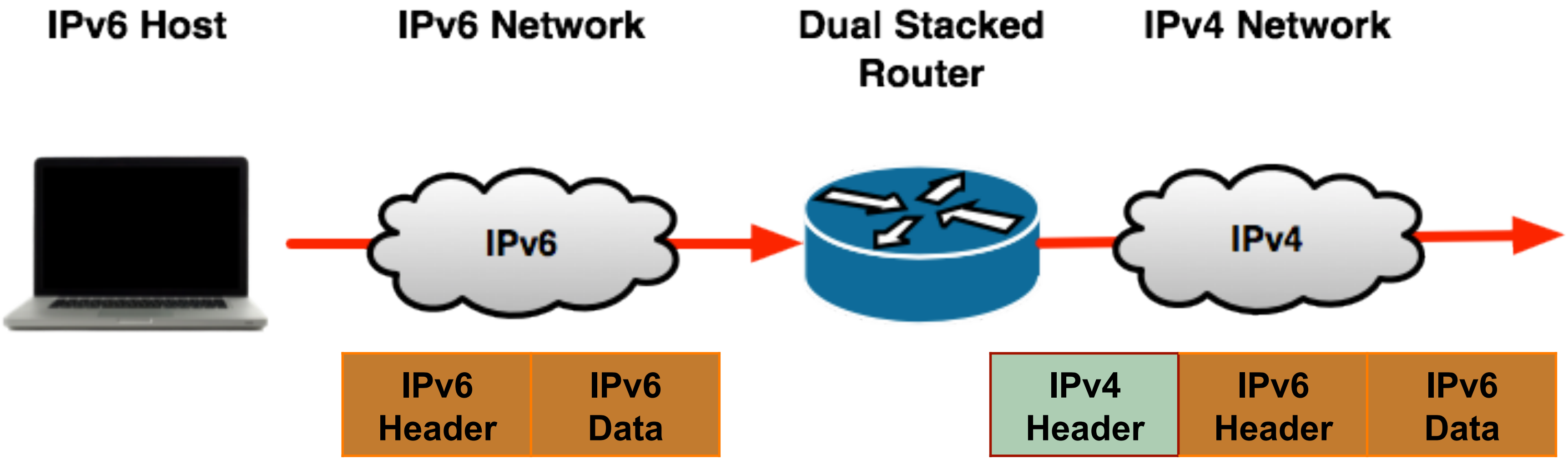


Tunnel encapsulation

- The steps for the encapsulation of the IPv6 packet
  - The entry point of the tunnel decrements the IPv6 hop limit by one
  - Encapsulates the packet in an IPv4 header
  - Transmits the encapsulated packet through the tunnel

IPv6 essentials by Silvia Hagen, p258

Tunnel encapsulation



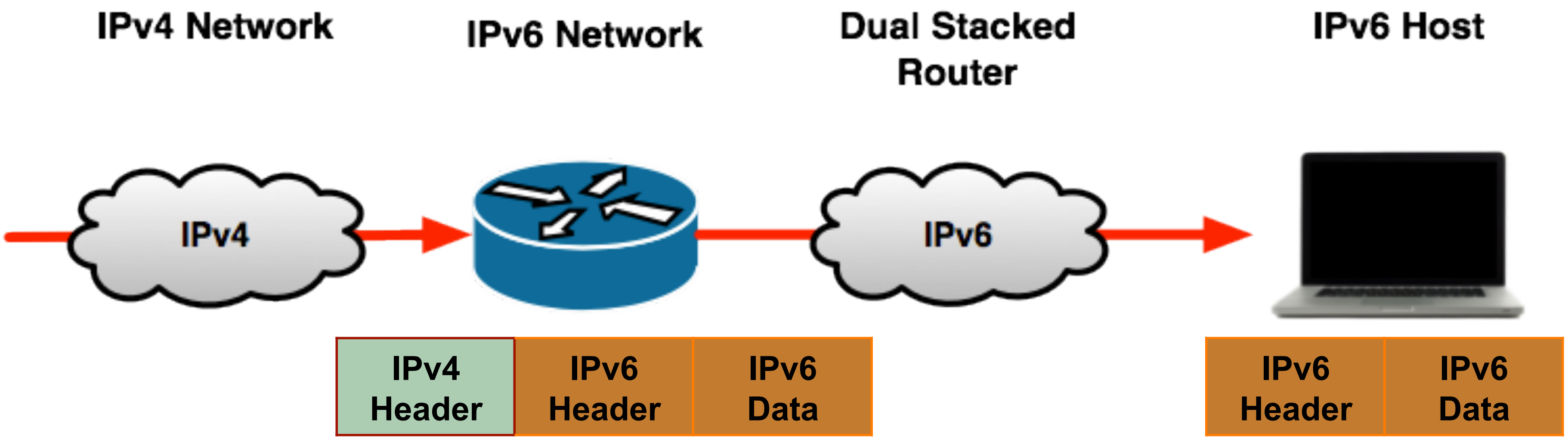
IPv6 essentials by Silvia Hagen, p258

Tunnel decapsulation

- The exit point of tunnel receives the encapsulated packet
  - If necessary, the IPv4 packet is fragmented
- It checks whether the source of the packet (tunnel entry point) is an acceptable source (according to its configuration)
  - If the packet is fragmented, the exit point reassembles it
- The exit point removes the IPv4 header
- Then it forwards the IPv6 packet to its original destination

IPv6 essentials by Silvia Hagen, p258

Tunnel decapsulation



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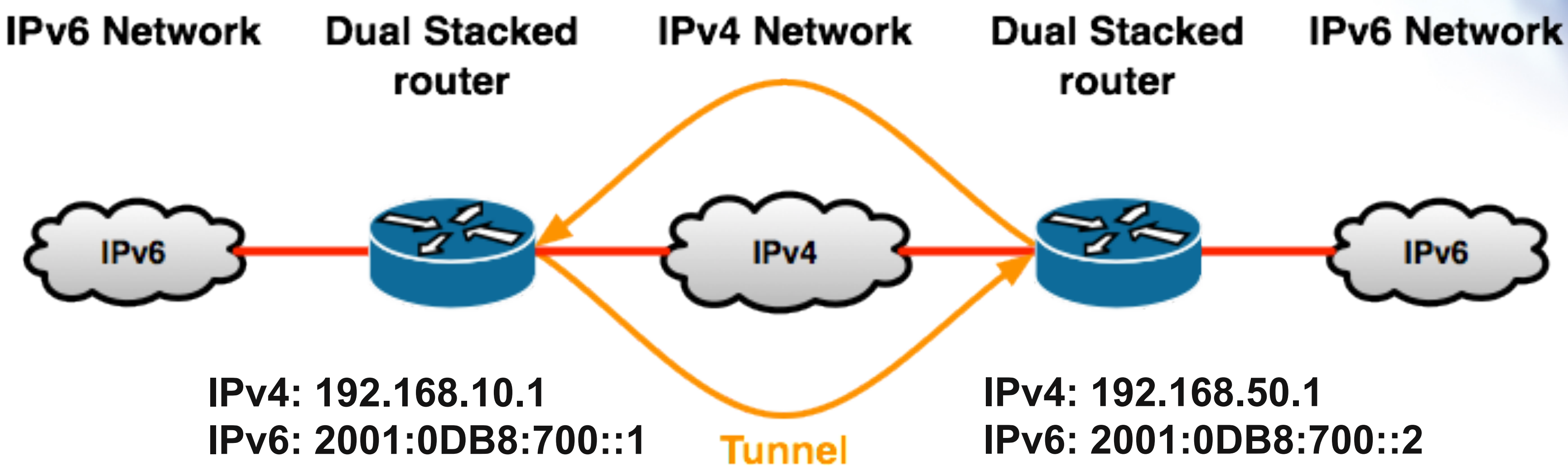
Manual tunneling

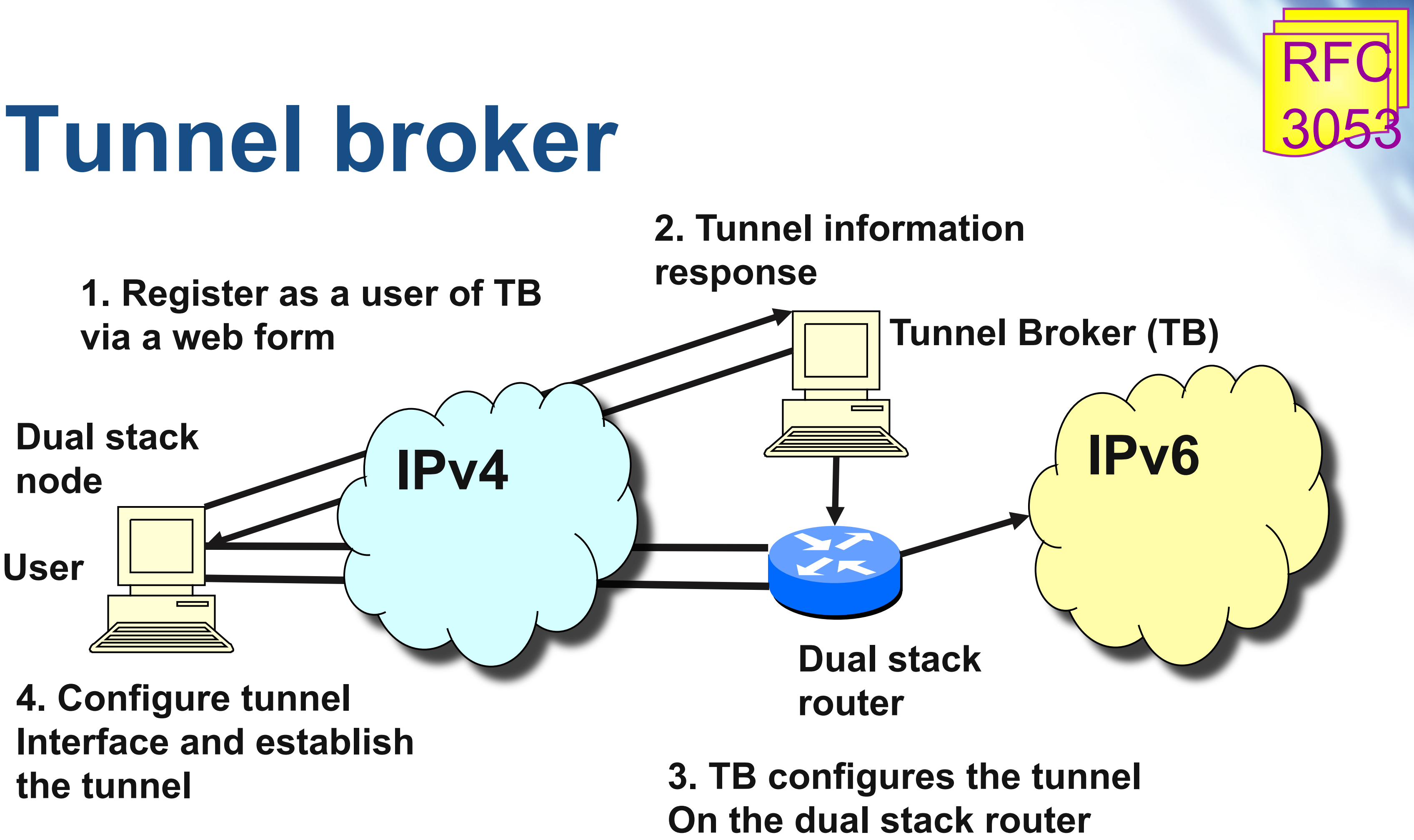


Manually configured tunnels require:

- Dual stack end points
- Explicit configuration with both IPv4 and IPv6 addresses at each end

Concept is borrowed from Cisco, Training material "Ipv6 Seminar" delivered at South Asian IPv6 Summit, Jan 2004

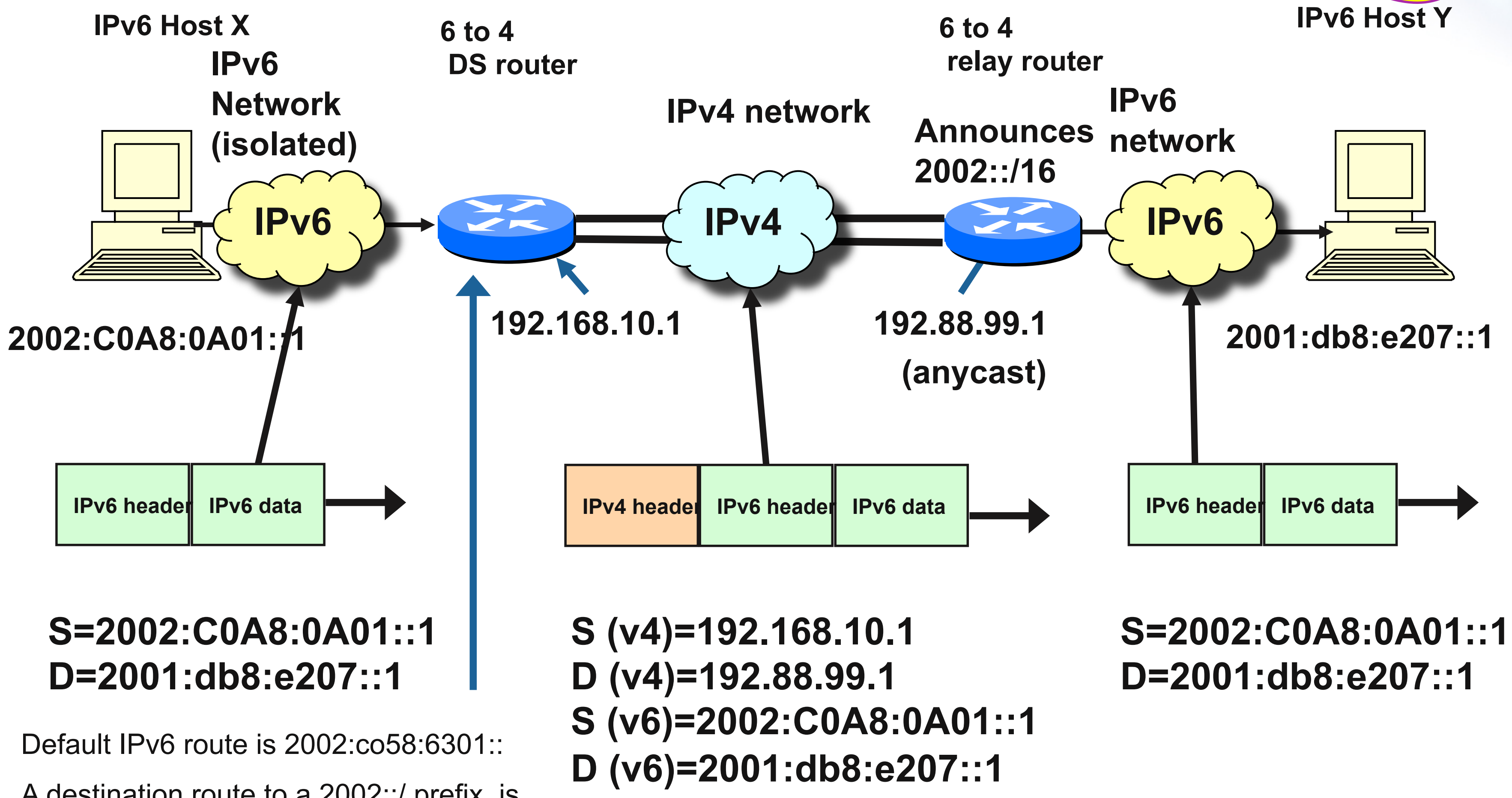
Tunnel broker



Automatic tunneling – 6to4

RFC 3068

RFC 3056



Default IPv6 route is 2002:co58:6301::

A destination route to a 2002::/ prefix is encapsulated in IPv4 and bits 17 – 48 used as the next hop. Ie 192.88.99.1 anycast

Agenda

- IPv6 Overview
- IPv6 Addressing
- IPv6 Address Management
- IPv6 Subnetting
- IPv6 Host Configuration
- IPv4 to IPv6 Transition Technologies
- **IPv6 DNS**
- APNIC Training ISP Network Topology Overview

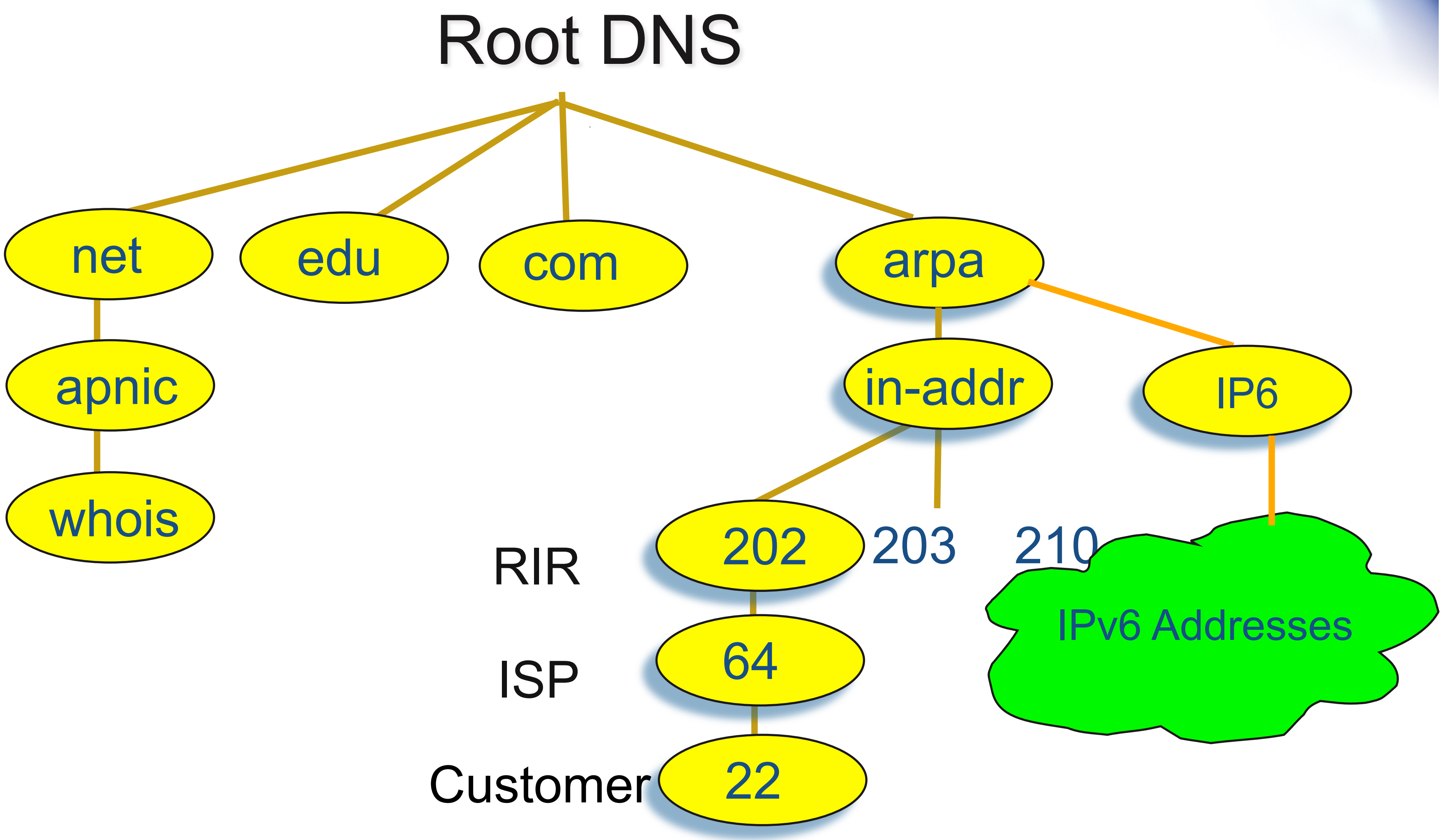
IPv6 representation in the DNS

- Forward lookup support: Multiple RR records for name to number
  - AAAA (Similar to A RR for IPv4)
- Reverse lookup support:
  - Reverse nibble format for zone ip6.arpa

IPv6 forward lookups

- Multiple addresses possible for any given name
  - Ex: in a multi-homed situation
- Can assign A records and AAAA records to a given name/domain
- Can also assign separate domains for IPv6 and IPv4

The reverse DNS tree – with IPv6



Agenda

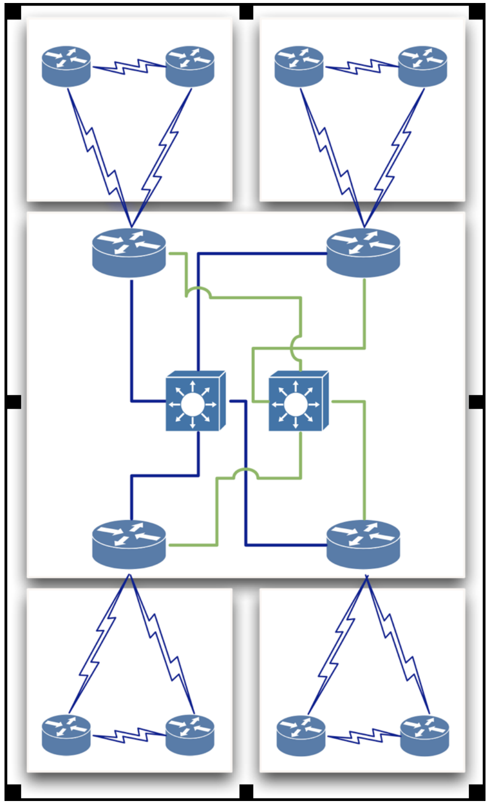
- IPv6 Overview
- IPv6 Addressing
- IPv6 Address Management
- IPv6 Subnetting
- IPv6 Host Configuration
- IPv4 to IPv6 Transition Technologies
- IPv6 DNS
- **APNIC Training ISP Network Topology Overview**

APNIC Training ISP Network Topology

Scenario:

- Training ISP has 4 main operating area or region
- Each region has 2 small POP
- Each region will have one datacenter to host content
- Regional network are inter-connected with multiple link

APNIC Training ISP Network Topology



APNIC Training ISP Topology Diagram

APNIC Training ISP Network Topology

Regional Network:

- Each regional network will have 3 routers
- 1 Core & 2 Edge Routers
- 2 Point of Presence (POP) for every region
- POP will use a router to terminate customer network i.e Edge Router
- Each POP is an aggregation point of ISP customer

APNIC Training ISP Network Topology

Access Network:

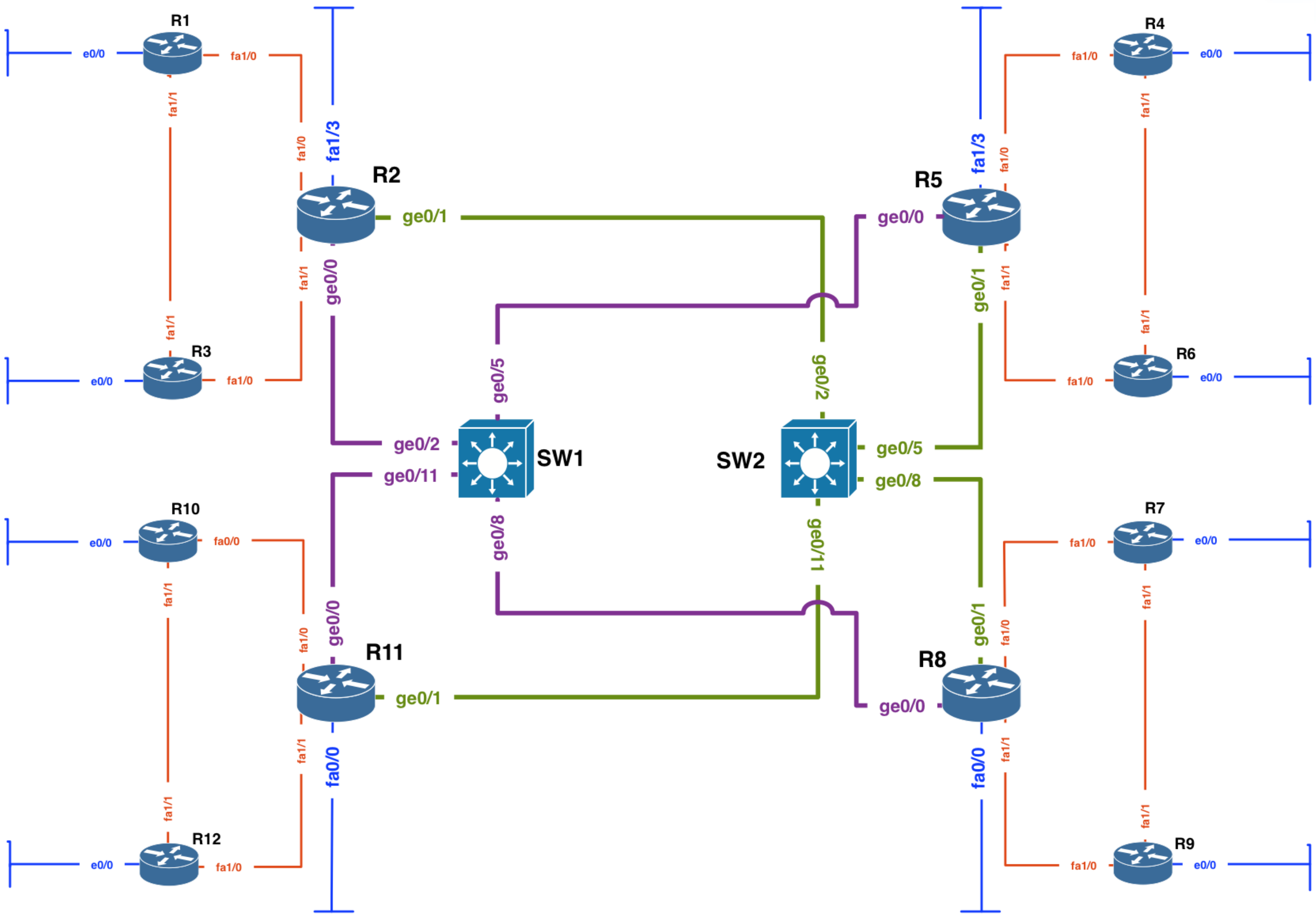
- Connection between customer network & Edge router
- Usually 10 to 100 MBPS link
- Separate routing policy from most of ISP
- Training ISP will connect them on edge router with separate customer IP prefix

APNIC Training ISP Network Topology

Transport Link:

- Inter-connection between regional core router
- Higher data transmission capacity then access link
- Training ISP has 2 transport link for link redundancy
- 2 Transport link i.e Purple link & Green link are connected to two L3 switch

APNIC Training ISP Network Topology



Training ISP Topology Diagram

APNIC Training ISP Network Topology

Design Consideration:

- Each regional network should have address summarization capability for customer block.
- Prefix planning should have scalability option for next couple of years for both customer block and infrastructure
- No Summarization require for WAN and loopback address

APNIC Training ISP Network Topology

Design Consideration:

- Conservation will get high preference for IPv4 address planning and aggregation will get high preference for IPv6 address planning.

APNIC Training ISP Network Topology

Design Consideration:

- OSPF is running in ISP network to carry infrastructure IP prefix
- Each region is a separate OSPF area
- Transport core is in OSPF area 0
- Customer will connect on either static or eBGP (Not OSPF)
- iBGP will carry external prefix within ISP network

APNIC Training ISP Network Topology

Design Consideration:

- Training ISP is already in production with IPv4 protocol
- Need to implement IPv6 within the same infrastructure
- Down time need to minimize as less as possible
- There has to be a smooth migration plan from IPv4 to IPv6

APNIC Training ISP IPV4 Addressing Plan

Summary parent block IPV4

Block#	Prefix	Size	Description
1	172.16.0.0	/19	Parent block
2	172.16.0.0	/20	Infrastructure
3	172.16.16.0	/20	Customer network

APNIC Training ISP IPV4 Addressing Plan

Detail DC infrastructure block IPV4

Block#	Prefix	Size	Description	SOR	Register
2	172.16.0.0	/20	Infrastructure		
4	172.16.0.0	/23	Router2 DC summary net		
5	172.16.0.0	/24	Router2 DC	No	Recommended
6	172.16.2.0	/23	Router5 DC summary net		
7	172.16.2.0	/24	Router5 DC	No	Recommended
8	172.16.4.0	/23	Router8 DC summary net		
9	172.16.4.0	/24	Router8 DC	No	Recommended
10	172.16.6.0	/23	Router11 DC summary net		
11	172.16.6.0	/24	Router11 DC	No	Recommended

APNIC Training ISP IPV4 Addressing Plan

Detail infrastructure WAN block IPV4

12	172.16.10.0	/24	WAN prefix		Optional
13	172.16.10.0	/30	Router2-1 WAN	No	
14	172.16.10.4	/30	Router2-3 WAN	No	
15	172.16.10.8	/30	Router1-3 WAN	No	
16	172.16.10.24	/30	Router5-4 WAN	No	
17	172.16.10.28	/30	Router5-6 WAN	No	
18	172.16.10.32	/30	Router4-6 WAN	No	
19	172.16.10.48	/30	Router8-7 WAN	No	
20	172.16.10.52	/30	Router8-9 WAN	No	
21	172.16.10.56	/30	Router7-9 WAN	No	
22	172.16.10.72	/30	Router11-10 WAN	No	
23	172.16.10.76	/30	Router11-12 WAN	No	
24	172.16.10.80	/30	Router10-12 WAN	No	

APNIC Training ISP IPV4 Addressing Plan

Detail infrastructure block Transport & Loopback IPV4

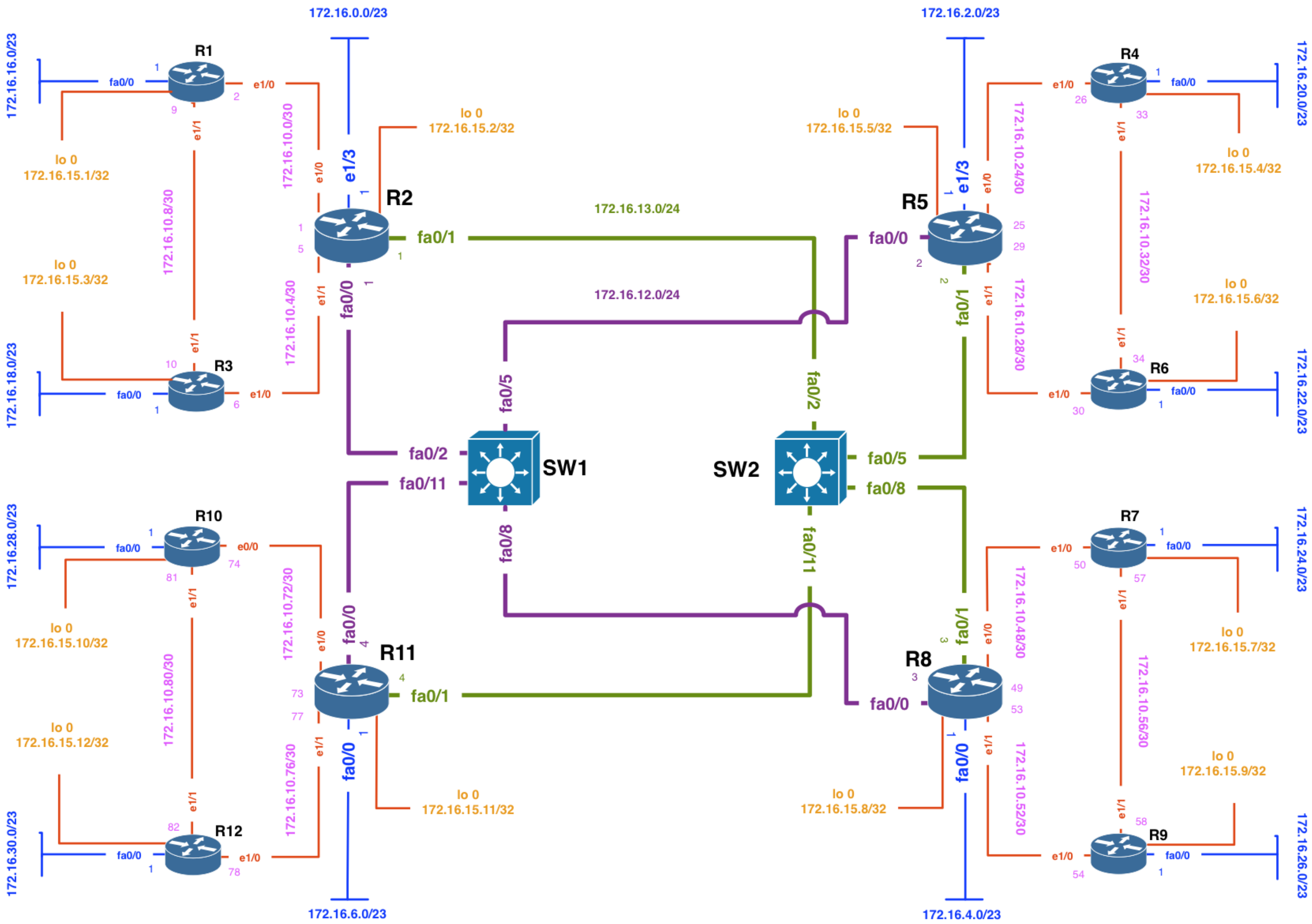
25	172.16.12.0	/24	Transit link BLUE	No	
26	172.16.13.0	/24	Transit link GREEN	No	
27	172.16.15.0	/24	Loopback	No	

APNIC Training ISP IPV4 Addressing Plan

Detail customer block IPV4

Block#	Prefix	Size	Description	SOR	Register
28	172.16.6.0	/20	Customer network		
29	172.16.16.0	/22	Router2 summary net		
30	172.16.16.0	/23	Router1 CS network	Yes	Must
31	172.16.18.0	/23	Router3 CS network	Yes	Must
32	172.16.20.0	/22	Router5 summary net		
33	172.16.20.0	/23	Router4 CS network	Yes	Must
34	172.16.22.0	/23	Router6 CS network	Yes	Must
35	172.16.24.0	/22	Router8 summary net		
36	172.16.24.0	/23	Router7 CS network	Yes	Must
37	172.16.26.0	/23	Router9 CS network	Yes	Must
38	172.16.28.0	/22	Router11 summary net		
39	172.16.28.0	/23	Router10 CS network	Yes	Must
40	172.16.30.0	/23	Router12 CS network	Yes	Must

APNIC Training ISP IPV4 Addressing Plan



APNIC Training ISP IPv4 Address Plan

APNIC Training ISP IPV6 Addressing Plan

IPv6 address plan consideration:

- Big IPv6 address space can cause very very large routing table size
- Most transit service provider apply IPv6 prefix filter on anything other then /32 & /48 prefix size
- Prefix announcement need to send to Internet should be either /32 or /48 bit boundary

APNIC Training ISP IPV6 Addressing Plan

IPv6 address plan consideration (RFC3177):

- WAN link can be used on /64 bit boundary
- End site/Customer sub allocation can be made on /56 bit boundary
- Utilization/HD ratio will be calculated based on /56 end site assignment/sub-allocation

APNIC Training ISP IPV6 Addressing Plan

Summary Parent Block & Regional Network (256x/40)

Block#	Prefix	Description
	2406:6400::/32	***Parent Block***
	2406:6400:0000:0000::/40	Infrastructure
	2406:6400:0100:0000::/40	Customer network Region 1
	2406:6400:0200:0000::/40	Customer network Region 2
	2406:6400:0300:0000::/40	Customer network Region 3
	2406:6400:0400:0000::/40	Customer network Region 4
	2406:6400:0500:0000::/40	
	2406:6400:0600:0000::/40	
	2406:6400:0700:0000::/40	
	2406:6400:0800:0000::/40	
	2406:6400:0900:0000::/40	
	2406:6400:0A00:0000::/40	
	2406:6400:0B00:0000::/40	
	2406:6400:0C00:0000::/40	
	2406:6400:0D00:0000::/40	
	2406:6400:0E00:0000::/40	
	2406:6400:0F00:0000::/40	

APNIC Training ISP IPV6 Addressing Plan

Summary Infrastructure Prefix (256x/48)

Block#	Prefix	Description
	2406:6400:0000:0000::/40	***Infrastructure***
	2406:6400:0000:0000::/48	Loopback
	2406:6400:0001:0000::/48	R2 DC Summary
	2406:6400:0002:0000::/48	R5 DC Summary
	2406:6400:0003:0000::/48	R8 DC Summary
	2406:6400:0004:0000::/48	R11 DC Summary
	2406:6400:0005:0000::/48	
	2406:6400:0006:0000::/48	
	2406:6400:0007:0000::/48	
	2406:6400:0008:0000::/48	
	2406:6400:0009:0000::/48	
	2406:6400:000A:0000::/48	
	2406:6400:000B:0000::/48	
	2406:6400:000C:0000::/48	
	2406:6400:000D:0000::/48	Purple Transport
	2406:6400:000E:0000::/48	Green Transport
	2406:6400:000F:0000::/48	WAN Prefix

APNIC Training ISP IPV6 Addressing Plan

IPv6 Address Plan WAN Prefix:

2406:6400:000F:0000::/48	WAN Prefix (65535x/64)

2406:6400:000F:0000::/64	R2-R1
2406:6400:000F:0001::/64	R2-R3
2406:6400:000F:0002::/64	R1-R3
2406:6400:000F:0003::/64	
2406:6400:000F:0004::/64	
2406:6400:000F:0005::/64	
2406:6400:000F:0006::/64	
2406:6400:000F:0007::/64	
2406:6400:000F:0008::/64	
2406:6400:000F:0009::/64	
2406:6400:000F:000A::/64	
2406:6400:000F:000B::/64	
2406:6400:000F:000C::/64	
2406:6400:000F:000D::/64	
2406:6400:000F:000E::/64	
2406:6400:000F:000F::/64	

2406:6400:000F:0010::/64	R5-R4
2406:6400:000F:0011::/64	R5-R6
2406:6400:000F:0012::/64	R4-R6
2406:6400:000F:0013::/64	
2406:6400:000F:0014::/64	
2406:6400:000F:0015::/64	
2406:6400:000F:0016::/64	
2406:6400:000F:0017::/64	
2406:6400:000F:0018::/64	
2406:6400:000F:0019::/64	
2406:6400:000F:001A::/64	
2406:6400:000F:001B::/64	
2406:6400:000F:001C::/64	
2406:6400:000F:001D::/64	
2406:6400:000F:001E::/64	
2406:6400:000F:001F::/64	

APNIC Training ISP IPV6 Addressing Plan

2406:6400:000F:0000::/48	*WAN Prefix (65535x/64)*

2406:6400:000F:0030::/64	R11-R10
2406:6400:000F:0031::/64	R11-R12
2406:6400:000F:0032::/64	R10-R12
2406:6400:000F:0033::/64	
2406:6400:000F:0034::/64	
2406:6400:000F:0035::/64	
2406:6400:000F:0036::/64	
2406:6400:000F:0037::/64	
2406:6400:000F:0038::/64	
2406:6400:000F:0039::/64	
2406:6400:000F:003A::/64	
2406:6400:000F:003B::/64	
2406:6400:000F:003C::/64	
2406:6400:000F:003D::/64	
2406:6400:000F:003E::/64	
2406:6400:000F:003F::/64	

2406:6400:000F:0020::/64	R8-R7
2406:6400:000F:0021::/64	R8-R9
2406:6400:000F:0022::/64	R7-R9
2406:6400:000F:0023::/64	
2406:6400:000F:0024::/64	
2406:6400:000F:0025::/64	
2406:6400:000F:0026::/64	
2406:6400:000F:0027::/64	
2406:6400:000F:0028::/64	
2406:6400:000F:0029::/64	
2406:6400:000F:002A::/64	
2406:6400:000F:002B::/64	
2406:6400:000F:002C::/64	
2406:6400:000F:002D::/64	
2406:6400:000F:002E::/64	
2406:6400:000F:002F::/64	

APNIC Training ISP IPV6 Addressing Plan

Summary Customer net Region 1 (256x/48)

Block#	Prefix	Description
	2406:6400:0100:0000::/40	Customer network Region 1
	2406:6400:0100:0000::/48	***R1 Cust Net***
	2406:6400:0101:0000::/48	
	2406:6400:0102:0000::/48	
	2406:6400:0103:0000::/48	
	2406:6400:0104:0000::/48	
	2406:6400:0105:0000::/48	
	2406:6400:0106:0000::/48	
	2406:6400:0107:0000::/48	
	2406:6400:0108:0000::/48	***R3 Cust Net***
	2406:6400:0109:0000::/48	
	2406:6400:010A:0000::/48	
	2406:6400:010B:0000::/48	
	2406:6400:010C:0000::/48	
	2406:6400:010D:0000::/48	
	2406:6400:010E:0000::/48	
	2406:6400:010F:0000::/48	

APNIC Training ISP IPV6 Addressing Plan

Summary Customer net Region 2 (256x/48)

Block#	Prefix	Description
	2406:6400:0200:0000::/40	Customer network Region 2
	2406:6400:0200:0000::/48	***R4 Cust Net***
	2406:6400:0201:0000::/48	
	2406:6400:0202:0000::/48	
	2406:6400:0203:0000::/48	
	2406:6400:0204:0000::/48	
	2406:6400:0205:0000::/48	
	2406:6400:0206:0000::/48	
	2406:6400:0207:0000::/48	
	2406:6400:0208:0000::/48	***R6 Cust Net***
	2406:6400:0209:0000::/48	
	2406:6400:020A:0000::/48	
	2406:6400:020B:0000::/48	
	2406:6400:020C:0000::/48	
	2406:6400:020D:0000::/48	
	2406:6400:020E:0000::/48	
	2406:6400:020F:0000::/48	

APNIC Training ISP IPV6 Addressing Plan

Summary Customer net Region 3 (256x/48)

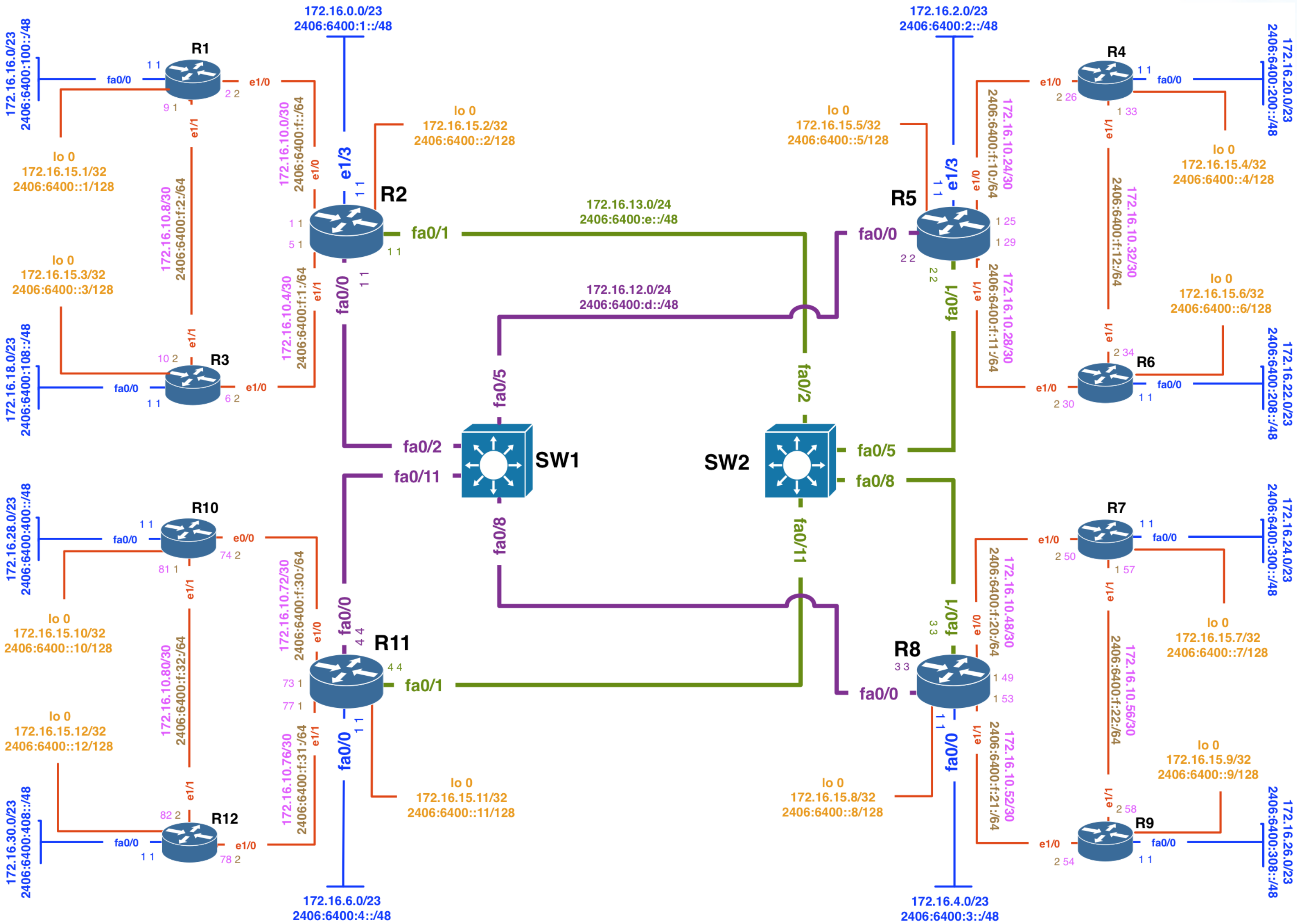
Block#	Prefix	Description
	2406:6400:0300:0000::/40	Customer network Region 3
	2406:6400:0300:0000::/48	***R7 Cust Net***
	2406:6400:0301:0000::/48	
	2406:6400:0302:0000::/48	
	2406:6400:0303:0000::/48	
	2406:6400:0304:0000::/48	
	2406:6400:0305:0000::/48	
	2406:6400:0306:0000::/48	
	2406:6400:0307:0000::/48	
	2406:6400:0308:0000::/48	***R9 Cust Net***
	2406:6400:0309:0000::/48	
	2406:6400:030A:0000::/48	
	2406:6400:030B:0000::/48	
	2406:6400:030C:0000::/48	
	2406:6400:030D:0000::/48	
	2406:6400:030E:0000::/48	
	2406:6400:030F:0000::/48	

APNIC Training ISP IPV6 Addressing Plan

Summary Customer net Region 4 (256x/48)

Block#	Prefix	Description
	2406:6400:0400:0000::/40	Customer network Region 4
	2406:6400:0400:0000::/48	***R10 Cust Net***
	2406:6400:0401:0000::/48	
	2406:6400:0402:0000::/48	
	2406:6400:0403:0000::/48	
	2406:6400:0404:0000::/48	
	2406:6400:0405:0000::/48	
	2406:6400:0406:0000::/48	
	2406:6400:0407:0000::/48	
	2406:6400:0408:0000::/48	***R12 Cust Net***
	2406:6400:0409:0000::/48	
	2406:6400:040A:0000::/48	
	2406:6400:040B:0000::/48	
	2406:6400:040C:0000::/48	
	2406:6400:040D:0000::/48	
	2406:6400:040E:0000::/48	
	2406:6400:040F:0000::/48	

APNIC Training ISP IPV6 Addressing Plan



Configuration of OSPF as IGP

Scenario:

- Training ISP need to configure OSPF as IGP for both IPv4 and IPv6
- Dual stack mechanism will be used to ensure both IPv4 and IPv6 operation
- OSPFv3 supports IPv6 routed protocol
- IGP is used to carry next hop only for BGP

Configuration of OSPF as IGP

Minimum Router OS require for OSPF3:

Cisco IOS

- 12.2(15)T or later (For OSPFv3)
- 12.2(2)T or later (For IPv6 support)

Jun OS

- JUNOS 8.4 or later

APNIC Training ISP - Deployment IPv6 in EGP

Scenario:

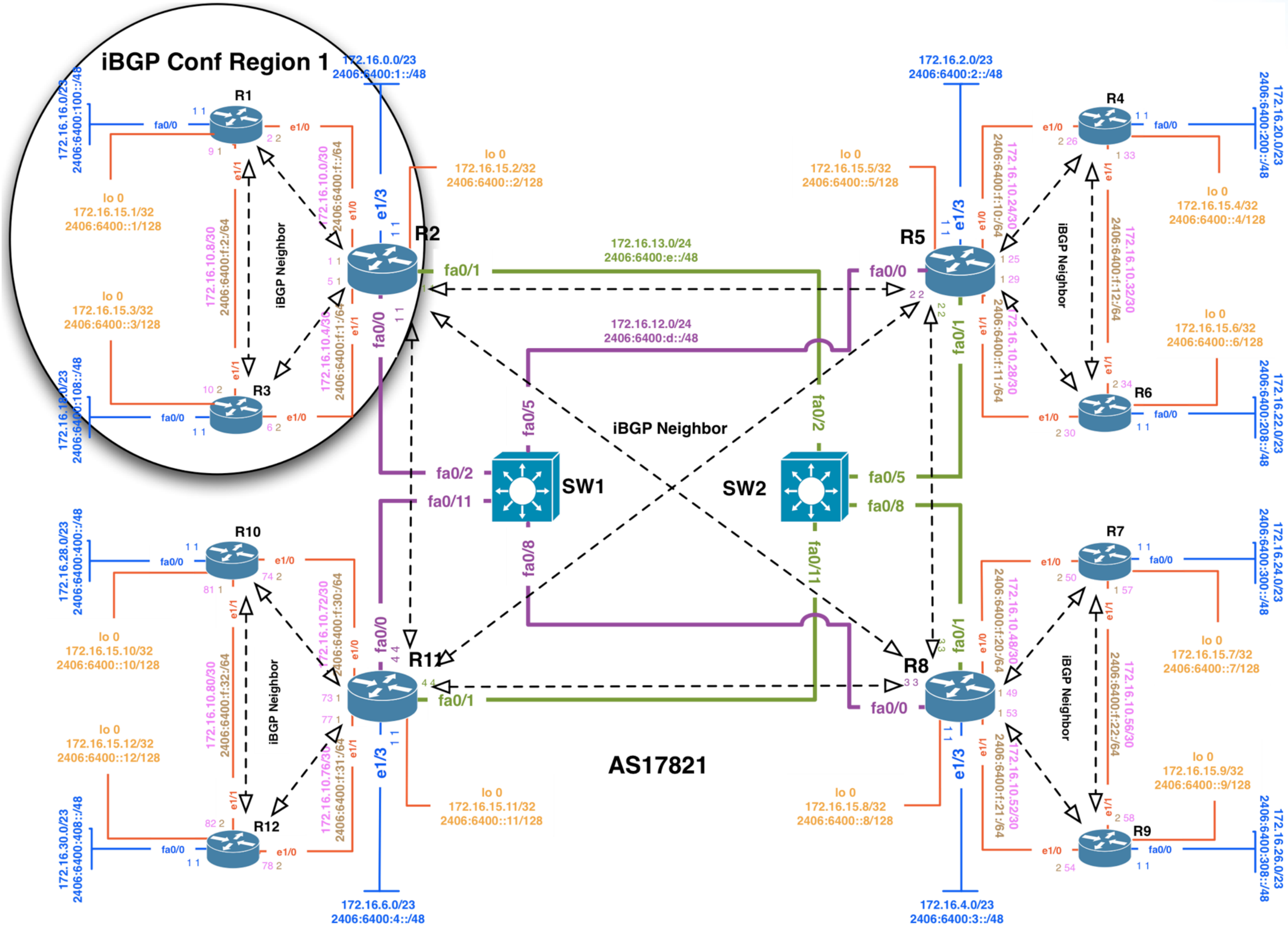
- BGP4 is used in Training ISP network
- iBGP is used between internal routers in Training ISP to carry external prefixes (i.e Customer & Global Internet Prefixes)
- Route Reflector is used to resolve iBGP full mesh scalability issue.

APNIC Training ISP - Deployment IPv6 in EGP

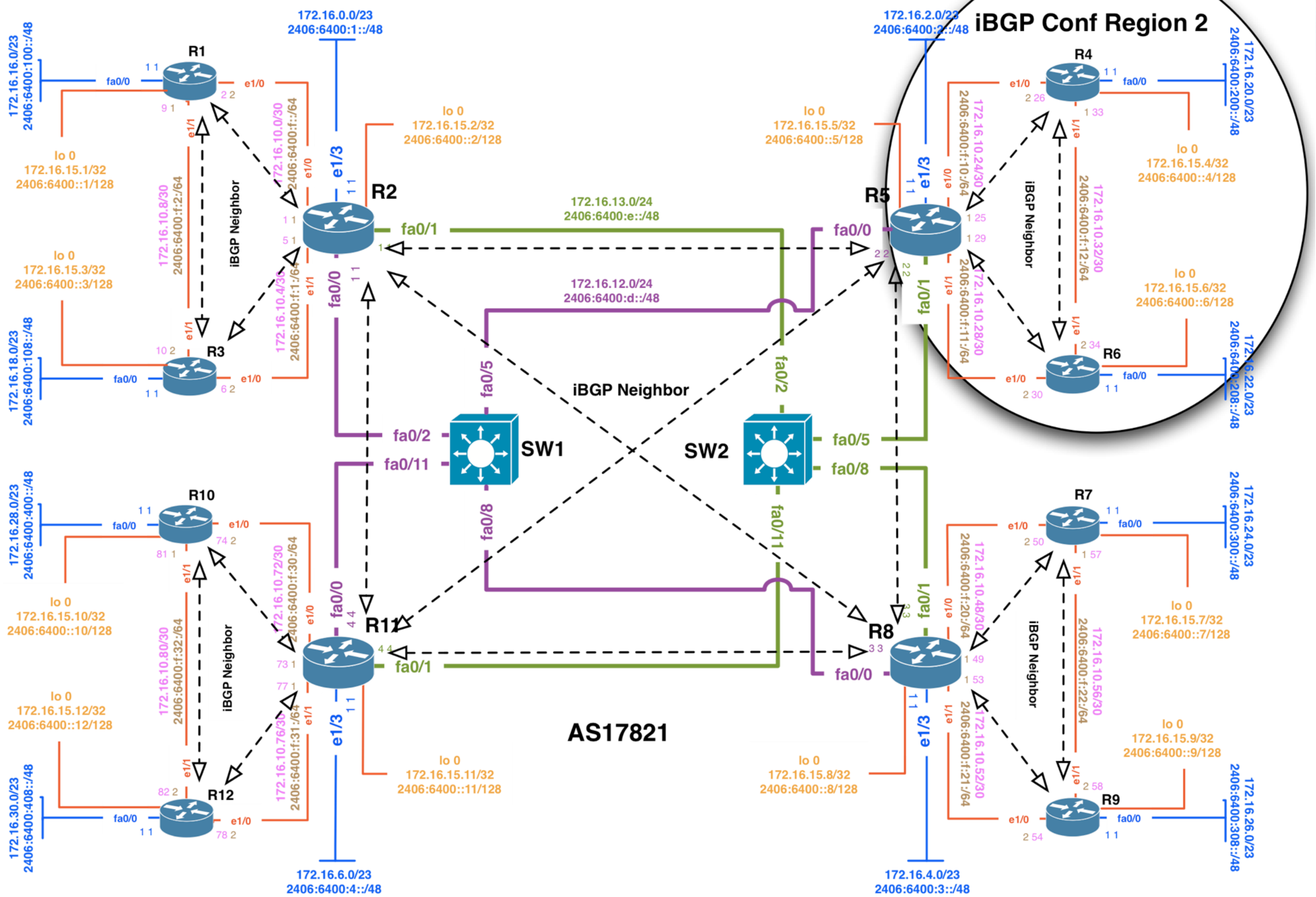
Scenario:

- Transit service with upstream ASes is configured with eBGP
- Customer network from downstream can also be configured with eBGP/Static
- Training ISP is having one native IPv6 transit and one tunnel IPv6 transit with AS45192 & AS131107 (2.35 as dot)

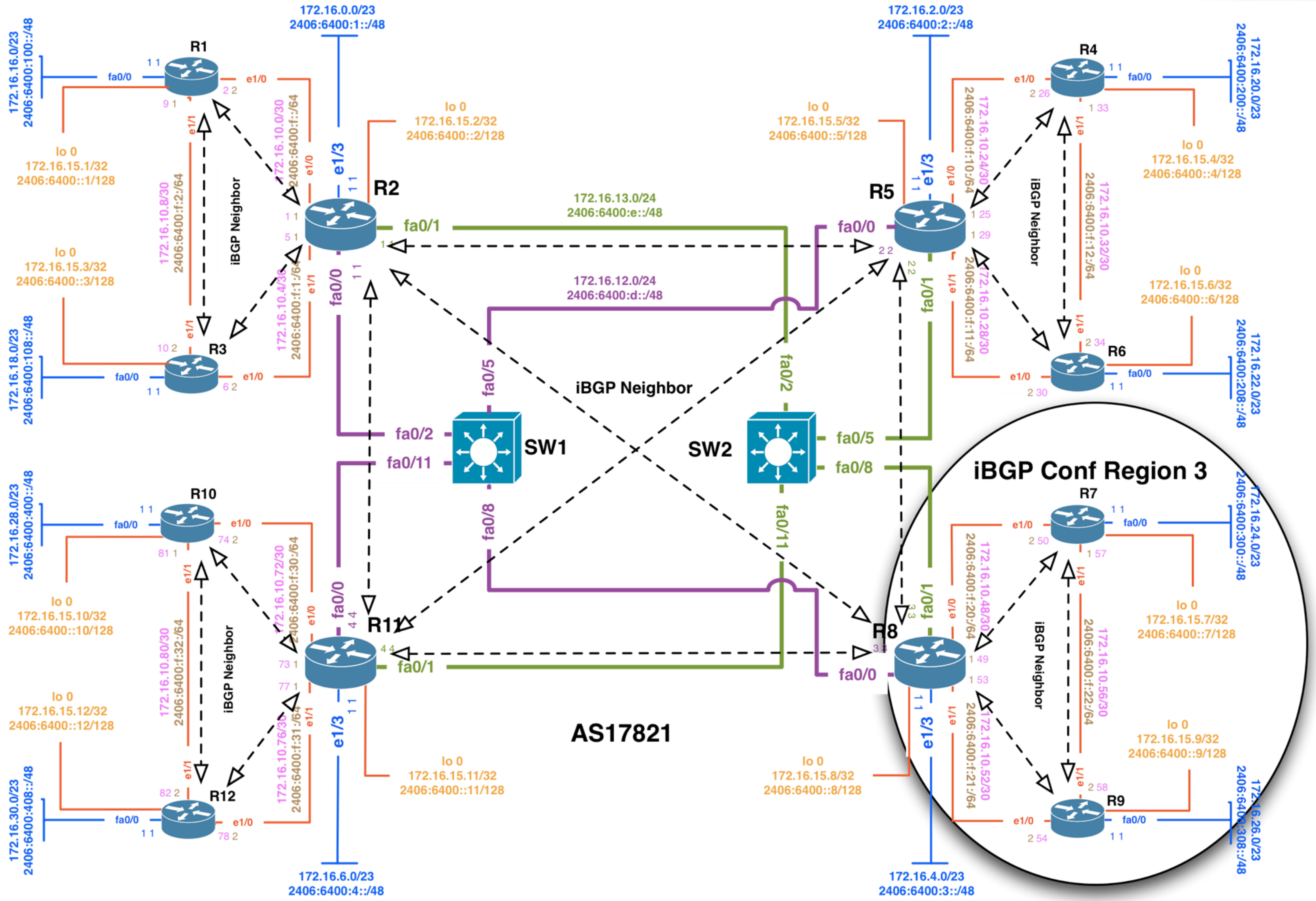
iBGP Peering For Region 1



iBGP Peering For Region 2



iBGP Peering For Region 3



Asia Pacific Network Information Centre

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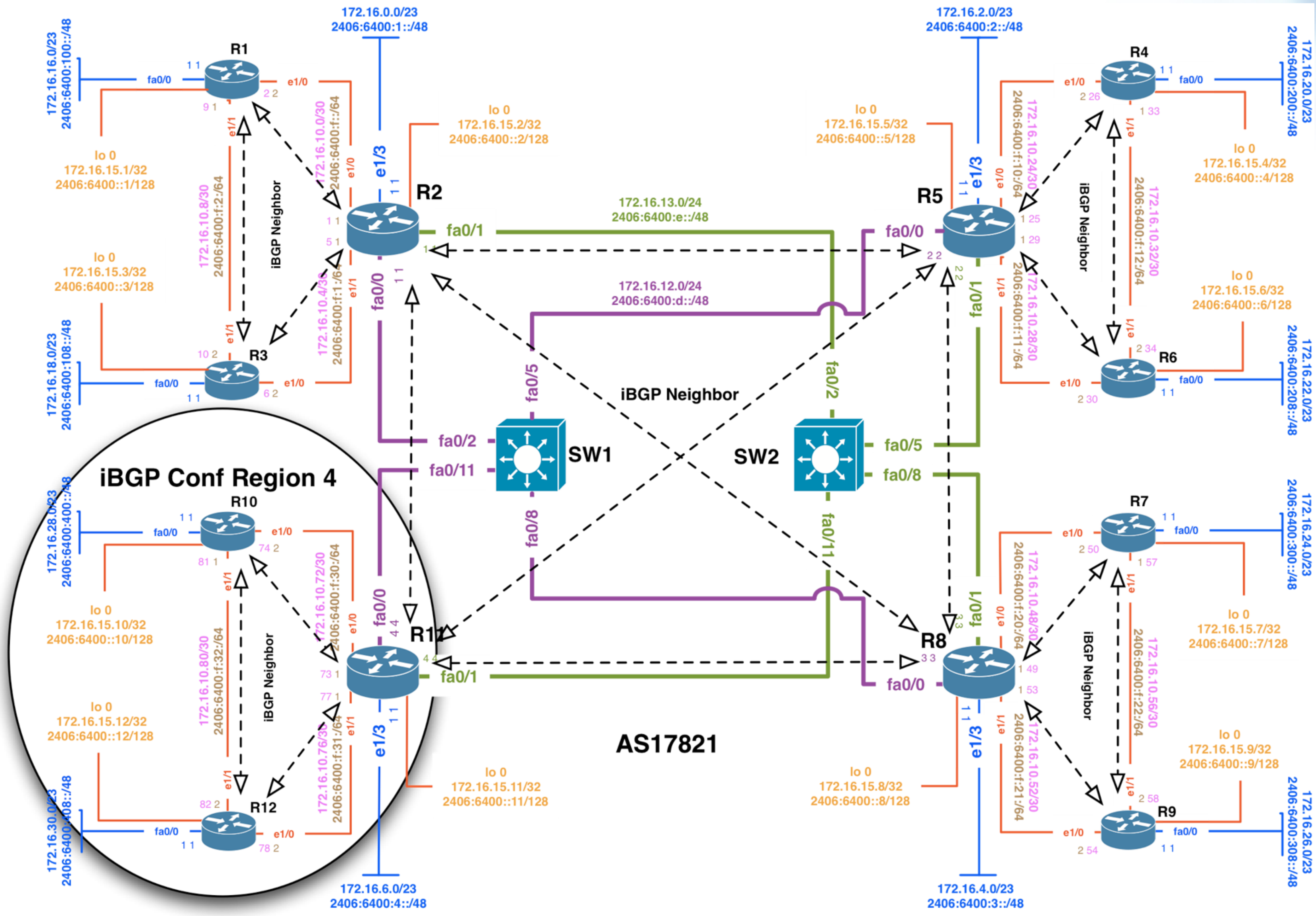
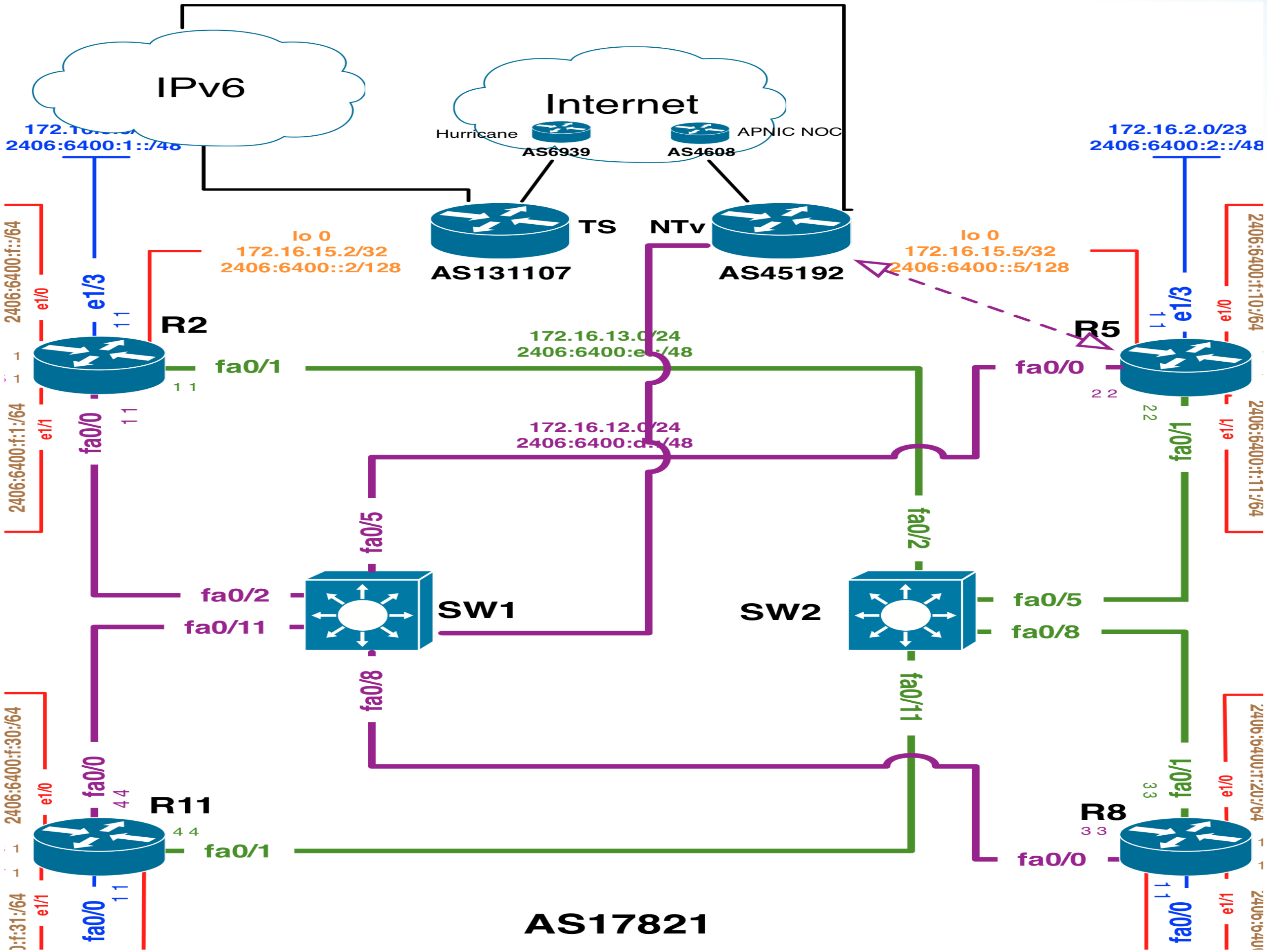
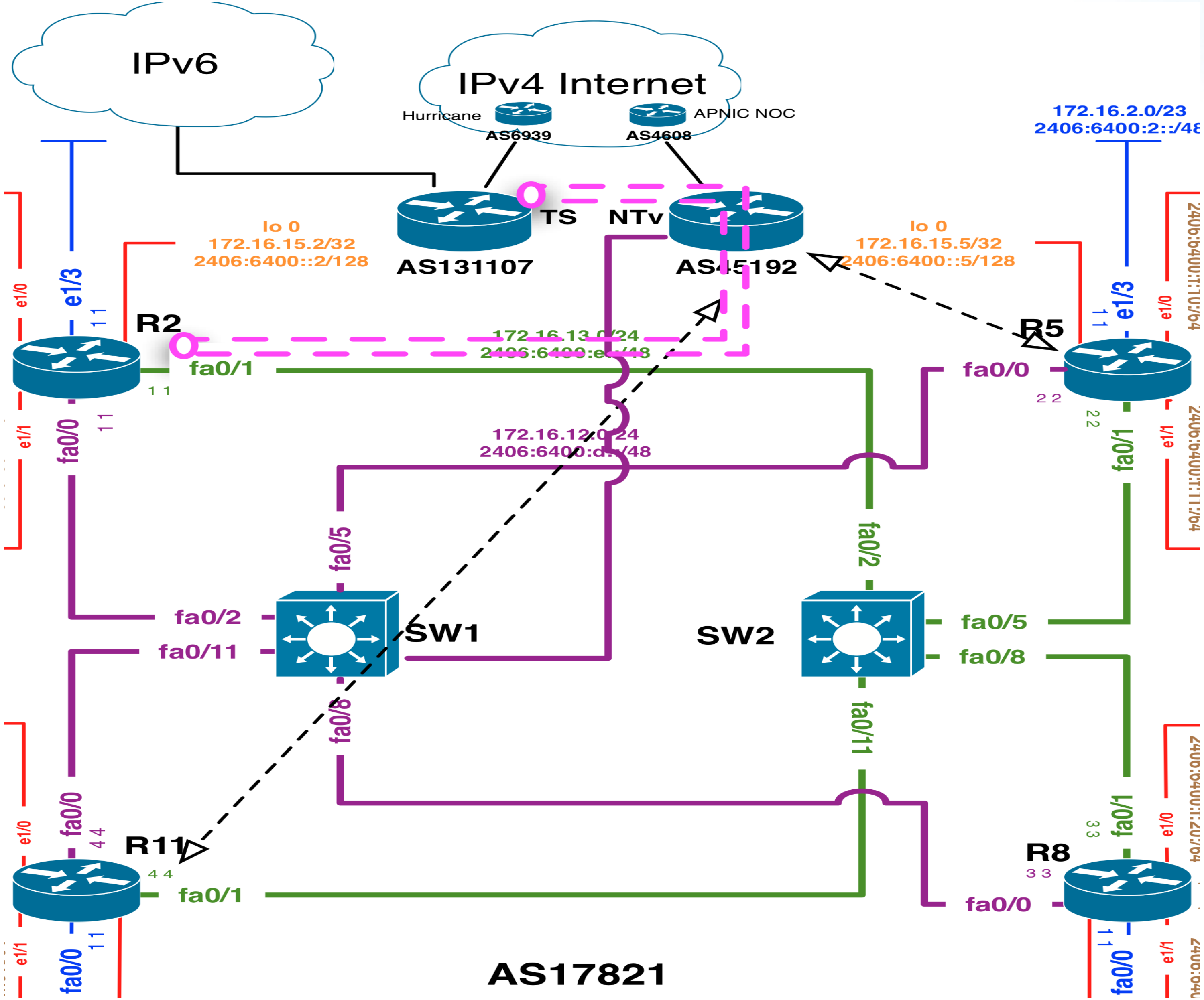
iBGP Peering For Region 4



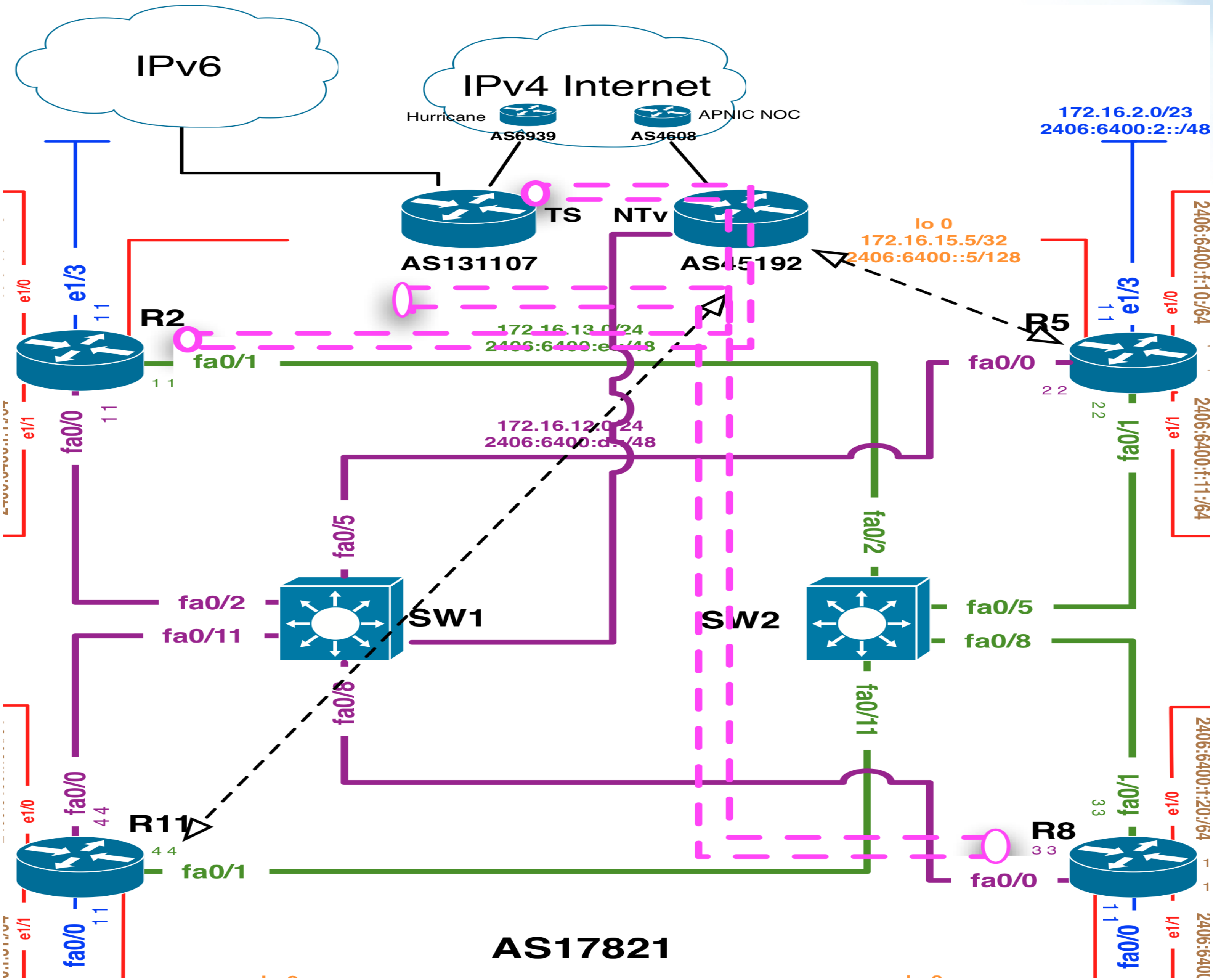
IPv6 Native Transit Conf Plan



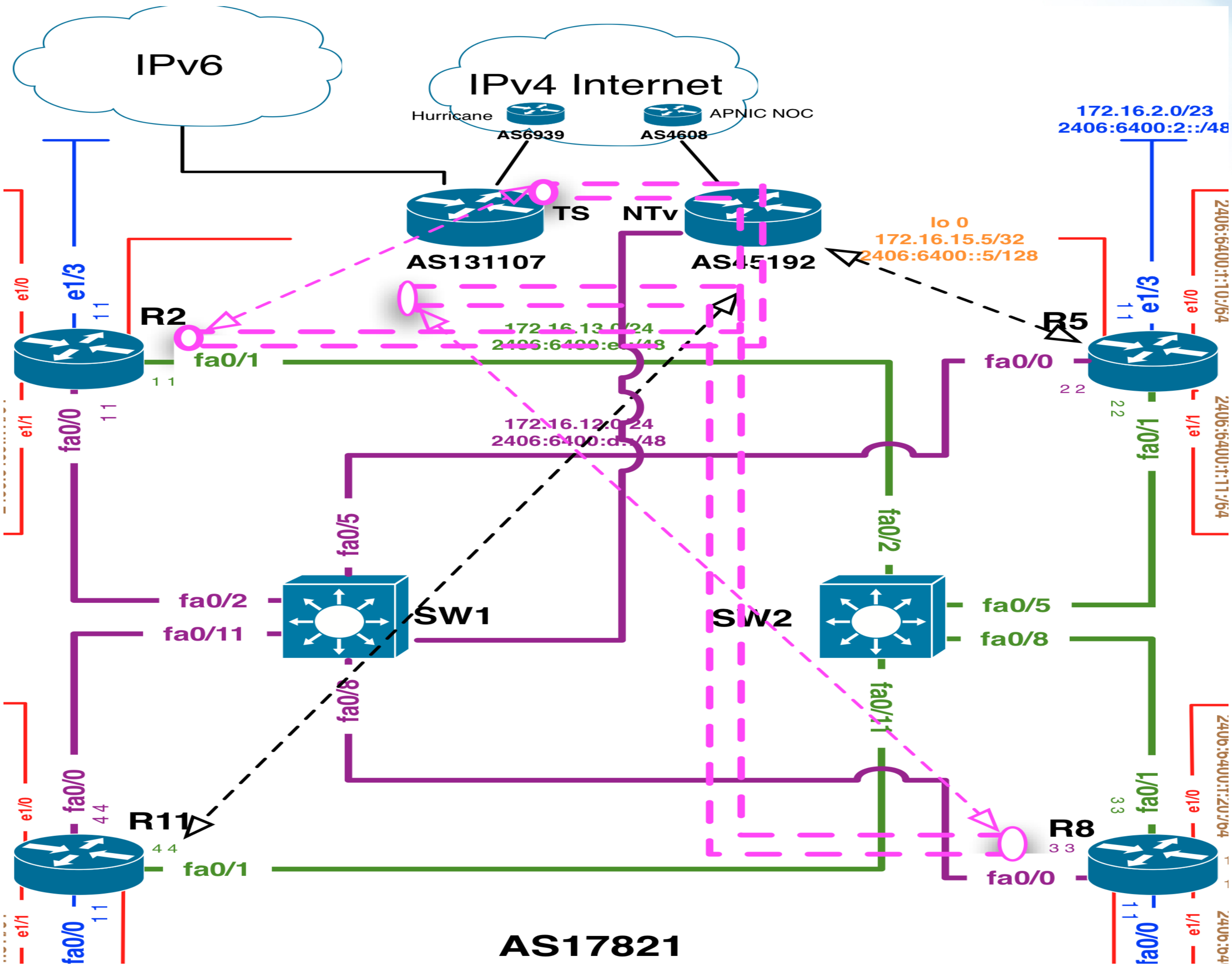
IPv6 Tunnel Transit Conf Plan



IPv6 Tunnel Transit Configuration



IPv6 Tunnel Transit Configuration



Finishing Up

Need any help?

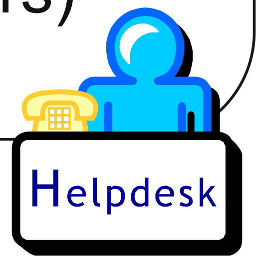
Member Services Helpdesk

-One point of contact for all member enquiries
-Online chat services

Helpdesk hours

9:00 am - 9:00 pm (AU EST, UTC + 10 hrs)

ph: +61 7 3858 3188   fax: 61 7 3858 3199

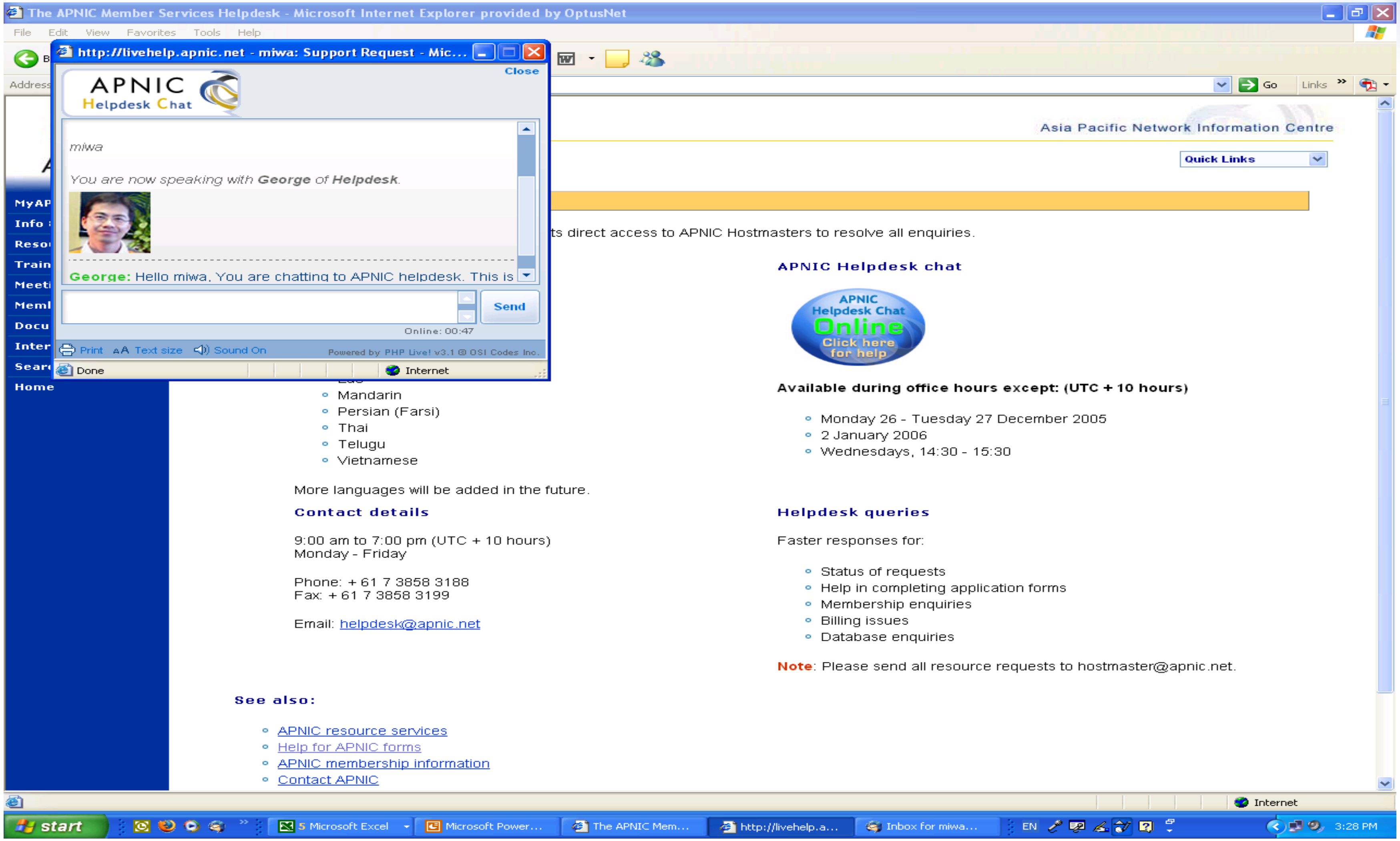


- *More personalised service*
  - Range of languages:

    Bahasa Indonesia, Bengali, Cantonese, English, Hindi, Mandarin, Thai, etc.

- *Faster response and resolution of queries*
  - IP resource applications, status of requests, obtaining help in completing application forms, membership enquiries, billing issues & database enquiries

APNIC Helpdesk chat



APNIC Website

Asia Pacific Network Information Centre

APNIC

Meeting Reminder

- The next meeting is being held in Hong Kong from 21 – 25 February 2011 in conjunction with APRICOT 2011.
- You can participate in person or remotely
- See the website for more details: http://meetings.apnic.net/31/home
- We look forward to seeing you there!

Questions?

Thank You! ☺

<champika@apnic.net>

Asia Pacific Network Information Centre

APNIC