IPv4/IPv6 Routing and Deployment Workshop

July 10-14, 2012, Karachi, Pakistan

In conjunction with

APNIC

Presenter

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Agenda

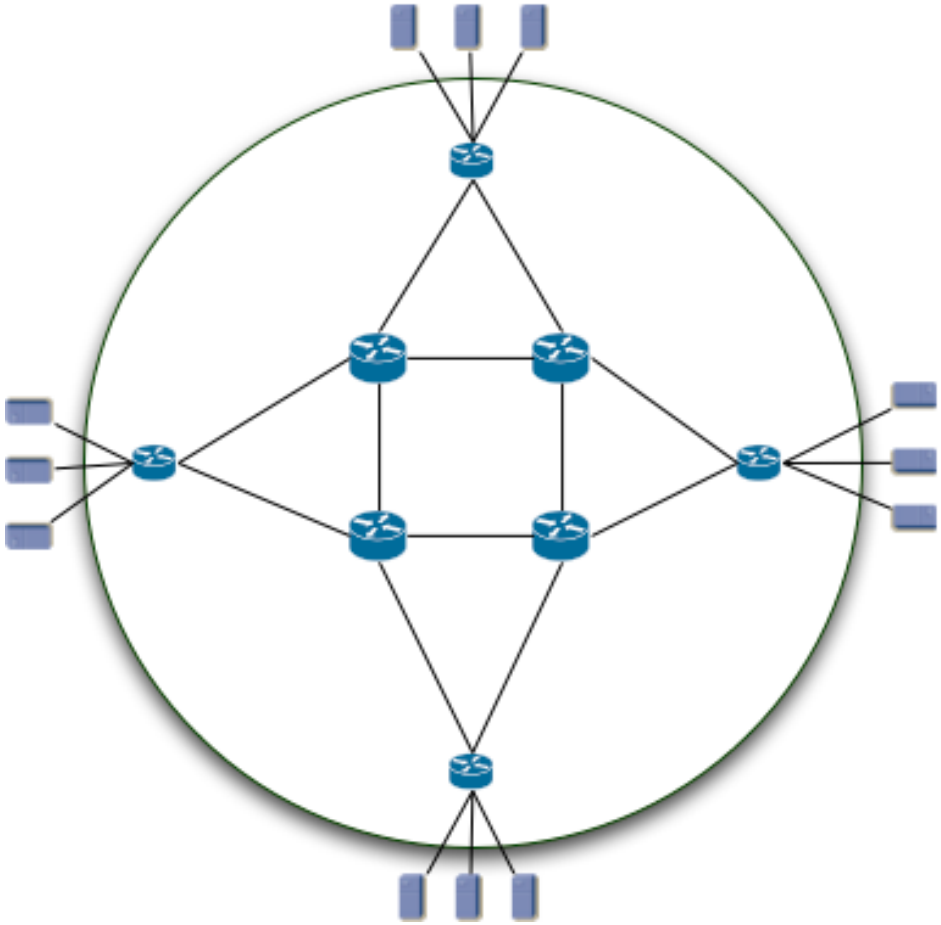
- Internet Fundamentals
- Internet Resource Management
- IP addressing and IP routing basics
- Introduction to IPv6 and Protocol Architecture
- IPv6 Addressing and Sub-netting
- IPv6 Host Configuration
- IPv4/IPv6 Deployment Plan – Case Study
- IPv4/IPv6 Deployment in IGP – Case Study
- IPv4 to IPv6 Transition Technologies
- IPv4/IPv6 Deployment in EGP – Case Study
- IPv6 DNS

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

Transition Concept



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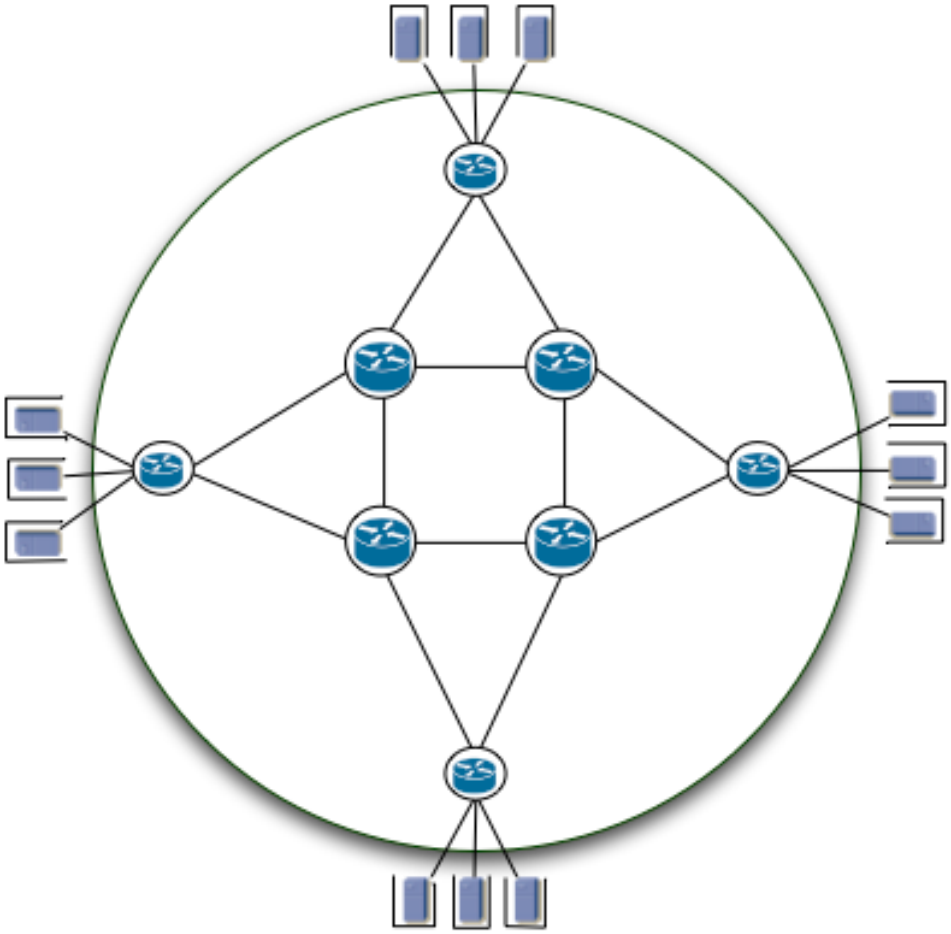

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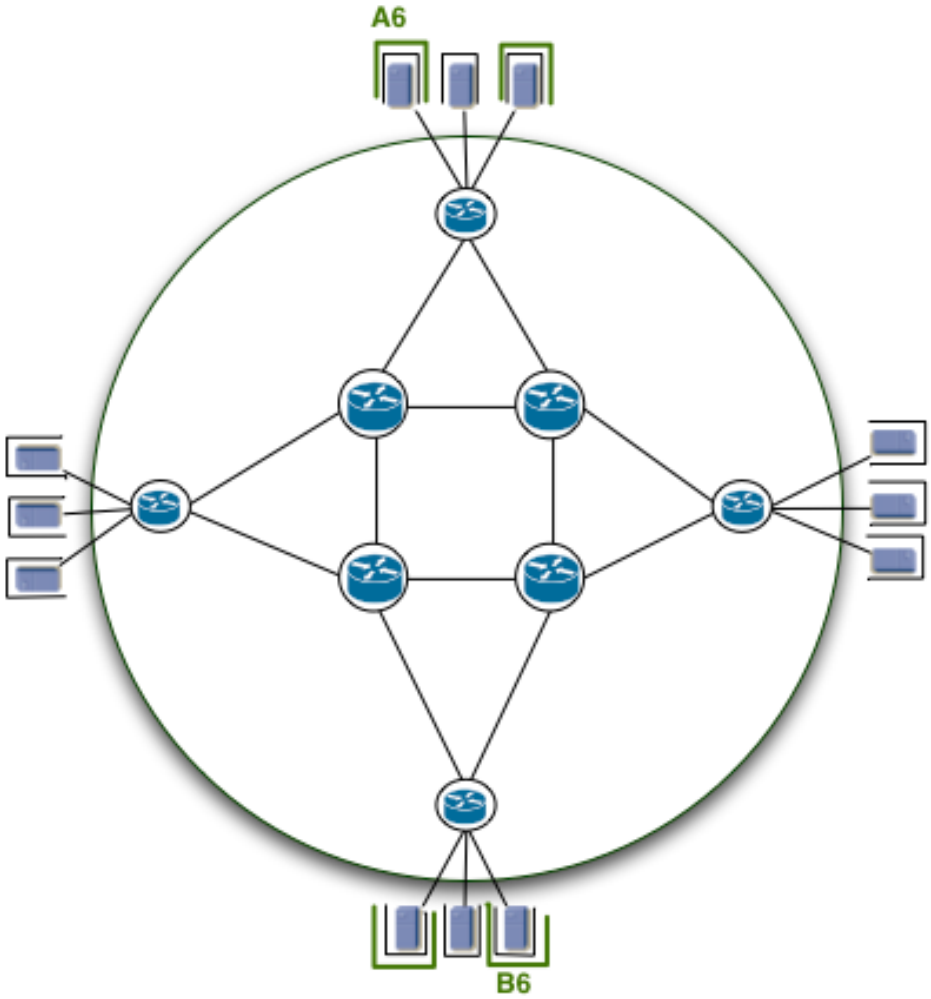

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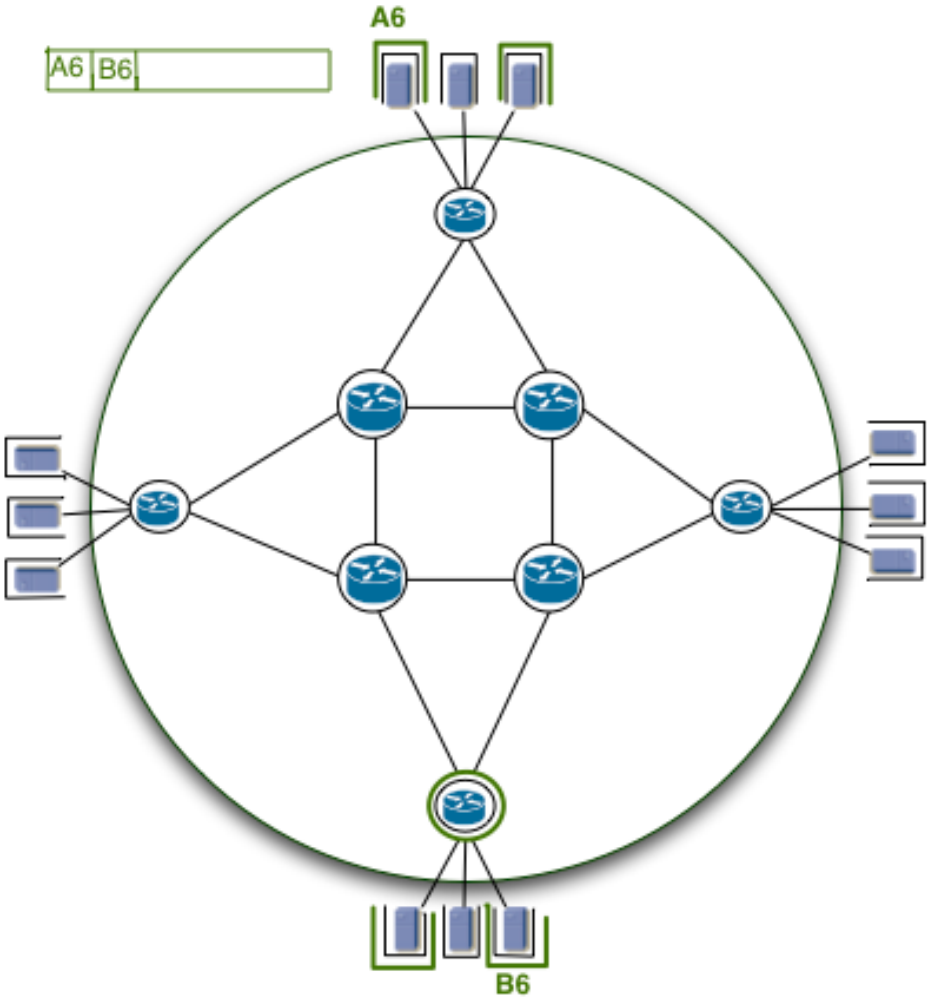

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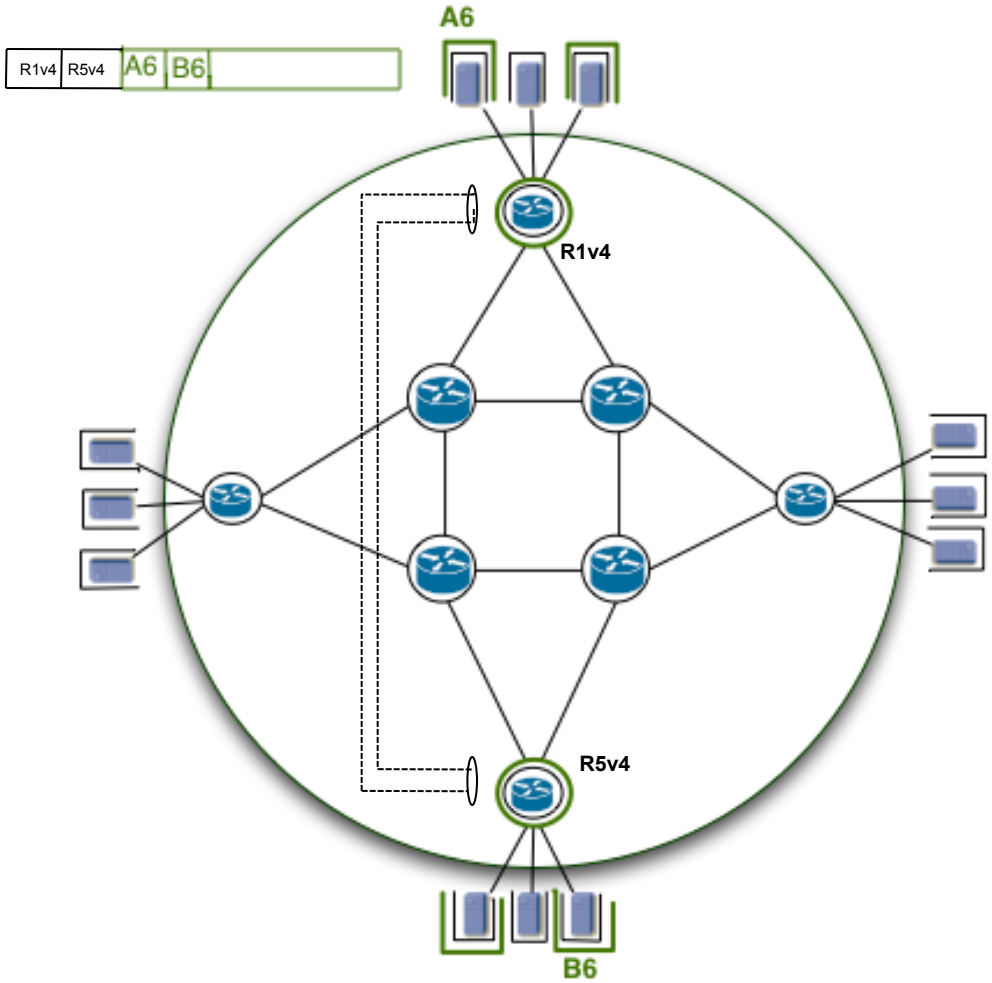

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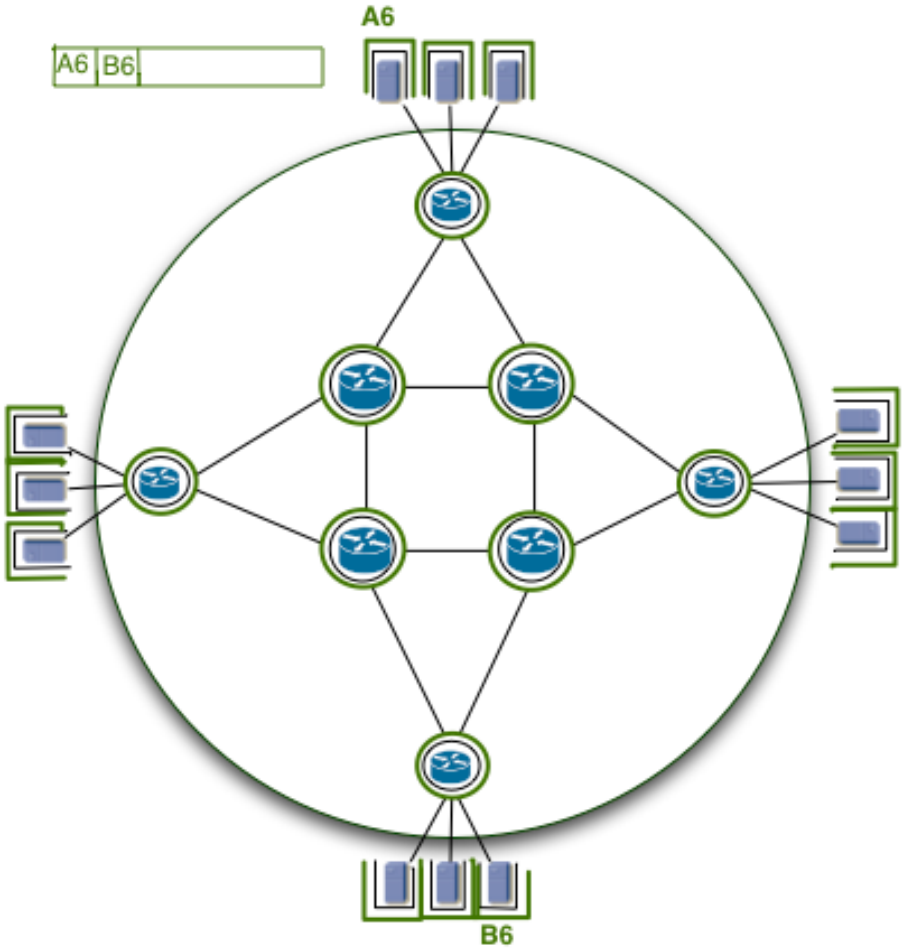


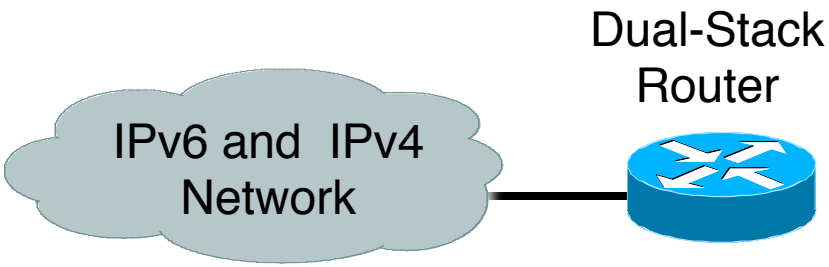
IPv4 to IPv6 Transition

- 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

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

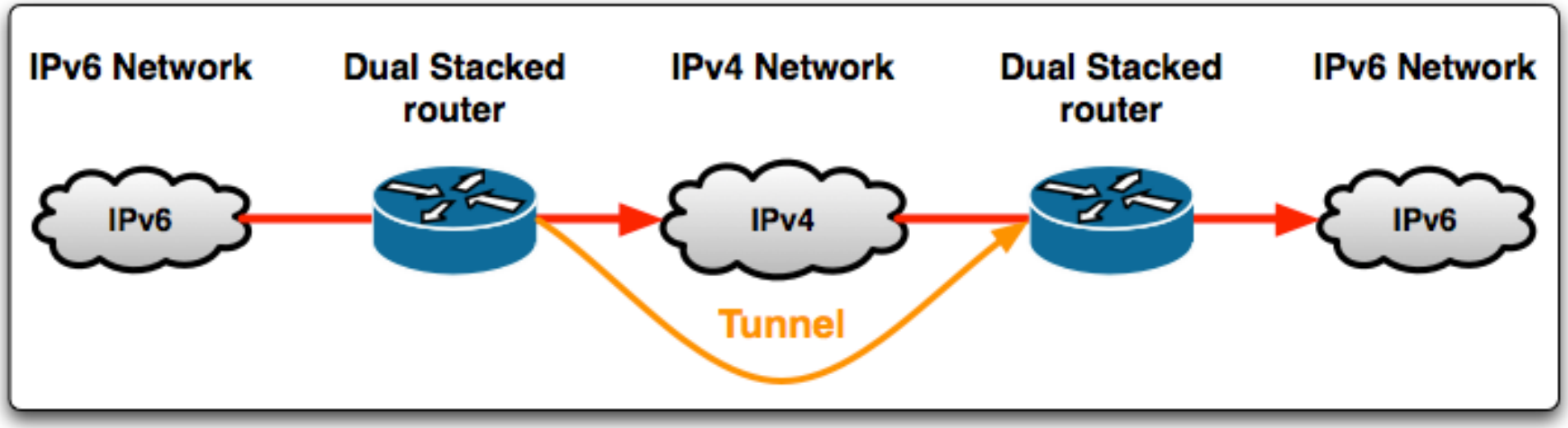
- Many techniques are available to establish a tunnel:
  - Manually configured
    - Manual Tunnel (RFC 2893)
    - GRE (RFC 2473)
  - Semi-automated
    - Tunnel broker
  - Automatic
    - 6to4 (RFC 3056)
    - 6rd

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

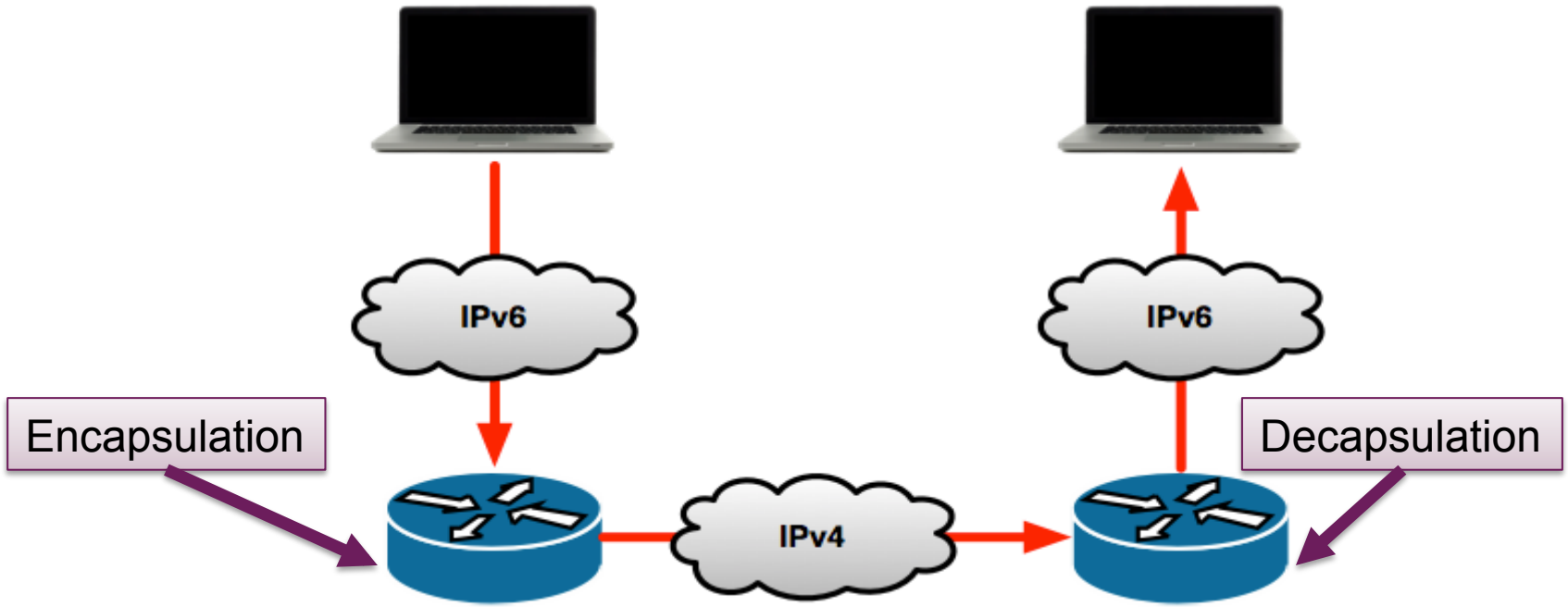
Tunneling – General Concept

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

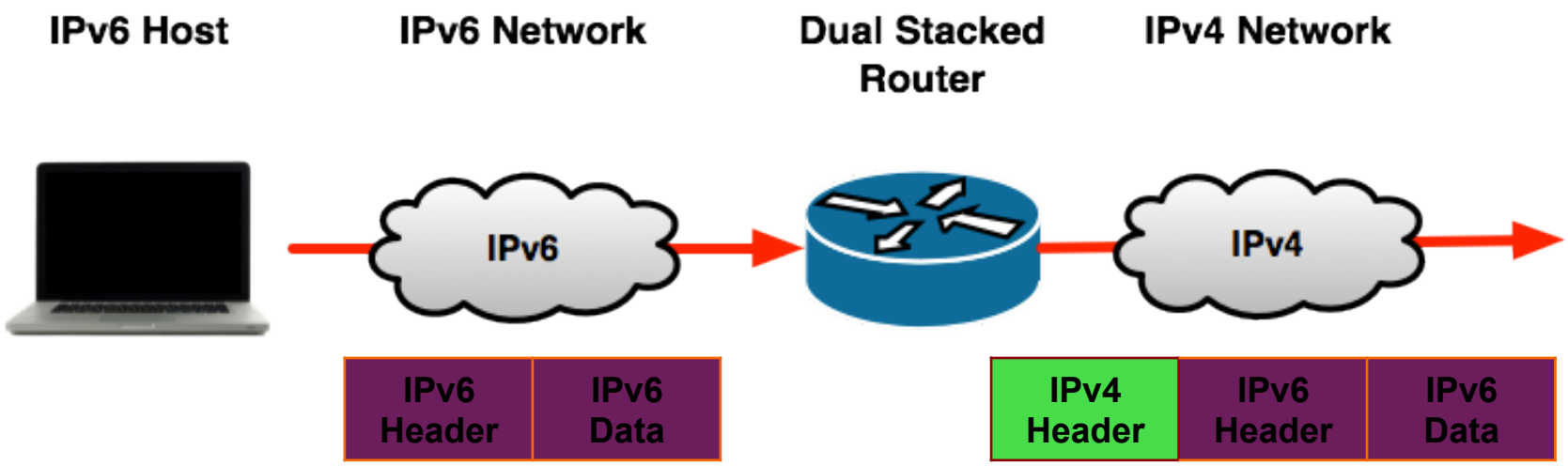


Tunneling – General Concept

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

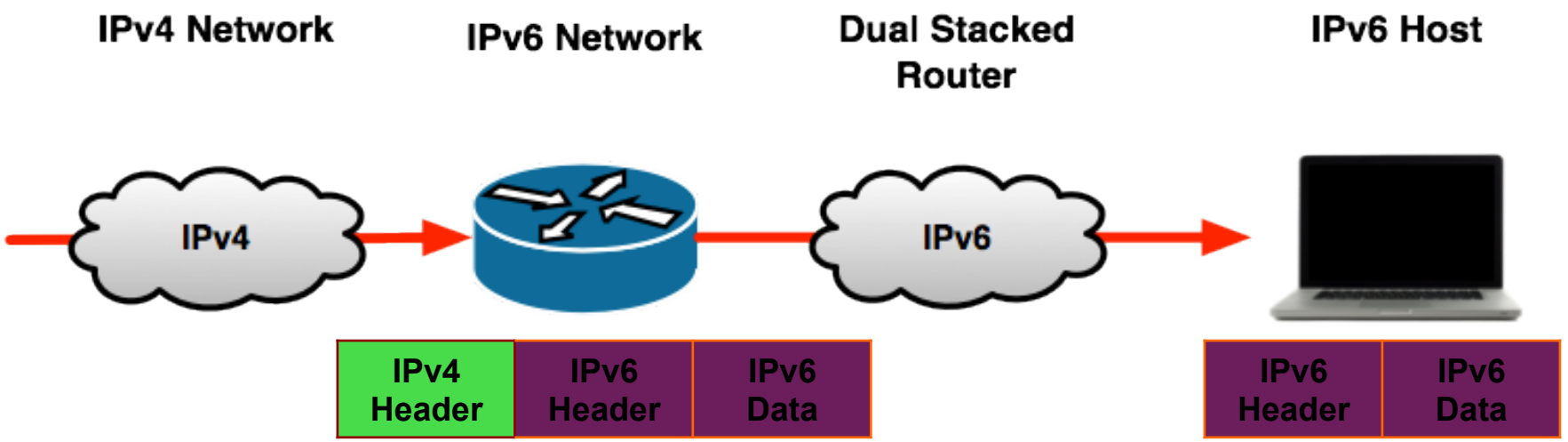


Tunnel Encapsulation



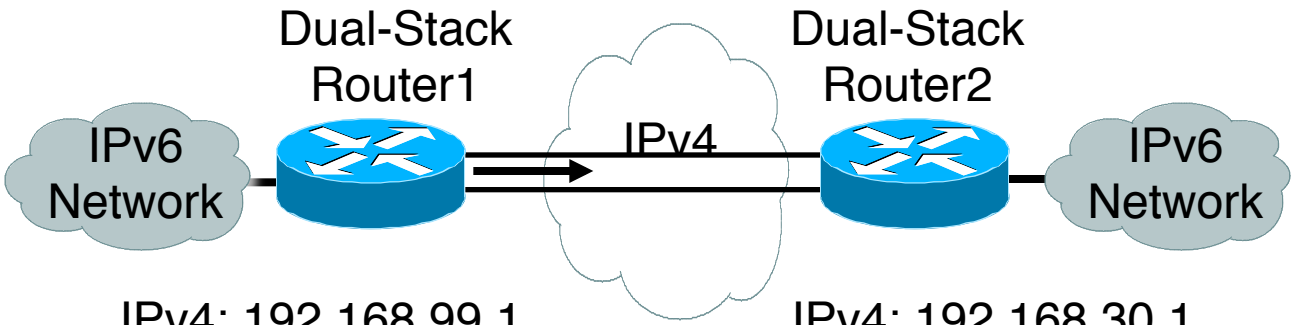
IPv6 essentials by Silvia Hagen, p258

Tunnel Decapsulation



IPv6 essentials by Silvia Hagen, p258

Manually Configured Tunnel (RFC2893)




```
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

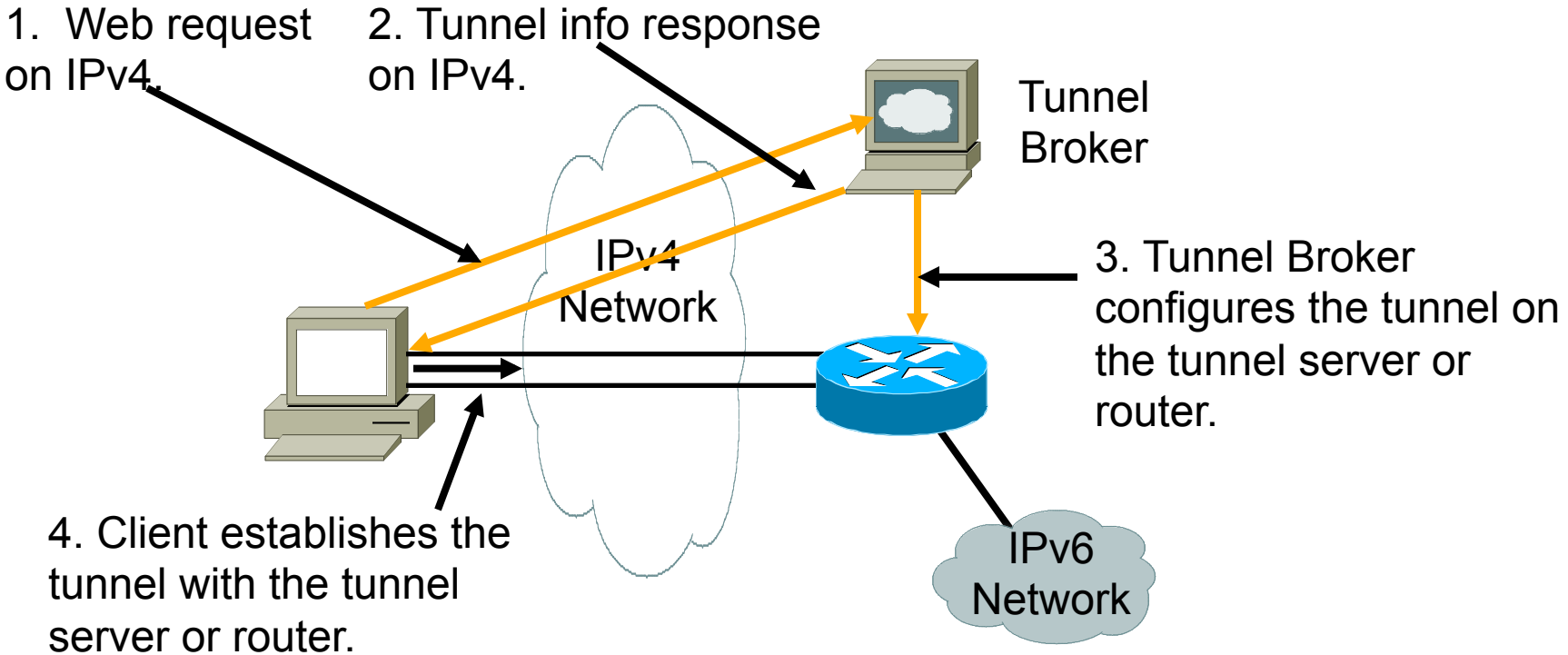
6to4 in the Internet

- 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

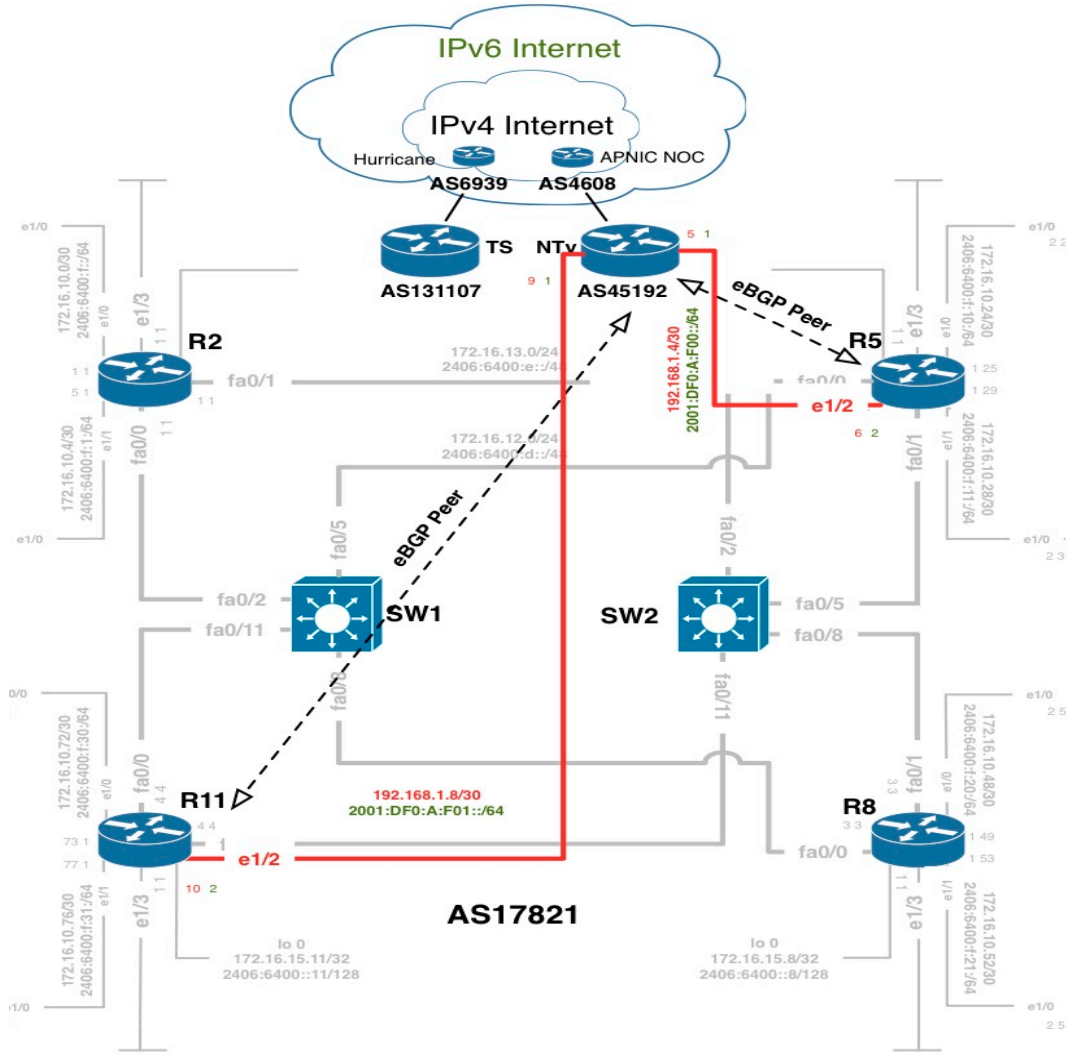
```
interface loopback0
 ip address 192.88.99.1
   255.255.255.255
 ipv6 address 2002:c058:6301::1/128
!
interface tunnel 2002
 no ip address
 ipv6 unnumbered Loopback0
 tunnel source Loopback0
 tunnel mode ipv6ip 6to4
 tunnel path-mtu-discovery
!
interface FastEthernet0/0
 ip address 105.3.37.1 255.255.255.0
 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
```

Tunnel Broker



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

IPv6 Native Transit Conf Plan



IPv6 IOS Command For eBGP

Adding eBGP Neighbor:

```
router bgp 17821
address-family ipv6
!
neighbor 2406:6400:000D:0000::5 remote-as 45192
neighbor 2406:6400:000D:0000::5 activate
```

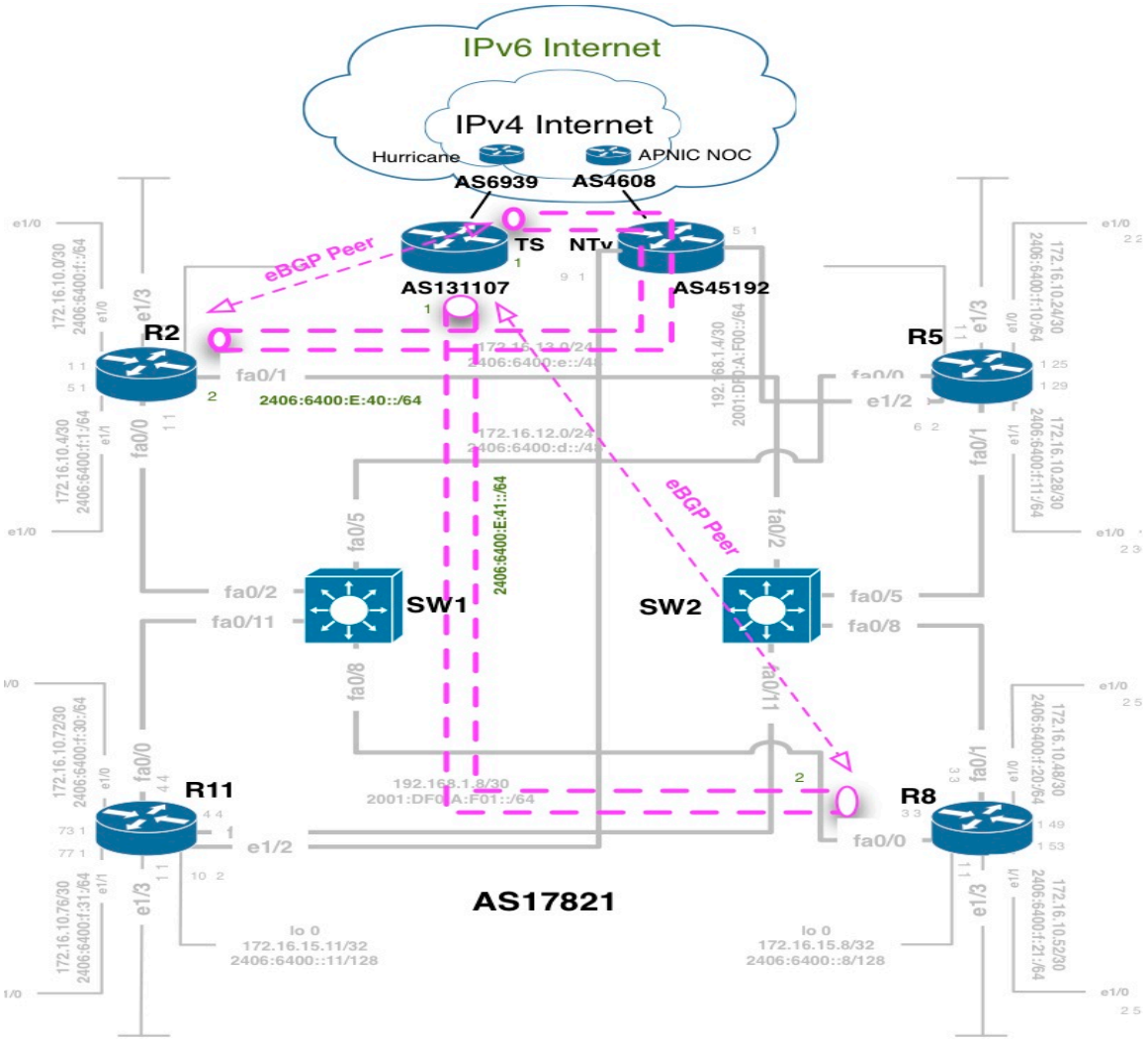
eBGP neighbor is always recommended with directly connected interface

IPv6 Native Transit Configuration

- Router5

```
config t
router bgp 17821
address-family ipv6
neighbor 2406:6400:000D:0000::5 remote-as 45192
neighbor 2406:6400:000D:0000::5 activate
neighbor 2406:6400:000E:0000::5 remote-as 45192
neighbor 2406:6400:000E:0000::5 activate
exit
exit
exit
Wr
```

IPv6 Tunnel Transit Configuration



6 to 4 Tunnel Configuration

IOS Command for Tunnel Interface:

Router2

```
config t
interface Tunnel0
tunnel source 172.16.15.2
tunnel destination 192.168.1.1
tunnel mode ipv6ip
ipv6 address 2406:6400:F:40::2/64
ipv6 enable
```

6 to 4 Tunnel Configuration

IOS Command for Tunnel Peering:

```
router bgp 17821
address-family ipv6
neighbor 2406:6400:F:40::1 remote-as 23456
neighbor 2406:6400:F:40::1 activate
```

AS Numbers

- Two Ranges:
  - [0 – 65535] are the original 16 bit
  - [65536 – 4294967295] are the new 32 bit
- Usages
  - 0 and 65535 Reserved
  - 1 to 64495 Public Internet
  - 64496 to 64511 Documentation –RFC5398
  - 64512 to 65534 Private use
  - 23456 represent 32 Bit range in 16 bit world
  - 65536 to 65551 Documentation – RFC 5398
  - 65552 to 4294967295 Public Internet

32 bit AS Number Representation

- AS DOT
  - Based upon 2-Byte AS representation
  - <Higher2bytes in decimal> . <Lower2bytes in decimal>
  - For example: AS 65546 is represented as 1.10
  - Easy to read, however hard for regular expressions
  - There is a meta character “.” in regular expression
  - i.e For example, a.c matches "abc", etc., but [a.c] matches only "a", ".", or "c”.

32 bit AS Number Representation

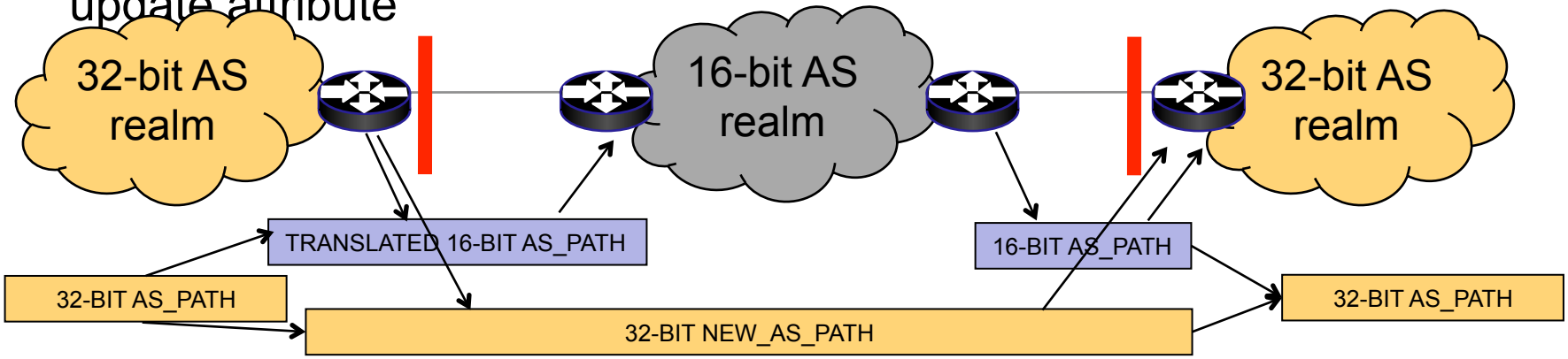
- AS PLAIN
  - ASPLAIN IETF preferred notation
  - Continuation on how a 2-Byte AS number has been represented historically
  - Notation: The 32 bit binary AS number is translated into a Single decimal value Example: AS 65546
  - Total AS Plain range (0 – 65535 - 65,536 - 4,294,967,295)

4 Byte AS Numbers

- 32 Bit range representation specified in RFC5396
- APNIC resource range:
  - In AS DOT: 2.0 ~ 2.1023
  - In AS PLAIN: 131072 ~ 132095
- AS number converter
- http://submit.apnic.net/cgi-bin/convert-asn.pl

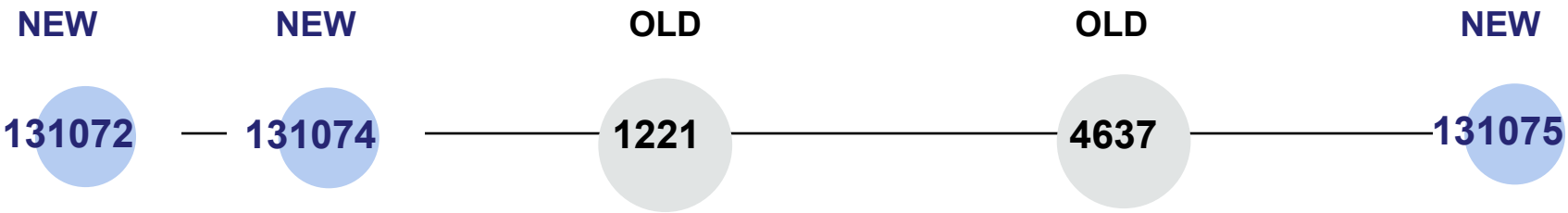
32-bit AS Transition

- Think about this space as a set of NEW / OLD boundaries
- Define the NEW / OLD and the OLD / NEW transitions
- Preserve all BGP information at the transition interfaces
  - Translate 32-bit AS Path information into a 16-bit representation
  - Tunnel 32-bit AS Path information through 16-bit AS domain as an update attribute



REASSEMBLE 32-bit AS_PATH

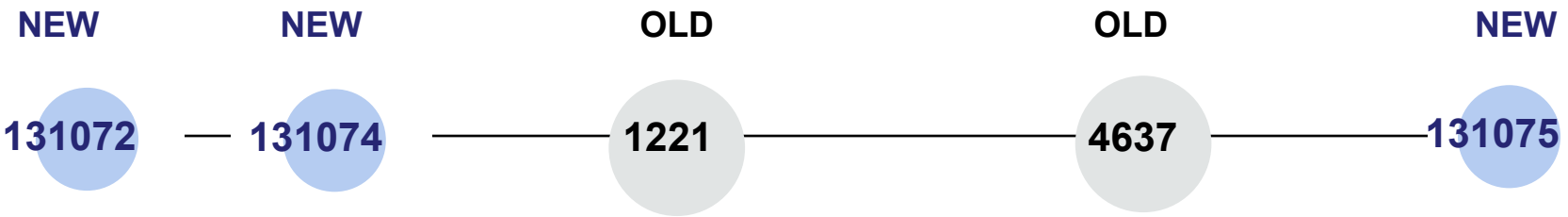
32-bit / 16-bit BGP Example



AS Path in the RIB

i

32-bit / 16-bit BGP Example



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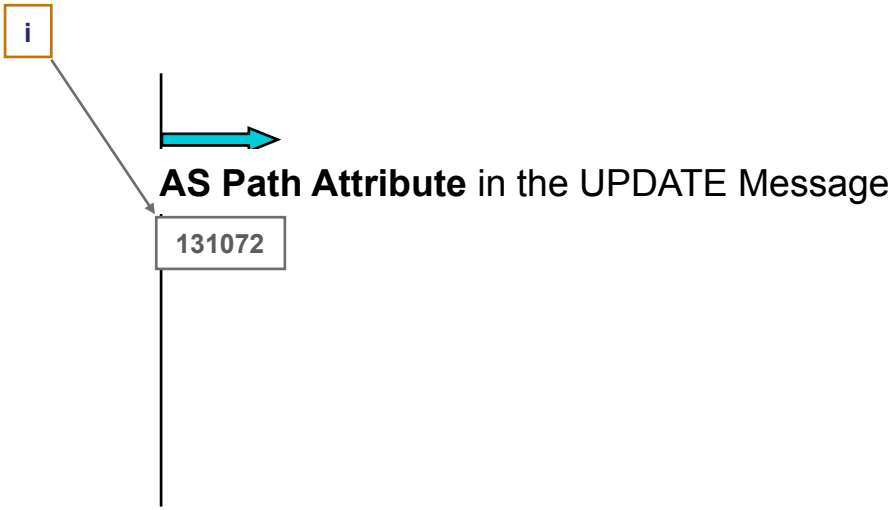

32-bit / 16-bit BGP Example

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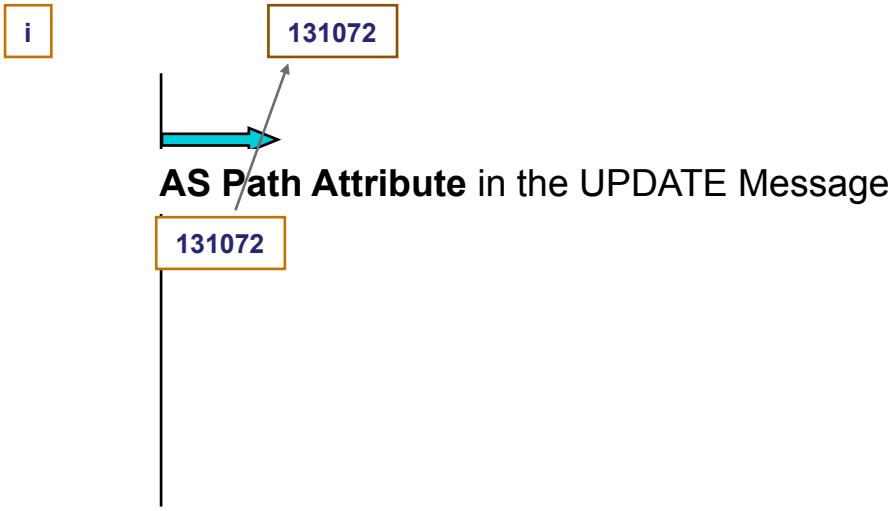

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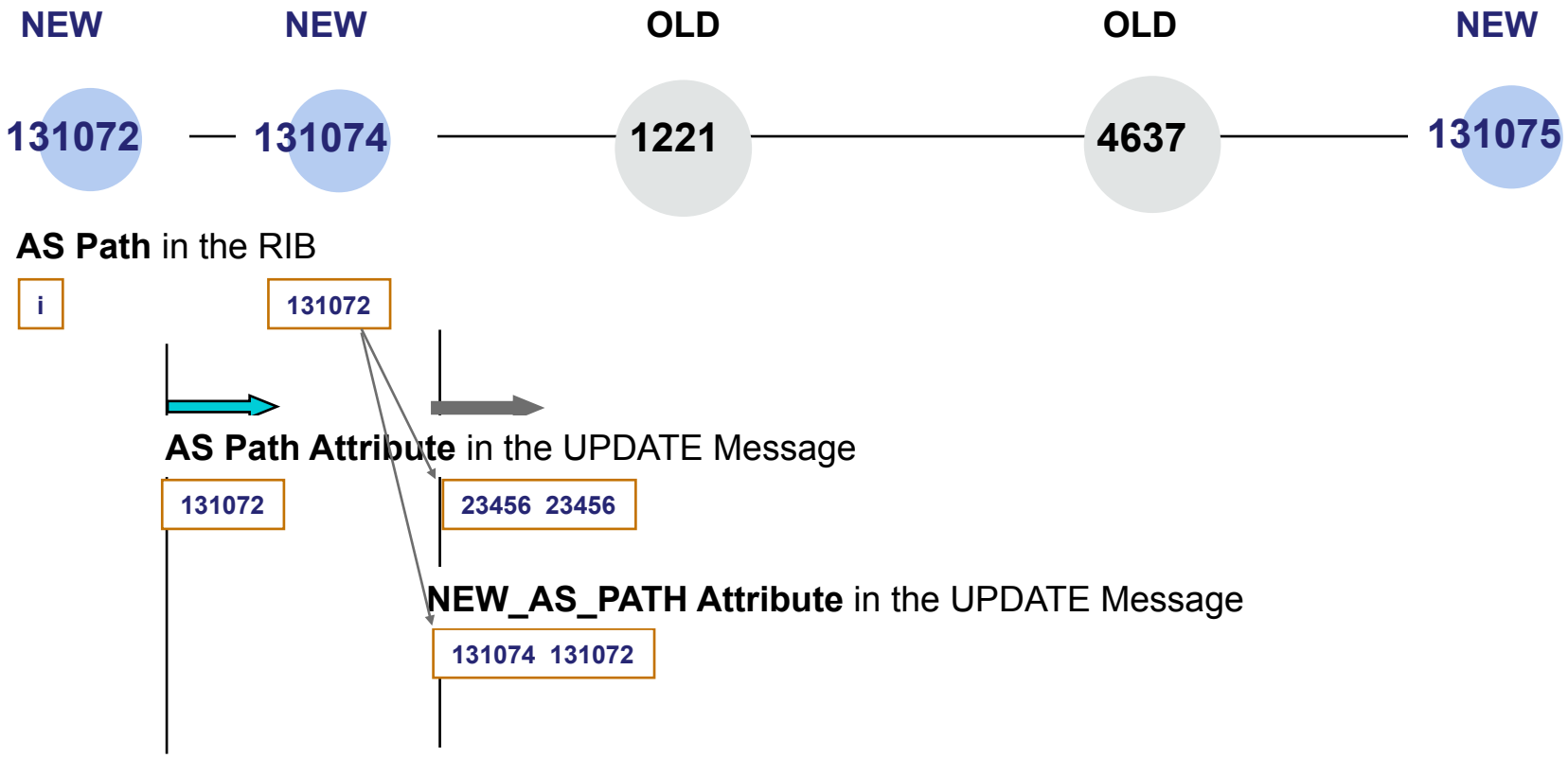

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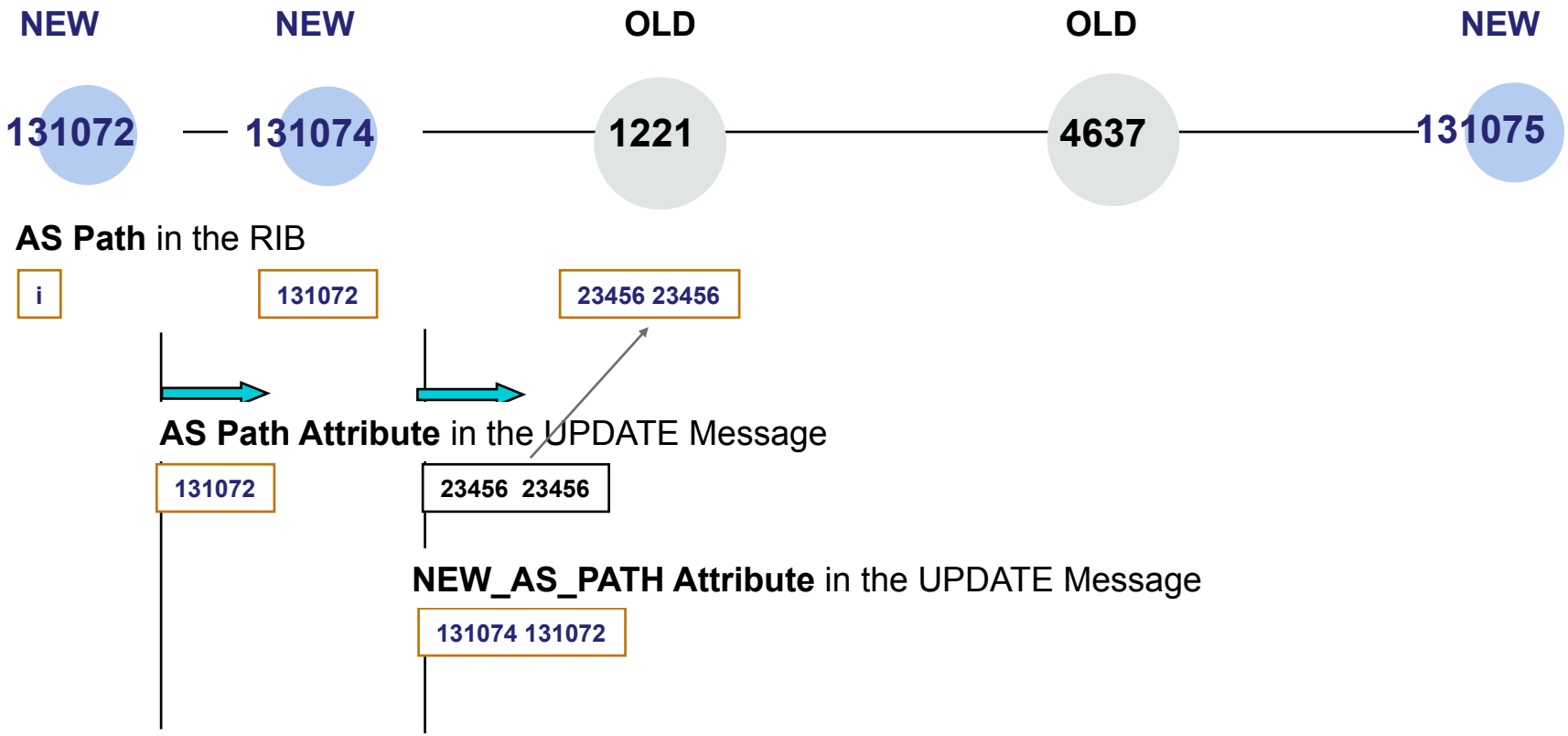

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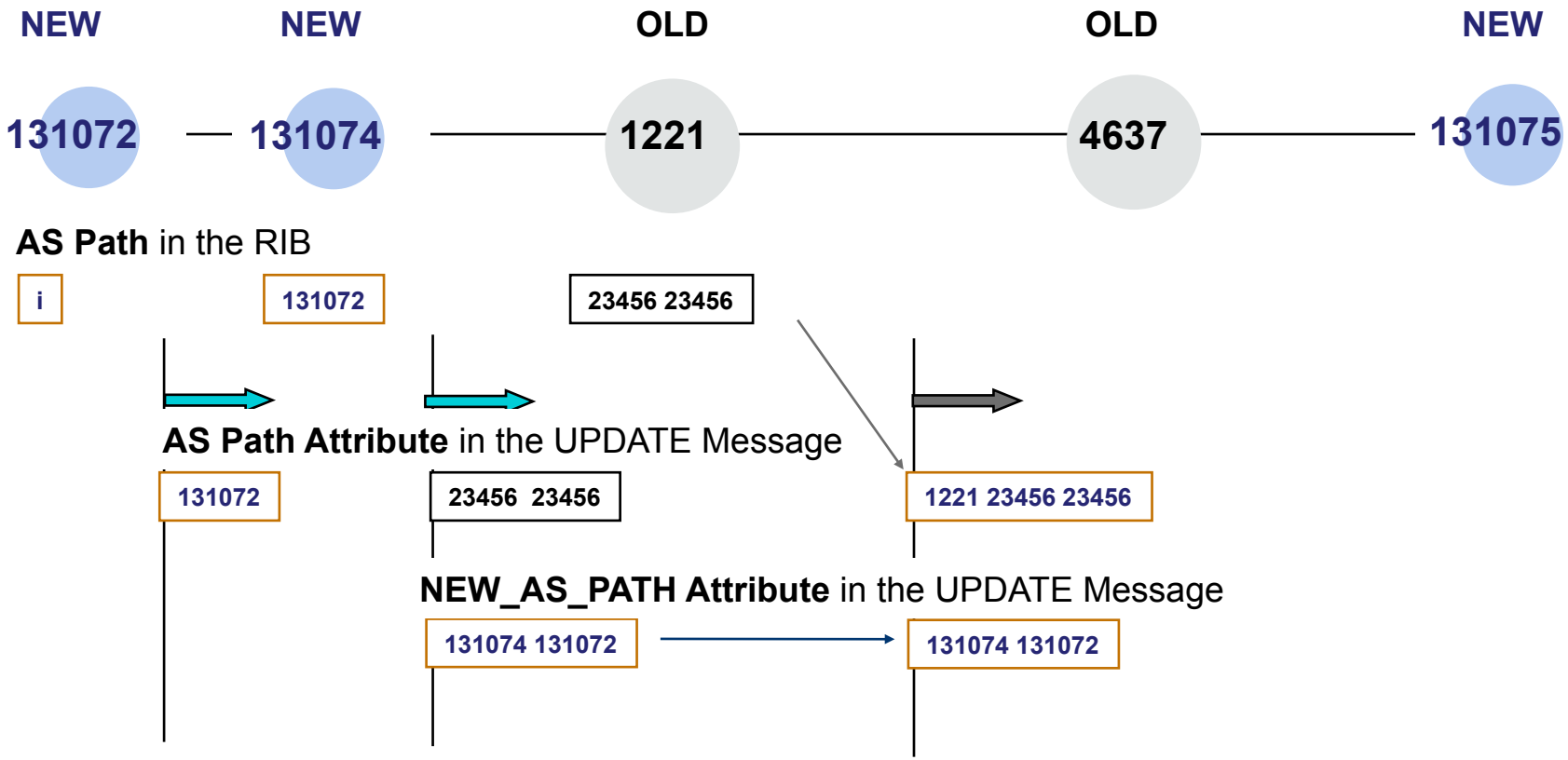

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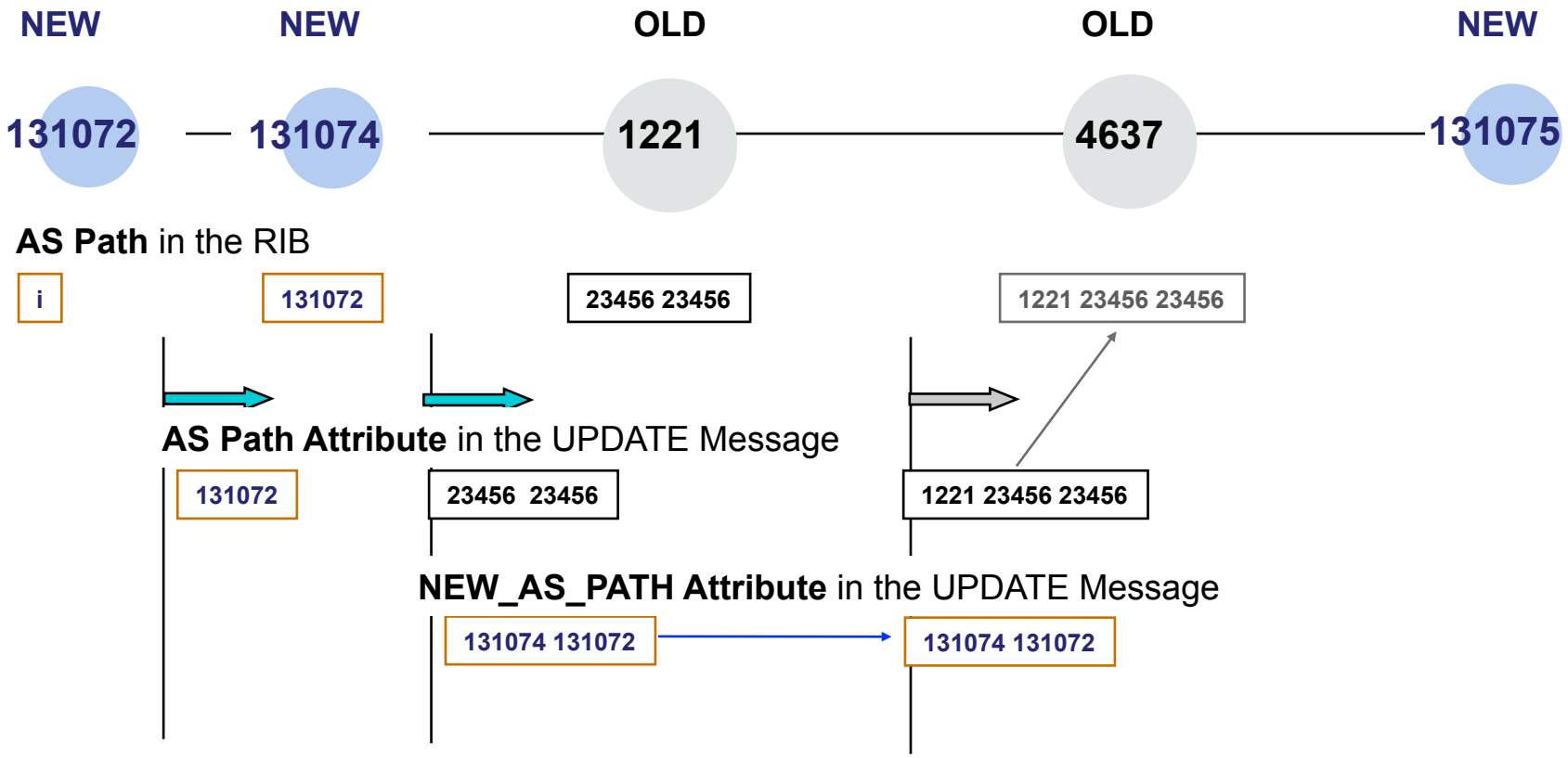

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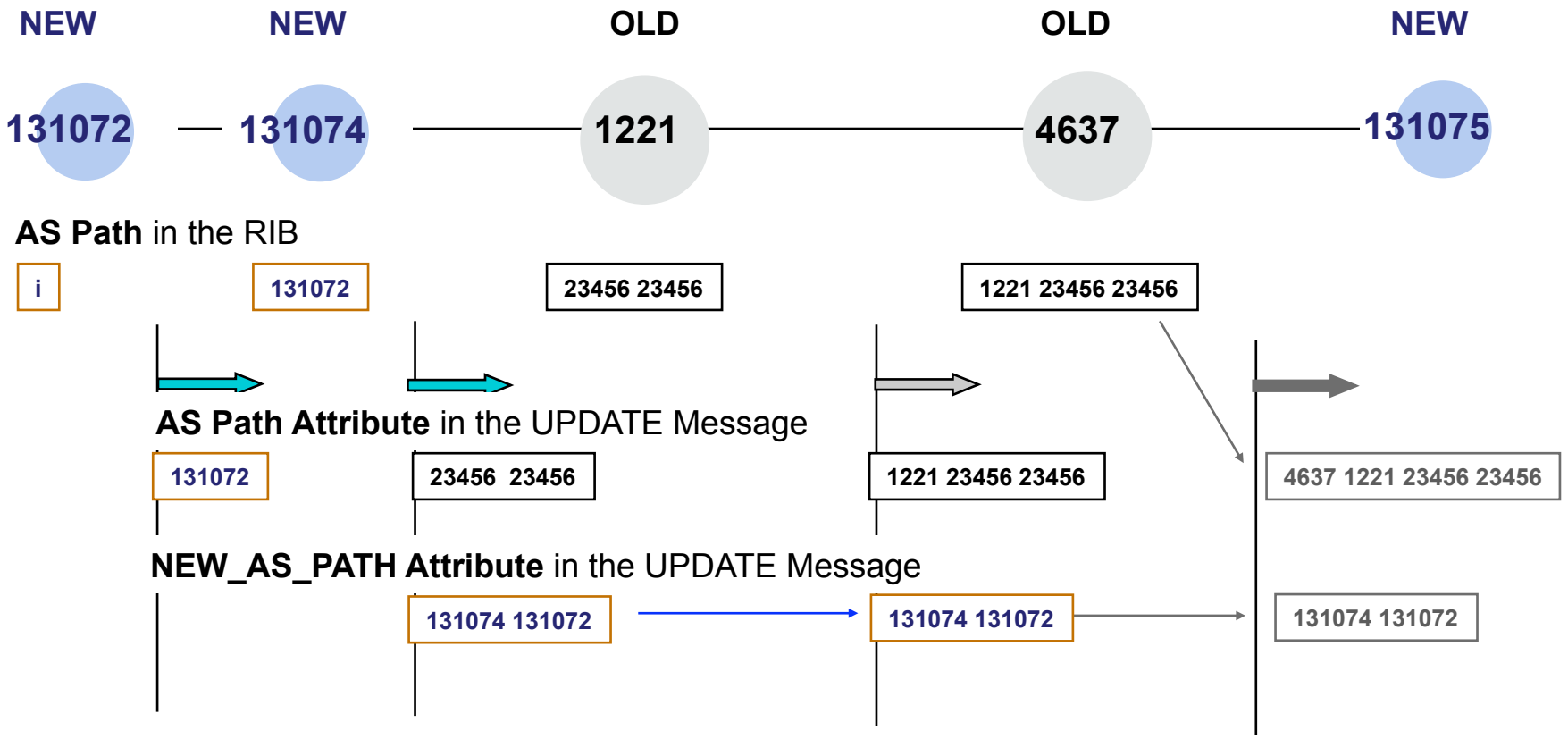

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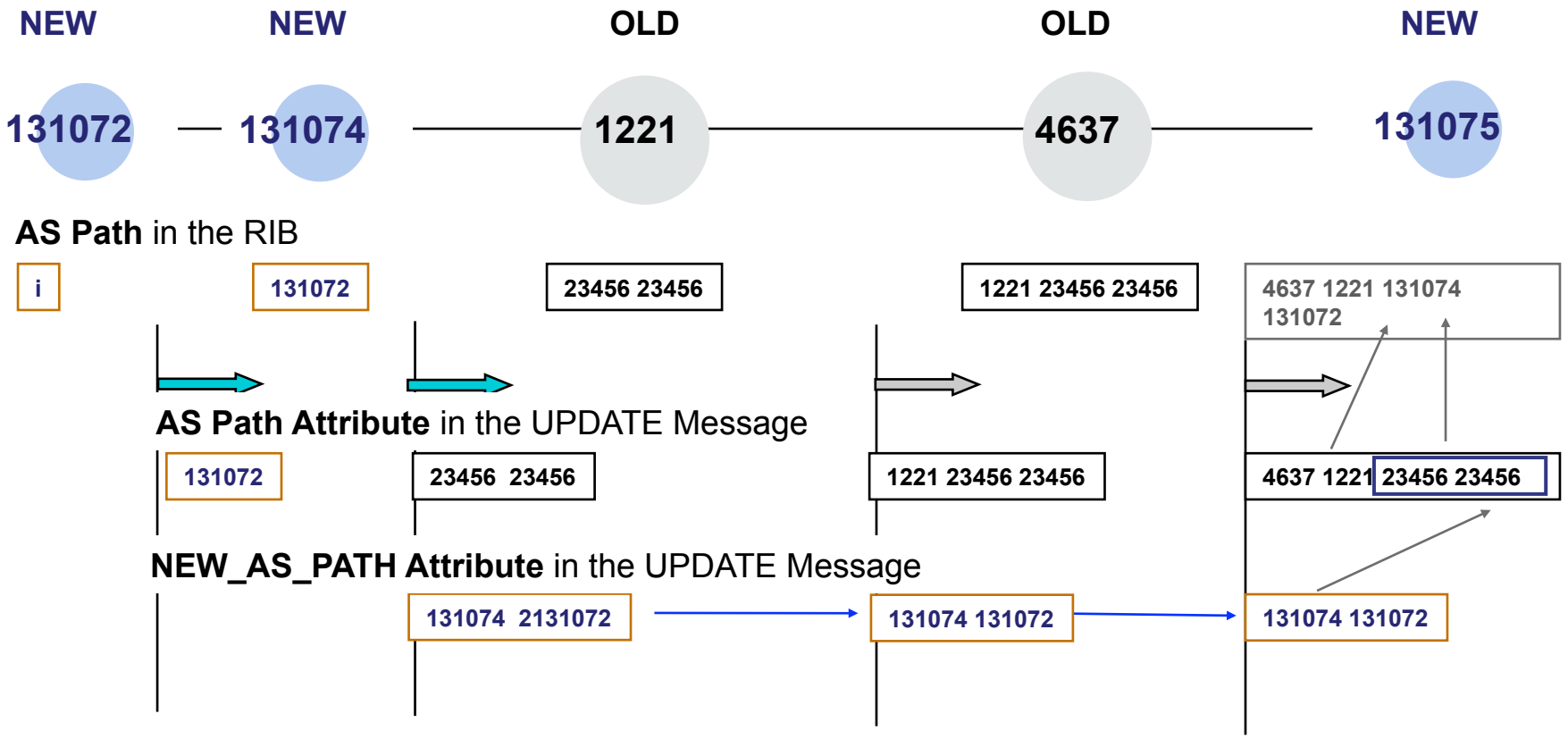

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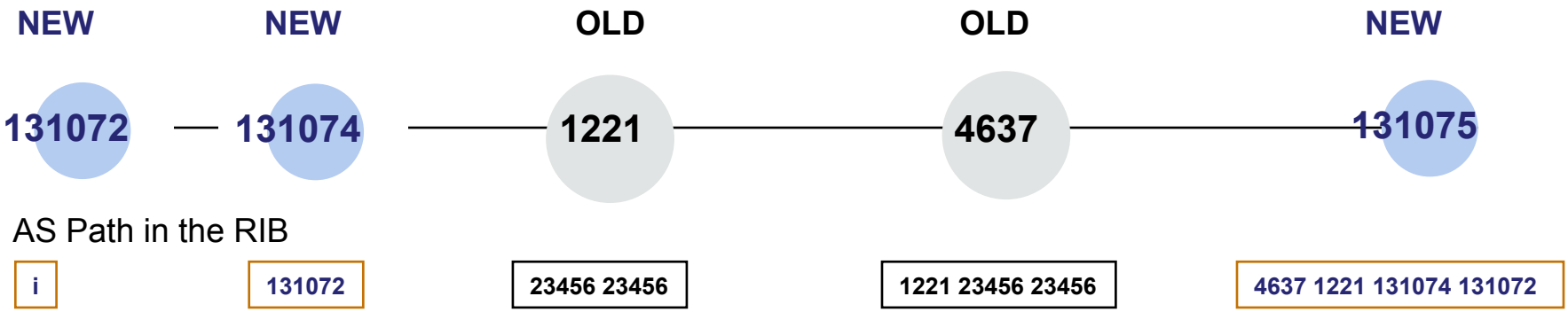
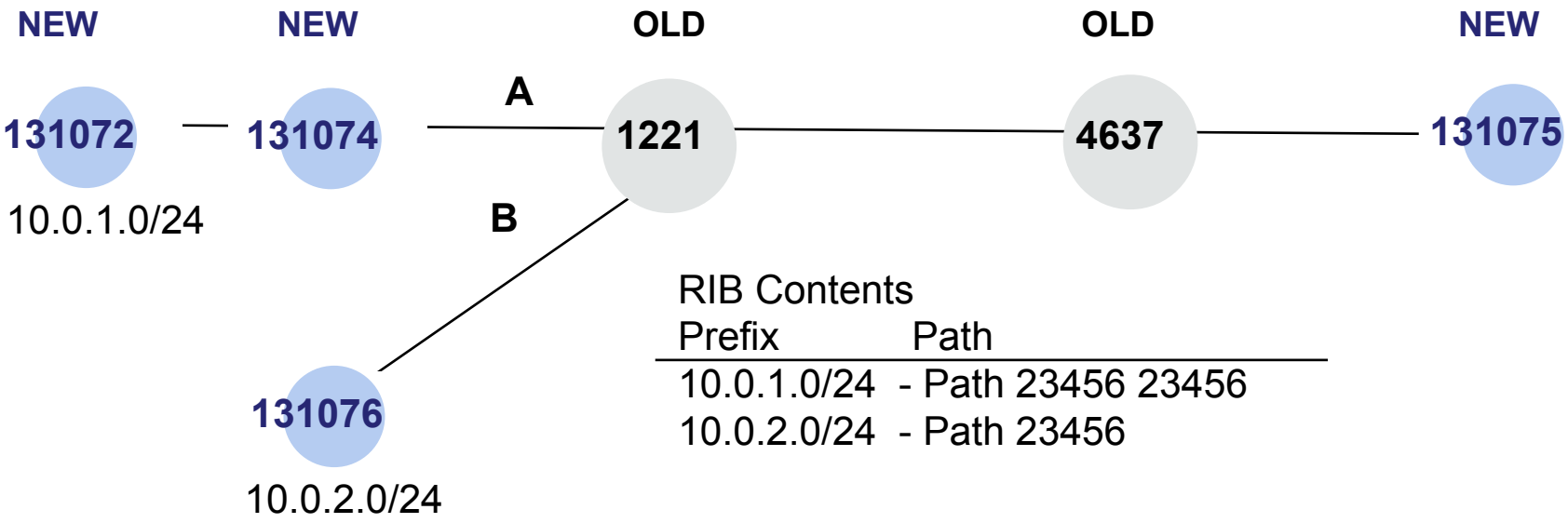
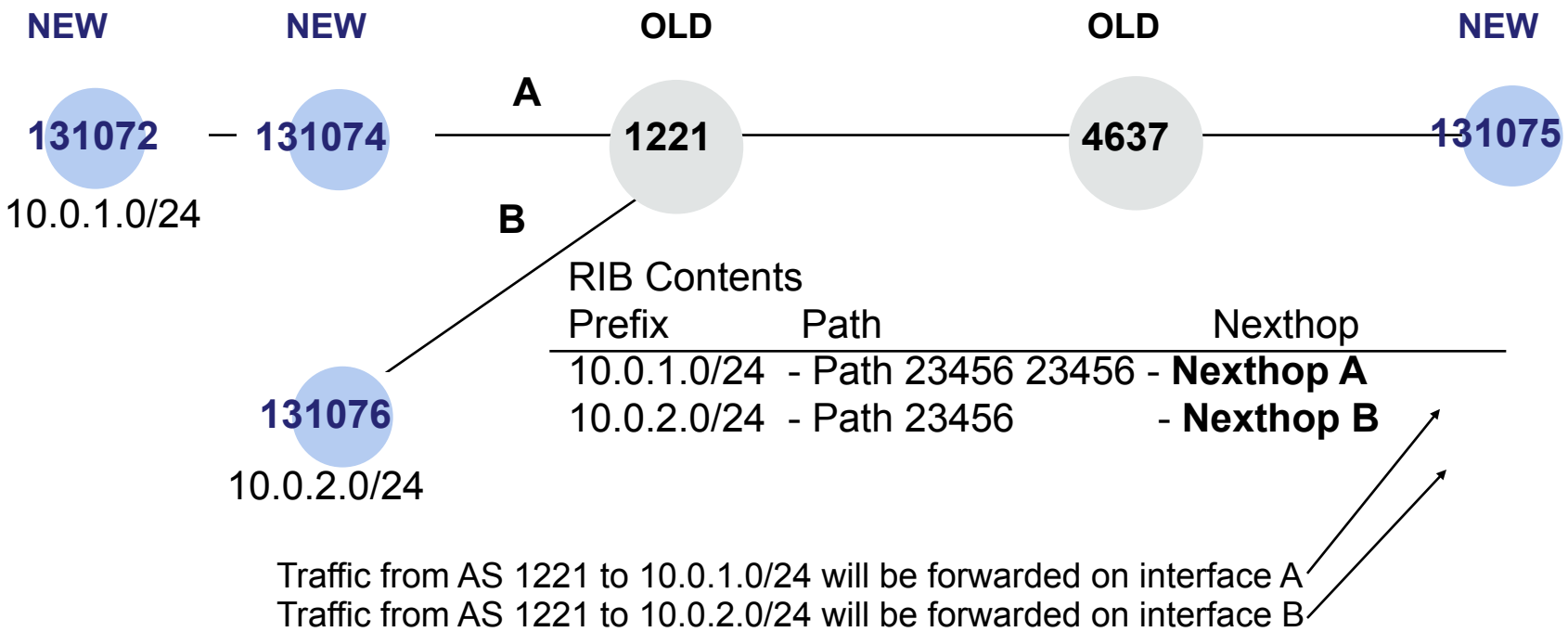


Can old-BGP get Confused?



NO! BGP Nexthop is the key!



This is standard BGP behaviour – nothing changes here for BGP as it is used today

Questions?