



# GTER24

## Introduction to IPv6



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# Why IPv6?



# A Need for IPv6?

- IETF IPv6 WG began in early 90s, to solve addressing growth issues, but
  - CIDR, NAT,...were developed
- IPv4 32 bit address = 4 billion hosts
  - ~40% of the IPv4 address space is still unused which is different from unallocated
  - The rising of Internet connected device and appliance will eventually deplete the IPv4 address space
- IP is everywhere
  - Data, voice, audio and video integration is a reality
  - Regional registries apply a strict allocation control
- So, only compelling reason: **More IP addresses**

# Why Not NAT

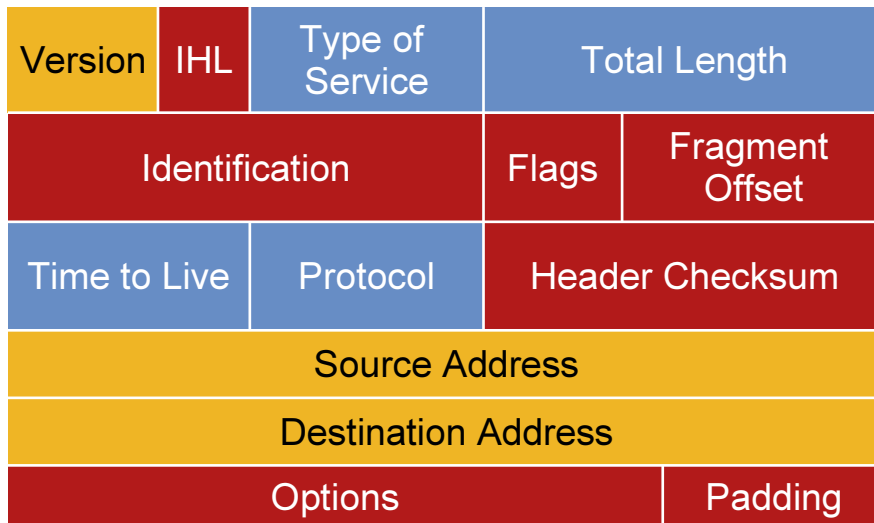
- It was created as a temp solution
- NAT breaks the end-to-end model
- Growth of NAT has slowed down growth of transparent applications
- No easy way to maintain states of NAT in case of node failures
- NAT break security
- NAT complicates mergers, double NATing is needed for devices to communicate with each other

# IPv6 Technology

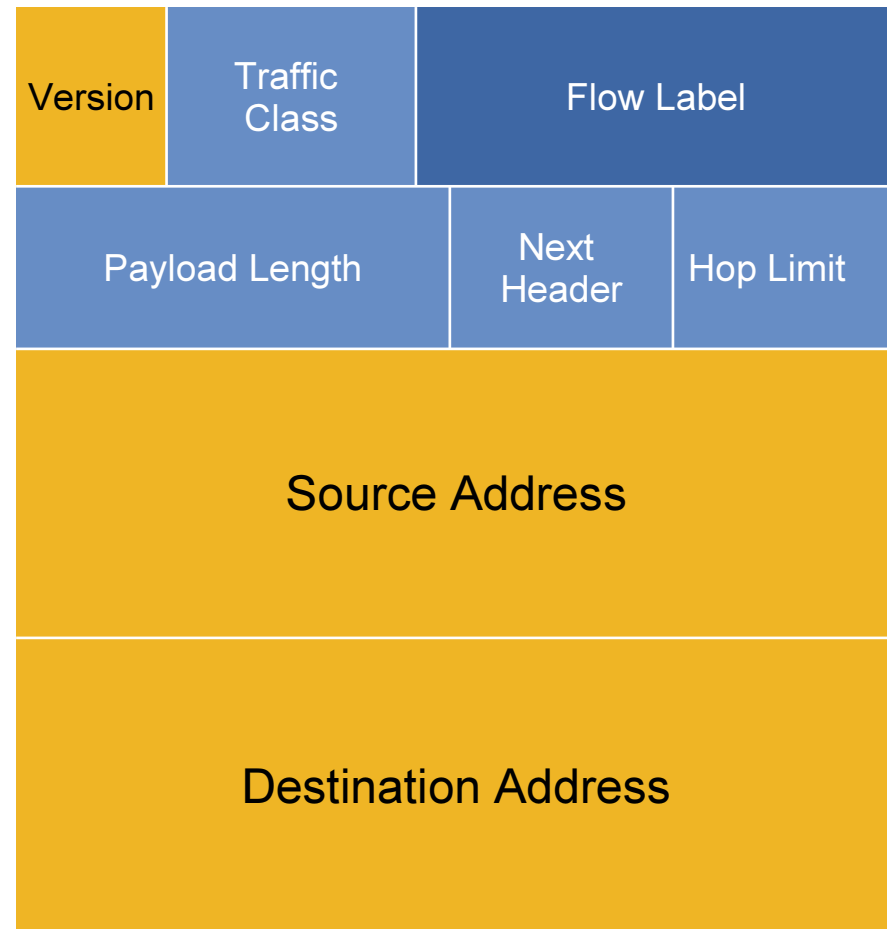


# IPv4 and IPv6 Header Comparison

## IPv4 Header



## IPv6 Header



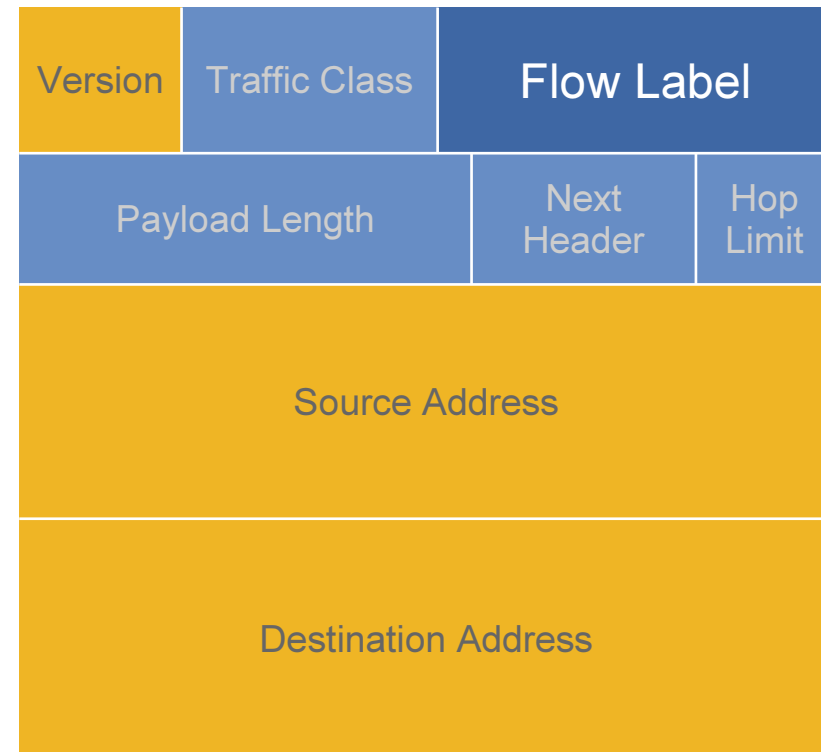
- Legend**
- Field's Name Kept from IPv4 to IPv6
  - Fields Not Kept in IPv6
  - Name and Position Changed in IPv6
  - New Field in IPv6

# IPv6 Header New Field—Flow Label (RFC3697)

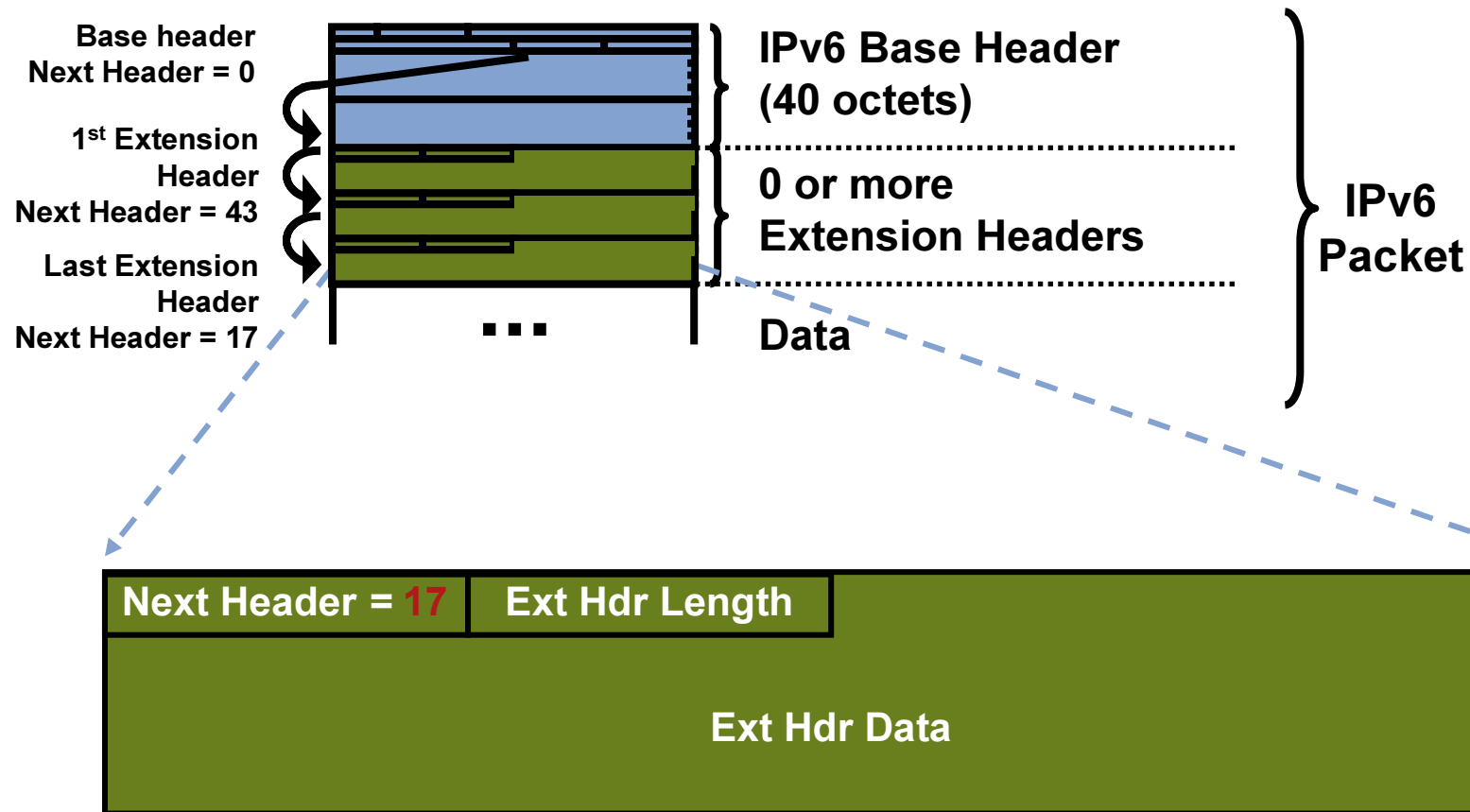
20-Bit Flow Label Field to Identify Specific Flows  
Needing Special QoS

- Flow classifiers had been based on 5-tuple: Source/destination address, protocol type and port numbers of transport
- Some of these fields may be unavailable due to fragmentation, encryption or locating them past extension headers
- With flow label, each source chooses its own flow label values; routers use source addr + flow label to identify distinct flows
- Flow label value of 0 used when no special QoS requested (the common case today)

IPv6 Header



# Extension Headers





# MTU Issues

- Minimum link MTU for IPv6 is 1280 octets (vs. 68 octets for IPv4)
  - => on links with MTU < 1280, link-specific fragmentation and reassembly must be used
- Implementations are expected to perform path MTU discovery to send packets bigger than 1280
- Minimal implementation can omit PMTU discovery as long as all packets kept  $\leq$  1280 octets
- A hop-by-hop option supports transmission of “jumbograms” with up to 232 octets of payload; payload is normally 216

# IPv6 Addressing



# IPv6 Addressing

IPv4 32-bits

IPv6 128-bits

$$2^{32} = 4,294,967,296$$

$$2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456$$

$$2^{128} = 2^{32} * 2^{96}$$

$$2^{96} = 79,228,162,514,264,337,593,543,950,336 \text{ times the number of possible IPv4 Addresses (79 trillion trillion)}$$

# Addressing Format

## Representation

- 16-bit hexadecimal numbers
- Numbers are separated by (:)
- Hex numbers are not case sensitive
- Abbreviations are possible

Leading zeros in contiguous block could be represented by (::)

Example:

**2001:0db8:0000:130F:0000:0000:087C:140B**

**2001:0db8:0:130F::87C:140B**

Double colon only appears once in the address

# Addressing

## Prefix Representation

- Representation of prefix is just like CIDR
- In this representation you attach the prefix length
- Like v4 address:

198.10.0.0/16

- V6 address is represented the same way:

2001:db8:12::/48

- Only leading zeros are omitted. Trailing zeros are not omitted

2001:0db8:0012::/48 = 2001:db8:12::/48

2001:db8:**1200**::/48 ≠ 2001:db8:12::/48

# IPv6—Addressing Model

- Addresses are assigned to interfaces

Change from IPv4 mode:

- **Interface “expected” to have multiple addresses**

- Addresses have scope

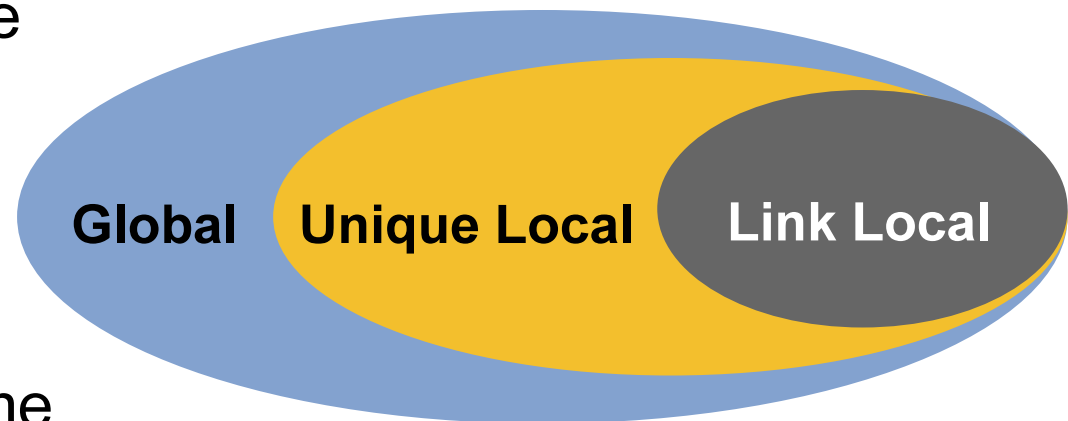
Link Local

Unique Local

Global

- Addresses have lifetime

Valid and preferred lifetime



# Types of IPv6 Addresses

- Unicast

Address of a single interface. One-to-one delivery to single interface

- Multicast

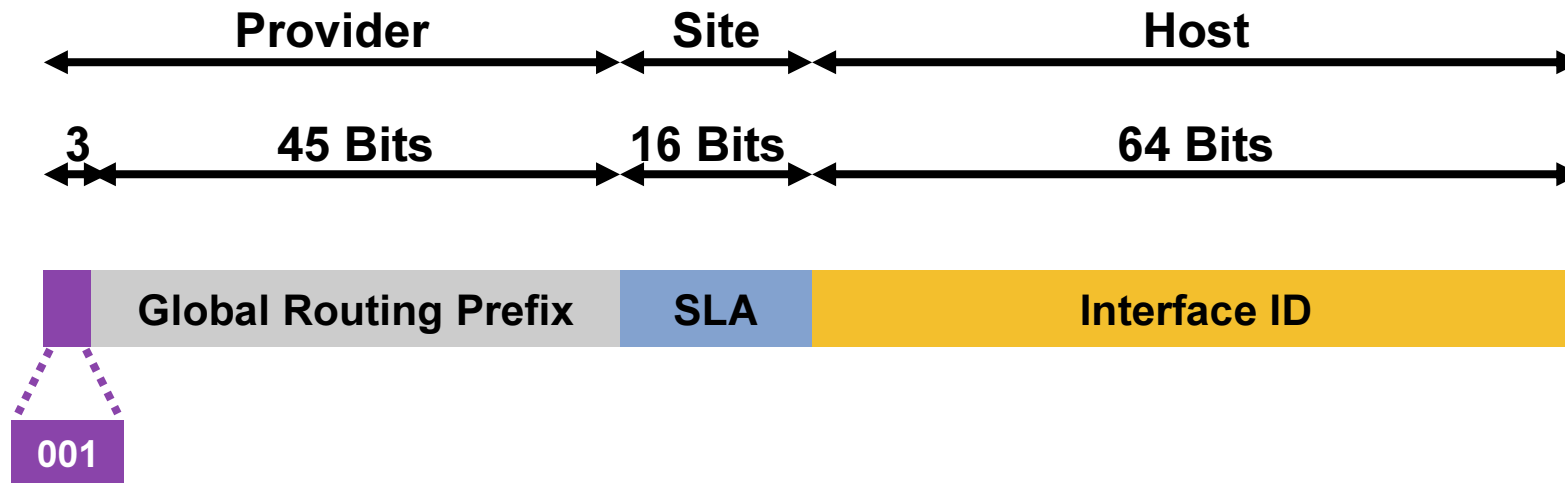
Address of a set of interfaces. One-to-many delivery to all interfaces in the set

- Anycast

Address of a set of interfaces. One-to-one-of-many delivery to a single interface in the set that is closest

- No more broadcast addresses

# Aggregatable Global Unicast Addresses

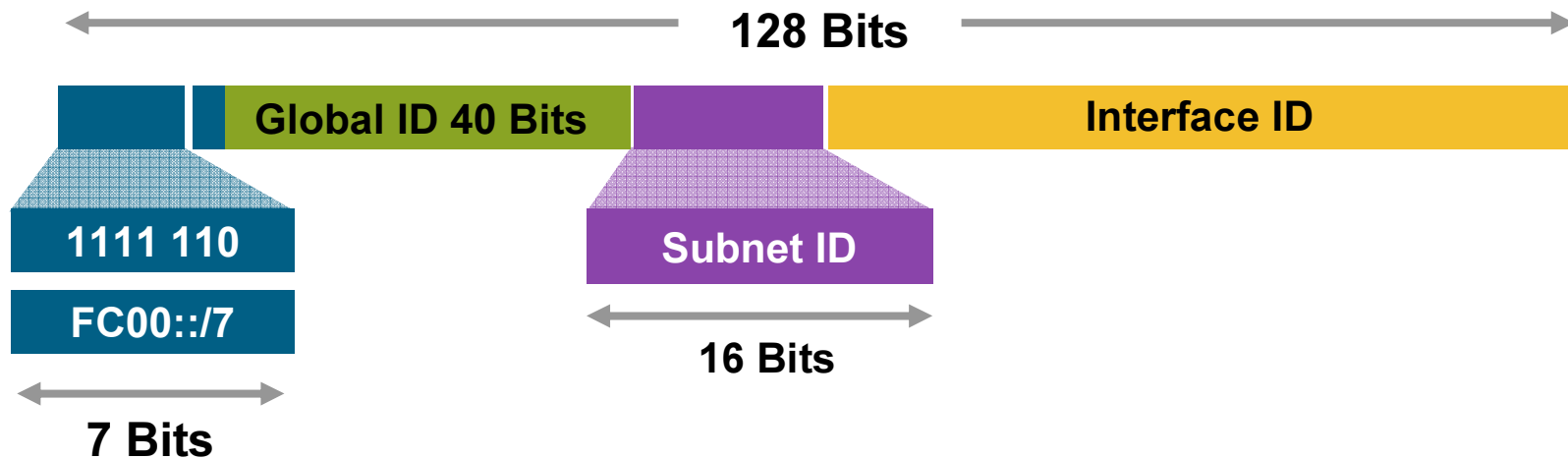


Aggregatable Global Unicast Addresses Are:

- Addresses for generic use of IPv6
- Structured as a hierarchy to keep the aggregation



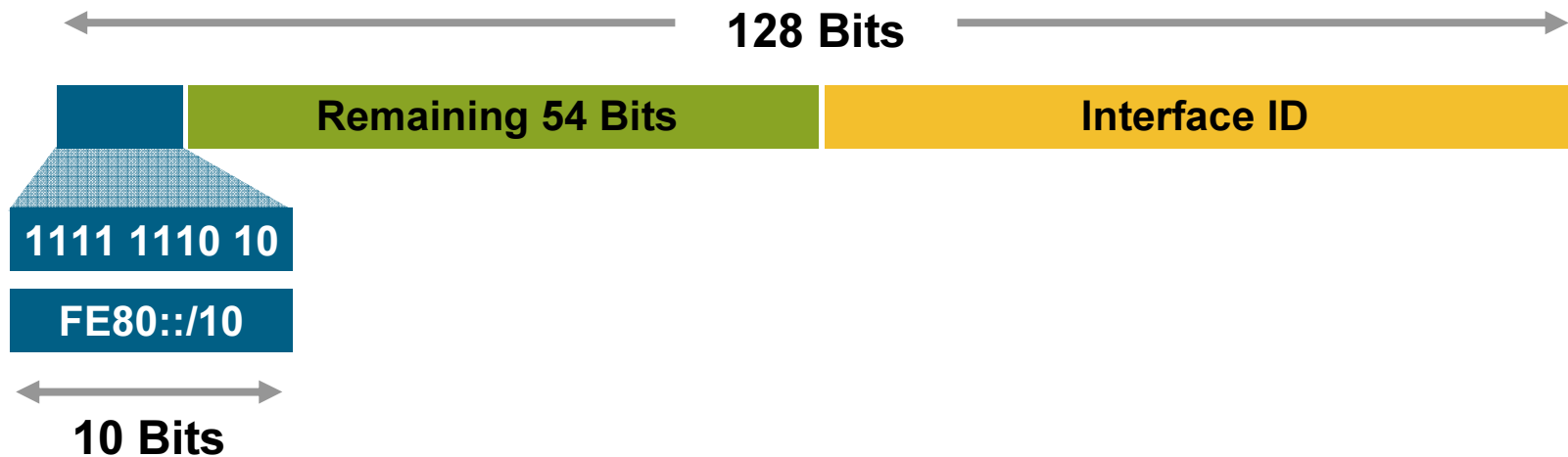
# Unique-Local



Unique-Local Addresses Used for:

- Local communications
- Inter-site VPNs
- Not routable on the Internet

# Link-Local



## Link-Local Addresses Used for:

- Mandatory Address for Communication between two IPv6 device (like ARP but at Layer 3)
- Automatically assigned by Router as soon as IPv6 is enabled
- Also used for Next-Hop calculation in Routing Protocols
- Only Link Specific scope
- Remaining 54 bits could be Zero or any manual configured value

# IPv6 Multicast Address

- IP multicast address has a prefix FF00::/8 (1111 1111); the second octet defines the lifetime and scope of the multicast address

8-bit	4-bit	4-bit	112-bit
1111 1111	Lifetime	Scope	Group-ID

Lifetime	
0	If Permanent
1	If Temporary

Scope	
1	Node
2	Link
5	Site
8	Organization
E	Global

# Some Well Known Multicast Addresses

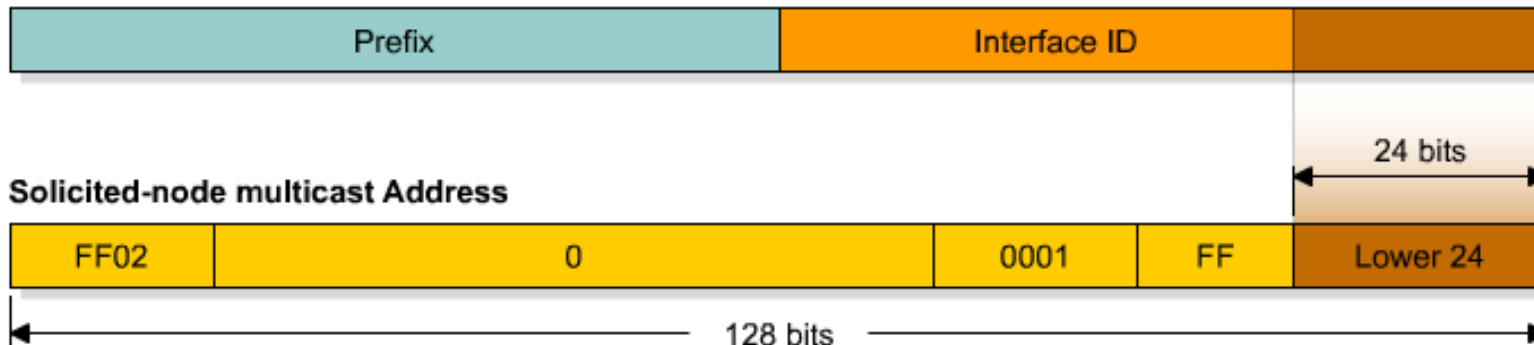
Address	Scope	Meaning
FF01::1	Node-Local	All Nodes
FF02::1	Link-Local	All Nodes
FF01::2	Node-Local	All Routers
FF02::2	Link-Local	All Routers
FF05::2	Site-Local	All Routers
FF02::1:FFXX:XXXX	Link-Local	Solicited-Node

- Note that 02 means that this is a permanent address and has link scope
- More details at <http://www.iana.org/assignments/ipv6-multicast-addresses>

# Solicited-Node Multicast Address

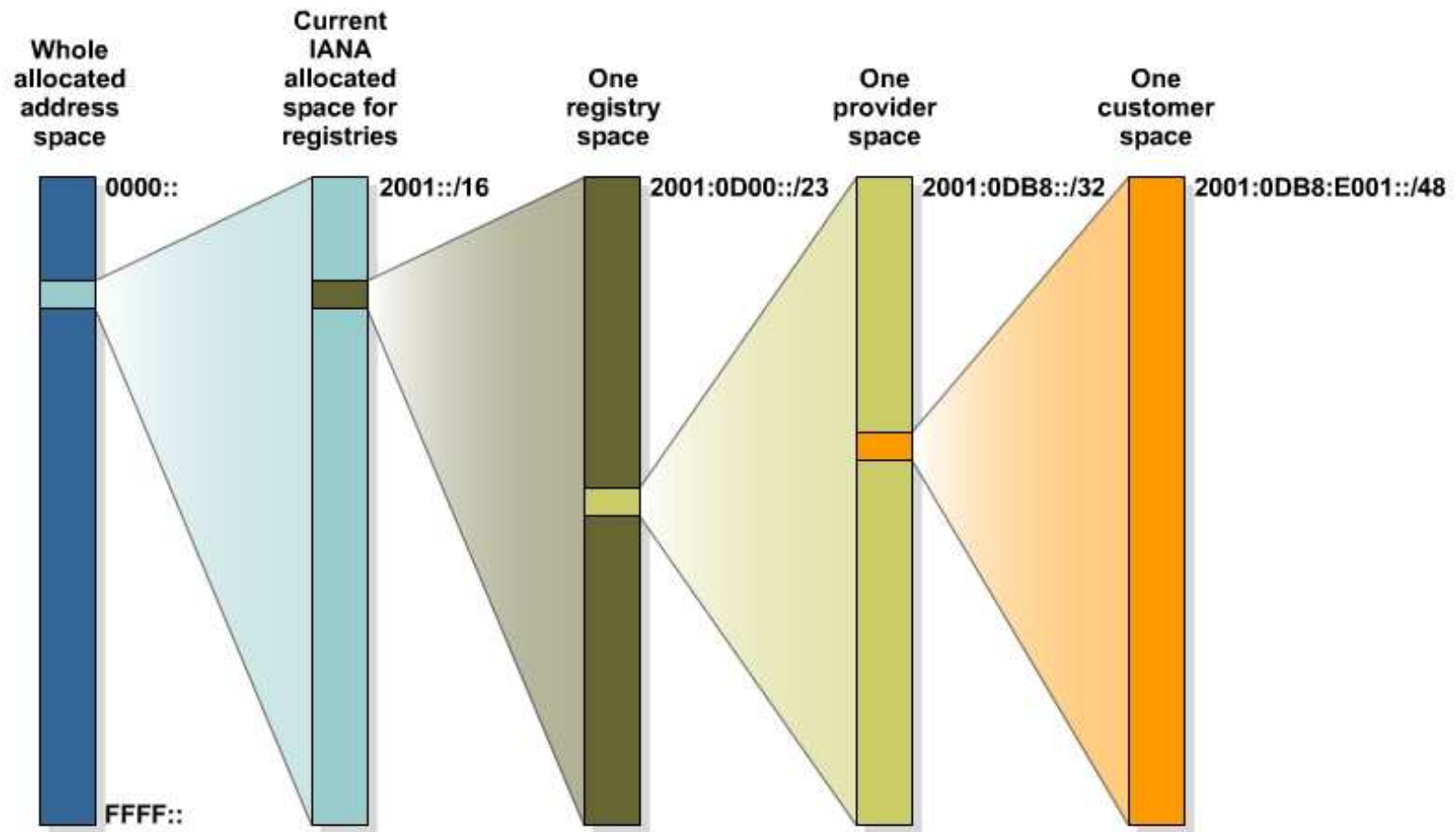
- For each unicast and anycast address configured there is a corresponding solicited-node multicast
- This is specially used for two purpose, for the replacement of ARP, and DAD
- Used in neighbor solicitation messages
- Multicast address with a link-local scope
- Solicited-node multicast consists of prefix + lower 24 bits from unicast, FF02::1:FF:

IPv6 Address



# IPv6 Address Allocation Process

## Partition of Allocated IPv6 Address Space



# IPv6 Address Allocation Process

## Partition of Allocated IPv6 Address Space (Cont.)

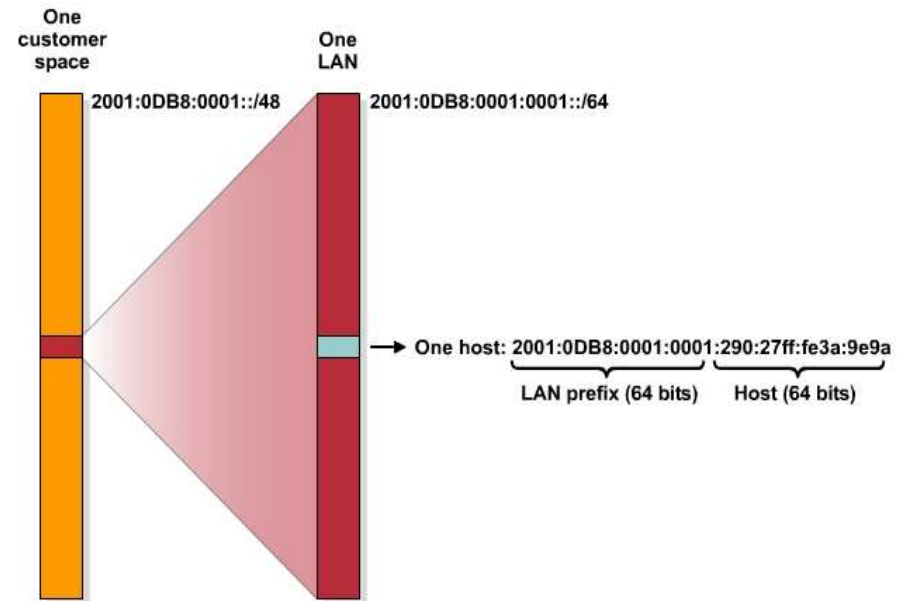
- Lowest-Order 64-bit field of unicast address may be assigned in several different ways:

Auto-configured from a 64-bit EUI-64, or expanded from a 48-bit MAC address (e.g., Ethernet address)

Auto-generated pseudo-random number (to address privacy concerns)

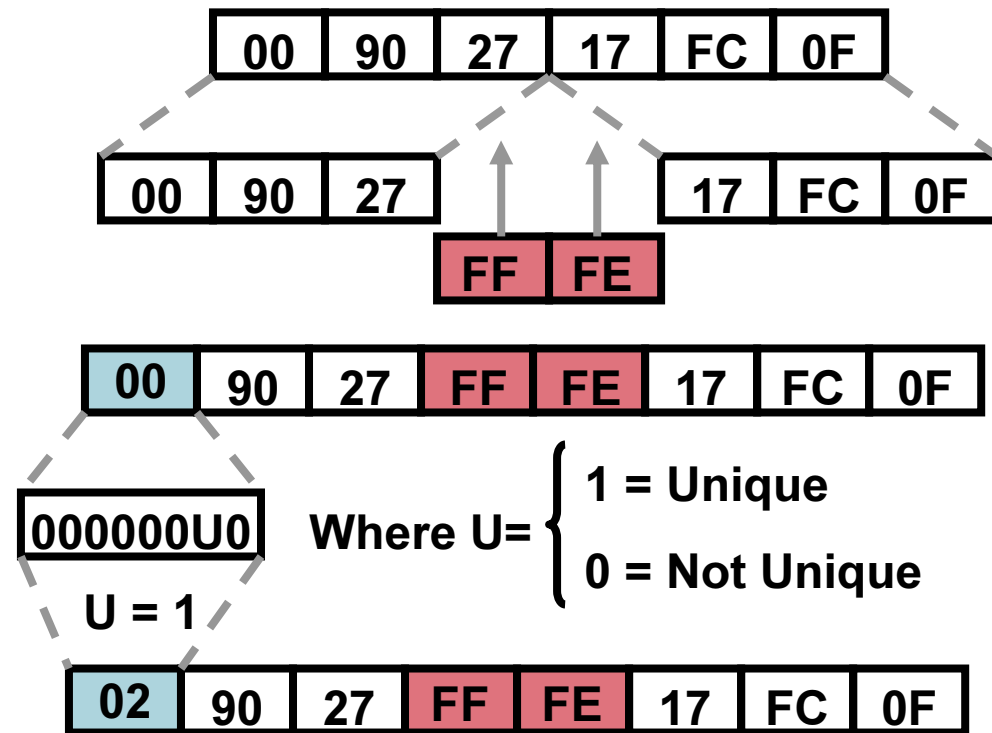
Assigned via DHCP

Manually configured



# IPv6 Interface Identifier

- Cisco uses the EUI-64 format to do stateless auto-configuration
- This format expands the 48 bit MAC address to 64 bits by inserting FFFE into the middle 16 bits
- To make sure that the chosen address is from a unique Ethernet MAC address, the universal/local (“u” bit) is set to 1 for global scope and 0 for local scope





# ICMPv6 and Neighbor Discovery



# ICMPv6

- Internet Control Message Protocol version 6
- RFC 2463
- Modification of ICMP from IPv4
- Message types are similar  
(but different types/codes)
  - Destination unreachable (type 1)
  - Packet too big (type 2)
  - Time exceeded (type 3)
  - Parameter problem (type 4)
  - Echo request/reply (type 128 and 129)

# Neighbor Discovery

- Neighbor discovery uses ICMPv6 messages, originated from node on link local with hop limit of 255
- Consists of IPv6 header, ICMPv6 header, neighbor discovery header, and neighbor discovery options
- Five neighbor discovery messages
  1. Router solicitation (ICMPv6 type 133)
  2. Router advertisement (ICMPv6 type 134)
  3. Neighbor solicitation (ICMPv6 type 135)
  4. Neighbor advertisement (ICMPv6 type 136)
  5. Redirect (ICMPv6 type 137)

# Router Solicitation and Advertisement



**1—ICMP Type = 133 (RS)**

**Src = link-local address (FE80::1/10)**

**Dst = all-routers multicast address (FF02::2)**

**Query = please send RA**

**2—ICMP Type = 134 (RA)**

**Src = link-local address (FE80::2/10)**

**Dst = all-nodes multicast address (FF02::1)**

**Data = options, subnet prefix, lifetime, autoconfig flag**

- Router solicitations (RS) are sent by booting nodes to request RAs for configuring the interfaces
- Routers send periodic Router Advertisements (RA) to the all-nodes multicast address

# Neighbor Solicitation and Advertisement



## Neighbor Solicitation

ICMP type = 135

Src = A

Dst = Solicited-node multicast of B

Data = link-layer address of A

Query = what is your link address?



## Neighbor Advertisement

ICMP type = 136

Src = B

Dst = A

Data = link-layer address of B



**A and B can now exchange  
packets on this link**

A large black double-headed arrow spanning the width of the diagram, indicating that A and B can now exchange packets on this link.

# Duplicate Address Detection

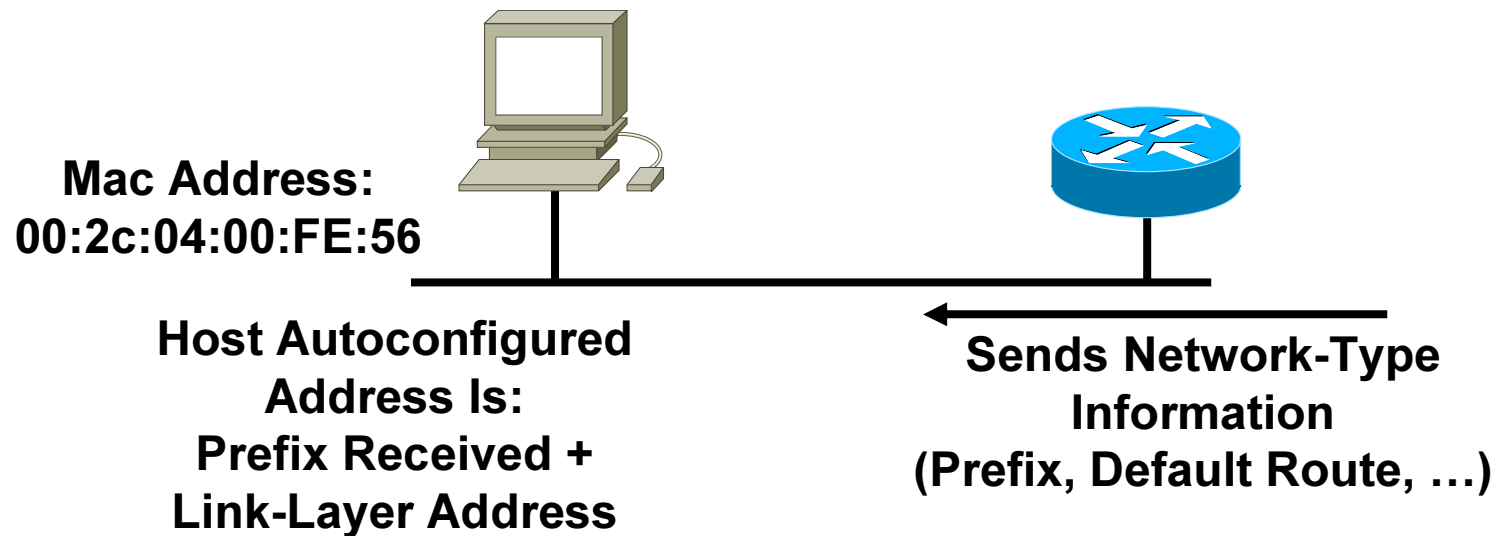


```
ICMP type = 135  
Src = 0 (:::)  
Dst = Solicited-node multicast of A  
Data = link-layer address of A  
Query = what is your link address?
```



- Duplicate Address Detection (DAD) uses neighbor solicitation to verify the existence of an address to be configured

# Autoconfiguration

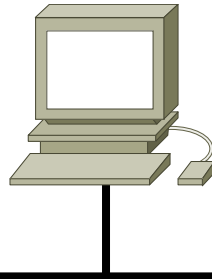


Larger Address Space Enables:

- The use of link-layer addresses inside the address space
- Autoconfiguration with “no collisions”
- Offers “plug and play”

# Renumbering

Mac Address:  
00:2c:04:00:FE:56



Host Autoconfigured  
Address Is:  
**New** Prefix Received  
+ Link-Layer Address



← Sends **New** Network-Type  
Information  
(Prefix, Default Route, ...)  
Data = Two prefixes:  
**Current prefix** (to be  
deprecated), with short  
lifetimes  
**New prefix** (to be used), with  
normal lifetimes

Larger Address Space Enables:

- Renumbering, using autoconfiguration and multiple addresses



# DHCP and DNS for IPv6



# DNS Basics

- DNS is a database managing Resource Records (RR)

Stockage of RR from various types—IPV4 and IPV6:

Start of Authority (SoA)

Name Server

Address—A and AAAA

Pointer—PTR

- DNS is an IP application

It uses either UDP or TCP on top of IPv4 or IPv6

- References

RFC3596: DNS Extensions to Support IP Version 6

RFC3363: Representing Internet Protocol Version 6 Addresses in Domain Name system (DNS)

RFC3364: Tradeoffs in Domain Name System (DNS) Support for Internet Protocol version 6 (IPv6)

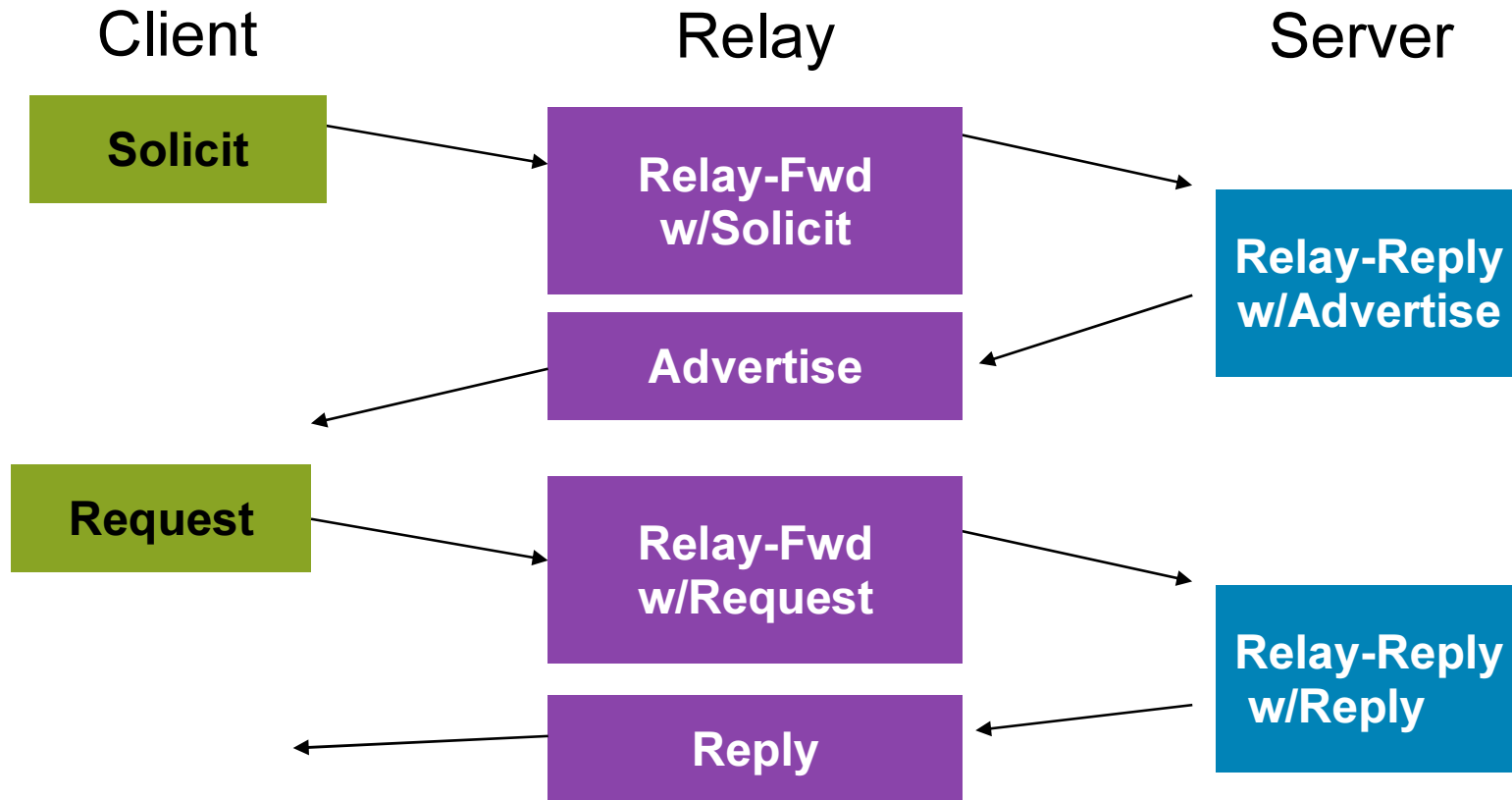
# IPv6 and DNS

	IPv4	IPv6
Hostname to IP address	<b>A record:</b> www.abc.test. A 192.168.30.1	<b>AAAA record:</b> www.abc.test AAAA 2001:db8:C18:1::2
IP address to hostname	<b>PTR record:</b> 1.30.168.192.in-addr.arpa. PTR www.abc.test.	<b>PTR record:</b> 2.0.1.0.0.0.8.1.c.0. 8.b.d.0.1.0.0.2.ip6.arpa PTR www.abc.test.

# DHCPv6

- Updated version of DHCP for IPv4
- Supports new addressing
- Can be used for renumbering
- DHCP Process is same as in IPv4, but,
- Client first detect the presence of routers on the link
- If found, then examines router advertisements to determine if DHCP can be used
- If no router found or if DHCP can be used, then
  - DHCP Solicit message is sent to the All-DHCP-Agents multicast address
  - Using the link-local address as the source address

# DHCPv6 Operation



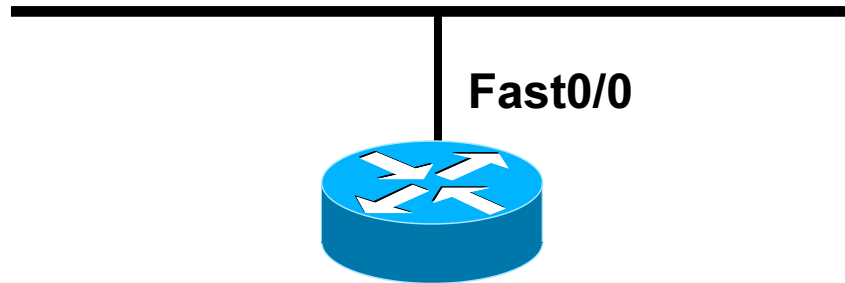
- All\_DHCP\_Relay\_Agents\_and\_Servers (FF02::1:2)
- All\_DHCP\_Servers (FF05::1:3)
- DHCP Messages: Clients listen UDP port 546; servers and relay agents listen on UDP port 547

# IPv6 Configurations



# IOS IPv6 Addressing Examples (1)

## Manual Interface Identifier

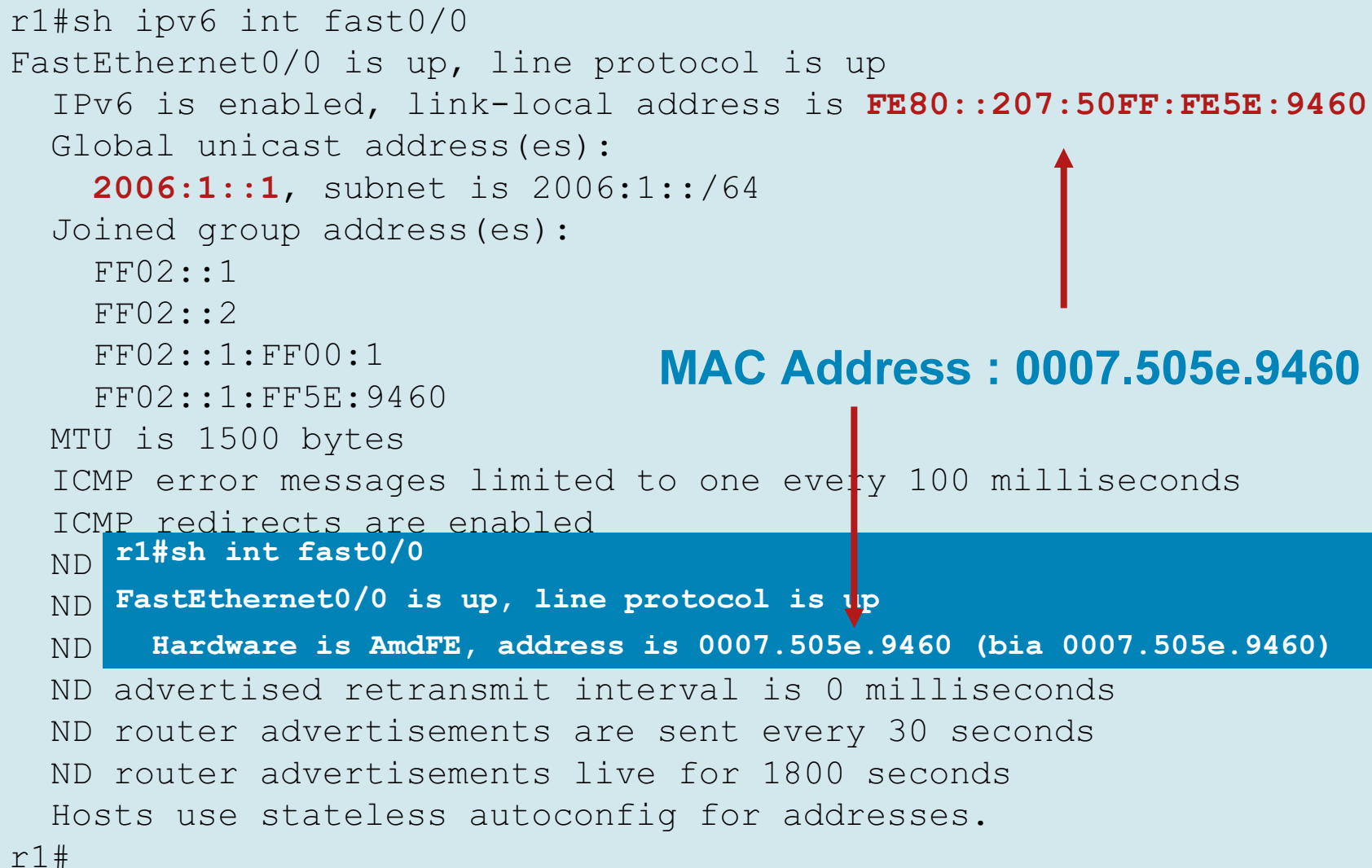


```
ipv6 unicast-routing
!  
interface FastEthernet0/0  
 ip address 10.151.1.1 255.255.255.0  
 ip pim sparse-mode  
 duplex auto  
 speed auto  
 ipv6 address 2006:1::1/64  
 ipv6 enable  
 ipv6 nd ra-interval 30  
 ipv6 nd prefix 2006:1::/64 300 300  
!
```

# IOS IPv6 Addressing Examples (1)

## Manual Interface Identifier

```
r1#sh ipv6 int fast0/0
FastEthernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::207:50FF:FE5E:9460
Global unicast address(es):
  2006:1::1, subnet is 2006:1::/64
Joined group address(es):
  FF02::1
  FF02::2
  FF02::1:FF00:1
  FF02::1:FF5E:9460
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ND r1#sh int fast0/0
ND FastEthernet0/0 is up, line protocol is up
ND Hardware is AmdFE, address is 0007.505e.9460 (bia 0007.505e.9460)
ND advertised retransmit interval is 0 milliseconds
ND router advertisements are sent every 30 seconds
ND router advertisements live for 1800 seconds
Hosts use stateless autoconfig for addresses.
r1#
```

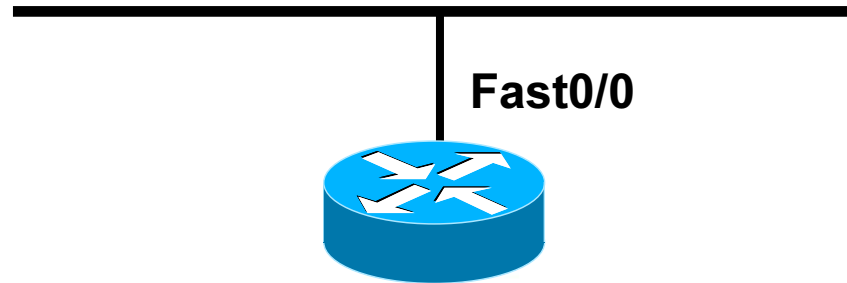


**MAC Address : 0007.505e.9460**



# IOS IPv6 Addressing Examples (2)

## EUI-64 Interface Identifier



```
ipv6 unicast-routing
!  
interface FastEthernet0/0  
 ip address 10.151.1.1 255.255.255.0  
 ip pim sparse-mode  
 duplex auto  
 speed auto  
 ipv6 address 2006:1::/64 eui-64  
 ipv6 enable  
 ipv6 nd ra-interval 30  
 ipv6 nd prefix 2006:1::/64 300 300  
!
```

# IOS IPv6 Addressing Examples (2)

## EUI-64 Interface Identifier

```
r1#sh ipv6 int fast0/0
FastEthernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::207:50FF:FE5E:9460
Global unicast address(es):
  2006:1::207:50FF:FE5E:9460, subnet is 2006:1::/64
Joined group address(es):
  FF02::1
  FF02::2
  FF02::1:FF5E:9460
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP
r1#sh int fast0/0
FastEthernet0/0 is up, line protocol is up
Hardware is AmdFE, address is 0007.505e.9460 (bia 0007.505e.9460)
ND advertised reachable time is 0 milliseconds
ND advertised retransmit interval is 0 milliseconds
ND router advertisements are sent every 30 seconds
ND router advertisements live for 1800 seconds
Hosts use stateless autoconfig for addresses.
r1#
```

**MAC Address : 0007.505e.9460**

# IPv6 Routing



# Static Routing



# Static Routing

*ipv6 route ipv6-prefix/prefix-length {ipv6-address | interface-type interface-number [ipv6-address]} [administrative-distance] [administrative-multicast-distance | unicast | multicast] [tag tag]*

## Examples:

- Forward packets for network 2001:DB8::0/32 through 2001:DB8:1:1::1 with an administrative distance of 10

```
Router(config)# ipv6 route 2001:DB8::0/32 2001:DB8:1:1::1 10
```

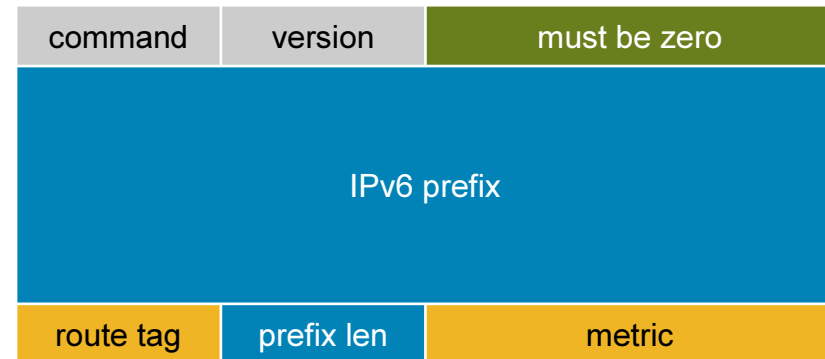
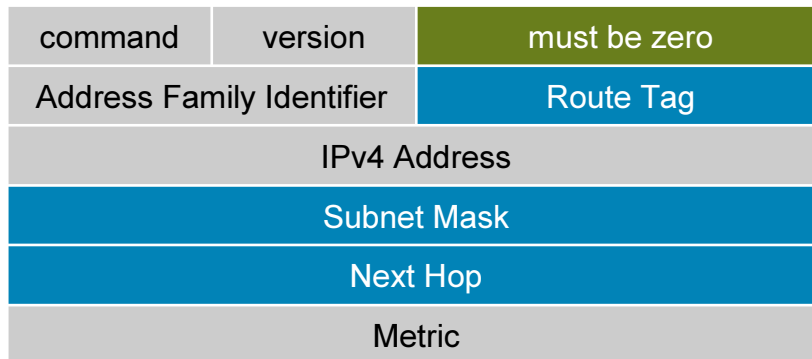
- Default route to 2001:DB8:1:1::1

```
Router(config)# ipv6 route ::/0 2001:DB8:1:1::1
```

# RIPng (RFC 2080)

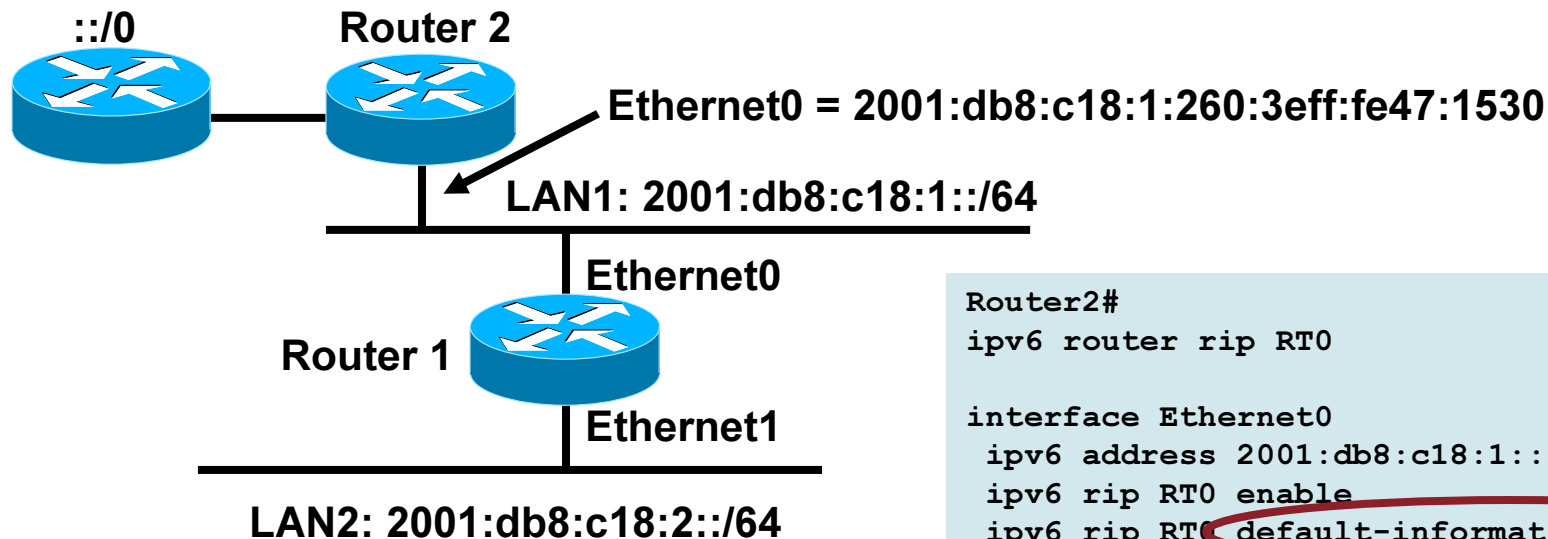


# Enhanced Routing Protocol Support RIPng Overview RFC 2080



- Similar characteristics as IPv4
  - Distance-vector, hop limit of 15, split-horizon, multicast based (**FF02::9**), UDP port (**521**) etc.
- Updated features for IPv6
  - IPv6 prefix & prefix len
- Special Handling for the NH
  - Route tag and prefix len for NH is all 0. Metric will have 0xFF; NH must be link local

# Enhanced Routing Protocol Support RIPng Configuration and Display



```
Router1#
ipv6 router rip RT0

interface Ethernet0
  ipv6 address 2001:db8:c18:1::/64 eui-64
  ipv6 rip RT0 enable
Interface Ethernet1
  ipv6 address 2001:db8:c18:2::/64 eui-64
  ipv6 rip RT0 enable
```

```
Router2#
ipv6 router rip RT0

interface Ethernet0
  ipv6 address 2001:db8:c18:1::/64 eui-64
  ipv6 rip RT0 enable
  ipv6 rip RT0 default-information originate
```

```
Router2# debug ipv6 rip
RIPng: Sending multicast update on Ethernet0 for RT0
src=FE80::260:3eff:fe47:1530
dst=FF02::9 (Ethernet0)
sport=521, dport=521, length=32
command=2, version=1, mhz=0, #rte=1
tag=0, metric=1, prefix=::/0
```

Multicast All  
RIP-Routers

Link-Local  
src Address



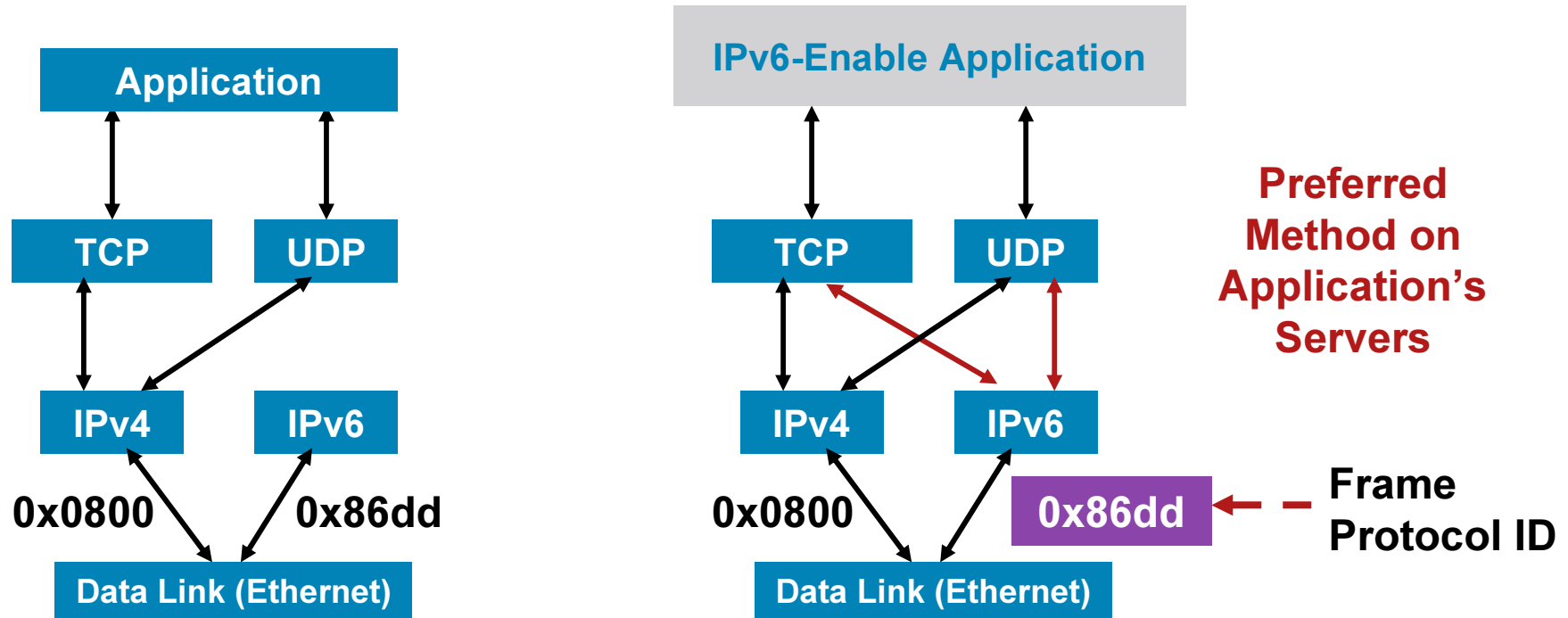
# Deployment Options



# IPv4-IPv6 Transition/Coexistence

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

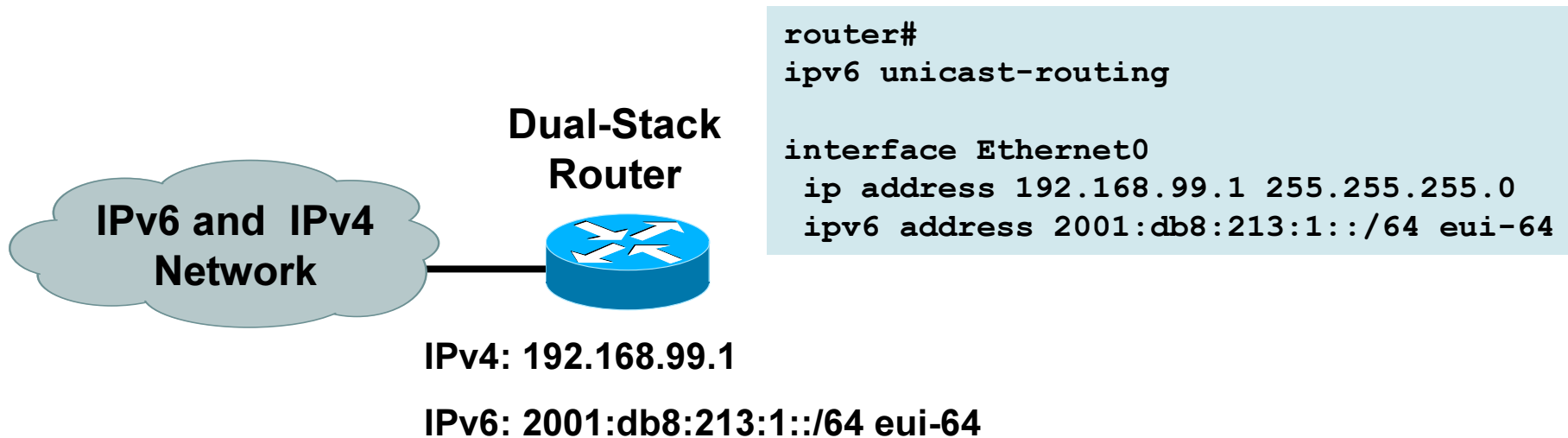
# Dual Stack Approach



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

# Cisco IOS Dual Stack Configuration



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, etc.

# Tunneling



# Tunneling

## Many Ways to Do Tunneling

- Some ideas same as before

GRE, MPLS, IP

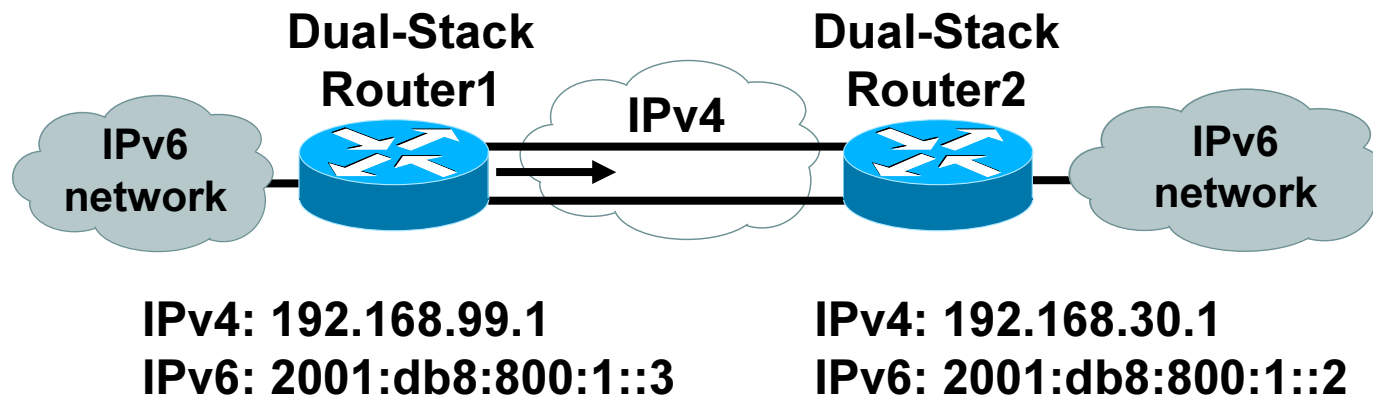
- Native IP over data link layers

ATM PVC, dWDM Lambda, Frame Relay PVC, Serial,  
Sonet/SDH, Ethernet

- Some new techniques

Automatic tunnels using IPv4 , compatible IPv6 address,  
6to4, ISATAP

# Manually Configured IPv6 over IPv4 Tunnel



```
router1#
```

```
interface Tunnel0
  ipv6 enable
  ipv6 address 2001:db8:c18:1::3/127
  tunnel source 192.168.99.1
  tunnel destination 192.168.30.1
  tunnel mode ipv6ip
```

```
router2#
```

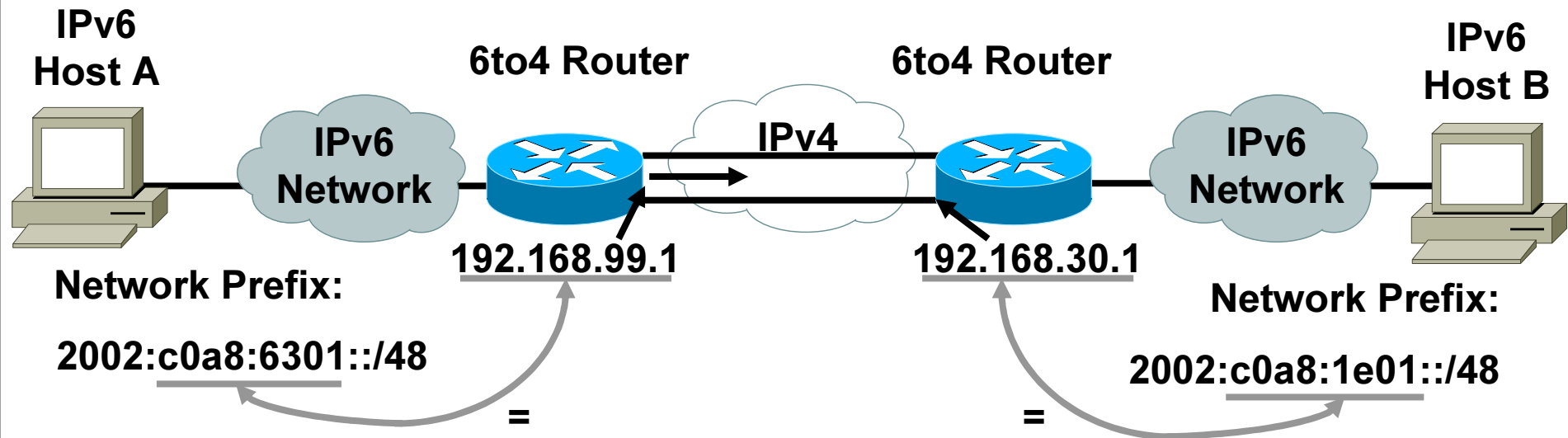
```
interface Tunnel0
  ipv6 enable
  ipv6 address 2001:db8:c18:1::2/127
  tunnel source 192.168.30.1
  tunnel destination 192.168.99.1
  tunnel mode ipv6ip
```

# 6to4 Tunneling





# Automatic 6to4 Tunnel (RFC 3056)



6to4:

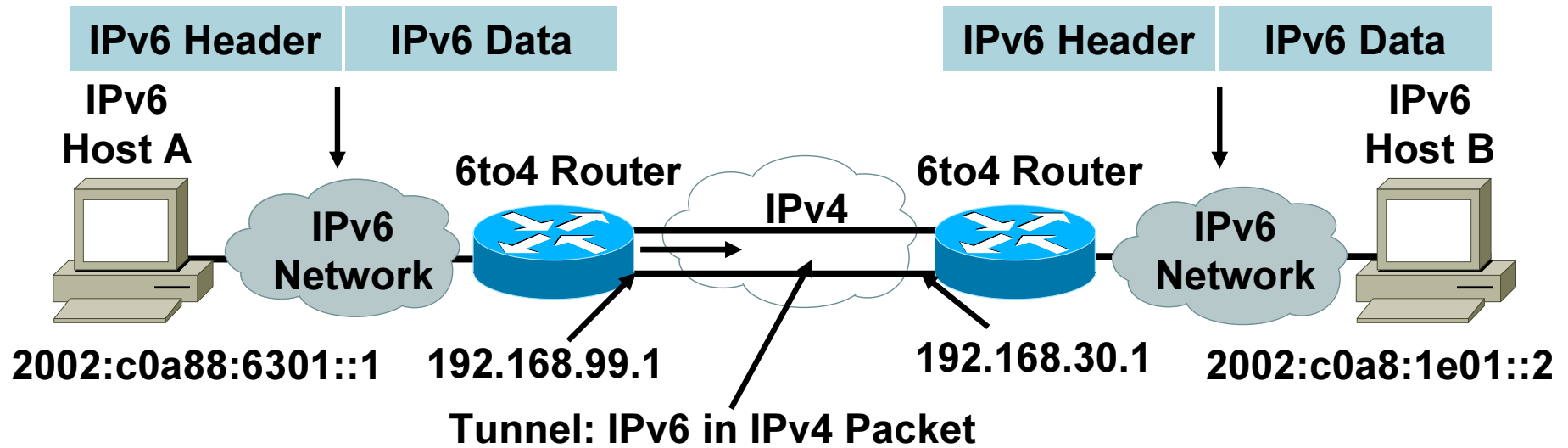
- Is an automatic tunnel method
- Gives a prefix to the attached IPv6 network



# Automatic 6to4 Tunnel (RFC 3056)

S=2002:c0a8:6301::1  
D=2002:c0a8:1e01::2

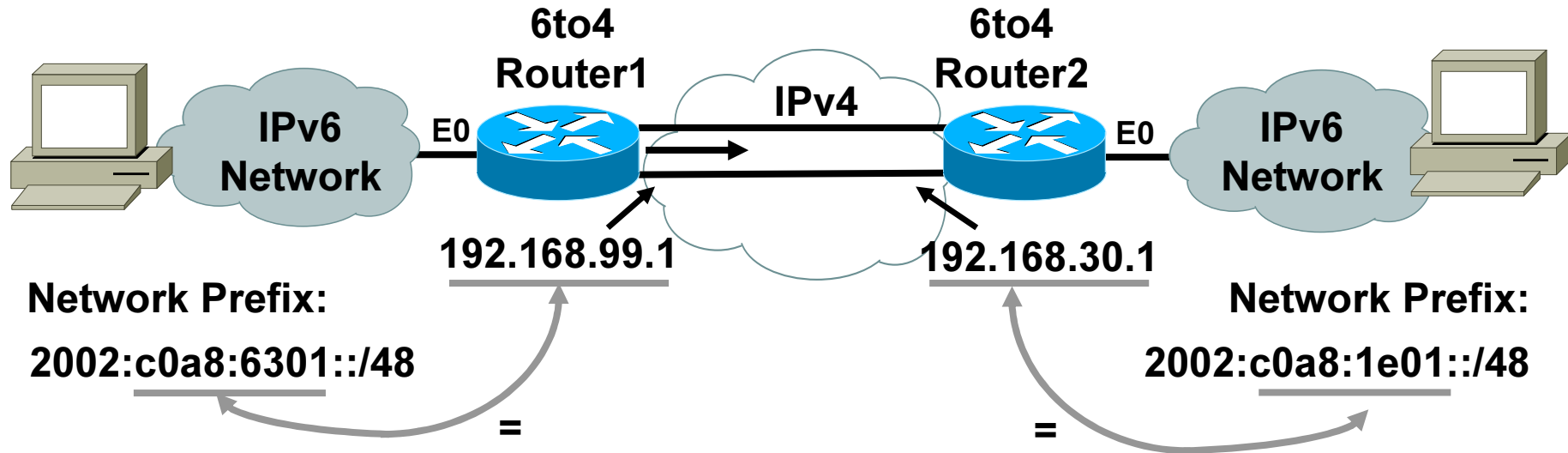
S=2002:c0a8:6301::1  
D=2002:c0a8:1e01::2



IPv4 Header    IPv6 Header    IPv6 Data

S(v4)=192.168.99.1  
D(v4)=192.168.30.1  
S(v6)=2002:c0a8:6301::1  
D(v6)=2002:c0a8:1e01::2

# Automatic 6to4 Configuration



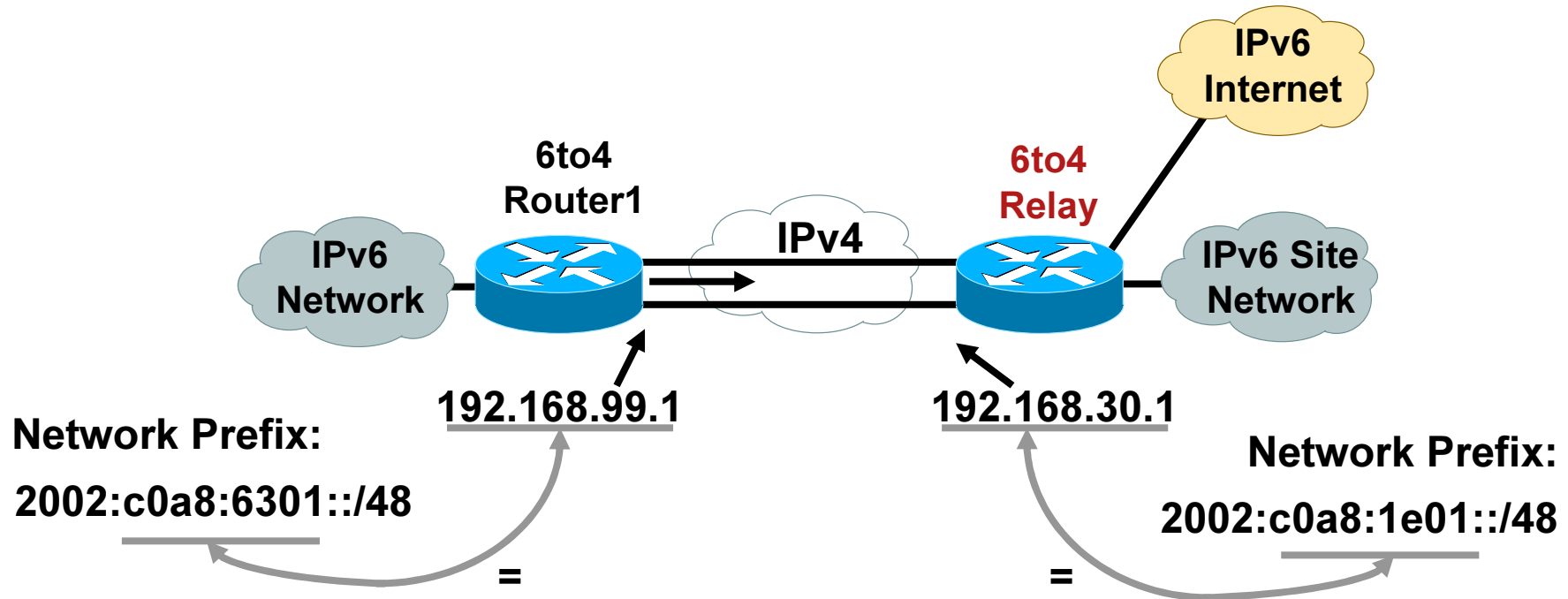
```
router1#
interface Ethernet0
  ipv6 address 2002:c0a8:6301:1::/64 eui-64
Interface Ethernet1
  ip address 192.168.99.1 255.255.0.0
interface Tunnel0
  ipv6 unnumbered Ethernet0
  tunnel source Ethernet1
  tunnel mode ipv6ip 6to4

ipv6 route 2002::/16 Tunnel0
```

```
router2#
interface Ethernet0
  ipv6 address 2002:c0a8:1e01:1::/64 eui-64
Interface Ethernet1
  ip address 192.168.30.1 255.255.0.0
interface Tunnel0
  ipv6 unnumbered Ethernet0
  tunnel source Ethernet1
  tunnel mode ipv6ip 6to4

ipv6 route 2002::/16 Tunnel0
```

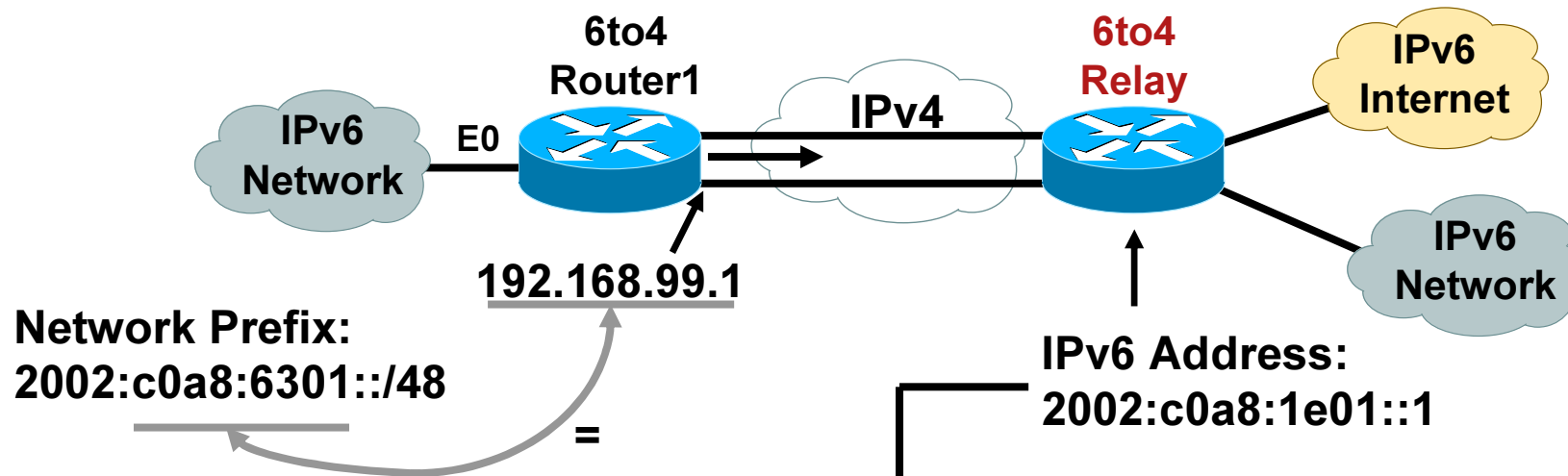
# Automatic 6to4 Relay



## 6to4 Relay:

- Is a gateway to the rest of the IPv6 Internet
- Is a default router

# Automatic 6to4 Relay Configuration



```
router1#  
interface Ethernet0  
  ipv6 address 2002:c0a8:6301:1::/64 eui-64  
Interface Ethernet1  
  ip address 192.168.99.1 255.255.0.0  
interface Tunnel0  
  no ip address  
  ipv6 unnumbered Ethernet0  
  tunnel source Ethernet1  
  tunnel mode ipv6ip 6to4  
  
ipv6 route 2002::/16 Tunnel0  
ipv6 route ::/0 2002:c0a8:1e01::1
```

# ISATAP Tunneling

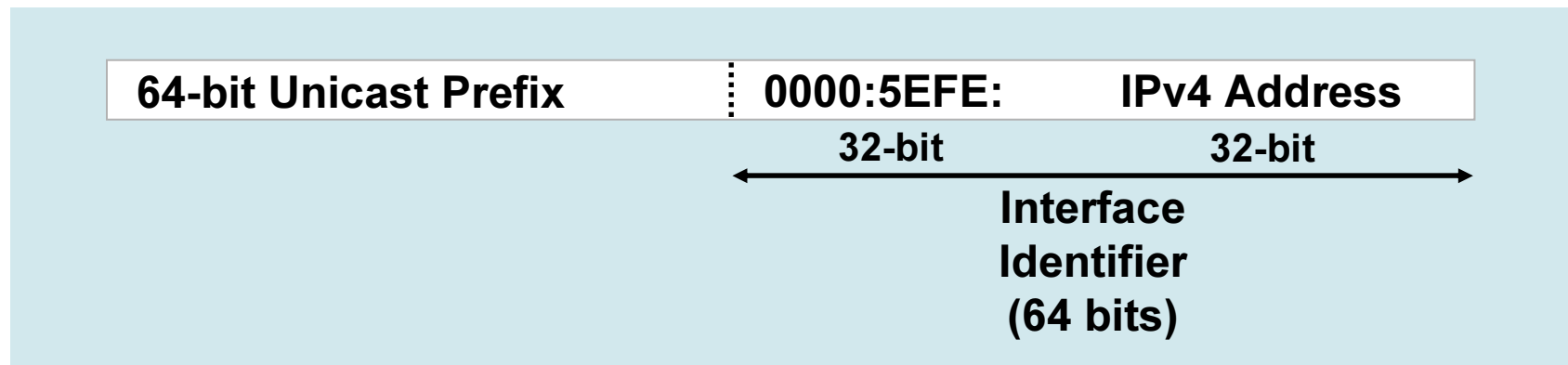


# Intrasite Automatic Tunnel Address Protocol

- RFC 4214
- To deploy a router is identified that carries ISATAP services
- ISATAP routers need to have at least one IPv4 interface and 0 or more IPv6 interface
- DNS entries are created for each of the ISATAP routers IPv4 addresses
- Hosts will automatically discover ISATAP routers and can get access to global IPv6 network
- Host can apply the ISATAP service before all this operation but its interface will only have a link local v6 address until the first router appears

# Intrasite Automatic Tunnel Address Protocol

Use IANA's OUI 00-00-5E and  
Encode IPv4 Address as Part of EUI-64



- ISATAP is used to tunnel IPv4 within as administrative domain (a site) to create a virtual IPv6 network over a IPv4 network
- Supported in Windows XP Pro SP1 and others



# IPv6 Campus ISATAP Configuration

- Supported in Windows XP Pro SP1 and others
- ISATAP connections look like one flat network
- Create DNS “A” record for “ISATAP” = 10.1.1.1
- Use Static Config if DNS use is not desired:  

```
C:\>netsh interface ipv6 isatap set  
router 10.1.1.1
```
- **Currently ISATAP does not support multicast!!**

## ISATAP Address Format:

64-bit Unicast Prefix

0000:5EFE:

IPv4 Address

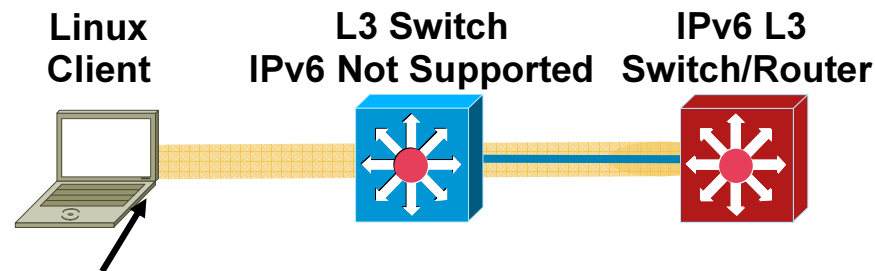
32-bit

32-bit

Interface ID

**2001:DB8:C003:111F:0:5EFE:10.1.2.100**

# Client Configuration (Linux): ISATAP Tunnels



10.1.1.100—Client IPv4 address

2001:DB8:C003:111f:0:5efe:10.1.1.100—IPv6 address

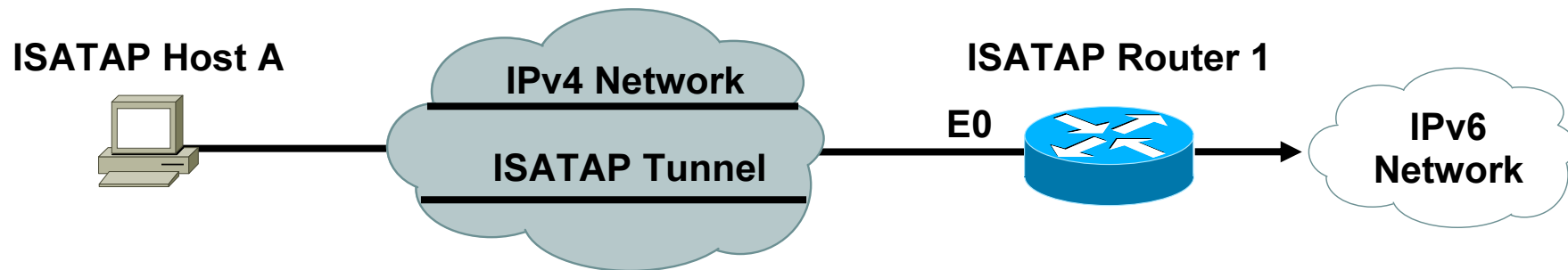
- IPv6-enabled
- Requires Kernel support for ISATAP—USAGI
- Modified IProute package—USAGI
- Must configure ISATAP router—**not** automatic

Host IP

Router IP

```
# ip tunnel add is0 mode isatap 10.1.1.100 v4any 30.1.1.1 ttl 64
# ip link set is0 up
```

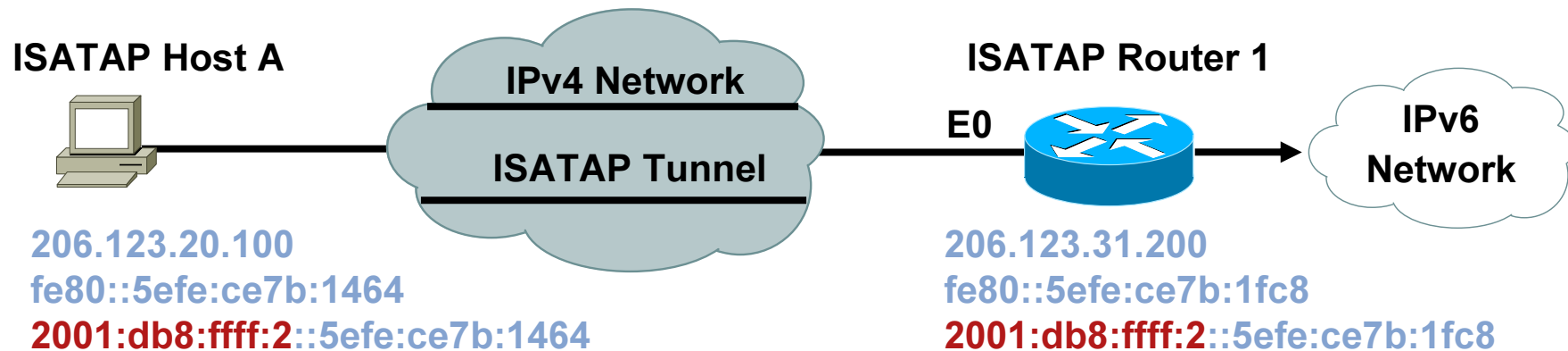
# Automatic Advertisement of ISATAP Prefix



ICMPv6 Type 133 (RS)  
IPv4 Source: 206.123.20.100  
IPv4 Destination: 206.123.31.200  
IPv6 Source: fe80::5efe:ce7b:1464  
IPv6 Destination: fe80::5efe:ce7b:1fc8  
Send me ISATAP Prefix

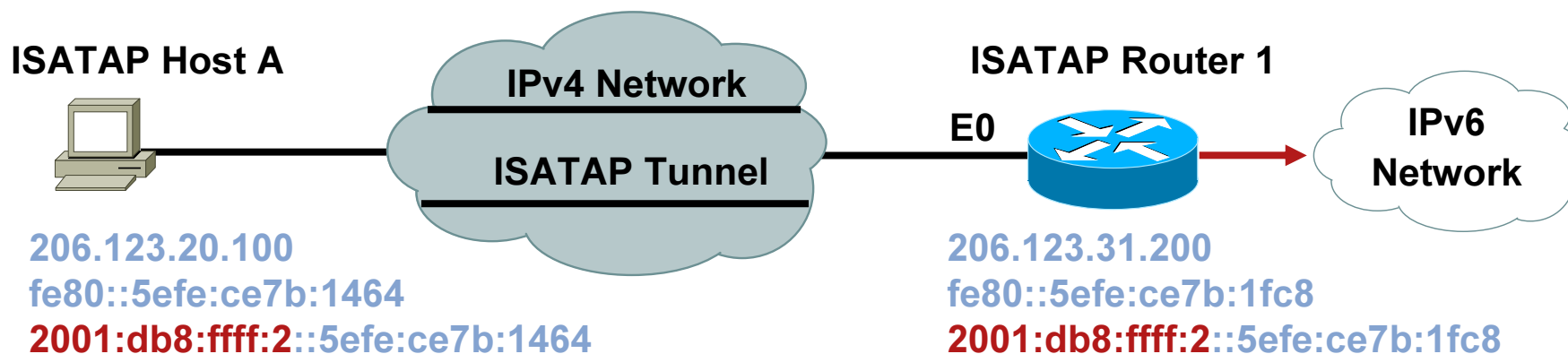
ICMPv6 Type 134 (RA)  
IPv4 Source: 206.123.31.200  
IPv4 Destination: 206.123.20.100  
IPv6 Source: fe80::5efe:ce7b:1fc8  
IPv6 Destination: fe80::5efe:ce7b:1464  
**ISATAP Prefix: 2001:db8:fff :2::/64**

# Automatic Address Assignment of Host and Router



- ISATAP host A receives the ISATAP prefix `2001:db8:ffff:2::/64` from ISATAP Router 1
- When ISATAP host A wants to send IPv6 packets to `2001:db8:ffff:2::5efe:ce7b:1fc8`, ISATAP host A encapsulates IPv6 packets in IPv4. The IPv4 packets of the IPv6 encapsulated packets use IPv4 source and destination address.

# Automatic Configuring ISATAP



```
ISATAP-router1#  
!  
interface Ethernet0  
 ip address 206.123.31.200 255.255.255.0  
!  
interface Tunnel0  
 ipv6 address 2001:db8:ffff:2::/64 eui-64  
 no ipv6 nd suppress-ra  
 tunnel source Ethernet0  
 tunnel mode ipv6ip isatap
```

- The tunnel source command must point to an interface with an IPv4 address configured
- Configure the ISATAP IPv6 address, and prefixes to be advertised just as you would with a native IPv6 interface
- The IPv6 address has to be configured as an EUI-64 address since the last 32 bits in the interface identifier is used as the IPv4 destination address

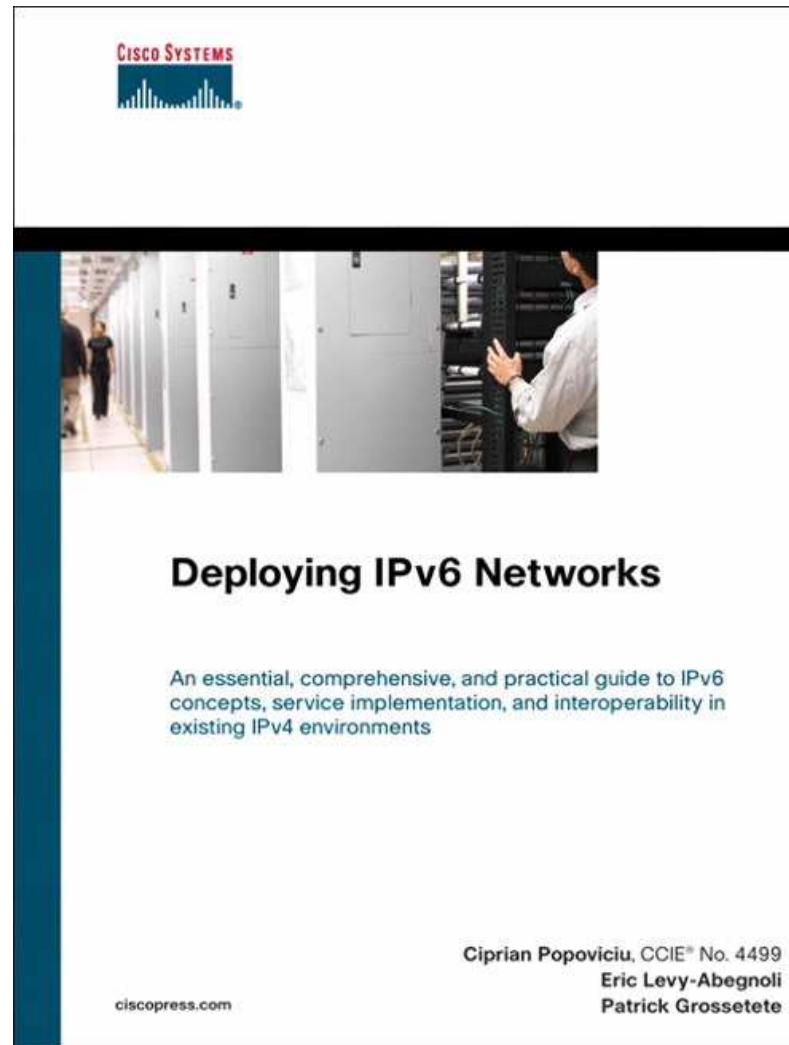
# Conclusion

- IPv6 is **real!**
- Start now rather than later
  - Purchase for the future
  - Start moving legacy application towards IPv6 support
  - Test, test and then test some more!
- Integration can be done per Application (Dual Stack or Tunneled)
- Microsoft Vista and Longhorn have IPv6 enabled by default and **preferred** over IPv4
- Things to consider:
  - Don't assume your favorite vendor/app/gear has an IPv6 plan
  - Full parity between IPv4 and IPv6 is still a ways off
  - Watch the standards and policies: <http://www.ietf.org> & [http://www.arin.net/policy/proposals/2006\\_4.html](http://www.arin.net/policy/proposals/2006_4.html)
- Enterprise and SP Deployment Scenarios:
  - [ISP IPv6 Deployment Scenarios in Broadband Access Networks \(RFC 4779\)](#)
  - [Scenarios and Analysis for Introducing IPv6 into ISP Networks \(RFC 4029\)](#)
  - [IPv6 Enterprise Network Scenarios \(RFC 4057\)](#)
  - [Procedures for Renumbering an IPv6 Network without a Flag Day \(RFC 4192\)](#)

# Q and A



# Recommended Reading





# More Information

- CCO IPv6

<http://www.cisco.com/ipv6>

- IPv6 e-Learning [requires CCO username/password]

<http://www.cisco.com/warp/customer/732/Tech/ipv6/elearning/>

- IPv6 Access Services

[http://www.cisco.com/warp/public/732/Tech/ipv6/docs/ipv6\\_access\\_wp\\_v2.pdf](http://www.cisco.com/warp/public/732/Tech/ipv6/docs/ipv6_access_wp_v2.pdf)

- ICMPv6 Packet Types and Codes TechNote

<http://www.cisco.com/warp/customer/105/icmpv6codes.html>

