Chapter 7

IP Addressing Services

Part II

Internet Protocol Version 6
IPv6

IPv6 – Why We Need More Address Space

- The IPv4 address space provides approximately 4,294,967,296 unique addresses.
    - Only 3.7 billion addresses are assignable.
        - Separates the addresses into classes.
        - Reserves addresses for multicasting, testing, and other specific uses.
    - As of January, 2007, approximately 2.4 billion of the available IPv4 addresses are already assigned to end users or ISPs.
    - Despite the large number, IPv4 address space is running out.

IPv6 – Why We Need More Address Space

IPv4 Address Allocation

1993

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
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240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Allocated

Unavailable

Available

16,777,216 addresses

IPv6 – Why We Need More Address Space

IPv4 Address Allocation

2000

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
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Available

16,777,216 addresses

IPv6 – Why We Need More Address Space

IPv4 Address Allocation

2007

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16,777,216 addresses

IPv6 – Why We Need More Address Space

IPv4 Address Allocation

August 2009

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Allocated

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16,777,216 addresses

http://www.personal.psu.edu/dvm105/blogs/ipv6/

IPv6 – Why We Need More Address Space

IPv4 Address Allocation

April 2010

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Allocated

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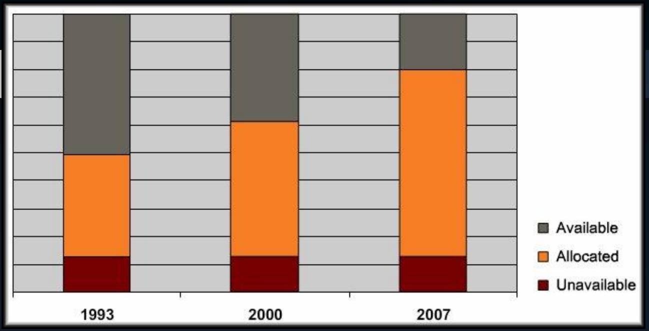
16,777,216 addresses

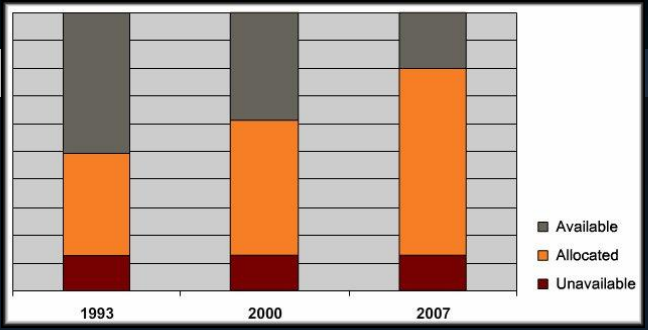
http://www.iana.org/assignments/ipv4-address-space/

IPv6 – Why Is Address Space Shrinking?



- Population Growth:
  - The Internet population is growing.
  - November 2005, Cisco estimate: 973 million users.
  - This number has doubled since then.
    - Users stay on longer.
    - Reserve IP addresses for longer periods.
    - Contacting more and more peers daily.
- Mobile Users:
    - More than one billion mobile phones.
    - More than 20 million IP-enabled mobile devices.

IPv6 – Why Is Address Space Shrinking?



- Transportation:
  - There will be more than one billion automobiles by 2008.
  - Newer models are IP-enabled to allow remote monitoring.
- Consumer Electronics:
  - The newest home appliances allow remote monitoring using IP technology.
    - e.g. Digital Video Recorders (DVRs) that download and update program guides.
    - Home networking.

Reasons for Using IPv6

- The ability to scale networks for future demands requires a limitless supply of IP addresses and improved mobility.
  - DHCP and NAT alone cannot meet these requirements.
  - IPv6 satisfies the increasingly complex requirements of hierarchical addressing that IPv4 does not provide.

IPv4: 4 octets
11000000.10101000.00001010.01100101
192.168.10.101
4,294,467,295 (2^32) IP addresses

IPv6: 16 octets
11010001.11011100.11001001.01110001.11011100. 11001100.01110001.11010001.11011100.11001001. 11010001.11011100.11001001.01110001.00000010.11011110
A524:72D3:2C80:DD02:0029:EC7A:002B:EA73
3.4 x 10^38 IP addresses

Reasons for Using IPv6

- Address Availability:
  - IPv4: 4 octets - 32 bits
    - 2^32 or 4,294,467,295 IP Addresses.
  - IPv6: 16 octets - 128 bits
    - 3.4 x 10^38 or

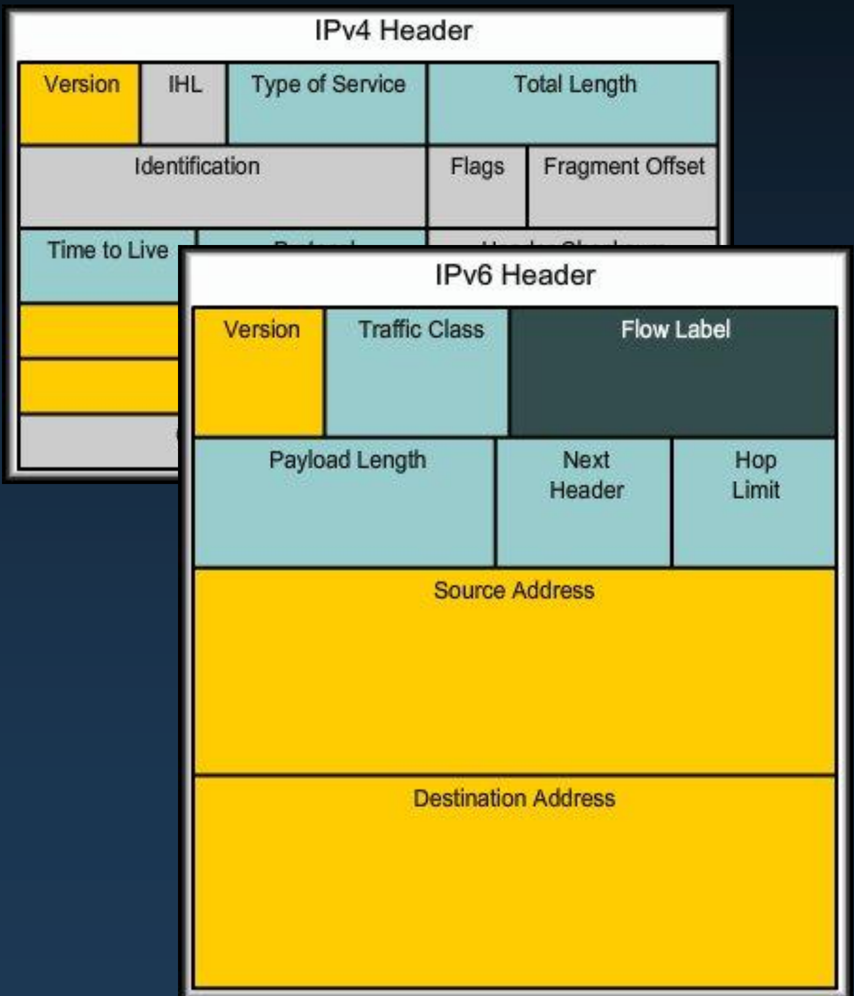
340,282,366,920,938,463,463,374,607,431,768,211,456

(340 undecillion) IP Addresses.

  - *Every atom of every person on Earth could be assigned 7 unique addresses with some to spare (assuming 7×10^{27} atoms per human x 6.5 Billion).*
  - *6×10^{27} IP/cm2*

Reasons for Using IPv6

- IPv6 Advanced Features:



Enhanced IP addressing:
- Global reachability and flexibility
- Aggregation
- Multihoming
- Autoconfiguration
- Plug-and-play
- End-to-end without NAT
- Renumbering

Mobility and security:
- Mobile IP RFC-compliant
- IPsec mandatory (or native) for IPv6

Simple header:
- Routing efficiency
- Performance and forwarding rate scalability
- No broadcasts
- No checksums
- Extension headers
- Flow labels

Transition richness:
- Dual-stack
- 6to4 and manual tunnels
- Translation

IPv6 Addressing

Characteristic	IPv4	IPv6
Format	x.x.x.x 4, 8-bit fields Separated by dots	x:x:x:x:x:x:x:x 8, 16-bit fields Separated by colons
Field Representation	Decimal Format	Groups of 4 hexadecimal digits, *case sensitive* for A, B, C, D, E and F.
Leading Zeroes	Omitted	Optional
Successive Zero Fields	Must be included	Can be represented by "::" *once* in an address.

IPv6 Addressing

- IPv6 Representation – Rule 1:
  - *The leading zeroes in any 16-bit segment do not have to be written. If any 16-bit segment has fewer than four hexadecimal digits, it is assumed that the missing digits are leading zeroes.*

2031	:	0000	:	130F	:	0000	:	0000	:	09C0	:	876A	:	130B
2031	:	0	:	130F	:	0	:	0	:	9C0	:	876A	:	BC00
8105	:	0000	:	0000	:	4B10	:	1000	:	0000	:	0000	:	0005
8105	:	0	:	0	:	4B10	:	1000	:	0	:	0	:	5
0000	:	0000	:	0000	:	0000	:	0000	:	0000	:	0000	:	0000
0	:	0	:	0	:	0	:	0	:	0	:	0	:	0

IPv6 Addressing

- IPv6 Representation – Rule 2:
  - *Any single, contiguous string of one or more 16-bit segments consisting of all zeroes can be represented once with a double colon.*

1080:0:0:0:8:800:200C:417A	=
FF01:0:0:0:0:0:0:101	=
0:0:0:0:0:0:0:1	=
0:0:0:0:0:0:0:0	=

IPv6 Addressing

- IPv6 Representation – Rule 2:
  - *Any single, contiguous string of one or more 16-bit segments consisting of all zeroes can be represented once with a double colon.*

Example: **1843:f01::22::fa**

- Illegal because the length of the two all-zero strings is ambiguous.

1843:00f0:0000:0000:0022:0000:0000:00fa

or

1843:00f0:0000:0000:0000:0022:0000:00fa

or

1843:00f0:0000:0022:0000:0000:0000:00fa

IPv6 Addressing

- IPv6 Representation:
  - Prefix:
    - IPv4 prefix (the network portion of the address) can be dotted decimal or bit count.
    - e.g. **198.10.0.0 255.255.255.0** or **/24**
    - IPv6 prefix is always represented by bit count.
      - e.g. **3ef8:ca62:12:cc::2/64**

```
      16    32 48 64
```

IPv6 Addressing

- IPv6 Representation:
  - In a URL, it is enclosed in brackets.
    - http://[2001:1:4F3A::206:AE14]:8080/index.html
      - URL parsers have to be modified.
      - Cumbersome for users.
        - Mostly for diagnostic purposes.
        - Use Fully Qualified Domain Names (FQDN).
        - *DNS MUST WORK!*

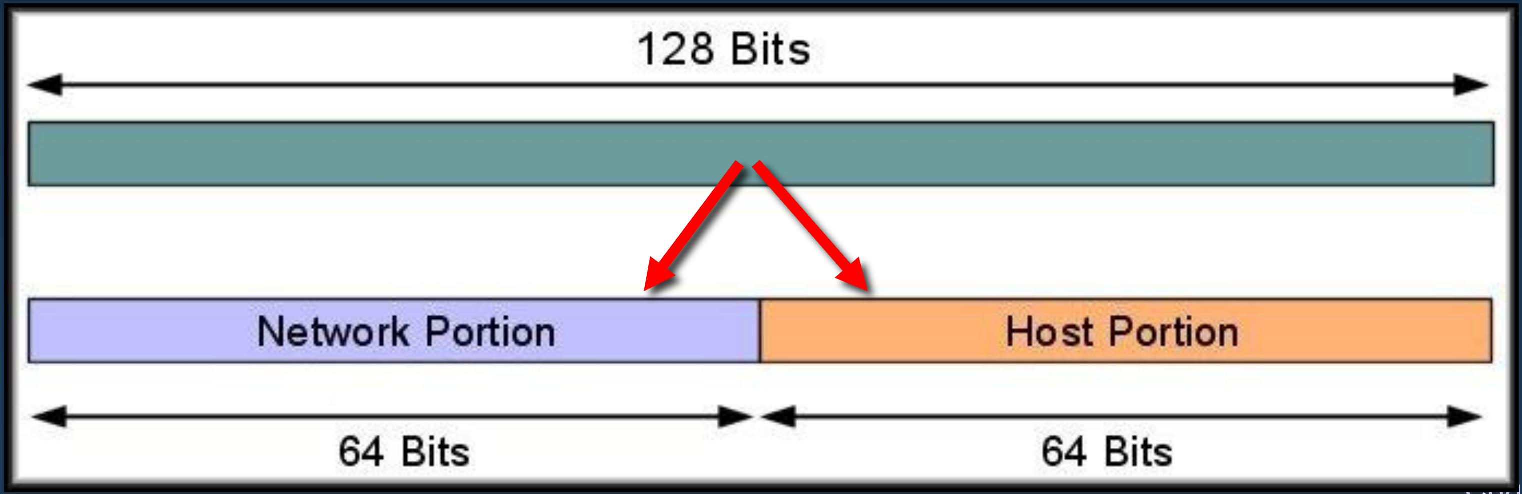
IPv6 Addressing

- IPV6 Address Types:
  - Unicast:
    - Global Unicast Address.
    - Link Local Unicast.
    - Unique Local Unicast.
  - Multicast.
  - Anycast.

  - Unlike IPv4, there is no broadcast address.
  - There is an “all nodes multicast” which serves the same purpose.

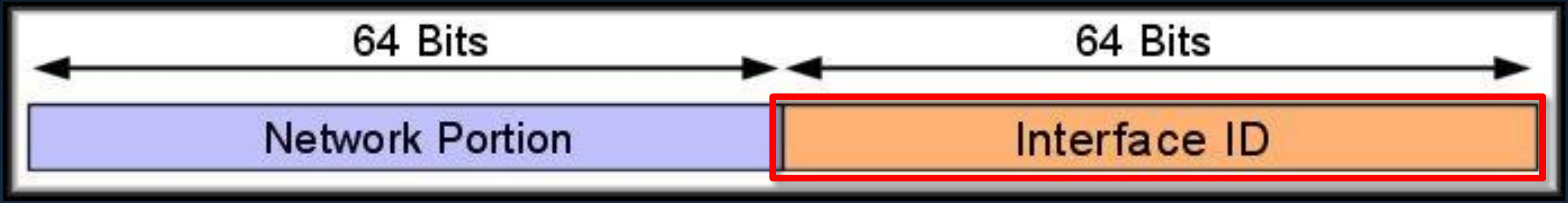
IPv6 Addressing

- Unicast Addressing:
  - A unicast address is an address that identifies a single device.
  - A global unicast address is a unicast address that is globally unique.
    - Can be routed globally with no modification.
- *How do we make a device globally identifiable?*



IPv6 Addressing

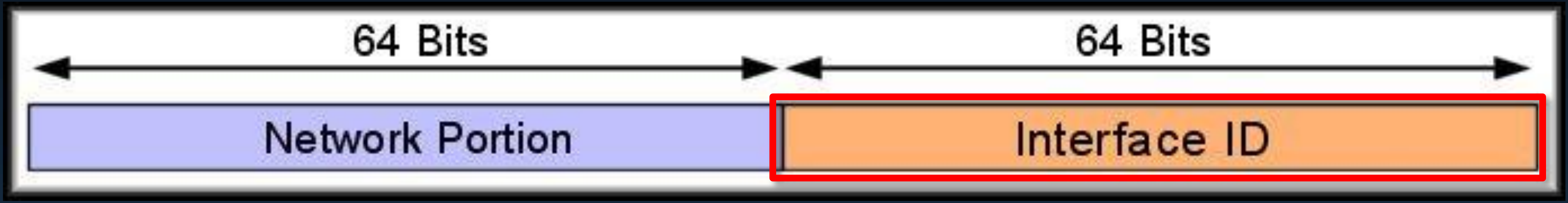
- Global Unicast Address:
  - *How do we make a device globally identifiable?*



  - The host portion of the address is called the Interface ID.
    - Can contain:
      - The interface's 48-bit MAC Address.
      - An identifier derived from the EUI-64 Address (more later).
      - A manually configured address.

IPv6 Addressing

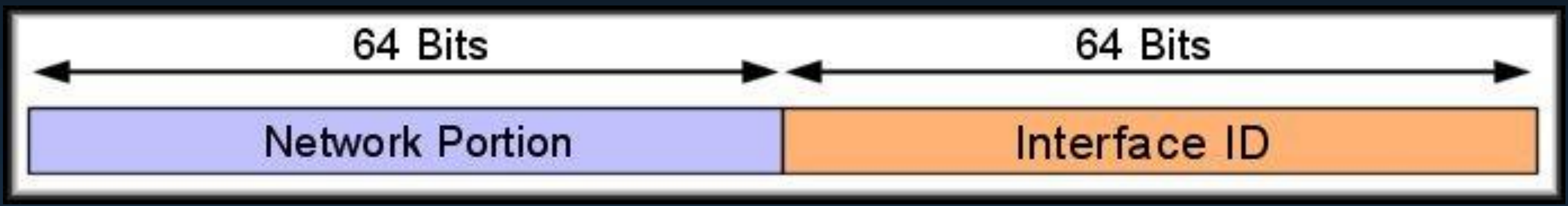
- Global Unicast Address:
  - *How do we make a device globally identifiable?*



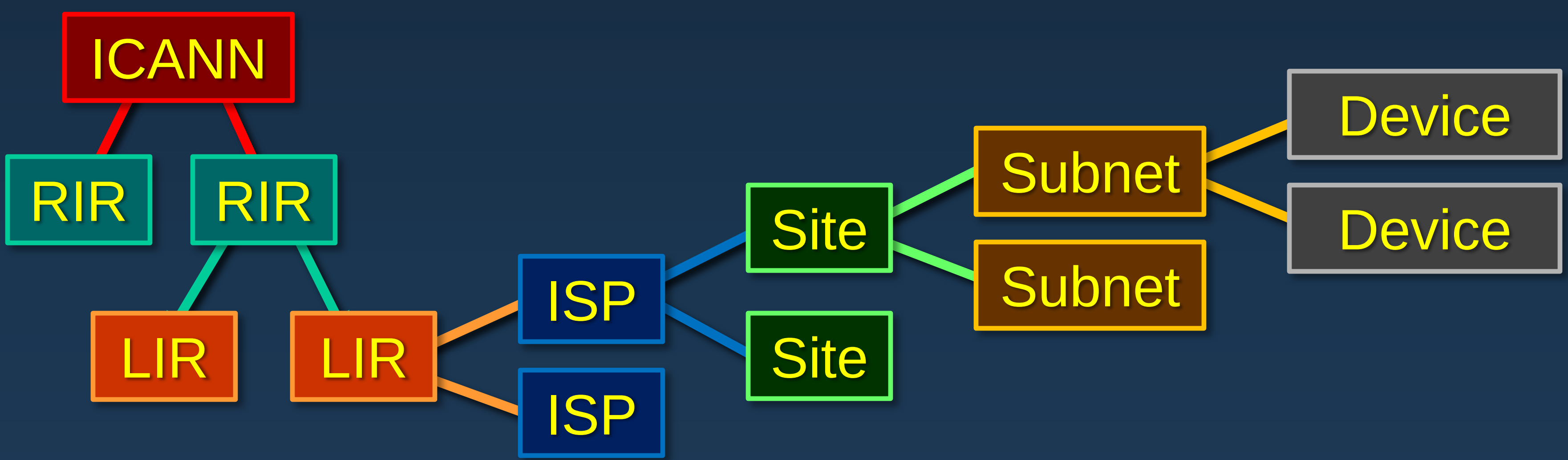
- The host portion of the address is called the Interface ID.
  - Address more correctly identifies an interface on a host than a host itself.
  - A single interface can have multiple IPv6 addresses, and can have an IPv4 address in addition.

IPv6 Addressing

- Global Unicast Address:
  - *So, how do we make this address globally routable?*



  - Well, what is the hierarchy we have to look at to do it?



IPv6 Addressing

- Global Unicast Address:
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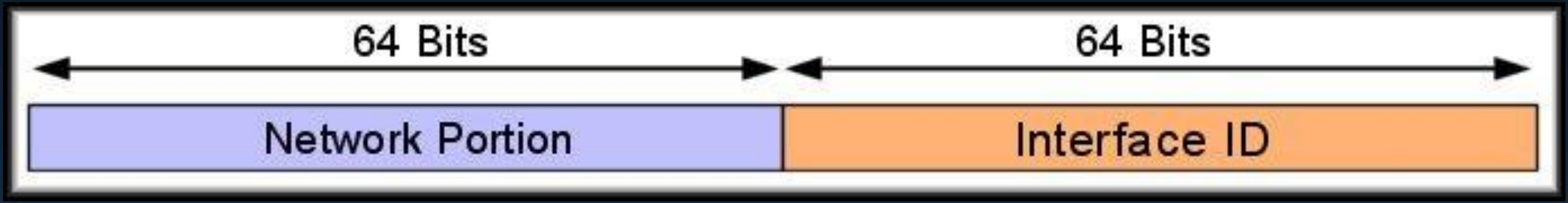
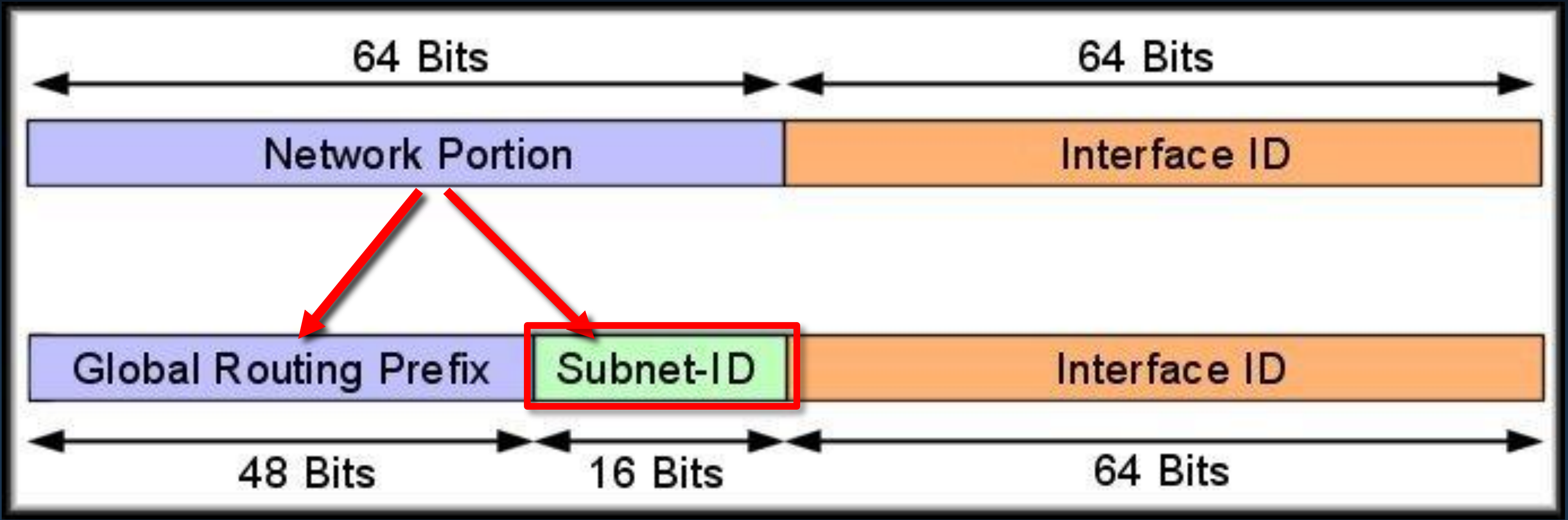


  - We'll divide the network portion so that there is room for:
    - The individual site administrator to add subnets.
    - The remainder of the network portion will identify the remainder of the hierarchy.

IPv6 Addressing

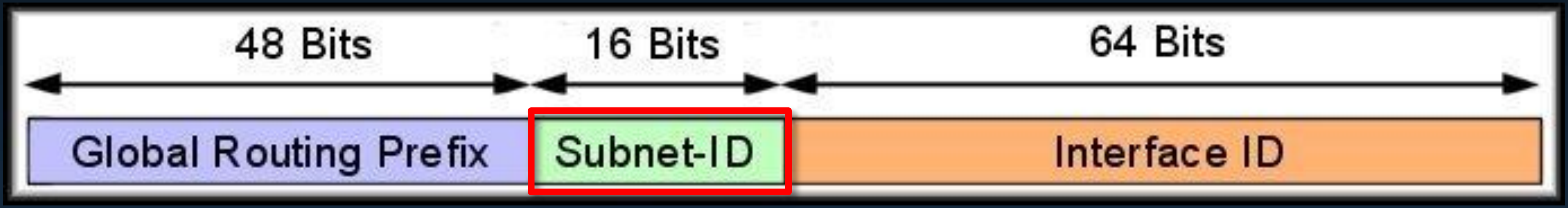
- Global Unicast Address:
  - *So, how do we make this address globally routable?*



  - Using 16 bits for the Subnet-ID allows 65,536 separate subnets…..(that might be enough)…

IPv6 Addressing

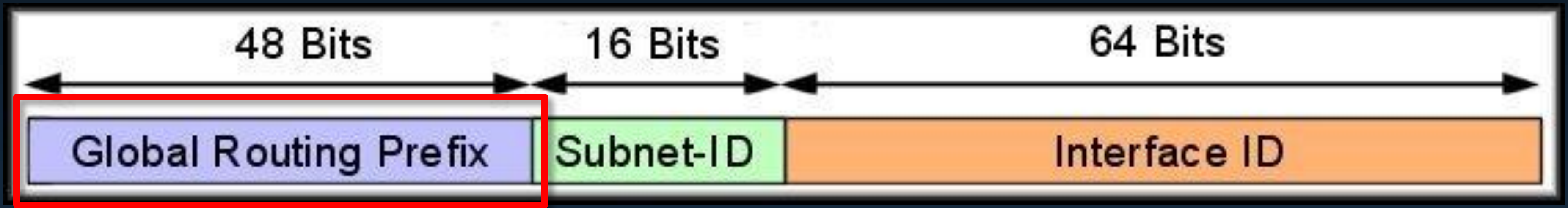
- Global Unicast Address:
  - *So, how do we make this address globally routable?*



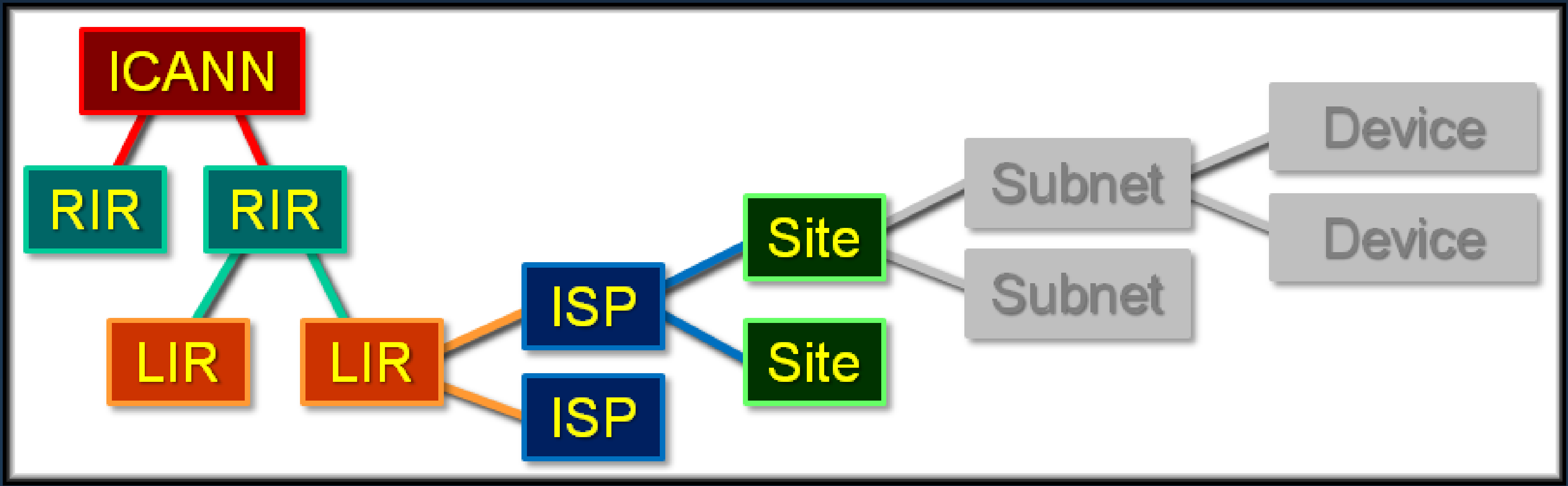
  - Making the Subnet ID a part of the network portion creates a clear separation of functions.
    - The network portion provides the location of a device down to the specific data link.
    - The host portion provides the identity of the device on the data link.

IPv6 Addressing

- Global Unicast Address:
  - *So, how do we make this address globally routable?*

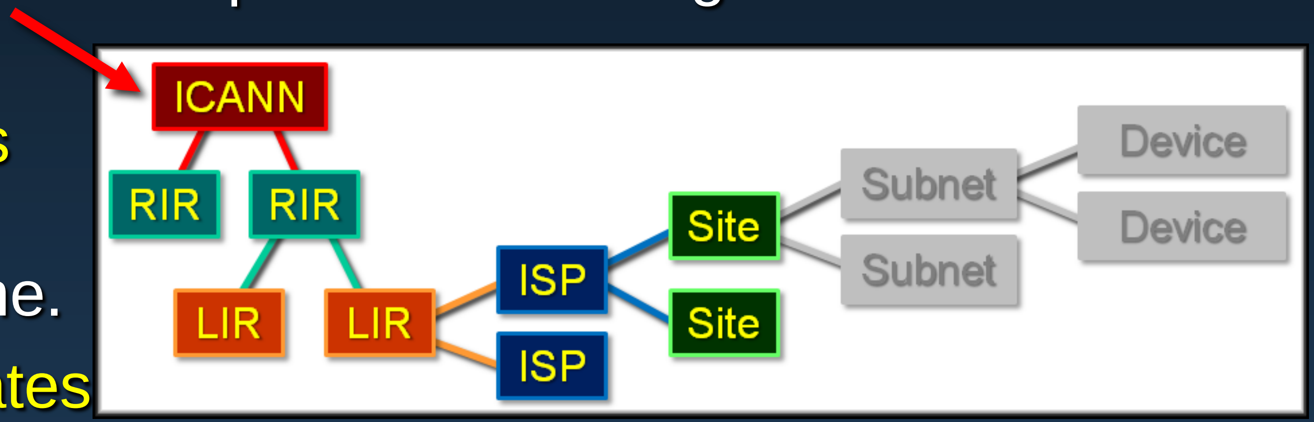


  - So, what do we have left?



IPv6 Addressing

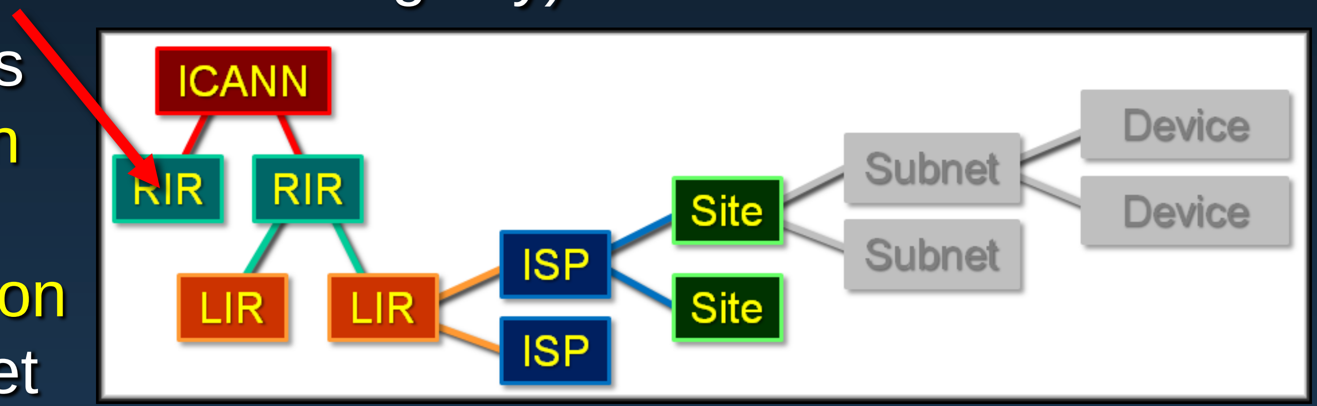
- IPv6 Global Unicast Address:
  - *To understand the prefix, we need to know the function of each organization in the hierarchy.*
  - ICANN (Internet Corporation for Assigned Names and Numbers):



    - Manages the DNS Root Zone.
    - Coordinates the global IP and AS number space and assigns them to the RIRs.

IPv6 Addressing

- IPv6 Global Unicast Address:
  - *To understand the prefix, we need to know the function of each organization in the hierarchy.*
  - RIR (Regional Internet Registry):
    - Oversees allocation and registration of Internet number resources within a particular region of the world.



      - IP addresses (both IPv4 and IPv6) and autonomous system numbers.

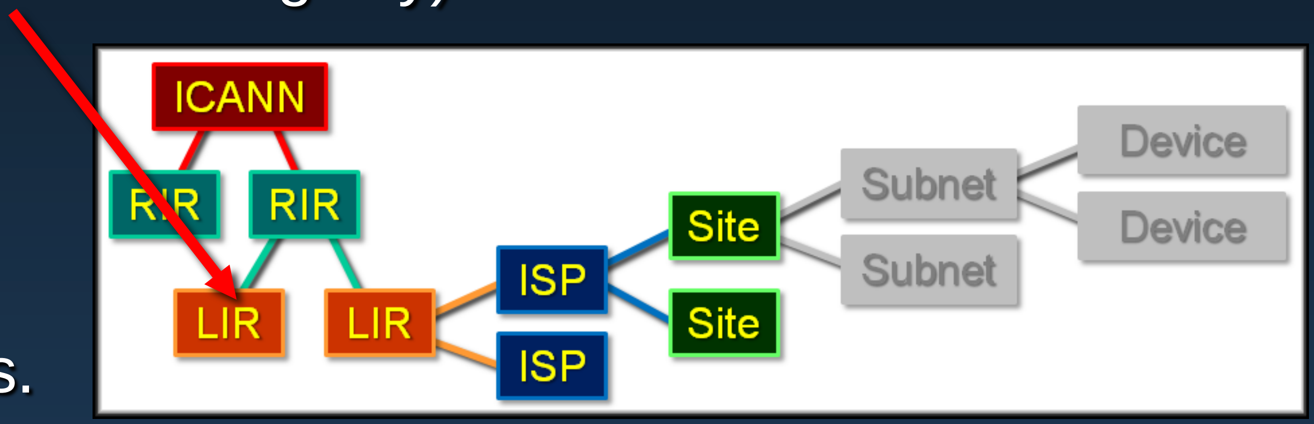
IPv6 Addressing

- IPv6 Global Unicast Address:
  - RIR
    (Regional Internet Registry):

AfriNIC	**Africa region**
APNIC	**Asia and Pacific region**
ARIN	**Canada, many Caribbean and North Atlantic islands, and the United States**
LACNIC	**Latin America and parts of the Caribbean**
RIPE NCC	**Europe, Parts of Asia and the Middle East**

IPv6 Addressing

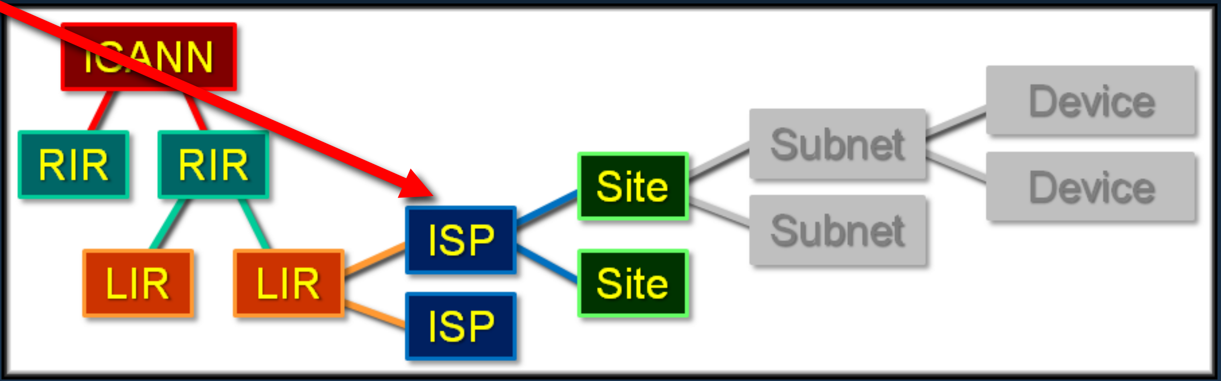
- IPv6 Global Unicast Address:
  - *To understand the prefix, we need to know the function of each organization in the hierarchy.*
  - LIR (Local Internet Registry):
    - Usually large Internet Service Providers.



    - Received an IP address allocation from a Regional Internet Registry (RIR).
    - May assign parts of this allocation to its own customers or smaller ISPs.

IPv6 Addressing

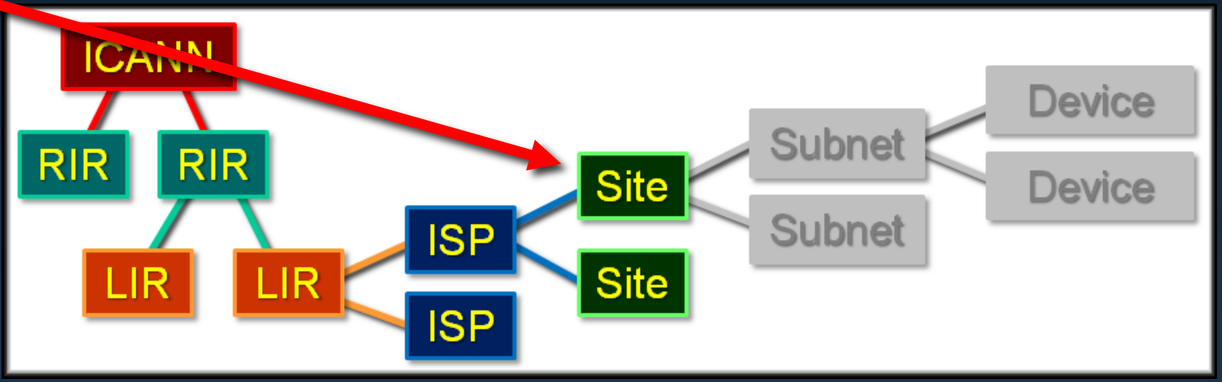
- IPv6 Global Unicast Address:
  - *To understand the prefix, we need to know the function of each organization in the hierarchy.*
  - ISP (Internet Service Provider):
    - A company that offers its customers access to the Internet.



    - The ISP connects to its customers using an appropriate data transmission technology.

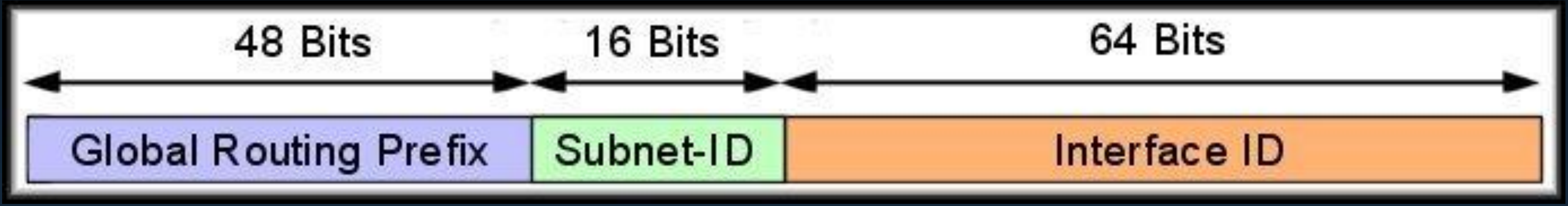
IPv6 Addressing

- IPv6 Global Unicast Address:
  - *To understand the prefix, we need to know the function of each organization in the hierarchy.*
  - Site:
    - The end customer of an ISP.
    - Can be individuals or corporations requiring Internet access.

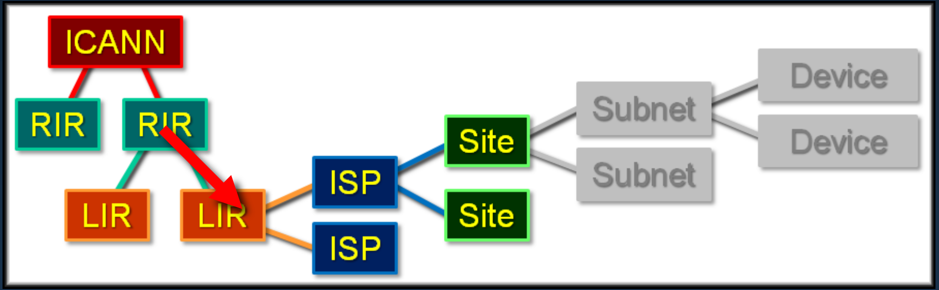


IPv6 Addressing

- IPv6 Global Unicast Address:
  - *So, how do we make this address globally routable?*



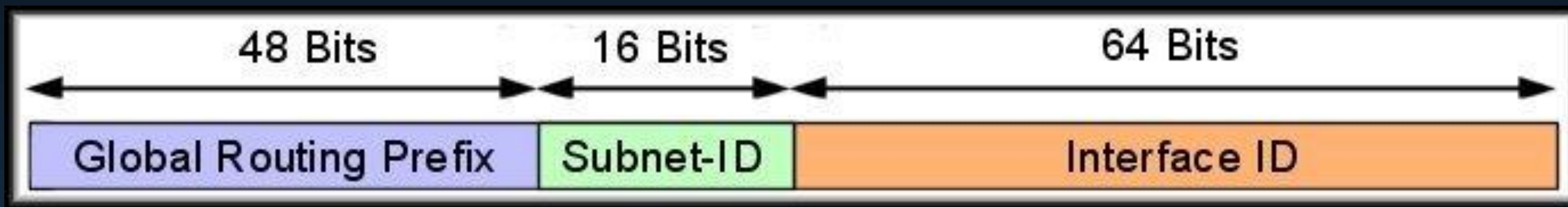
  - With very few exceptions:
    - Interface ID is 64 bits.
    - Subnet ID is 16 bits.



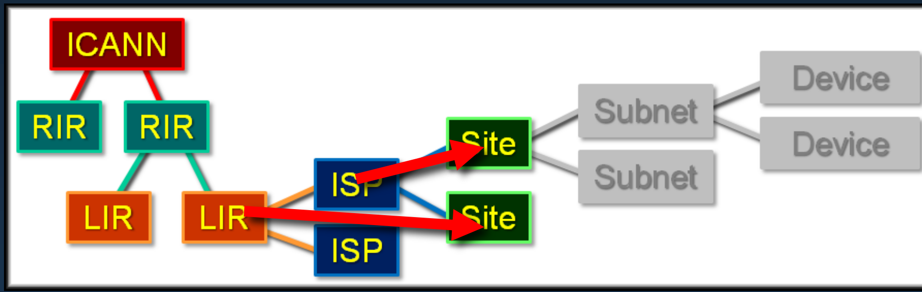
  - The ICANN and the Regional Internet Registries (RIRs) assign IPv6 prefixes (normally /23) to the Local Internet Registries (LIRs).

IPv6 Addressing

- IPv6 Global Unicast Address:
  - *So, how do we make this address globally routable?*



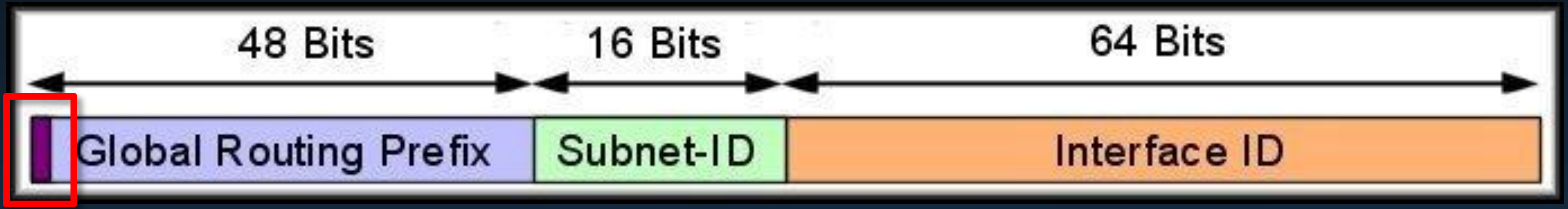
  - The LIRs and ISPs then allocate longer prefixes to their customers.



  - In the majority of cases, the prefixes assigned are /48.

IPv6 Addressing

- IPv6 Global Unicast Address:
  - *So, how do we make this address globally routable?*



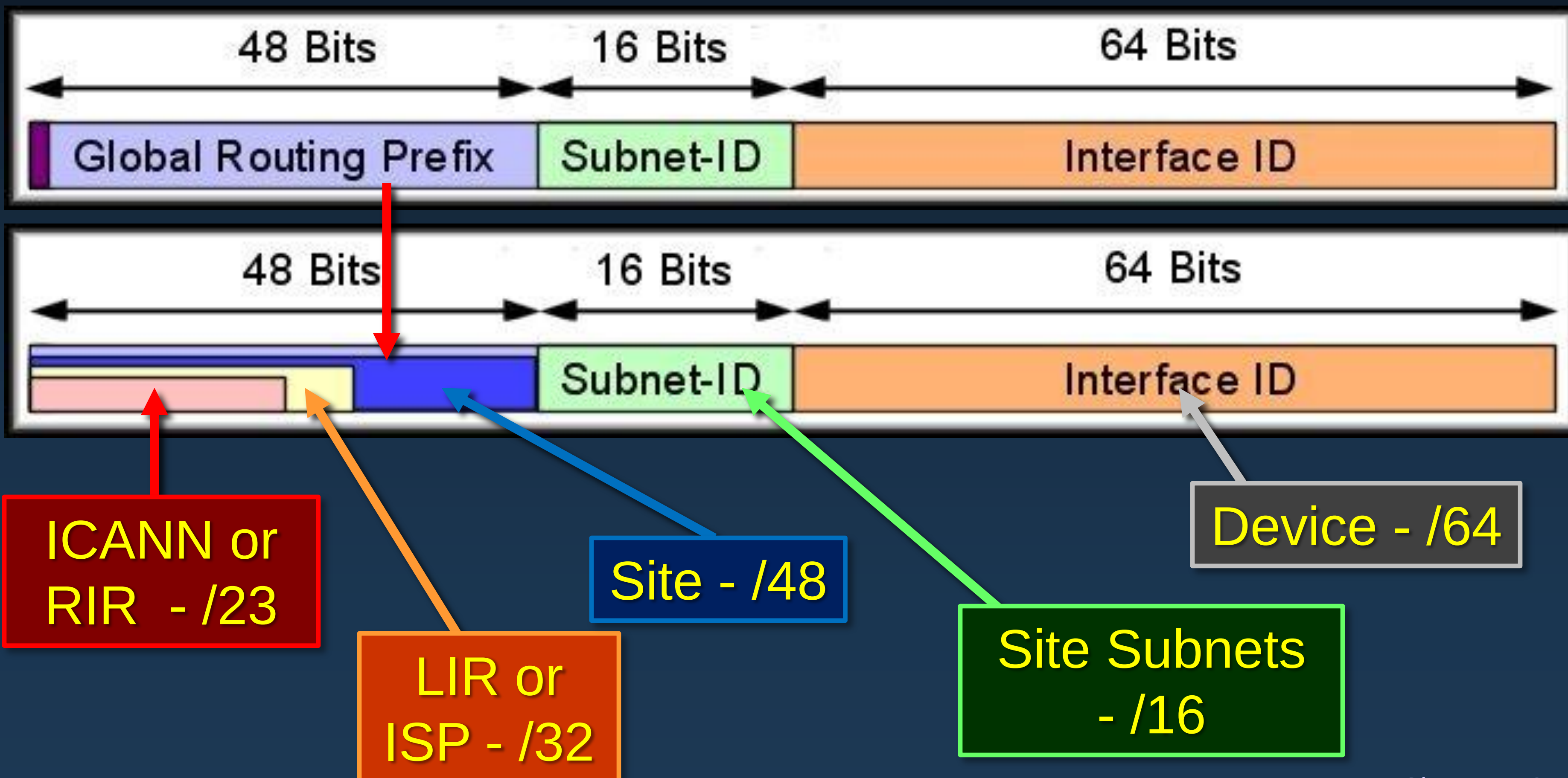
- Begins with binary 001.
- More easily recognized as beginning with a hexadecimal 2 or 3.

0010 xxxx or 0011 xxxx

- ICANN assigns global unicast IPv6 addresses as public and globally-unique IPv6 addresses.
  - *No need for NAT.*

IPv6 Addressing

- IPv6 Global Unicast Address:
  - *So, how do we make this address globally routable?*



FYI

IPv6 Addressing

- Reserved Addresses:
  - A portion of the IPv6 address space is reserved for various uses, both present and future.

Address Type	High Order Bits (Binary)	High-Order Bits (Hex)
Unspecified	00…0	::/128
Loopback	00…1	::1/128
Multicast	11111111…	FF00::/8
Link Local Unicast	1111111010	FE80::/10
Global Unicast	001	2xxx::/4 or 3xxx::/4
Reserved (Future Global unicast)	Everything Else	

IPv6 Addressing

- Unspecified Addresses (::/128):
  - In IPv4, an IP address of all zeroes has a special meaning:
    - In a host, it refers to the host itself, and is used when a device does not know its own address.
    - In IPv6, this concept has been formalized, and the all-zeroes address (0:0:0:0:0:0:0:0) is named the "unspecified" address.
    - It is typically used in the source field of a datagram that is sent by a device that seeks to have its IP address configured.

IPv6 Addressing

- Loopback Address (::1/128):
  - Just as in IPv4, a provision has been made for a special loopback IPv6 address.
    - Datagrams sent to this address "loop back" to the sending device.
    - In IPv6 there is just one address, not a whole block, for this function.

IPv6 Addressing

- Link Local Unicast Address (FE80::/10):
  - New to the concept of addressing with IP.
    - These addresses refer only to a particular physical network.
    - Routers do not forward datagrams using link-local addresses.
    - They are only for local communication on a particular physical network segment.
      - Automatic address configuration.
      - Neighbor discovery.
      - Router discovery.
      - IPv6 Routing Protocols.

IPv6 Addressing

- Multicast Address(FF00::/8):
  - A multicast address identifies a multicast group (set of devices).
  - A packet being sent to a multicast group is originated by a single device.
    - A multicast packet normally has a unicast address as its source address and a multicast address as its destination address.
  - A multicast address never appears in a packet as a source address.
  - There is no reserved broadcast address like IPv4.

FYI

IPv6 Addressing

- Multicast Address(FF00::/8):
  - Examples of well-known IPv6 Multicast Addresses

Address	Multicast Group
FF02::1	All Nodes
FF02::2	All Routers
FF02::5	OSPFv3 Routers
FF02::6	OSPFv3 Designated Routers
FF02::9	RIPng Routers
FF02::A	EIGRP Routers
FF02::B	Mobile Agents
FF02:C	DHCP Servers / Relay Agents
FF02::D	All PIM Routers

IPv6 Address Management

- IPv6 addresses use Interface Identifiers to identify interfaces on a link.
  - Think of them as the host portion of an IPv6 address.
  - They must be unique on a specific link.
  - They are always 64 bits and can be dynamically derived from a Layer 2 address (MAC).
- Four methods of address assignment:
  - Static assignment using a manual interface ID.
  - Static assignment using an EUI-64 interface ID.
  - Dynamic Stateless Autoconfiguration.
  - Dymanic DHCP for IPv6 (DHCPv6)

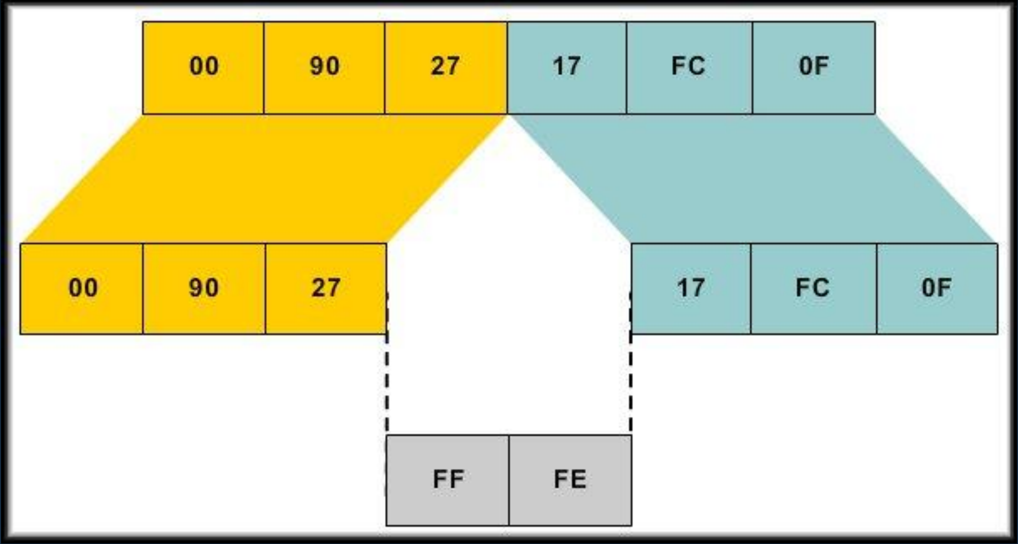
IPv6 Address Management

- Static assignment using a manual interface ID.
  - Manually assign both the prefix (network) and interface ID (host) portion of the IPv6 address.
  - To configure an IPv6 address on a Cisco router interface, use the **ipv6 address** command in interface configuration mode.

```
R1(config-if)#ipv6 address
              2001:DB8:2222:7272::72/64
```

IPv6 Address Management

- Static assignment using an EUI-64 interface ID.
  - The EUI-64 standard explains how to stretch IEEE 802 MAC addresses from 48 to 64 bits by inserting the 16-bit 0xFFFE in the middle at the 24th bit of the MAC address to create a 64-bit, unique interface identifier.




```
R1(config-if)#ipv6 address
                2001:DB8:2222:7272::/64 eui-64
```

IPv6 Address Management

- Dynamic Stateless Autoconfiguration:
  - Autoconfiguration automatically configures the IPv6 address.
  - The autoconfiguration mechanism was introduced to enable plug-and-play networking of these devices to help reduce administration overhead.
  - Uses IPv6 NDP (Neighbor Discovery Protocol) router solicitation and router advertisement messages to obtain the information.

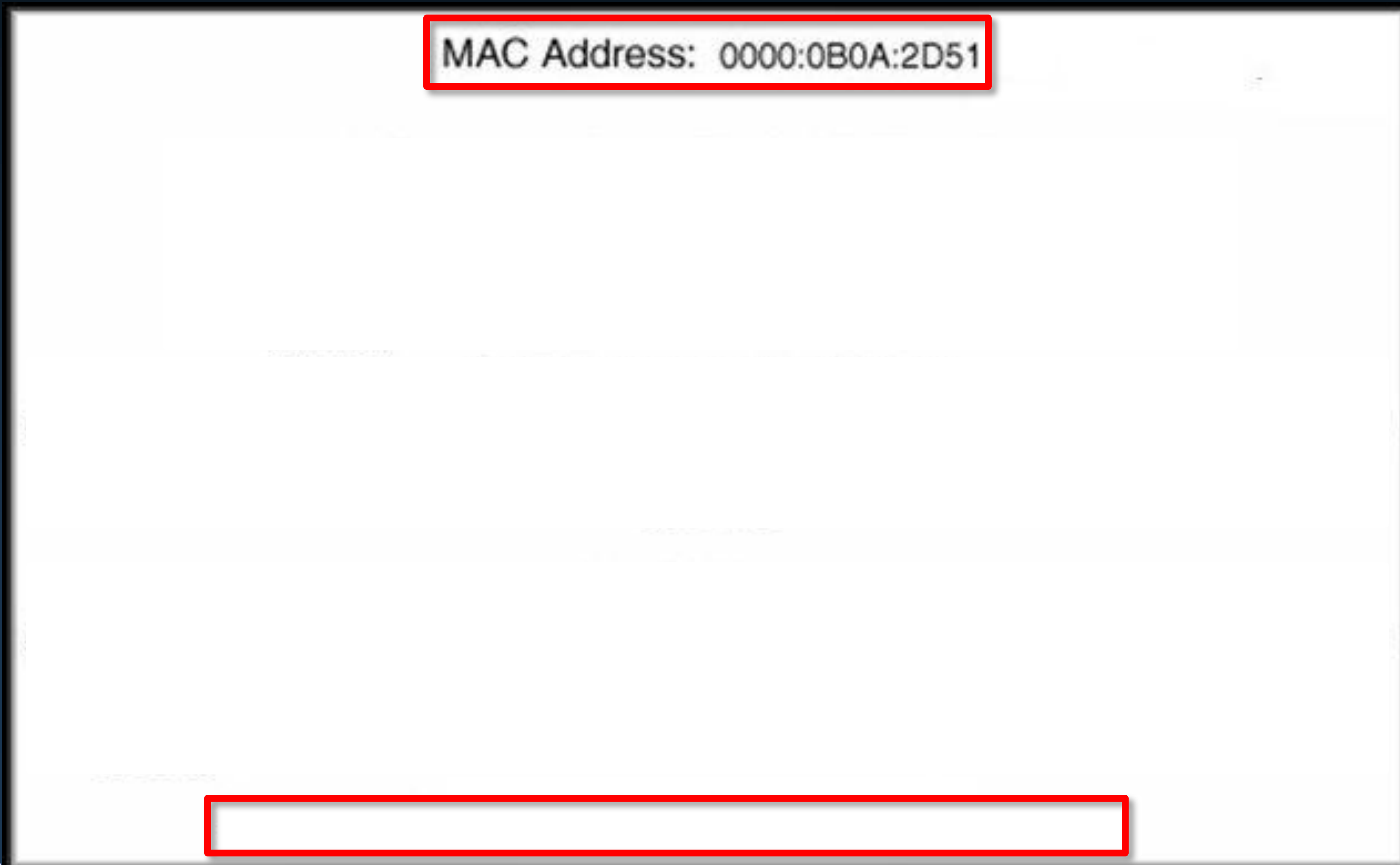
FYI

IPv6 Address Management

- Dynamic Stateless Autoconfiguration:
  1. The router interface has been configured with an IPv6 address.
  2. A device entering the network will query the router for its address using ICMPv6 to exchange Neighbor Discovery Protocol (NDP) messages.
  3. The router will respond with its address and the device will use:
     - The Global Routing Prefix (64 bits) from the router address.
     - EUI-64 to add the device's MAC address.

FYI IPv6 Address Management

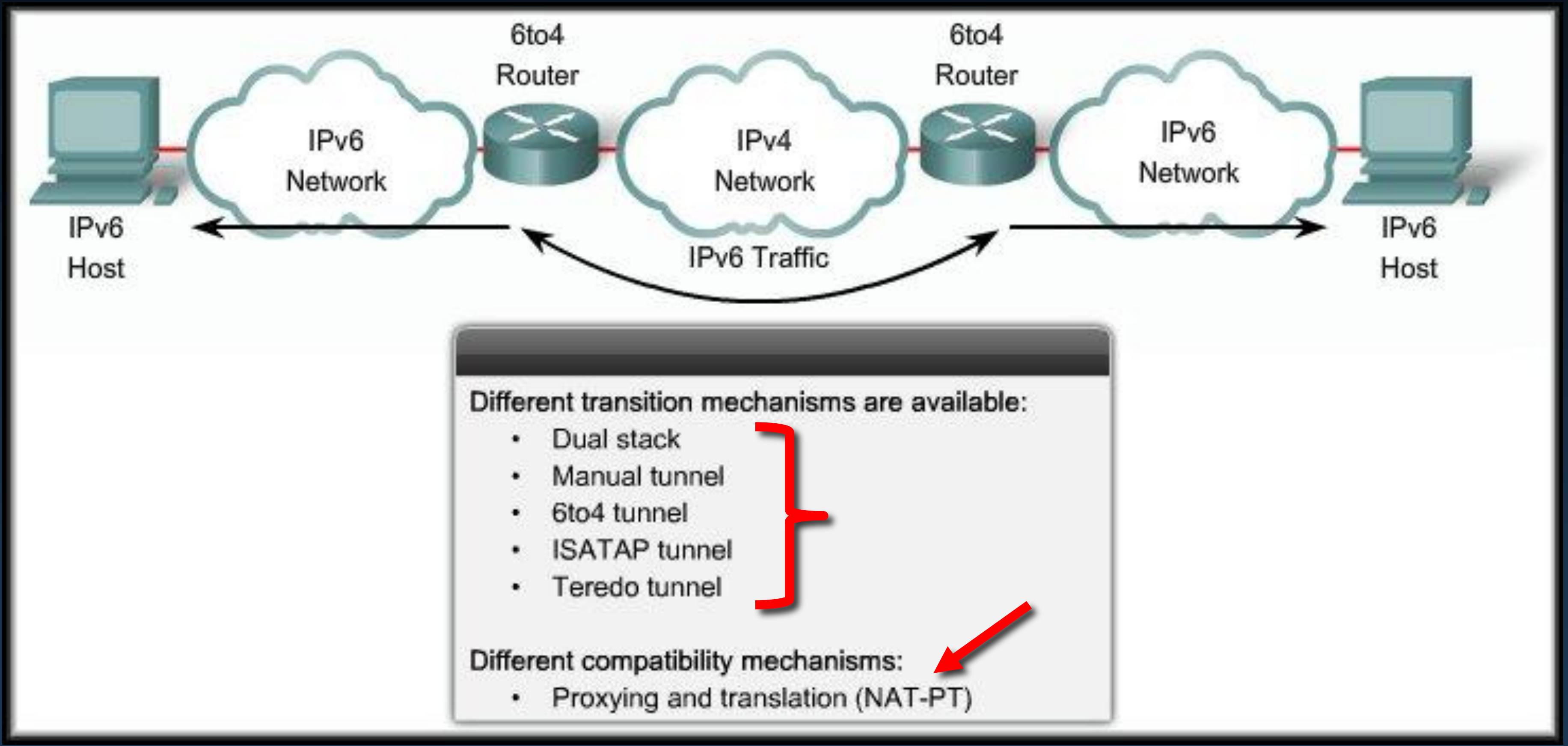
- Dynamic Stateless Autoconfiguration: Using EUI-64.



IPv6 Address Management

- Dynamic DHCPv6 for IPv6:
  - Similar DHCP for IPv4.
    - Host sends a multicast packet searching for the DHCP server.
    - DHCP server replies.
    - DHCP client sends a message asking for a lease of an IP address.
    - DHCP server replies, listing an IPv6 address, prefix length, default router, and DNS IP addresses.
  - DHCPv4 and DHCPv6 actually differ in detail, but the basic process remains the same.

IPv6 Transition Strategies



IPv6 Transition Strategies

- Dual Stack:
  - Method in which a node has implementation and connectivity to both an IPv4 and IPv6 network.
  - The recommended option.
  - Involves running IPv4 and IPv6 at the same time.
- Tunneling (4 Methods):
  - Manual IPv6-over-IPv4 tunneling:
    - An IPv6 packet is encapsulated within the IPv4 protocol. This method requires dual-stack routers.

IPv6 Transition Strategies

- Tunneling (4 Methods):
  - Dynamic 6to4 tunneling:
    - Automatically establishes the connection of IPv6 islands through an IPv4 network, typically the Internet.
    - It dynamically applies a valid, unique IPv6 prefix to each IPv6 island, which enables the fast deployment of IPv6 in a corporate network without address retrieval from the ISPs or registries.

FYI

IPv6 Transition Strategies

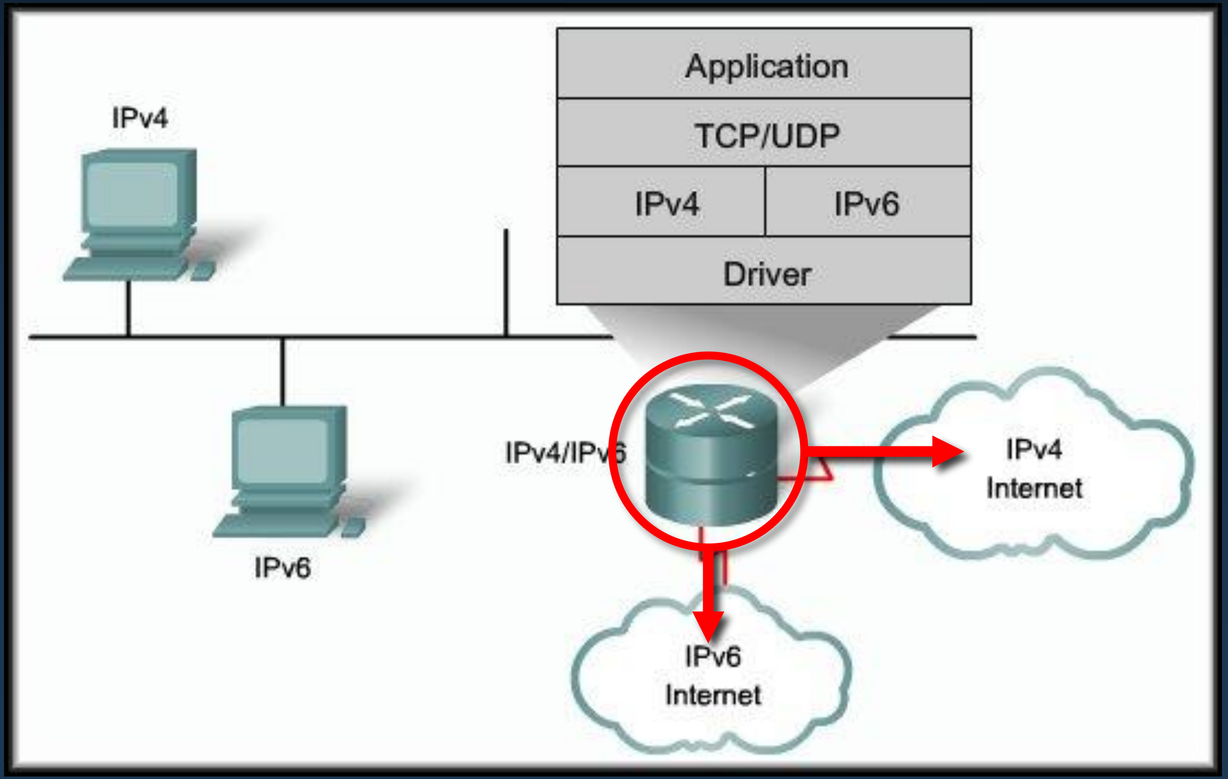
- Tunneling (4 Methods):
  - Intra-Site Automatic Tunnel Addressing Protocol (ISATAP) tunneling:
    - Creates a virtual IPv6 network over an IPv4 infrastructure.
  - Teredo tunneling:
    - Provides host-to-host automatic tunneling instead of gateway tunneling.

IPv6 Transition Strategies

- NAT-Protocol Translation (NAT-PT):
  - Cisco IOS Release 12.3(2)T and later (with the appropriate feature set) also include NAT-PT between IPv6 and IPv4.
  - This translation allows direct communication between hosts that use different versions of the IP protocol.
  - These translations are more complex than IPv4 NAT.
  - At this time, this translation technique is the least favorable option and should be used as a last resort.

Cisco IOS Dual Stack

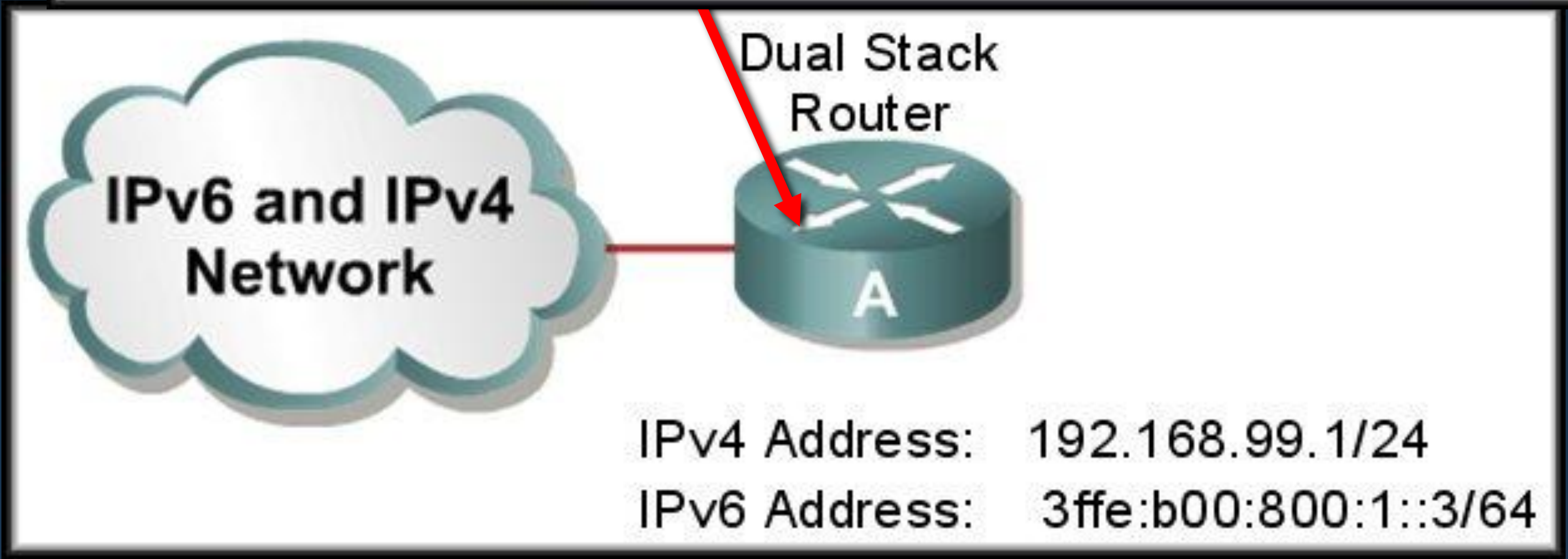
- Dual Stacking is an integration method that allows a node to have simultaneous connectivity to an IPv4 and IPv6 network.
- Each node has two protocol stacks with the configuration on the same interface or on multiple interfaces.



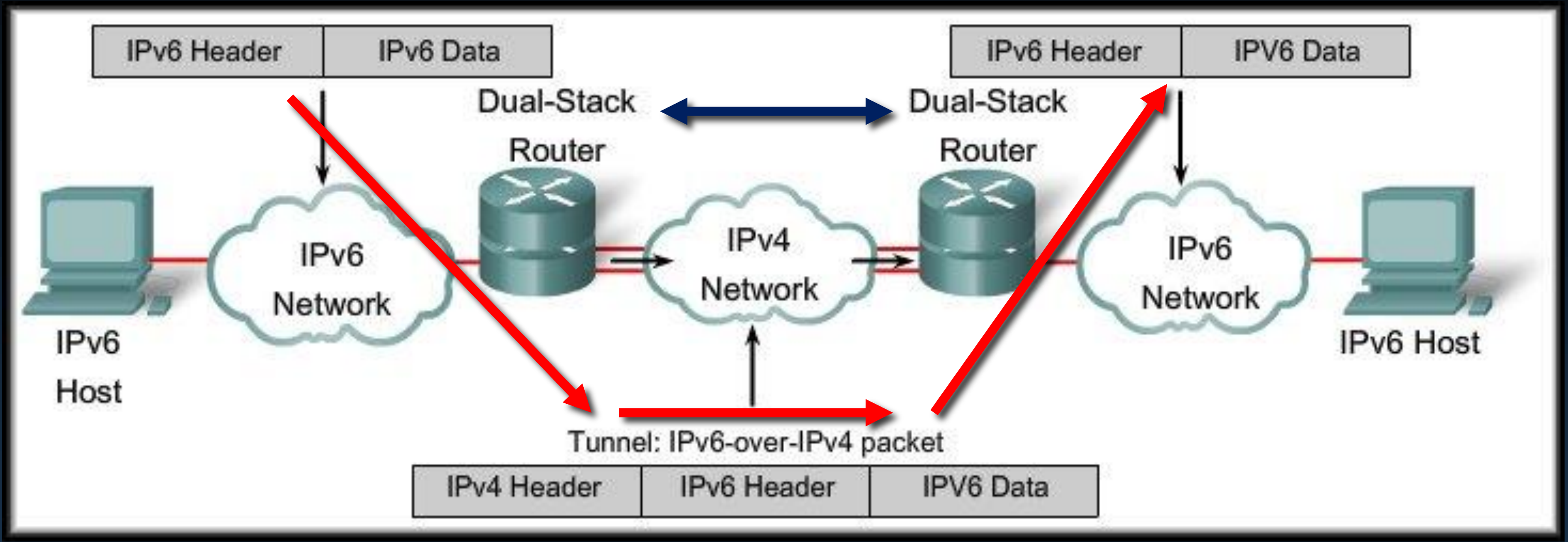
Cisco IOS Dual Stack

- If both IPv4 and IPv6 addresses are configured on an interface, the interface is considered dual stacked.

```
RTA(config)#interface fa0/0
RTA(config-if)#ip address 192.168.99.1 255.255.255.0
RTA(config-if)#ipv6 address 3ffe:b00:800:1::3/64
```

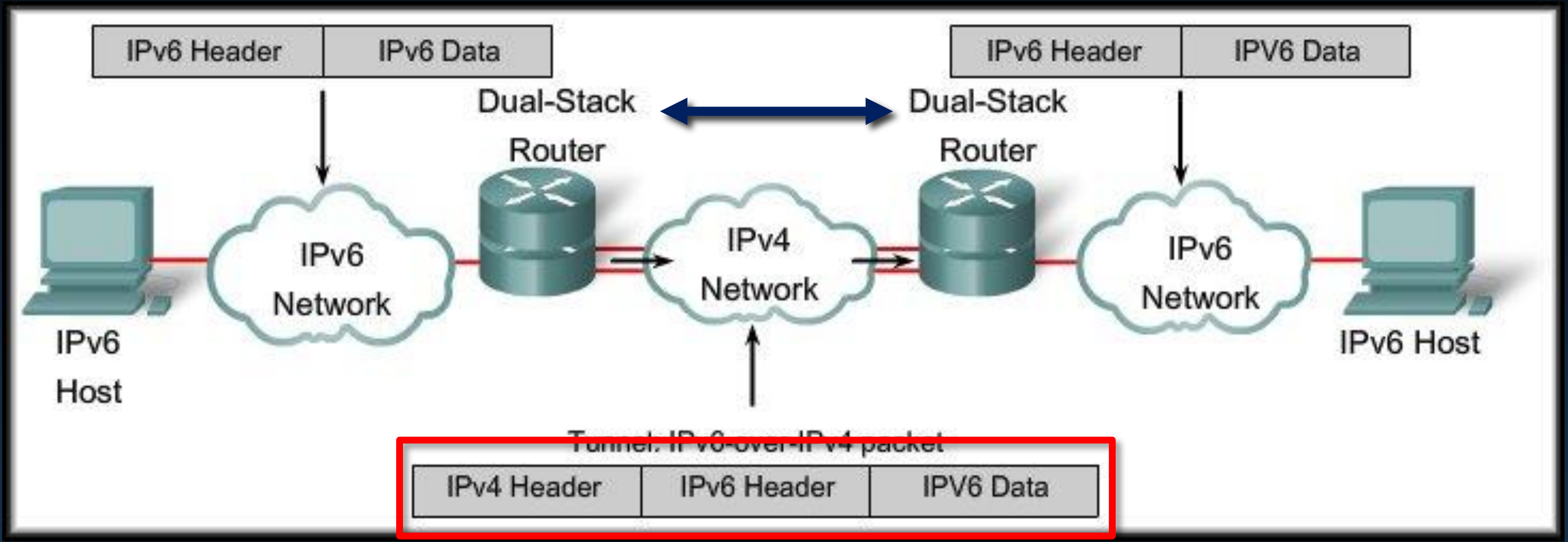


IPv6 Tunneling



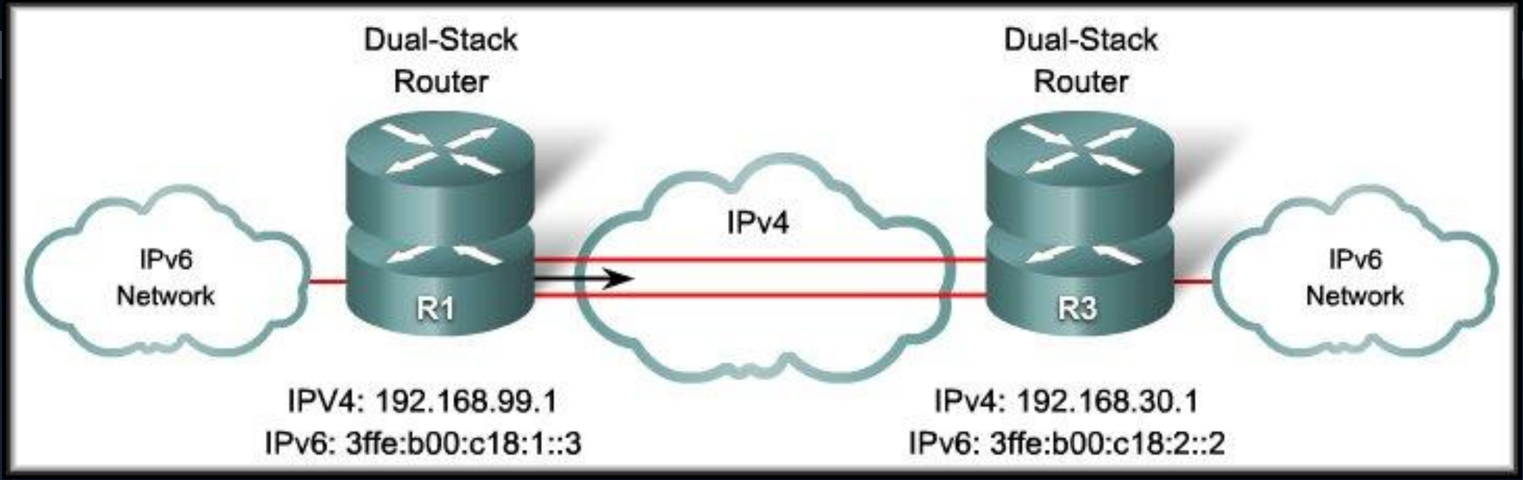
- Tunneling is an integration method where an IPv6 packet is encapsulated within another protocol.
- This is considered dual stacking.
- Tunneling encapsulates the IPv6 packet in the IPv4 packet.

IPv6 Tunneling



- When IPv4 is used to encapsulate the IPv6 packet:
  - Protocol type of 41.
  - 20-byte IPv4 header with no options.
  - IPv6 header and payload.
  - Requires dual stacked routers.

IPv6 Tunneling



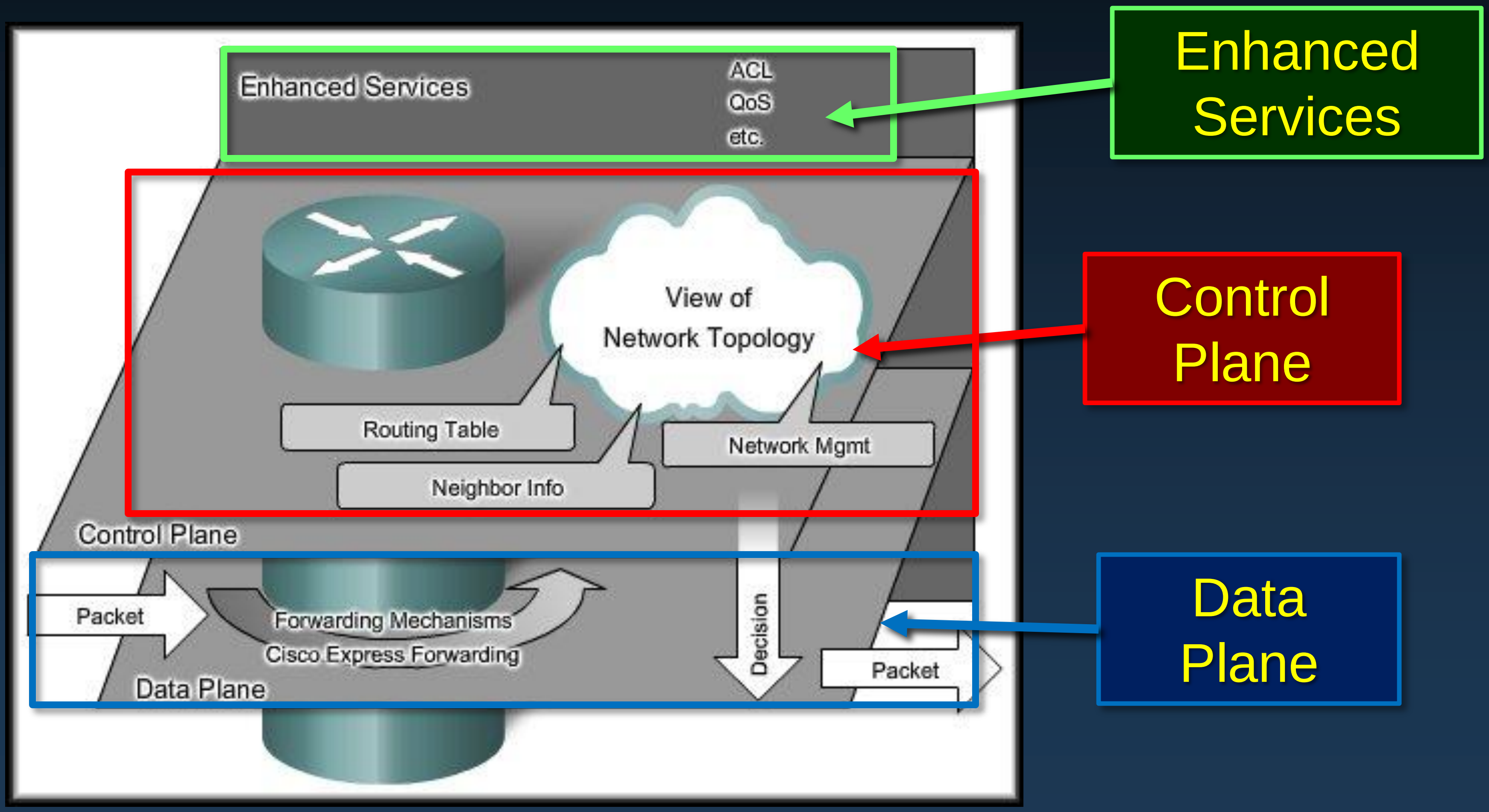
- Manually Configured IPv6 Tunnel:
  - Equivalent to a permanent link between two IPv6 domains over an IPv4 backbone.
  - The primary use is for stable connections that require regular, secure communication:
    - Between two edge routers.
    - Between an end system and an edge router.
    - For connection to remote IPv6 networks.

Routing Configurations with IPv6

- Like IPv4 classless inter-domain routing (CIDR), IPv6 uses longest prefix match routing.
- The IPv6 larger address spaces make room for large address allocations to ISPs and organizations.
  - An ISP aggregates all of the prefixes of its customers into a single prefix and announces the single prefix to the IPv6 Internet.
  - The increased address space is sufficient to allow organizations to define a single prefix for their entire network.
- *How does this affect router performance?*

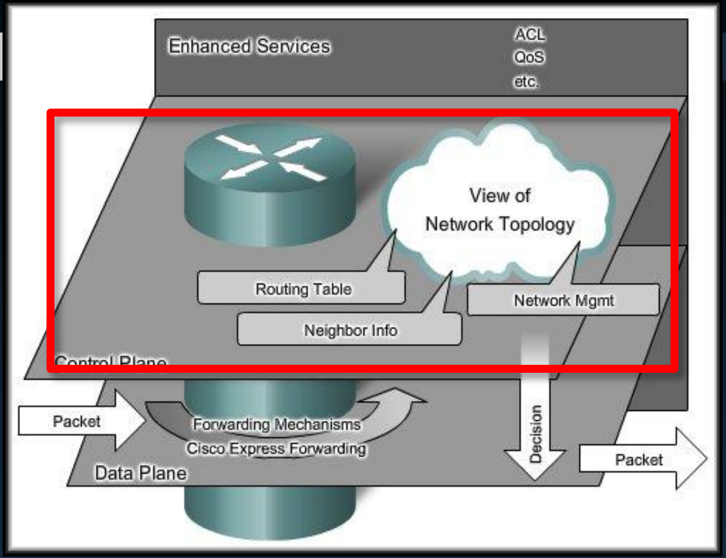
Routing Configurations with IPv6

- How a router functions in a network.

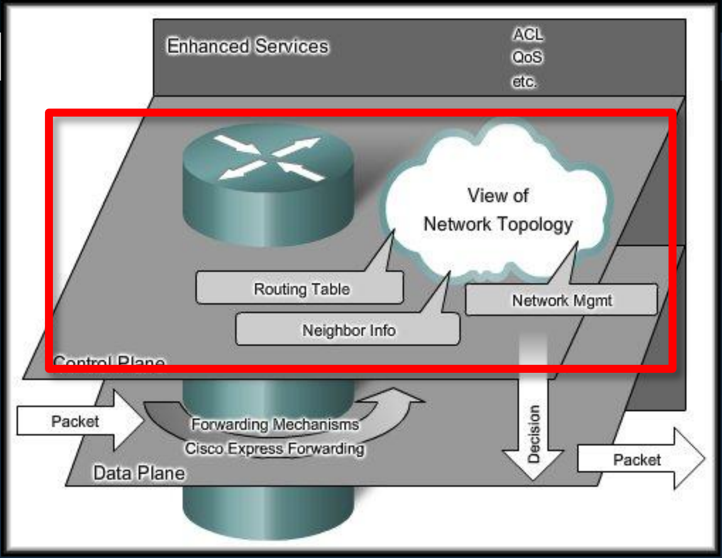


Routing Configurations with IPv6

- How a router functions in a network.
  - *Control Plane:*
    - Handles the interaction of the router with the other network elements.
    - Provides the information for:
      - Decisions.
      - Control the overall router operation.
        - Routing protocols.
        - Network management.

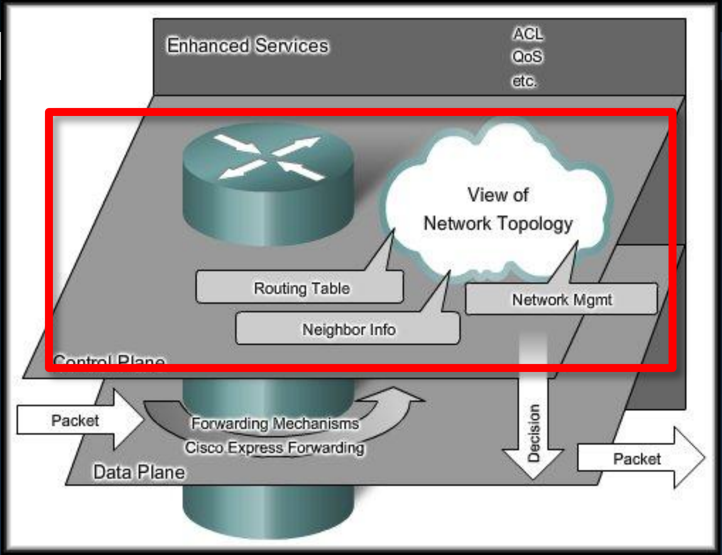


Routing Configurations with IPv6



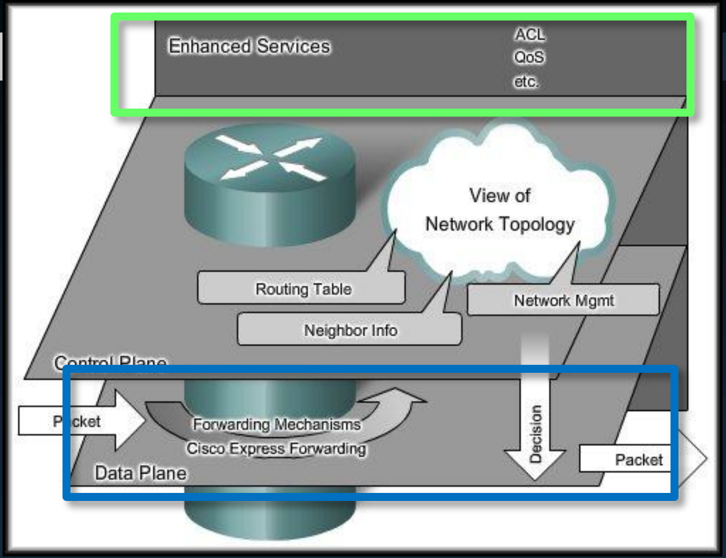
- How a router functions in a network.
  - *Control Plane:*
    - IPv6 Address Size:
      - May perform slower than IPv4 depending on the number of cycles it takes to process the new address.
    - Multiple Ipv6 Node Addresses:
      - Because IPv6 nodes can use several IPv6 unicast addresses, memory consumption of the Neighbor Discovery cache may be affected.

Routing Configurations with IPv6



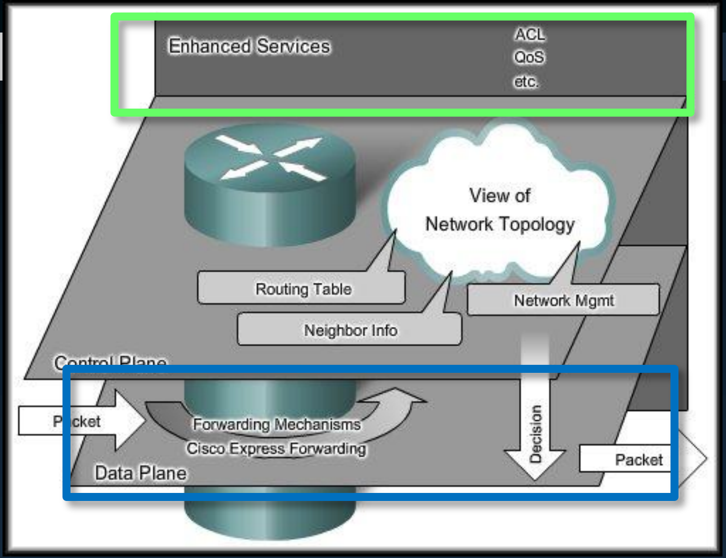
- How a router functions in a network.
  - *Control Plane:*
    - Ipv6 Routing Protocols:
      - IPv6 routing protocols are similar to their IPv4 counterparts, but since an IPv6 prefix is four times larger than an IPv4 prefix, routing updates have to carry more information.
    - IPv6 Routing Table Size:
      - Increased IPv6 address space implies larger routing tables and higher memory requirements to support them.

Routing Configurations with IPv6



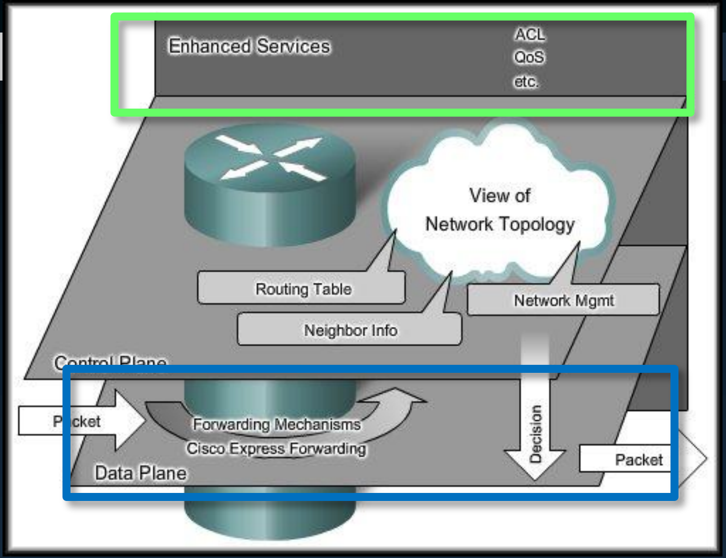
- How a router functions in a network.
  - *Data Plane:*
    - Handles packet forwarding from one physical or logical interface to another.
  - *Enhanced Services:*
    - Include advanced features applied when forwarding data:
      - Packet filtering (ACLS).
      - Quality of Service (QoS).
      - Encryption.
      - Translation and accounting.

Routing Configurations with IPv6



- How a router functions in a network.
  - *Data Plane and Enhanced Services:*
    - Parsing IPV6 Headers:
      - Applications, including mobile IPv6, often use IPv6 address information in extension headers. Additional fields require additional processing.
      - For example, an ACL used to filter Layer 4 (ports) must apply the filter to all packets.
        - If the length of the extension header is larger than the router can handle it will severely affect the forwarding performance of the router.

Routing Configurations with IPv6



- How a router functions in a network.
  - *Data Plane and Enhanced Services:*
    - IPv6 Address Lookup:
      - IPv6 performs a lookup on packets entering the router to find the correct output interface.
      - IPv4 - parses a 32-bit destination address.
      - IPv6 - parses a 128-bit destination address.
      - Application-Specific Integrated Circuit (ASIC) originally designed for IPv4.
      - Could result in sending packets into slower software processing or dropping them.

RIPng Routing Protocol

- Routing Information Protocol next-generation (RIPng):
  - Based on RIPv2:
    - Distance Vector.
    - Limit of 15 hops.
    - Split Horizon and Poison Reverse.
    - Only neighboring routers exchange local messages.
    - Updates on UDP port 521.
  - Updated features:
    - IPv6 prefix and next hop address.
    - Uses multicast group FF02::9 as the destination for all RIP updates.
    - Supported on Cisco 12.2(2)T and later.

RIPng Routing Protocol

Feature	RIPv2	RIPng
Advertises routes for…	IPv4	IPv6
Layer 3 / 4 Protocols	IPv4 / UDP	IPv6 / UDP
UDP Port	520	521
Distance Vector	Yes	Yes
Default Administrative Distance	120	120
Supports VLSM	Yes	Yes
Automatic Summarization	Yes	N/A
Uses Split Horizon / Poison Reverse	Yes	Yes
30 Second Periodic Full Updates	Yes	Yes
Uses Hop Count Metric	Yes	Yes
Metric Meaning Infinity	16	16
Multicast Update Destination	224.0.0.9	FF02::9

Configuring IPv6 Addresses

- Enabling IPv6 on Cisco Routers:

Static or eui-64

```
R1(config)# ipv6 unicast-routing

R1(config)# interface FastEthernet0/0
R1(config-if)# ipv6 address 2001:db8:c18:1::/64 eiu-64
```

Device Mac = 0260:3E47:1530

```
R1(config)#show ipv6 interface Fa0/0

fastetherneto/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::260:3EFF:FE47:1530

Global unicast address(es):
2001:DB8:C18:1:260:3EFF:FE47:1530, subnet is 2001:DBB:C18:1::/64
Joined group address(es):
FF02::1:FF47:1530
FF02::1
FF02::2
MTU is 1500 bytes
```

Configuring IPv6 Addresses

- Cisco IOS IPv6 name resolution:
  - Define a static name for an IPv6 address using the command:

```
ipv6 hostname [port] ipv6-address1
      [ipv6-address2...ipv6-address4]
```

  - You can define up to four IPv6 addresses for one hostname.
  - The port option refers to the Telnet port to be used for the associated host.

Configuring IPv6 Addresses

- Cisco IOS IPv6 name resolution:
  - Specify the DNS server used by the router with the command:

    `ip name-server address`

  - The address can be an IPv4 or IPv6 address.
  - You can specify up to six DNS servers with this command.

Configuring RIPng with IPv6

- When configuring supported routing protocols in IPv6, you must:
  - Create the routing process.

```
Router(config)#ipv6 unicast-routing
Router(config)#ipv6 router rip name
```

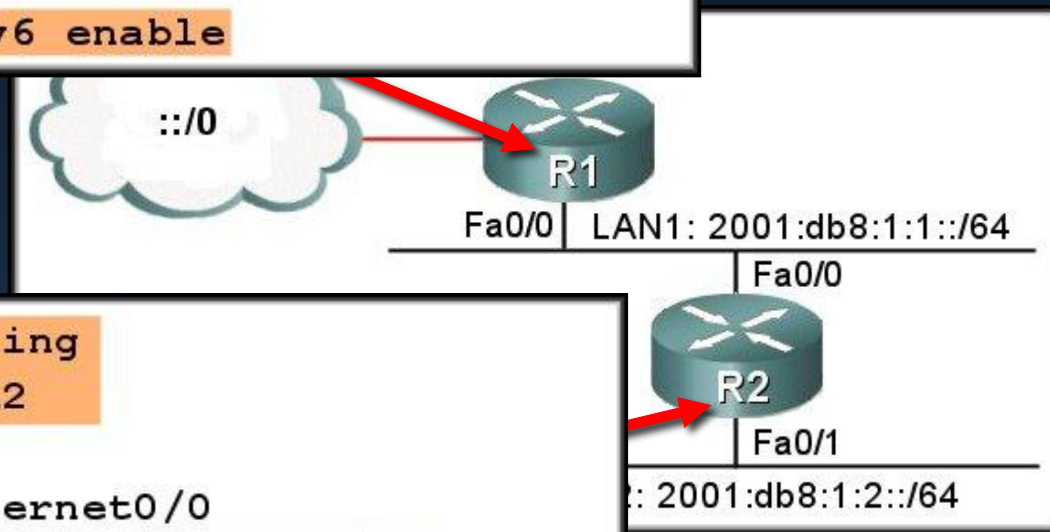
  - Enable the routing process on interfaces.

```
Router(config-if)#ipv6 rip name enable
```

Configuring RIPng with IPv6

```
R1(config)# ipv6 unicast-routing
R1(config)# ipv6 router myv6

R1(config)# interface FastEthernet0/0
R1(config-if)# ipv6 address 2001:db8:1:1::/64 eui-64
R1(config-if)# ipv6 rip myv6 enable
```




```
R2(config)# ipv6 unicast-routing
R2(config)# ipv6 router myv6R2

R2(config)# interface FastEthernet0/0
R2(config-if)# ipv6 address 2001:db8:1:1::/64 eui-64
R2(config-if)# ipv6 rip myv6R2 enable

R2(config)# interface FastEthernet0/1
R2(config-if)# ipv6 address 2001:db8:1:2::/64 eui-64
R2(config-if)# ipv6 rip myv6R2 enable
```

Verifying RIPng with IPv6

Command	Purpose
show ipv6 interface	Displays the status of interfaces configured for IPv6.
show ipv6 interface brief	Displays a summarized status of interfaces configured for IPv6.
show ipv6 neighbors	Displays IPv6 neighbor discovery cache information.
show ipv6 protocols	Displays the parameters and current state of the active IPv6 routing protocol processes.
show ipv6 rip	Displays information about current IPv6 Routing Information Protocol (RIP) processes.
show ipv6 route	Displays the current IPv6 routing table.
show ipv6 route summary	Displays a summarized form of the current IPv6 routing table.
show ipv6 routers	Displays IPv6 router advertisement information received from other routers.
show ipv6 static	Displays only static IPv6 routes installed in the routing table.
show ipv6 static 2001:db8:5555:0/16	Displays only static route information about the specific address given.
show ipv6 static interface serial 0/0	Displays only static route information with the specified interface as the outgoing interface.
show ipv6 static detail	Displays a more detailed entry for IPv6 static routes.
show ipv6 traffic	Displays statistics about IPv6 traffic.

Troubleshooting RIPng with IPv6

Command	Purpose
`clear ipv6 rip`	Deletes routes from the IPv6 RIP routing table and, if installed, routes in the IPv6 routing table.
`clear ipv6 route *`	Deletes all routes from the IPv6 routing table. NOTE: Clearing all routes from the routing table will cause high CPU use rates as the routing table is rebuilt.
`clear ipv6 route 2001:db8:c18:3::/64`	Clears this specific route from the IPv6 routing table.
`clear ipv6 traffic`	Resets IPv6 traffic counters.
`debug ipv6 packet`	Displays debug messages for IPv6 packets.
`debug ipv6 rip`	Displays debug messages for IPv6 RIP routing transactions.
`debug ipv6 routing`	Displays debug messages for IPv6 routing table updates and route cache updates.