



Chapter 8: IP Addressing



Introduction to Networks

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Chapter 8: Objectives

Upon completion of this chapter, you will be able to:

- Describe the structure of an IPv4 address.
- Characteristics and uses of the unicast, broadcast, and multicast IPv4 addresses.
- Compare the use of public address space and private address space.
- Explain the need for IPv6 addressing.
- Describe the representation of an IPv6 address.
- Describe types of IPv6 network addresses.
- Configure global unicast addresses.
- Describe the role of ICMP in an IP network (Include IPv4 and IPv6.)
- Use ping and traceroute utilities to test network connectivity.

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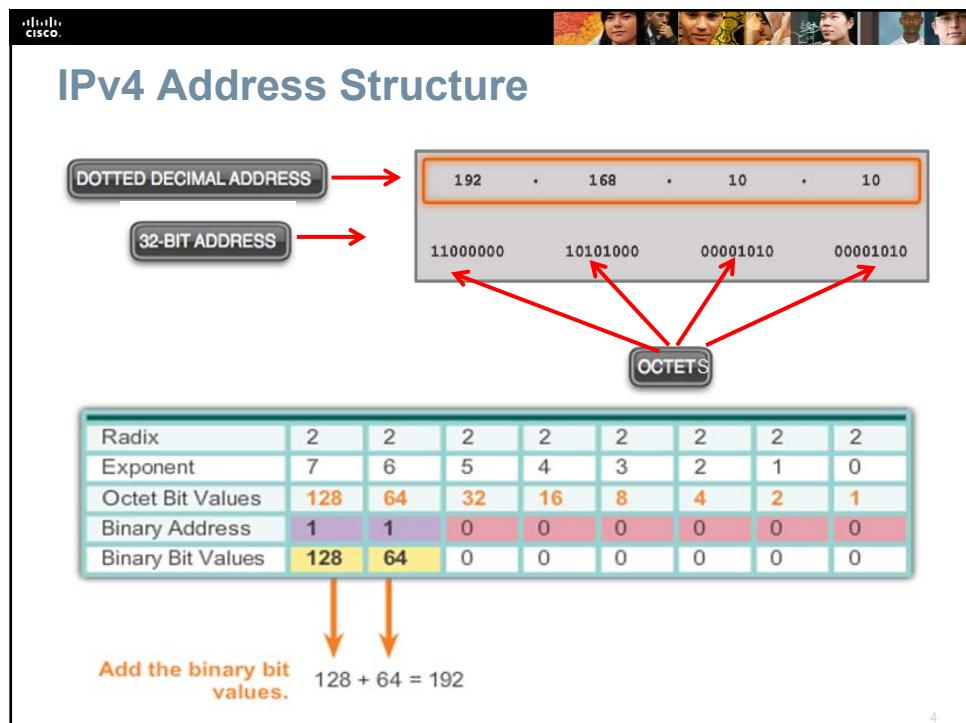


8.1 IPv4 Network Addresses



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Converting Binary to Decimal

Binary: 10110000

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	0	1	1	0	0	0	0

$$128 + 0 + 32 + 16 + 0 + 0 + 0 + 0$$

Answer = 176

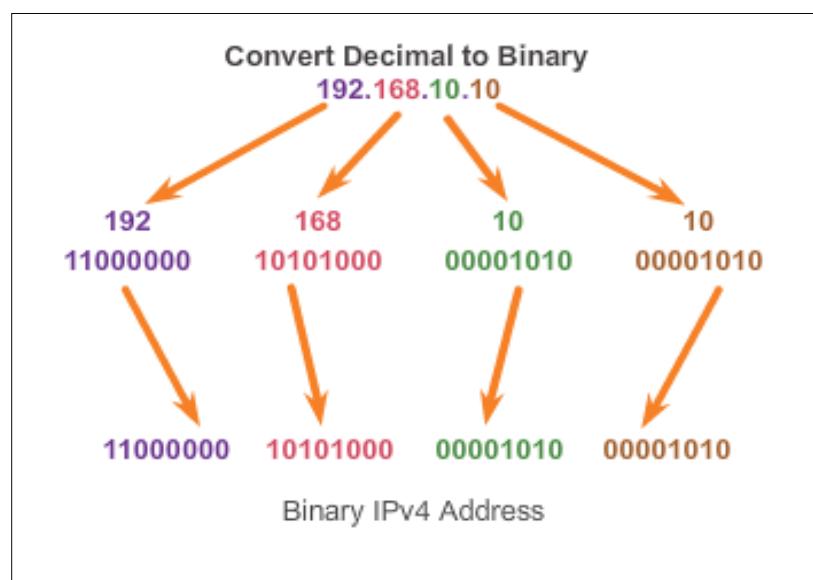
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
128	64	32	16	8	4	2	1
1	1	1	1	1	1	1	1

Answer = 255

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Converting from Decimal to Binary

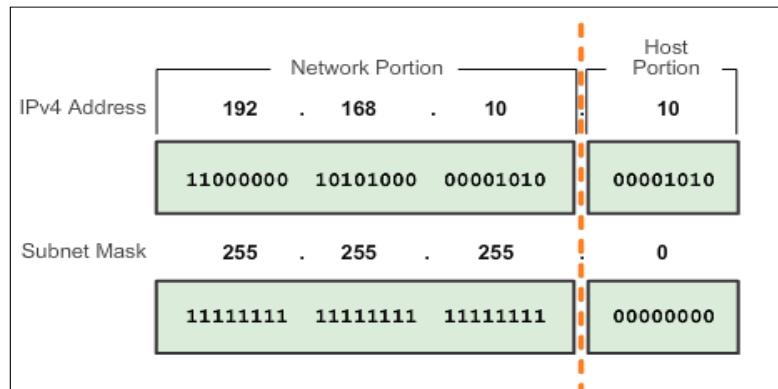


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Network and Host Portion of IP Address

- To define the network and host portions of an address, devices use a separate 32-bit pattern called a subnet mask.
- The subnet mask does not actually contain the network or host portion of an IPv4 address, it just says where to look for these portions in a given IPv4 address.



Network and Host Portion of IP Address

Valid Subnet Masks

Subnet Value	Bit Value							
	128	64	32	16	8	4	2	1
255	1	1	1	1	1	1	1	1
254	1	1	1	1	1	1	1	0
252	1	1	1	1	1	1	0	0
248	1	1	1	1	1	0	0	0
240	1	1	1	1	0	0	0	0
224	1	1	1	0	0	0	0	0
192	1	1	0	0	0	0	0	0
128	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

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Examining the Prefix Length

Dotted Decimal		Significant bits shown in binary
Network Address	10.1.1.0/24	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.254	10.1.1.11111110
Broadcast Address	10.1.1.255	10.1.1.11111111
Number of hosts:	$2^8 - 2 = 254$ hosts	24 bits Network

Dotted Decimal		Significant bits shown in binary
Network Address	10.1.1.0/25	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.126	10.1.1.01111110
Broadcast Address	10.1.1.127	10.1.1.01111111
Number of hosts:	$2^7 - 2 = 126$ hosts	25 bits Network

Dotted Decimal		Significant bits shown in binary
Network Address	10.1.1.0/26	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.62	10.1.1.00111110
Broadcast Address	10.1.1.63	10.1.1.00111111
Number of hosts:	$2^6 - 2 = 62$ hosts	26 bits Network

Examining the Prefix Length (contd)

Dotted Decimal		Significant bits shown in binary
Network Address	10.1.1.0/27	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.30	10.1.1.00011110
Broadcast Address	10.1.1.31	10.1.1.00011111
Number of hosts:	$2^5 - 2 = 30$ hosts	

Dotted Decimal		Significant bits shown in binary
Network Address	10.1.1.0/28	10.1.1.00000000
First Host Address	10.1.1.1	10.1.1.00000001
Last Host Address	10.1.1.14	10.1.1.00001110
Broadcast Address	10.1.1.15	10.1.1.00001111
Number of hosts:	$2^4 - 2 = 14$ hosts	

No. of Hosts = $2^H - 2$
Where H = no. of host bits

IPv4 Network, Host and Broadcast Address

Network Address: 10.1.1.0 /24

Network Portion			Host Portion	
10	1	1	0	
00001010	00000001	00000001	00000000	All 0s – NETWORK ADDRESS
10	1	1	10	0s and 1s in host portion
00001010	00000001	00000001	00001010	
10	1	1	255	
00001010	00000001	00000001	11111111	All 1s – BROADCAST ADDRESS

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First Host and Last Host Addresses

Network Address: 10.1.1.0 /24

Usable address range: 10.1.1.1 to 10.1.1.254

Network Portion			Host Portion	
10	1	1	1	FIRST HOST
00001010	00000001	00000001	00000001	All 0s and a 1 in the host portion
10	1	1	254	LAST HOST
00001010	00000001	00000001	11111110	All 1s and a 0 in the host portion

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Bitwise AND Operation

1 AND 1 = 1 1 AND 0 = 0 0 AND 1 = 0 0 AND 0 = 0

IPv4 Address	192	.	168	.	10	.	10
	11000000	10101000	00001010		00001010		
Subnet Mask	255	.	255	.	255	.	0
	11111111	11111111	11111111		00000000		
Network Address	192	.	168	.	10	.	0
	11000000	10101000	00001010		00000000		

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Assigning a Static IPv4 Address to a Host

LAN Interface Properties

The dialog shows the connection is using Intel(R) 82579LM Gigabit Network Connection and lists several components under 'This connection uses the following items': Client for Microsoft Networks, Deterministic Network Enhancer, QoS Packet Scheduler, File and Printer Sharing for Microsoft Networks, Internet Protocol Version 6 (TCP/IPv6), Internet Protocol Version 4 (TCP/IPv4), Link-Layer Topology Discovery Mapper I/O Driver, and Link-Layer Topology Discovery Responder.

Configuring a Static IPv4 Address

The dialog is set to 'Use the following IP address' and shows the following values: IP address: 10 . 0 . 0 . 1, Subnet mask: 255 . 255 . 255 . 0, and Default gateway: 10 . 0 . 0 . 254. Other options like 'Obtain an IP address automatically' and 'Obtain DNS server address automatically' are disabled.

Assigning Dynamic IPv4 Address to a Host

DHCP – The preferred method of assigning IPv4 addresses to hosts on large networks because it reduces the burden on network support staff and virtually eliminates entry errors.

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Unicast Transmission

In an IPv4 network, the hosts can communicate one of three different ways: **Unicast**, **Broadcast** and **Multicast**

#1 **Unicast** – the process of sending a packet from one host to an individual host.

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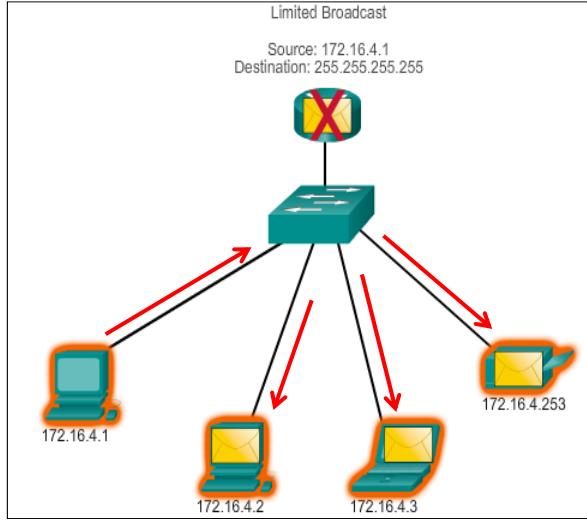
Broadcast Transmission

#2 Broadcast – the process of sending a packet from one host to all hosts in the network.

NOTE: Routers do not forward a limited broadcast!

Directed broadcast

- Destination 172.16.4.255
- Hosts within the 172.16.4.0 /24 network.



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Broadcast Transmission (Contd.)

- **Limited broadcast** address is the address formed by setting all 32 bits of the IP address to 1 (255.255.255.255).
- The **limited broadcast** address is used when an IP node must perform a one-to-everyone delivery on the local network but the network ID is unknown.
- **Directed broadcast** packets have a destination IP address that is a valid **broadcast** address (e.g. 172.16.4.255) for the subnet that is the target of the **directed broadcast** (the target subnet).
- The intent of an **directed broadcast** is to flood the target subnet with the **broadcast** packets without **broadcasting** to the entire network.

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Multicast Transmission

#3 Multicast – The process of sending a packet from one host to a selected group of hosts, possibly in different networks.

- Reduces traffic.
- Reserved for addressing multicast groups – 224.0.0.0 to 239.255.255.255.
- Link local – 224.0.0.0 to 224.0.0.255 (Example: routing information exchanged by routing protocols)
- Globally scoped addresses – 224.0.1.0 to 238.255.255.255 (Example: 224.0.1.1 has been reserved for Network Time Protocol)

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Public and Private IPv4 Addresses



Private address blocks are:

- Hosts that do not require access to the Internet can use private addresses
 - 10.0.0.0 to 10.255.255.255 (10.0.0.0 /8)
 - 172.16.0.0 to 172.31.255.255 (172.16.0.0 /12)
 - 192.168.0.0 to 192.168.255.255 (192.168.0.0 /16)

Shared address space addresses:

- Not globally routable
- Intended only for use in service provider networks.
- Address block is 100.64.0.0 /10

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Special Use IPv4 Addresses

- **Network and Broadcast addresses** – within each network the first and last addresses cannot be assigned to hosts.
- **Loopback address** – 127.0.0.1 a special address that hosts use to direct traffic to themselves (addresses 127.0.0.0 to 127.255.255.255 are reserved).
- **Link-Local address** – 169.254.0.0 to 169.254.255.255 (169.254.0.0/16) addresses can be automatically assigned to the local host.
- **TEST-NET addresses** – 192.0.2.0 to 192.0.2.255 (192.0.2.0/24) set aside for teaching and learning purposes, used in documentation and network examples
- **Experimental addresses** – 240.0.0.0 to 255.255.255.254 are listed as reserved.

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Legacy Classful Addressing

IP Address Classes

Address Class	1st octet range (decimal)	1st octet bits (green bits do not change)	Network(N) and Host(H) parts of address	Default subnet mask (decimal and binary)	Number of possible networks and hosts per network
A	1-127**	00000000- 01111111	N.H.H.H	255.0.0.0 11111111 00000000 00000000 00000000	128 nets (2^7) 16,777,214 hosts per net ($2^{24}-2$)
B	128-191	10000000- 10111111	N.N.H.H	255.255.0.0 11111111 10000000 00000000 00000000	16,384 nets (2^{14}) 65,534 hosts per net ($2^{16}-2$)
C	192-223	11000000- 11011111	N.N.N.H	255.255.255.0 11111111 11000000 00000000 00000000	2,097,150 nets (2^{21}) 254 hosts per net ($2^{8}-2$)
D	224-239	11100000- 11101111	NA (multicast)		
E	240-255	11110000- 11111111	NA (experimental)		

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Legacy Classful Addressing (contd.)



Classless Addressing

- Formal name is Classless Inter-Domain Routing (CIDR, pronounced “cider”).
- Created a new set of standards that allowed service providers to allocate IPv4 addresses on any address bit boundary (prefix length) instead of only by a class A, B or C address.
 - Class A: /8 → 8 bits network & 24 bits hosts.
 - Class B: /16 → 16 bits network & 16 bits hosts.
 - Class C: /24 → 24 bits network & 8 bits hosts.

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Assignment of IP Addresses

Regional Internet Registries (RIRs)



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8.2 IPv6 Network Addresses



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The Need for IPv6

- IPv6 is designed to be the successor to IPv4.
- Depletion of IPv4 address space has been the motivating factor for moving to IPv6.
- Projections show that all five RIRs will run out of IPv4 addresses between 2015 and 2020.
- IPv4 (32 bits) has a theoretical maximum of 4.3 billion addresses, plus private addresses in combination with NAT.
(4,000,000,000 addresses)
- IPv6 with a 128-bit address space provides for 340 undecillion addresses.
(340,000,000,000,000,000,000,000,000,000,000,000,000,000)
- IPv6 fixes the limitations of IPv4 and includes additional enhancements, such as ICMPv6.

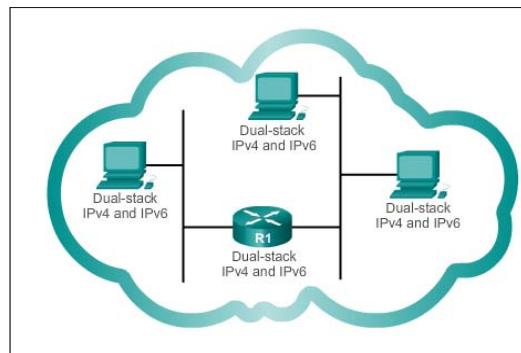
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IPv4 and IPv6 Coexistence

The migration techniques can be divided into three categories:
Dual-stack, Tunnelling and Translation.

Dual-stack



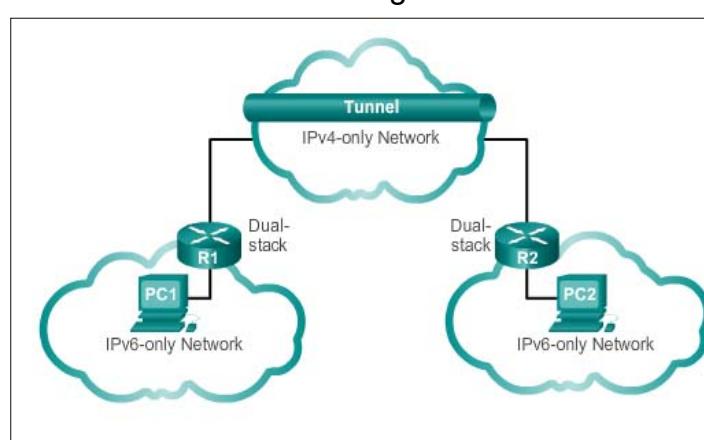
Dual-stack: Allows IPv4 and IPv6 to coexist on the same network.
Devices run both IPv4 and IPv6 protocol simultaneously.

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IPv4 and IPv6 Coexistence (cont.)

Tunnelling



Tunnelling: A method of transporting an IPv6 packet over an IPv4 network. The IPv6 packet is encapsulated inside an IPv4 packet.

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IPv4 and IPv6 Coexistence (cont.)

Translation

Translation: The Network Address Translation 64 (NAT64) allows IPv6-enabled devices to communicate with IPv4 - enabled devices using a translation technique similar to NAT for IPv4. An IPv6 packet is translated to an IPv4 packet and vice versa.

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Hexadecimal Number System

- Hexadecimal is a base sixteen system.
- Base 16 numbering system uses the numbers 0 to 9 and the letters A to F.
- Four bits (half of a byte) can be represented with a single hexadecimal value.

Hexadecimal	Decimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111

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Look at the binary bit patterns that match the decimal and hexadecimal values.

Hexadecimal	Decimal	Binary
00	0	0000 0000
01	1	0000 0001
02	2	0000 0010
03	3	0000 0011
04	4	0000 0100
05	5	0000 0101
06	6	0000 0110
07	7	0000 0111
08	8	0000 1000
0A	10	0000 1010
0F	15	0000 1111
10	16	0001 0000
20	32	0010 0000
40	64	0100 0000
80	128	1000 0000
C0	192	1100 0000
CA	202	1100 1010
F0	240	1111 0000
FF	255	1111 1111

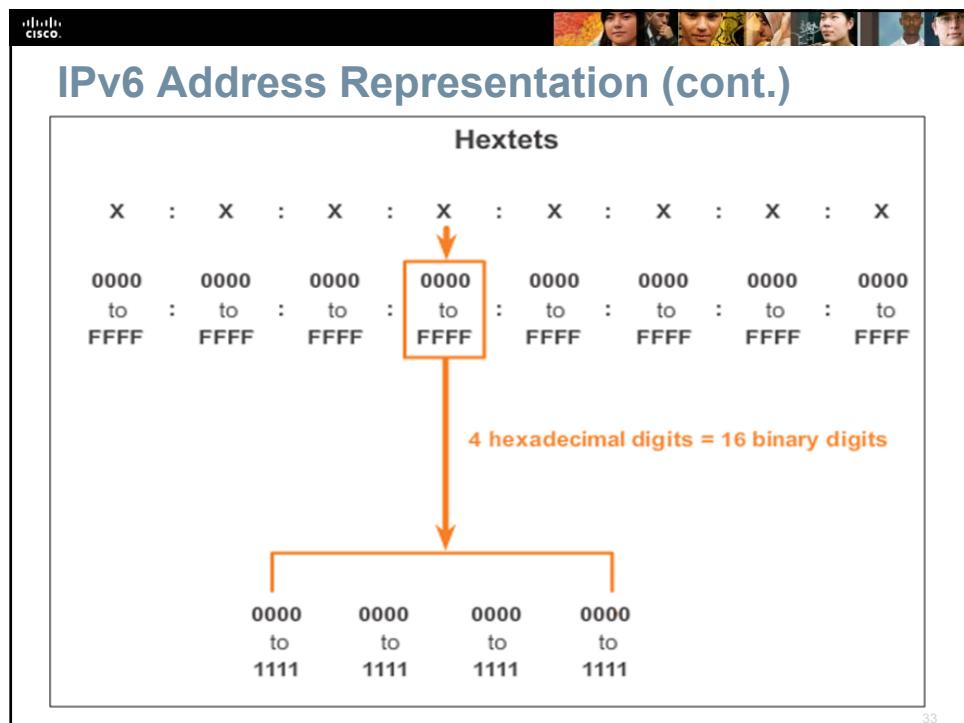
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IPv6 Address Representation

- 128 bits in length and written as a string of hexadecimal values.
- In IPv6, 4 bits represents a single hexadecimal digit, 32 hexadecimal value = IPv6 address


```
2001:0DB8:0000:1111:0000:0000:0000:0200
      FE80:0000:0000:0000:0123:4567:89AB:CDEF
```
- Hextet used to refer to a segment of 16 bits or four hexadecimals.
- Can be written in either lowercase or uppercase.

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Rule 1- Omitting Leading 0s

- The first rule to help reduce the notation of IPv6 addresses is any **leading 0s** (zeros) in any 16-bit section or hextet can be omitted.
- 01AB can be represented as 1AB.
- 09F0 can be represented as 9F0.
- 0A00 can be represented as A00.
- 00AB can be represented as AB.

Preferred	2001: 0 DB8: 000 A:1000: 0000 : 0000 : 0000 : 0100
No leading <u>0s</u>	2001: DB8: A:1000: 0: 0: 0: 100
Compressed	2001:DB8:A:1000:0:0:0:100

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Rule 2 - Omitting All 0 Segments

- A double colon (::) can replace any single, contiguous string of one or more 16-bit segments (hextets) consisting of all 0's.
- Double colon (::) can only be used once within an address otherwise the address will be ambiguous.
- Known as the *compressed format*.
- Incorrect address - 2001:0DB8::ABCD::1234.

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Rule 2 - Omitting All 0 Segments (cont.)

Example #1

Preferred	2001:0DB8:0000:0000:ABCD:0000:0000:0100
Omit leading 0s	2001: DB8: 0: 0: ABCD: 0: 0: 100
Compressed	2001:DB8::ABCD:0:0:100
OR	
Compressed	2001:DB8:0:0:ABCD::100

Only one :: may be used.

Example #2

Preferred	FE80:0000:0000:0000:0123:4567:89AB:CDEF
Omit leading 0s	FE80: 0: 0: 0: 123:4567:89AB:CDEF
Compressed	FE80::123:4567:89AB:CDEF

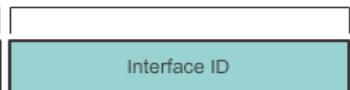
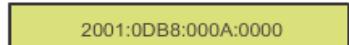
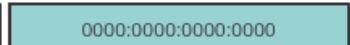
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IPv6 Prefix Length

- IPv6 does not use the dotted-decimal subnet mask notation
- Prefix length indicates the network portion of an IPv6 address using the following format:
 - IPv6 address/prefix length.
 - Prefix length can range from 0 to 128.
 - Typical prefix length is /64.

/64 Prefix

64 bits	64 bits
	
Example: 2001:0DB8:000A::/64	
	

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IPv6 Address Types

★

There are three types of IPv6 addresses:

- Unicast
- Multicast
- Anycast.

Note: IPv6 does not have broadcast addresses.

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IPv6 Unicast Addresses

Unicast

- Uniquely identifies an interface on an IPv6-enabled device.
- A packet sent to a unicast address is received by the interface that is assigned that address.

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IPv6 Unicast Addresses (cont.)

Types of Unicast addresses

```

graph TD
    IUA[IPv6 Unicast Addresses] --- GU[Global Unicast]
    IUA --- LL[Link-local]
    IUA --- LB[Loopback ::1/128]
    IUA --- UA[Unspecified Address ::/128]
    IUA --- UL[Unique Local FC00::/7 - FDFF::/7]
    IUA --- EI[Embedded IPv4]
  
```

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IPv6 Unicast Addresses (cont.)

Global Unicast

- Similar to a public IPv4 address.
- Globally unique.
- Internet routable addresses.
- Can be configured statically or assigned dynamically.

Link-local

- Used to communicate with other devices on the same local link.
- Confined to a single link
- Not routable beyond the link.

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IPv6 Unicast Addresses (cont.)

Loopback

- Used by a host to send a packet to itself and cannot be assigned to a physical interface.
- Ping an IPv6 loopback address to test the configuration of TCP/IP on the local host.
- All-0s except for the last bit, represented as ::1/128 or just ::1.

Unspecified Address

- All-0's address represented as ::/128 or just ::
- Cannot be assigned to an interface and is only used as a source address.
- An unspecified address is used as a source address when the device does not yet have a permanent IPv6 address or when the source of the packet is irrelevant to the destination.

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IPv6 Unicast Addresses (cont.)

Unique Local

- Similar to private addresses for IPv4.
- Used for local addressing within a site or between a limited number of sites.
- In the range of FC00::/7 to FDFF::/7.

IPv4 Embedded (not covered in this course)

- Used to help transition from IPv4 to IPv6.

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IPv6 Link-Local Unicast Addresses

- Every IPv6-enabled network interface is REQUIRED to have a link-local address.
- Enables a device to communicate with other IPv6-enabled devices on the same link and only on that link (subnet).
- FE80::/10 range, first 10 bits are 1111 1110 10xx xxxx
- **1111 1110 10**00 0000** (FE80) - 1111 1110 10**11 1111** (FEBF)**

The diagram illustrates the structure of an IPv6 link-local address. It shows a 128-bit address divided into four main fields: a 10-bit prefix (FE80::/10), a 54-bit subnet identifier, and a 64-bit Interface ID. The Interface ID field is further divided into two parts: a 16-bit prefix (1111 1110 10) and a 48-bit Interface Identifier (Interface ID). The entire address is labeled as being "Automatically or Manual Configured".

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Packets with a source or destination link-local address cannot be routed beyond the link from where the packet originated.

IPv6 Link-Local Communications

IPv6 Packet
Source IPv6 Address FE80::AAAA Destination IPv6 Address FE80::DDDD

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Structure of an IPv6 Global Unicast Address

- IPv6 global unicast addresses are globally unique and routable on the IPv6 Internet.
- Equivalent to public IPv4 addresses.
- ICANN allocates IPv6 address blocks to the five Regional Internet Registries (RIR)

Currently, only global unicast addresses with the first three bits of **001** or **2000::/3** are being assigned.

Global Routing Prefix	Subnet ID	Interface ID
-----------------------	-----------	--------------

Range of first hexet:

001 0000 0000 0000 (2000)
to
0011 1111 1111 1111 (3FFF)

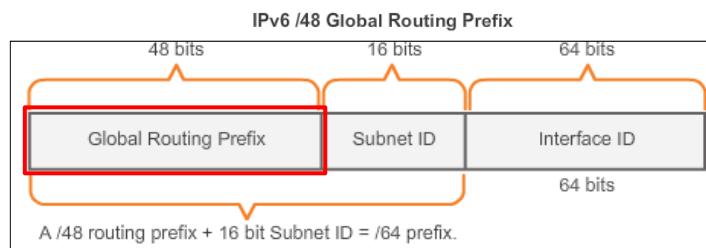
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Structure of an IPv6 Global Unicast Address (cont.)

A global unicast address has three parts: Global Routing Prefix, Subnet ID and Interface ID.

- **Global Routing Prefix** is the prefix or network portion of the address assigned by the provider, such as an ISP, to a customer or site, currently, RIR's assign a /48 global routing prefix to customers.
- 2001:0DB8:ACAD::/48 has a prefix that indicates that the first 48 bits (2001:0DB8:ACAD) is the prefix or network portion.

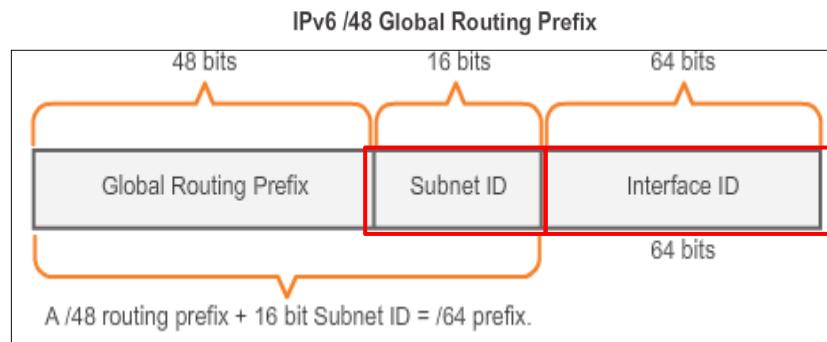


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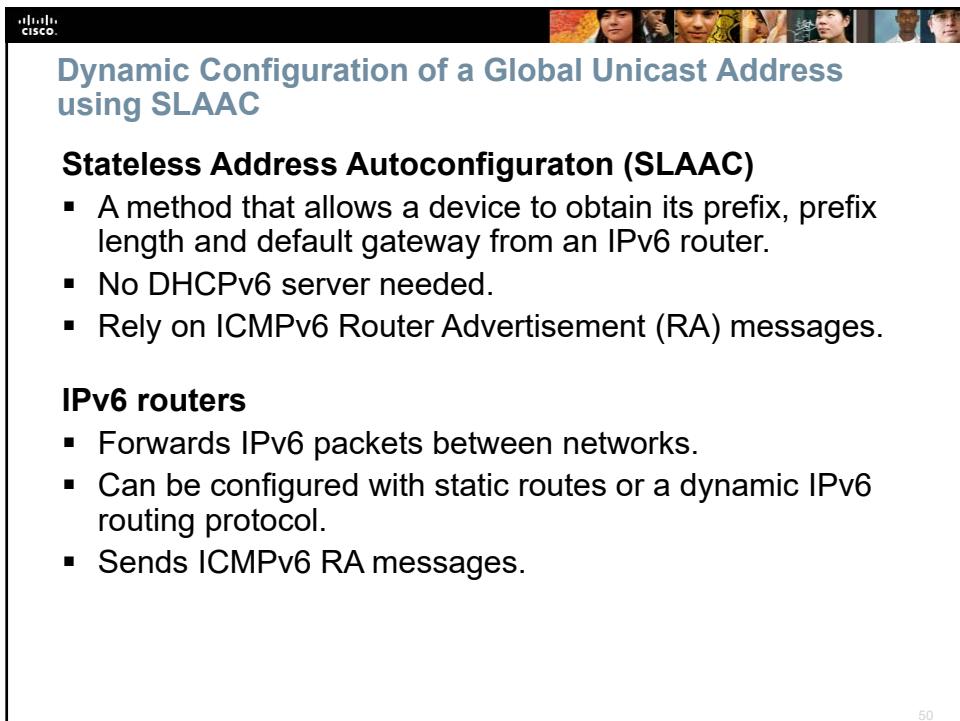
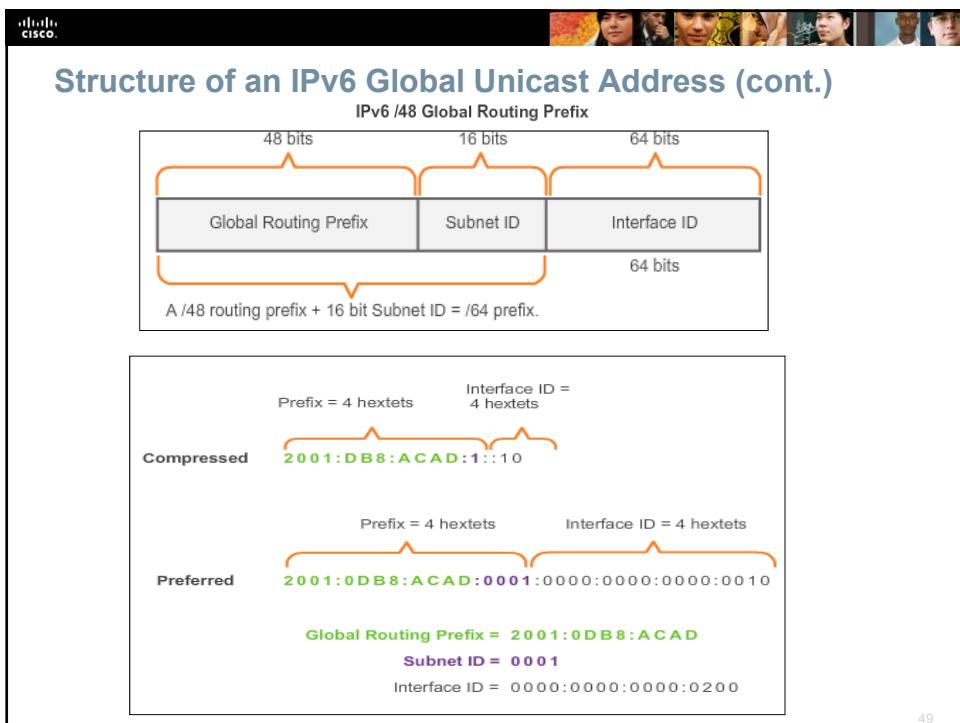


Structure of an IPv6 Global Unicast Address (cont.)

- **Subnet ID** is used by an organization to identify subnets within its site.
- **Interface ID**
 - Equivalent to the host portion of an IPv4 address.
 - Used because a single host may have multiple interfaces, each having one or more IPv6 addresses.



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DYNAMIC CONFIGURATION OF A GLOBAL UNICAST ADDRESS USING SLAAC

- The **IPv6 unicast-routing** command enables IPv6 routing.
- RA message can contain one of the following three options:
 - SLAAC Only – Uses the information contained in the RA message.
 - SLAAC and DHCPv6 – Uses the information contained in the RA message and get other information from the DHCPv6 server, stateless DHCPv6 (for example, DNS).
 - DHCPv6 only – The device should not use the information in the RA, stateful DHCPv6.
- Routers send ICMPv6 RA messages using the link-local address as the source IPv6 address

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DYNAMIC CONFIGURATION OF A GLOBAL UNICAST ADDRESS USING SLAAC

Router Solicitation and Router Advertisement Messages

1 Router Solicitation – To all IPv6 routers
"I need addressing information from the router."

2 Router Advertisement – To all IPv6 nodes
Option 1 (SLAAC Only) – "Here is your Prefix, Prefix-length, Default Gateway information."

Router Advertisement Options

Option 1 (SLAAC Only) – "I'm everything you need (Prefix, Prefix-length, Default Gateway)"
Option 2 (SLAAC and DHCPv6) – "Here is my information but you need to get other information such as DNS addresses from a DHCPv6 server."
Option 3 (DHCPv6 Only) – "I can't help you. Ask a DHCPv6 server for all your information."

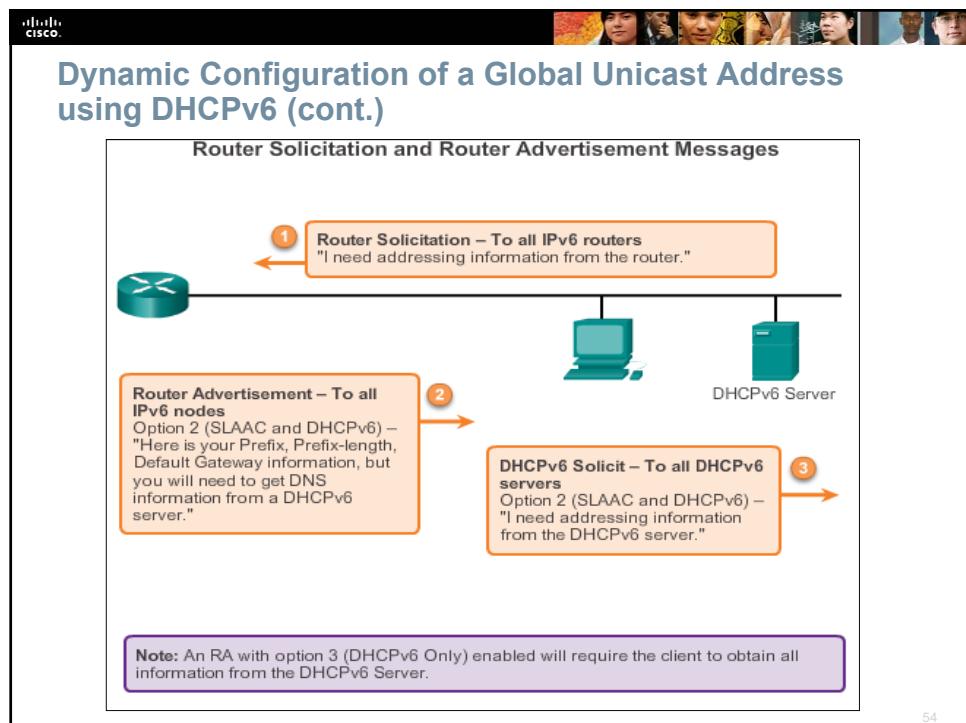
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Dynamic Configuration of a Global Unicast Address using DHCPv6

Dynamic Host Configuration Protocol for IPv6 (DHCPv6)

- Similar to IPv4.
- Automatically receives addressing information, including a global unicast address, prefix length, default gateway address and the addresses of DNS servers using the services of a DHCPv6 server.
- Device may receive all or some of its IPv6 addressing information from a DHCPv6 server depending upon whether option 2 (SLAAC and DHCPv6) or option 3 (DHCPv6 only) is specified in the ICMPv6 RA message.
- Host may choose to ignore whatever is in the router's RA message and obtain its IPv6 address and other information directly from a DHCPv6 server.

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EUI-64 Process or Randomly Generated

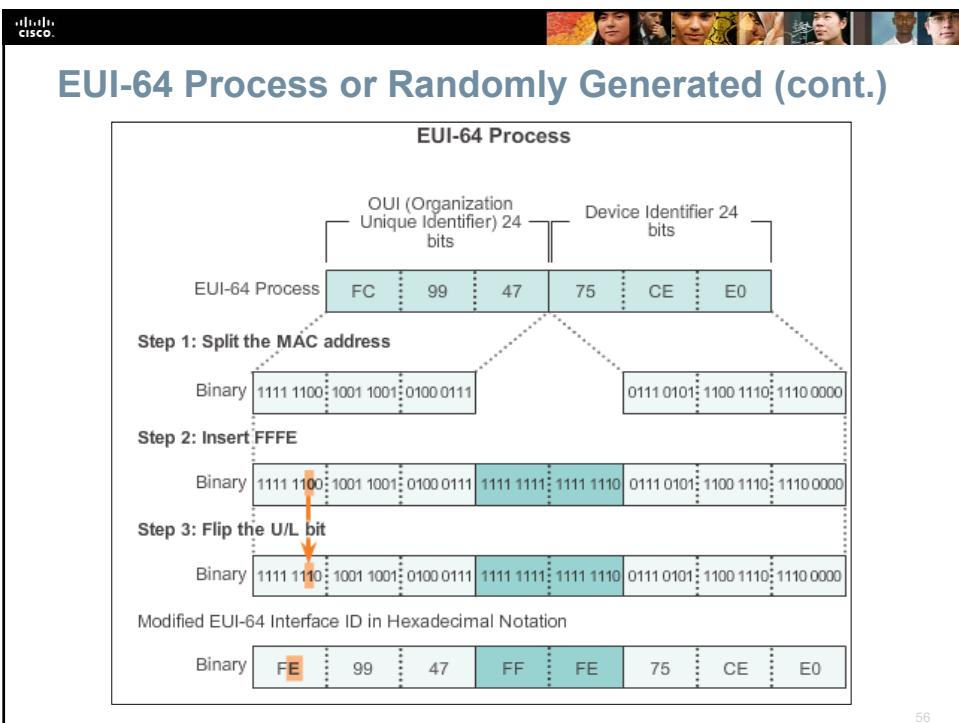
EUI-64 Process

- Uses a client's 48-bit Ethernet MAC address and inserts another 16 bits (hexadecimal FFFE) in the middle of the 48-bit MAC address to create a 64-bit Interface ID.
- Advantage is that the Ethernet MAC address can be used to determine the interface; is easily tracked.

EUI-64 Interface ID is represented in binary and comprises three parts:

- 24-bit OUI from the client MAC address, but the 7th bit (the Universally/Locally bit) is reversed (0 becomes a 1).
- Inserted as a 16-bit value FFFE.
- 24-bit device identifier from the client MAC address.

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EUI-64 Process or Randomly Generated (cont.)

```
R1#show interface gigabitethernet 0/0
GigabitEthernet0/0 is up, line protocol is up
  Hardware is CN Gigabit Ethernet, address is fc99.4775.c3e0
  (bia fc99.4775.c3e0)
<Output Omitted>

R1#show ipv6 interface brief
GigabitEthernet0/0      [up/up]
  FE80::FE99:47FF:FE75:C3E0
  2001:DB8:ACAD:1::1
GigabitEthernet0/1      [up/up]
  FE80::FE99:47FF:FE75:C3E1
  2001:DB8:ACAD:2::1
Serial0/0/0             [up/up]
  FE80::FE99:47FF:FE75:C3E0
  2001:DB8:ACAD:3::1
Serial0/0/1             [administratively down/down]
  unassigned
R1#
```

Link-local addresses using EUI-64

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EUI-64 Process or Randomly Generated (cont.)

Randomly Generated Interface IDs

- Depending upon the operating system, a device can use a randomly generated Interface ID instead of using the MAC address and the EUI-64 process.
- Beginning with Windows Vista, Windows uses a randomly generated Interface ID instead of one created with EUI-64.
- Windows XP (and previous Windows operating systems) used EUI-64.

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Dynamic Link-local Addresses

Link-Local Address

- After a global unicast address is assigned to an interface, an IPv6-enabled device automatically generates its link-local address.
- Must have a link-local address that enables a device to communicate with other IPv6-enabled devices on the same subnet.
- Uses the link-local address of the local router for its default gateway IPv6 address.
- Routers exchange dynamic routing protocol messages using link-local addresses.
- Routers' routing tables use the link-local address to identify the next-hop router when forwarding IPv6 packets.

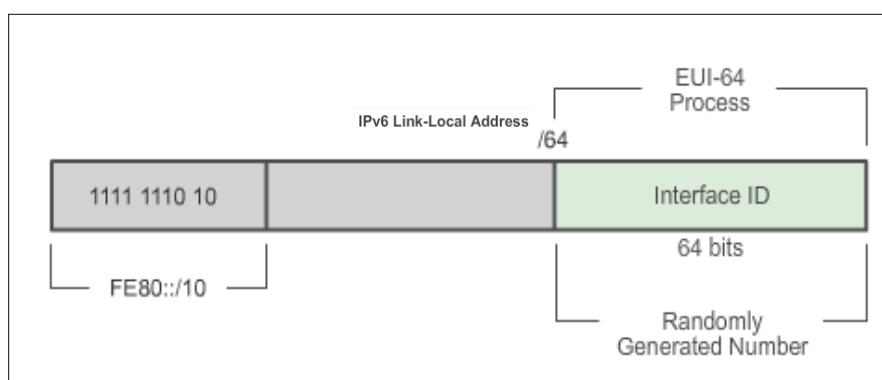
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Dynamic Link-local Addresses (cont.)

Dynamically Assigned

The link-local address is dynamically created using the FE80::/10 prefix and the Interface ID.



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Static Link-local Addresses

Configuring Link-local

```
R1(config)#interface gigabitethernet 0/0
R1(config-if)#ipv6 address fe80::1 ?
    link-local  Use link-local address

R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface gigabitethernet 0/1
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#exit
R1(config)#interface serial 0/0/0
R1(config-if)#ipv6 address fe80::1 link-local
R1(config-if)#

```

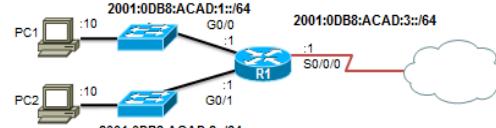
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Verifying IPv6 Address Configuration

Each interface has two IPv6 addresses:

1. global unicast address that was configured
2. one that begins with FE80 is automatically added as a link-local unicast address



```
R1#show ipv6 interface brief
GigabitEthernet0/0      [up/up]
    FE80::FE99:47FF:FE75:C3E0
    2001:0DB8:ACAD:1::1
GigabitEthernet0/1      [up/up]
    FE80::FE99:47FF:FE75:C3E1
    2001:0DB8:ACAD:2::1
Serial0/0/0              [up/up]
    FE80::FE99:47FF:FE75:C3E0
    2001:0DB8:ACAD:3::1
Serial0/0/1              [administratively down/down]
    unassigned
R1#
```

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Verifying IPv6 Address Configuration (cont.)

```
R1#show ipv6 route
IPv6 Routing Table - default - 7 entries
Codes: C - Connected, L - Local, S - Static, U - Per-user
Static

<output omitted>

C  2001:DB8:ACAD:1::/64 [0/0]
    via GigabitEthernet0/0, directly connected
L  2001:DB8:ACAD:1::1/128 [0/0]
    via GigabitEthernet0/0, receive
C  2001:DB8:ACAD:2::/64 [0/0]
    via GigabitEthernet0/1, directly connected
L  2001:DB8:ACAD:2::1/128 [0/0]
    via GigabitEthernet0/1, receive
C  2001:DB8:ACAD:3::/64 [0/0]
    via Serial0/0/0, directly connected
L  2001:DB8:ACAD:3::1/128 [0/0]
    via Serial0/0/0, receive
L  FF00::/8 [0/0]
    via Null0, receive
R1#
```

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Assigned IPv6 Multicast Addresses

- IPv6 multicast addresses have the prefix FF00::/8
- There are two types of IPv6 multicast addresses:
 - Assigned multicast
 - Solicited node multicast

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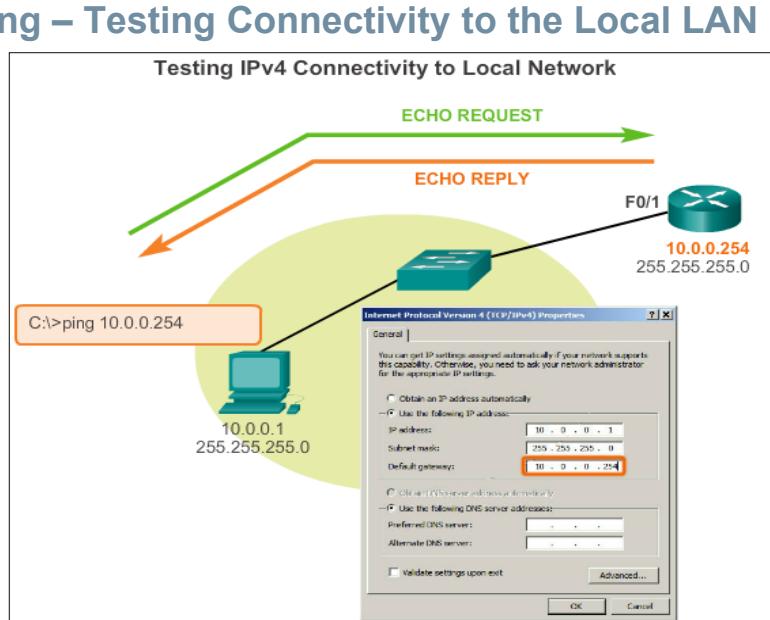
8.3 Connectivity Verification



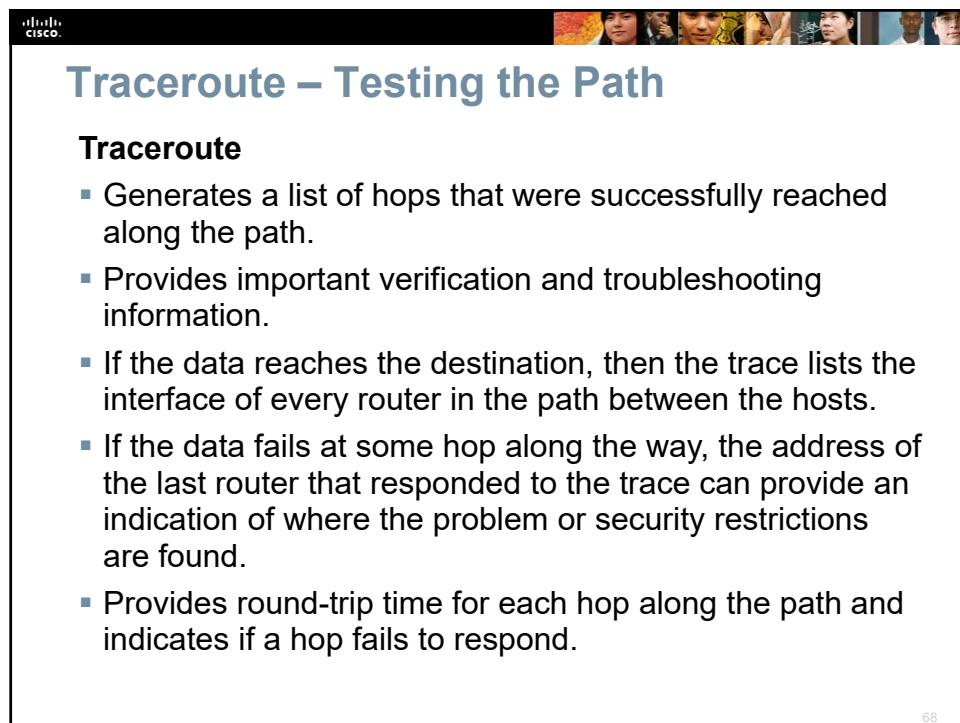
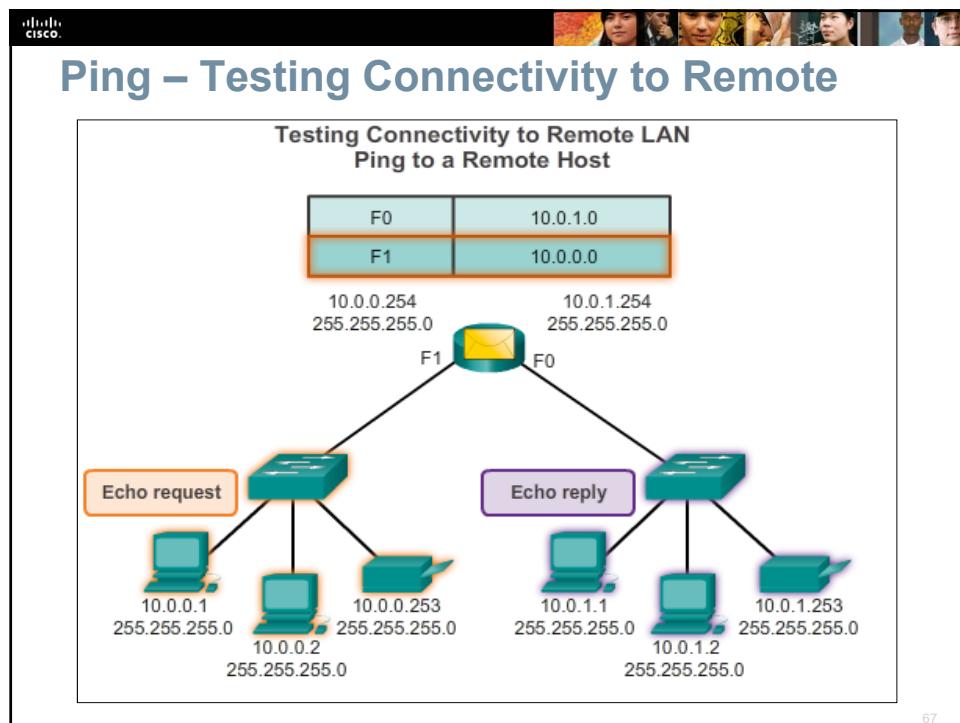
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Ping – Testing Connectivity to the Local LAN



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Summary

- IP addresses are hierarchical with network, subnetwork, and host portions.
- IPv4 is 32 bits long & is expressed as dotted decimal.
- An IP address can represent a complete network (Network address), a specific host (Host address), or the Broadcast address (represent all hosts) of the network.
- The subnet mask or prefix (e.g. /24) is used to determine the network portion of an IP address.
- DHCP enables the automatic assignment of addressing information such as IP address, subnet mask, default gateway, and other configuration information.

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Summary (cont.)

- IPv4 hosts can communicate in one of three different ways: unicast, broadcast and multicast.
- The private IPv4 address blocks are: 10.0.0.0/8, 172.16.0.0/12, and 192.168.0.0/16.
- The depletion of IPv4 address space is the motivating factor for moving to IPv6.
- Each IPv6 address has 128 bits versus the 32 bits in an IPv4 address.
- The prefix length is used to indicate the network portion of an IPv6 address using the following format: IPv6 address/prefix length.
- There are three types of IPv6 addresses: unicast, multicast, and anycast.
- ICMP is available for both IPv4 and IPv6.

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