IPV6 (Internet Protocol Version 6):

- IPv4 has only about 4.3 billion addresses available in theory.
- Only about 250 million addresses can be assigned to devices.
- There are about 6.5 billion people in the world today.
- Estimated over 10 percent of that population is connected to the Internet.
- Besides PC, phones, laptops, routers, switches & other devices connect to Internet.
- Short-term solution is NAT (Network Address Translation) and PAT.
- IPv6 replaces the 32-bit IPv4 address with a 128-bit address.
- IPv6 making 340 trillion, trillion, trillion IP addresses available.
- IPv6 is latest version of IP, identifies devices across the internet.

Benefits of IPV6:

- There is many benefits and advantages of IPV6.

Larger Address Space	IPv6 uses 128-bit addresses instead of the 32-bit addresses.
Globally Unique IP Addresses	The additional address spaces allow each node to have a unique address and eliminate the need for NAT.
Simplified Header	IPv6's header has been simplified by moving all unnecessary information and options to the end of the IPv6 header.
End-to-End Connectivity	Every system now has unique IP address and can traverse through the Internet without using NAT or other translating components.
Address Auto Configuration	Dynamic assignment of IPv6 addresses. IPv6 hosts can automatically configure themselves, with or without a DHCP server.
No Broadcast	IPv6 does not have any broadcast support anymore. It uses multicast to communicate with multiple hosts**.**
Anycast Support	IPv6 has introduced Anycast mode of packet routing. In this mode, multiple interfaces over the Internet are assigned same Anycast IP address. Routers, while routing, send the packet to the nearest destination.
Mobility	IPv6 has built-in support for mobile devices. Hosts will be able to move from one network to another and keep their current IPv6 address.
Not require NAT / PAT	IPv6 have many addresses that why do not need NAT or PAT anymore, every device in the network can have a public IPv6 address.
IP Security	IPv6 has native support for IPsec, you don't have to use it but its built-in the protocol.

IPV6 Address Representation:

- IPv6 addresses are written as hexadecimal numbers.
- Colons between each set of four hexadecimal digits (which is 16 bits).
- So IPv6 is a 16bit-eight coloned-hex, the format is **x:x:x:x:x:x:x:x.**
- Where x is a 16-bit hexadecimal field.
- 2035:0001:2BC5:0000:0000:087C:0000:000A
- Fortunately, you can shorten the written form of IPv6 addresses.
- Leading zero within each set of four hexadecimal digits can be omitted.
- Pair of colons (::) can be used, once within an address.
- To represent any number of successive 0s but once in the address 2035:1:2BC5:: 87C:0:A

IPV4 VS IPV6	
IPV4	**IPV6**
32 Bits Address	128 Bits Address
8 Bits Group	16 Bits Group
4 Groups	8 Groups
Dotted (.) Decimal Notation	Use (:) to Separate Groups
Decimal Number System	Hexadecimal Number System
Classes [A, B, C, D, E]	No Classes
Subnetting Required	No Subnetting Required
No Built-In Security	Built-In Security
Unicast, Multicast, Broadcast	Unicast, Multicast, Anycast, No Broadcast
No Short Form Available	Short Form Available
Manual or DHCP	Auto configuration or DHCPv6
ICMP	ICMPv6
Broadcast Yes	Broadcast No
Broadcast ARP	Multicast Neighbor Finding

IPv6 Address Types:

- IPv6 looks different from IPv4 but there are some similarities.
- IPv4 & IPv6 both have unicast addresses and multicast addresses.
- IPv4 and IPv6 still have “public and private” ranges.

Global Unicast Addresses:

- A unicast address is an address that identifies a single device.
- A global unicast address is a unicast address that is globally unique.
- Global Unicast IPv6 addresses are internet routable IPv6 addresses.
- Global Unicast IPv6 addresses are the same as public IPv4. (2000:: /.

Unique Local:

- Unique Local Works somewhat like private IPv4 addresses.
- Possibility that multiple organizations use the exact same addresses.
- No requirement for registering with any numbering authority.
- Unique Local addresses are starting from FD as the first two hex digits.

Link-local Addresses:

- Link Local IPv6 addresses allow communications between devices on a local link.
- Link Local IPv6 addresses are not routable.
- Link Local IPv6 addresses are used on a subnet.
- Link-Local addresses are like the private addresses in IPv4.
- Link-Local addresses are staring from FE80:: /.

Multicast:

- Multicast address identifies not one device but a set of devices a multicast group.
- Multicast address format of IPv6 multicast address is first 8 bits always all ones.
- Multicast addresses are starting from FF.

Function	**Multicast Group**	**IPv4 Equivalent**
All Hosts	FF02::1	Subnet broadcast address
All Routers	FF02::2	224.0.0.2
OSPFv3 Routers	FF02::5	224.0.0.5
OSPFv3 Routers	FF02::6	224.0.0.6
EIGRPv6	FF02::9	224.0.0.9
RIPng	FF02::A	224.0.0.10
DHCP	FF02::C	

Anycast:

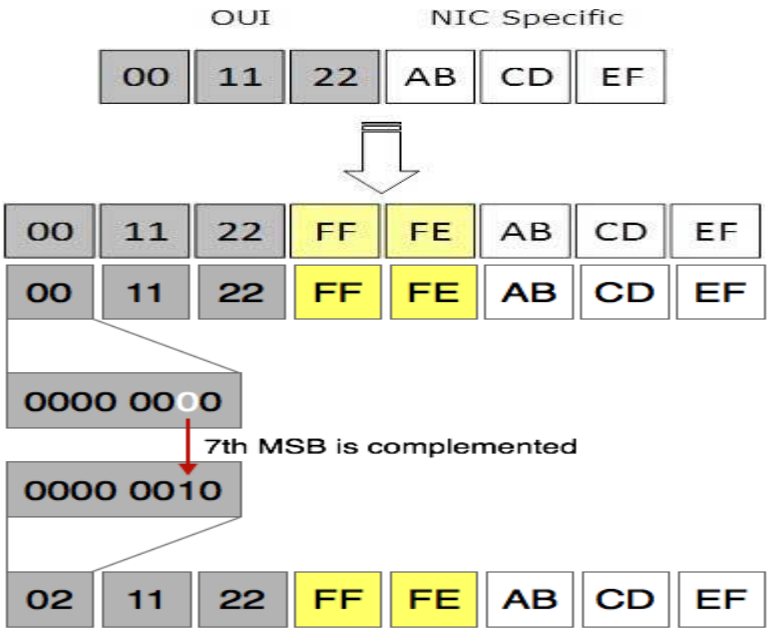
- Anycast address represents a service rather than a device.
- Anycast same address can reside on one or more devices providing the same service.
- Anycast multiple interfaces (hosts) are assigned same Anycast IP address.

IPV6 Loopback Addresses:

- Used by a node to send an IPv6 packet to itself.
- An IPv6 loopback address functions the same as an IPv4 loopback address.
- It normally uses for checking protocols stacks.
- The IPv6 loopback address is 0000:0000:0000:0000:0000:0000:0000:0001/128,
- IPV6 Loopback Address can also be represented as ::1.

Modified EUI 64:

- EUI stands for Extended Unique Identifier.
- A host can auto-configure its Interface ID by using EUI-64 format.
- First, a host divides its own MAC address into two 24-bits halves.
- Then 16-bit Hex value 0xFFFE is sandwiched into those two halves of MAC address.
- This resulting in Extended Unique Identifier-64 Interface ID.
- To convert EUI-64 ID into IPv6 Interface Identifier.
- The most significant seventh bit of EUI-64 ID is complemented.



Stateless Address Auto Configuration (SLAAC):

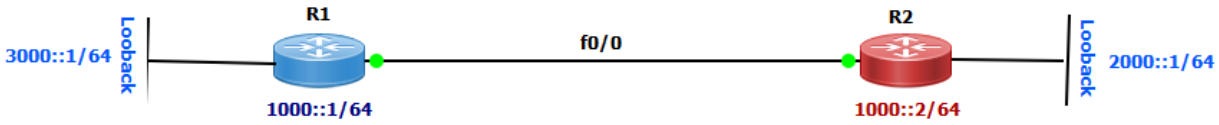
- IPv6 Stateless address Autoconfiguration is similar to DHCP in IPv4.
- Stateless Autoconfiguration for IPv6 is like a “Mini-DHCP” server for IPv6.
- Routers running IPv6 give prefix & gateway address to clients looking for IPv6 address.
- SLAAC is a method, which obtain an IPv6 global unicast address without DHCPv6 server.
- Stateless service means there is no server that maintains network address information.
- This is a unique feature only to IPv6 which provides simple “plug & play” networking.
- By default, SLAAC only provide IPv6 address and a default gateway to client devices.
- Nodes listen for ICMPv6 Router Advertisements (RA) messages periodically.

IPv4-Compatible IPv6 Addresses:

- It use 0s in the 1st 96bits, and are used in the transition/migration strategies.
- Example: 10.10.100.16 can be represented in IPv6 as:
- 0:0:0:0:0:10:10:100:16
- :: 10:10:100:16
- :: A: A: 64:10

Configure IPv6 Addressing:

- IPv6 address configuration is simple like IPV4.
- IPV6 address can be configured by many ways.
- Manually through DHCP Server, Auto-Configuration, and through EUI-64.



R1 Configuration	R2 Configuration
R1(config)# ipv6 unicast-routing	R2(config)# ipv6 unicast-routing
R1(config)#interface f0/0 R1(config-if)#ipv6 add 1000::1/64 R1(config-if)#no shutdown	R2(config)#interface f0/0 R2(config-if)#ipv6 add 1000::2/64 R2(config-if)#no shutdown
R1(config)#interface loopback 1 R1(config-if)#ipv6 add 3000::1/64	R2(config)#interface loopback 1 R2(config-if)#ipv6 add 2000::1/64
R1#show ipv6 interface br	R2#show ipv6 interface br
R1#show ipv6 interface f0/0	R2#show ipv6 interface f0/0
R1#ping ipv6 1000::1	R2#ping 1000::2
R1#show ipv6 route	R2#show ipv6 route

IPv6 Stateless Address Auto Configuration:

- IPv6 has a new IPv6 address configuration feature called Stateless Auto-configuration.
- IPv6 Stateless Autoconfiguration allows a network interface to automatically learn the IPv6 Network Prefix, IPv6 Prefix Length, default router IPv6 address and DNSv6 server addresses.
- Stateless Address Auto Configuration work properly IPv6 Unicast Routing must be enabled.

R1 Configuration	R1 Configuration
R1(config)# ipv6 unicast-routing	R2(config)# ipv6 unicast-routing
R1(config)#interface f0/0 R1(config-if)#ipv6 add 1000::1/64 R1(config-if)#ipv6 enable R1(config-if)#no shutdown	R2(config)#interface f0/0 R2(config-if)#ipv6 address autoconfig R2(config-if)#ipv6 enable R2(config-if)#no shutdown
R1#show ipv6 interface br	R2#show ipv6 interface br
R1#show ipv6 interface f0/0	R2#show ipv6 interface f0/0

IPv6 Static Routing:

- Like IPv4, static routes also can be configured in IPv6 Cisco Routers.
- Static IPv6 routes can be used in small networks.
- Where the overhead of a routing protocol is not required.
- Routers in IPv6 find best paths to destinations based on metrics & AD.

R1 Configuration	**R2 Configuration**
R1(config)# ipv6 unicast-routing	R2(config)# ipv6 unicast-routing
R1(config)#interface f0/0 R1(config-if)#ipv6 add 1000::1/64 R1(config-if)#no shutdown	R2(config)#interface f0/0 R2(config-if)#ipv6 add 1000::2/64 R2(config-if)#no shutdown
R1(config)#interface loopback 1 R1(config-if)#ipv6 add 3000::1/64	R2(config)#interface loopback 1 R2(config-if)#ipv6 add 2000::1/64
R1(config)# ipv6 route 0::/0 1000::2	R2(config)# ipv6 route 0::/0 1000::1
R1(config)# ipv6 route 2000::/64 1000::2	R2(config)# ipv6 route 3000::/64 1000::1
R1# show ipv6 route	R2# show ipv6 route
R1# show ipv6 route static	R2# show ipv6 route static