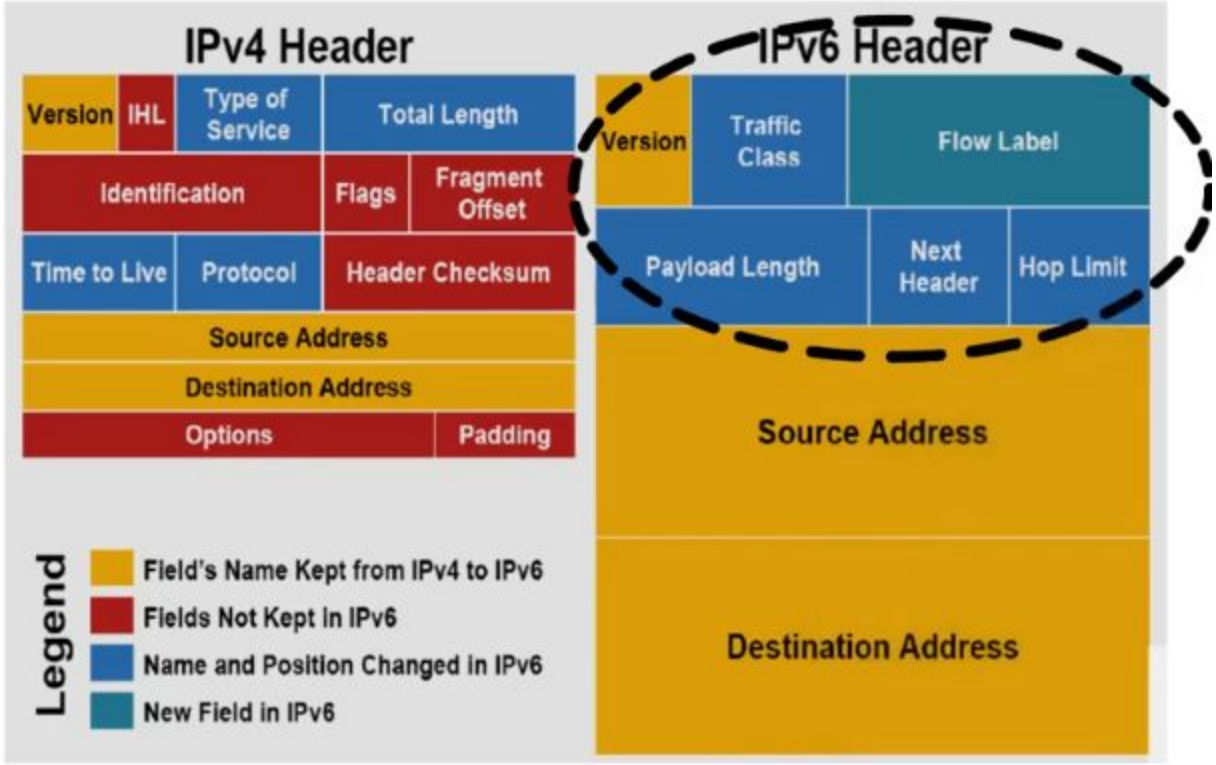
Internet Protocol Version 6 (IPv6)

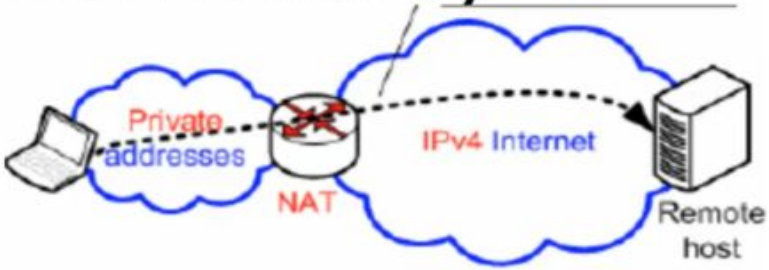
IPv6 Features

- Expanded addressing capabilities: From 32 bits to 128 bits
- Header format simplification.
- End to End reachability : avoids NAT
- Support for resource allocation.
- Faster forwarding or routing.
- Improved support for extensions and options.
- Support for more security.
- Support for mobility.
- Stateless Autoconfiguration - No DHCP

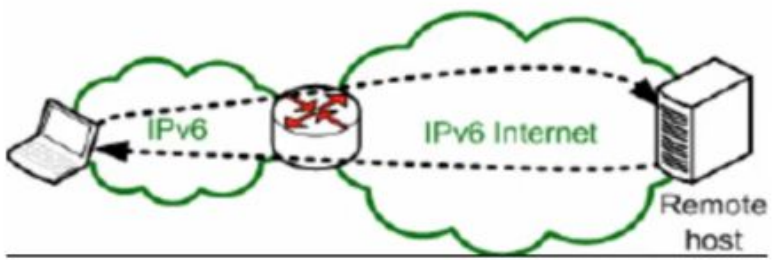
Simplified Header



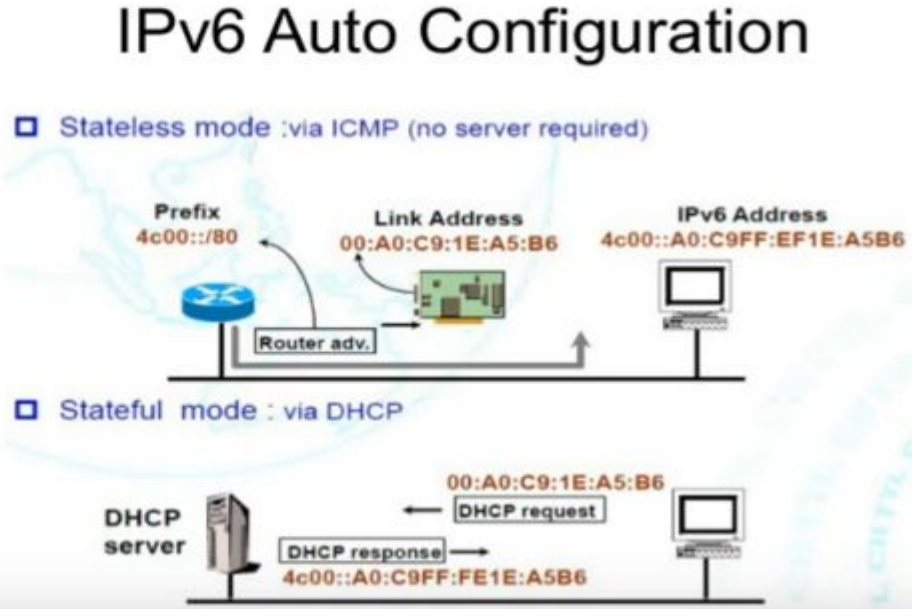
End-to-end Connectivity



No NAT required



Auto-configuration

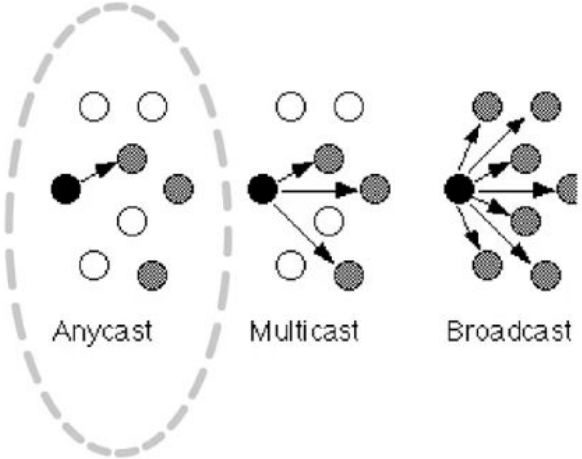


IPSec

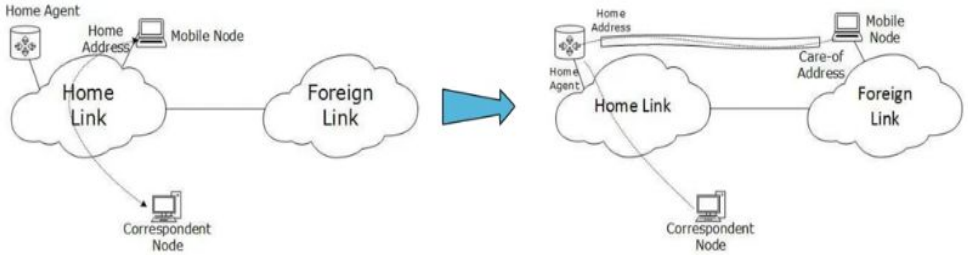
Initially it was decided that IPv6 must have IPSec security, making it more secure than IPv4.

Optional

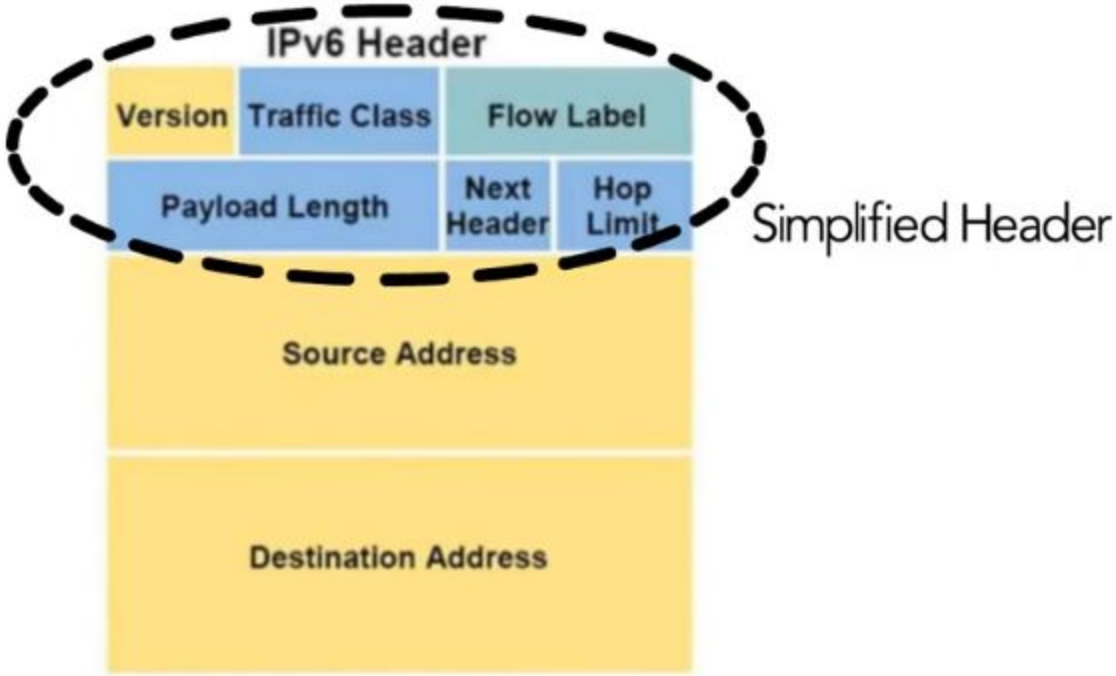
Anycast Support



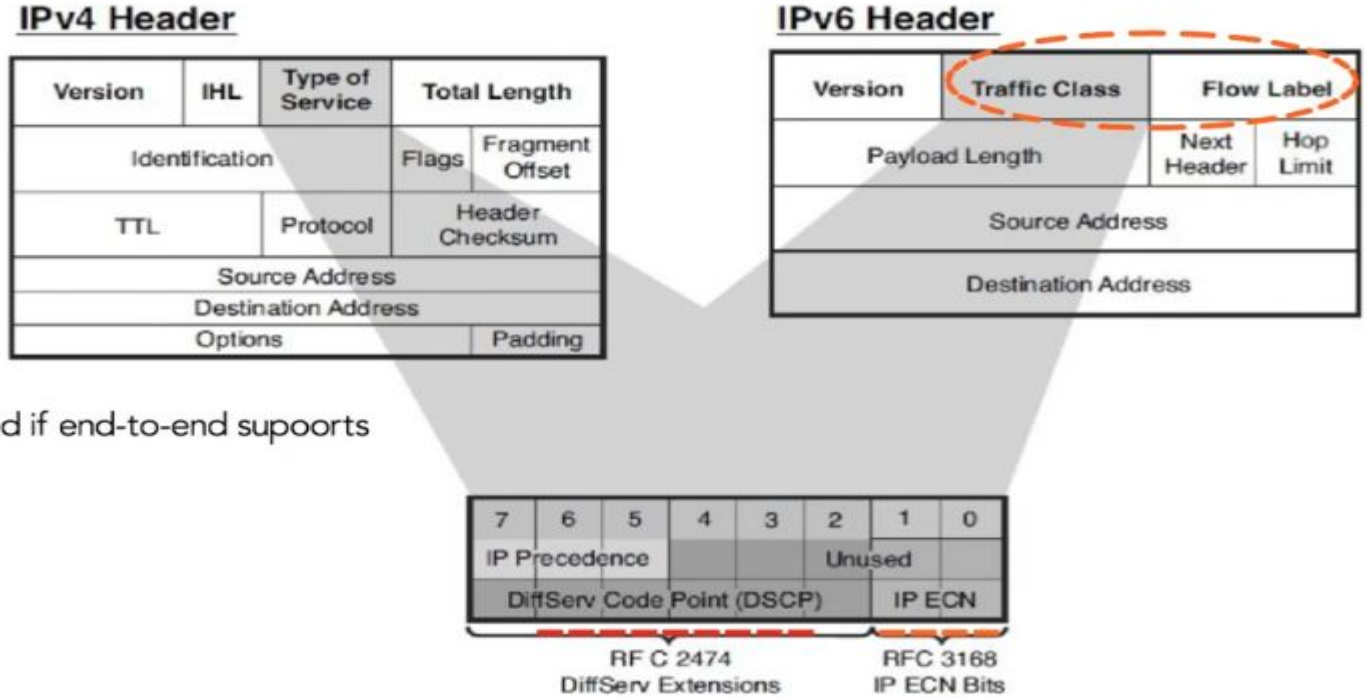
Mobility



Faster Forwarding/Routing



Enhanced Priority Support



Only can be used if end-to-end supoorts

Smooth Transition

Large IP address scheme

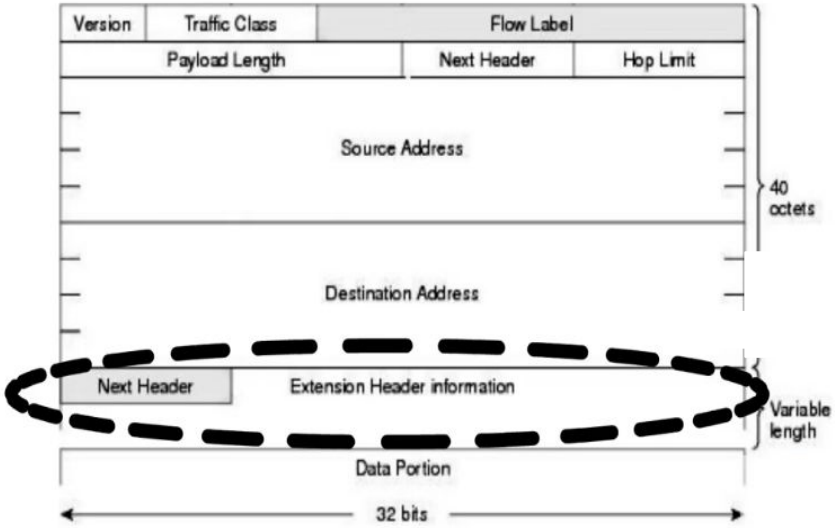
Globally unique IP address scheme

NAT is not required

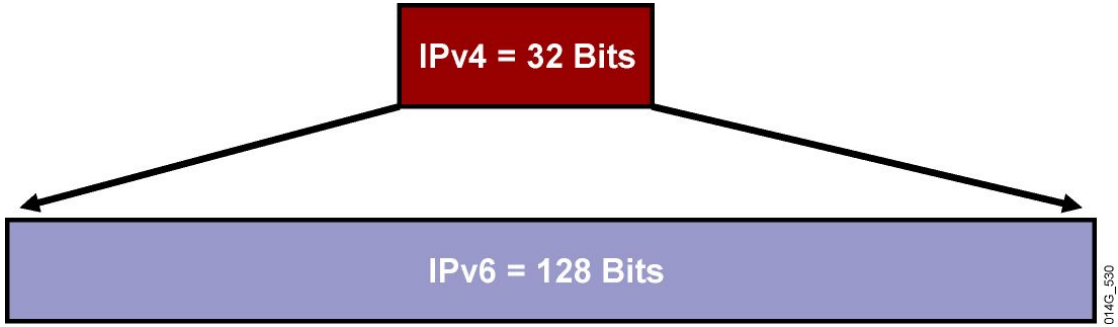
Header is less loaded

Forwarding Decision

Extensibility



IPv6 Address:



- 128 bit address
- Notations:
  - Dotted decimal notation
  - Colon Hexadecimal notation
    - 128 bits is divided into 8 sections, each 2 bytes in length.
    - Ex: FDEC:BA98:7654:3210:ADBF:BBFF:2922:FFFF

Shortening the address:

- Zero Compression:
  - Step1: FDEC:0000:0000:0000:0000:BBFF:0000:FFFF
  - Step2: FDEC:0:0:0:0:BBFF:0:FFFF
  - Step3: FDEC::BBFF:0:FFFF

Abbreviating IPv6 Addresses
Two basic rules let you, or any computer, shorten or abbreviate an IPv6 address:
1. Inside each quartet of four hex digits, remove the leading 0s (0s on the left side of the quartet) in the three positions on the left. (Note: at this step, a quartet of 0000 will leave a single 0.)
2. Find any string of two or more consecutive quartets of all hex 0s, and replace that set of quartets with a double colon (::). The :: means "two or more quartets of all 0s." However, **you can only use :: once in a single address, because otherwise the exact IPv6 might not be clear.**

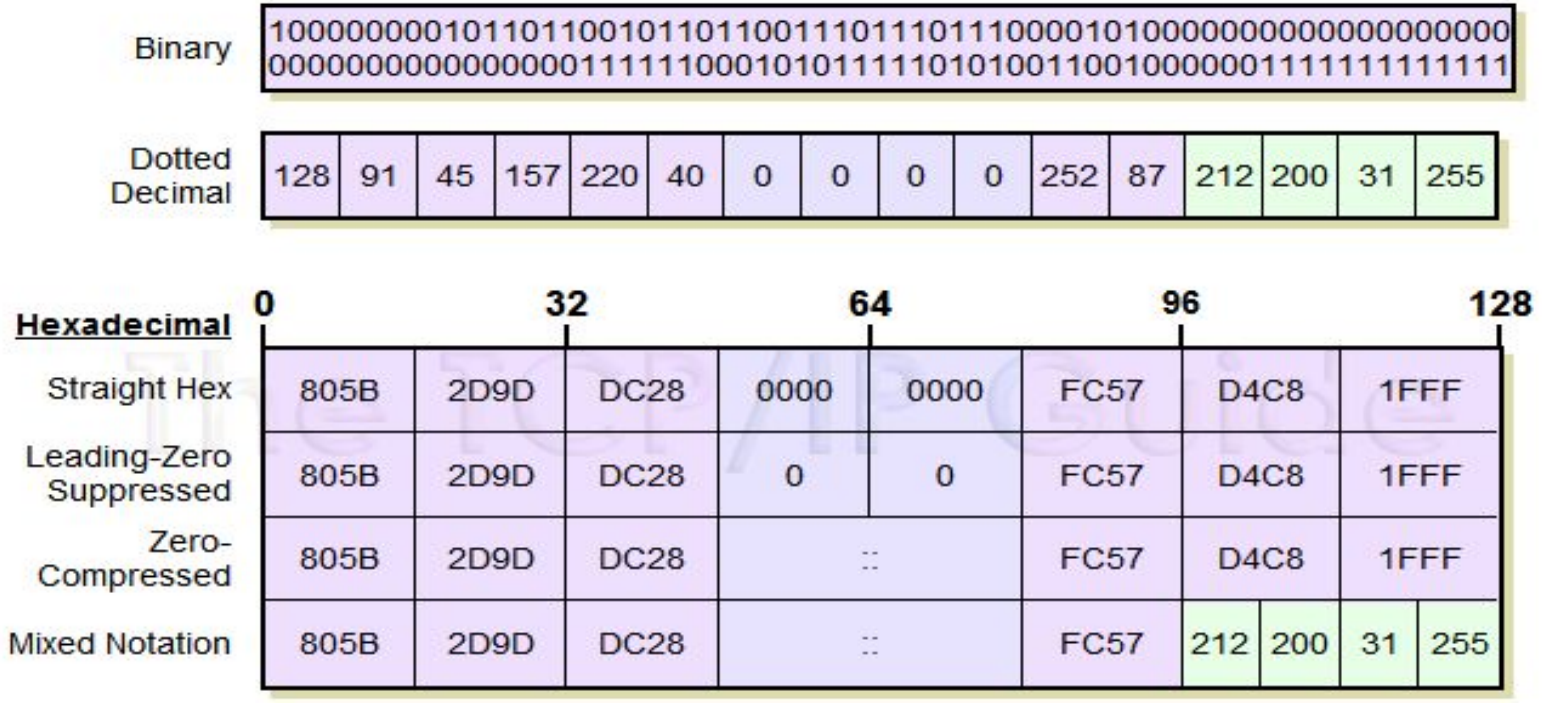
Address Abbreviation and Expansion:

Full	Abbreviation
2340:0000:0010:0100:1000:ABCD:0101:1010	
	30A0:ABCD:EF12:3456:ABC:B0B0:9999:9009
2222:3333:4444:5555:0000:0000:6060:0707	
	3210::
210F:0000:0000:0000:CCCC:0000:0000:000D	
	34BA:B:B::20
FE80:0000:0000:0000:DEAD:BEFF:FEEF:CAFE	
	FE80::FACE:BAFF:FEBE:CAFE

Answers:

Full	Abbreviation
2340:0000:0010:0100:1000:ABCD:0101:1010	2340:0:10:100:1000:ABCD:101:1010
30A0:ABCD:EF12:3456:0ABC:B0B0:9999:9009	30A0:ABCD:EF12:3456:ABC:B0B0:9999:9009
2222:3333:4444:5555:0000:0000:6060:0707	2222:3333:4444:5555::6060:707
3210:0000:0000:0000:0000:0000:0000:0000	3210::
210F:0000:0000:0000:CCCC:0000:0000:000D	210F::CCCC:0:0:D
34BA:000B:000B:0000:0000:0000:0000:0020	34BA:B:B::20
FE80:0000:0000:0000:DEAD:BEFF:FEEF:CAFE	FE80::DEAD:BEFF:FEEF:CAFE
FE80:0000:0000:0000:FACE:BAFF:FEBE:CAFE	FE80::FACE:BAFF:FEBE:CAFE

Example:


Binary
10000000010110110010110110011101110111000010100000000000000000
00000000000000001111110001010111110101001100100000011111111111
Dotted Decimal
128 91 45 157 220 40 0 0 0 0 252 87 212 200 31 255
Hexadecimal
0
32
64
96
128
Straight Hex
805B 2D9D DC28 0000 0000 FC57 D4C8 1FFF
Leading-Zero Suppressed
805B 2D9D DC28 0 0 FC57 D4C8 1FFF
Zero-Compressed
805B 2D9D DC28 :: FC57 D4C8 1FFF
Mixed Notation
805B 2D9D DC28 :: FC57 212 200 31 255

IPv6 Address

- Prefixes for IPv6 subnets, routes, and address ranges are expressed in the same way as Classless Inter-Domain Routing (CIDR) notation.
- An IPv6 prefix is written in ***address/prefix-length*** notation.
- For example, in IPv6 address: ***2001:0DB8:0000:000b:0000:0000:0000:001A/64***
    - ***2001:0DB8:0000:000b::/64*** represents the network prefix and the possible IPv6 addresses ranges from:
    - ***2001:0DB8:0000:000b:0000:0000:0000:0001/64 to 2001:0DB8:0000:000b:ffff:ffff:ffff:ffff/64.***

Prefix length is multiple of 4 here,

2001:0DB8:AAAA:0002:1234:5678:9ABC:EF01/64

2001:DB8:AAAA:2::/64

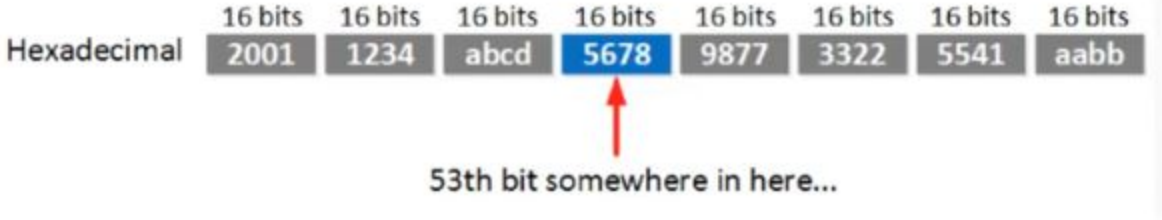
Find the IPv6 Prefix from an Address/PL

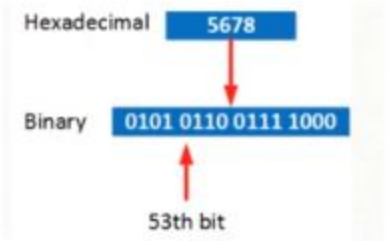
2340:0:10:100:1000:ABCD:101:1010/64

2340:0:10:100::/64

When the prefix length is not a multiple of 16 or 4 it means we have to do some binary calculations.

2001:1234:abcd:5678:9877:3322:5541:aabb/53





2001:1234:abcd:5000:0:0:0:0/53

IPv6 Address

- IPv6 Addresses:
  - **Network address** or site prefix : **First 48 bits**
  - **Subnet Address** or subnet prefix: **Next 16 bits**
  - **Device Address** : **Last 64 bits**
  - Example: in the following IPv6 address:
    - 2001:db8:abcd:0012:0000:0000:0000:0000
    - The network address is 2001:db8:abcd, and the subnet address is 12 (using the short form notation and eliminating the leading zeroes).
    - Together, these two groupings are the IPv6 prefix. The device address in the example is 0000:0000:0000:0000.

Finding IPv6 Prefix

For example, consider the following IPv6 address that is assigned to a host on a LAN:

2000:1234:5678:9ABC:1234:5678:9ABC:1111/64

zeroing out the last 64 bits (16 digits) of the address, you find the following prefix value:

2000:1234:5678:9ABC:0000:0000:0000:0000/64

Abbreviated : **2000:1234:5678:9ABC::/64**

Problems:

Address/Length	Prefix
2340:0:10:100:1000:ABCD:101:1010/64	
30A0:ABCD:EF12:3456:ABC:B0B0:9999:9009/64	
2222:3333:4444:5555::6060:707/64	
3210::ABCD:101:1010/64	

Variable Length Prefix

2BCD::FACE:BEFF:FEBE:CAFE/48	
3FED:F:E0:D00:FACE:BAFF:FE00:0/48	
210F:A:B:C:CCCC:B0B0:9999:9009/40	
34BA:B:B:0:5555:0:6060:707/36	

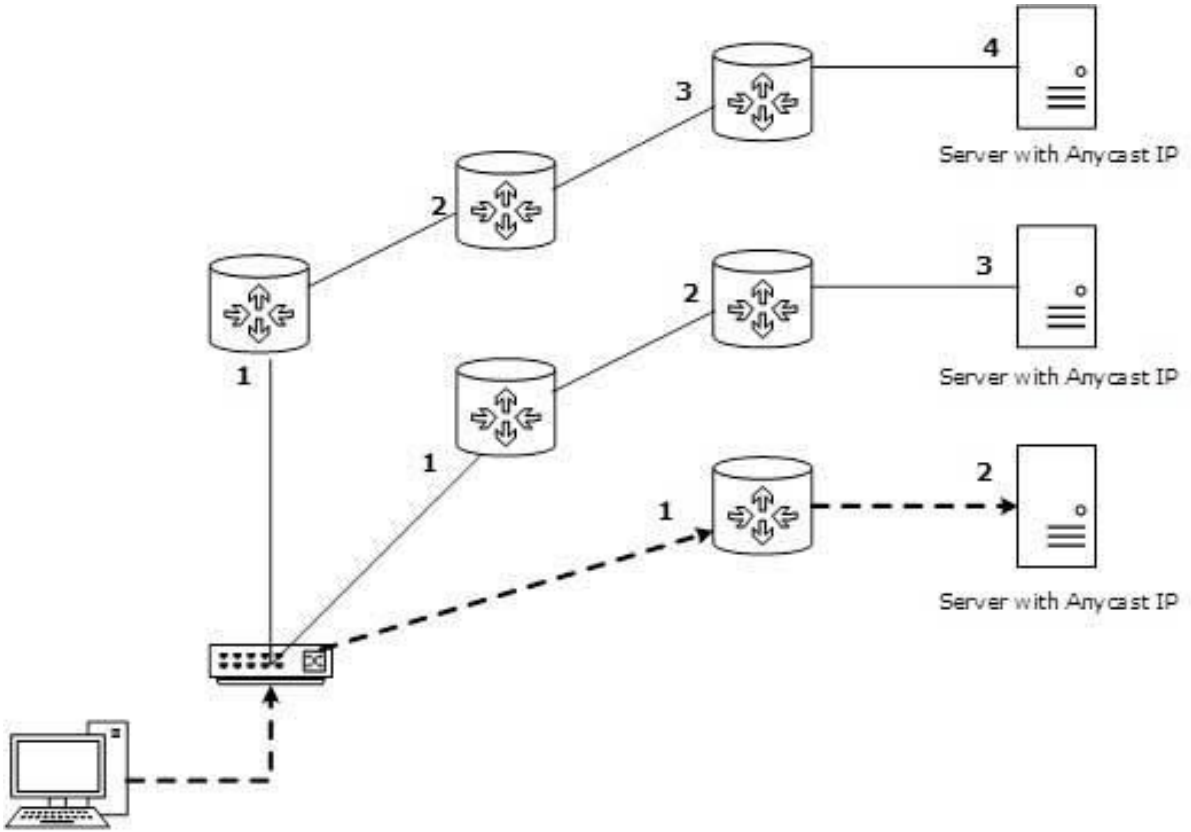
Answers:

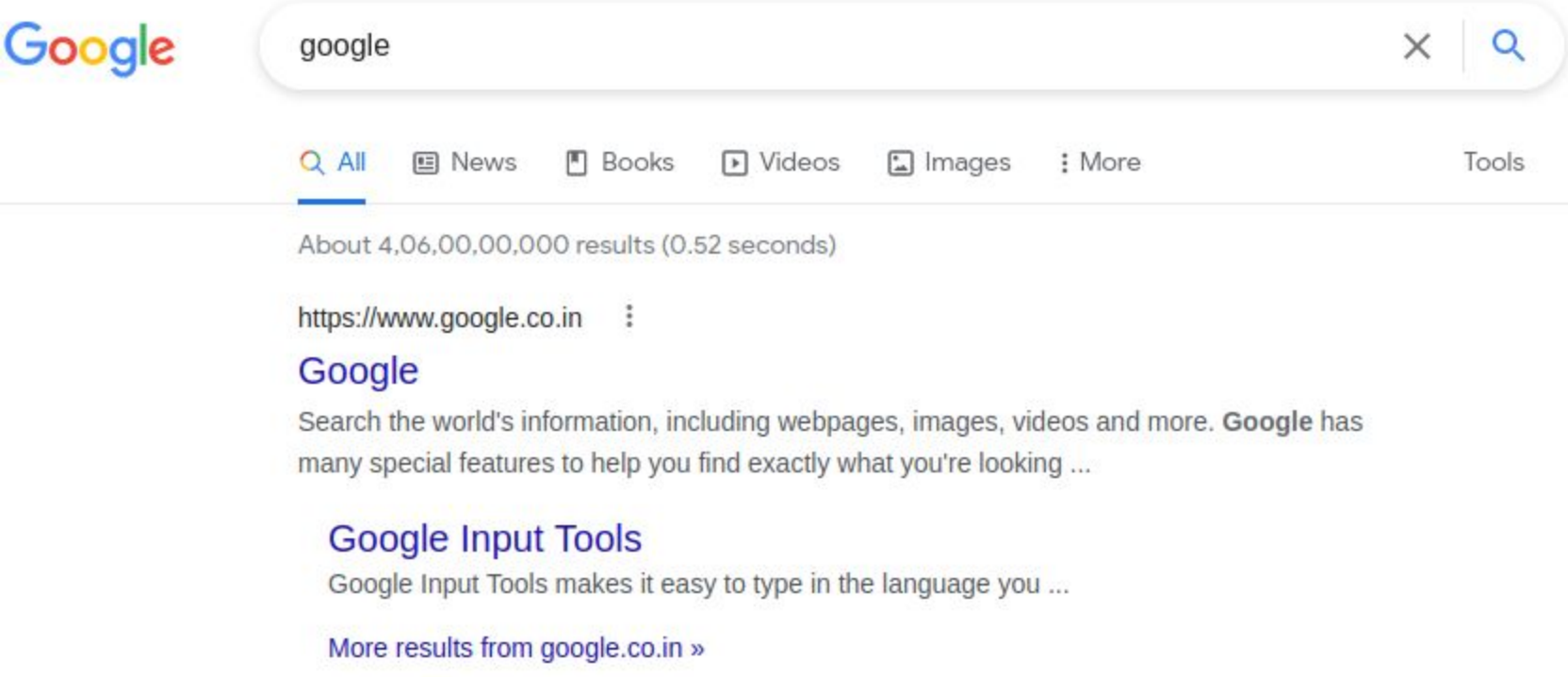
Address/Length	Prefix
2340:0:10:100:1000:ABCD:101:1010/64	2340:0:10:100::/64
30A0:ABCD:EF12:3456:ABC:B0B0:9999:9009/64	30A0:ABCD:EF12:3456::/64
2222:3333:4444:5555::6060:707/64	2222:3333:4444:5555::/64
3210::ABCD:101:1010/64	3210::/64
2BCD::FACE:BEFF:FEBE:CAFE/48	2BCD::/48
3FED:F:E0:D00:FACE:BAFF:FE00:0/48	3FED:F:E0::/48
210F:A:B:C:CCCC:B0B0:9999:9009/40	210F:A::/40
34BA:B:B:0:5555:0:6060:707/36	34BA:B::/36

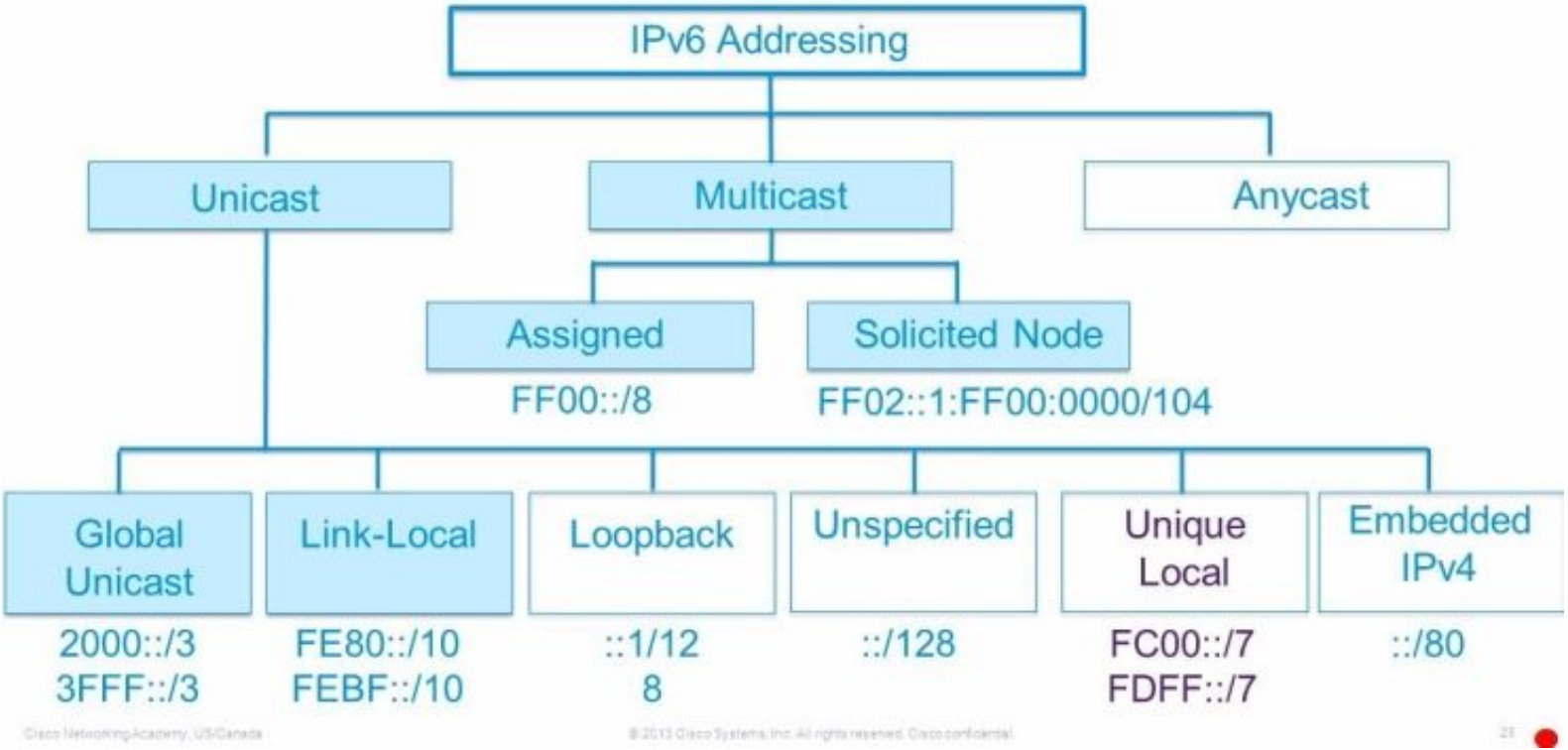
IPv6 Addressing Modes

- Unicast
- Multicast
- **Anycast**
  - In this addressing mode, multiple interfaces (hosts) are assigned same Anycast IP address.
  - When a host wishes to communicate with a host equipped with an Anycast IP address, sends a Unicast message.
  - With the help of complex routing mechanism, that Unicast message is delivered to the host closest to the Sender, in terms of Routing cost

Anycast

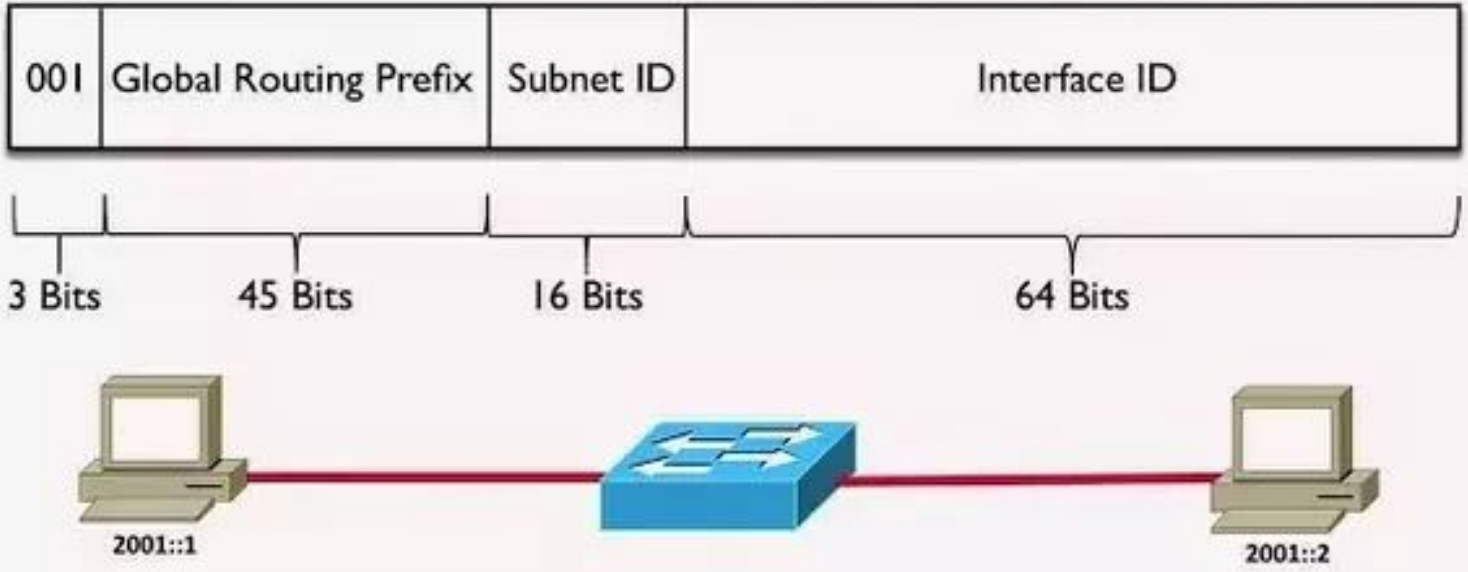

4
3
Server with Anycast IP
2
3
2
1
1
2
1
Server with Anycast IP
Server with Anycast IP


Google
google
All
News
Books
Videos
Images
More
Tools
About 4,06,00,00,000 results (0.52 seconds)
https://www.google.co.in
Google
Search the world's information, including webpages, images, videos and more. Google has many special features to help you find exactly what you're looking ...
Google Input Tools
Google Input Tools makes it easy to type in the language you ...
More results from google.co.in »

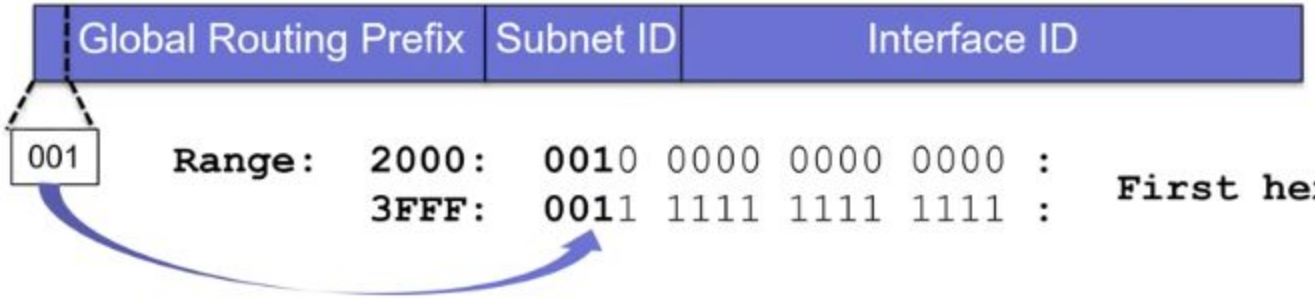

IPv6 Addressing
Unicast
Multicast
Anycast
Assigned
FF00::/8
Solicited Node
FF02::1:FF00:0000/104
Global Unicast
2000::/3
3FFF::/3
Link-Local
FE80::/10
FEBF::/10
Loopback
::1/128
Unspecified
::/128
Unique Local
FC00::/7
FDFF::/7
Embedded IPv4
::/80

Global Unicast Address

- Addressing starts with 2000::/3
- Addressing assigned by the IANA

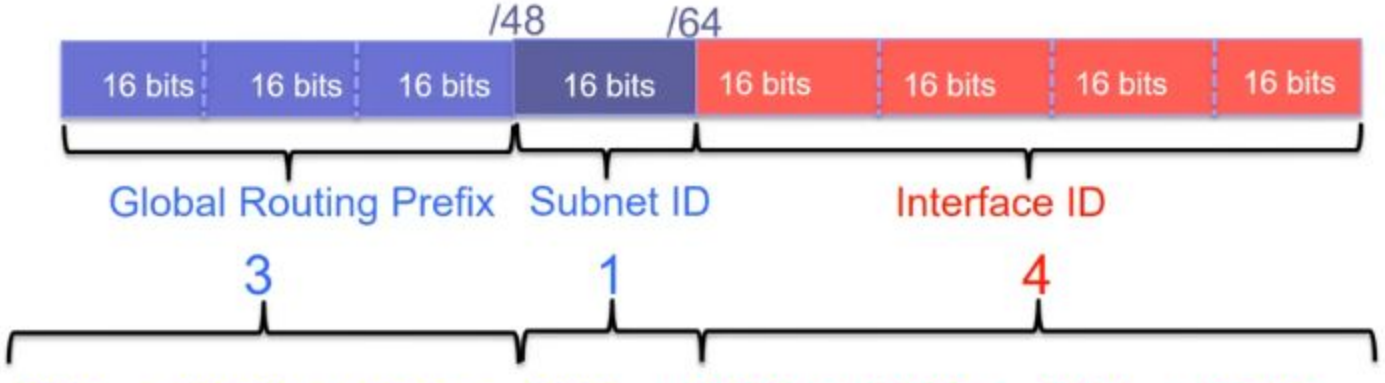


Global Unicast Address Range



Range:
2000::/64 to 3fff:fff:fff:fff::/64

/64 Global Unicast Address and the 3-1-4 Rule



2001 : 0DB8 : CAFE : 0001 : 0000 : 0000 : 0000 : 0100

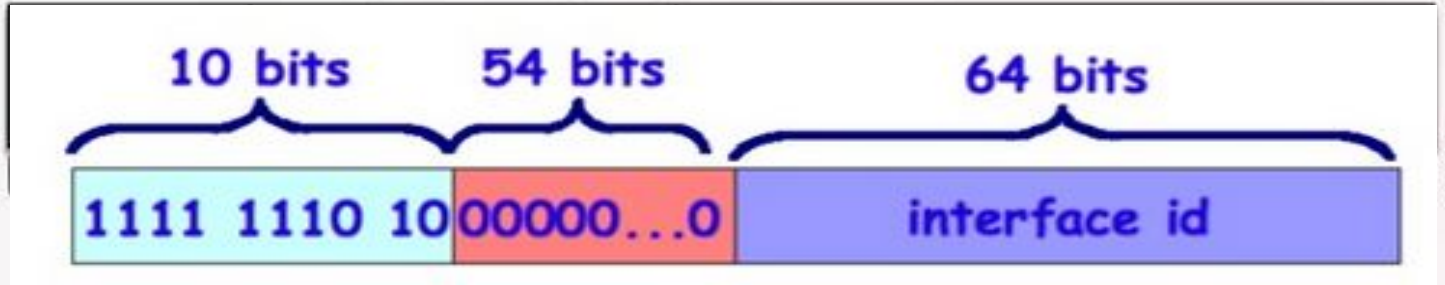
3 + 1 = 4 (/64) : 4

2001:0DB8:CAFE:0001:0000:0000:0000:0100/64

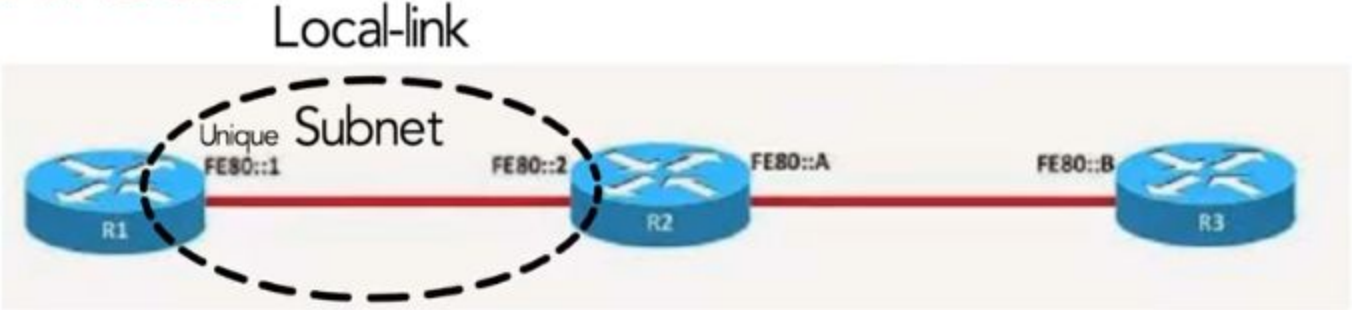
2001:DB8:CAFE:1::100/64

Link Local Address

- Addressing starts with FE80::/10
- Can only communicate on one network segment
- Similar to the IPv4 APIPA addresses (169.254.0.0/16)
- Can be automatically or statically assigned



Link local



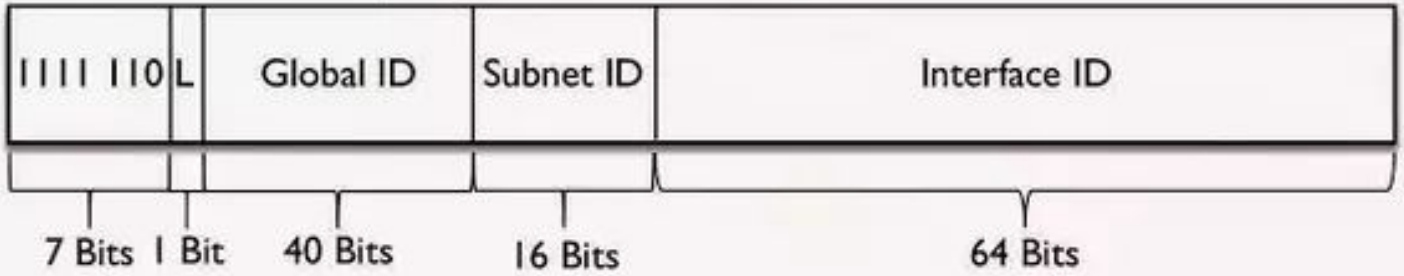
Duplicate Address Detection (DAD)

FE80::/10

Unique Local Address

- Addressing starts with FC00::/7
- Cannot be routed over the public Internet
- Similar to IPv4 private addresses
- If the address is locally assigned, the L bit is set to a 1

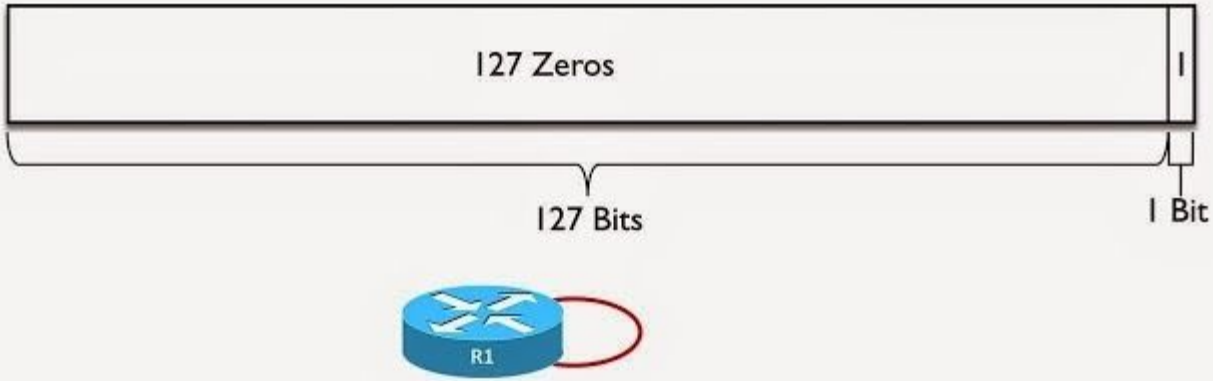
fc00::/7 to fdff::/7

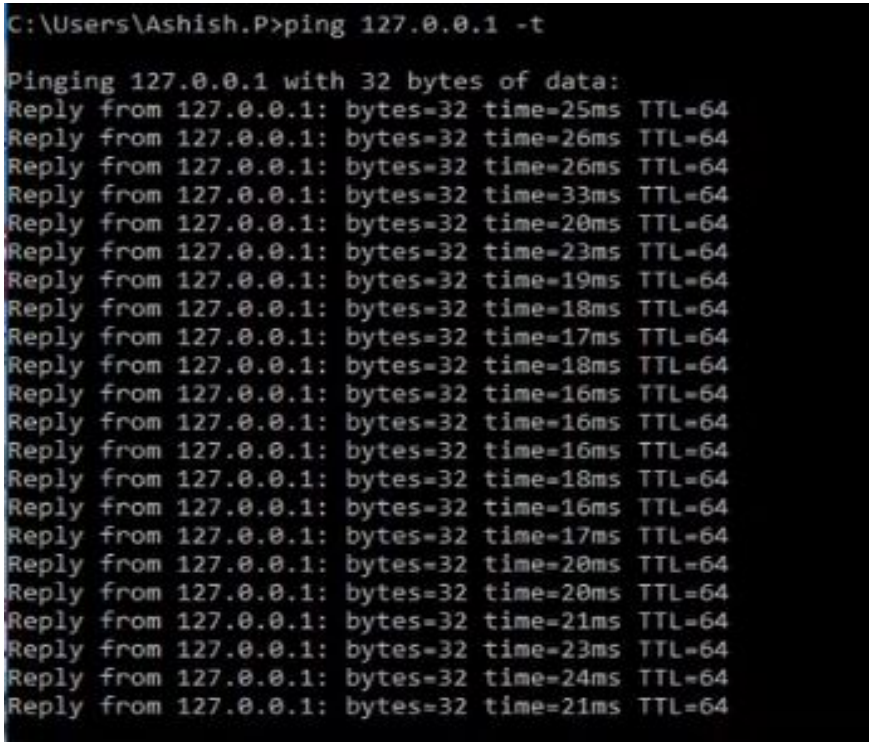


Special Addresses

Loopback Address

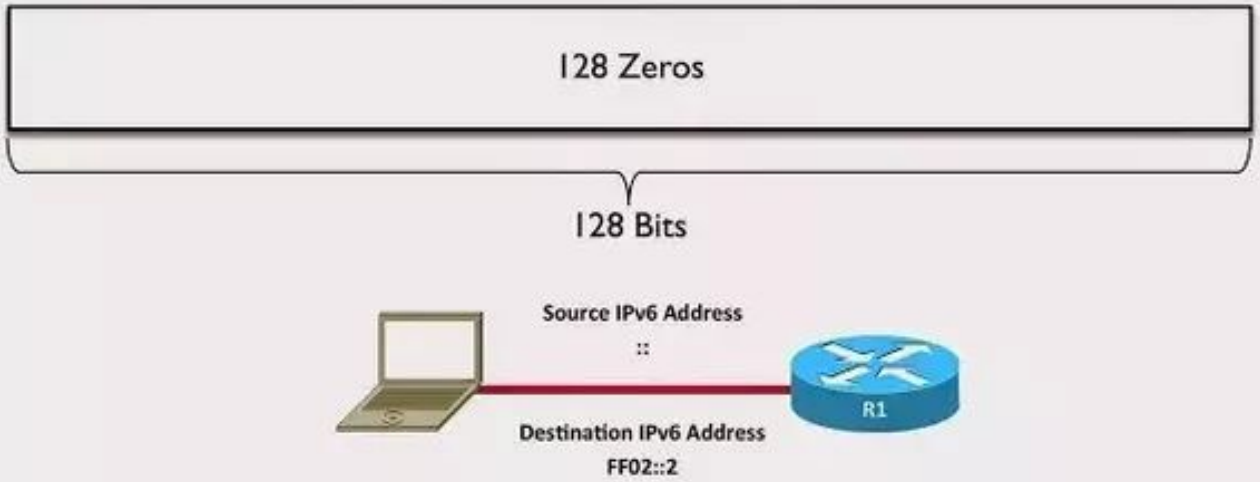
- Written as **::1**
- Also known as ***localhost***
- Similar to the IPv4 127.0.0.1 addresses
- Can be used to verify the IPv6 stack is operating on a device




C:\Users\Ashish.P>ping 127.0.0.1 -t
Pinging 127.0.0.1 with 32 bytes of data:
Reply from 127.0.0.1: bytes=32 time=25ms TTL=64
Reply from 127.0.0.1: bytes=32 time=26ms TTL=64
Reply from 127.0.0.1: bytes=32 time=26ms TTL=64
Reply from 127.0.0.1: bytes=32 time=33ms TTL=64
Reply from 127.0.0.1: bytes=32 time=20ms TTL=64
Reply from 127.0.0.1: bytes=32 time=23ms TTL=64
Reply from 127.0.0.1: bytes=32 time=19ms TTL=64
Reply from 127.0.0.1: bytes=32 time=18ms TTL=64
Reply from 127.0.0.1: bytes=32 time=17ms TTL=64
Reply from 127.0.0.1: bytes=32 time=18ms TTL=64
Reply from 127.0.0.1: bytes=32 time=16ms TTL=64
Reply from 127.0.0.1: bytes=32 time=16ms TTL=64
Reply from 127.0.0.1: bytes=32 time=16ms TTL=64
Reply from 127.0.0.1: bytes=32 time=18ms TTL=64
Reply from 127.0.0.1: bytes=32 time=16ms TTL=64
Reply from 127.0.0.1: bytes=32 time=17ms TTL=64
Reply from 127.0.0.1: bytes=32 time=20ms TTL=64
Reply from 127.0.0.1: bytes=32 time=20ms TTL=64
Reply from 127.0.0.1: bytes=32 time=21ms TTL=64
Reply from 127.0.0.1: bytes=32 time=23ms TTL=64
Reply from 127.0.0.1: bytes=32 time=24ms TTL=64
Reply from 127.0.0.1: bytes=32 time=21ms TTL=64

Unspecified Address

- Written as ::
- Used for a client's source address when sending a Neighbor Solicitation message
- Used for a client's source address when sending a Router Solicitation message



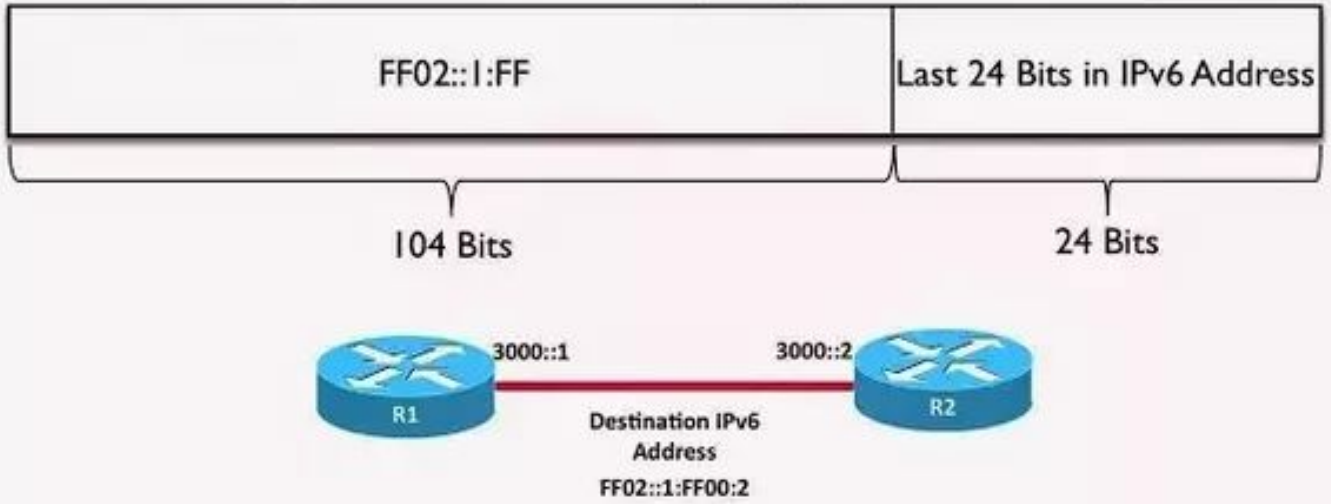
Contd…

- Entire address consists of zeros
- Prefix is of 8 bits (00000000)
- Rest 120 bits (000….000)

- It is used when host does not know its own address and sends an enquiry to find its own address
- In enquiry it must define an source address .
- This addresses can not used as a destination addresses

Solicited-Node Multicast Address

- Address begins with FF02::1:FF
- Address ends with the last 24 bits of the corresponding IPv6 address
- Used instead of an IPv4 ARP broadcast
- Also used for Duplicate Address Detection (DAD)

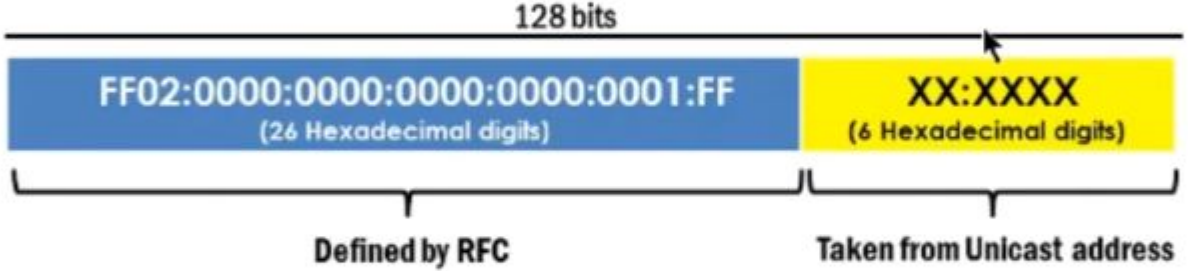


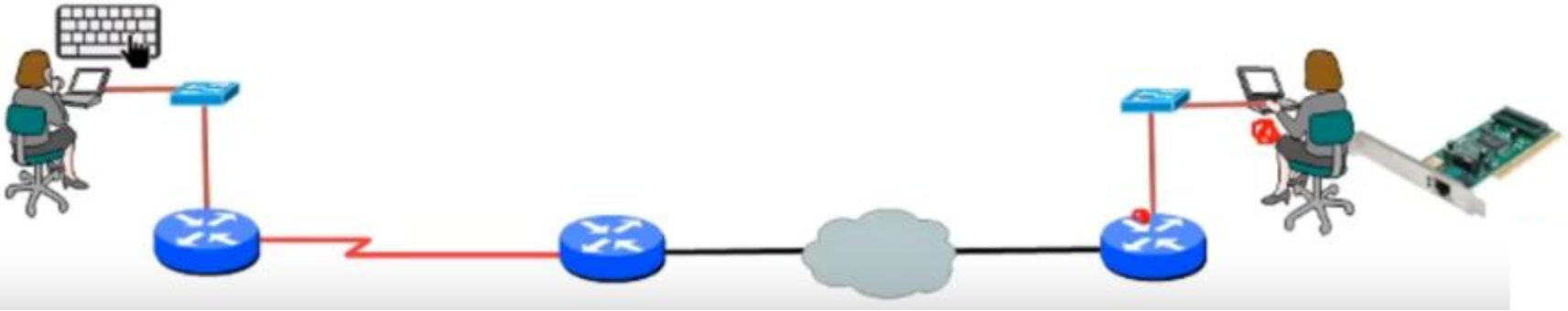
Solicited-Node Multicast Addresses

TCP/IP defines ARP to map an IP address to MAC address on the same LAN

IPv6 Neighbor Discovery Protocol (NDP) replaces IPv4 ARP and it uses solicited-nodemulticast address

Router calculates solicited-node multicast address for each interface as follows





Address Scope