

# IPv6 Addressing



# IPv6 Addressing

- How is an IPv6 address represented
  - represented in Hexadecimal
- Classifications of IPv6 addresses
- Reserved Multicast addresses



# IPv6 Addressing

- How do we count?
- Base 10 numbering system (10 symbols)
- 0 – 9
- Known as the “decimal” system

# IPv6 Addressing

- How do computers count? (a.k.a, “bits”)
- Base 2 numbering system (2 symbols)
- 0 – 1
- Known as the “binary” system

# IPv6 Addressing

- What is hexadecimal?
- Base 16 numbering system (16 symbols)
- 0 – F
- A simplified way to represent groups of 4 binary “bits”

# IPv6 Addressing

Counting hexadecimal

0	9	14
1	A	15
2	B	16
3	C	17
4	D	18
5	E	19
6	F	1A
7	10	1B
8	11	1C
	12	1D
	13	



# IPv6 Addressing

- How was it done with IPv4?
- 32 bit address
- Divided into 4 “octets” (8 bits or a byte)
- Each octet ranging from (0-255)

11001011 10001110 10000010 00000101  
203 . 142 . 130 . 5



# IPv6 Addressing

128-bit address  
Represented in  
hexadecimal

<u>DEC</u>	<u>BIN</u>	<u>HEX</u>
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F





# IPv6 Addressing

128 bit address

0011 1111 1111 1110 1000 0000 1111 0000  
0000 0000 0000 0010 0000 0000 0000 0000  
0000 0000 0000 0000 0000 0000 0001 0000  
0000 0000 0000 0000 0000 0000 0000 0000

Represented in Hex (every 4 bits)

3FFE:80F0:0002:0000:0000:0010:0000:0000



# IPv6 Addressing

3FFE:80F0:0002:0000:0000:0010:0000:0000

Every 4 hex is separated by a colon “ : ”

Every 4 hex represents 16 bits or 2 bytes



# IPv6 Addressing

3FFE:80F0:0002:0000:0000:0010:0000:0000

3FFE:80F0:2:0:0:10:0:0

- Drop leading zeros within any 16-bit chunk

# IPv6 Addressing

3FFE:80F0:0002:0000:0000:0010:0000:0000

3FFE:80F0:2::10:0:0

- Represent any contiguous multiple chunks of zeros into a double colon, but use only once.

# IPv6 Addressing

3FFE:80F0:0002:0000:0000:0010:0000:0000

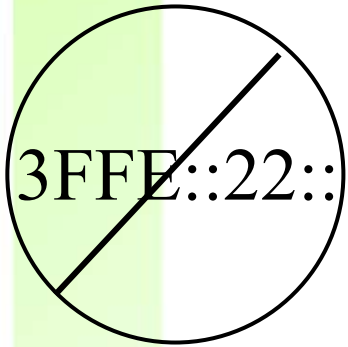
3FFE:80F0:2:0:0:10::



- Only allowed once in address

# IPv6 Addressing

3FFE:0000:0000:0000:0022:0000:0000:0000



3FFE::22:0:0:0 or 3FFE:0:0:0:22::

- Only allowed once in address or else it becomes ambiguous

# IPv6 Prefix

2001:CB8E:2A::D15/64

2001:CB8E:002A:0000:0000:0000:0000:0D15

0010 0000 0000 0001 1100 1011 1000 1110 0000 0000 0010 1010 0000 0000 0000 0000 /  
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 1101 0001 0101

2001:CB8E:2A::/64 is network



# IPv6 Prefix

2002:3F0E:102A::7/48

2002:3F0E:102A:0000:0000:0000:0000:0007

0010 0000 0000 0010 0011 1111 0000 1110 0001 0000 0010 1010/0000 0000 0000 0000  
0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0111

2002:3F0E:102A::/48 is network





# IPv6 Prefix

3FFE:10C2:43EE:D0C:F::C15/126

3FFE:10C2:43EE:0D0C:000F:0000:0000:0C15

0011 1111 1111 1110 0001 0000 1100 0010 0100 0011 1110 1110 0000 1101 0000 1100  
0000 0000 0000 1111 0000 0000 0000 0000 0000 0000 0000 0000 0000 1100 0001 0101

3FFE:10C2:43EE:D0C:F::C14/126 is network



# IPv6 Prefix

2002:3F0E:102A:3010:33::7/75



# IPv6 Prefix

2002:3F0E:102A:3010:33::7/75

2002:3F0E:102A:3010:0033:0000:0000:0007

0010 0000 0000 0010 0011 1111 0000 1110 0001 0000 0010 1010 0011 0000 0001 0000  
0000 0000 001/1 0011 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0000 0111

2002:3F03:102A:3010:20::/75



# Types of IPv6 Addresses

- Unicast
- Multicast (no broadcast)
- Anycast

# Unicast Address

- A single unique address identifying an IPv6 interface

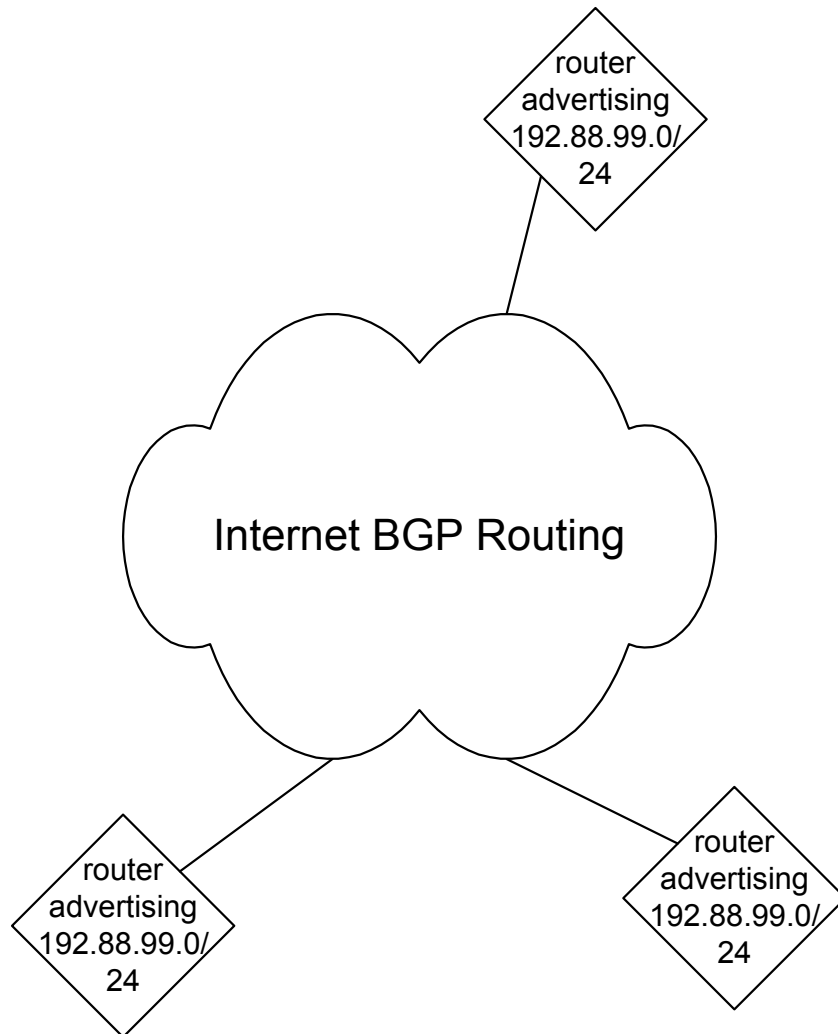
# Multicast Address

- An identifier for a group of interfaces.
  - Usually belonging to more than one node
  - Interfaces may belong to more than one multicast group
  - Replaces broadcasts
  - May not be used as a source address

# Anycast Address

- An IPv6 address that is assigned to more than one interface (typically more than one node).
  - Same as Unicast addresses
  - Derived from the same address space
  - Packets destined for anycast address are delivered to the “nearest” interface
  - Subnet router anycast address definition

# Anycast example





# Other IPv6 Addresses

- The unspecified Address
  - 0:0:0:0:0:0:0:0 ::
- The loopback Address
  - 0:0:0:0:0:0:0:1 ::1



# IPv6 Addressing

0000 0000	Unassigned*	011	Unassigned
0000 0001	Unassigned	100	Unassigned
0000 001	NSAP	101	Unassigned
0000 01	Unassigned	110	Unassigned
0000 1	Unassigned	1110	Unassigned
0001	Unassigned	1111 0	Unassigned
001	Aggregatable	1111 10	Unassigned
010	Unassigned	1111 110	Unassigned
		1111 1110 0	Unassigned

\* Some reserved addresses are from this space



# IPv6 Addressing

1111 1110 10	Link-Local-Use	FE80
1111 1110 11	Site-Local-Use	FEC0*
1111 1111	Multicast	FF—

\* Being deprecated



# IPv6 Addressing

- Unicast Addressing
  - ISPs assign these addresses to organizations
  - Offers globally-unique addresses



# IPv6 Addressing

- Site-Local-Use Addresses\*
  - Assigned to interfaces within an isolated intranet
  - Can easily be migrated to provider-based addresses
  - Much like private addressing in IPv4 (i.e. 10.0.0.0 network)

\*Being deprecated



# IPv6 Addressing

- Link-Local-Use Addresses
  - **All IPv6 interfaces** have a link-local address
  - Used to reach neighboring nodes attached to same link
  - Self-configured by interface
  - Router will not forward packets with Link-Local source or destination

# IPv6 Addressing

- Link-Local-Use Addresses
  - Usually formed by pre-pending the “well known” Link-Local prefix FE80::0 to the Interface Identifier
  - Can be statically assigned or created through a pseudo random process

# IPv6 Addressing

- Interface Identifier
  - Always 64 bits (least significant)
  - Can be “randomly” generated – RFC 3041
  - Ethernet uses MAC (or EUI-64)



# IPv6 Addressing

- What is EUI-64
  - Extended Unique Identifier. Replaces MAC addresses
  - 24-bit company\_id (tracked by IEEE)
  - 40-bit “unique” identifier

# IPv6 Addressing

- What is MAC and how does it work w/ EUI
  - Media Access Control. 48 bits
  - 24-bit company\_id (tracked by IEEE)
  - 24-bit “unique” identifier
  - Mapped into EUI-64 for creation of an Interface Identifier

# IPv6 Addressing

- How is MAC converted to EUI
  - Example MAC CC-CC-CC-UU-UU-UU
    - CC = Company identifier
    - UU = Unique identifier
  - Insert FF-FE between CC and UU
  - CC CC CC FF FE UU UU UU

# IPv6 Addressing

- Example MAC-to-EUI conversion
  - MAC = 00-D0-59-0C-61-F3
  - EUI = 00-D0-59-FF-FE-0C-61-F3

# IPv6 Addressing

- The IPv6 interface identifier is formed by complimenting the “Universal/Local” bit in an EUI-64 address
  - EUI = 00-D0-59-0C-61-F3
  - 0000 0000 1101 0000 0101 1001 0000 1100 0110 0001 1111 0011
  - IPv6 identifier = 02-D0-59-FF-FE-0C-61-F3



# IPv6 Addressing continued

## Multicast



# IPv6 Multicast Assignments

## Node-Local Scope

1111 1111 0000 0001

FF01:0:0:0:0:0:0:1

All Nodes Address

FF01:0:0:0:0:0:0:2

All Routers Address



# IPv6 Multicast Assignments

## Link-Local Scope

FF02:0:0:0:0:0:0:1

All Nodes Address

FF02:0:0:0:0:0:0:2

All Routers Address

FF02:0:0:0:0:0:0:3

Unassigned

FF02:0:0:0:0:0:0:4

DVMRP Routers

FF02:0:0:0:0:0:0:5

OSPF/IGMP

FF02:0:0:0:0:0:0:6

OSPF/IGMP DR

FF02:0:0:0:0:0:0:7

ST Routers

FF02:0:0:0:0:0:0:8

ST Hosts





# IPv6 Multicast Assignments

## Link-Local Scope - continued

FF02:0:0:0:0:0:0:9

RIP Routers

FF02:0:0:0:0:0:0:A

EIGRP Routers

FF02:0:0:0:0:0:0:B

Mobile-Agents

FF02:0:0:0:0:0:0:D

All PIM Routers

FF02:0:0:0:0:0:0:E

RSVP encapsulation

FF02:0:0:0:0:0:1:1

Link Name

FF02:0:0:0:0:0:1:2

All-dhcp-agents

FF02:0:0:0:0:0:FFXX:XXXX

Solicited node



# IPv6 Multicast Assignments

## Site-Local Scope

FF05:0:0:0:0:0:0:2

All Routers Address

FF05:0:0:0:0:0:0:3

All DHCP Servers

FF05:0:0:0:0:0:0:4

All DHCP Relays

FF05:0:0:0:0:0:0:1000

Service Location

FF05:0:0:0:0:0:0:13FF



# IPv6 Multicast Assignments

## All Scope

FF0X:0:0:0:0:0:0:101 NTP Server

FF0X:0:0:0:0:0:0:102 SGI-Dogfight

FF0X:0:0:0:0:0:0:103 Rwhod



# IPv6 Multicast Assignments

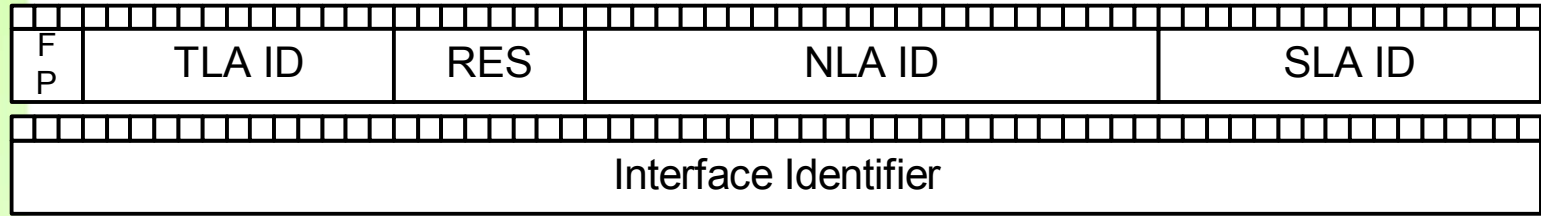
- Scope Level
  - FF01 – Node Local
  - FF02 – Link Local
  - FF05 – Site Local



# IPv6 TLA structure

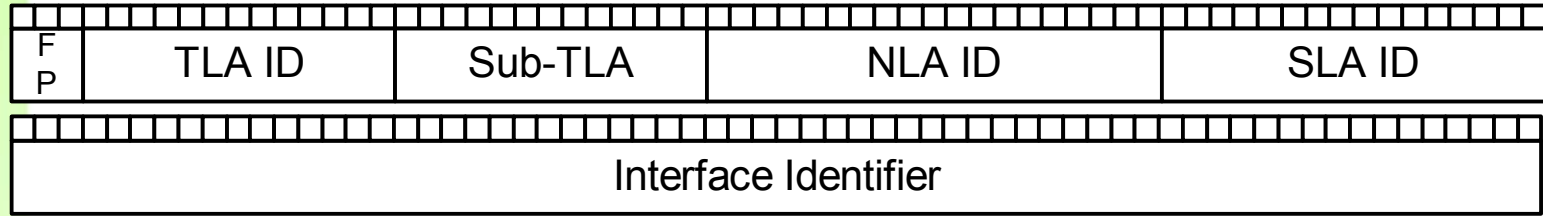


# Aggregatable Global Unicast



- FP – 3 bits – Format Prefix (001)
- TLA – 13 bits – Top Level Aggregator (8192)
- RES – 8 bits – Reserved
- NLA – 24 bits – Next Level Aggregator
- SLA – 16 bits – Site Level Aggregator
- Interface Identifier – 64 bits
- RFC 2373

# Aggregatable Global Unicast



- FP – 3 bits – Format Prefix (001)
- TLA – 13 bits – Top Level Aggregator (8192)
- Sub-TLA - 13 bits - Sub-Top Level Aggregator
- NLA ID - 19 bits - Next Level Aggregator
- SLA – 16 bits – Site Level Aggregator
- Interface Identifier – 64 bits
- RFC 2928