IPv6

Why was it developed?

3.4 * 10^38 No of Addresses

Conceptual

Bits	128
Hextets	8, 16 bits each, set of 4hex character
Separator	Colon
Parts	Network Prefix + Interface ID
Network Prefix	Routing prefix + Subnet ID, NP is 64 bits most commonly
Routing Prefix	Usually 48bits
Subnet ID	Usually 12bits
Interface ID	ID for hosts in the Network
Subnet	**/x** tells the no of bits used by Network Prefix
Loopback	::1
Note	IPv6 can neither be ::(meaning all 0) nor it can be all ‘f’
All-Nodes Multicast	ff02::1

IPv6 Address Types

There is Link-Local(Unicast), Global Unicast, Multicast and Any-cast Address in IPV6

Why multiple Casting Schemes?

Large Address Space	More address could be reserved for Casting
Multicasting	Getting rid of broadcast overload

Simplification	More flexible network management
Goals	More Anycast and Multicast

Note	There is no Broadcasting in IPv6

Unicast Address

When a computer boots up, it assigns itself a unicast IP6 address. It is like IP4 APIPA but we call it **Link-Local Addressing**. Note that it is only intended to use within the network

First 64 bits	**fe80:: (fe80, followed by 54 zeros)**
Defined by	**RFC 4291**
Last 64 bits(ID)	Generated in two ways
1)	A random 64-bit number called **Privacy Extension** or also called **Temporary Address**
2)	**EUI, using MAC**
Use of Link-Local	Generally for local network needs
Note	IP4 APIPA is generated over non-connectivity whereas IP6 link-local is **always** supposed to be generating irrespective of connectivity

Global Unicast Address

Generally received from the internet and is used for outside-lan communication. Note that these keep on changing because otherwise the MAC can be compromised

Multicast Address

This means, sending data to interested groups of people. In IP4, we have 224.0.0.0 for Multicasting but in IP6, there are different types of Multicasts depending upon what kind of purpose we are using it for. The address is defined in such a way that it's parts would tell us its intended use. For

example

Example 1	ff02::2
First ‘2’	Indicates that the address is intended for the local use
Second ‘2’	Indicates that it is destined for **router** in that local network
Example 2	ff02::1
Number ‘2’	Indicates that the address is intended for the local use in the network
Number ‘1’	Indicates that the destination is a particular **node** in that LAN

When we want to send data to all the nodes in a Multicast Group, we basically choose the virtual MAC address as the destination, which would forward this to every other node. This virtual MAC is called **Multicast MAC Address**

Multicast MAC	48-bit Virtual
First 16 bits	**33:33 Hex always**
Last 32	Derived from the Multicast Address

Anycast Address
It is generally pre-configured while setting up IPv6. It is configured in such a way that everyone who is sharing a **particular service** would be configured with the same address. Nodes in the anycast group would be shared with data based on the closest metrics

Example	CDN(Content Delivery Network)
CDN	Everyone who is a part of CDN Anycast would receive Netflix anycasting right

from the closest server

Neighbour Discovery

NDP(Neighbour Discovery Protocol) similar to ARP. It is done using **ICMPv6**. Note that there are several packet types for NDP. These are

Neighbour Solicitation	For Discovering other nodes
	ff02::1:ffxx:xxxx
Last six ‘x’	Denotes the last six digits of destined unicast for which we want to find the MAC
Neighbour Advertisement	The one who sent NS adds a NA in the **Neighbor Discovery Cache** with the sending packet just to tell the corresponding system that you can reach me directly at my MAC using unicast
Router Solicitation	For finding routers in the network
Router Advertisement	Response to RS where destined address is all-nodes multicast
Redirect	Used where multiple routers are available. This would be used by the routers to tell us the best path to a destination incase there are many

How to get IPv6?

SLAAC(Stateless Address Auto Configuration)

It works on NDP where the user would be getting their IPv6 from the RA. The RA would only give them **Network Prefix**, rest users have their own.

Note that the NA given by the RA will be same as the Router's. Router is allowed to do so because it has an IP from the upper level, either by the network admin or the ISP as **DHCPv6-PD (Prefix Delegation)**

Note: To check that an address is not already taken, the user sends a NS to its link-local before requesting SLACC

DHCP

For IPv6, it works in 2 different ways

Stateless	Letting the user use SLACC
Stateful	Full 128 bit address

Aggregation

DFZ(Default Free Zone)	These are tier-1 routers where path to every router in known, 850,000 in number
Aggregation	The process of creating subsets out of existing top-tier routes is called Aggregation. The top tiers will have /16 followed by /24, /32 etc
Why Aggr?	To reduce complexity of routing table
If ISP changed?	The ISP sends an RA to all-node multicast

Moving to IP6

Dual Stack	A computer with both IP4 and IP6
Transition Mechanisms	
4to6	Tunnelling by encapsulating an IP4 packet into an IP6 packet
6in4	Opposite
Tunnel Brokers	Provide Endpoints for IP6 connection and

	configuration
TSP(Tunnel Setup Protocol)	
TIC(Tunnel Information and Control Protocol)	
Overlay tunnel	Sending IP6 over IP4
NAT64	For Translating IP6 to IP4
	NAT64 Gateway either Stateless Mapping or Stateful Mapping
Stateless	NAT64 on server
Stateful Mapping	NAT64 on client computer
DNS64	For translating DNS queries