

IPV6

There aren't enough available IPV4 addresses, IPV4 address assignments are controlled by IANA (Internet Assigned Numbers Authority) that distributes IPV4 address space to various RIRs(Regional Internet Registries) which then assign them to companies that need them.

IPV6 is 128 bits, written in hexadecimal(8 quartets), leading zeroes can be removed, consecutive quarters of all 0s can be replaced with "::" only once, change all host bits to 0s to get the prefix.

Typically IPV6 addresses from ISP have /48 block and subnets use /64 prefix.

2001:db8 range is reserved for examples and documentation.

Command: `ipv6 unicast-routing` to allow router to perform IPV6 routing.

Command: `ipv6 address <address>/prefix`. Command: `show ipv6 interface brief`.

EUI → extended unique identifier to convert mac address into a 64-bit interface identifier for host portion of IPV6, by dividing mac address in half, inserting FFFE in the middle and inverting the 7th bit, using command:

`Ipv6 address <network> ::/ prefix eui-64`.

UAA → Universally Administered Address uniquely assigned to device by manufacturer.

LAA → Locally Administered Address assigned by admin and doesn't have to be globally unique.

Can be identified by the 7th bit of MAC address U/L bit 0 → UAA, 1 → LAA, in IPV6 the meaning of U/L is reversed.

Global unicast addresses are public addresses that hosts can use over the internet, must register to use them as they have to be globally unique.

The range is: 2000::/3, now defined as all addresses which aren't reserved to other purposes.

Unique Local addresses: private addresses can't be used over the internet, can be used without registered yet not routed over the internet, FC00::/7 is reserved range, a later update requires 8th bit to be set to 1 so 1st 2 digits are FD, 40 bit global ID should be randomly generated so that in case of merging companies subnets are not duplicated.

Link Local addresses: Automatically generated on IPV6 interfaces, command `ipv6 enable` is to enable ipv6 on interface without configuring ipv6 address, link local address is auto generated, range → FE80::/10, 54 bits after FE80/10 should be all 0s, interface id is generated using EUI-64, used to communicate within a single link/subnet, routers will not route packets with a link local destination IPV6 address, routing protocol peerings as OSPFv3 use link local address for neighbor adjacency, can be used as next hop for static routes, for neighbor discovery protocol IPV6 ARP replacement.

Multicast addresses: one source to multiple destinations that have joined multicast group, range FF00::/8, IPV6 doesn't use broadcast, instead it uses all nodes/hosts multicast.

Multicast scopes: 1- Interface-local FF01 → packet doesn't leave local device, send traffic within local device.

2- link local FF02: packet remains in local subnet. 3- site-local FF05 → packet forwarded by routers in a single physical location not a WAN. 4- Organization-local FF08 → wider in scope than site-local can be all subnets of an entire organization. 5- Global FF0E → no boundaries, can be routed over the internet.

Anycast Address: new feature of IPV6, one to one of many, multiple routers are configured with the same IPV6, they use a routing protocol to advertise the address, when hosts send packets to that dest address, routers forward it to nearest metric router configured with that IP, add "anycast" to the end of command and use //128 prefix.

Unspecified IPV6 address: when a device doesn't know its address and for default routes (::).

Loopback address: (::1) to test protocol stack on a local device.

Unique local addresses are not routable over the internet yet they are routed between subnets.

RFC (Request for Comments): a publication from ISOC (Internet Society) and associated orgs like IETF and are the official docs of internet specifications, protocols, .. etc.

RFC stated that: leading 0s must be removed, longest or leftmost string of 0s must be removed and hex chars are small.

IPV6 header: a fixed header format of size 40 bytes, fields are → 1- version: 4 bits. 2- 8 bits traffic class for QoS to indicate high priority traffic. 3- 20 bits flow label to identify specific traffic flows as specific src and dest communication. 4- 16 bits payload length in bytes excluding IPV6 header length. 5- 8 bits next header for type of encapsulated segment. 6- 8 bits next hop limit that is incremented by 1 by each router forwards it, if reached 0 the packet is discarded.

7- 128 bits src IPV6. 8- 128 bits dest IPV6.

Solicited Node multicast address: is calculated from a unicast address = ff02::1:ff concat last 6 hex of unicast address.

NDP (Node Discovery Protocol) is used instead of ARP using ICMPv6 and solicited node multicast address to learn MAC.

Types of messages: NS → Neighbor Solicitation. NA → Neighbor Advertisement, destination mac address is a multicast mac address based on dest solicited node address.

Show IPV6 neighbor table command to show ipv6 neighbor table equivalent to show arp, link local address is learned automatically.

NDP also allows hosts to automatically discover routers on the local network, using RS → router solicitation sent to multicast FF02::2 to all routers to ask routers on local link to identify themselves when an interface is enabled or a host is connected to a network. RA → router advertisement sent to FF02::1 to all nodes in local link, they are sent in response to RS and periodically so that the router announces its presence as well as other information about the link, hosts can use them to automatically learn default gateways.

SLAAC (Stateless Address Auto Configuration): hosts use RS/RA to learn IPV6 prefix of local link and then auto generate an IPV6 address command: ipv6 address autoconfig (host part is generated with eui or randomly generated depending on device maker).

Duplicate Address Detection (DAD): allows hosts to check if other devices on the local link are using the same IPV6 address any time an IPV6 enabled interface is initialized or an IPV6 address is configured on an interface, a host sends NS to its own IPV6 address if it doesn't get a reply, it knows the address is unique.

If IPV6 routing is disabled the router can send and receive IPV6 traffic but not route them.

Routes to link local addresses are not added to the routing table.

To configure AD (administrative distance add it to the end of the static route) (floating static route).

Types of static routes: 1- Directly attached via exit interface. 2- Recursive via next hop. 3- Fully Specified via both.

In IPV6 directly attached static routes can't be used if interface is an Ethernet interface.