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Kenya Education Network

Introduction to IPV6

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What is IPV6

IPV6 is a new suite of protocol know as Internet protocol version 6. That is used to provide a much larger address space.

The IETF developed IPV6 to deal with the following issues

- IPV4 address exaustion
- Need for simpler auto configuration and renumbering
- Requirement for security at IP Level IPSec
- Improved Protocol design
- New possibilities for managing flows

Kindly check https://www.internetsociety.org/tutorials/exploring-ipv6/introduction-ipv6

Regional Internet Registries

- Asia Pacific Network information Center (APNIC)
- African Network information Center(AFRINIC)
- American Registry for Internet Number (ARIN)
- Latin America and Caribbean Network information center LACNIC
- Réseaux IP Européens Network Coordination Centre (RIPE)

How IPV address are assigned

CIDR Subnet	Number of IPs
/128	1
LAN Segment – /64	18,446,744,073,709,551,616
Residential – /56	4,722,366,482,869,645,213,696
Business – /48	1,208,925,819,614,629,174,706,176
ISP – /32	79,228,162,514,264,337,593,543,950,336
/16	5,192,296,858,534,827,628,530,496,329,220,096
/8	1,329,227,995,784,915,872,903,807,060,280,344,576

Understanding IPV6 address Space

- IPV4 address is 32 bits in length. This makes it possible to connect approximately 4.2 Billion users only. An example of binary IPV4 is

10101100,00010000,11111110,00000001

- The IPV6 address is a 128 bit address space that allows you to do 340 trillion, trillion, trillion addresses. Sample IPV6 address

00100000000000100001101101110000000000000000000000000000000000000000000000000000000000000000,
00000000,00000000,00000000,00000000,00000001

Understanding IPV6 address Space Cont..

IPV6 has a massive length and therefore we have to find a way of writing it in a human readable format.

If we were to convert the 128 bit address from our previous example to a decimal format we would have the address below.

128.91.45.157.220.40.0.0.0.0.252.87.212.200.31.255

Which is still weird and not easy to read.

An easier address to read would look like this.

805b:2d9d:dc28::fc57:d4c8:1fff

Converting IPV6 128 bit address to Hexadecimal

Take a look at the binary to hexadecimal conversion below.

Binary	Hex	Binary	Hex
0000	0	1000	8
0001	1	1001	9
0010	2	1010	a
0011	3	1011	b
0100	4	1100	c
0101	5	1101	d
0110	6	1110	e
0111	7	1111	f

Dealing with Zeros in IPV6

In IPv6 one can eliminate leading zeros and use full colon in between succeeding zeros.

There is Zero compression using **::** eg

Ffee:0000:aa00 is equivalent Ffee::aa00

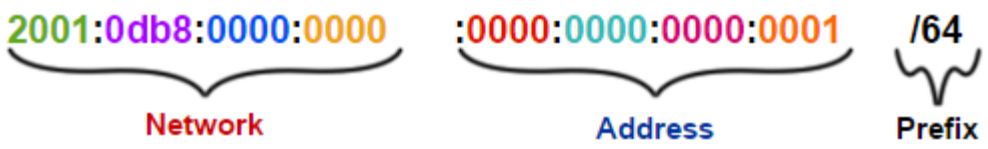
or Zero suppression that omits leading zeros

0000:0000:0001 is equivalent to 0::1

IPv6 Prefixes and address types

IPv6 addressing has a hierarchical structure similar to that of IPv4. This means that IPv6 addresses can be subnetted for performance and security reasons in the same way as IPv4.

The bits on the left of an IPv6 address (high-order bits) specify the network, the other bits specify particular addresses in that network.



IPv6 Prefixes and address types

- Unicast IPV6 addresses.

As with IPv4, unicast addresses are the most common type of IPv6 address you will work with.

An IPv6 unicast address identifies a single interface. Packets sent to a unicast address are delivered to that specific interface. So unicast is communication between a single sender and a single receiver over a network.

Because of the abundance of addresses available with IPv6, it is very likely that virtually every machine attached to your network has at least one global unicast address assigned to each interface. (Read that sentence again, if you don't mind.)

This is an example of a Unicast address: **2000::a12:34ff:fe56:7890** (Take not that they all begin with 2000::)

In addition to global unicast addresses, IPv6 also recognizes other sub-sets of unicast addresses including link-local, site-local, unique local IPv6 unicast, and special addresses

IPv6 Prefixes and address types

- Anicast IPV6 addresses

IPv6 anycast addresses identify groups of interfaces.

Packets destined to an anycast address are sent to the nearest interface in the group, as determined by the active routing protocols.

So this type of address facilitates communication between any sender and the nearest of a group of receivers in a network.

Anycast addresses are allocated from the Unicast address space and are not syntactically distinguishable from unicast addresses.

IPv6 Prefixes and address types

- Multicast IPV6 addresses

An IPv6 multicast address identifies a group of interfaces, again typically belonging to different nodes. Packets sent to a multicast address are delivered to all interfaces in the group.

So multicast addresses facilitate communication between a single sender and multiple receivers.

You can recognize Multicast addresses because they all begin with the same prefix -**ff00::/8**.

An example of Multicast address is **ff01:0:0:0:0:0:0:2**

IPv6 Prefixes and address types

Special IPV6 address

Address Type	Binary Prefix	Hex Prefix
Unspecified	0000...0 (128 bits)	::/128
Loopback	000...01 (128 bits)	::1/128
IPv4 Mapped	00...01111111111111111 (96 bits)	::ffff:0:0/96
Unique Local Unicast (ULA)	1111110	fc00::/7
Link-Local Unicast	1111111010	fe80::/10

IPv6 Prefixes and address types

Special IPV6 address

- **Unspecified** address – It is all zeros used for an IPV6 node seeking to receive and address
- **Loopback-IPv6** has a single address for the loopback function, instead of a whole block as in IPv4
- **IPV4 Mapped address**-A /96 prefix leaves 32 bits, exactly enough to hold an embedded IPv4 address. IPv4 Mapped IPv6 addresses are used to represent an IPv4 node's address as an IPv6 address. This address type was defined to help with the transition from IPv4 to IPv6.
- **Link Local addreseses-As** the name implies, Link-Local addresses are unicast addresses to be used on a single link.Packets with a Link-Local source or destination address will not be forwarded to other links. These addresses are used for neighbor discovery, automatic address configuration, and in circumstances when no routers are present.

Protocol, Neighbor Discovery, and SLAAC

Router Discovery

IPV6 uses ICMP V 6 for router discovery

Hosts send **Router Solicitation** messages to the multicast address. Routers on the host's network immediately respond with a **Router Advertisement**

Routers periodically send out **Router Advertisement** messages to

- Announce presence
- Advertise prefixes
- Assist in address configuration
- Share other information about the link

Protocol, Neighbor Discovery, and SLAAC

Neighbor advertisement

IPV6 routers discover one another on the network by sending a router solicitation message to their neigbors. The neighbors then respond with a router advertisement

Neighbor Unreachability detection

If an IPV6 router does not receive acknowledgements from a node after a long time it will send a unicast address to confirm the same.

Redirects

It is a redirect feature similar to IPV4 that allows a node to redirect a flow to another router

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Questions

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Thank You

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