
Internet Protocols

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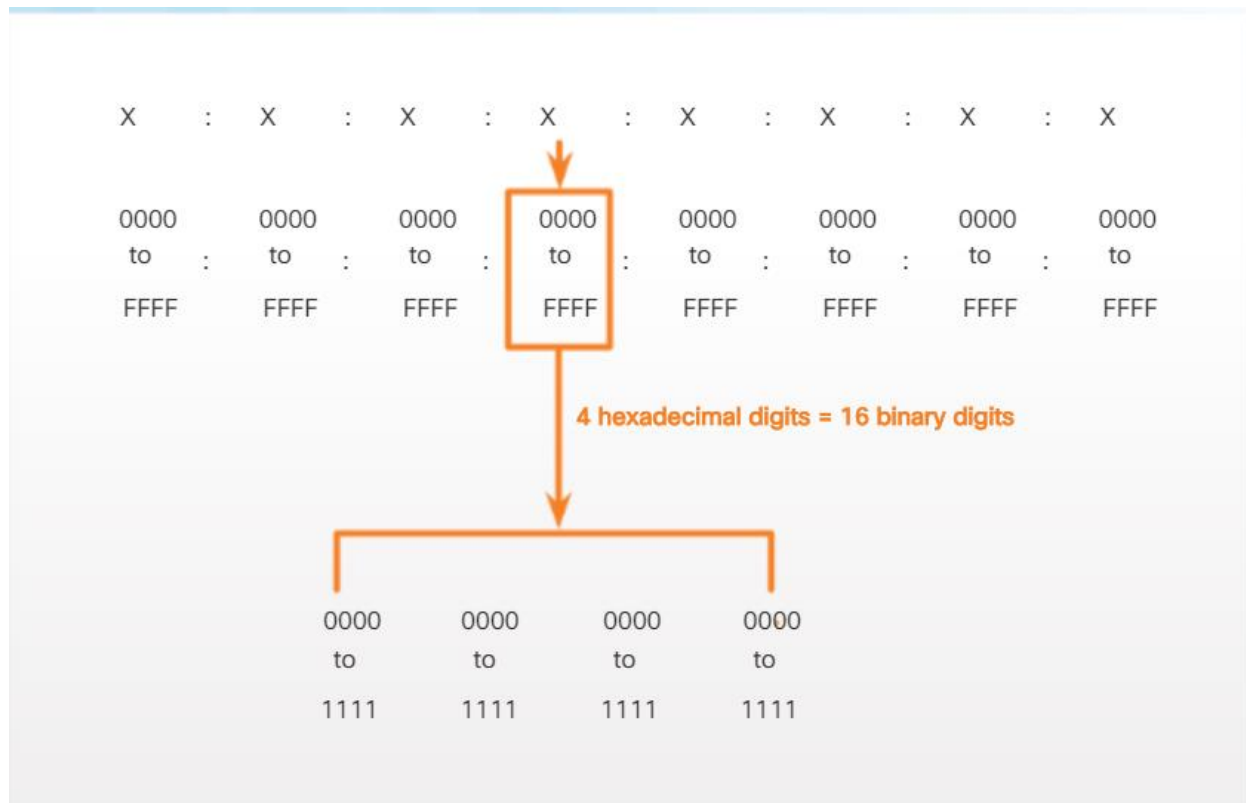
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1. IPv6

“Today, more than 99% of our world remain unconnected. Tomorrow we connect everything” – [1]
Cisco Networking Academy(2019)Cisco Networking Academy, Available at: URL
<https://static-course-assets.s3.amazonaws.com/ITN6/en/index.html#7.0.1.1>, accessed 04.JAN.2019

Every device which communicate over the internet needs Internet Protocol (IP). Addressing is crucial for data communication between hosts, regardless of whether the hosts are on the same network, or on different networks. Designing, implementing and managing an effective IP addressing plan ensures that networks can operate effectively and efficiently. IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion. IPv6 is intended to replace IPv4. In December 1998, IPv6 became a Draft Standard for the IETF, who subsequently ratified it as an Internet standard on 14 July 2017. IPv4 provide 4.3 billion addresses which will be exhausted probably in the next few years while IPv6 provide 3.4×10^{38} possible addresses more than enough and a lot improved IP features. The actual number is slightly smaller, as multiple ranges are reserved for special use or completely excluded from use. Today's networks, as well as the Internet, have a numerous of unforeseen requirements that simply weren't even considerations when IPv4 was created. Network engineers tried to compensate with a packs of add-ons that can actually make implementing them more difficult than they would be if they were required by a standard. By default, IPv6 has improved upon and included many of those features as standard and mandatory. One of these sweet new standards is IPsec—a feature that provides end-to-end security. IPv6 addresses are 128 bits in length and written as a string of hexadecimal values. X:X:X:X:X:X:X Every 4 bits is represented by a single hexadecimal digit



Each "X" in the picture above represent four hexadecimal values. Pv6 addresses are not case-sensitive and can be written in either uppercase or lowercase. When referring to 8 bits of an IPv4 address we utilize the term octet. In IPv6, a hextet is the informal term used to refer to a portion of 16 bits or four hexadecimal values. Every "x" is a solitary hextet, 16 bits or four hexadecimal digits. There are ways to write down IPv6 addresses which are more user friendly. There is a rule which help us to reduce notation of the IPv6 and the rule is to omit every leading 0s (zeros) in any 16-bit section or hextet. For instance:

02FF can be represent as 2FF

07AC can be represent as 7AC

0C00 can be represented as C00

00CB can be represented as CB

It is important to be remembered that this rule is ONLY for leading 0s alternatively the address would become ambiguous.

Another rule to help reduce the notation of IPv6 addresses is that a double colon (::) can replace any single, contiguous string of one or more 16-bit segments (hextets) consisting of all 0s. The double colon (::) can only be used once within an address, otherwise there would be more than one possible resulting address. When used with the omitting leading 0s technique, the notation of IPv6 address can often be greatly reduced. This is commonly known as the compressed format

Preferred	2001:0DB8:0000:1111:0000:0000:0000:0200
No leading 0s	2001: DB8: 0:1111: 0: 0: 0: 200
Compressed	2001:DB8:0:1111::200

IPv6 is modified in three types of addresses that is Unicast, Multicast and Anycast unlike IPv4 which are unicast, multicast and broadcast. Broadcast in IPv6 does not exist because of numerous problems which cause. One of the worst of course is undesirable broadcast storms. This is uncontrolled broadcast forwarding of traffic which can bring entire network down and consume the whole bandwidth.

Multicast - An IPv6 multicast address is used to send a single IPv6 packet to multiple destinations. Multicast (FF00::/8) Again, as in IPv4, packets addressed to a multicast address are conveyed to all interfaces tuned into the multicast address. Now and then individuals call them "one-to-many" addresses. It's extremely simple to recognize a multicast address in IPv6 in the light of the fact that they always begin with FF

Anycast - An IPv6 anycast address is any IPv6 unicast address that can be assigned to multiple devices. A packet sent to an anycast address is routed to the nearest device having that address. Anycast Like multicast addresses, an anycast address distinguishes different interfaces on various devices. Be that as it may, there is a major contrast: the anycast packet is delivered to just a single device—actually, to the nearest one it finds defined in terms of routing distance. What's more, once more, this addresses extraordinary on the grounds that you can apply a solitary address to more than one host. These are referred to as "one-to-closest" addresses. Anycast addresses are typically just arranged on routers, never hosts, and a source address would never be an anycast address. Of note is that the IETF reserved the main 128 locations for each/64 for use with anycast addresses. There are plenty of special, reserved IPv6 addresses like in IPv4

There is IPv6 all nodes multicast which is like IPv4 broadcast.

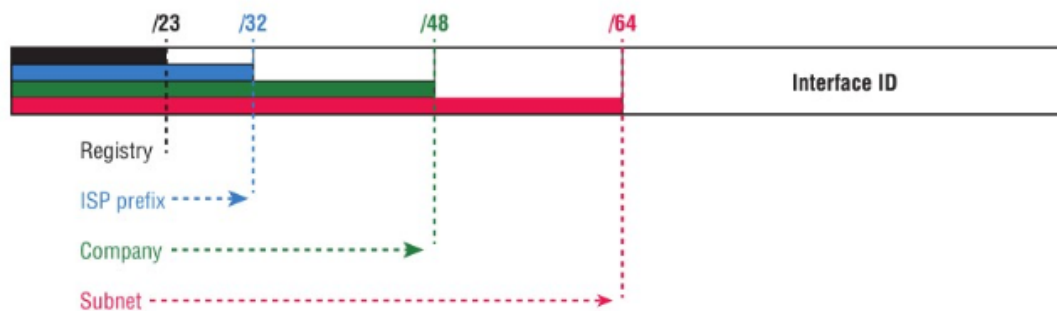
IPv6 does not use the dotted-decimal subnet mask notation. The prefix length is used to indicate the network portion of an IPv6 address. A typical IPv6 prefix length for LANs and most different sorts of networks is /64. This implies the prefix or networks portion of the address is 64 bits long, leaving another 64 bits for the interface ID (host partition) of the address.

Unicast - An IPv6 unicast address uniquely identifies an interface on an IPv6-enabled device. A packet sent to a unicast address is received by the interface that is assigned that address. Similar to IPv4, a source IPv6 address must be a unicast address. The destination IPv6 address can be either a unicast or a multicast address. The most common types of IPv6 unicast addresses are global unicast addresses (GUA) and link-local unicast addresses. There are few types of Unicast addresses - **Global unicast**, **link-local**, **Unique local**

Global unicast addresses are like IPv4 public addresses they are unique and can be assigned dynamically or configured statically. Global addresses start at 2000::/3. Figure 14.2 shows content of unicast address.

The Global Unicast address has three parts – Global routing prefix, Subnet ID, and interface ID. The Internet Service Provider can provide you with a minimum /48 network ID, which in turn provides you 16-bits to create a unique 64-bit router interface address. The last 64-bits are the unique host ID. IPv6 global unicast addresses (GUA) are globally unique and routable on the IPv6 Internet. These addresses are equivalent to public IPv4 addresses. The Internet Committee for Assigned Names and Numbers (ICANN), the operator for IANA, allocates IPv6 address blocks to the five RIRs. Currently, only global unicast addresses with the first three bits of 001 or 2000::/3 are being assigned. At the end of the day, the first hexadecimal digit of a GUA address will begin with a 2 or a 3. This is only 1/8th of the total available IPv6 address space, excluding only a very small portion for other types of unicast and multicast addresses.

FIGURE 14.2 IPv6 global unicast addresses



Link local is something like a subnet Link-local addresses are used to interact with other devices on the same local link. Link-local addresses are limited to a single link. The unique addresses must only be confirmed on that link because they are not routable beyond the link like in a broadcast domain, routers will not forward packets with a link-local source or destination address. Link local addresses start with (FE80::/10)

Unique local addresses (FC00::/7 to FDFF::/7)These addresses are likewise expected for nonrouting purposes over the Internet, yet they are almost globally unique,, so it's far-fetched you'll ever have one of them overlap. Unique local addresses were designed to replace site-local addresses, so they basically do precisely what IPv4 private addresses do: permit correspondence all through a site while being routable to various local networks. Site-local addresses expostulated as of September 2004.

An IPv6 link-local address enables a device to communicate with other IPv6-enabled devices on the same link and only on that link (subnet). Packets with a source or destination link-local address cannot be routed beyond the link from which the packet originated. The global unicast address is not a requirement. However, every IPv6-enabled network interface is required to have a link-local address. If a link-local address is not configured manually on an interface, the device will automatically create its own without communicating with a DHCP server. IPv6-enabled hosts create an IPv6 link-local address even if the device has not been assigned a global unicast IPv6 address. This allows IPv6-enabled devices to communicate with other IPv6-enabled devices on the same subnet. This includes communication with the default gateway (router)

Here are some special IPv6 addresses:

Address	Meaning
0:0:0:0:0:0:0:0	Equals ::. This is the equivalent of IPv4's 0.0.0.0 and is typically the source address of a host before the host receives an IP address when you are using DHCP-driven stateful configuration.
0:0:0:0:0:0:0:1	Equals ::1. The equivalent of 127.0.0.1 in IPv4.
0:0:0:0:0:0:192.168.100.1	This is how an IPv4 address would be written in a mixed IPv6/IPv4 network environment.
2000::/3	The global unicast address range.
FC00::/7	The unique local unicast range.
FE80::/10	The link-local unicast range.
FF00::/8	The multicast range.
3FFF:FFFF::/32	Reserved for examples and documentation.
2001:0DB8::/32	Also reserved for examples and documentation.
2002::/16	Used with 6-to-4 tunneling, which is an IPv4-to-IPv6 transition system. The structure allows IPv6 packets to be transmitted over an IPv4 network without the need to configure explicit tunnels.

[2] ToddLammle()CCNA routing and switching [online]available at: URL https://docs.google.com/file/d/0B4kMbWusMgMMZTZ6RVNZUS14UnM/view?fbclid=IwAR1QbKkr21rB9Zv8MLbzqWOXtz7J2QMt6ZB84Mmj_YUdJekAzc4RrrC-8is

2. IP addressing scheme for School of Management and Engineering

Task condition:

Design an IP addressing scheme for School of Management and Engineering

As a network administrator, you are asked to design a hierarchical IP addressing scheme for Faculty's networks. Choose a suitable network address to support more than 2000 users and future growth. The requirements are:

IP addressing scheme to support:

- a) School of Applied Computing: 20 staff, lab301 – 60 pcs, Lab302 – 30 pcs, Lab303 – 36 pcs, Lab 304 – 45 pcs, Lab306 – 40 pcs, Lab308 – 140 pcs, Lab309 – 50 pcs and Lab310 – 18 pcs.
- b) School of Automotive Engineering: 25 staff, lab101 – 40 pcs, Lab102 – 25 pcs, Lab103 – 35 pcs, Lab205 – 40 pcs, Lab206 – 48 pcs, CAD lab – 20 pcs and Lab301 – 50 pcs.
- c) School of Engineering: 18 staff, lab201 – 20 pcs, Lab202 – 80 pcs, Lab203 – 65 pcs, Lab205 – 25 pcs, Lab404 – 45 pcs, Lab408 – 28 pcs, Lab409 – 80 pcs, Lab410 – 45 pcs.
 - A Test centre – 20 pcs, 1 IP phone, a printer – **D**
 - An Open Access lab with 245 pcs and 5 printers - **E**
 - Assign appropriate IPv6 address for 6 servers located at the University building-**F**
 - The servers are DNS, Email, Finance, Registry, File server and a Print server. Assign appropriate IPv6 address for the link between MP and ISP. - **G**

In the condition of this task is written we have to design a network which support 2000 host.

I chose 172.16.0.0 / 24 class B address which provides 256 subnets and 254 hosts per subnet and outnumber significantly the requirements of 2000 host and which I will use very wisely without wasting addresses with the help of VLSN (variable length subnet mask). It is chosen to have 254 host in a subnet not by chance but because maximum host which we have in the condition is 250 in the open access lab – E

So in the three schools (a, b, c) + test centre (D) + open access lab(E) + University Building with servers (F) + servers- DNS, Email, Finance , Registry , File server and Printer Server (G) we have 28 different networks and I start with

172.16.0.0 /24 - which provides 256 subnets and 254 hosts per subnet

172.16.1.0 /24

172.16.2.0 /24

172.16.3.0 172.16.255.0

172.16.1.0 /24 – lab308 need 140 hosts that why we use /24 because give us 256 possible host if we use /23 we will be in shortage with 128 possible hosts

172.16.2.0 /25 lab202

172.16.2.128/25 lab203

172.16.3.0 / 25 lab409

I used here suffix / 25 because I Need maximum 126 hosts per subnet. Basically I took 2 subnets /24 and break them into four /25 last 172.16.3.128 is not used

172.16.4.0 /26 lab301

172.16.4.64 /26 lab303

172.16.4.128 /26 lab304

172.16.4.192 /26 lab306

172.16.5.0 /26 lab309

172.16.5.64 /26 lab101

172.16.5.128 /26 lab103

172.16.5.192 /26 lab205 (B) from School of Automotive Engineering

172.16.6.0 / 26 lab 206

172.16.6.64 /26 lab301

172.16.6.128 / 26 lab404

172.16.6.192 /26 lab410

172.16.7.0 /27 stuff from School of Applied Computing
172.16.7.32 /27 lab302
172.16.7.64 /27 lab310
172.16.7.96 /27 stuff from School of Automotive Engineering
172.16.7.128 /27 lab102
172.16.7.160 /27 CAD lab
172.16.7.192 / 27 stuff from School of Engineering "C"
172.16.7.224 /27 lab201
172.16.8.0 /27 lab205 from "C" School of Engineering
172.16.8.32 /27 lab408
172.16.8.64 /27 test centre
172.16.9.0 / 29 servers (G)

Respectfully we have:

- for every 172.16.x.x /26 four subnets and 62 available hosts per subnet
- for 172.16.x.x /27 eight subnets and 30 hosts
- for 172.16.x.x / 29 thirty two subnets and 6 hosts
-

and IPv6 addresses for:

DNS - FE80::1/10

Email - FE80::2/10

Finance - FE80::3/10

Registry - FE80::4/10

File server FE80::5/10

Print server FE80::6/10

References

[1] Cisco Networking Academy(2019)Cisco Networking Academy, Available at: URL <https://static-course-assets.s3.amazonaws.com/ITN6/en/index.html#7.0.1.1>, accessed 04.JAN.2019

[2] ToddLammle()CCNA routing and switching [online]available at: URL https://docs.google.com/file/d/0B4kMbWusMgMMZTZ6RVNZUS14UnM/view?fbclid=IwAR1QbKkr21rB9Zv8MLbzqWOXtz7J2QMt6ZB84Mmj_YUdJekAzc4RrrC-8is