

Lanka Education and Research Network

IPv4/IPv6 Addressing

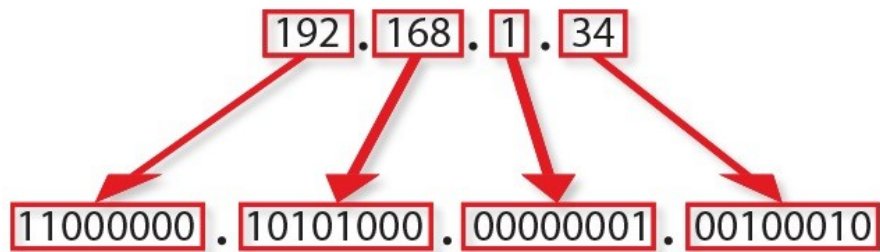
25-28 April 2022

Tuning up Campus Network

Dhammika Lalantha / LEARN

IP addressing

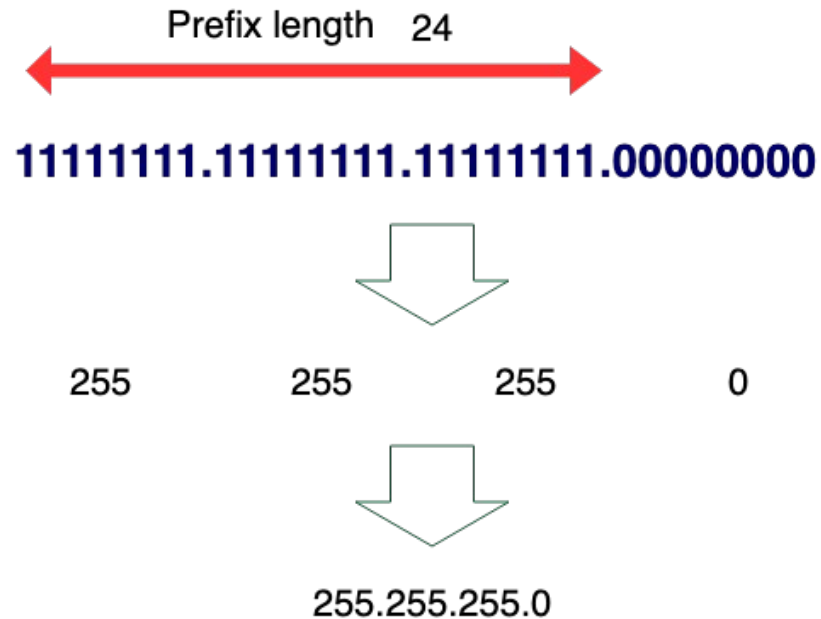
- **IP Address** – The unique 32 bit number ID assigned to a host in a network
- Ex: IP address 192.168.1.34
- Binary representation
 - 32 bits long for IPv4 address



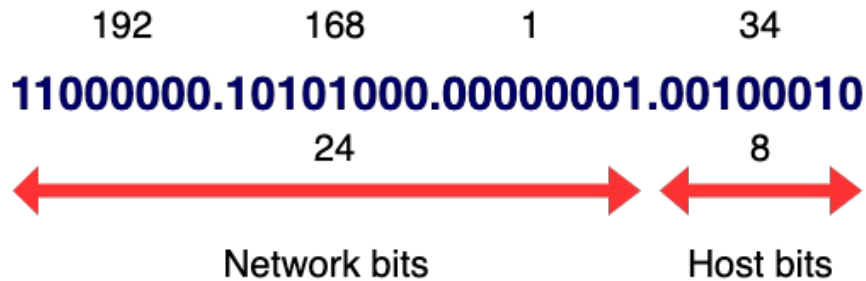
- **Subnet** – A logical subdivision of an IP network
 - 192.168.1.0/24
- **Subnet Mask** - A 32-bit combination used to identify network ID and host ID of an IP address
 - 255.255.255.0
- **Prefix length** – Another way of expressing the subnet mask.
 - 24 for the above

IP addressing

- Prefix length vs Network mask



- Network and Host bits



IP addressing

- Network Address – First address in the network and used for identification of the network segment
- Ex: 192.168.1.34/24

192.168.1.34 → 11000000.10101000.00000001.00100010
255.255.255.0 → 11111111.11111111.11111111.00000000

Make all host bits zero



192.168.1.0 ← 11000000.10101000.00000001.00000000

IP addressing

- Broadcast Address – Last address in the network and used for addressing all the hosts in the network

192.168.1.34 → 11000000.10101000.00000001.00100010
255.255.255.0 → 11111111.11111111.11111111.00000000

Make all host bits ones (1)



192.168.1.255 ← 11000000.10101000.00000001.11111111

Subnetting

- Dividing a computer network into multiple logical networks
- Why subnet your network?
 - Improve network performance and speed
 - Reduce network congestion
 - Enhance network security
 - Simplified network administration

IP Address Classes

- Allows IP addresses to be shared by organizations of different sizes

IP address classes

Class	1st Octet Decimal Range	1st Octet High Order Bits	Network/Host ID (N=Network, H=Host)	Default Subnet Mask	Number of Networks	Hosts per Network (Usable Addresses)
A	1 – 126*	0	N.H.H.H	255.0.0.0	126 ($2^7 - 2$)	16,777,214 ($2^{24} - 2$)
B	128 – 191	10	N.N.H.H	255.255.0.0	16,382 ($2^{14} - 2$)	65,534 ($2^{16} - 2$)
C	192 – 223	110	N.N.N.H	255.255.255.0	2,097,150 ($2^{21} - 2$)	254 ($2^8 - 2$)
D	224 – 239	1110	Reserved for Multicasting			
E	240 – 254	1111	Experimental; used for research			

Private IP addresses

- Reserved by Internet Assigned Numbers Authority (IANA) for use within private networks (LANs)

Private IP Addresses

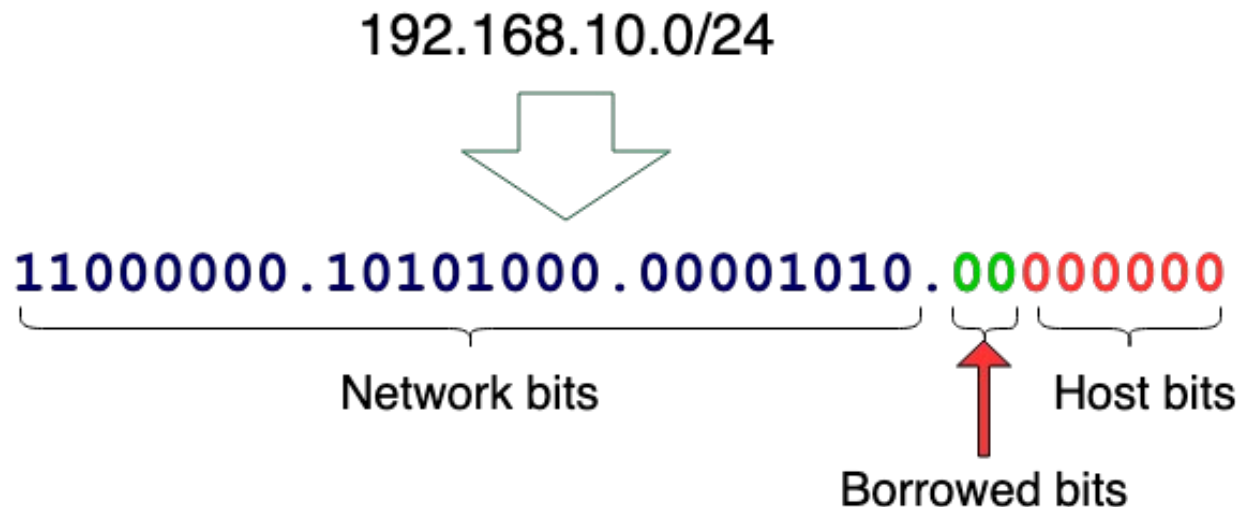
Class	Private Networks	Subnet Mask	Address Range
A	10.0.0.0	255.0.0.0	10.0.0.0 - 10.255.255.255
B	172.16.0.0 - 172.31.0.0	255.240.0.0	172.16.0.0 - 172.31.255.255
C	192.168.0.0	255.255.0.0	192.168.0.0 - 192.168.255.255

Subnetting

- Divide network 192.168.10.0/24 into 4 subnets

Number of subnets = 2^b (b – borrowed bits)

$$2^b = 4 \Rightarrow b = 2$$



Subnetting

- Lookup table for Class C networks (for Classful networks Only)

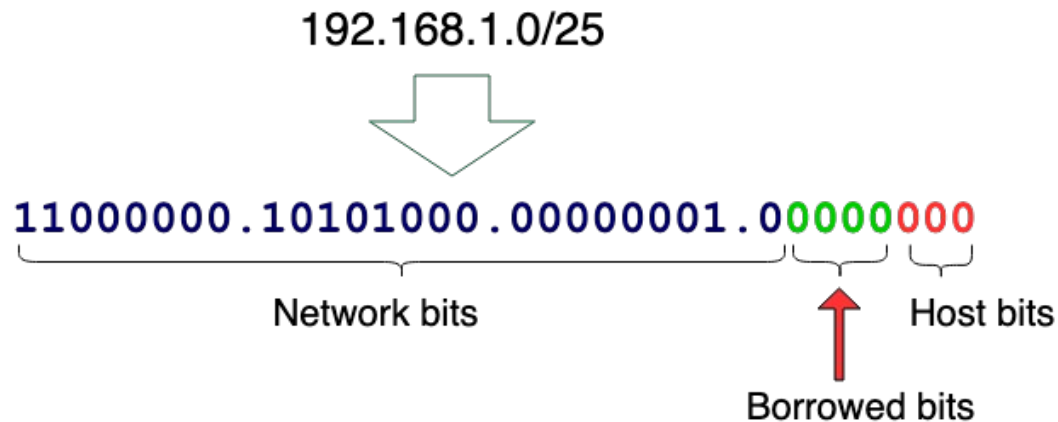
Network Bits	Subnet Mask	Bits Borrowed	Subnets	Hosts/Subnet
24	255.255.255.0	0	1	254
25	255.255.255.128	1	2	126
26	255.255.255.192	2	4	62
27	255.255.255.224	3	8	30
28	255.255.255.240	4	16	14
29	255.255.255.248	5	32	6
30	255.255.255.252	6	64	2

Subnetting

- Divide sub network 192.168.1.0/25 (Classless) into subnets with 6 hosts.

Number of usable host addresses = $2^h - 2$ (h – host bits)

$$2^h - 2 = 6 \Rightarrow h = 3$$



Number of subnets = $2^b = 4 \Rightarrow b = 2$ (b – borrowed bits)

Variable Length Subnet Mask (VLSM)

- Subnet a given network with different sizes of subnet masks.
 - Efficient use of the address space.
 - Example network:
 - Administration staff – 12
 - Accounting staff – 5
 - Library staff – 6
 - Non-Academic staff - 35
 - Academic staff – 20
 - Students – 110
 - What is the suitable IP address class to be used?
 - How to design a network for above using VLSM if given network 192.168.100.0/24?
-

Variable Length Subnet Mask (VLSM)

- How to subnet your network with VLSM ?
- Follow the below simple procedure to subnet your network with the given requirements.
 - Sort the subnets by number of hosts per subnet in descending order.
 - Allocate the highest range of IPs to the highest requirement.
Choose a suitable subnet mask to fill the requirement.
 - Next choose the next highest requirement and assign a subnet with suitable subnet mask from the remaining network.
 - Do this until the all requirements are given a subnet.

Variable Length Subnet Mask (VLSM)

Answer:

User group	# of Hosts	Subnet
Students	110	192.168.100.0/25
Non-acadmeic	35	192.168.100.128/26
Academic	20	192.168.100.192/27
Administrative	12	192.168.100.224/28
Library	6	192.168.100.240/29
Accounting	5	192.168.100.248/29

Classless Inter Domain Routing (CIDR)

- Based on the concept of VLSM
- flexible way of allocating IP addresses in contrast to deprecated classful IP addressing
- Efficiently use the available IP address space.
- Reduce the routing table entries by aggregating multiple classful address blocks
 - 192.168.0.0/24, 192.168.1.0/24, ..., 192.168.255.0/24 => 192.168.0.0/16
- CIDR Notation
 - A.B.C.D/N ; A.B.C.D – Network address, N – Network Prefix length
 - Ex1 : 192.248.4.0/24
 - Ex2 : 10.12.3.23/27
 - EX3 : 192.168.0.0/22

Supernetting

- Summarizing a bunch of contiguous networks to form a larger network.
- Used for route summarization
- Can be used with routing protocols which supports CIDR
 - EIGRP, OSPF, BGP, IS-IS, RIPv2
 - RIP does not support
- Sometimes CIDR and Supernetting are used interchangeably

What is IPv6 ?

- Expanded Address space
 - 128 bit address length
- Header Format Simplification
 - Fixed length
 - IPv6 header is twice as long (40 bytes) as IPv4 header without options (20 bytes)
- No checksum at the IP network layer
 - Speed up packet forwarding
- Fixed 64 bits interface identifier no smaller subnets allocated
- Authentication and Privacy Capabilities
 - IPsec is integrated
- No more Broadcast, instead supports Anycast

Larger Address Space

- IPv4
 - 32 bits
 - 4,294,967,296 possible addressable devices
- IPv6
 - 128 bits: 4 times the size in bits
 - 3.4×10^{38} possible addressable devices
 - 340,282,366,920,938,463,463,374,607,431,768,211,456

IPv6 Address Representation

- Human readable form represented with hexadecimal numbers
- 16 bit segments are separated by colon
 - 2031:0000:130F:0000:0000:09C0:876A:130B
- Leading zeros in a field are optional:
 - 2031:0000:130F:0000:0000:09C0:876A:130B
 - 2031:0000:130F:0000:0000:9C0:876A:130B
- Successive fields of 0 represented as ::, but only once in an address:
 - 2031:0000:130F:0000:0000:09C0:876A:130B
 - 2031:0000:130F::09C0:876A:130B is OK
 - 2031::130F:0000:0000:09C0:876A:130B is OK, but not the shortest
 - 2031::130F::9C0:876A:130B is NOT OK

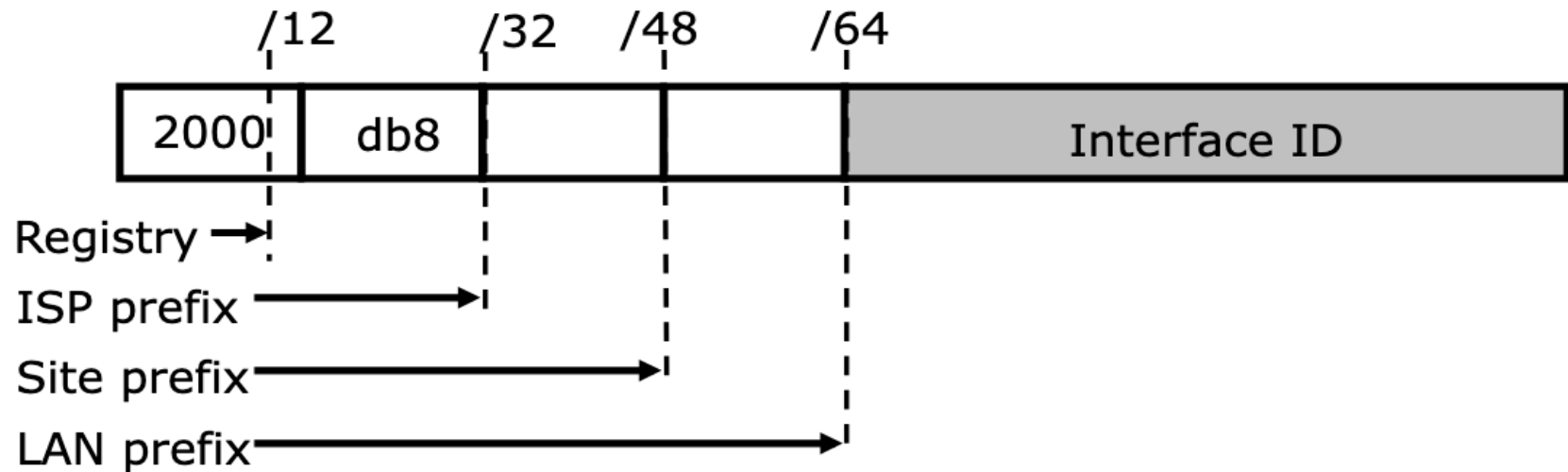
IPv6 Address Representation

- Putting it all together
 - 2031:0:130F::9C0:876A:130B
- All 0's
 - 0:0:0:0:0:0:0:0 => ::
- Loopback address
 - 0:0:0:0:0:0:0:1 => ::1

IPv6 Address Representation

- Prefix Representation
 - Representation of prefix is just like IPv4 CIDR
 - In this representation you attach the prefix length
 - Like IPv4 address:
 - 198.10.0.0/16
 - IPv6 address is represented in the same way:
 - 2001:db8:12::/40

IPv6 Address Allocation



- The allocation process is:
 - The IANA is allocating out of 2000::/3 for initial IPv6 unicast use
 - Each registry gets a /12 prefix from the IANA
 - Registry allocates a /32 prefix (or larger) to an IPv6 ISP
 - Policy is that an ISP allocates a /48 prefix to each end customer

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Thank You

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