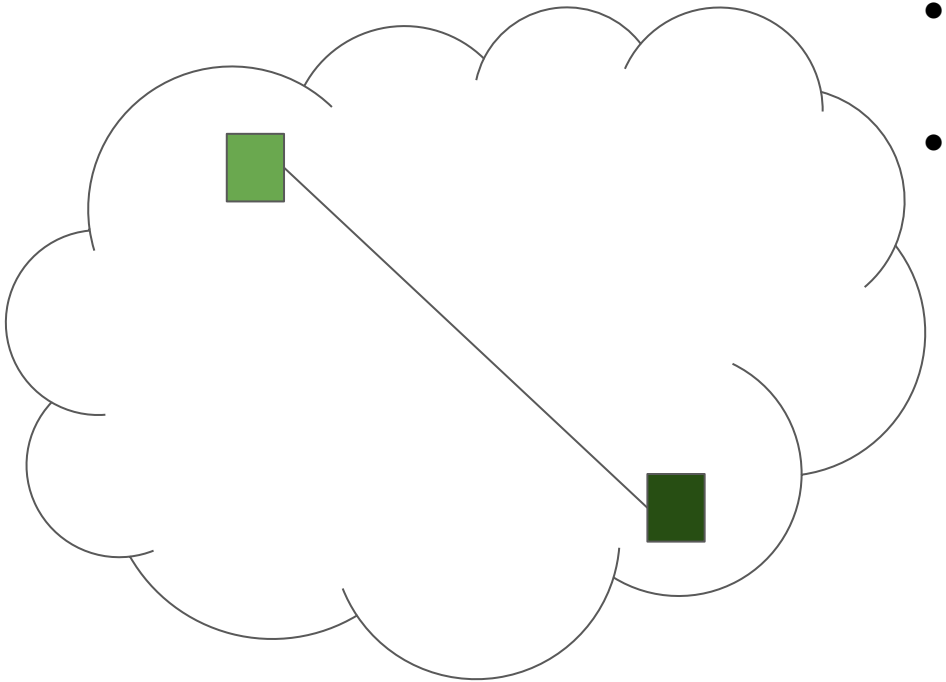
Addressing

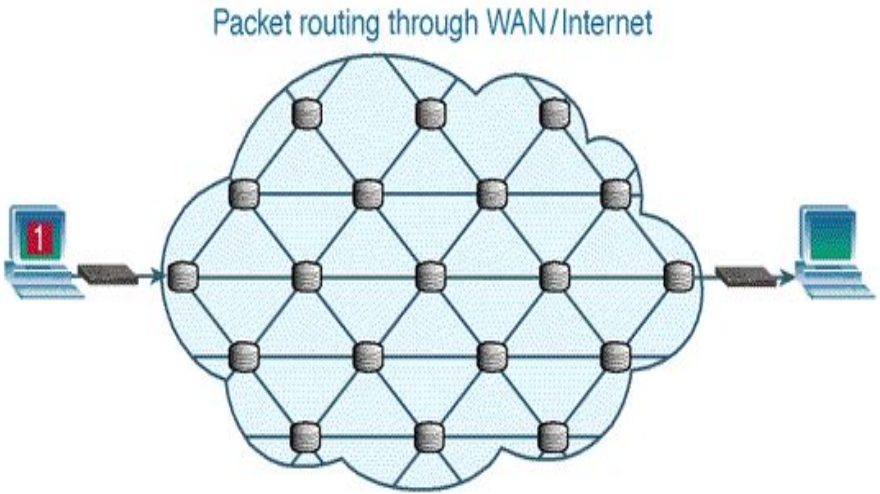
Internet Protocol (IP)



- Standards on “how data packets moves through a network”
- Protocol defines mainly:
  - IP Address
  - IP Routing

IP Routing

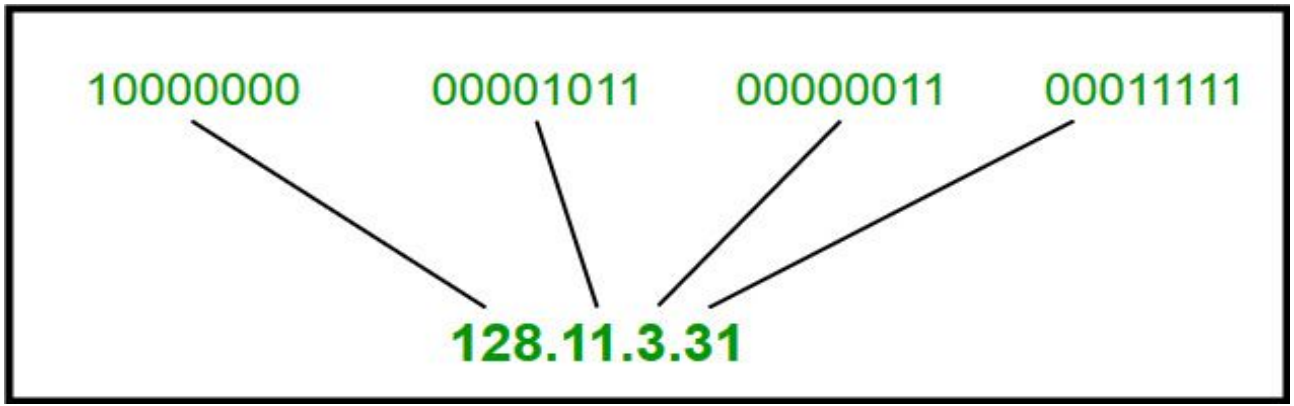
- **Packet Switching**
  - Break data into chunks at source node, called “Packets”
  - Packet contents or payload has
    - Data
    - Control info:
      - Source and destination IP Addr
      - Sequence number
  - No pre-known path.
  - Each packet is forwarded by the nodes towards destination node.
  - Packets are reassembled at destination node.



https://giphy.com/gifs/packnetwork-112f41tQK1G1ag

IP Address

- Unique number to identify any device in network (Host or Router).
- IP Address = Network address + Host address
- Represented as:
  - 32 bits in 4 octets
  - 4 decimal digits dot separated

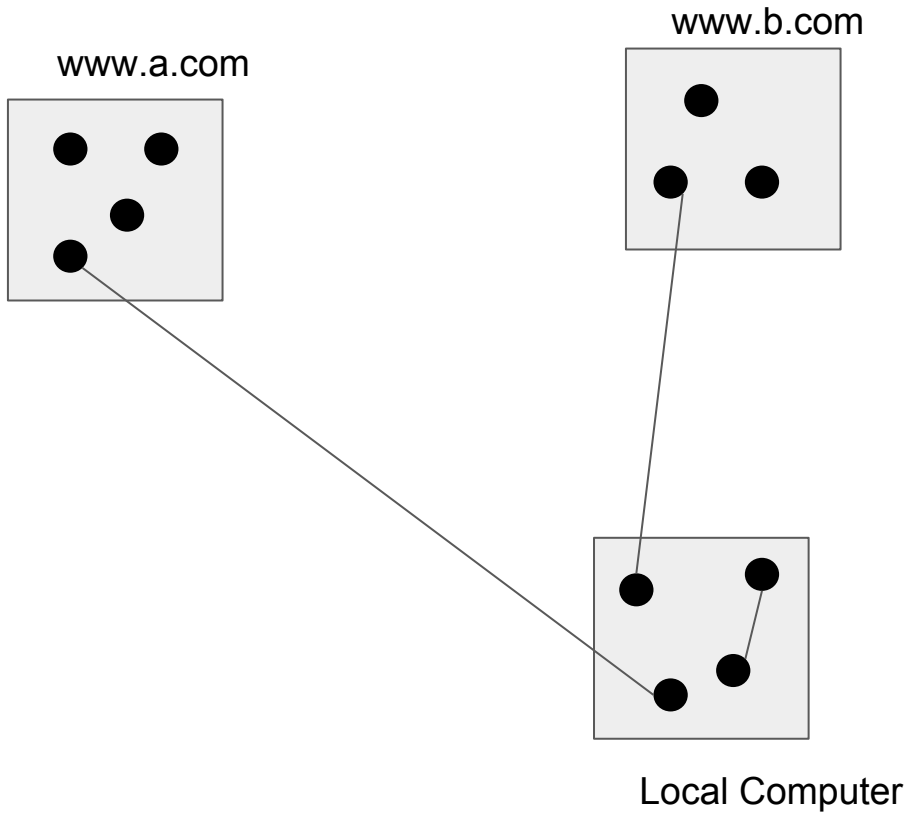


https://www.geeksforgeeks.org/wp-content/uploads/IP_addressing_1.jpg

Port Numbers

- Number to identify the process on host.
- Part of TCP payload header.
- 16 bit number

- Types:
  - Well known ports (20 & 21, 25, 80 & 443)
  - Ephemeral/ Temporary(till the time the process is running), eg: Host my python web app at 1234 port



ifconfig

```
en0: flags=8863<UP,BROADCAST,SMART,RUNNING,SIMPLEX,MULTICAST> mtu 1500
        ether 98:01:a7:b3:80:21
        inet6 fe80::9a01:a7ff:feb3:8021%en0 prefixlen 64 duplicated scopeid 0x4
        inet 192.168.1.105 netmask 0xffffff00 broadcast 192.168.1.255
        nd6 options=9<PERFORMNUD,IFDISABLED>
        media: autoselect
        status: active
```

- System admin utility in Unix like systems.
- Configure/ Control/ Query network interfaces, eg:
  - set IP and network mask of a machine.
  - enable/ disable interface
  - Set network interface at system startup
- Tags: eth or lo(127.0.0.1) or wlan

Network classes

IP = Network ID + Host ID

CLASS	LEADING BITS	NET ID BITS	HOST ID BITS	NO. OF NETWORKS	ADDRESSES PER NETWORK	START ADDRESS	END ADDRESS
CLASS A	0	8	24	2^{7} (128)	2^{24} (16,777,216)	0.0.0.0	127.255.255.255
CLASS B	10	16	16	2^{14} (16,384)	2^{16} (65,536)	128.0.0.0	191.255.255.255
CLASS C	110	24	8	2^{21} (2,097,152)	2^{8} (256)	192.0.0.0	223.255.255.255
CLASS D	1110	NOT DEFINED	NOT DEFINED	NOT DEFINED	NOT DEFINED	224.0.0.0	239.255.255.255
CLASS E	1111	NOT DEFINED	NOT DEFINED	NOT DEFINED	NOT DEFINED	240.0.0.0	255.255.255.255

https://www.geeksforgeeks.org/wp-content/uploads/gq/2015/07/nethostdata.jpg

Network Mask

- **32 bit number to identify network and host part in an IP Address.**
- Eg: Find net ID and host ID for given mask:

  (8.20.15.1 255.0.0.0) or (8.20.15.1 /8)

  A = 8.20.15.1 = 00001000 . 00010100 . 00001111 . 00000001
  M = 255.0.0.0 = 11111111 . 00000000 . 00000000 . 00000000

  -- NET ID --|----------HOST ID ----------

  netid = 00001000 = 8

  (address bits which have corresponding mask bits set to 1)

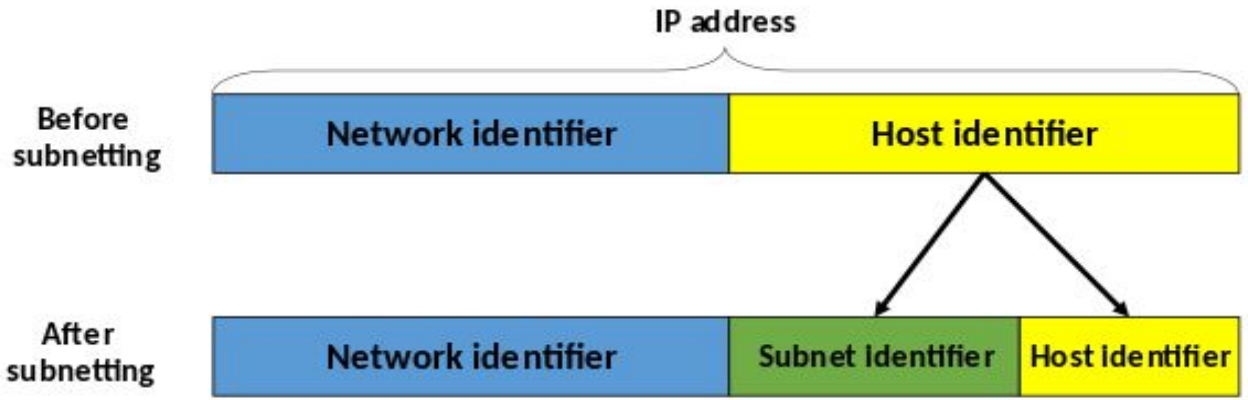
  hostid = 00010100.00001111.00000001 = 20.15.1

  (address bits that have corresponding mask bits set to 0)

  - Default masks:
    - **Class A: 255.0.0.0 or /8**
    - **Class B : 255.255.0.0 or /16**
    - **Class C : 255.255.255.0 or /32**

Subnetting

- Logically partitioning any class A, B or C networks.
- Network = Group of Subnets, where every
  Subnet = Group of Hosts
- Why?
  - Avoid congestion inside network. Within subnet traffic does not impact outside subnet.
  - Security.
  - Different physical media.



https://en.wikipedia.org/wiki/File:Subnetting_Concept-en.svg

Subnet Mask

- 32 bit number to identify Subnet and Host ID from IP
- Extension of natural mask of the class

It is a Class C network with:

Subnet bits = 3
Subnets = (2^3) = 8
Host bits = (8-3) = 5
Host/subnet = (2^5) = 32
Usable host ids/ subnet
= # Host/subnet - 2 = 30

Eg: Find net ID and host ID for subnet mask:
(204.17.5.0 255.255.255.224) or (204.17.5.0/27)

204.17.5.0	**-**	**11001100**	**.**	**00010001**	**.**	**00000101**	**.**	**00000000**
255.255.255.224	**-**	**11111111**	**.**	**11111111**	**.**	**11111111**	**.**	**11100000**

----------Network----------.--------sub-------

So, what are the possible net IDs and host IDs inside this network?

Solution: address/mask is (204.17.5.0 255.255.255.224) or (204.17.5.0/27)

Subnets	Subnet Mask = /27 Subnet octet = 4 Subnet bits = 3	Subnet Address	Subnet Mask	# Hosts = 32 Possible Host IDs	Host address Start	Host address End
1	"000 00000"	204.17.5.0	255.255.255.224	0-31	204.17.5.1	204.17.5.30
2	"001 00000"	204.17.5.32	255.255.255.224	32-63	204.17.5.33	204.17.5.62
3	"010 00000"	204.17.5.64	255.255.255.224	64-95	204.17.5.65	204.17.5.94
4	"011 00000"	204.17.5.96	255.255.255.224	96-127	204.17.5.97	204.17.5.126
5	"100 00000"	204.17.5.128	255.255.255.224	128-159	204.17.5.129	204.17.5.158
6	"101 00000"	204.17.5.160	255.255.255.224	160-191	204.17.5.161	204.17.5.190
7	"110 00000"	204.17.5.192	255.255.255.224	192-223	204.17.5.193	204.17.5.222
8	"111 00000"	204.17.5.224	255.255.255.224	224-256	204.17.5.225	204.17.5.254

Special Addresses in Subnet

- First host address in subnet = Network Address
- Last host address in subnet = Broadcast Address

Problem Statement 1

What is the subnet address for IP: 172.16.17.30/20?

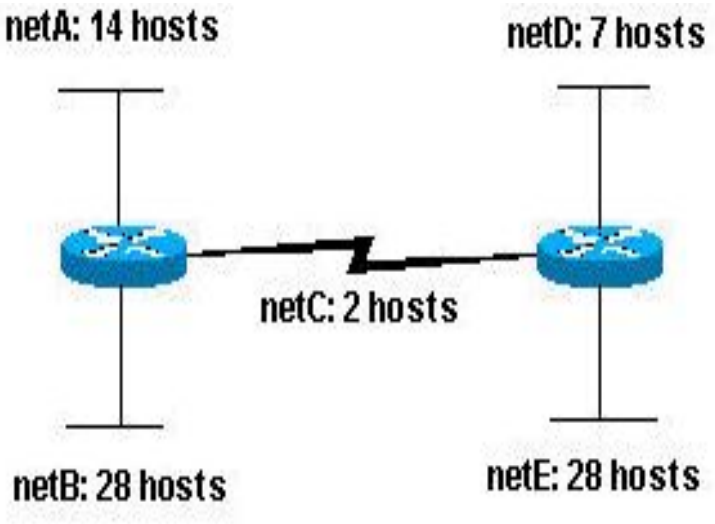
Subnet address = Network address of subnet

IP/mask:

172.16.17.30	**-**	**10101100**	**.**	**00010000**	**.**	**00010001**	**.**	**00011110**
/20	**-**	**11111111**	**.**	**11111111**	**.**	**11110000**	**.**	**00000000**
Subnet	**-**	**10101100**	**.**	**00010000**	**.**	**00010000**	**.**	**00000000**
	-	**172**	**.**	**16**	**.**	**16**	**.**	**0**

Problem Statement 2

Given the Class C network of 204.15.5.0/24, subnet the network in order to create the network in given figure with the host requirements shown:



 # Subnets = 5

 # Subnet bits = 3

 # Host bits = 5

 # Hosts/subnet = 2^5 = 32

Hence possible!

netA: 204.15.5.0/27 host address range 1 to 30
netB: 204.15.5.32/27 host address range 33 to 62
netC: 204.15.5.64/27 host address range 65 to 94
netD: 204.15.5.96/27 host address range 97 to 126
netE: 204.15.5.128/27 host address range 129 to 158

VLSM & CIDR

- Same subnet mask applied to each subnet
  - # hosts/ subnet is same for all hosts.
  - Unused IPs in subnets

- VLSM
  - Variable Length Subnet Masks
  - Use different masks for every subnet based on number of hosts needed in that subnet

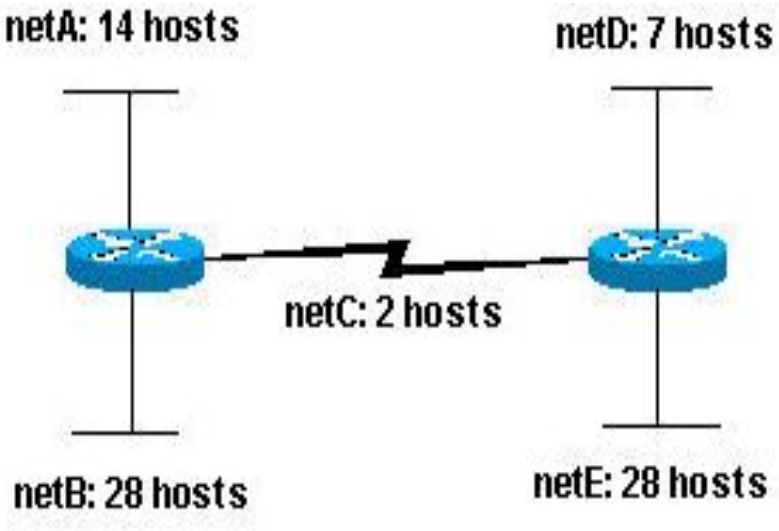
- CIDR
  - Classless Inter Domain Routing
  - No classes in IP, [**IP = Prefix /length of mask],** eg:

    (172.16.17.30 255.255.240.0) = **172.16.17.30/20**, since d240 = b11110000

  - Benefits:
    - Improves address space utilization
    - Hierarchical network architecture
    - Routing scalability

Problem Statement 2 - Using VLSM

Given the Class C network of 204.15.5.0/24, subnet the network in order to create the network in given figure with the host requirements shown:



netA, 14 hosts: or 16 hosts, 4 bit host ID, 28 bit net ID, requires a /28 (255.255.255.240) mask

netB, 28 hosts: or 30 hosts, 5 bit host ID, 27 bit net ID, requires a /27 (255.255.255.224) mask

netC, 2 hosts: or 4 hosts, 2 bit host ID, 30 bit net ID, requires a /30 (255.255.255.252) mask

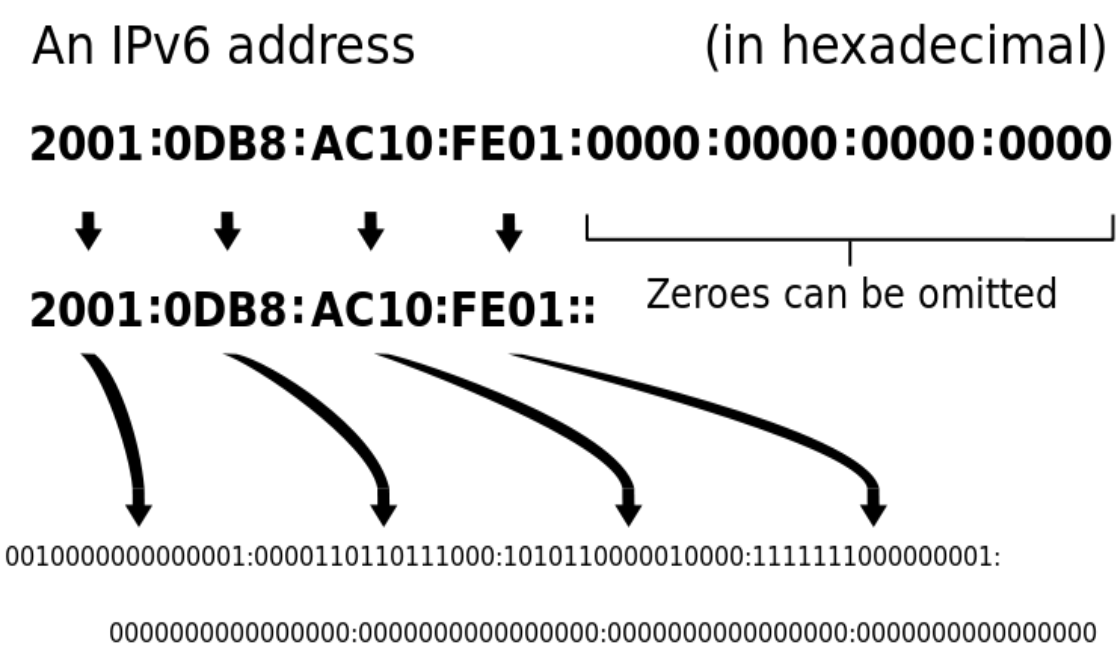
netD, 7 hosts: or 9 hosts, 4 bit host ID, 28 bit net ID, requires a /28 (255.255.255.240) mask

netE, 7 hosts: same as netB

Assign address starting from largest subnet:

netB: 204.15.5.0/27 host address range (32, 0-31) 1 to 30
netE: 204.15.5.32/27 host address range (32, 32-63) 33 to 62
netA: 204.15.5.64/28 host address range (16, 64-79) 65 to 78
netD: 204.15.5.80/28 host address range (16, 80-95) 81 to 94
netC: 204.15.5.96/30 host address range (4, 96-99) 97 to 98

IPv6



- Upgraded version of IPv4.
- 128 bit address, (8 groups, each group is 16 bits or 4 hexadecimal bits)
- Benefits?
  - Increased addr space
  - No NAT required, each device has its IP (IOT)
  - IPSec built in
  - No DHCP required, auto-configurable

https://en.wikipedia.org/wiki/IPv6_address#/media/File:Ipv6_address_leading_zeros.svg

Private IP address ranges

- The private IP addresses are the reserved IP address blocks that cannot be routed through the internet. Since private IP addresses are only intended to be used in private networks, they are not globally unique.
- The private IP address must be unique within its network (usually LAN) so that there is no conflict between two computers within its network.
    - **10.0.0.0 - 10.255.255.255**
    - **172.16.0.0 - 172.31.255.255**
    - **192.168.0.0 - 192.168.255.255**

Public IP address ranges

- Public IP address is the address that is assigned to a computing device to allow direct access over the Internet. (e.g: web server, email server and any server device directly accessible from the Internet)
- A public IP address is globally unique, and can only be assigned to a unique device.

DHCP

- Dynamic Host Configuration Protocol (DHCP) is a network management protocol used to dynamically assign an IP address to any new node entering the network.
- DHCP permits a node to be configured automatically.
- DHCP clients to dynamically configure the network configuration data without any manual setup process.
- DHCP minimizes configuration errors caused by manual IP address configuration

DNS

- Domain Name System (DNS) translates Internet domain and host names to IP addresses and vice versa.
- DNS is a client/server network communication systems.
- DNS clients send requests to and receive responses from DNS servers.
    - Requests containing a name, that result in an IP address being returned from the server, are called forward DNS lookups.
    - Requests containing an IP address and resulting in a name, called reverse DNS lookups