IP Address in Networking

Subnetting in Networking

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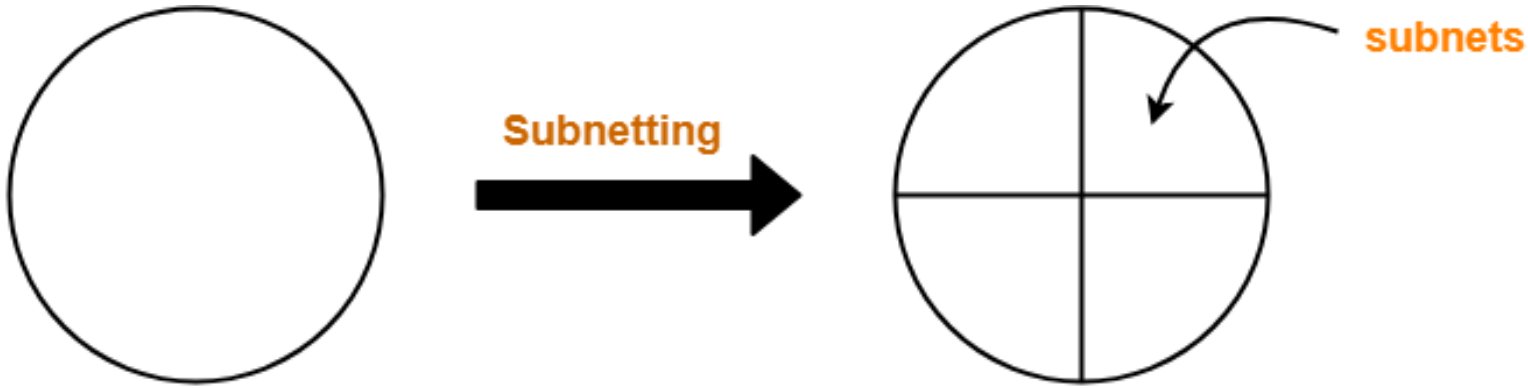
Subnetting

- Subnetting is a process of dividing a single network into multiple sub networks.
- The number of sub networks created depends upon the requirements.

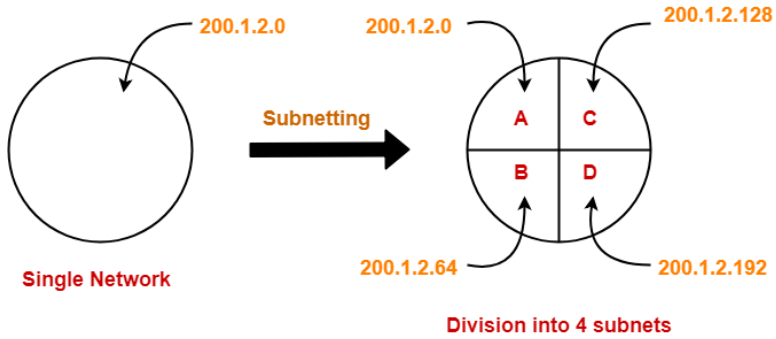


- **Subnet Mask**
  - Subnet mask is a 32 bit number which is a sequence of 1s followed by a sequence of 0s where
    - 1s represent the global network ID part and the subnet ID part.
    - 0s represent the host ID part.

How to Calculate Subnet Mask?

- For any given IP Address, the subnet mask is calculated-
  - By setting all the bits reserved for network ID part and subnet ID part to 1.
  - By setting all the bits reserved for host ID part to 0.
- **Subnet Mask Examples**
  - Consider we have a network having IP Address 200.1.2.0.
  - Clearly, this IP Address belongs to class C.
  - 24 bits are reserved for the Network ID part.
  - 8 bits are reserved for the Host ID part.
  - Subnet mask is obtained-
    - By setting the first 24 bits to 1.
    - By setting the remaining 8 bits to 0.
    - = 11111111.11111111.11111111.00000000
      = 255.255.255.0

- **Example-02:** Consider a single network having IP Address 200.1.2.0 is divided into 4 subnets as shown-



- Now, let us calculate the mask subnet for each subnet.
  - 24 bits identify the global network.
  - 2 bits identify the subnet.
  - 6 bits identify the host.
- For each subnet, subnet mask is obtained-
  - By setting the first 26 bits to 1.
  - By setting the remaining 6 bits to 0.
  - Subnet mask
    $= 11111111.11111111.11111111.11000000$
    $= 255.255.255.192$
- **Note:** In fixed length subnetting, All the subnets have same subnet mask since the size of each subnet is same.

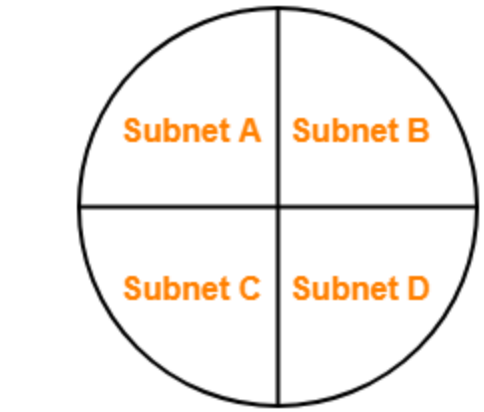
Q Consider a single network having IP Address 200.1.2.0 is divided into 3 subnets as shown-

- **For Subnet A**
  - 24 bits identify the global network.
  - 1 bit identify the subnet.
  - 7 bits identify the host.
- For subnet A, subnet mask is obtained-
  - By setting the first 25 bits to 1.
  - By setting the remaining 7 bits to 0.
  - Subnet mask
    $= 11111111.11111111.11111111.10000000$
    $= 255.255.255.128$
- **For Subnet B And Subnet C**
  - 24 bits identify the global network.
  - 2 bits identify the subnet.
  - 6 bits identify the host.
- **For subnet B and subnet C, subnet mask is obtained-**
  - By setting the first 26 bits to 1.
  - By setting the remaining 6 bits to 0.

- Subnet mask
  = 11111111.11111111.11111111.11000000
  = 255.255.255.192
- **NOTE**
  - In variable length subnetting, All the subnets do not have same subnet mask since the size of each subnet is not same.
  - Default mask for different classes of IP Address are-
    - Default subnet mask for Class A = 255.0.0.0
    - Default subnet mask for Class B = 255.255.0.0
    - Default subnet mask for Class C = 255.255.255.0
  - **Note: 2**
    - Network size is the total number of hosts present in it.
    - Networks of same size always have the same subnet mask.
    - Networks of different size always have the different subnet mask.
  - **Note: 3**
    - For a network having larger size, its subnet mask will be smaller (number of 1s will be less).
    - For a network having smaller size, its subnet mask will be larger (number of 1s will be more).

Arrangement Of Subnets

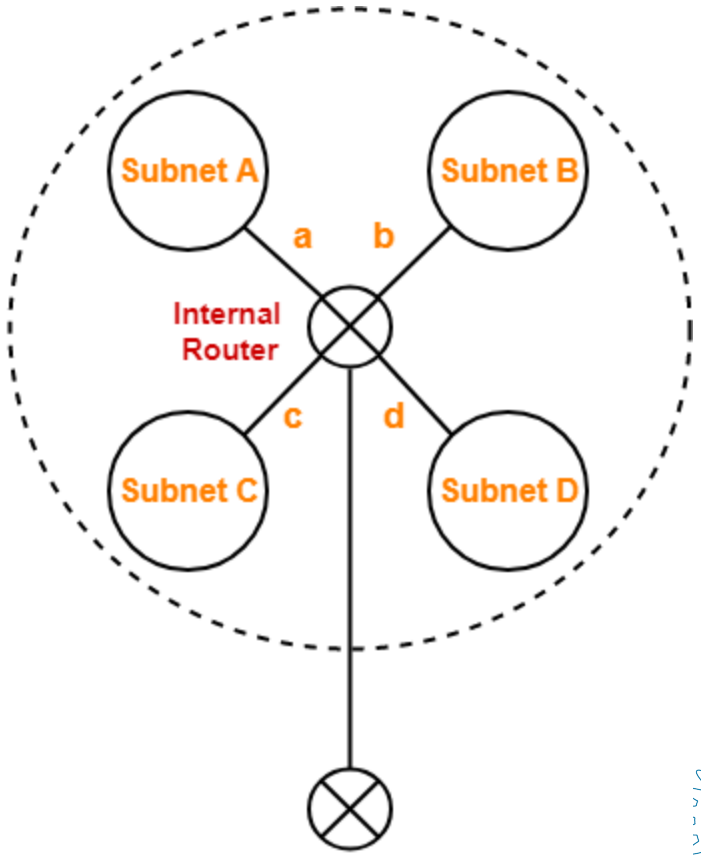
- All the subnets are connected to an internal router.
- Internal router is connected to an external router.
- The link connecting the internal router with a subnet is called as an interface.



Division of a network into 4 subnets

(Logical View)

Arrangement



External Router

(Physical View)

Working

- When a data packet arrives,
  - External router forwards the data packet to the internal router.
  - Internal router identifies the interface on which it should forward the incoming data packet.
  - Internal router forwards the data packet on that interface.
- **Routing Table**
  - A table is maintained by the internal router called as Routing table.
  - It helps the internal router to decide on which interface the data packet should be forwarded.
- **Routing table consists of the following three fields-**
  - IP Address of the destination subnet
  - Subnet mask of the subnet
  - Interface

Q Consider a network is subnetted into 4 subnets as shown in the above picture.

- The IP Address of the 4 subnets are-
  - 200.1.2.0 (Subnet A)
  - 200.1.2.64 (Subnet B)
  - 200.1.2.128 (Subnet C)
  - 200.1.2.192 (Subnet D)

Destination	Subnet Mask	Interface
200.1.2.0	255.255.255.192	a
200.1.2.64	255.255.255.192	b
200.1.2.128	255.255.255.192	c
200.1.2.192	255.255.255.192	d
Default	0.0.0.0	e

Routing Table Example

- **Step-01:**
  - Router performs the bitwise ANDing of-
  - Destination IP Address mentioned on the data packet
  - And all the subnet masks one by one.

- **Step-02:**
  - Router compares each result with their corresponding IP Address of the destination subnet in the routing table.
  - Then, following three cases may occur-
    - If there occurs only one match, then Router forwards the data packet on the corresponding interface.
    - If there occurs more than one match, then
      Router forwards the data packet on the interface corresponding to the longest subnet mask.
    - If there occurs no match, then
      Router forwards the data packet on the interface corresponding to the default entry.

Important Notes

- **Note-01:**
  - In fixed length subnetting,
    - All the subnets have the same subnet mask.
    - So, bitwise ANDing is performed only once.
  - If the result matches to any of the destination subnet IP Address,
    - Router forwards the data packet on its corresponding interface.
    - Otherwise, it is forwarded on the default interface.
- **Note-02:**
  - In variable length subnetting,
    - All the subnets do not have the same subnet mask.
    - So, bitwise ANDing is performed once with each subnet mask.
    - Then, the above three cases are followed.
- **Note-03:**
  - Subnet mask for default route = 0.0.0.0
  - Subnet mask for host specific route = 255.255.255.255

Important Notes

- **Note-04:**
  - A host may also be directly connected to the router.
  - In that case, there exists a host specific route from the router to the host.
  - Router saves the IP Address of that host in the Destination Network column.
  - Router saves 255.255.255.255 in the Subnet Mask column.
  - The ANDing of its destination address and subnet mask yields the IP Address of the host.
  - When a data packet arrives for that specific host, bitwise ANDing is performed.
  - When the result of ANDing is the IP Address of the host, packet is forwarded to its host specific route.

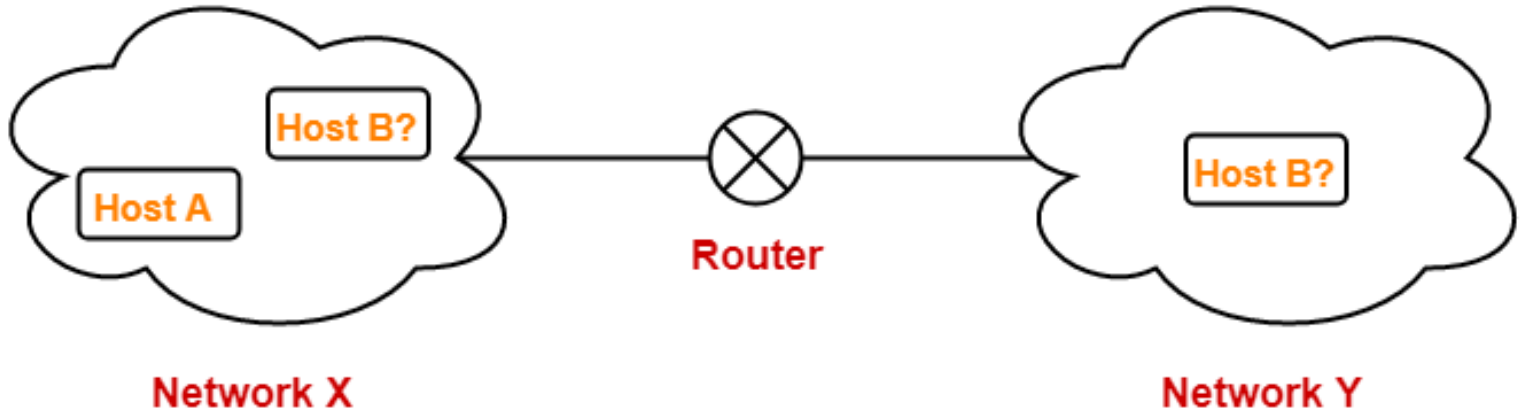
Concept To Know

- When any host connects to the internet, ISP provides following 4 things to the host-
  - **IP Address:**
    - ISP assigns an IP Address to the host so that it can be uniquely identified on the Internet.
  - **Default Gateway:**
    - Default router connected to the network in which the host is present is the default gateway for the host.
  - **Subnet Mask:**
    - Subnet mask is a 32 bit number that is assigned to the host.
    - It is used to determine to which network the given IP Address belongs to.
  - **DNS**
    - Domain Name Service (DNS) is used to translate the domain name into an IP Address.

Subnet Mask Use

- Subnet mask is used to determine to which network the given IP Address belongs to.
  - Host use its subnet mask to determine whether the other host it wants to communicate with is present within the same network or not.
  - If the destination host is present within the same network, then source host sends the packet directly to the destination host.
  - If the destination host is present in some other network, then source host routes the packet to the default gateway (router).
  - Router then sends the packet to the destination host.

- **Example**
  - There is a host A present in some network X.
  - There is a host B.
  - Host A wants to send a packet to host B.
- Before transmitting the packet, host A determines whether host B is present within the same network or not.



- To determine whether destination host is present within the same network or not, source host follows the following steps-
  - Source host computes its own network address using its own IP Address and subnet mask.
  - After computation, source host obtains its network address with respect to itself.
  - Source host computes the network address of destination host using destination IP Address and its own subnet mask.
  - After computation, source host obtains the network address of destination host with respect to itself.
- Source host compares the two results obtained in the above steps.
  - **Case-01:If the results are same**
    - Source host assumes that the destination host is present within the same network.
    - Source host sends the packet directly to the destination host.

- **Case-02: If the results are different**
  - Source host assumes that the destination host is present in some other network.
  - Source host sends the packet via router to the destination host.
- **Important Points**
  - Each host knows only its own subnet mask.
  - It does not know the subnet mask of any other host.
  - The conclusion drawn by a host about the presence of other host within the same or different network might be wrong.
  - Consider host A draws some conclusion about host B.
  - Then, same conclusion might not be drawn by host B about host A.
  - Both the hosts have to perform the above procedure separately at their ends to conclude anything.

Thank You