Name of Trainer :- Prof. Digamber T. Bodake

Subject :- Computer Networks

Topic :- IP Addressing & Subnetting

Date :- 13/06/2017

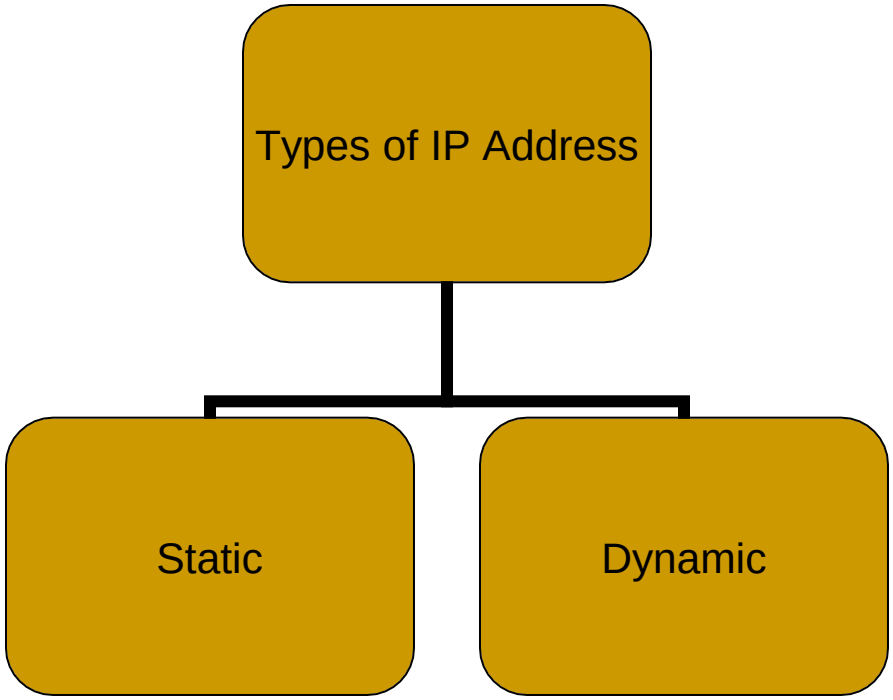
Objectives

Students will be able to:

- *Understand IP Addressing & Subnetting*
- *Identify different classes of IP addresses*
- *Describe IP Subnet*
- *Identify IP Masks*
- *Solve Subnetting Examples*

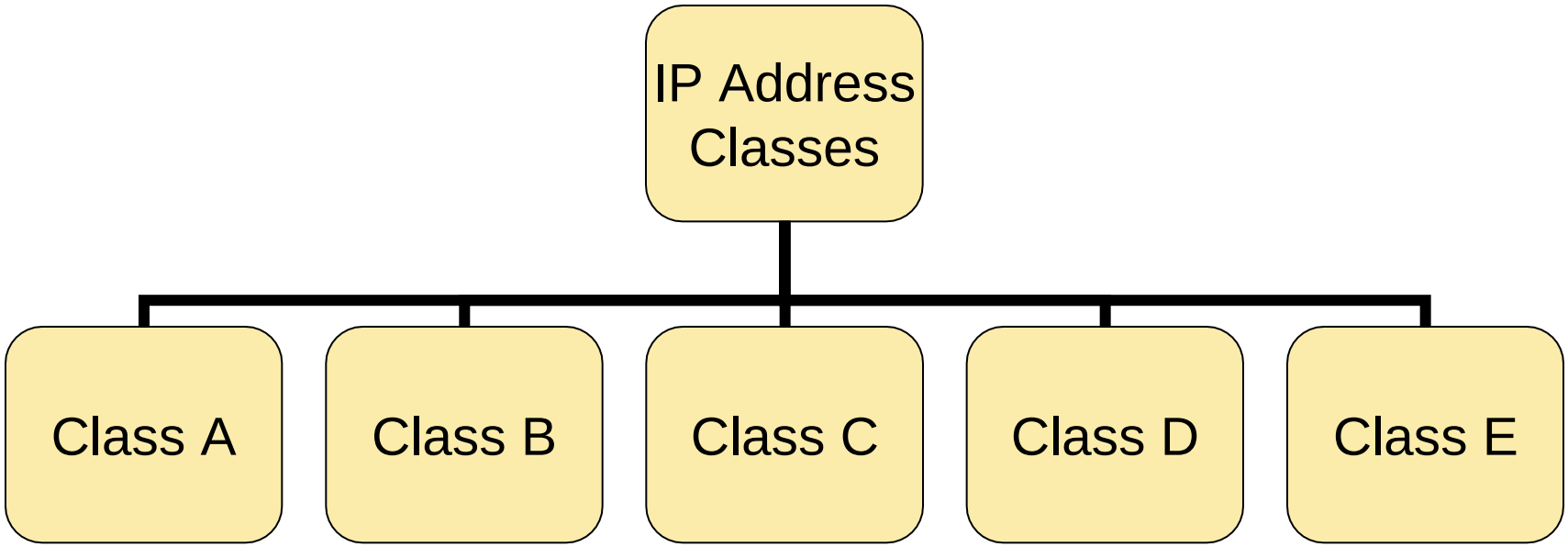
IP Address

- A Unique, 32-bit address used by computers to communicate over a computer network



Classes of Address

- IP address structure consists of two addresses, Network and Host
- IP address is divided into five classes

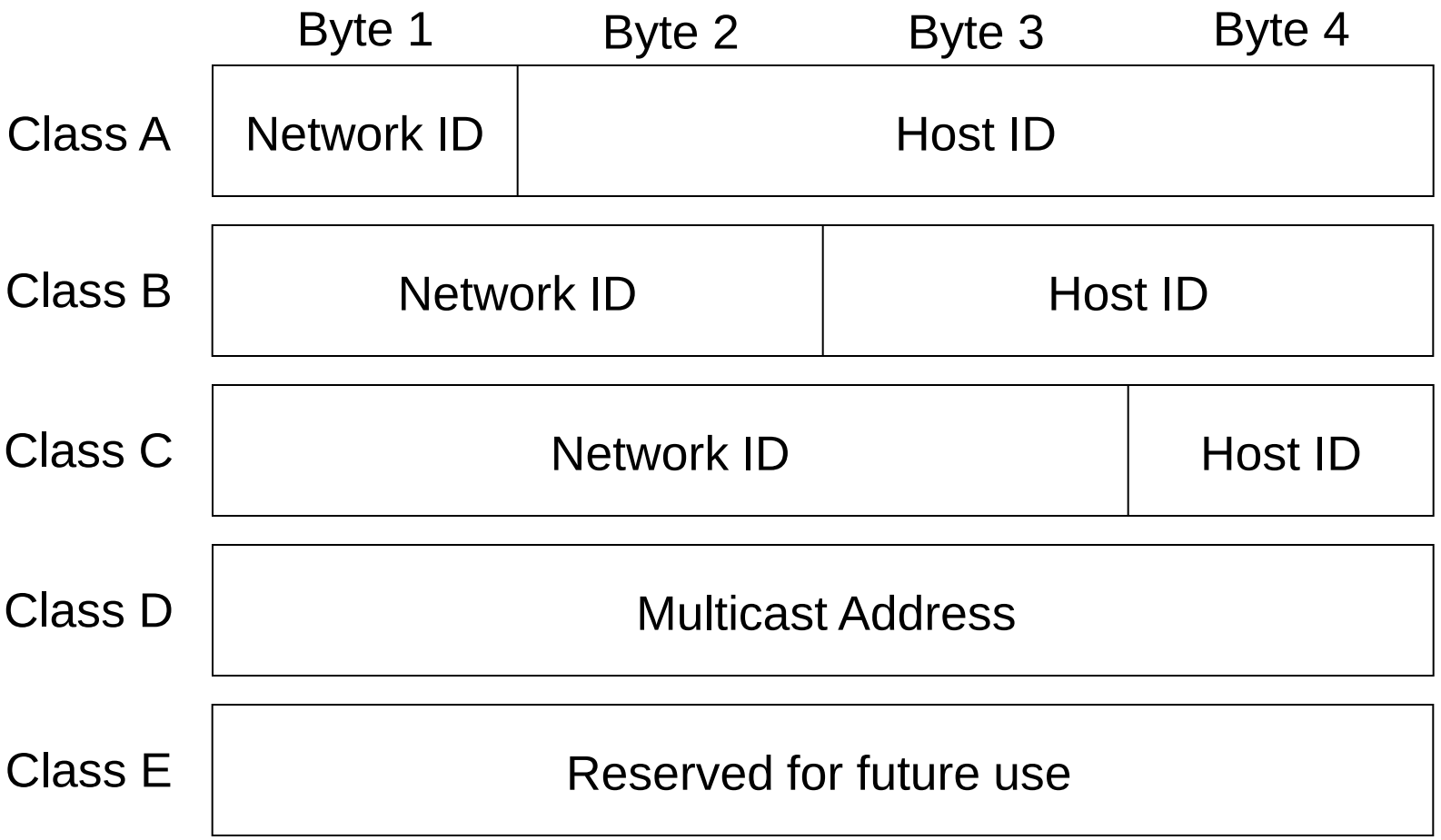


IP Address Classes

- The 5 IP classes are split up based on the value in the 1st octet:

IP Address Class Assignments	
Class	*First Octet Value*
Class A	0 ~ 127
Class B	128 ~ 191
Class C	192 ~ 223
Class D	224 ~ 239
Class E	240 ~ 255

IP Address Classes *(Cont.)*



IP Addresses Classes *(Cont.)*

Characteristics of the IP Address Classes						
Class	Address Range	Identify Bits (binary value)	Bits in Network ID	Number of Networks	Bits in Host ID	Number of Hosts/ Network
A	0 ~ 127	1 (0)	7	126	24	16,777,214
B	128~191	2 (10)	14	16,382	16	5,534
C	192~223	3 (110)	21	2,097,150	8	254

Examples of IP Address

- 14.23.120.8 - The first byte of the address represents 14 which lies between 0 and 127, hence Class A address.
- 134.11.78.56 - The first byte of address is 134 which lies between 128 and 191 hence the address belongs to Class B.
- 193.14.56.22 - As first byte is 193 which is between 192 and 223, hence the address belongs to Class C.

Special Addresses *(Cont.)*

- A list of these addresses for each IP address class:

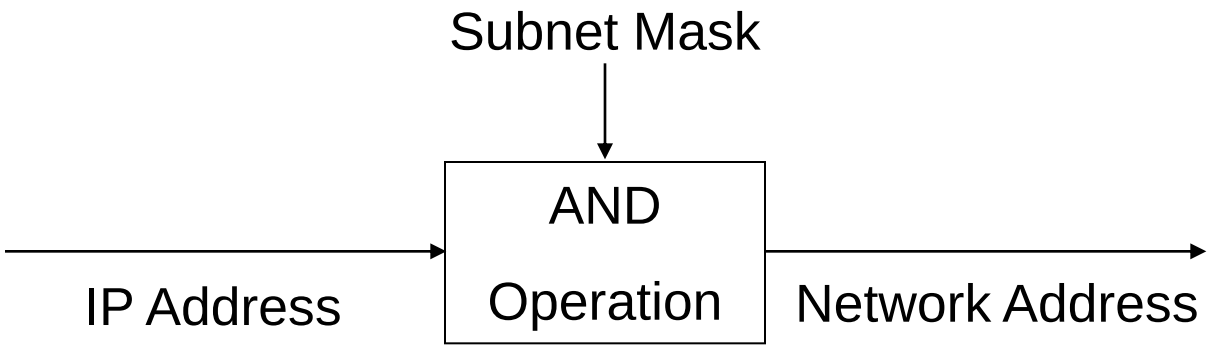
Special Local Network Addresses	
IP Class	**Address Range**
Class A	10.0.0.0 ~ 10.255.255.255
Class B	172.16.0.0 ~ 172.31.255.255
Class C	192.168.0.0 ~ 192.168.255.255

Subnet Mask

- An IP address has 2 parts:
  - The Network identification.
  - The Host identification.
- Frequently, the Network & Host portions of the address need to be separately extracted.
- In most cases, if you know the address class, it's easy to separate the 2 portions.

Subnet Mask

- Specifies part of IP address used to identify a subnetwork.
- Subnet mask when logically ANDed with IP address provides 32-bit network address



Default Mask

- Has predetermined number of 1s
- Class A, B and C contains 1s in network ID fields for default subnet mask

Address Class	Default Mask (in Binary)
Class A	11111111.00000000.00000000.00000000
Class B	11111111.11111111.00000000.00000000
Class C	11111111.11111111.11111111.00000000

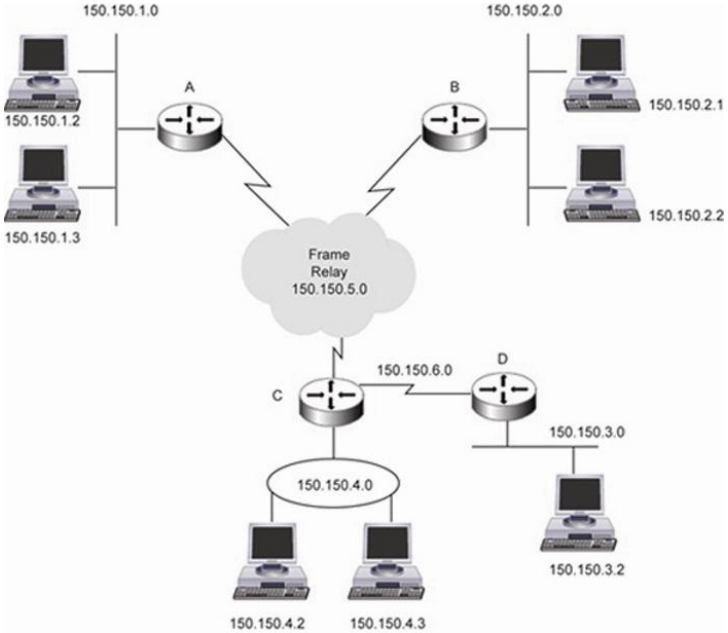
Default Standard Subnet Masks

- There are default standard subnet masks for Class A, B and C addresses:

Default Subnet Masks	
Address Class	*Subnet Mask*
Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

IP Subnetting

- Allows you to divide a network into smaller sub-networks
- Each subnet has its own sub-network address
- Subnet can be created within Class A, B, or C based networks



Subnetting

- Division of a network into subnets
  - For example, division of a Class B address into several Class C addresses
- Some of the host IDs are used for creating subnet IDs

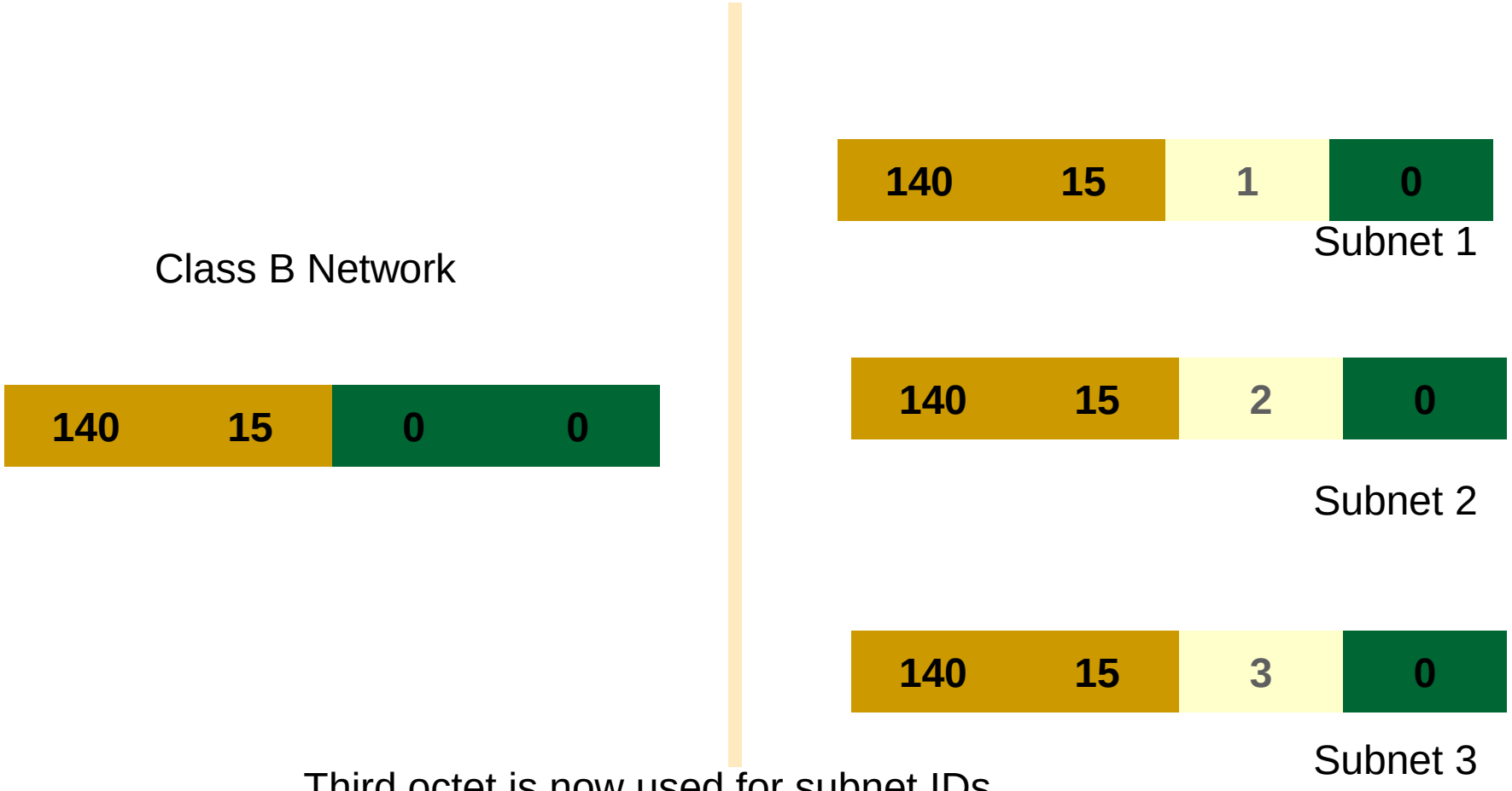
Need for Subnetting

- Classes A and B have a large number of hosts corresponding to each network ID
- It may be desirable to subdivide the hosts in Class C subnets
- Often, there is a limitation on the number of hosts that could be hosted on a single network segment
  - The limitation may be imposed by concerns related to the management of hardware
- Smaller broadcast domains are more efficient and easy to manage

Subnetting Principle

- Use parts of the host IDs for subnetting purpose
- A subnet mask is used to facilitate the flow of traffic between the different subnets and the outside network (hops)
  - A hop is the distance a data packet travels form one node to the other

Using Host IDs to Subnet



Knowing How to Calculate Subnets

- To determine the number of subnets & hosts per subnet available for any of the available subnet masks, 2 simple formulas to calculate these numbers:
- Number of Subnets=(2^n)
- Number of Host per Subnets=(2^{h-2})

Knowing How to Calculate Subnets *(Cont.)*

- Although the 2 formulas look identical, the key is to remember the number you're trying to calculate, hosts or subnets.
- Eg., suppose you are asked to determine the number of subnets available & the number of hosts available on each subnet on the network 192.168.1.0 ➔

Knowing How to Calculate Subnets *(Cont.)*

- Using the subnet & hosts formulas, the answers are easily calculated. Of course, you must know your powers of 2 to calculate the answers.

Subnetting – Example

- **Host IP Address**: 138.101.114.250
- **Network Mask**: 255.255.0.0 (or /16)
- **Subnet Mask**: 255.255.255.192 (or /26)

Given the following Host IP Address, Network Mask and Subnet mask find the following information:

- Major Network Information
  - Major Network Address
  - Major Network Broadcast Address
  - Range of Hosts if not subnetted
- Subnet Information
  - Subnet Address
  - Range of Host Addresses (first host and last host)
  - Broadcast Address
- Other Subnet Information
  - Total number of subnets
  - Number of hosts per subnet

Major Network Information

- **Host IP Address**: 138.101.114.250
- **Network Mask**: 255.255.0.0
- **Subnet Mask**: 255.255.255.192

- **Major Network Address**: 138.101.0.0
- **Major Network Broadcast Address**: 138.101.255.255
- **Range of Hosts if not Subnetted**: 138.101.0.1 to 138.101.255.254

Step 1: Convert to Binary

128	64	32	16	8	4	2	1

	138.	**101.**	**114.**	**250**
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
	255.	**255.**	**255.**	**192**

Step 1:

Translate Host IP Address and Subnet Mask into binary notation

Step 2: Find the Subnet Address

	138.	101.	114.	250
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
Network	10001010	01100101	01110010	11000000
	138	**101**	**114**	**192**

Step 2:

Determine the Network (or Subnet) where this Host address lives:

1. Draw a line under the mask
2. Perform a bit-wise AND operation on the IP Address and the Subnet Mask

   Note: 1 AND 1 results in a 1, 0 AND anything results in a 0
3. Express the result in Dotted Decimal Notation
4. The result is the **Subnet Address** of this Subnet or "Wire" which is 138.101.114.192

Step 2: Find the Subnet Address

	138.	101.	114.	250
IP Address	10001010	01100101	01110010	11111010
Mask	11111111	11111111	11111111	11000000
Network	10001010	01100101	01110010	11000000
	138	**101**	**114**	**192**

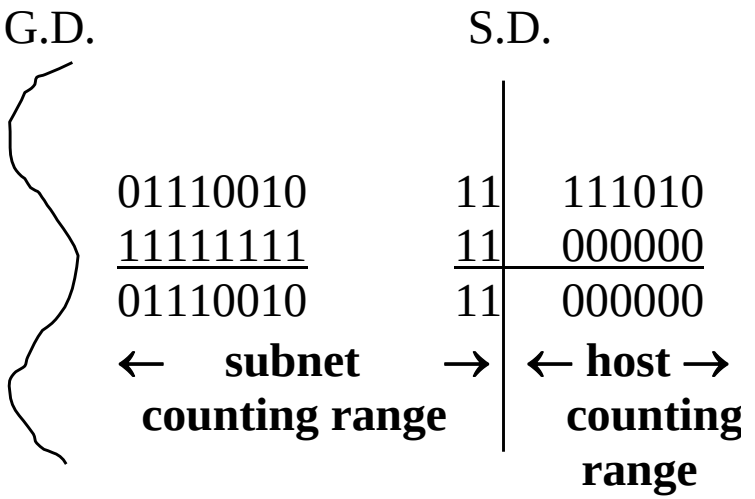
Step 2:

Determine the Network (or Subnet) where this Host address lives:

Quick method:

1. Find the last (right-most) 1 bit in the subnet mask.
2. Copy all of the bits in the IP address to the Network Address
3. Add 0's for the rest of the bits in the Network Address

Step 3: Subnet Range / Host Range

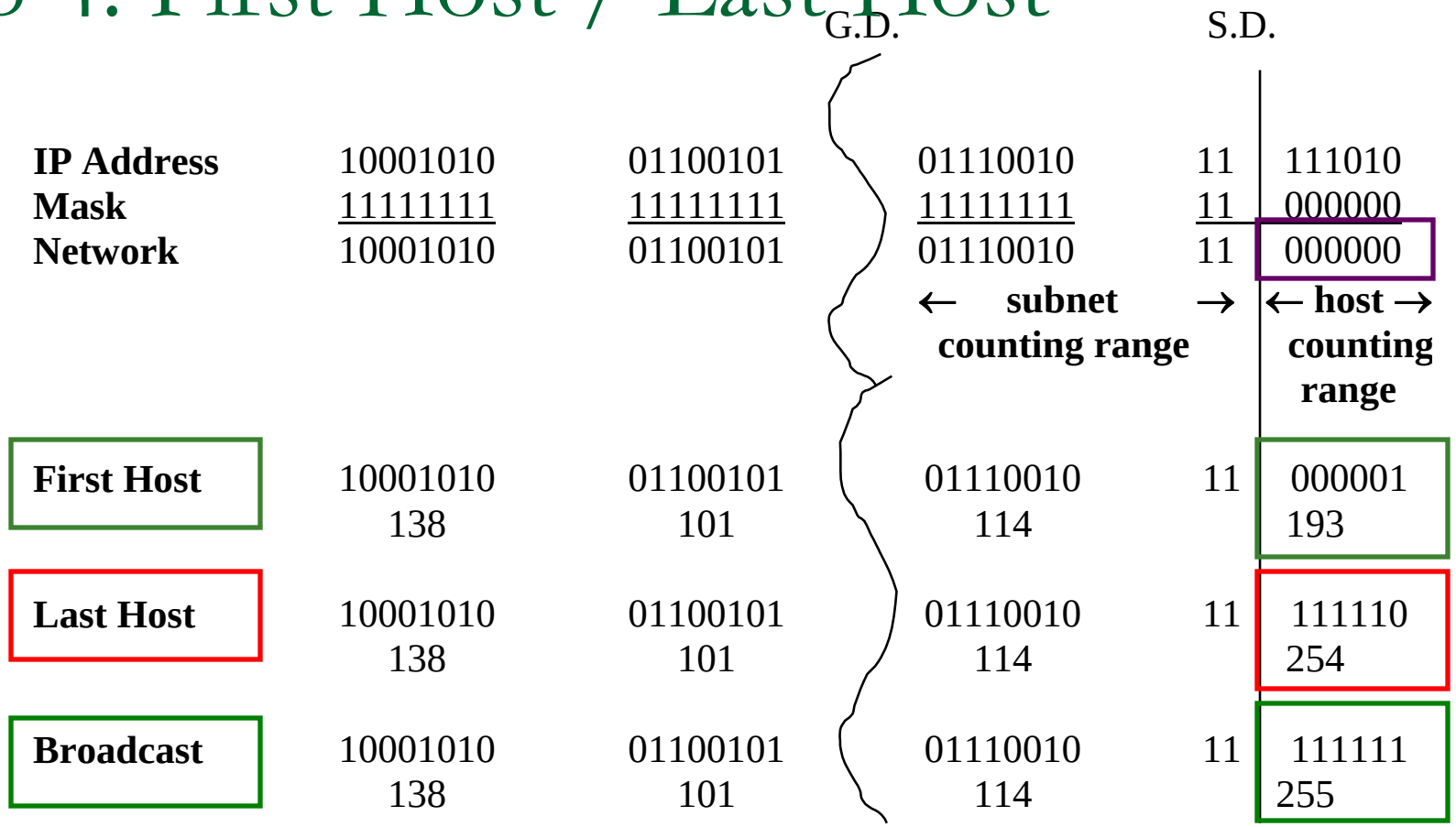


Step 3:

Determine which bits in the address contain Network (subnet) information and which contain Host information:

- Use the **Network Mask**: 255.255.0.0 and divide (**Great Divide**) the from the rest of the address.
- Use **Subnet Mask**: 255.255.255.192 and divide (**Small Divide**) the subnet from the hosts between the last “1” and the first “0” in the subnet mask.

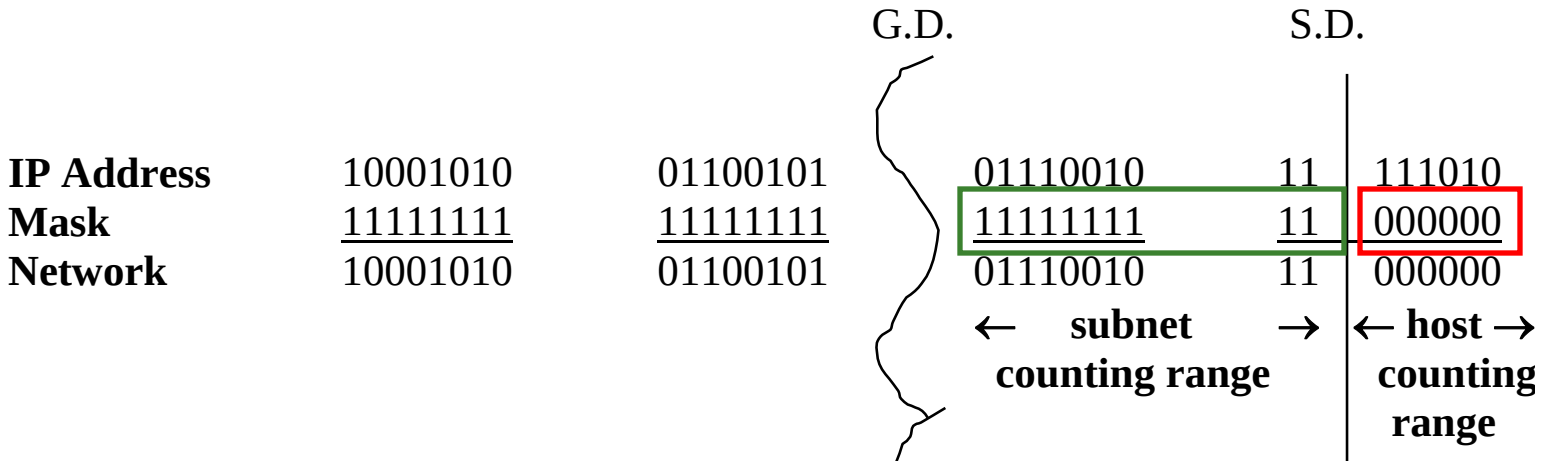
Step 4: First Host / Last Host



Host Portion

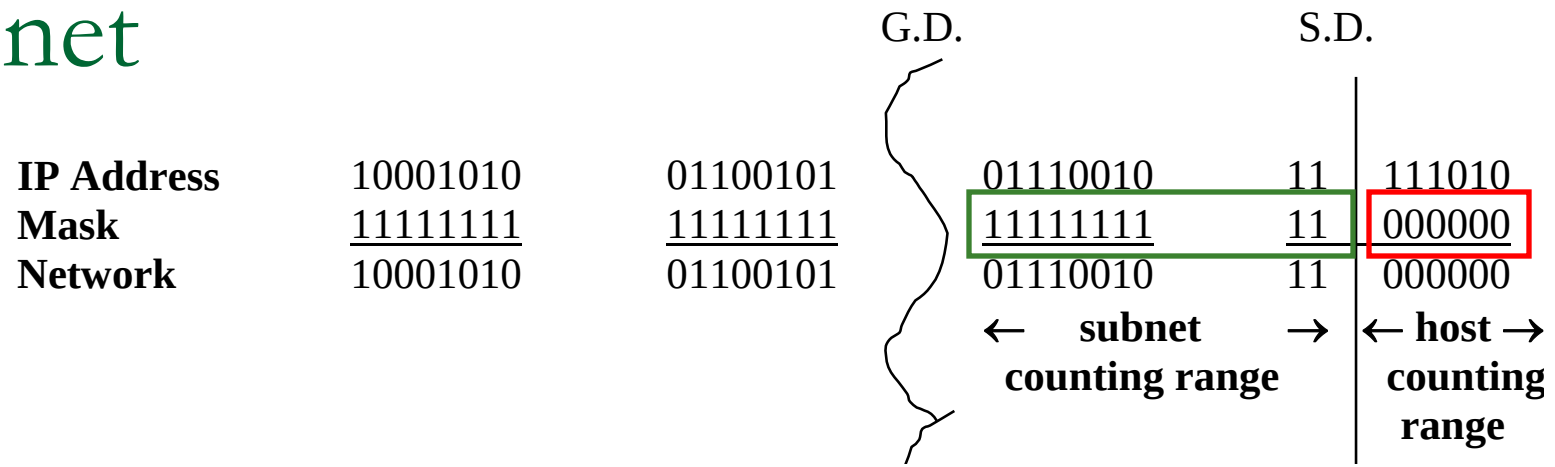
- **Subnet Address:** all 0's
- **First Host**: all 0's and a 1
- **Last Host**: all 1's and a 0
- **Broadcast**: all 1's

Step 5: Total Number of Subnets



- Total number of subnets
  - Number of subnet bits 10
  - $2^{10} = 1,024$
  - 1,024 total subnets
    - Subtract one "**if**" all-zeros subnet cannot be used
    - Subtract one "**if**" all-ones subnet cannot be used

Step 6: Total Number of Hosts per Subnet



- Total number of hosts per subnet
  - Number of host bits 6
  - $2^6 = 64$
  - 64 host per subnets
    - Subtract one for the subnet address
    - Subtract one for the broadcast address
  - 62 hosts per subnet

Summary

- An IP address defines unique address of a device over a network
- An IP address is a 32 Byte address and is divided into various classes namely Class A, Class B, Class C, Class D and Class E
- In Classless addressing, network address field can extend further to Host Id field
- Subnetting allows one to create multiple logical networks within a single Class A, B, or C address based network
- A subnet mask is a 32-bit IP address, when bit-wise ANDed with given IP address provides with the address required to identify a subnet