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Assignment Title 2: (i) Understand and document IP addressing and subnetting such that you should be able to create Subnets in natural masks, subnet mask, CIDR range, count usable and total hosts in a IP address range.

#INTRODUCTION

In computer networking, IP addressing and subnetting are essential for designing scalable and efficient networks. Subnetting enables network segmentation by dividing large IP address blocks into smaller, manageable sub-networks. This report outlines how to interpret IP addresses using classful addressing, natural masks, CIDR notation, and subnet masks. It also explains how to calculate total and usable hosts in each subnet.

#OBJECTIVE

- Understand IP address structure (IPv4 focus).
- Create subnets using natural masks, subnet masks, and CIDR.
- Calculate the total number of subnets and hosts.
- Determine usable host IP addresses within each subnet.
- Interpret and apply CIDR ranges.

#Scope

- IPv4 addressing and subnetting.
- Classful addressing and subnetting.
- CIDR (Classless Inter-Domain Routing).
- Host calculation in subnets.

#THEORY & CONCEPTS

IP Address Structure

- IPv4 Address: 32 bits long, divided into 4 octets.
    - Example: 192.168.1.1
- Binary representation: 11000000.10101000.00000001.00000001

Classful Addressing and Natural Masks

Class	Starting Octet	Default Subnet Mask	CIDR	Default Host Range
A	1 - 126	255.0.0.0	/8	16,777,214 hosts
B	128 - 191	255.255.0.0	/16	65,534 hosts
C	192 - 223	255.255.255.0	/24	254 hosts

- Classful Addressing divides the IP address space into fixed classes (A, B, C).
- Natural mask is the default subnet mask based on the class.

CIDR Notation

CIDR (Classless Inter-Domain Routing) replaces classful boundaries, allowing for flexible subnetting.
Format: IP_address/CIDR_prefix
Example: 192.168.1.0/26

- CIDR /26 means 26 bits are for network, and 6 bits are for host.

Subnetting

Key Formulae:

- Total Hosts = 2^{number of host bits}
- Usable Hosts = Total - 2 (Network & Broadcast)
- Block Size = 256 - subnet mask octet
- Number of Subnets = 2^{borrowed bits}

#Practical Subnetting Examples

Example 1: Subnet 192.168.1.0/24 into 4 subnets

Step-by-Step:

- Original CIDR: /24 → 255.255.255.0
- 4 subnets → Need 2 bits ($2^2 = 4$)
- New CIDR: /26 → 255.255.255.192

Subnets:

Subnet	Network Address	Range	Broadcast Address	Usable Hosts
1	192.168.1.0/26	192.168.1.1 - 62	192.168.1.63	62
2	192.168.1.64/26	192.168.1.65 - 126	192.168.1.127	62
3	192.168.1.128/26	192.168.1.129 - 190	192.168.1.191	62
4	192.168.1.192/26	192.168.1.193 - 254	192.168.1.255	62

- Total Hosts/Subnet = $2^6 = 64$
- Usable Hosts/Subnet = 64 - 2 = 62

Example 2: Determine subnet mask and host count for /20

- CIDR /20 → 32 - 20 = 12 host bits
- Total hosts = $2^{12} = 4096$

- Usable hosts = $4096 - 2 = 4094$
- Subnet Mask: $255.255.240.0$

Example 3: Find the number of subnets in Class B network with /20

- Original mask for Class B = /16
- New mask = /20 → 4 borrowed bits
- Number of Subnets = $2^4 = 16$
- Hosts/Subnet = $2^{12} - 2 = 4094$

#Summary Table: Common CIDR to Subnet Info

CIDR	Subnet Mask	Host Bits	Total Hosts	Usable Hosts
/30	255.255.255.252	2	4	2
/29	255.255.255.248	3	8	6
/28	255.255.255.240	4	16	14
/27	255.255.255.224	5	32	30
/26	255.255.255.192	6	64	62
/24	255.255.255.0	8	256	254
/22	255.255.252.0	10	1024	1022

#CONCLUSION

This report covered detailed aspects of IP addressing and subnetting with IPv4. Subnetting enhances routing efficiency, security, and network scalability. Using CIDR, one can design custom networks that fit any organization's needs, ensuring optimal use of available IP space.