

Computer Networking

IP Addressing and Subnetting



Overview

- 1 IP Addressing and Subnetting
 - IP Addressing
 - Subnetting



IP Addresses

- Data sent over the **network** has two destination addresses.
- A **MAC address** is a unique identifier assigned to **NIC**.
- An **IP address** uniquely identifies a **device** on the **Internet**.
- **Routing** is the process of moving **packets** across the network.



IP Addresses

```
Select C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 10.0.19042.985]
(c) Microsoft Corporation. All rights reserved.

C:\Users\AMU LAB>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet 2:

    Connection-specific DNS Suffix  . : 
    Link-local IPv6 Address . . . . . : fe80::340a:b52a:9b30:ba7f%13
    IPv4 Address. . . . . : 192.168.5.63
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 192.168.5.1

C:\Users\AMU LAB>
```

IP Addresses

- Conversion from Dotted Decimal Format to Binary:

	128	64	32	16	8	4	2	1
192								

- 192.168.5.63 = 11000000 10101000 00000101 00111111

Subnet Masks

- A **subnet** mask tells us the network bits and the host bits that are in the IP address.
- A subnet mask can be expressed using **dotted decimal** 255.255.255.0 or /24 using **prefix notation**.
- More information about IP addresses and subnets can be accessed from Request For Comments - **RFC's**.



IP Address Classes

Class	Leading Bit Pattern	First Octet in Decimal
A	0XXXXXXXX	0 - 127
B	10XXXXXXX	128 - 191
C	110XXXXXX	192 - 223
D	1110XXXXX	224 - 239
E	1111XXXXX	240 - 255

Public IP Address¹ Classes

- Class A: 1 - 126
- Class B: 128 - 191
- Class C: 192 - 223



¹An address that is received from an ISP

Public IP Address Classes

- Non-assignable numbers to hosts:
 - 127: loopback testing
 - Class D: 224 - 239: multicasting
 - Class E: 240 - 255: future use and experimentation



Private Address Classes ²

- 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



²These addresses can communicate outside using either NAT or PAT

Network Masks

	Class A	Class B	Class C
1st Octet Range	1-126	128-191	192-223
Network Mask	255.0.0.0	255.255.0.0	255.255.255.0

Number of Subnets Formula

- Number of subnet bits, N
$$N = (\#^3 \text{ of bits in subnet mask}) - (\# \text{ of bits in network mask})$$
- Number of valid subnets = (2^N)



³# means number

Number of Hosts Formula

- Number of host bits, H
 $H = 32 - (\text{\# of ones in the subnet mask})$
- Number of valid hosts = $(2^H) - 2^4$



⁴Reasons for subtracting 2: The first address in the subnet is the subnet number itself and the last address in the subnet is the broadcast address for that subnet

Custom Subnet Masks

Problem 1

- Using the information below, determine the **address class**, **default subnet mask**, **custom subnet mask**, **total number of subnets**, **total number of host addresses**, **number of usable addresses**, and **number of bits borrowed**

Number of needed subnets	14
Number of needed usable hosts	14
Network Address	192.10.10.0

Problem 1

Solutions

Address Class	C
Default Subnet Mask	255.255.255.0
Custom Subnet Mask	255.255.255.240
Total Number of Subnets	16
Total Number of Host Addresses	16
Number of Usable Addresses	14
Number of Bits Borrowed	4

Custom Subnet Masks

Problem 2

- Using the information below, determine the **address class, default subnet mask, custom subnet mask, total number of subnets, total number of host addresses, number of usable addresses, and number of bits borrowed**

Number of needed subnets	60
Number of needed usable hosts	1000
Network Address	128.77.0.0



Problem 2

Solutions

Address Class	B
Default Subnet Mask	255.255.0.0
Custom Subnet Mask	255.255.252.0
Total Number of Subnets	64
Total Number of Host Addresses	1024
Number of Usable Addresses	1022
Number of Bits Borrowed	6

Subnetting

- **Subnetting** is the process of taking a block of IP addresses and dividing them down into smaller pieces.
- Subnetting can be explained using the metaphor of a **pie** (or pizza)
- Choices of sharing a pie; give the entire pie to one person or cut the pie into slices and share among the persons.



Subnetting



*20.0.0.0 /8 doesn't need
to be subnetted, since
only one network segment
exists.*

Subnetting



FLSM

Challenge 1

- Using the information below, determine **what is the 3rd subnet range?**, **what is the subnet broadcast address for the 3rd subnet?**, and **what are the assignable addresses for the 2nd subnet?**

Number of needed subnets	14
Number of needed usable hosts	14
Network Address	192.10.10.0

Challenge 1

Solutions

3rd Subnet Range	192.10.10.32 - 192.10.10.47
3rd Subnet Broadcast Address	192.10.10.47
2nd Subnet Assignable Addresses	192.10.10.17 - 192.10.10.30



FLSM

Challenge 2

- Using the information below, determine **what is the 3rd subnet range?**, **what is the subnet broadcast address for the 3rd subnet?**, and **what are the assignable addresses for the 2nd subnet?**

Number of needed subnets	1000
Number of needed usable hosts	60
Network Address	165.100.0.0

Challenge 2

Solutions

3rd Subnet Range	165.100.0.128 - 165.100.0.191
3rd Subnet Broadcast Address	165.100.0.191
2nd Subnet Assignable Addresses	165.100.0.65 - 165.100.0.126



Networking Addressing

- A network addressing (IP plan) table comprises of the following fields;
 - Subnet
 - Network Address
 - Range of Valid Hosts
 - Broadcast Address

VLSM

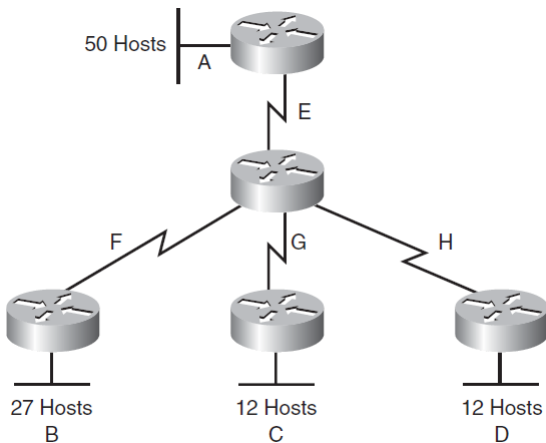


Figure: Use 192.168.100.0 /24

VLSM

Solution

Subnet	Network Address	Range of Valid Hosts	Broadcast Address
A	192.168.100.0 255.255.255.192	192.168.100.1 – 192.168.100.62	192.168.100.63
B	192.168.100.64 255.255.255.224	192.168.100.65 – 192.168.100.94	192.168.100.95
C	192.168.100.96 255.255.255.240	192.168.100.97 – 192.168.100.110	192.168.100.111
D	192.168.100.112 255.255.255.240	192.168.100.113 – 192.168.100.126	192.168.100.127
E	192.168.100.128 255.255.255.252	192.168.100.129 – 192.168.100.130	192.168.100.131
F	192.168.100.132 255.255.255.252	192.168.100.133 – 192.168.100.134	192.168.100.135
G	192.168.100.136 255.255.255.252	192.168.100.137 – 192.168.100.138	192.168.100.139
H	192.168.100.140 255.255.255.252	192.168.100.141 – 192.168.100.142	192.168.100.143

Questions? Comments? Discussion?

