Computer Hardware & Networking& Server Configurations (H7E3 04)

UNIT 05:
Network devices and protocols

Lecturer: Thilina Rajakaruna

BEng(SEng), SCQF Level 7(EQF 5)(SEng), SCQF Level 8(EQF 5)(SEng), PgDip(Edu)

Summary

The IPv4 octet can only have a value range of 0 - 255.

192.168.152.2 – Dotted Decimal Notation

11110111 10011100 01111110 11100001 – Binary Notation

Class A – 0.0.0.0 – 127.255.255.255	First Bit - 0
Class B – 128.0.0.0 – 191.255.255.255	First Two Bit - 10
Class C – 192.0.0.0 – 223.255.255.255	First Three Bit - 110
Class D – 224.0.0.0 – 239.255.255.255	First Four Bit - 1110
Class E – 240.0.0.0 – 255.255.255.255	First Five Bit - 11110

Divide IP addresses into classes.

100.220.255.244 - Class A

168.141.255.444 - Not Valid IP Addresses

192.141.255.244 - Class C

152.141.155.204 - Class B

161.141.250.204 - Class B

182.241.350.204 - Not Valid IP Addresses

250.241.150.200 – Class E

230.111.160.208 – Class D

Subnetting

- Networks continued to grow and connect to the Internet throughout the 1980s and into the 1990s, with many organizations adding hundreds, and even thousands, of hosts to their network. An organization with thousands of hosts should have been well served by a Class B network, however, there were some problems.

- First, organizations with thousands of hosts rarely had them all in one place. Some organizations wanted to separate individual departments from each other for security or management purposes. Second, a primary type of packet forwarded on a network is the broadcast packet. Broadcast packets are forwarded to all hosts within a single logical network. With thousands of hosts on a single network sending broadcast traffic, and limited bandwidth available, network performance significantly decreased as more hosts were added.

- To solve these problems, the organizations leading the development of the Internet chose to partition their networks into mini-networks, or sub networks, using a process called subnetting. How can a single IP network get split into multiple networks so that each subnet is treated as a separate network ?

- RFC 917, Internet Subnets, defines the subnet mask as the method routers use to isolate the network portion from an IP address. When a router receives a packet, it uses the destination IP address in the packet and the subnet masks associated with the routes in its routing table to determine the appropriate path on which to forward the packet.

- The router reads the subnet mask from left to right, bit for bit. If a bit in the subnet mask is set to 1, it indicates that the value in that position is part of the network ID. A 0 in the subnet mask indicates that the value in that position is part of the host ID.

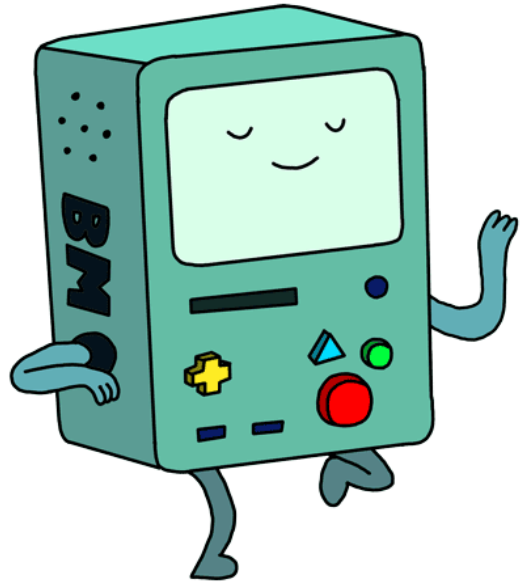
IP Address Classes					
Address Class	1st Octet Range (Decimal)	1st Octet Bits (Green Bits Don't Change)	Network (N) And Host (H) Parts Of Address	Default Subnet Mask (Decimal and Binary)	Notes and Host address Range
A	1 -127	00000000 – 01111111	N.H.H.H	255.0.0.0 11111111.00000000. .00000000.00000000	Commercial 1.0.0.1 – 126.255.255.254
B	128 – 191	10000000 – 10111111	N.N.H.H	255.255.0.0 11111111.11111111. 00000000. 00000000	Commercial 128.0.0.1 – 191.255.255.254
C	192 – 223	11000000 – 11011111	N.N.N.H	255.255.255.0 11111111.11111111. 11111111.00000000	Commercial 192.0.0.1 – 223.255.255.254
D	224 – 239	11100000 – 11101111	Not For Commercial Use As a Host		Multicast (Reserved) 224.0.0.1 – 239.255.255.254
E	240 - 255	11110000 -11111111	Not For Commercial Use As Host		Experimental (Reserved) 240.0.0.1 – 255.255.255.255

- Class A Address 127.0.0.0 is Reserved For Loopback Testing.

- All Zeros (0) and All Ones (1) are Invalid Hosts Addresses.

- In the original IP address hierarchy, there are two levels: a network and a host. In a classful addressing scheme, the first three leading bit values are used to determine that an IP address is either a Class A, B, or C. When an address is identified by class, the number of bits that make up the network ID and the number of bits that make up the host ID are known. The default subnet masks for the network classes are:

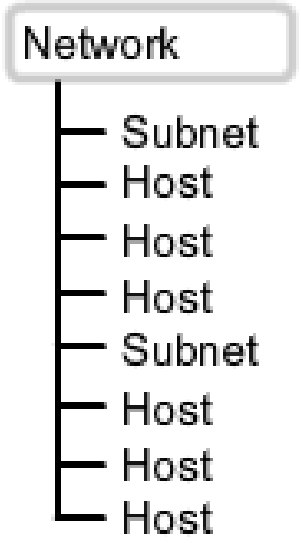
- Class A 255.0.0.0
- Class B 255.255.0.0
- Class C 255.255.255.0

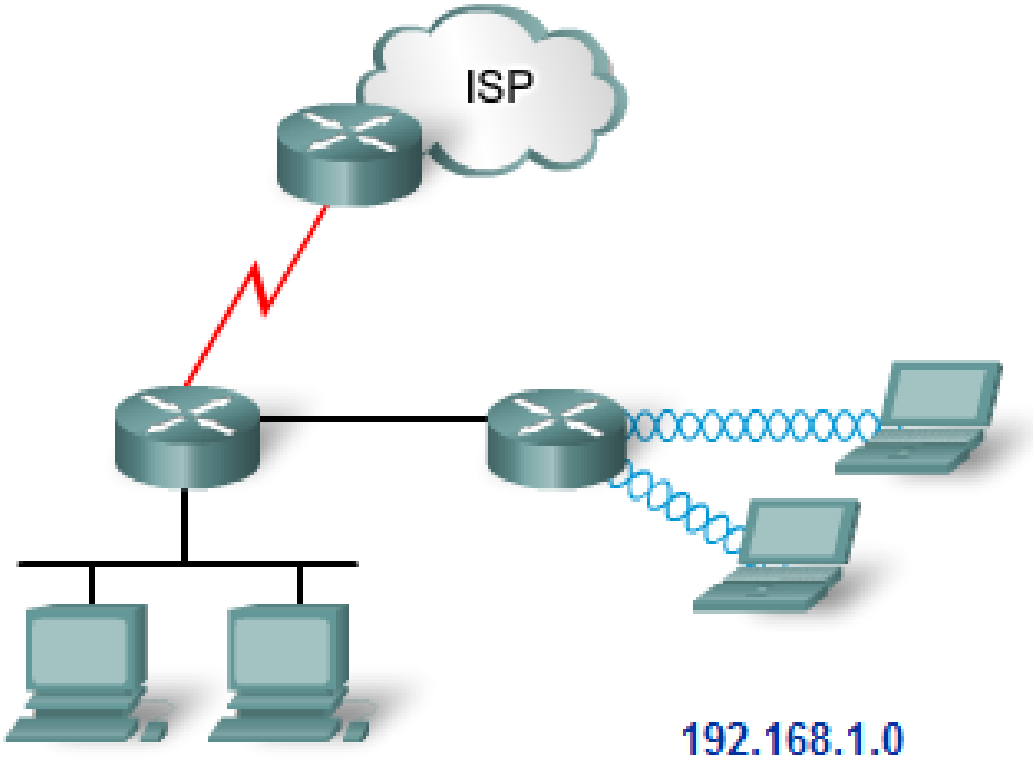


- Subdividing a classful network adds a level to the network hierarchy. Now there are three levels: a network, a sub network, and a host. How can the subnet mask be modified to indicate the new hierarchical level?

- A single Class A, B, or C network address space can be divided into multiple subnetworks by using bits from the host address space to designate the subnet ID. As an example, an organization using a Class C address space has two offices in different buildings. To make the network easier to manage, the network administrators want each location to have a logically separate network. Taking two bits from the host address increases the subnet mask length from the default 24 bits to 26 bits, or 255.255.255.192.

- When bits are borrowed from the host portion of the address to identify the subnet, fewer bits are available for individual hosts. If two bits are used for the subnet ID, only six bits are left in the host portion of the address.

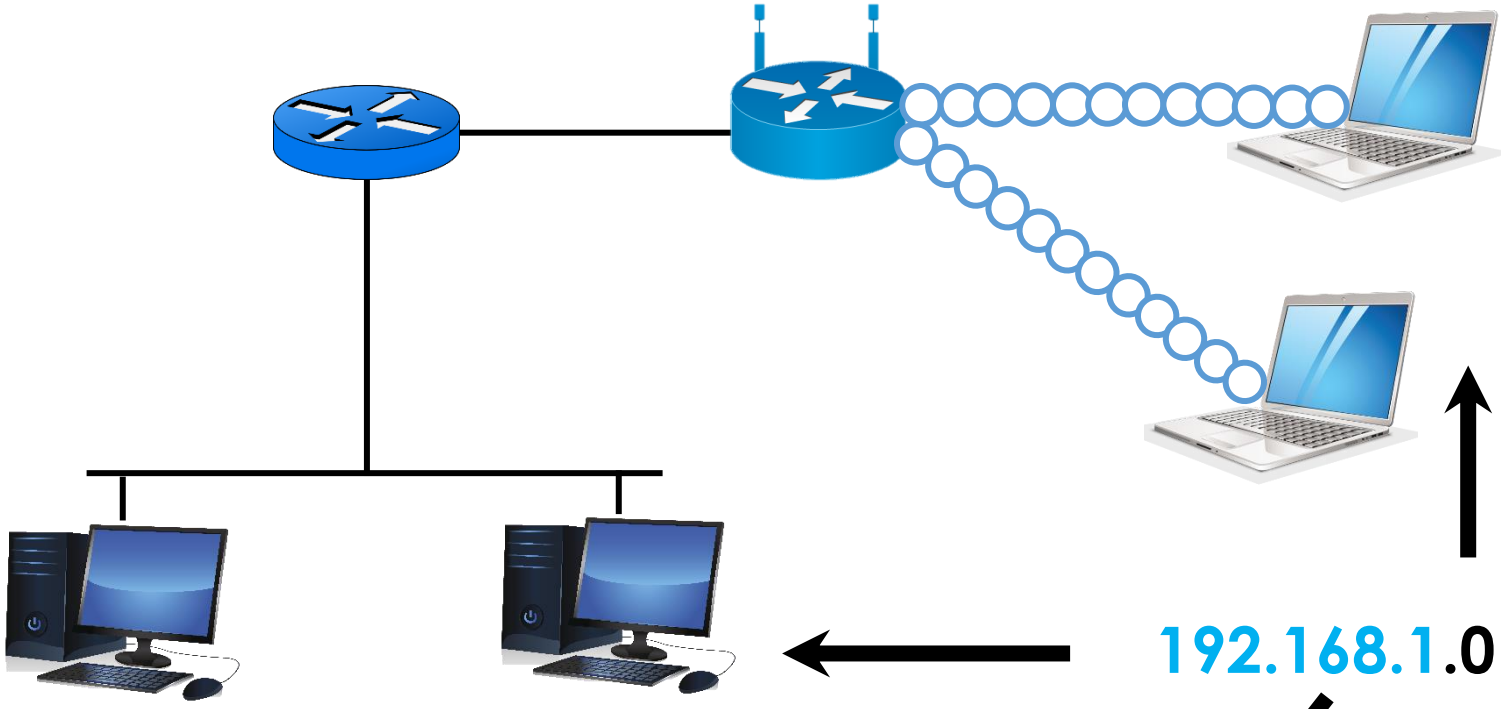




- With traditional classful subnetting, the same number of host bits is used to designate the subnet ID for all the resulting subnetworks. This type of subnetting always results in a fixed number of subnets and a fixed number of hosts per subnet. For this reason, this is known as fixed-length subnetting.

- The decision about how many host bits to use for the subnet ID is a big planning decision. There are two considerations when planning subnets: the number of hosts on each network, and the number of individual local networks needed. The table for the subnet possibilities for the 192.168.1.0 network shows how the selection of a number of bits for the subnet ID affects both the number of possible subnets and the number of hosts that can be in each subnet.

- One thing to keep in mind is that in all IPv4 networks, two host addresses are reserved: the all-0s and the all-1s. An address with all 0s in the host portion of the address is an invalid host address and usually refers to the entire network or subnetwork. An address with all 1s in the host portion is used as the local network broadcast address. When a network is subnetted, each subnet contains an all-0s and an all-1s host address that cannot be used for individual host addresses.



192.168.1.0

11000000 10101000 00000001 hhhhhhhh

- When a network is partitioned, the router must use a modified or custom subnet mask to distinguish the subnets from each other.

- A default subnet mask and a custom subnet mask differ from each other in that the default subnet masks only change on octet boundaries. For instance, the default subnet mask for a Class A network is 255.0.0.0. Custom subnet masks take bits from the host ID portion of the IP address and add them to the default subnet mask.

- To create a custom subnet mask, the first question to answer is how many bits to take from the host ID to add to the subnet mask? The number of bits to borrow to meet a specific number of subnets can be determined by the math equation: 2^n, where n equals the number of bits borrowed.

- If three subnets are required, there must be enough subnet bits to allow for three unique subnet addresses.

- For example, if starting with a Class C address, such as 192.168.1.0, there are only eight host bits to borrow from. Each bit can only be a 1 or a 0. To allow for three subnets, at least two of the eight bits must be borrowed. This creates four subnets total:

- **00 - 1st subnet**
- **01 - 2nd subnet**
- **10 - 3rd subnet**
- **11 - 4th subnet**

- In the above example, two bits were borrowed, $2^2 = 4$ or $2 \times 2 = 4$, so four subnets were created. If between five and eight subnets were needed, then three bits would be required ($2^3 = 8 \; or \; 2 \times 2 \times 2$).

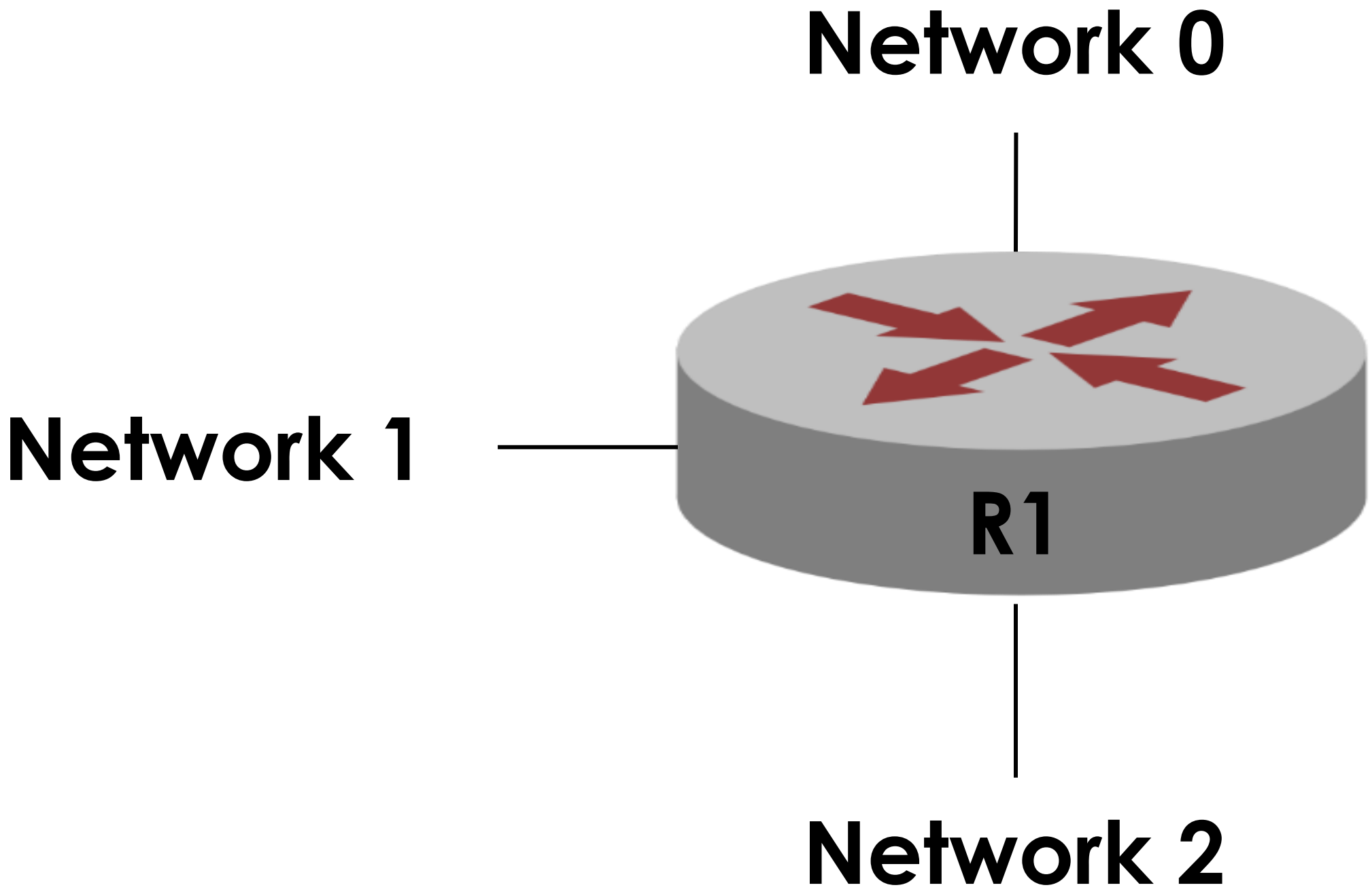
- The number of bits selected for the subnet ID affects both the number of possible subnets and the number of hosts that can be in each subnet

- With classed subnetting, the number of bits required for the subnet ID depends on two factors: the number of subnets created and the number of hosts per subnet.

- In classed, or fixed-length, subnetting, all subnets must be the same size, which means that the maximum number of hosts that each subnet can support is the same for all subnets created. The more bits that are taken for the subnet ID, the fewer bits left for host IDs.

- The same base equation, $\boldsymbol{2^n}$, with a slight modification, can be used to determine the number of host IDs available based on the number of host bits remaining. Because each subnet has two host addresses that are reserved, the all-0s and all-1s addresses, the equation to determine the number of hosts supported is modified to $\boldsymbol{2^n - 2}$.

- After it is determined how many bits make up the subnet address, all devices on the network are informed of the subdivision by the subnet mask. With the subnet mask, it is possible to tell which subnet an IP address is in and to design simple classful subnet IP address schemes.

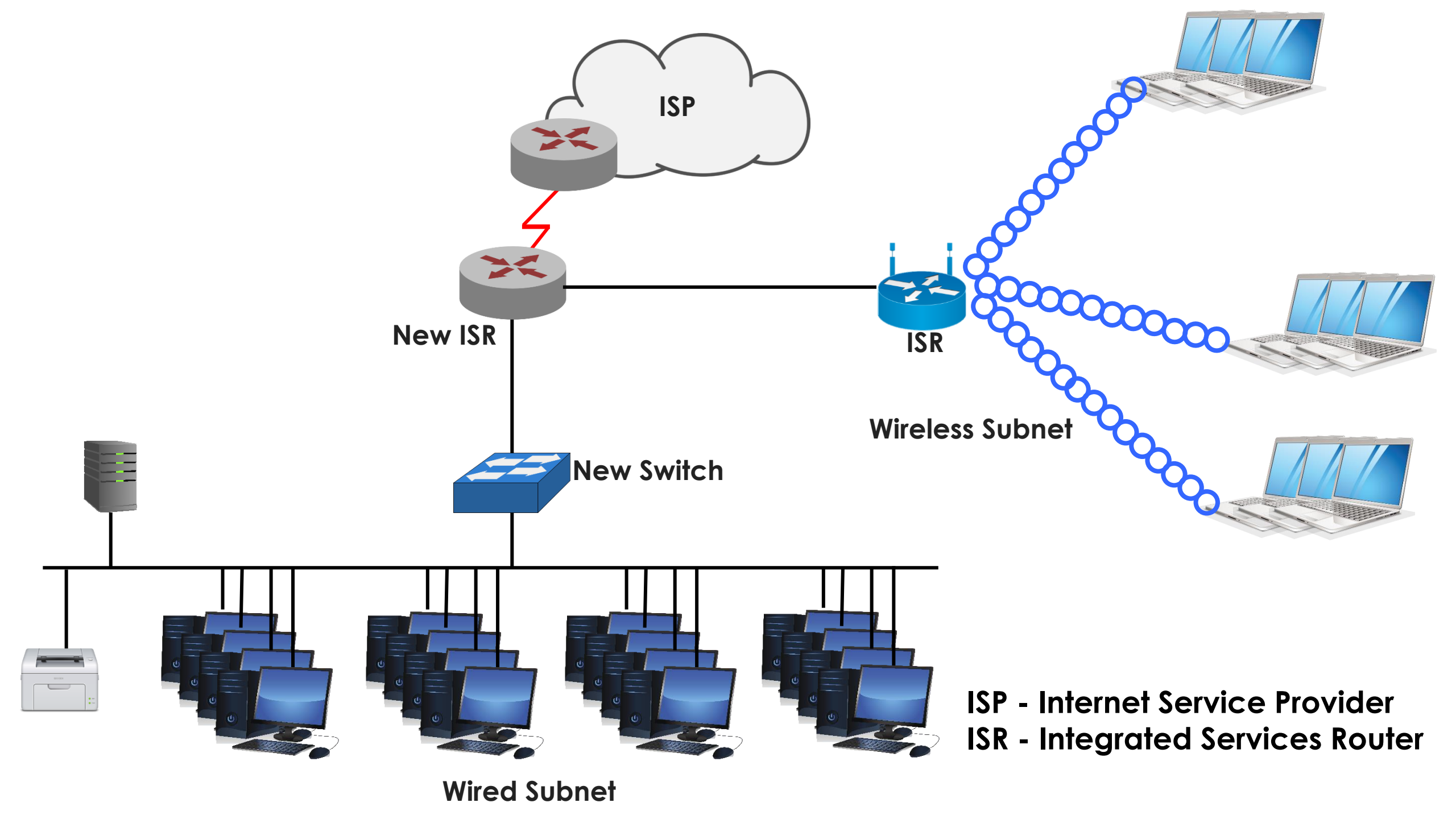

Network 0
Network 1
R1
Network 2

- Subnetting solved a number of problems that existed with the original classed network address spaces. It permitted organizations that owned a class A, B, or C address to subdivide their address space into smaller local subnets to more efficiently assign addresses. However, subnetting is also important in helping to minimize traffic loads and for adding security measures between networks.

- An example of a situation that might require subnetting is an ISP customer that has outgrown its initial network installation. In this network, the original small, integrated wireless router is overloaded with traffic from both wired and wireless users. Because of its relatively small size, a Class C address space is used to address the network.

- One possible solution to the problem of the overloaded network is to add a second networking device, such as a larger integrated service router (ISR). When adding a device, it is a good practice to place the wired and wireless users on separate local subnetworks to increase security. The original wireless router can still be used to provide the wireless users with connectivity and security on one network. Hubs or switches connecting the wired users can then be directly connected to the new ISR using a different network. The ISR and the wireless router can then be directly connected with a third network.

- This new network configuration requires that the existing Class C network be divided into at least three subnetworks. Using classful subnetting, at least two bits must be taken from the host portion of the address to meet the customer requirements. This subnetting scheme results in the creation of four individual networks, each with 62 available host addresses (64 possible addresses, minus the all-0s and all-1s addresses).


ISP
New ISR
ISR
Wireless Subnet
New Switch
Wired Subnet
ISP - Internet Service Provider
ISR - Integrated Services Router

Contact Me ...

Email : thilina.jiat@gmail.com

THANK YOU