Computer Networks - Lab 11

OBJECTIVES

After these Lab students shall be able to

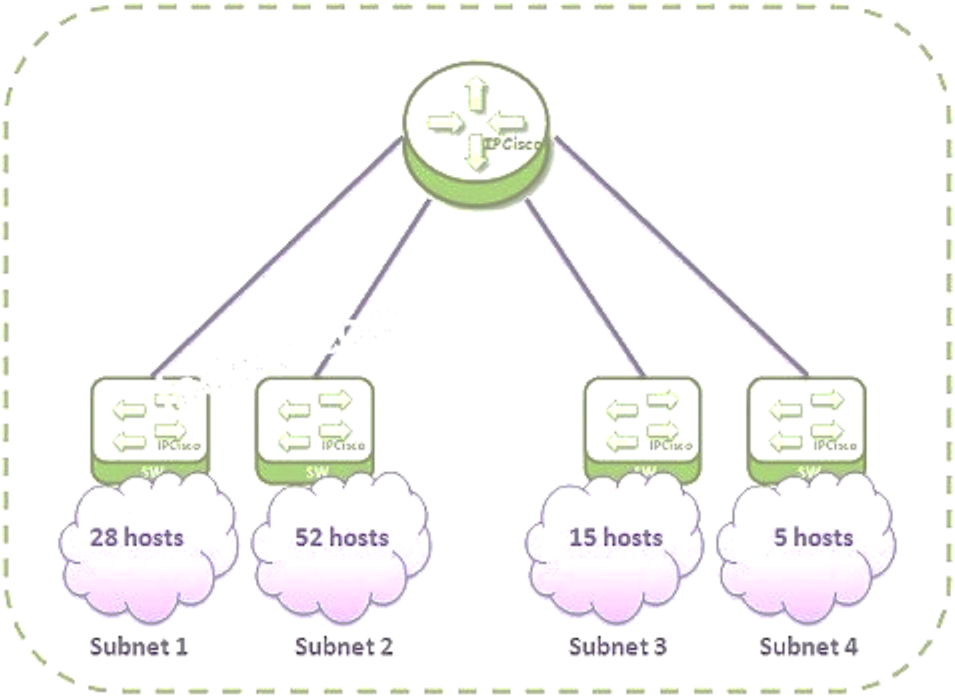
- **Understand IP Subnetting**
  - **CIDR versus VLSM**
  - **Special Subnets**
- **Subnetting Examples**
- **VLSM Example**
- **Practical Implementation Subnetting in Cisco Packet Tracer**

PRE-LAB READING ASSIGNMENT

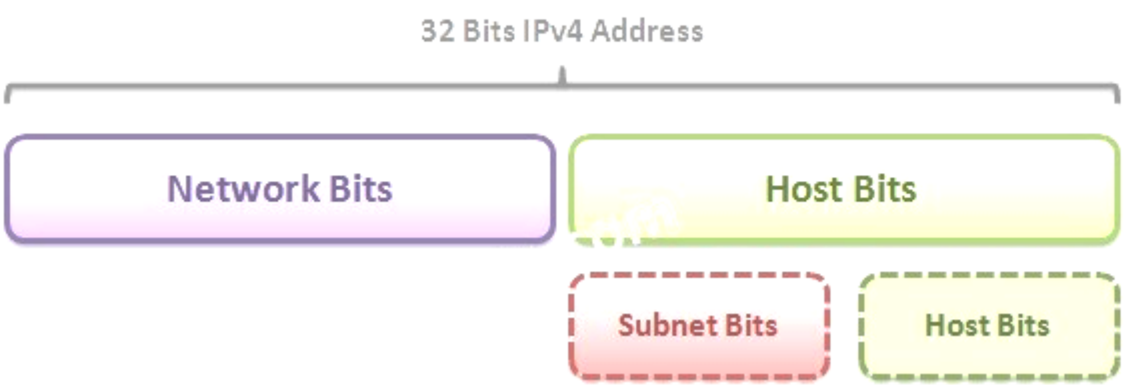
Remember the delivered lecture carefully.

Table of Contents

IP Subnetting



As we talked about before, there are two parts in an **IP Address**. One for them is Network part and the another is Host part. With **IP Subnetting**, we are adding one more part. This is **"Subnet Part"**. From the Host part, we borrow some bits and we will use this part for Subnet. In this lesson, we will learn Subnetting with **Subnetting Examples**.



As a basic defining, **Subnetting** is dividing the network into smaller network groups and by doing this, using the **IP Address** Block more efficient.

For Subnetting, **Subnet Masks** are used. Subnets masks are 32 bit addresses like IP Addresses. Subnet Masks are used with IP Addresses. The 1s represents the network parts, and 0s represents the host parts.

We can show Subnet Masks with four octets like **IP addresses** (255.255.255.0) or we can show it like /X . Here, for the 255.255.255.0 Subnet Mask, we can use /24. This means that the first 24 bit is full of 1s and it is network part.

CIDR versus VLSM

In Subnetting, there are two important terms. These are :

- CIDR (Classless Inter Domain Routing)
- VLSM (Variable Length Subnet Mask)

CIDR (Classless Inter Domain Routing) is the term that is used for using IP addresses independent from their traditional IP Classes. In other words, CIDR is using IP addresses without classes.

VLSM (Variable Length Subnet Mask) is the term that is used for using different Subnet Mask for different sub networks. In another words, it is the mechanism that allows different Subnet Masks and provide division of a network into sub networks. It is like Subnet of subnets.

CIDR is used on the addresses that will advertise to the internet. So, it is used in the Internet Service Provider part. **VLSM** is used in a company or in smaller networks to use IP address spaces ideally.

Subnetting is one of the important lessons of Networking.

Special Subnets

In Subnetting some Subnet Masks are used specifically sometimes. These are /24, /30, /31/ and /32.

- /24 **is the Subnet Mask that is usually used in the local networks by default.**
- /32 **is the Subnet Mask used generally on Loopback and System interfaces.**
- /31 **is the Subnet Mask used on point-to-point links.**
- /30 **is also widely used in Service Provider Networks for point-to-point connections.**

Loopback Interface is the "**virtual**" interfaces. There can be many Loopback interfaces in a Router. Loopback Interfaces are used for its "always up and never physically down" characteristics generally. We give these Loopback Interfaces a /32 **Loopback IP address**.

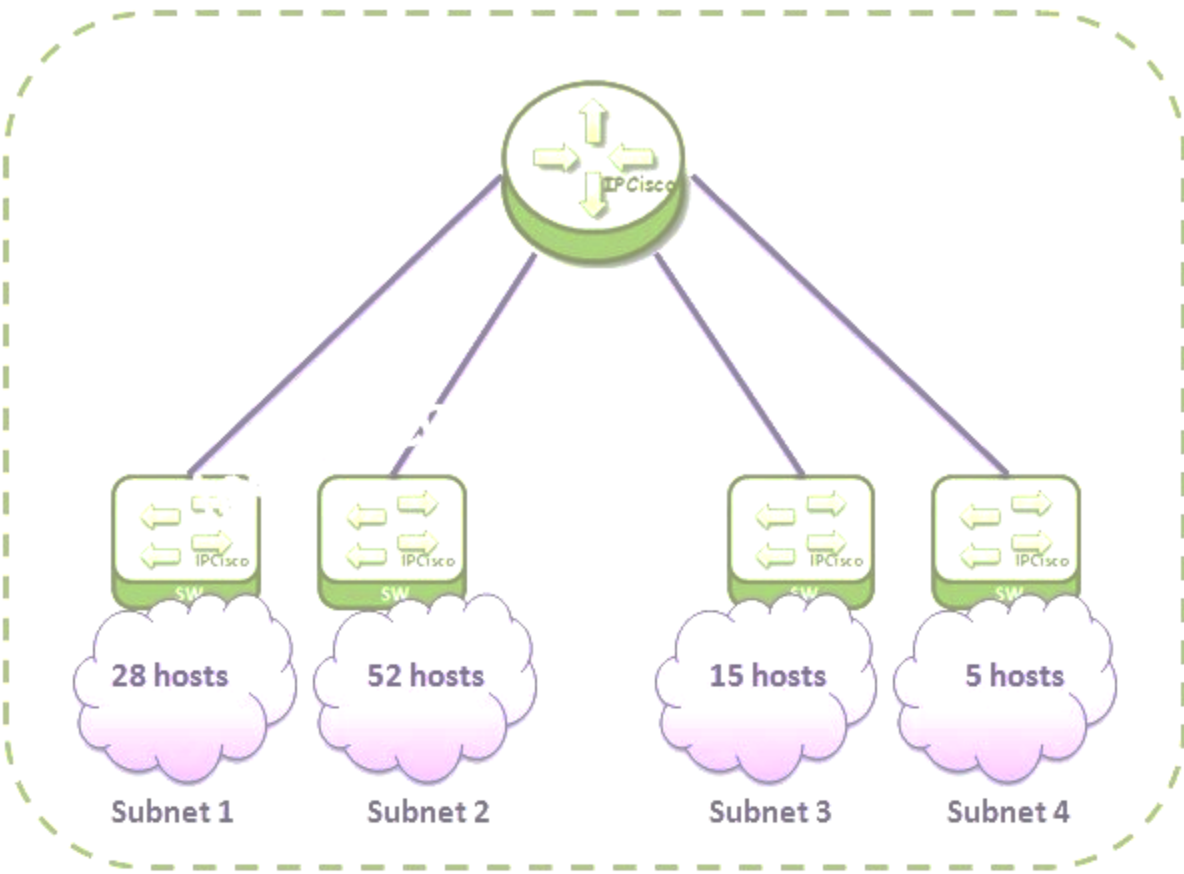
There is also a **System Address** that is used on Alcatel-Lucent Service Routers. This is a specific loopback address that provide to reach the router's itself. This address is very important for ALU routers. It is used in many protocol configurations. System addresses are /32 **IP addresses**.

Now, let's practice what we have learned with **Subnetting Examples**.

Subnetting Example

In the last of these **Subnetting Examples**, we will see our network's needs and according to these needs, we will determine our IP Address Prefixes.

We will use the below topology. And we have given **192.168.1.0/24** IP Address.



As you can see, in this topology, there are four subnets and each subnets host address need is also given.

Subnet 1 = 28 hosts
Subnet 2 = 52 hosts
Subnet 3 = 15 host
Subnet 4 = 5 hosts

To overcome this Subnetting issue, firstly we determine the host bits for each subnet.

For the first subnet; we need 5 host bits. With 5 bits we can have 2^5=32 addresses. This means that there are 32-2 usable host addresses.

For the second subnet; we need 6 host bits. With 6 bits we can have 2^6=64 addresses. This means that there are 64-2 usable host addresses.

For the third subnet; we need 5 host bits. With 5 bits we can have 2^5=32 addresses. You can think that we can use 2^4=16 address. But we cannot. Because, one of the address is used for broadcast address and the other is for network address. This means that there are 14 usable addresses.

For the fourth subnet; we need 3 host bits. With 3 bits we can have 2^3=8 addresses. This means that there are 8-2 usable host addresses.

Now let’s pick it up.

For first subnet, our Subnet Mask will be /27 (27 network bits and 5 host bits. 5+27=32)
For second subnet, our Subnet Mask will be /26 (26 network bits and 6 host bits. 6+26=32)
For third subnet, our Subnet Mask will be /27 (27 network bits and 5 host bits. 5+27=32)
For fourth subnet, our Subnet Mask will be /29 (29 network bits and 3 host bits. 3+29=32)

Here, the router interfaces will also need **IP address**. So, for each subnet, one IP address will be go to the Router interface.

Remember, we have given an IP address 192.168.1.0/24. Let's divide this Prefix according to the above values.

Let's begin with the biggest network. If we use /26 with 192.168.1.0 like 192.168.1.0/26, then we will have 4 subnets. The given Subnet was 24 and our new subnet is 26. 26-24=2 and 2^2=4 subnets.

192.168.1.0/26
192.168.1.64/26
192.168.1.128/26
192.168.1.192/26

We will use the first one for the Subnet 2. (192.168.1.0/26)

Now, for the first and third subnet, let's use the second block (192.168.1.64/26) and divide it again. If we divide it by borrowing a bit again, then we will have two subnets.

192.168.1.64/27
192.168.1.96/27

We can use these two Prefixes for first and second subnet.

And lastly, for the small subnet, we can use the above third block(192.168.10.128/26). We will divide it again. Because we need only 5 host address.

When we divide again, we will have the below small subnets, and we can use the first one for our fourth and last Subnet.

192.168.1.128/29
192.168.1.136/29
192.168.1.144/29
192.168.1.152/29
192.168.1.160/29
192.168.1.168/29
192.168.1.176/29
192.168.1.184/29

As you can see, with this Subnetting, we have used our IP Block very efficiently. The unused remaining blocks can be used in the future. What are these remaining blocks let's remember. The remaining blocks are the last block of **/26 subnets** and the last 7 block of **/29 subnets**.

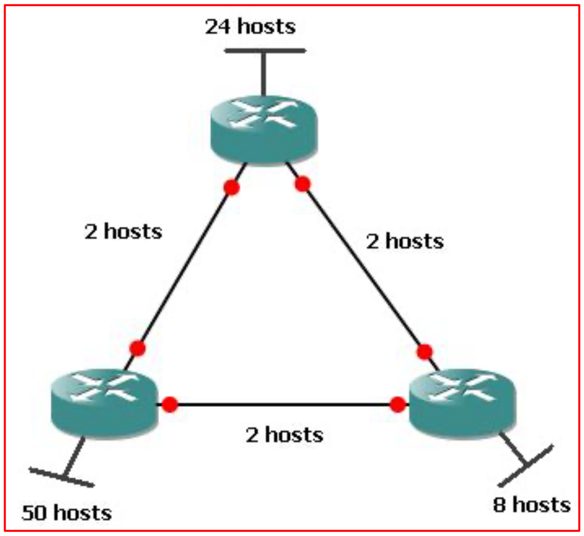
At the end our subnets will be like below:

```
192.168.1.0/26
192.168.1.64/27
192.168.1.96/27
192.168.1.128/29
```

This is **VLSM (Variable Length Subnet Mask)**. Its meaning is using subnet of subnets or dividing a network into smaller network with using different subnet masks.

VLSM example with five networks

Available subnet – 192.168.2.0/24



We have biggest subnet of 50 hosts

2x2x2x2x2x2 = 64 -2 = 62 hosts in a subnet

11111111.11111111.11111111.11000000

Subnet Mask for 50 hosts subnet is 255.255.255.192

Sunbet range - 192.168.2.0 - 192.168.2.63

Remaining IP range - 192.168.2.64 - 192.168.2.255

Next biggest subnet has 24 hosts

2x2x2x2x2 = 32 -2 = 30 hosts in a subnet

11111111.11111111.11111111.11100000

Subnet Mask for 24 hosts subnet is 255.255.255.224

Sunbet range - 192.168.2.64 - 192.168.2.95

Remaining IP Range - 192.168.2.96 - 192.168.2.255

Next biggest subnet has 8 hosts

2x2x2x2 = 16 -2 = 14 hosts in a subnet

11111111.11111111.11111111.11110000

Subnet Mask for 24 hosts subnet is 255.255.255.240

Sunbet range - 192.168.2.96 - 192.168.2.111

Remaining IP Range - 192.168.2.112 - 192.168.2.255

Next three subnets has 2 hosts each

2x2 = 4 -2 = 2 hosts in a subnet

11111111.11111111.11111111.111111 00

Subnet Mask for 2 hosts subnet is 255.255.255.252

Sunbet range - 192.168.2.112 - 192.168.2.115

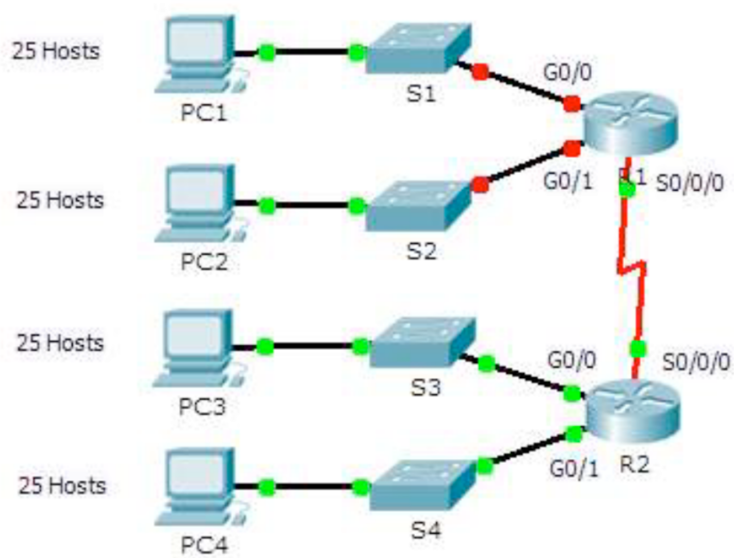
192.168.2.116 - 192.168.2.119

192.168.2.120 - 192.168.2.123

We still have remaining ip range from 192.168.2.124 - 192.168.2.255

Lab Tasks:

Topology A:



Objectives

Part 1: Design an IP Addressing Scheme

Part 2: Assign IP Addresses to Network Devices and Verify Connectivity

Scenario

In this activity, you are given the network address of 192.168.100.0/24 to subnet and provide the IP addressing for the Packet Tracer network. Each LAN in the network requires at least 25 addresses for end devices, the switch and the router. The connection between R1 to R2 will require an IP address for each end of the link.

Instructions

- Design an IP Addressing Scheme
- Subnet the 192.168.100.0/24 network into the appropriate number of subnets.

Questions:

1. Based on the topology, how many subnets are needed?
2. How many bits must be borrowed to support the number of subnets in the topology?
3. How many subnets does this create?
4. How many usable hosts does this create per subnet?

Note: If your answer is less than the 25 hosts required, then you borrowed too many bits.

5. Calculate the binary value for the first five subnets. The first two subnets have been done for you.

Subnet	Network Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	192.168.100.	0	0	0	0	0	0	0	0
1	192.168.100.	0	0	1	0	0	0	0	0
2	192.168.100.								
3	192.168.100.								
4	192.168.100.								

6. Calculate the binary and decimal value of the new subnet mask.

First Octet	Second Octet	Third Octet	Mask Bit 7	Mask Bit 6	Mask Bit 5	Mask Bit 4	Mask Bit 3	Mask Bit 2	Mask Bit 1	Mask Bit 0
11111111	11111111	11111111								

First Octet	Second Octet	Third Octet	Mask Bit 7	Mask Bit 6	Mask Bit 5	Mask Bit 4	Mask Bit 3	Mask Bit 2	Mask Bit 1	Mask Bit 0
First Decimal Octet	**Second Decimal Octet**	**Third Decimal Octet**	**Fourth Decimal Octet**							
255.	255.	255.								

7. Fill in the **Subnet Table**, listing the decimal value of all available subnets, the first and last usable host address, and the broadcast address. Repeat until all addresses are listed.

   Note: You may not need to use all rows.

Subnet Table

Subnet Number	Subnet Address	First Usable Host Address	Last Usable Host Address	Broadcast Address
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Step 2: Assign the subnets to the network shown in the topology.

a) Assign Subnet 0 to the LAN connected to the GigabitEthernet 0/0 interface of R1:

b) Assign Subnet 1 to the LAN connected to the GigabitEthernet 0/1 interface of R1:

c) Assign Subnet 2 to the LAN connected to the GigabitEthernet 0/0 interface of R2:

d) Assign Subnet 3 to the LAN connected to the GigabitEthernet 0/1 interface of R2:

e) Assign Subnet 4 to the WAN link between R1 to R2:

Step 3: Document the addressing scheme.

Fill in the **Addressing Table** using the following guidelines:

- Assign the first usable IP addresses in each subnet to R1 for the two LAN links and the WAN link.
- Assign the first usable IP addresses in each subnet to R2 for the LAN links. Assign the last usable IP address for the WAN link.
- Assign the second usable IP address in the attached subnets to the switches.
- Assign the last usable IP addresses to the PCs in each subnet.

Device	Interface	IP Address	Subnet Mask	Default Gateway
R1	G0/0			
	G0/1			
	S0/0/0			
R2	G0/0			
	G0/1			
	S0/0/0			
S1	VLAN 1			
S2	VLAN 1			
S3	VLAN 1			
S4	VLAN 1			
PC1	NIC			
PC2	NIC			
PC3	NIC			
PC4	NIC			

Part 2: Implement given topology in Packet Tracer and Assign IP Addresses to Network Devices and Verify Connectivity.

Topology B:

Implement Task 4 (Lab 10) in Packet Tracer and Assign IP Addresses to Network Devices and Verify Connectivity.