CSE 4512 [Computer Networks Lab]

Lab # 02

1. Objectives:

- Understand the working principle of a network simulator (Cisco Packet Tracer)
- Understand the packet tracer environment
- Learn about HTTP packets
- Learn about the OSI models and TCP/IP
- Understand the basics of IP Subnetting
- Learn to subnet a network following the given specifications

2. Introduction:

In this lab (meaning the whole semester), you'll be working on simulating different real-life networks and understand the networking concepts introduced in the theory course. Over the course of completing each lab, you will get to know how various protocols and mechanisms work and also you'll have an idea on how to operate an industry-standard network simulator. A network simulator is basically a software that allows users to create and analyze computer networks. One can create different network topologies and understand how various components of a network interact with each other. These are used in both academia and industry to understand system behavior without requiring any physical network component.

In all of the labs, you'll be working with a specific network simulator called **Cisco Packet Tracer**. There are also other network simulators like GNS3, NS2 etc. But we've selected Cisco Packet tracer for its large adoption across the industry and widely available documentation. We believe, by being acquainted and well-versed with this network simulator, students will acquire fundamental knowledge of modern network components and as a bonus, will have easier time acing the different Network Professional (CCNA, CCNP etc.) certifications that require working with Cisco Packet Tracer.

Some quick points about the labs:

- Skim the whole pdf before starting the tasks.
- Concepts and tasks introduced in each lab will be needed for completing next labs. So make sure you fully understand each lab and don’t skip any lab.
- Do not copy and paste from your fellow classmates. You may discuss with them but the tasks must be done by yourself and the corresponding lab report must be your own production. You might take help from online resources but Do Not Copy and Paste. In case of online resource, please give a reference. It doesn't cost any to acknowledge someone's work.
- In case of any problem or query, feel free to ask/contact the instructors.

3. Theory:

In this lab, you'll be implementing basic switch and router configuration in cisco packet tracer. So, before anything, lets first understand what a router and a switch is.

Switch:

A switch operates in the data-link layer and is responsible for connecting different devices in a *single network*. As with any data-link layer device, a switch sends and receives data in *frames*. In general, switches use *MAC addresses* for forwarding data and these are restricted to wired connections only.

Router:

Router operates in the network layer and connects *different networks* together to form inter-networks. Routers unit of data is a *packet* and *IP addresses* are used to forward data packets. Unlike switches, routers can work with both wired and wireless connections.

Figure 1: Router and switch in real-life (leftmost two) and inside Cisco Packet Tracer (rightmost two)

IP

Subnetting:

In the early days of networking, organizations could only use one network from the class A, B or C address space that were allocated to them. This resulted in a huge wastage of address space and newer demands for IP address could not be met properly. To overcome this problem, IP subnetting concept was introduced which enables splitting already existing larger networks into smaller networks. Use of subnetting freed up unnecessary allocation of IPv4 addresses and also made network management easier. Now, let's see how this subnetting actually works in practice. You know a IPv4 address consists of two portions: a Network part and a Host part. A class A address will have 8 bits for its network portion and rest 24 bits for its host portion. What we do in subnetting is we take some bits from the host portion and designate them as subnetwork portion and the rest of the bits are used for host addressing. Then the number of bits in the subnetwork portion (raised to the power of 2) will define the number of possible subnets. A bit-mask known as subnet mask is used to differentiate between the subnetwork and host portion. A subnet mask is a 32-bit mask which contains 1's in its most significant bits equal to the number of bits in the network+subnetwork portion of an address. The remaining bits in the subnet mask are zero. Put in another way, the number of 0's in a subnet mask is equal to the number of hosts in each subnet. A concrete example of IP subnetting is given below. Let's consider the network with IP address 172.16.0.0. This is a class B IP address and we know for a class B address, first 16 bits are the Network portion and rest 16 bits are host portion. Now, let's say, we want to have 2 subnets out of this bigger network. We'll then take 1 bit (as 2^1=2) from 16 bits host portion. Then host portion will have 15 bits

in total which means each subnet will have (2^15)-2 = 32,768-2 = 32,766 hosts. And the subnet mask will be 255.255.128.0.

172.16.0.0 - 10101100 00010000 00000000 00000000 ⇦ Network Address

255.255.128.0 - 11111111 11111111 10000000 00000000 ⇦ Subnet Mask

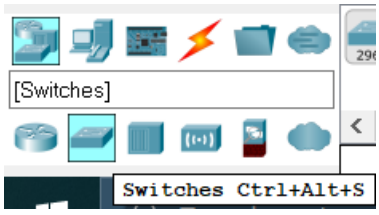
Note that, a different notation known as CIDR (Classless Inter-Domain Routing) notation is also used to specify a subnet mask. This is basically the number of bits in network portion (including the subnetwork portion) of an IP address and is written with a / in front of it. So, for our running example, it would be written as 172.16.0.0/17 as there are 17 bits in network portion. For remainder portion of this lab handout, we will use this CIDR notation. So, continuing on the above example, the two subnets will be 172.16.0.0/17 (subnet A) and 172.16.128.0/17 (subnet B). Each subnet will now function as an independent network. So, at the cost of reducing total number of hosts in a network, we've added another level of network to ease management and reduce IP address wastage. In a similar way, a bigger network can be subnetted to meet the number of host requirement. Now, that we've an understanding of how IP subnetting works, we are ready to understand VLSM (Variable Length Subnet Mask) addressing scheme which is a special form subnetting.

Now that you've got an idea about switch and router, let's get your hands dirty.

4. Basic Switch Configuration:

Now you'll configure a switch inside the cisco packet tracer. Note that all the commands used below will only work in case of cisco devices. One important point while working in packet tracer is that it supports *tab completion*, meaning if you press tab key after typing only some initial letters of a command then it will be auto completed. Also if you just type in a portion of a command it will work as long as the portion you typed is not ambiguous. For example, the command *configure terminal* will also work if you just type *conf t*.

I. Select a switch in the left-most pane of the packet tracer window under Network Devices category and drag it into the workspace. Remember that you can see the name of a component by just hovering over it.



II. If you hover over the switch you will see a list of interfaces, their status (up/down), MAC address etc. This info will come in handy while setting up the network.


```
Port              Link   VLAN   IP Address         MAC Address
FastEthernet0/1   Down   1      --                 0050.0F05.5201
FastEthernet0/2   Down   1      --                 0050.0F05.5202
FastEthernet0/3   Down   1      --                 0050.0F05.5203
FastEthernet0/4   Down   1      --                 0050.0F05.5204
FastEthernet0/5   Down   1      --                 0050.0F05.5205
FastEthernet0/6   Down   1      --                 0050.0F05.5206
FastEthernet0/7   Down   1      --                 0050.0F05.5207
FastEthernet0/8   Down   1      --                 0050.0F05.5208
FastEthernet0/9   Down   1      --                 0050.0F05.5209
FastEthernet0/10  Down   1      --                 0050.0F05.520A
FastEthernet0/11  Down   1      --                 0050.0F05.520B
FastEthernet0/12  Down   1      --                 0050.0F05.520C
FastEthernet0/13  Down   1      --                 0050.0F05.520D
FastEthernet0/14  Down   1      --                 0050.0F05.520E
FastEthernet0/15  Down   1      --                 0050.0F05.520F
FastEthernet0/16  Down   1      --                 0050.0F05.5210
FastEthernet0/17  Down   1      --                 0050.0F05.5211
FastEthernet0/18  Down   1      --                 0050.0F05.5212
FastEthernet0/19  Down   1      --                 0050.0F05.5213
FastEthernet0/20  Down   1      --                 0050.0F05.5214
FastEthernet0/21  Down   1      --                 0050.0F05.5215
FastEthernet0/22  Down   1      --                 0050.0F05.5216
FastEthernet0/23  Down   1      --                 0050.0F05.5217
FastEthernet0/24  Down   1      --                 0050.0F05.5218
GigabitEthernet0/1 Down  1      --                 0050.0F05.5219
GigabitEthernet0/2 Down  1      --                 0050.0F05.521A
Vlan1             Down   1      <not set>          0001.C9D0.ADE1
Hostname: Switch

Physical Location: Intercity, Home City, Corporate Office, Main Wiring Closet
```

III. Now, select the switch in the workspace and you'll see 4 different tabs namely *Physical*, *Config*, *CLI* and *Attributes*. For the most part of our work, you'll be working with the CLI tab. you can write different commands here and those will be executed directly on the switch.

IV. Intially the CLI prompt will be like following:

```
Switch>
```

V. For configuring the switch, you need to enter *privileged mode* by typing the following:

```
Router> enable
Router#
```

You'll notice that the > symbol after `Router` is changed to # to indicate privileged mode.

VI. All the commands needed to setup a cisco device are stored in configuration files. There are mainly two of these: *startup-config* and *running-config*. running-config is stored in device's RAM and is lost whenever the device is switched off. startup-config is stored in NVRAM or non-volatile ram and all configuration changes are saved even if the device loses power. So, whenever you are done with configuration changes, you need to save it to startup-config so that when the device boots later the changes are retained. To view the configs, type in the following:

```
Switch# show running-config
Switch# show startup-config
```

Note that, at the very first, there won't be any startup-config. Only a basic running-config will be available.

VII. Now, enter into Global Configuration Mode. This mode allows users to modify the running-config.

```
Switch# configure terminal
Switch(config)#
```

VIII. Give the switch a *hostname*.

```
Switch(config)# hostname IUT
IUT(config)#
```

Note that, the commands in cisco are not case-sensitive, meaning you could also use *HOSTNAME* instead of *hostname*.

IX. You're at the end of basic switch configuration. As mentioned in step VI, to make all the changes you did till now persistent, the running-config has to be saved in startup-config. This is done by the following command:

```
IUT# copy running-config startup-config
```

X. Now you can view the running-config as well as startup-config by entering commands in step VI.

XI. Some interface related commands:

```
IUT# show interface
IUT# show ip interface brief
IUT# show interface <interface name>
IUT# show interface status
```

5. Basic Router Configuration:

I. Select a router from the left-most pane as before the switch.

II. Hover over the router to view information about various interfaces and their status.

III –

Port	Link	VLAN	IP Address	IPv6 Address	MAC Address
GigabitEthernet0/0	Down	--	<not set>	<not set>	0090.0CB0.DD01
GigabitEthernet0/1	Down	--	<not set>	<not set>	0090.0CB0.DD02
GigabitEthernet0/2	Down	--	<not set>	<not set>	0090.0CB0.DD03
Vlan1	Down	1	<not set>	<not set>	0002.4AAB.987E

Hostname: Router

Physical Location: Intercity, Home City, Corporate Office, Main Wiring Closet

VIII. Same as steps III-X of switch.

IX. Configure the interfaces. Remember that a router can have multiple interfaces and you'll need to configure each one separately. While doing the tasks, follow given network specification carefully to properly assign the ip addresses to the router interfaces. This is where most students

get stuck. And remember to use the tab completion feature because you'll need it a lot at this step.

```
IUT(config)# interface fastEthernet 0/0
IUT(config-if)# ip address 192.168.11.1 255.255.255.0
IUT(config-if)# no shutdown
IUT(config-if)# description LAN-NORTH-HALL

IUT(config)# interface gigabitEthernet 0/0
IUT(config-if)# ip address 192.168.12.1 255.255.255.0
IUT(config-if)# no shutdown
IUT(config-if)# description LAN-SOUTH-HALL

IUT(config)# interface serial 0/0/0
IUT(config-if)# ip address 192.168.13.1 255.255.255.0
IUT(config-if)# no shutdown

IUT(config)# interface VLAN 1
IUT(config-if)# ip address 192.168.10.5 255.255.255.0
IUT(config-if)# no shutdown
IUT(config-if)# description VLAN-Management
```

X. Finally, its time to save the running-config to startup-config as like before.

```
IUT# copy running-config startup-config
```

XI. Interface related commands for a router are same as switch.

Some final points to consider before moving on to the tasks:

- Make proper use of the tab completion feature.
- Look carefully at the prompt to understand what state you're in now. Not all states accept every command. For example, *(config-if)* tells that you're in interface setup mode. *(config-line)* means you're in line setup mode. Make sure the state you're in matches the command you're typing.
- Type *exit* at any state to move back to the previous state.
- Remember to run all commands in privileged mode.
- Type *end* to return to initial state in privileged mode.

- Follow the given network specification in the task very carefully.

6. Tasks:

Task 1

Follow the task given in the PDF titled “Understanding TCP-IP and OSI Models in Action”. Use the .pka file provided along with the task for proper evaluation.

Task 2

You are given a network 192.168.X+10.0 where X is the last 3 digits of your student ID. You are quickly running out because of immense network expansion. You need to change your approach to how you assign new networks. You find the idea of subnets. Using this, create 3 subnetworks from a given network. From now on, you decide to make arrangements to accommodate **25 hosts for one subnetwork and 10 hosts for each of the other two subnetworks.** Show its proper communication by installing atleast 2 PCs per subnetwork.