Internship Report on Computer Networking

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Summary

This report details a summer internship at Construction Specialties'. I worked with the IT Operations team in the Networking division. I learned a lot about Computer Networks during my internship and gained a lot of experience. As being new to the networking field I had to learn a lot, but never did I feel burdened in any way. This internship is meant to give me real life experience of networking which will help me in my B. Tech program from Vellore Institute of Technology, AP in Computer Science and Engineering with specialization in Network and Security and my career.

This report includes how a network can be set up for accommodating 50 users, what are the different equipment required and what configurations you should use and how to protect your network against unwanted people. Explanation and screenshots for each step are given which will help the user with the configuration. The screenshots have been from the Cisco Packet Tracer tool which has a free student version.

Introduction

Construction Specialties' is a leader in architectural building products with a vision to be a globally recognized source for integrated solutions that redefine architecture. The CS headquarters is located at Lebanon, New Jersey. Their mission is to understand their customers' individual design needs and provide inspired solutions for a more "intelligent built" environment.

They work on three principles – Creativity, Solutions, and Integrity

Creativity to have the curiosity and confidence to look beyond what's "been done" to discover potential and create new opportunities. Solutions driven through collaboration with its customers, CS makes it our mission to find the best answers to their problems. We draw on our extensive expertise to bring their unique vision to life. Integrity not just about getting a job done but also about getting done right.

I have been lucky to work with a team of professionals who provide IT support all over the world and maintain such a huge global network. In my opinion and now I have learned about computer networks I know that there are infinite ways in which a system can work in a wrong manner and fixing it by troubleshooting can be a near-impossible task and still they

Project and Learning Experience

In the initial week of my internship, I was assigned a project and a research topic. My project was to set up an environment for a small office with 50 users and give them internet access and my research topic was "How a single ethernet cable provides two different IP addresses for two devices?"

During my internship, I had a constant and very interesting learning path. In the first week, I was asked about my experience of computer networks (which I had none), then about my past projects, topics of interest and my subjects. After this, I was given a learning path with all the topics to explore. I learned about the different terminologies related to networking, different components on a network, basic requirements for getting online, different types of network, various device setting to manually and automatically receive network addressing required for connectivity.

I also used different tools on my way to gain further experience. One of these tools was Cisco Packet Tracer which I also used to complete my project. Cisco Packet Tracer is a very powerful simulation tool for networking which is used to create a virtual network for your home or your office. You can define each and everything with specific details. I practiced on it trying different equipment, cables, topologies, options to explore and had fun doing that.

After the networking basics on the physical layer and data link layer, I moved up to the networking layer where I learned about commands like ping and tracert which are used to extract more information about the connected network. Also, I built a peer to peer network on CPT which help me understand how simple and a network can be.

There are a set of rules which govern the internet, these rules are called protocols in the networking world. For each layer of the OSI model of networking these protocols are defined. I learned about these protocols and understood how different pieces of information are split and transported with slightly different ways just to ensure proper connectivity and security. I also learned that the MAC address of the device can help you determine the manufacturer of the device.

Later I got to know about the Address Resolution Protocol (ARP) which is used to map Ethernet and IPv4 addresses for communications in the LAN. While connected to a network many people may access the internet for sending and receiving data. The data travels in the form of packets and these packets can be captured by a tool called Wireshark. Using this tool, we can analyze the data packets and retrieve information in it.

After that, I learned about the different types of communications, examine the ARP table, how routers are used on the interconnected network and finally examine the IP address configuration and traffic on the network.

For the next week, I deepened my knowledge about the Internet Protocol (IP). That included the need for the public and private IP address, how is NAT used. Then I learned about the transport layer protocols – TCP and UDP and where these protocols are used. After that, I learned about DNS and witnessed the practical usage of protocols like – Telnet, FTP, SSH, IM, etc.

After learning about IP addresses and all the protocols, it was time to set up a network for a home. So specifically, I learned about the technologies used in a home network, features, and functions of a typical home network router, different connections like – wired and wireless. Then I configured the wireless client to connect to the home router network and configured the router's DHCP pool and security measures.

Security is a measure concern nowadays and people transfer a lot of data through the internet. If the network used is insecure and hackers try to decrypt your data, you can get into trouble. So, I learned about the network security threats and attacks and how to secure the network. I further learned more about firewalls, software, and tools which can help protect us against unauthorized access, data loss, and service disruptions.

Finally, in the last week, I learned to use a terminal emulator on a PC to access the CLI on a Cisco Networking device, explain to basic features and functionality of small Cisco routers. I also learned about the common Cisco CLI commands, used Packet Tracer simulation software to practice configuration tasks using the command line interface. Further, I performed basic configuration tasks on a Cisco switch and router to enable network communications, used best practices to secure Cisco networking devices from unauthorized access, used command line utilities to test and verify network connectivity. In the end, I completed my learning path by knowing about the process of troubleshooting on a network that does not work as expected, verify that the devices have the correct configuration settings, use common network utilities to test connectivity between network-attached devices and identify issues that can cause Internet connectivity problems.

Project Expectation and Scenario

Project – To set up an environment for 50 users in an office with an internet connection.

Equipment to Be Used

The pieces of equipment we will need are very basic. For just 50 user's environment, I am assuming it's a start-up. We need a router, switch and end-devices like PCs.

1. **Router** – I have used the Cisco Router 2811. I used this router because various different types of modules are available, which means we can modify this router at a low cost. But you can use any router which supports HWIC-2T module. HWIC-2T is a Cisco 2-Port Serial High-Speed WAN Interface Card, providing 2 serial ports.

Figure – A Cisco 2811 series router.

2. **Switch** – I have used the Cisco 2950 switch with 24 fast ethernet ports. We can easily connect another switch to it using a cross-over cable and increase the total number of available ports.

Figure – A Cisco 2950 Switch

3. **PCs** – You can use any PC equipped with PT-HOST-NM-1CFE Module which provides one Fast-Ethernet interface for use with copper media. Ideal for a wide range of LAN applications, the Fast Ethernet network modules support many internetworking features and standards.

4. **Straight-Through cables** – A type of twisted pair of ethernet cable that is used in LAN to connect your PC to a network hub such as router or (in this case) switch. Actually, if you want to connect two similar network equipment you would need a cross-over cable but nowadays the equipment can identify on which line to send and receive data, so you can get away by using a straight through cable also.

Figure – A linkup CAT 10 straight through ethernet cable, but you can use any category if the ethernet cable is straight through.

NOTE >> There are a few more requirements like an internet subscription from any ISP, a coaxial cable (which will most probably be provided by your ISP), an idea about the topology of your network (but I won't be mentioning it as it will depend on the map and area of your office) and a console cable which will be required to connect to your router to configure it. Apart from this if you also keep a cross-over ethernet cable handy that will help you in the troubleshooting process.

Procedure and Configurations

1. Now we have all the equipment ready, we can start setting up our environment. Now, the first and foremost thing you should understand is that there are various ways to do this. Maybe you are using different pieces of equipment because it is easily available or maybe you are just given a specific requirement which is different from this, it won't be a problem unless your equipment has the required modules installed.

    So, now to start with the setup process, I would like you to connect the devices as shown in the below figure.

- Connect the coaxial/ethernet cable provided by your internet service provider to your office router. Make sure you connect it in the correct port as not all the ports are meant for input. (Generally, it is the serial port having a different color from the rest of the ports).
- Now, connect a console cable in the console port of the router and RS232 port of your computer. (You can later remove the computer once the configuration is done)
- Connect the switch to the router using a straight-through cable.
- Finally, you are left with your end device, the PCs. Connect them whenever you want to test your connection. The PCs will also connect using the straight through cable.
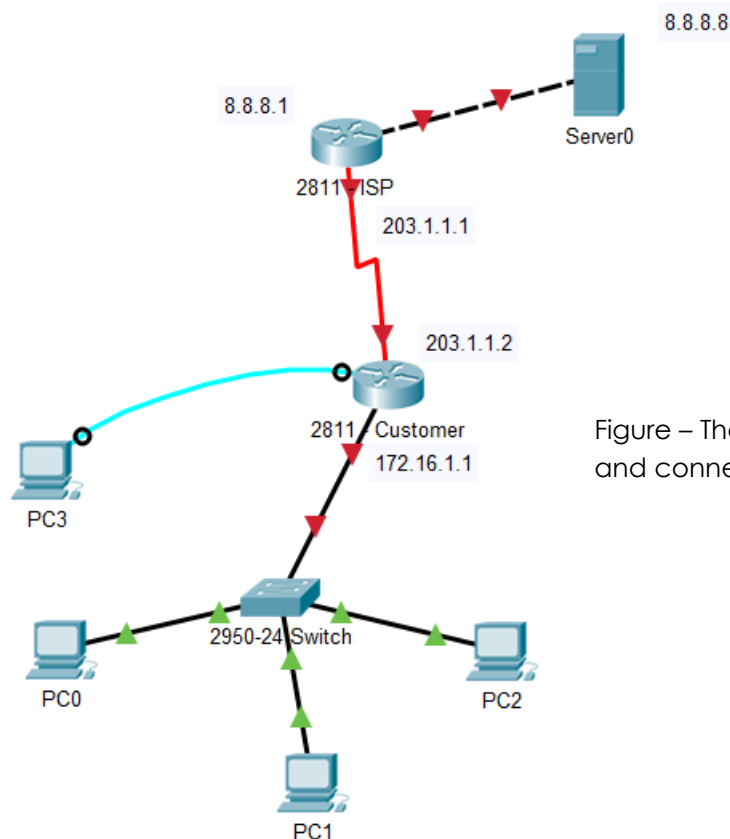

Figure – The initial step to setup and connect the equipment.

2. When you are done with the setup, you can move on to the next setup. As I was doing a simulation of the whole setup, I had to configure my web server also. You can ignore this step if you are directly doing your setup in a real environment.

In this step, the server is given an IP address, subnet mask, default gateway, and DNS server statically.

Note > You can leave the IPv6 configuration as we are not going to use that in this setup.

Image – IP configuration page for the web server

3. Let's start configuring our router now. So, open a terminal connection with your router and then we can start with our process.

So, just leave the port configuration at defaults and click OK button to get access to the CLI of the router. After getting the access, follow the below procedure –
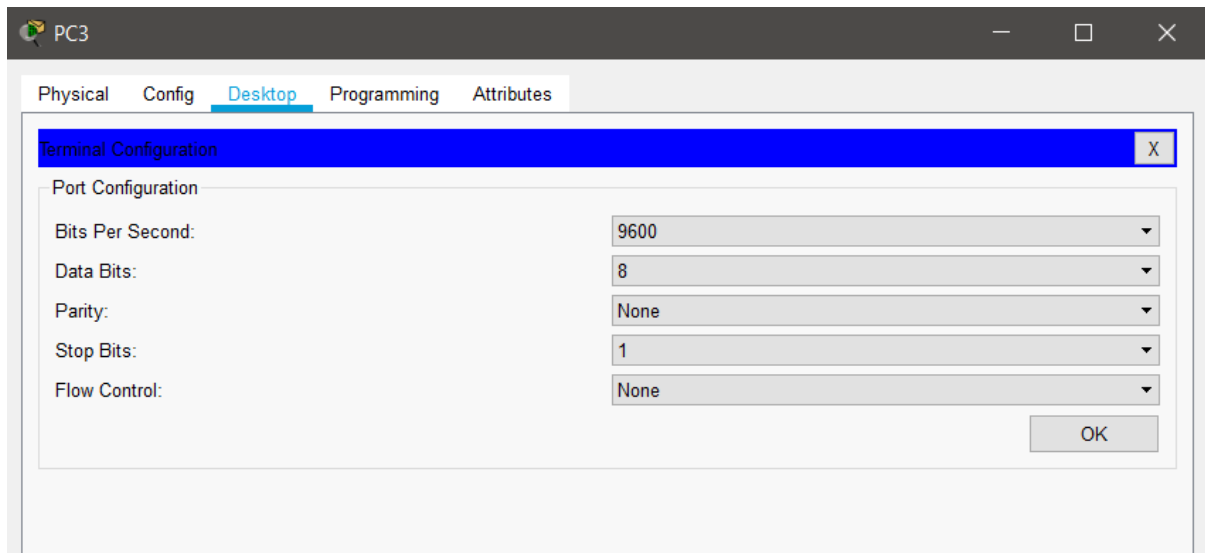
- First, we are going to change the name of the router, from "Router" to "Customer". For that to happen we will need to access the *Privileged EXEC mode* from *User EXEC mode* and then into the *Global Configuration Mode*. Now we can simply use `hostname name` command to change the name of the router.
- Next, we assign an IP address to the interface at which our switch is connected. For doing that we use the following commands –
  - o `int f0/0`
  - o `IP address 172.16.1.1 255.255.255.0`
  - o `no shutdown`

```
Router>ena
Router#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname Customer
Customer(config)#int f0/0
Customer(config-if)#ip address 172.16.1.1 255.255.255.0
Customer(config-if)#no shutdown

Customer(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up

Customer(config-if)#int s0/0/0
Customer(config-if)#ip address 203.1.1.2 255.255.255.0
Customer(config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0/0, changed state to down
Customer(config-if)#
```

- Finally, at the end of this step, we assign an IP address to the serial port at which the coax/ethernet cable from the ISP is connected, using the following commands –
  - o `int s0/0/0`
  - o `IP address 203.1.1.2 255.255.255.0`
  - o `no shutdown`

Note >> The IP address I assigned at the FastEthernet0 port is my choice, if you want you can assign a completely different but valid IP address. Secondly, the IP at the serial port is given by the ISP so it is required that you use their given IP address only.

4. The next step is configuring the ISP router, so, again you can skip this step if you are setting up in a real environment. So, just read through the steps for information or if you are going to simulate your setup on Cisco Packet Tracer first.

   In this step, we will set the hostname for the ISP router, give the IP address at the serial port which is connected to your router and the port on which it connects to the internet through a server. So, follow through the commands –

- Go to the global configuration mode and change the hostname with the already used `hostname name` command.
- Now type `int s0/0/0` to go to configure interface mode.
- Set the IP address and the subnet mask using the `IP address 203.1.1.1 255.255.255.0`
- Finally, the `no shutdown` command to apply the settings.

```
Router>enable
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#hostname ISP
ISP(config)#int s0/0/0
ISP(config-if)#ip address 203.1.1.1 255.255.255.0
ISP(config-if)#no shut

ISP(config-if)#
%LINK-5-CHANGED: Interface Serial0/0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/0/0,
changed state to up

ISP(config-if)#int f0/0
ISP(config-if)#ip address 8.8.8.1 255.255.255.0
ISP(config-if)#no shutdown

ISP(config-if)#
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0,
changed state to up

ISP(config-if)#
```

5. Further moving ahead and completing the configuration of the ISP router we will be setting up the IP route and use the show command to check if our settings have been applied correctly or not.

   - So, first, go ahead into the global configuration mode. You can do so by using the `enable` and after that executing the `configure terminal` command.
   - Next to set up the IP route use the `IP route 172.16.1.0 255.255.255.0 203.1.1.2` command.
   - Execute the `exit` command to apply the settings.
   - Now let's check if the settings have been applied properly. Type `show IP route` and hit the *Enter key*. The results are shown below in the image.

```
ISP>ena
ISP#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
ISP(config)#ip route
% Incomplete command.
ISP(config)#ip route 172.16.1.0 255.255.255.0 203.1.1.2
ISP(config)#exit
ISP#
%SYS-5-CONFIG_I: Configured from console by console

ISP#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     8.0.0.0/24 is subnetted, 1 subnets
C       8.8.8.0 is directly connected, FastEthernet0/0
     172.16.0.0/24 is subnetted, 1 subnets
S       172.16.1.0 [1/0] via 203.1.1.2
C    203.1.1.0/24 is directly connected, Serial0/0/0
```

6. Getting back to our office router, now we will configure the DHCP pool, network IP, default router and DNS server. So, let's see how we are going to implement it.

   - Go into the global configuration mode using the `enable` command followed by the `configure terminal` command.
   - Now type the `IP DHCP excluded-address 172.16.1.1 172.16.1.99` command.
   - Then execute the `IP DHCP pool Internet-LAN` command.
   - `Network 172.16.1.0 255.255.255.0`
   - `Default-router 172.16.1.1`
   - `dns-server 8.8.8.8`

```
Customer#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Customer(config)#ip dhcp excluded-address 172.16.1.1 172.16.1.99
Customer(config)#ip dhcp poo Internal-LAN
Customer(dhcp-config)#network 172.16.1.0 255.255.255.0
Customer(dhcp-config)#default-router 172.16.1.1
Customer(dhcp-config)#dns-server 8.8.8.8
Customer(dhcp-config)#
```

7. So, now we are done with the hard part of configuring our router, we can proceed to set our PCs to obtain the IP address automatically.

   - Head over to the IP configuration setting in your PC and set it to DHCP (or the option may be named as "Obtain an IP address automatically"). Now you will see that IP address, subnet mask, default gateway, and DNS server are all obtained automatically.

8. There are just a few more settings you have to tweak before you can actually start using the internet. If you may have gone through step 5, you will remember we executed an IP route command in the ISP router. Now we are going to do the same for the office router. Also, we will set the incoming and outgoing ports for packets for the PCs to upload and download data without stressing the network.

But before proceeding I would like to tell about IP route command. So, IP route command is basically used to configure the static route. We do this because the static route is the most secure way of routing. This also increases the overall performance of the network.

- Now follow the commands given in the image below to complete the step.
- `Ip route 0.0.0.0 0.0.0.0 203.1.1.1`
- `Enable`
- `Configure terminal`
- `Int f0/1`
- `Ip nat inside`
- `Exit`
- `Int s0/0/0`
- `Ip nat outside`
- `Exit`
- `Access-list 100 permit IP any any`
- `Ip nat inside source list 100 interface s0/0/0 overload`

```
Customer(config)#ip route 0.0.0.0 0.0.0.0 203.1.1.1
Customer>enable
Customer#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Customer(config)#int f0/1
Customer(config-if)#ip nat inside
Customer(config-if)#exit
Customer(config)#int s0/0/0
Customer(config-if)#ip nat outside
Customer(config-if)#exit
Customer(config)#
Customer(config)#
Customer(config)#
Customer(config)#access-list 100 permit ip any any
Customer(config)#
Customer(config)#ip nat inside source list 100 interface s0/0/0 overload
Customer(config)#
```

9. Now you can check your connectivity with the web server by using the ping command in your command prompt.
   - `ping 8.8.8.8`

   Results are shown in the images below.

```
Packet Tracer PC Command Line 1.0
C:\>ping 8.8.8.8

Pinging 8.8.8.8 with 32 bytes of data:

Request timed out.
Reply from 8.8.8.8: bytes=32 time=1ms TTL=126
Reply from 8.8.8.8: bytes=32 time=5ms TTL=126
Reply from 8.8.8.8: bytes=32 time=5ms TTL=126

Ping statistics for 8.8.8.8:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 5ms, Average = 3ms

C:\>
```
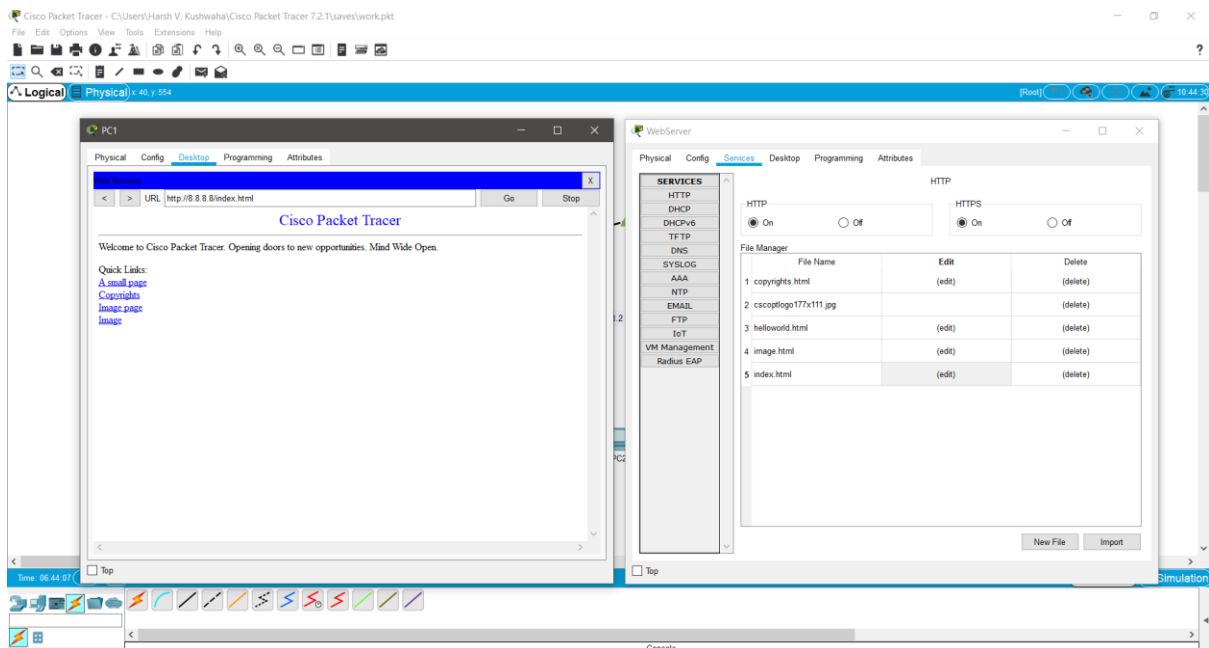
10. Lastly, now you have the connectivity and the network setup is done. You would like to implement some security measures so that not anyone can barge into your network and change the settings or configurations. So, we set a password for the user EXEC mode, privileged EXEC mode, secure SSH and Telnet connections, save all passwords in a config file, provide a legal notification and save the configurations. Refer the image below for commands –

- Configure the device name
  - hostname *name*

- Secure user EXEC mode
  - line console 0
  - password *password*
  - login

- Secure remote Telnet / SSH access
  - line vty 0 15
  - password *password*
  - login

- Secure privileged EXEC mode
  - enable secret *password*

- Secure all passwords in the config file
  - service password-encryption

- Provide legal notification
  - banner motd *delimiter message delimiter*

- Save the configuration
  - copy running-config startup-config

```
Customer>
Customer>enable
Customer#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Customer(config)#line console 0
Customer(config-line)#password cisco
Customer(config-line)#login
Customer(config-line)#line vty 0 4
Customer(config-line)#password cisco
Customer(config-line)#login
Customer(config-line)#exit
Customer(config)#enable secret class
Customer(config)#service password-encryption
Customer(config)#banner motd #Authorized Access Only!#
Customer(config)#exit
Customer#
%SYS-5-CONFIG_I: Configured from console by console
```

Research Topic – How a single ethernet cable provides separate IP for VoIP and Computer

Various offices have different network management and thus they vary a lot in terms of implementation, technologies, and techniques. For employees whose work includes a lot of communication, a VoIP and computer are a must. Now both the devices are meant to be connected to the office network, one for data transfer and the other for voice transfer. Obviously, wireless access points are provided but a connection through an ethernet cable is preferred because of faster and more secure delivery.

So, now the question arises are we going to drop two ethernet ports at each workplace(one for each device)? Yes, this is quite possible but also raises the cost of building a network. To complete the task feasible, one possible solution is using VoIP phones. These phones consist of two ports – one RJ11 and one RJ45. The idea is to daisy chain the computer and VoIP phone with the network.
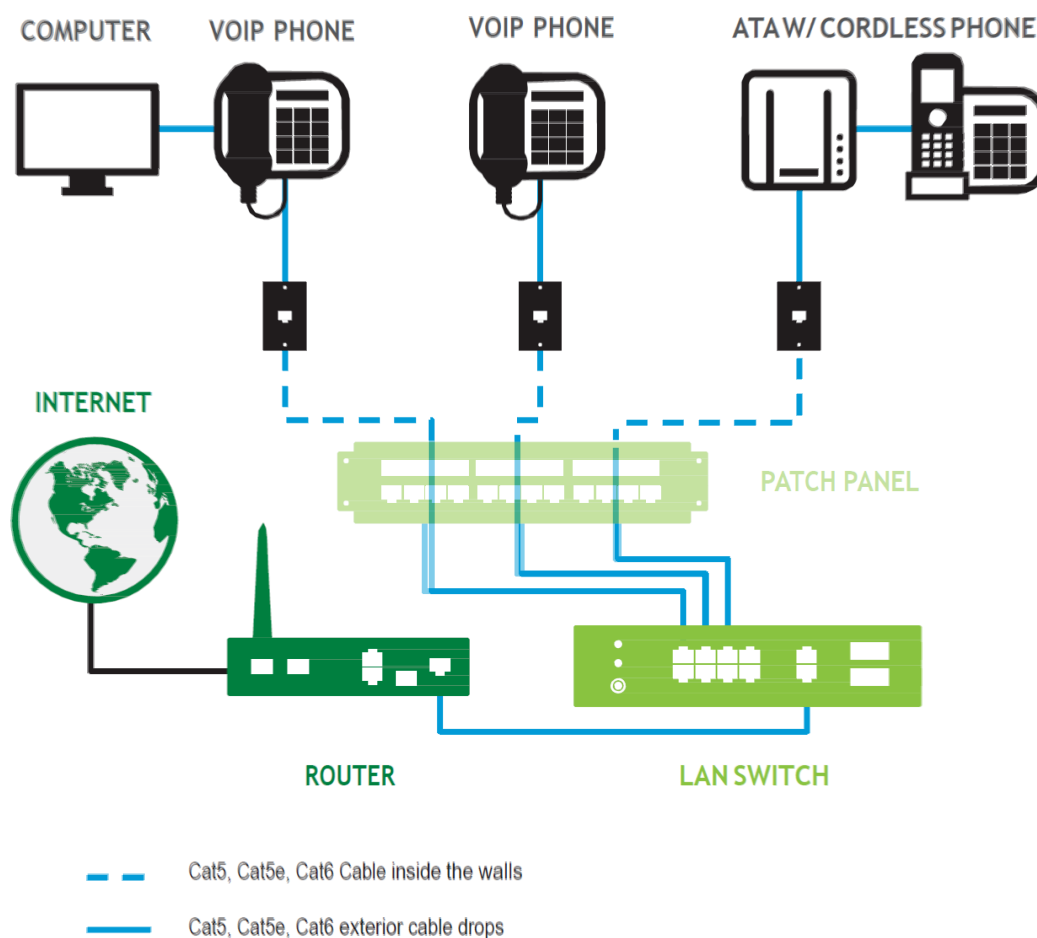
This might connect your computer to the network but there is a chance of VoIP failing and the computer might also get disconnected from the network. That is why for such PCs, an option "Failover Wi-Fi" is enabled. But many people quite disagree with daisy chain because if the VoIP phones do not support the gigabit port then that may slow down the network on the computer and that is quite true. For the daisy chaining to work fluently, a high-speed port is required. If any link between the server and the computer is slow and hold back the full potential of the network.

But still, the IP address for both the devices are not yet resolved. A single ethernet cable carrying the packets of data from computer and VoIP may not be able to differentiate the information passed on from both the device. So, the solution to this problem is a virtual ethernet splitter.

Update 1 port

Switchport	HYDS01 / 14
Name	
Tags	+
Port enabled	**Enabled** Disabled
PoE	**Enabled** Disabled
Type	Trunk **Access**
Access policy	Open ▼
VLAN	201
Voice VLAN	110
Link	Auto negotiate ▼
RSTP	**Enabled** Disabled
STP guard	Disabled ▼
Port schedule	Unscheduled ▼
Port isolation	Enabled **Disabled**

A system administrator can configure the port settings for the particular switch and make the packets deliver at different VLAN ports. As you can see in the image above 201 and 110 are the port numbers at which the packets are going to be transferred form VLAN and Voice VLAN. Generally, there is only one VLAN per port, but you can configure the settings to change it to a different number according to the number of devices you are going to connect. When the data is transmitted back to the VoIP phone it just grabs the data on the incoming port number 110 and transmits ahead the data on the port 201.

There are more different settings also present, like – PoE (Power over Ethernet), RSTP (Rapid Scanning Tree Protocol), STP (Scanning Tree Protocol) Guard, port isolation, access policy, etc. These can be used to customise your equipment even further.

Evaluating my experience of Internship

Doing my 2nd-year internship in the field of computer networks with Construction Specialties' was a very good experience. I got a great opportunity to learn and experience new things. The work environment was friendly, and no pressure was put on me. Everybody treated me like their younger brother and helped me in every way possible. Although I attended this internship for not a very long duration but still, I will remember this experience forever.

At such an age I am right now, I think it is very important to be ambitious and strive for the best, also grab each opportunity thrown my way and experience new things. Being in Hyderabad, a major hub in the field of information and technology, also added a lot to my very long learning list. Meeting many new people from a different culture and speaking different was wonderful.

My topic of internship – Computer Network had so much to learn, discover and experience that even after my internship I will still continue to research new topics and work on projects. The practicality of the subject in day to day life is so much that sometimes you don't even realize how many complex algorithms and protocols are making things possible. A simple mail or message you send from one part of the world to the another may just take a few milliseconds and may not look complex but the efforts to send to the other side are terrific. This makes me even more curious about the topic. Truly this internship will help me a lot in my career and my life.