LAN DESIGN FOR MY LOCALITY

COMPUTER NETWORKS
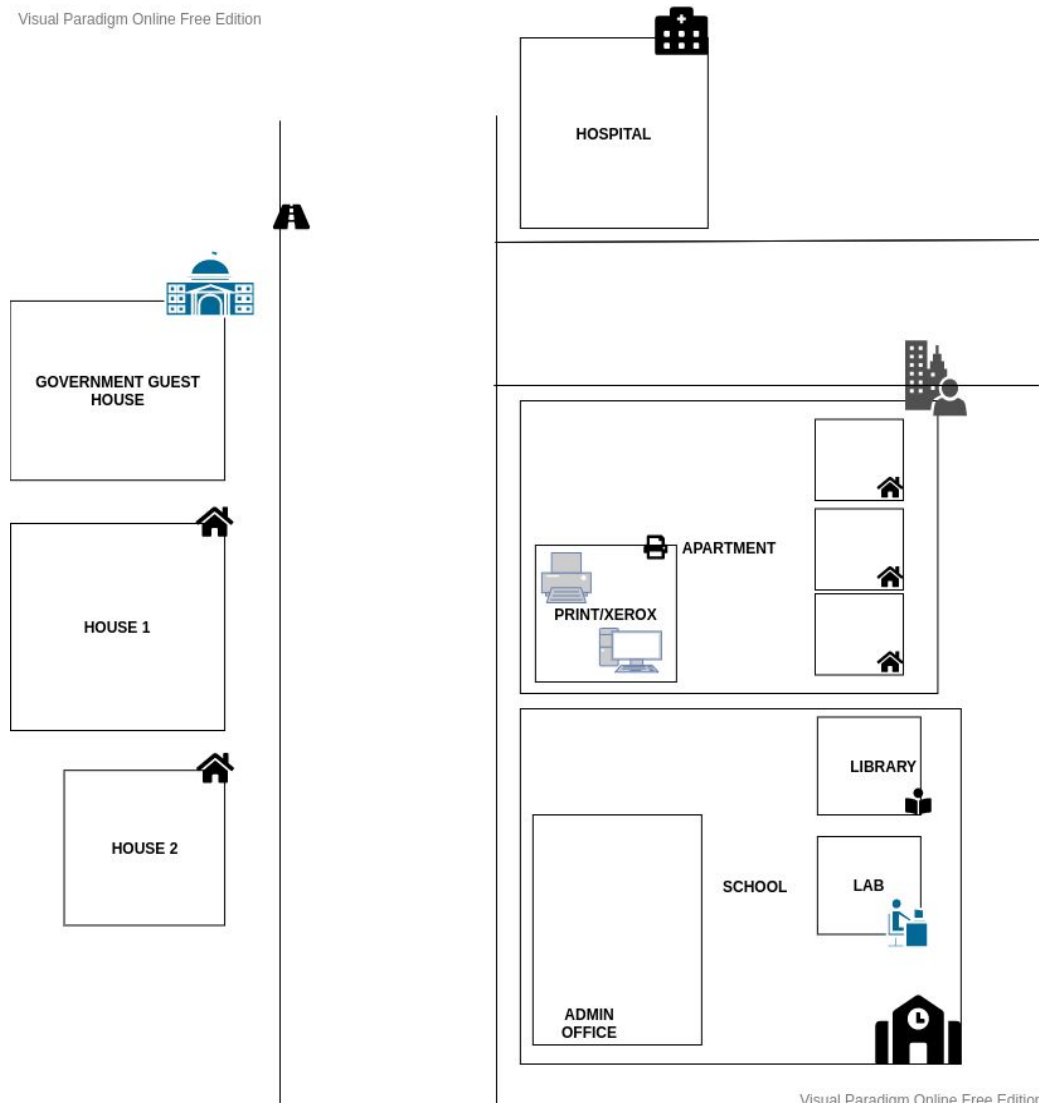
SRIHARSHITHA BONDUGULA   **2018111013**

_____

DESCRIPTION OF THE LOCALITY

The following is the layout of the locality for which this Local Area Network is being designed.

HOSPITAL

GOVERNMENT GUEST HOUSE

HOUSE 1

HOUSE 2

APARTMENT

PRINT/XEROX

LIBRARY

SCHOOL

LAB

ADMIN OFFICE

It covers a distance of 180 metres with 6 buildings.
The width of the road is about 20 metres.

Apartment has 10 flats. House 1 have 3 families residing in 3 floors. One family resides in House 2. The hospital is a newly built-one and has around 20-30 beds with 10-15 staff working.

The number of users that may use this network can be calculated as follows;

Number of flats in the apartment = 10
Number of families in house1 = 3
Number of families in house2 = 1
Number of people in the guest house = 4
Number of people in the XEROX/PRINT shop = 2
Maximum number of people residing in these 4 buildings can be around **60-70**
[(10+3+1)*4 = 56 considering 4 people per family]

Number of people in the administrative office of the school = **5**
Number of students the lab/library can accommodate = **30-40**

Number of staff in the hospital = **10-15**
Total = **135-170**

Devices that will use the network; PCs, Laptops, Mobile phones, Tablets, TVs, Printer. The network can be further expanded for the usage of biometric devices, projectors, and CC cameras in the school. WLAN is used in some of the buildings.

The locality includes students belonging to different age groups and well-educated people who are in regular use of internet. This network will be useful in these desperate times where everything is done online.

COMPONENTS

Network topology: As the people are in constant use of internet, once the network is set-up, it would not be disturbed for a long time. But considering the locality, there might be a need to expand the network. Tree topology is robust and it is easier to be expanded unlike bus/ring topologies where network will be disrupted each time a node is to be added. Hence I chose *Tree topology* for the design. Even if one of the devices in the network fails, other devices would not be effected and it is easy to install.

Internet Service provider: These are the companies that provide access to the internet. Some of them are ACT(airtel), JioFiber, broadband internet service providers etc. The ones which are available in our area are *Hi-Reach Broadband ISP* and *Jio GigaFiber*. Any one of them with a *300-500 Mbps plan* (Internet Connectivity Speed) can be chosen.

Gateway: As the name says, it is a hardware device that acts a 'gate' between 2 networks (a router or a firewall or a server or a device) and it protects the nodes in the network. To ensure security of the network, a Gateway- **Firewall** can be used. It acts as a first line of defense, blocking unwanted traffic and unrecognized sources.
<u>Model</u> -
Cisco ASA 5545-X Firewall (Next generation Firewall for internet edge)
With up to *3 Gbps* of firewall throughput, this model meets the evolving security needs by providing innovative next-generation firewall services that make it possible to take advantage of new applications and devices without compromising security. This with *FirePOWER service* can be used as a proxy server+firewall and can also be used with VPN features.

Layer-2 Switch: The Layer 2 switch forwards data packets based on the Layer 2 information like MAC addresses. They are used to reduce traffic in the local network. It is cheaper and easy to deploy.
<u>Model</u> -
Cisco Catalyst 1000 Series (They provide Layer 2 access for branch offices, conventional workspace, and out-of-wiring closet applications)

- 3 Cisco layer 2 switches with 24 ports of model C1000-24P-4G-L (24 10/100/1000 Mbps PoE+ ports)

C1000-24T-4G-L can also be used as an alternative. This is not a PoE+ port but an Ethernet port. PoE+ ports send 10/100/1000 Mbps of data and 15W, 30W, 60W, and up to 90W of power budget to devices over Cat5e and Cat6 Ethernet cables for a maximum distance of 100m and hence more expensive than Ethernet ports.

Layer-3 Switch: Layer 3 switches or multilayer switches are used for routing. They forward frames based on layer 2 address and packet based on layer 3 address, performing the functions of a router and a switch. Router or a layer-3 switch can be used for routing purposes. Using a layer-3 switch is better when we need more ports and better network performance as by using the layer-2 information it routes packets faster than a router. I chose a layer-3 switch as it has a high throughput, high switching capacity and is cheaper when compared to a router.

Model -

Catalyst 9300 series switches (the latest ones built with security, mobility, cloud and IoT at their core)

- 2 Cisco layer 3 switches with 48 ports of model C9300-24P-A (Stackable 48 10/100/1000 Mbps PoE+ ports)
- 1 Cisco layer 3 switch with 24 ports of model C9300-48P-A (Stackable 24 10/100/1000 Mbps PoE+ ports)

C9300-24T-A and C9300-48T-A are other alternatives that can be used. These are not PoE+ ports but are Ethernet ports. PoE+ ports send 10/100/1000 Mbps of data and 15W, 30W, 60W, and up to 90W of power budget to devices over Cat5e and Cat6 Ethernet cables for a maximum distance of 100m and hence more expensive than Ethernet ports.

Cabling: Fiber optic cables are expensive and harder to install but are efficient and have higher transmission capacity compared to twisted pair cables. Twisted pair cables perform best over short distances and are cheaper and easy to install. So, I have chosen the cables according to the distance and transmission rate. Preferring high transmission at the top of the network, I have decided to use fiber optic cables to make connections between ISP, firewall and the layer-3 switches at the top of the tree. For connections within the buildings

and the ones which are over distance below 100m, it is preferable to use twisted pair cables as they perform best over short distances. For other connections that are over 100m of distance, fibre optic cables can be used.

- **Twisted and unshielded pair cables:**
Though unshielded cables are prone to noise, they are cheaper and easy to maintain than the shielded ones. They (*10-1000Mbps*) transmit as fast as shielded cables (10-100Mbps). As these cables are being used for very short distances and are not prone to too much of EMI, *UTP cables* can be used. Cat 5e/6/7 cables can be used. CAT5e cables provide improved crosstalk specification, allowing it to support speeds of up to 1Gbps. Though CAT7 and CAT6 cables are more durable and support higher speeds, for them to be used, all other components should be correspondingly certified. This makes it more costlier. Extra caution must be given during deployment of these cables whereas CAT5e cables are cheaper and forgiving when porper cables termination and deployment guidelines are not met. Hence, *CAT5e cables* which have data rate upto *1Gbps* can be used. Around 25 such cables will be required.
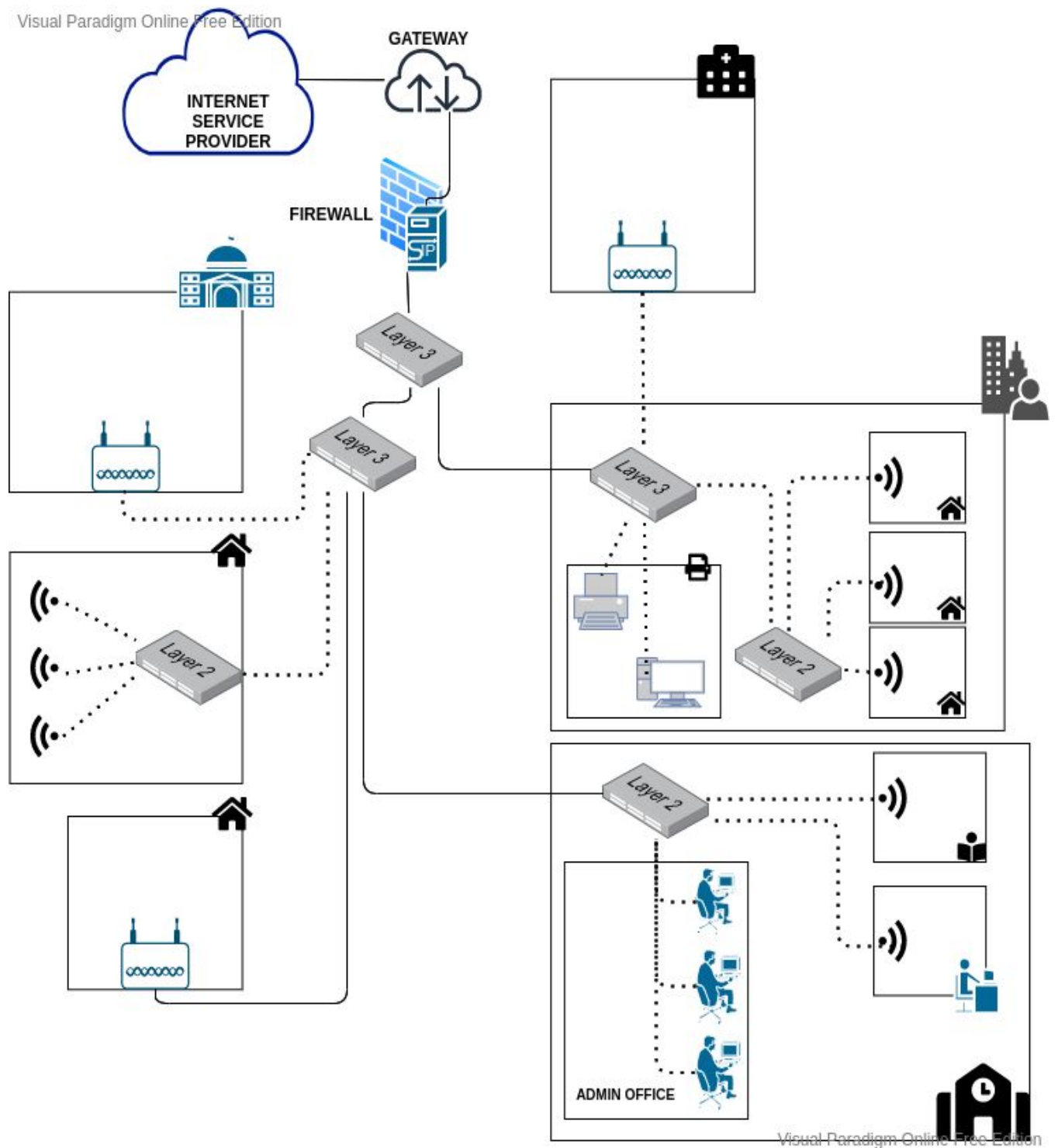
- **Fibre optic cables:** Multimode fiber is more commonly used in LAN backbones within buildings. Multimode fiber uses LEDs as the light source, while single-mode fiber generally uses laser light sources.
<u>Model</u> - *Spectrum Multimode Laser Optimized Duplex Fiber Optic Cable* (*Data Rate : 10Gbps covers upto the distance of 300 meters, Spectrum Technologies*) 6 such cables are required.
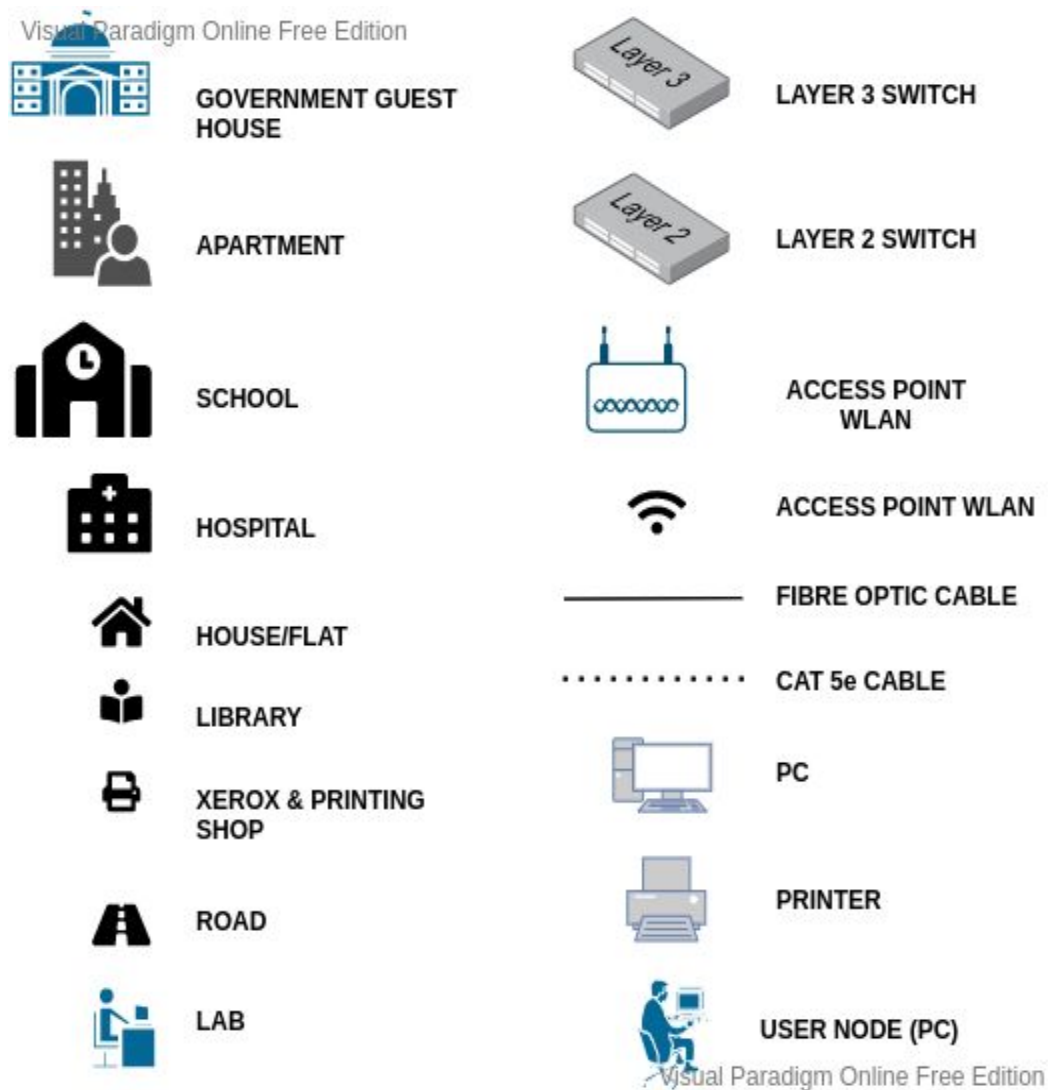
Access points: These devices create a wireless local area network, or WLAN, usually in an office or large building. An access point connects to a wired router, switch, or hub via an Ethernet cable, and projects a Wi-Fi signal to a designated area. As it is configured for small areas, root access points can be used.
<u>Model</u> - *Cisco Meraki or Cisco Aironet 3700 Series* can be used. Around 20 of them are needed. The model can be chosen according to the usage.

NETWORK DESIGN

GATEWAY

INTERNET SERVICE PROVIDER

FIREWALL

Layer 3

Layer 3

Layer 3

Layer 2

Layer 2

Layer 2

ADMIN OFFICE

LEGEND

GOVERNMENT GUEST HOUSE

APARTMENT

SCHOOL

HOSPITAL

HOUSE/FLAT

LIBRARY

XEROX & PRINTING SHOP

ROAD

LAB

LAYER 3 SWITCH

LAYER 2 SWITCH

ACCESS POINT WLAN

ACCESS POINT WLAN

FIBRE OPTIC CABLE

CAT 5e CABLE

PC

PRINTER

USER NODE (PC)

IP ADDRESSING SCHEME

Every node in the network is identified with the help of an IP address.

ISP has a public IP Address.

This scheme is to assign each host in the network a private IP address.

The 32 bit IP address (IPv4) is divided into 5 sub-classes, each of them having a valid range of IP addresses. Based on the number of hosts and network segments, we can decide which class to be chosen.

Calculating the number of required usables addresses;

For hospital -> 50
For school -> 100
For each house/flat -> 10 * number of houses/flats = 10*15=150
For the shop -> 4

Total = 304, Hence, we need 304 usable addresses + 2 reserved addresses.

As the Minimum number of usable host addresses required is greater than 256, we cannot use class C IP addresses.

So, we have to use class B IP addresses that range from 128.0.x.x – 191.255.x.x. Address mask for the network is 255.255.0.0 (/16 in CDR notation). Mask bits = 16.

Last 2 octaves can be used for host addresses. Total number of addresses that can be used is 2^16 among which 2 of them are not counted (since the first one is reserved for the network number and the last one is reserved for broadcast IP), i.e 65534

Consider that the network ID is 128.1.0.0. So, 128.1.0.0 and 128.1.255.255 will be the reserved addresses.

We can allocate them as follows:

SCHOOL
Address range: 128.1.0.1 - 128.1.0.100

HOUSE 1
Address range for family 1: 128.1.0.101 - 128.1.0.110
Address range for family 2: 128.1.0.111 - 128.1.0.120
Address range for family 3: 128.1.0.121 - 128.1.0.130

HOUSE 2

Address range: 128.1.0.131 - 128.1.0.140

GOVERNMENT GUEST HOUSE

Address range: 128.1.0.141 - 128.1.0.150

APARTMENT

Address range for flat 1: 128.1.0.151 - 128.1.0.160
Address range for flat 2: 128.1.0.161 - 128.1.0.170
Address range for flat 3: 128.1.0.171 - 128.1.0.180
Address range for flat 4: 128.1.0.181 - 128.1.0.190
Address range for flat 5: 128.1.0.191 - 128.1.0.200
Address range for flat 6: 128.1.0.201 - 128.1.0.210
Address range for flat 7: 128.1.0.211 - 128.1.0.220
Address range for flat 8: 128.1.0.221 - 128.1.0.230
Address range for flat 9: 128.1.0.231 - 128.1.0.240
Address range for flat 10: 128.1.0.241 - 128.1.0.250

SHOP

Address range: 128.1.0.251 - 128.1.0.255

HOSPITAL

Address range: 128.1.1.1 - 128.1.1.50

We have allocated 304 addresses out of 65534 available addresses. We are still left with 65230 addresses. These can be used for future if the network is expanded.

USE CASES

As it is built in a closer community, the choice of devices, cables etc can be done according to the people's usage. Cost efficient devices can be chosen and used accordingly. Security and heavy usage issues can also be dealt with personally and efficiently.

1) **Students:** Our locality is a home to students of different ages. Using online sources and internet has increased in today's education curriculum. Some of the students are attending online classes. This LAN provides good access to internet making these things easy for them. Students in the school can also have acces to the internet in their lab and library.

2) **Entertainment:** Most of the women in our locality are house wives. Watching movies, listening to songs, reading books online, learning to cook etc are their sources of entertainment. Having a TV or mobile connected to internet (WLAN) makes things easier for them. Government officials visiting the guest house can also use this WLAN to entertain themselves. They usually gather around in weekends and project a movie or a cricket match.

3) **School:** This network allows sharing of resources and data in the administrative offices of the school. Access to the internet is also required for some tasks. Other devices like printers and scanners can also be connected if required. It can also be used further for the installation of CC-cameras and for biometric devices. It will also be helpful to the teachers as they can also use the PCs connected to the network in the labs and libraries and finish their works in the school itself during their leisure instead of carrying them to home where there may or may not be a good network available.

4) **Hospitals:** It is useful for the staff working in the hospitals to share files, data and resources. It can be further used for installation of CC-cameras. The TV which is installed for the patients in the waiting hall also has the access to internet and can be used to play songs or a movie.

5) **XEROX/PRINT shop:**The children from the school frequently have assignments and projects. Most of these demand printing different things from the internet. These students can directly visit the shop and use the PC which is connected to the LAN to download and print the required books or images.

REFERENCES:

https://www.cisco.com/c/en_in/solutions/small-business/resource-center/networking/what-is-access-point.html

http://www.firewall.cx/networking-topics/cabling-utp-fibre/112-network-cabling-utp.html

http://www.fiber-optic-components.com/shielded-vs-unshielded-ethernet-cable-use.html

https://blog.router-switch.com/2011/12/layer-2-switches-layer-3-switches/#:~:text=The%20Cisco%20Catalyst

https://www.cisco.com/c/en/us/products/switches/catalyst-1000-series-switches/index.html#~benefits

https://www.router-switch.com/cisco-catalyst-9300-switches-price.html

https://www.cdw.com/content/cdw/en/articles/networking/2018/11/30/ethernet-switch-vs-hub-vs-router.html

https://www.cisco.com/c/en/us/products/collateral/security/asa-5500-series-next-generation-firewalls/data_sheet_c78-701808.html

https://www.geeksforgeeks.org/introduction-of-classful-ip-addressing/