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Designing a Network

In this report, we evaluate and examine available options for designing a network for the Boys Hostel at IIIT Delhi. This would cover evaluating and determining the best options for the interconnection of both, the building's internal network (LAN) and external connection to an ISP and other building networks.

While designing the network, the following assumptions about the building would be taken:

- Number of Floors : 6 + Ground
- Number of Wings : 3
- Number of students : approximately 400 students
- **Wings:**
    - Wing A : 12 Double rooms (50 m x 12 m)
    - Wing B : 12 Single Rooms (50 m x 12 m)
    - Wing C : 24 Single Rooms (90m x 12 m)

ELEMENTS OF THE NETWORK

The network will aim to connect all devices such as Desktops, Laptops, Mobiles, and other personal devices in a Local Area Network (LAN). The overall network would also be connected to LANs in other buildings of the institute and to the Internet. This would be done by segregating the network into two parts, which consist of the following components:

1. *Internal LAN Connections*
    a. *Distribution Layer Switch* (DLS) - This is the physical backbone of the network which holds up the entire LAN.
    b. *Access Layer Switch* (ALS) - Provides network connectivity to their area. Typically connected to DLS via some form of cabling.
    c. *Vertical Cabling* - Provides connection between the DLS and ALS of each floors.
    d. *Horizontal Cabling* - Provides connection between the ALS and localhost of end level devices via a port (Ethernet) in the room. This would also connect the ALS to the routers on the same level.
    e. *Routers* - Provides wireless connectivity to all devices within range.
    f. UPS - A backup power supply for the distribution level switch in case of a power cut.
2. Connection to external LAN and Internet
    a. *Distribution Layer Switch* - The switch used in the internal LAN would also serve as the primary connection to the backbone of other networks in the other buildings of the institute.

b. *Optic Fibre Cabling* - The building's network would be connected to other building's via optic fibre.

COMPONENT DETAILS

DISTRIBUTION LEVEL SWITCH

For distribution level switch, we go with Cisco. Even though Cisco switches are more expensive, reliability of Cisco is leagues ahead of that of HP. We consider the following options:

1. Cisco Catalyst 6800 Series
2. Cisco Catalyst 6500 Series
3. Cisco Catalyst 4500-X Series
4. Cisco Catalyst 3850 Fibre Switch Series

Our Choice: ***Cisco Catalyst 4500-X Series***

Specifications:

- Upto 40 1/10 Gigabit ports
- 8 Hot-Swap uplink ports
- Size : 1 rack unit
- Power Consumption : ~330W
- PoE Power : 4 - 30W
- Price : $16,000/-

The 6800 and 6500 Series typically offers more than 40 ports. The 3850 Series offers 24 ports. Our requirement is 21 ports (3 switches for 7 floors each). With possibility of future upgrades, 24 is too less a margin and more than 40 is to high.

Power consumption starts from 350W for the 3850 Series and 700W for the 6000 Series and above.

The price of 6000 Series switches ranges from $25,000 - $40,000.

Hence, the Cisco Catalyst 4500-X Series is one of the most suited options for our needs.

ACCESS LEVEL SWITCH

For access level switches, we go with HP. HP switches' cost covers repair for a certain amount of years. Access level switches being bought more in number and used more rigorously (as it is connected to every room and router on the floor), would need such support. Moreover, HP is on average cheaper than Cisco. We consider the following options:

1. HP 8200 zl Switch Series
2. HP 7500 Switch Series
3. HP 5400zl Switch Series
4. HP 5400R zl2 Switch Series

Our Choice: ***HP 5400R zl2 Switch Series***

Specifications:

- Support of 288 ports
- Support for 10/100/1000GbE

- Configuration menu
- 1920 Gbps switching capacity
- SNMP manager, Command-line interface, Web browser (and more management features)
- Price range: $2,400 - $7,500/-

Since the 7000 and 8000 Series switches price from $8,200 - $22,000/-, we do not consider them, even if they fit our requirements. Such a price range would increase our overall cost by huge amounts.

However, 5400zl and 5400R zl2 were close competitors. The major reasons to choose the latter were slightly better price, more Ethernet slots, and more management features.

VERTICAL CABLING

This forms the backbone of our LAN in the boys hostel. It provides a connection between the different access level switch present on each floor. We can either stick to the CAT 5e cable for this, or use optic fibre cables.

We decided to use optical fibres for this, due to the higher bandwidth supported by it, and due since they can run much longer distances than copper twisted pair cables. There is no need for singlemode fibres, the bandwidth supported by mulit mode optical fibre is sufficient for our network.

Required length = 14 ft x 7 = approximately 100 feet.

Cost of multimode optical fibre cable = 150 $ per 500 feet [2]

Cost required = $ 30

HORIZONTAL CABLING

The horizontal cabling would connect the Access Level Switch on each floor with every room and router on the floor. Depending upon the occupancy, the number of Ethernet ports would be connected to the ALS via this cabling (2 ports for Double room, 1 port for Single room). This cabling limits the maximum available data rate to each individual connected system. Since upgrading the cabling or extending it is typically very expensive, and quite time consuming (as it may require parts of the building to be teared down), it is considered as a long term investment.

The available technologies for cabling are the following :

- Category 5e : Allows rates up to 1 gigabit per second
- Category 5 : Allows rates up to 100 megabits per second
- Category 4 : Allows rates up to 10 megabits per second

It is redundant to discuss other available cabling technologies, as they are obsolete and the maximum data rates they support are very low. Their low cost is not a good enough trade off compared to their data ratres.

Total students = 400

Assuming not more than 50 high speed download (10Mbps) at the same time.

*Total capacity needed = 50 * 10 = 500Mbps*

According to the above calculations, Category 5e cable would be sufficient to provide a ethernet connection that keeps up with the required data rates. Since the length of any wing (measured from the access layer switch to any host) is not greater than 100 meters, we will not require any repeaters.

Length of cable required for each floor = 90 + 50 + 50 = 190 m

Distance to furthest room from ASL = 45m (ASL is placed in middle of wing)

Length of cable = 45m

*Total length = 45 * 60 (rooms) = 2700m = 8900ft*

Cost of cable = Rs. 7,000 per 500 feet [source]

*Total cost = **$1900/- per floor***

Total cost = $ 13, 300/-

ROUTERS

The routers work as Access Points(AP) for wireless connectivity to the network. Any device having a wire network card and in range of the AP would be connected to the network. We consider the following options from **Cisco Aironet Series**:

	600 Series	**700W Series**	**1600 Series**	**2600 Series**	**3600 Series**
Idea for	Remote work	Residence Hall	Medium size enterprise	Large enterprise	Very large offices
Max Data Rate	300 Mbps	300 Mbps	300 Mbps	450 Mbps	1.3 Gbps
Max Client Support	15	100	128	200	200
Price	~$150	~$200	~$300-$400	$450	>$500

Our Choice: ***Cisco Catalyst 1600 Series***

Most of the routers have similar specifications. The 2600 and 3600 Series are too expensive for the features they offer. The 600 and 700W series, though cheaper, do not give the same signal strength. Hence, The Cisco Catalyst 1600 Series would be ideal.

Cost of single router = $375

Number of routers per floor = 5 (total 7 floors)

*Total Cost = 375*5*7 = $21000/-*

WIRING CLOSETS

Ideally, closets where switches are placed should be robust and naturally ventilated. Forced air ventilation or mechanical cooling is not required. Since the load is not very high on the access level will not lead to a lot of heat.

CONNECTION TO INTERNET

The distribution level switch will be connected to the core switch in the IT room. This should be done using single mode optical fibre. The core switch will allow internet connection, through the NKN connection.

Topology

The topology of this network is **extended star**. There are switches on each floor, which have a parent switch on the ground floor. This parent switch is connected to the core switch in the IT room using single mode optical fibre cable.

Conclusion

In this report, we have discussed how we will develop a local area network for the boys hostel at IIIT Delhi. This network has access to the internet, and provides wired as well as wireless network. This network will cater to approximately 400 students, providing a bandwidth of 1 Gbps. The topology of the network is **extended star**.

There are access level switches on each floor, which have cat5e cables running out of them to each room and the router access points. These access level switches are connected to a

parent switch placed on the ground floor. This is connected to the IT room. The total cost of this network sums up to $ 57, 800 /-

References

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