Network Design of RM

- Computer Networks : CS425A -

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Introduction

This report deals with designing a network layout for CSE department i.e. **Rajeev Motwani building**. Objective of the assignment is to give comprehensive report of how network nodes are connected to each other, how is wiring done, how many network nodes are needed in each room, lab, study lounge etc, which type of wire viz. fiber, Cat-6, Cat-7 etc would be needed, how everything is connected internally, how connection to outside network or internet is done, is firewall needed and many more questions. All of these will be answered in this report. We have used the blue print of RM for the more accurate design of network layout.

Design

The following services are required in the building:

- Wifi throughout the building
- LAN for internal communication (ex. within labs, printers)
- CCTV Cameras
- Internet Connection
- DNS, Mail, Web & VPN Server
- Proxy & Firewall

Building structure

There are in total 6 floors in Rajeev Motwani building. We describe below the requirement of routers, switches, wifi in each floor and what type of wire, router are needed. We'll divide each floor into two halves i.e left half and right half for easy reference.

First Floor

In this floor, left half has a lecture hall and right half has a server room and common area. For the lecture hall, 2 wifi routers of range 49 meters are assigned at the 2 ends of the classroom as shown in figure. This is done to ensure the proper coverage of whole classroom. Also, these routers are separately connected to a switch which is further connected to main router. Lecture hall will also contain 3-4 LAN ports for high speed internet. In right half, one wifi router will be provided as shown in th figure for common area.

Second Floor

In this floor, left half is the extension of lecture hall in first floor. Right half contains a PG lab and a professor's cabin. Network design of PG Lab is shown in next section. Broadly, right half will contain one wifi router and some LAN ports in common study area

Third Floor

Left half contains Conference room as shown in figure. Again, two wifi router and some LAN ports would be needed keeping in mind the density of persons in conference room. Right half has a PG lab with same structure as above, one wifi router and some LAN ports for study lounge.

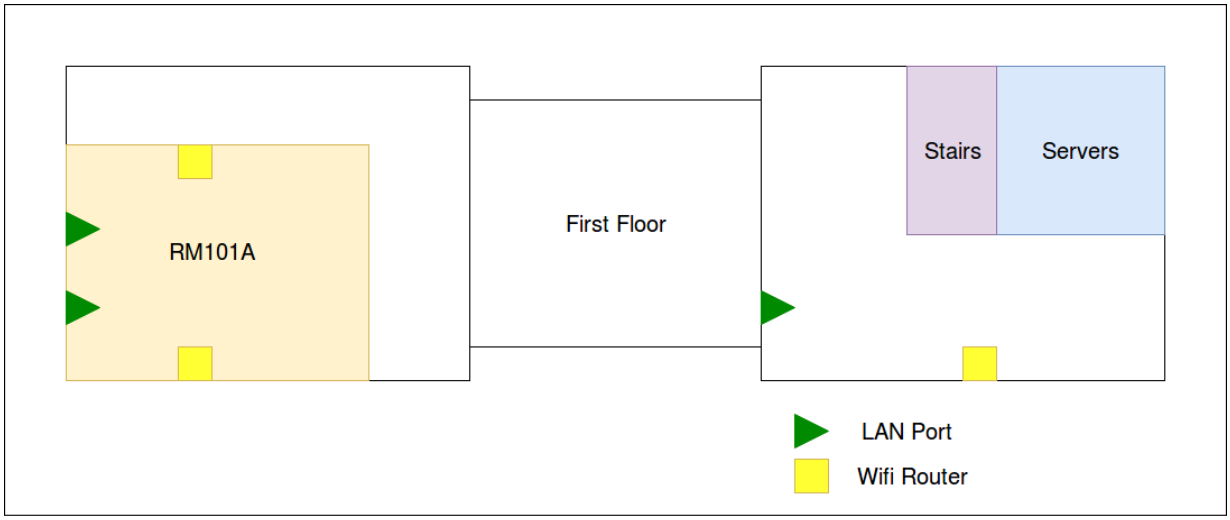

Figure 1: First Floor Layout

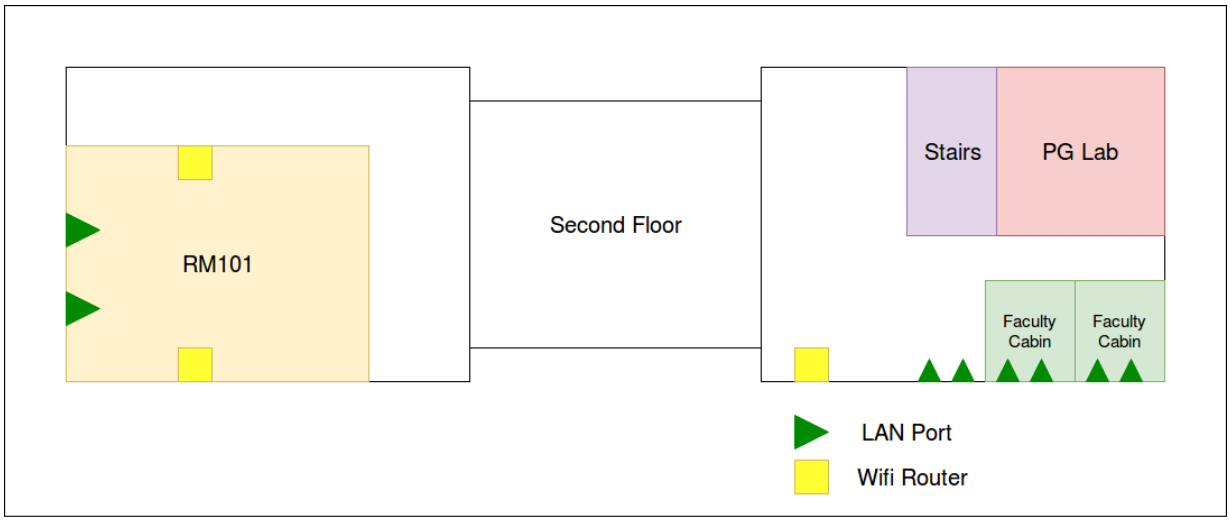

Figure 2: Second Floor Layout

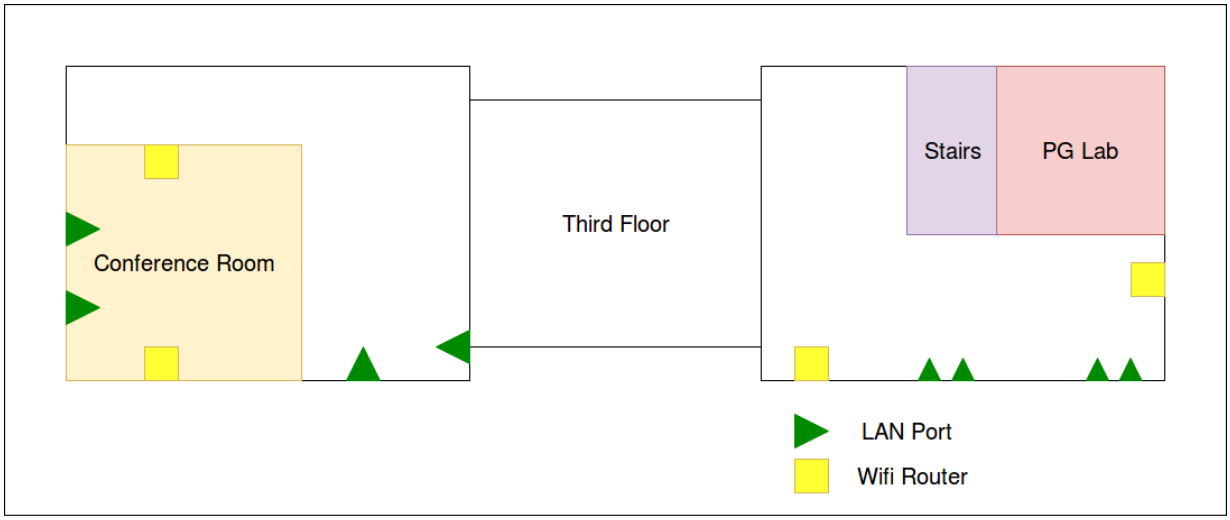

Figure 3: Third Floor Layout

Fourth & Fifth Floor

This floor has several PG labs, faculty offices and study lounges as shown in the figure. Each faculty office will have one printer and two LAN ports. Fifth floor is same as fourth floor.

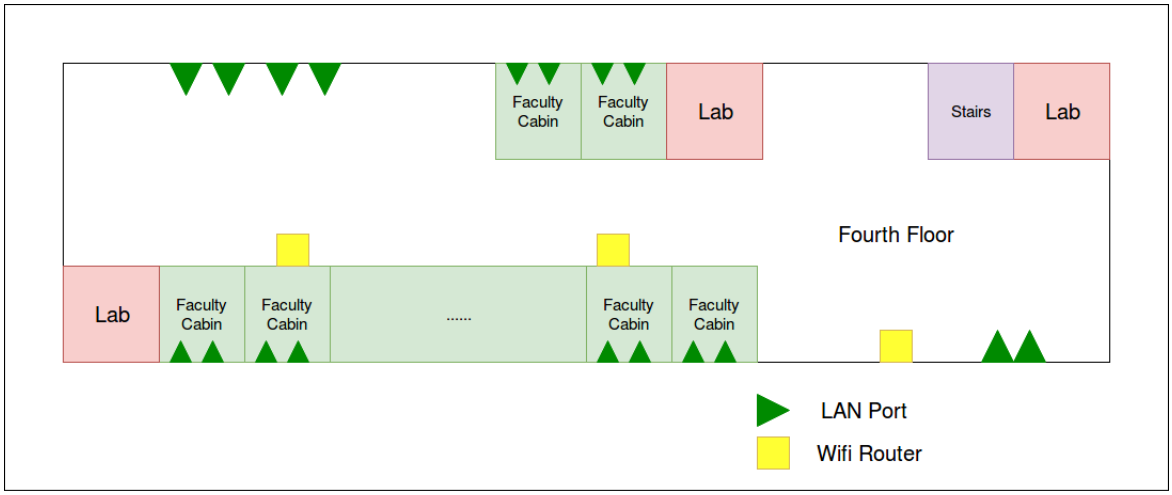

Figure 4: Fourth Floor Layout

Overall Design

- There will be a single root router which is connected to the internet.
- All the floor will have a dedicated switch which will be connected to router in a star topology.
- Within each floor, all devices - wifi routers, office PCs, lab switches will be connected to a floor switch using star topology.
- So, we are using hierarchical star topology because malfunctioning at a single node doesn't have any impact on other nodes and also diagnosis is lot easier.
- This is important because malfunctioning of a single wifi router should not be impacting other devices on that floor or malfunctioning of a single floor switch should not be impacting other floor switches of RM building which is a more serious problems. And also we would want to quickly identify fault and correct it. That's why we choose star topology.
- We choose switches over hubs because it improves the bandwidth of network and efficiently maintains traffic which is important considering large network of RM building.
- For connecting devices within a floor, office PCs will be connected using unshielded twisted-pair enhanced is a form of Cat 5 cable (Cat-5e). Cat-5e support 1 Gbps(125 Megabytes per sec) over a distance of 100 metres which would be sufficient for a single PC. Lab switch and wifi routers is connected to the floor switch through Cat-7 cable which support a data speed of upto 10Gbps over a length of 100 meters. All floor switches will be connected to a lone router through Cat-7 cable.

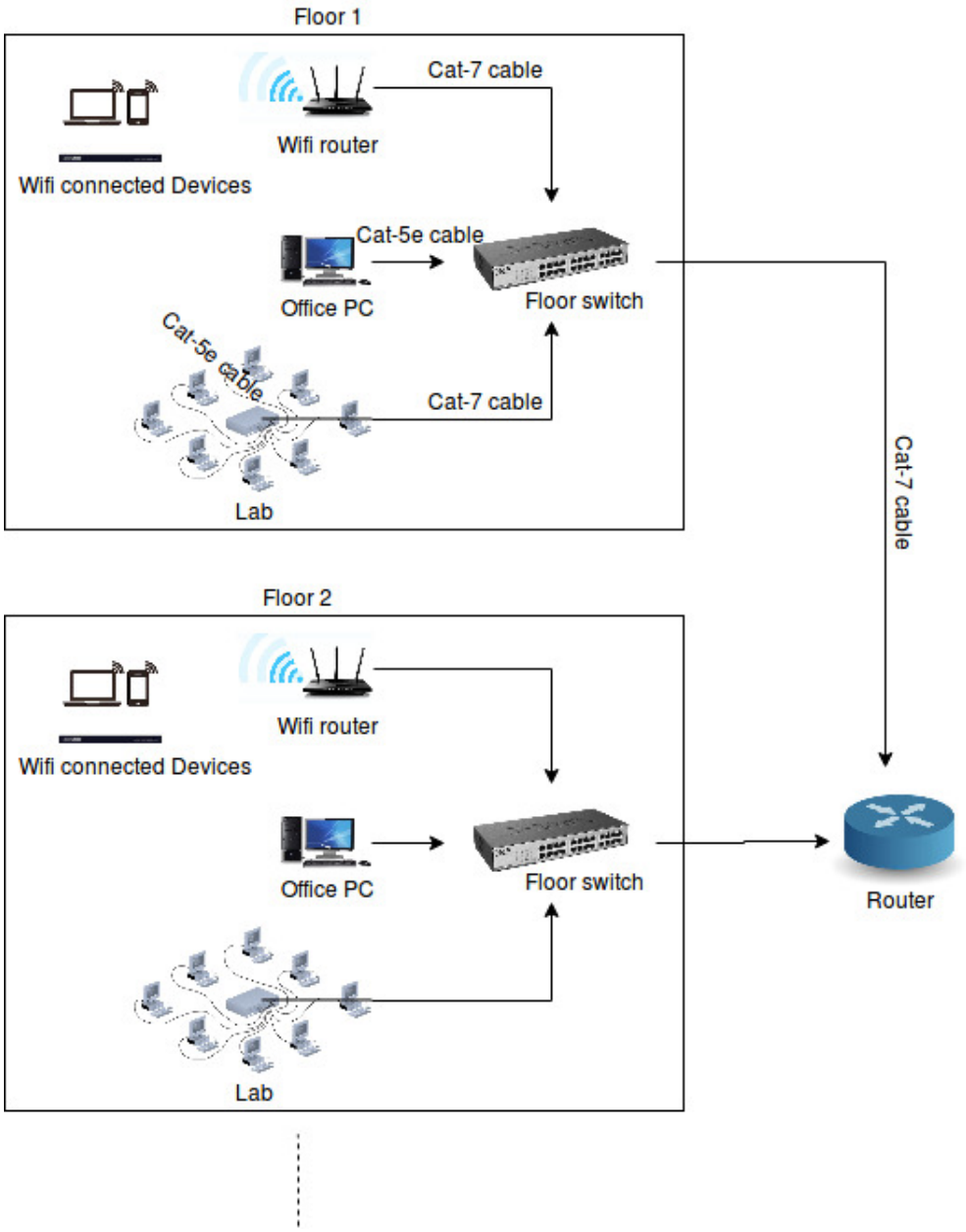

Figure 5: Overall Network Structure

Design Within a Lab

Topology

All the labs contain around 14-15 PCs. So, we can either use star or ring topology but we would prefer using star topology as malfunctioning of one PCs does not affect the working of other PCs and also diagnosis is lot easier. All the PCs inside a lab are connected to a central switch through a LAN cable. Central switch is connected to a switch of that floor.

Cabling

For cabling inside labs, we would be using unshielded twisted-pair enhanced is a form of Cat 5 cable (Cat-5e). Cat-5e support 1 Gbps(125 Megabytes per sec) over a distance of 100 metres. This data speed is more than sufficient for a single PC. Although we can also use Cat-5 cable

which has a data speed of 12 Mega bytes per sec but for downloading large datasets, students might need a larger speed so we proposed to use Cat-5e.

Lab switch is connected to the floor switch through Cat-7 cable which support a data speed of upto 10Gbps over a length of 100 meters. This data speed can easily fulfill the need of 14-15 devices.

DNS, Mail, Web & VPN Server

- We will setup a mail server that receives mails from local users as well as remote sender and transfer them to their respective clients within the network and also forwards outgoing emails for delivery.
- Similarly the DNS Server & Web Server will be set up. These servers will be directly connected to the root router (gateway) for providing their services.
- For providing access to the internal network from outside, we will setup a VPN server.
- VPN server will have two network cards- one for the public IP and one for the private IP. Once the user authenticates himself/herself correctly, VPN server will allocate a port on private IP for the user just like DHCP does and forward the request to the root router(gateway).

CCTV Cameras

We will use RG-59 cable which is the coaxial cable for the connection of CCTV cameras. All CCTV cameras are connected to the central system via these network cables where we can monitor the activities within the building.

IP Addressing

- On the basis of the hierarchical topology of the network, we divide the overall network into different subnets corresponding to each floor.
- A subnet for a floor comprises of a switch and all children (like wifi routers, LAN ports) connected to a switch. As per our condition, each floor could have atmost 40-50 nodes, so subnet masks of 25-26 range would suffice.
- We will use static IP addressing instead of dynamic IP addressing for all ports in the switches. This will cut the cost of using DHCP server and will reduce the cost of maintenance of the server.
- Therefore, each nodes viz. PC, wifi routers, printer will have a static IP assigned to it.
- Responsibility of each switch would be to redirect requests in its subnet or passing the request to its parent router. Then parent router would have the same responsibility.
- But for certain services which need constant connection to Internet, we'll be using static IP like mail server etc.
- Subnetting is done to make routing faster and easier across each floors.

Internet Connection

- We propose having the root router act as a gateway. Since all internal IPs will be private IPs, this router will perform Network Address Translation.
- Also, the gateway will be connected to DNS server, Mail Server, Web Server etc.
- We can then have a NAPT (Network Address and Port Translation) device connecting the root router (gateway) to the outside world.
- It sets priority order to the devices for an information packet. Since all devices in the network would be given a private IP, a lookup table is created with entries as private IP and port and corresponding public IP and port. Now when a request from a device is sent to outside world, router checks if it has session running or not and then changes the source IP in packet header to a public IP and sends the request to destination server. An entry is created for this in this table. Now when a reply comes back with addressing its public IP and a port, this is looked up into the table, corresponding private IP and port number is found, packet header is changed with destination address to private IP and packet is forwarded there.
- The NAT will also store some static IP mappings such as for the mail server and the DNS.
- We also propose to have a firewall placed after the NAT for security purposes. The firewall can be used to filter the packets going in and out of the private network thus allowing control over the packets being requested from the Internet.

Firewall & Proxy

For the security of our network, firewall is a must. We will place it between the Network Address Translation (NAT) and the internet. Common purpose usage of term firewall is for packet filtering on the network layer.

For advanced security we will add proxy server as a component of firewall. It inspects the applications and hence takes better decisions. Proxy servers provide increased performance and security. A gateway from the firewall is setup for the rest of the internet. We set them as a web proxy so that certain services like ftp, torrent are not allowed through the firewall.

References & Credits

- Head First Networking Book by Al Anderson and Ryan Benedetti
- Proxy Server: `https://kb.iu.edu/d/ahoo`
- Cable specification: electornics-notes.com