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19CSE301 COMPUTER NETWORKS

(SMART INSTITUTIONAL NETWORK)

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ABSTRACT

Computer networks have a significant impact on the working of an organization. Universities depend on the proper functioning and analysis of their networks for education, administration, communication, e-library, automation, etc. An efficient network is essential to facilitate the systematic and cost-efficient transfer of information in an organization in the form of messages, files, and resources. The project provides insights into various concepts such as topology design, IP address configuration, and how to send information in the form of packets to the wireless networks of different areas of a University.

The aim of this project is to design the topology of the university network using the software Cisco Packet Tracer with the implementation of wireless networking systems. This university network consists of the following devices:

1) Router (1941)
2) Switches (2960-24TT)
3) Email server
4) DNS server
5) WEB server (HTTP)
6) Wireless Device (Access Point)
7) PCs
8) Laptops
9) Smartphones
10) IOT devices

The design includes the following parts of the University:

- Smart parking area
- Smart guest home
- Hostel Blocks: Girls Block and Boys Block
- Academic Blocks: AB1 and AB2
- Dome Building and Library
- Smart IT Consulting

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i)INTRODUCTION

The word “digital” is very significant in today’s world, with an increase in the development of technology the entire world is moving towards the digital era. The educational institution plays an important role in this digitalization, hence the campus should adapt to digital means of networking as well and become a “digital campus”. Going wireless plays an important role in this digitalization. The wireless network makes the connection easy with a reduction in the use of wires or cables. A wired connection makes it difficult to keep track of all the devices and to manage the cable connection, which is not only chaotic but also challenging to handle.

Campus networking via wireless connection becomes an important part of campus life and provides the main way for teachers and students to access educational resources, which gives an important platform to exchange information. As laptops and intelligent terminals are widely used, demand for access to information anytime and anywhere has become more and more urgent, but traditional cable networks cannot meet this requirement. Then wireless network construction becomes necessary and essential. The wireless network is one of the important components of a digital campus and wisdom campus. It provides an efficient way to explore the internet with a mobile terminal for teachers and students regardless of cables and places. This is an important mark of the

modern campus as a supplement of a cable network. With the development of network and communication technology, cable networks on a university campus bring much convenience for teaching and research work. But for mobility and flexibility, it has obvious shortcomings. A wireless network can overcome these drawbacks and has been applied to the university campus.

- Project Statement :

In this mini-project, we defined a simulation of campus networks based on wireless networking. The network is divided into two sets: one for the campus area and the other for the hostel area.

The major aim of this project is to show the wireless connectivity that is used in universities to make the network efficient and mobile at the same time. Mobility is the major concentration of this project. In order to provide equal functionality to all the users (college staff and students), we have added DNS, Email, and HTTP servers for the maximum utilization of resources.

Hence the campus network provides different services such as connecting the user to the internet, data sharing among users (students, teachers, and different university members), accessing different web services for different functionalities, so it needs wireless networking for smooth processing.

ii)LITERATURE REVIEW

- What is Packet Tracer? [1]

Packet Tracer is a cross-platform visual simulation tool designed by Cisco Systems that allows users to create network topologies and imitate modern computer networks. The software allows users to simulate the configuration of Cisco routers and switches using a simulated command-line interface. Packet Tracer makes use of a drag-and-drop user interface, allowing users to add and remove simulated network devices as they see fit. The software is mainly focused on Certified Cisco Network Associate Academy students as an educational tool for helping them learn fundamental CCNA concepts. Previously students enrolled in a CCNA Academy program could freely download and use the tool free of charge for educational use.

- Router

A router is a device like a switch that routes data packets based on their IP addresses. The router is mainly a Network Layer device. Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets. Router divides broadcast domains of hosts connected through it.

- Switch

A network switch (also called switching hub, bridging hub, officially MAC bridge is networking hardware that connects devices on a computer network by using packet switching to receive and forward data to the destination device. A network switch is a multiport network bridge that uses MAC addresses to forward data at the data link layer (layer 2) of the OSI model. Some switches can also forward data at the network layer (layer 3) by additionally incorporating routing functionality. Such switches are commonly known as layer-3 switches or multilayer switches.

- Network Packet

A network packet is a formatted unit of data carried by a packet-switched network. A packet consists of control information and user data, which is also known as the payload.

- Server [2]

A server is a computer or system that provides resources, data, services, or programs to other computers, known as clients, over a network. In theory, whenever computers share resources with client machines they are considered servers. There are many types of servers, including web servers, mail servers, and virtual servers.

Many networks contain one or more of the common servers. The servers used in our project are as follows:

➢DNS Server

DNS stands for Domain Name System servers which are application servers that provide a human-friendly naming method to the user computers in order to make IP addresses readable by users. The DNS system is a widely distributed database of names and other DNS servers, each of which can be used to request an otherwise unknown computer name. When a user needs the address of a system, it sends a DNS request with the name of the desired resource to a DNS server. The DNS server responds with the necessary IP address from its table of names.

➢WEB Server

One of the widely used servers in today's market is a web server. A web server is a special kind of application server that hosts programs and data requested by users across the Internet or an intranet. Web servers respond to requests from browsers running on client computers for web pages, or other web-based services.

➢EMAIL Server

An e-mail server is a server that handles and delivers e-mail over a network, using standard email protocols. For example, the SMTP protocol sends messages and handles outgoing mail requests. The POP3 protocol receives messages

and is used to process incoming mail. When you log on to a mail server using a webmail interface or email client, these protocols handle all the connections behind the scenes.

- Wireless Network

A wireless network broadcasts an access signal to the workstations or PCs. This enables mobility among laptops, tablets, and PCs from room to room while maintaining a firm network connection continuously. A wireless network also presents additional security requirements.

- Ethernet

This is the backbone of our network. It consists of the cabling and is typically able to

transfer data at a rate of 100mb/s. It is a system for connecting a number of computer systems to form a local area network, with protocols to control the passing of information and to avoid simultaneous transmission by two or more systems. Among the different types of ethernet, we have used Gigabit Ethernet, which is a type of Ethernet network capable of transferring data at a rate of 1000 Mbps and fast Ethernet is a type of Ethernet network that can transfer data at a rate of 100 Mbps.

- Computing Device

Computing devices are the electronic devices that take user inputs, process the inputs, and then provide us with the end results. These devices may be Smartphones, PC Desktops, Laptops, printer, and many more.

- Internet Protocol

  Internet Protocol (IP) is one of the fundamental protocols that allow the internet to work. IP addresses are a unique set of numbers on each network and they allow machines to address each other across a network. It is implemented on the internet layer in the IP/TCP model.

- SSH Protocol[3]

  Secure Shell enables a user to access a remote device and manage it remotely. However, with SSH, all data transmitted over a network (including usernames and passwords) is encrypted and secure from eavesdropping.

  SSH is a client-server protocol, with an SSH client and an SSH server. The client machine (such as a PC) establishes a connection to an SSH server running on a remote device (such as a router). Once the connection has been established, a network admin can execute commands on the remote device.

- Benefits of wireless networking over wired networking[5]

  To better understand the wide usage of wireless networking in today's world, is to start with the benefits it has over traditional wired networking is crucial for our project implementation. Some major aspects have been stated below that show the various advantages of a wireless network over wired ones.

1. Mobility

   One of the major advantages of wireless is mobility. Users have the freedom to move within the area of the network with their computing devices staying connected to a network without being concerned about the cable connection.

2. Less Hassle

   The wireless network helps in the reduction of large amounts of cables or wires which becomes chaotic and difficult to maintain, it makes the connection hassle-free.

3. Accessibility

   Provide network access across your organization, even in areas that have been challenging to reach with the wired network, so your entire team can stay in touch.

4. Expandability

   The wireless network helps in the expansion of the network to a wide range by adding multiple new users and locations without additional need to run cables and wires.

5. Guest Access

   Offer secure network access to guest users, including customers and business partners, while keeping your network resources protected.

With lots of advantages, there come disadvantages as well, like security issues which can be resolved using strict protection passwords. Also, the Speed of wireless networks is considered to be slow and having low bandwidth when compared to the direct cable connection networks.

- Simulation Environment

The simulations of our network topology can be easily achieved using cisco packet tracer. Using a simulation mode, you can see packets flowing from one node to another and can also click on a packet to see detailed information about the OSI layers of the networking. Packet Tracer offers a huge platform to combine realistic simulation and visualize them simultaneously. Cisco Packet Tracer makes learning and teaching significantly easier by supporting multi-user collaboration and by providing a realistic simulation environment for experimenting with projects.

iii)WORK DONE

In order to make our project understandable, we have divided the content into steps. They are as follows:

1. Software and hardware requirements

Before heading towards the implementation we need to make sure of the following requirements.

- A proper workstation (any mid-high range laptop will suffice).
- Packet Tracer by Cisco
- 8 GB RAM.
- Any 10,000+ Average CPU Mark scored processor.
- 16 GB of dedicated hard disk space.
- USB 3.0+ port.

2. Brief knowledge about our approach

The proposed wireless network is implemented for a university campus. We have made a virtual visualization of the network using the Cisco Packet tracer which provides a huge platform for users to test their projects using simulation tools. A Wireless network in an educational campus makes it easier for teachers and students to access

educational resources, by enabling an important platform to exchange information.

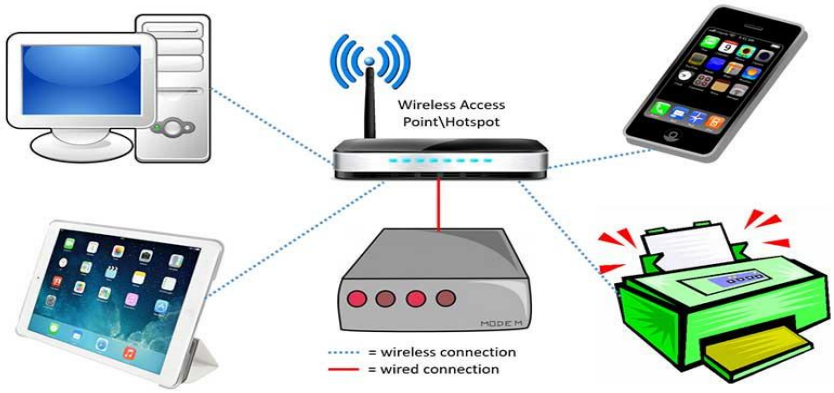


Figure 1: Shows the wireless connection access by various tool

3. Network Requirements

Manipal University Jaipur outline is considered for this wireless university network.
The network is divided into 2 areas :

1. Campus Area
   The Campus area is further divided into various accessing points like Dome building, Library, Academic Blocks (AB1 and AB2), Server Centre, and IT consulting.
2. Hostel Area
   The Hostel area is further divided into Boys blocks and Girls blocks respectively.

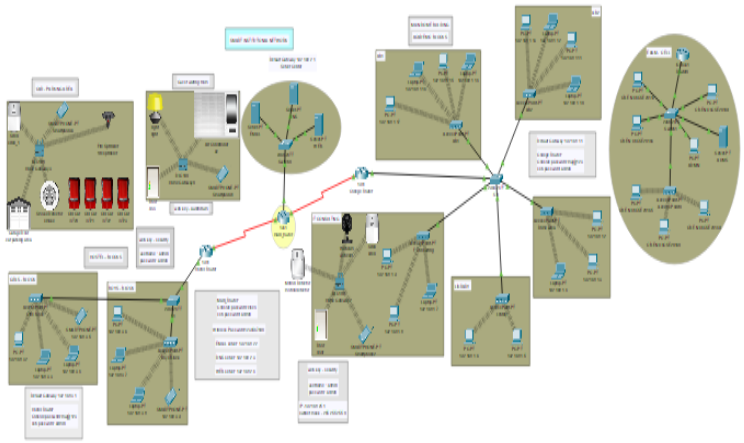


Figure 2:Basic layout of our wireless access points in University

Devices Used In The Network

Devices	Quantity
1) Router (1941)	4
2) Switches (2960-24TT)	4
3) EMAIL server	1
4) DNS server	1
5) WEB server (HTTP)	1
6) Wireless Device (Access Point)	8
7) PCs	19
8) Laptops	10
9) Smartphones	5
10) Home gateway	3
11) IOT devices	9

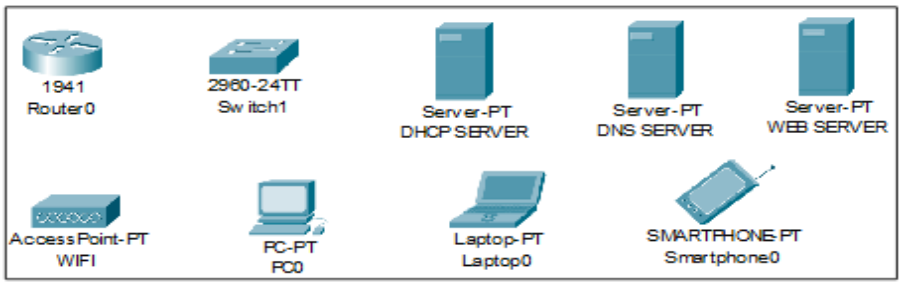


Figure 3: Devices used in the network

4. Implementation and Flow Diagram

- To design the wireless network of the university we initially started by placing the core devices into the frame as mentioned in the layout.

- Firstly, we placed the main router at the centre of the university outline, which was further connected to the server switch using the gigabit ethernet port with copper straight-through cable and sub routers (campus router and hostel router) using the serial port with serial DCE cable at the hostel area and campus area respectively.

- The server switch was further connected to the EMAIL, DNS, and WEB servers respectively.

- Campus router was connected to the campus switch which was further connected with wireless access points of the academic block

(AB1 and AB2), dome building, library, and IT consulting.

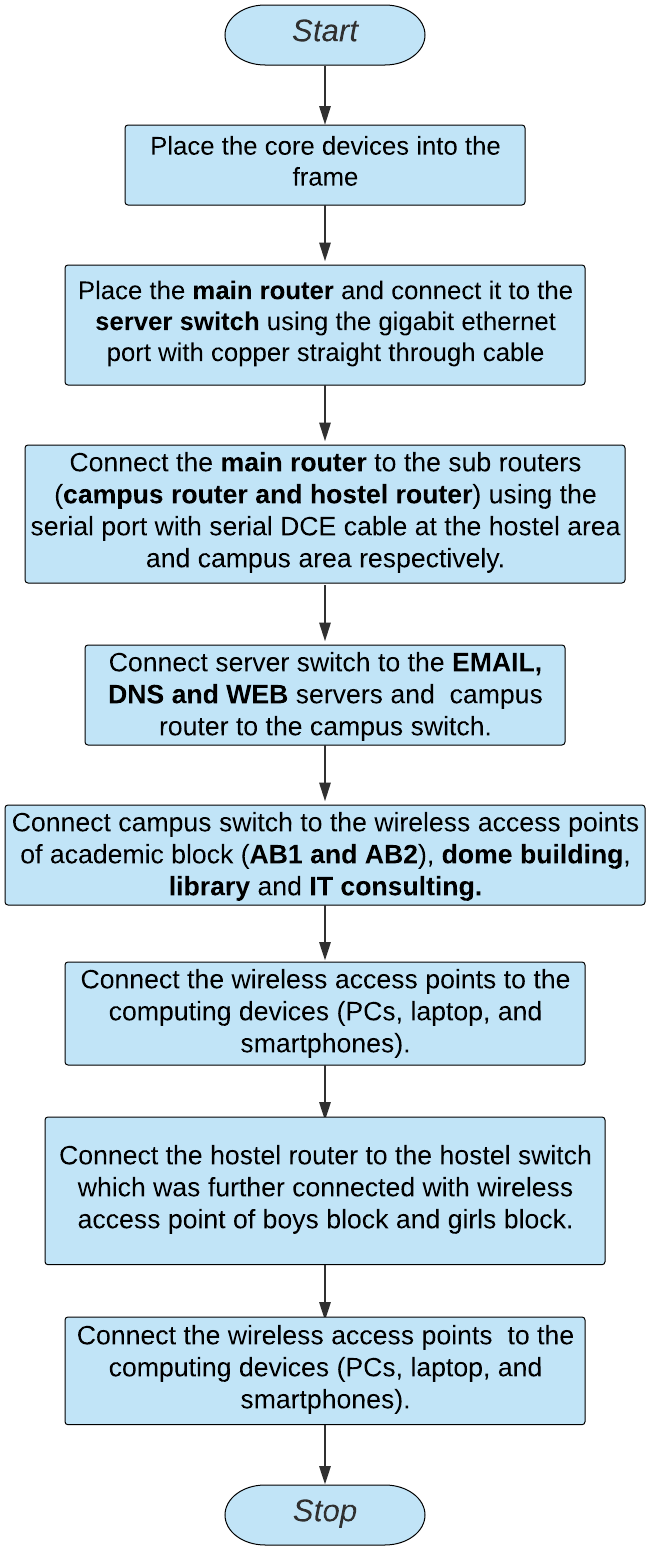
- The wireless access points were then connected to computing devices (PCs, laptops, and smartphones).

- Similarly, the hostel router was connected to the hostel switch which was further connected with the wireless access point of boys block and girls block.

- The wireless access points were then connected to the computing devices (PCs, laptops, and smartphones), every area has a dedicated access point which can only be connected with the help of a password.

- All these connections are made through ethernet ports (gigabit ethernet and fast ethernet) using copper straight-through cables.

- Along with these features smart parking system along with smoke detection and smart guest home and It consulting room with automatic monitoring system is also included.

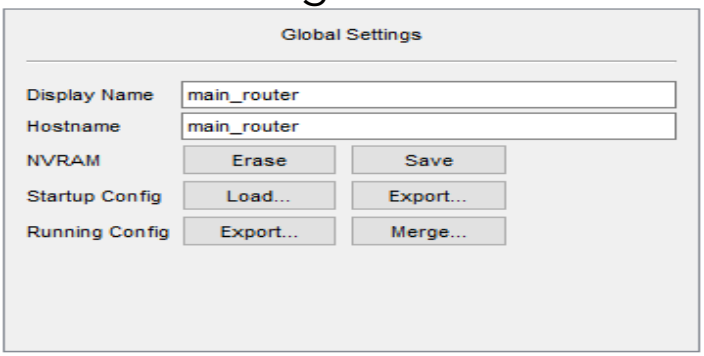


This is the flow diagram for a better understanding of the steps mentioned above.

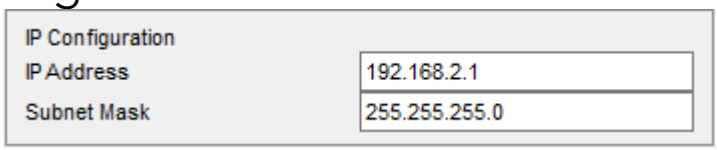
5. Configuring IP Addresses

We have attached the screenshots of all the IP configuration below:

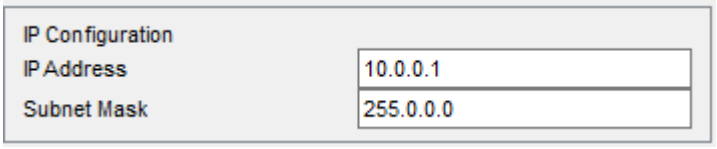
- Main Router configuration



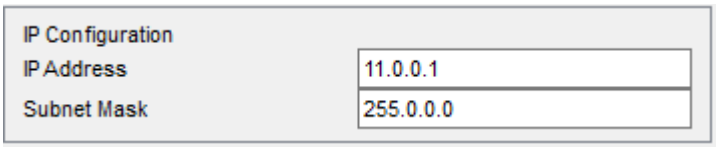
GigabitEthernet0/1



Serial0/1/0



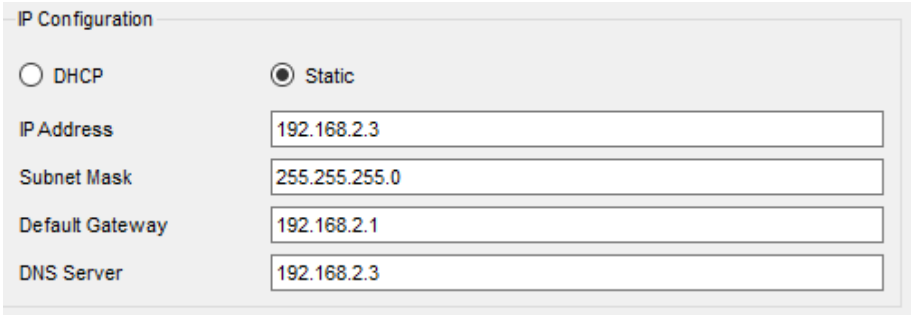
Serial0/1/1

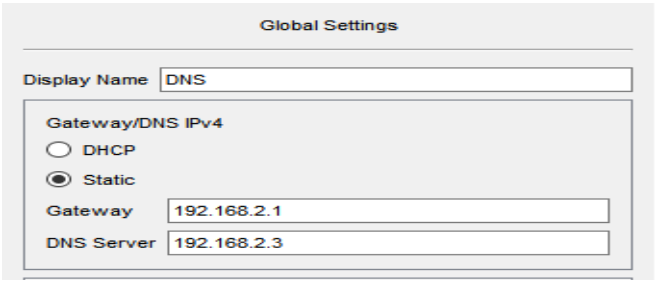


RIP

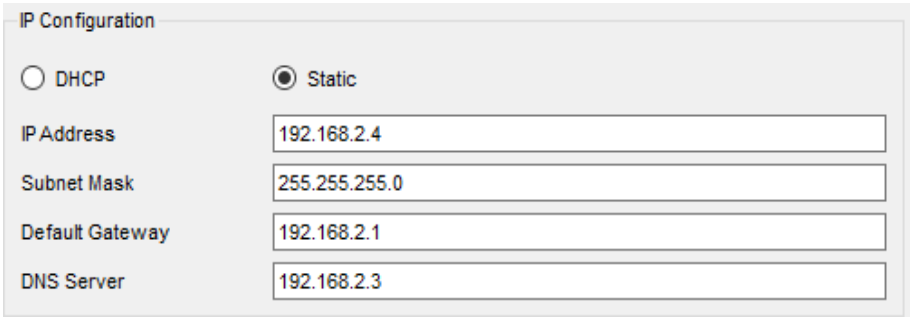
Network Address
10.0.0.0
11.0.0.0
192.168.1.0
192.168.2.0

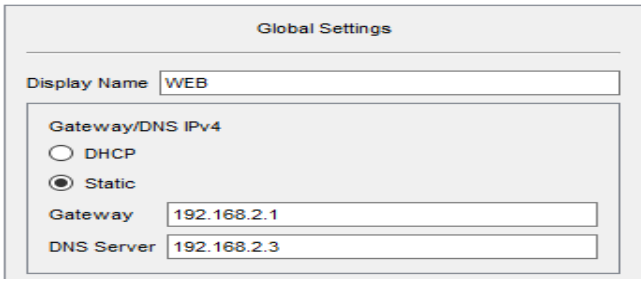
- DNS SERVER



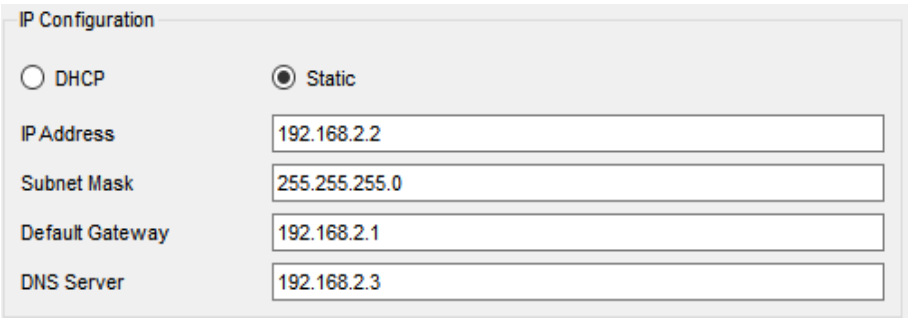


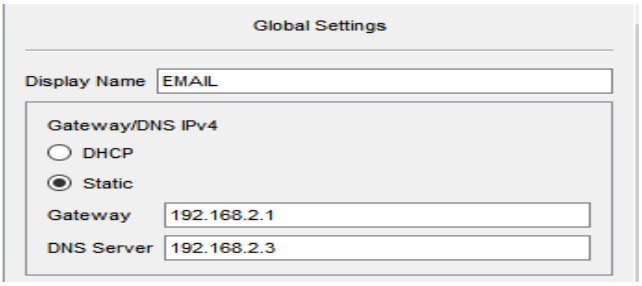
- WEB SERVER





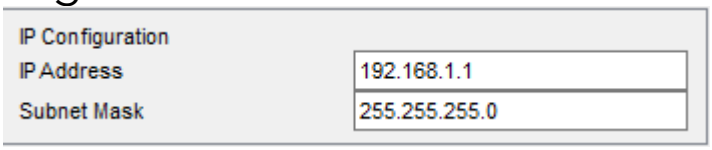
- Email server



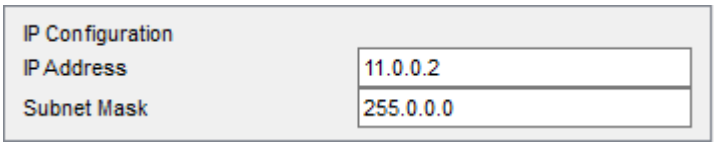


- COLLEGE ROUTER

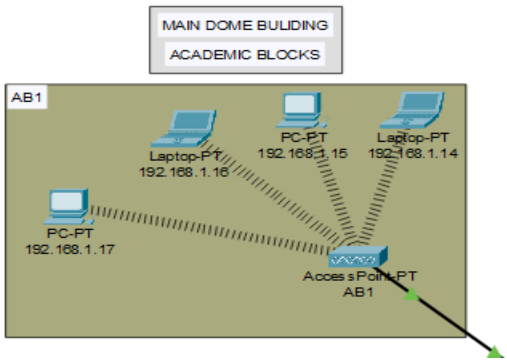
GigabitEthernet0/0



Serial0/1/0

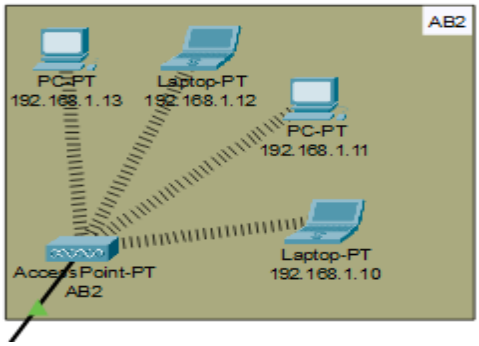


- ACADEMIC BLOCK 1



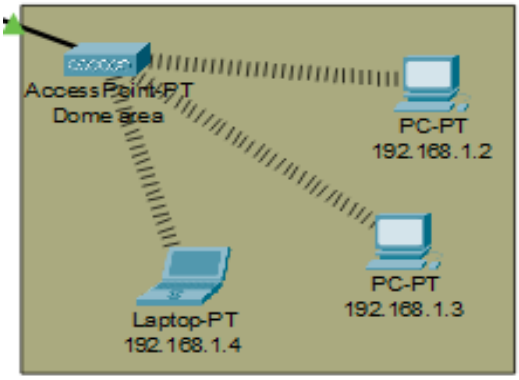
IP Address are as follows
192.168.1.14- Laptop
192.168.1.15- PC
192.168.1.16- Laptop
192.168.1.17- PC
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.1.1
DNS Server- 192.168.2.3

- ACADEMIC BLOCK 2



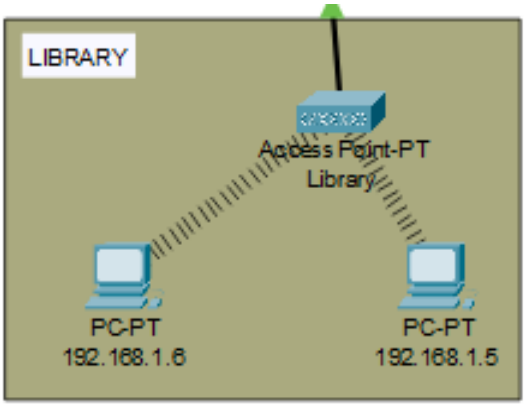
IP Address are as follows
192.168.1.10- Laptop
192.168.1.11- PC
192.168.1.12- Laptop
192.168.1.13- PC
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.1.1
DNS Server- 192.168.2.3

- DOME BUILDING



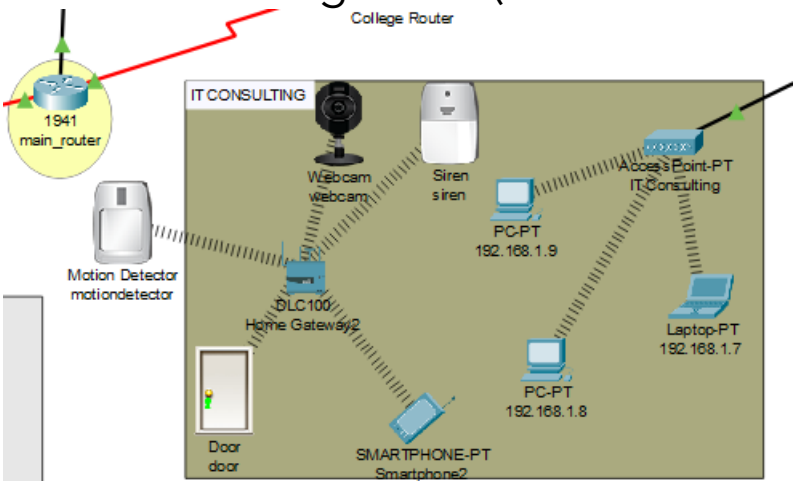
IP Addresses are as follows
192.168.1.2- PC
192.168.1.3- PC
192.168.1.4- Laptop
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.1.1
DNS Server- 192.168.2.3

- LIBRARY



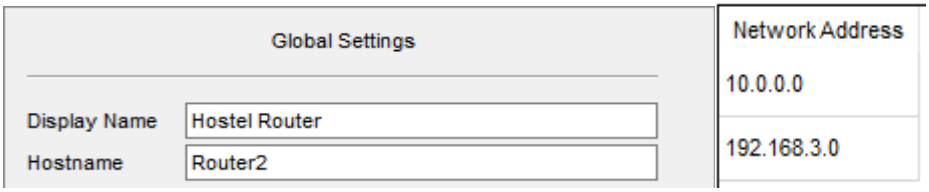
IP Addresses are as follows
192.168.1.5- PC
192.168.1.6- PC
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.1.1
DNS Server- 192.168.2.3

- Smart IT Consulting room (with motion detector)

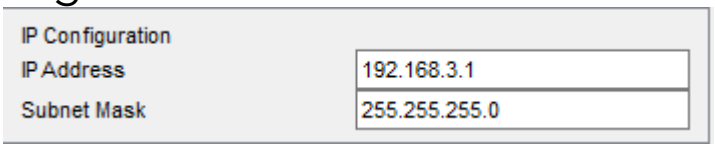


IP Addresses are as follows
192.168.1.7- Laptop
192.168.1.8- PC
192.168.1.9- PC
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.1.1
DNS Server- 192.168.2.3

- HOSTEL ROUTER



GigabitEthernet0/0



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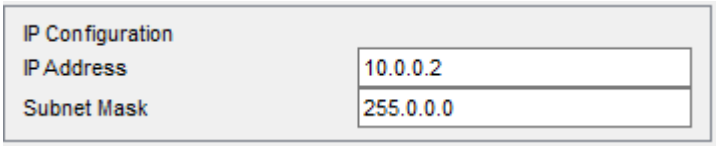
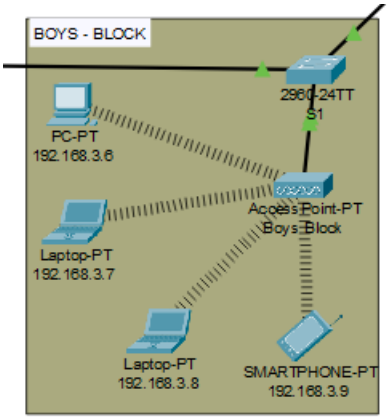
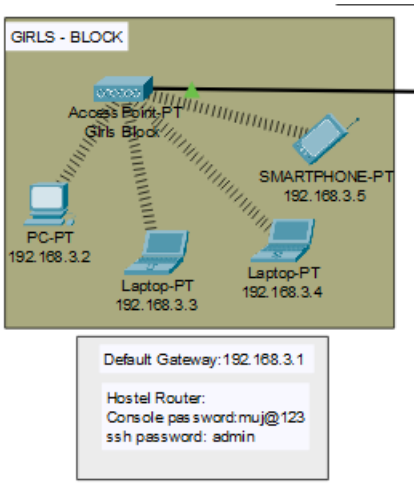


- Boys Block



IP Addresses are as follows
192.168.3.6- PC
192.168.3.7-Laptop
192.168.3.8- PC
192.168.3.9- Smartphone
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.3.1
DNS Server- 192.168.2.3

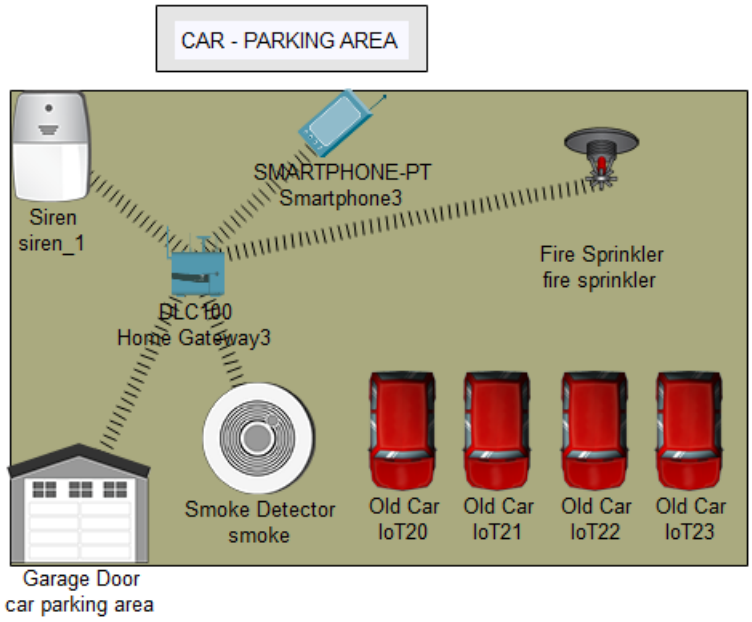
- Girls Block



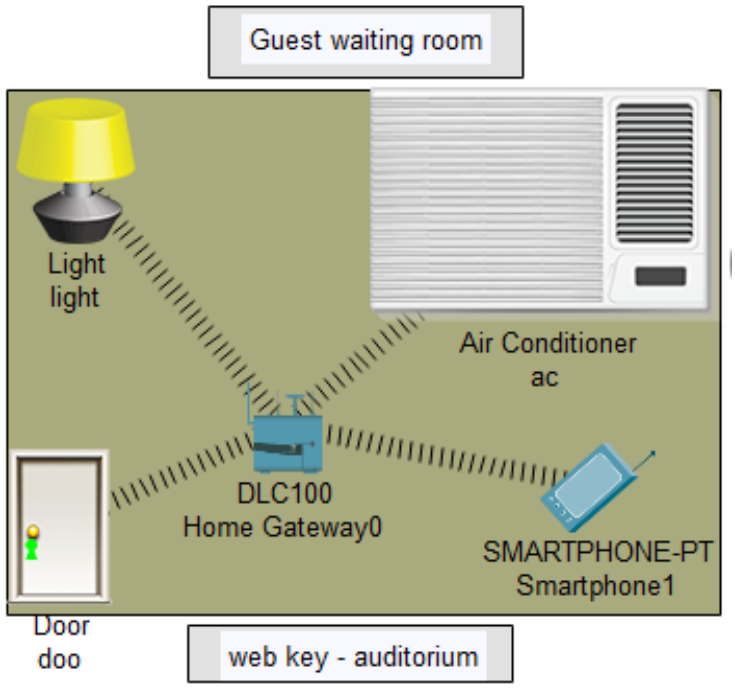
IP Addresses are as follows
192.168.3.2- PC
192.168.3.3-Laptop

192.168.3.4- PC
192.168.3.5- Smartphone
Subnet Mask- 255.255.255.0
Default Gateway- 192.168.3.1
DNS Server- 192.168.2.3

- Smart parking area

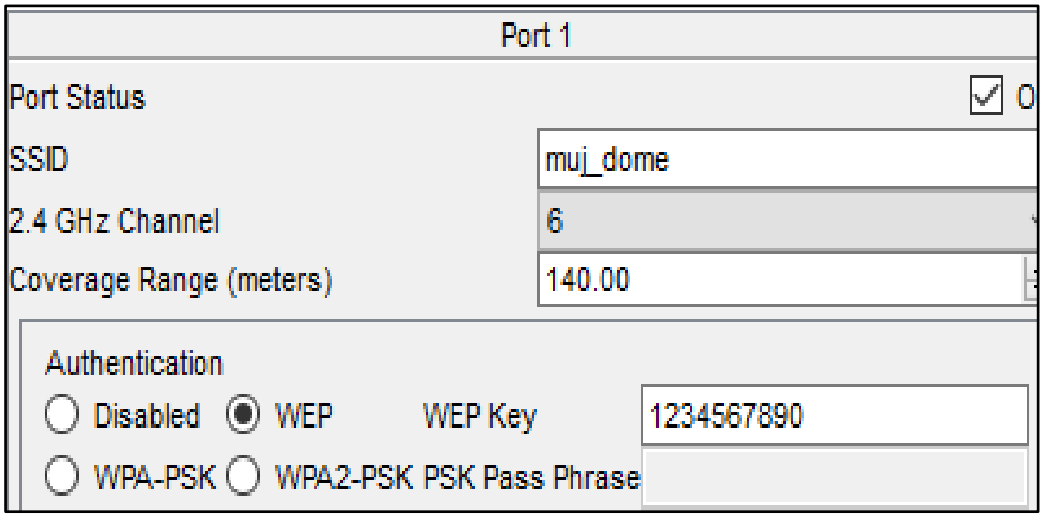


- Smart guest home



- WIRELESS ACCESS POINT

SSID	Password
1)muj_dome	1234567890
2)muj_library	1234567890
3)muj_ITC	1234567890
4)muj_AB1	1234567890
5)muj_AB2	1234567890
6)muj_boys	1234567890
7)muj_girls	1234567890

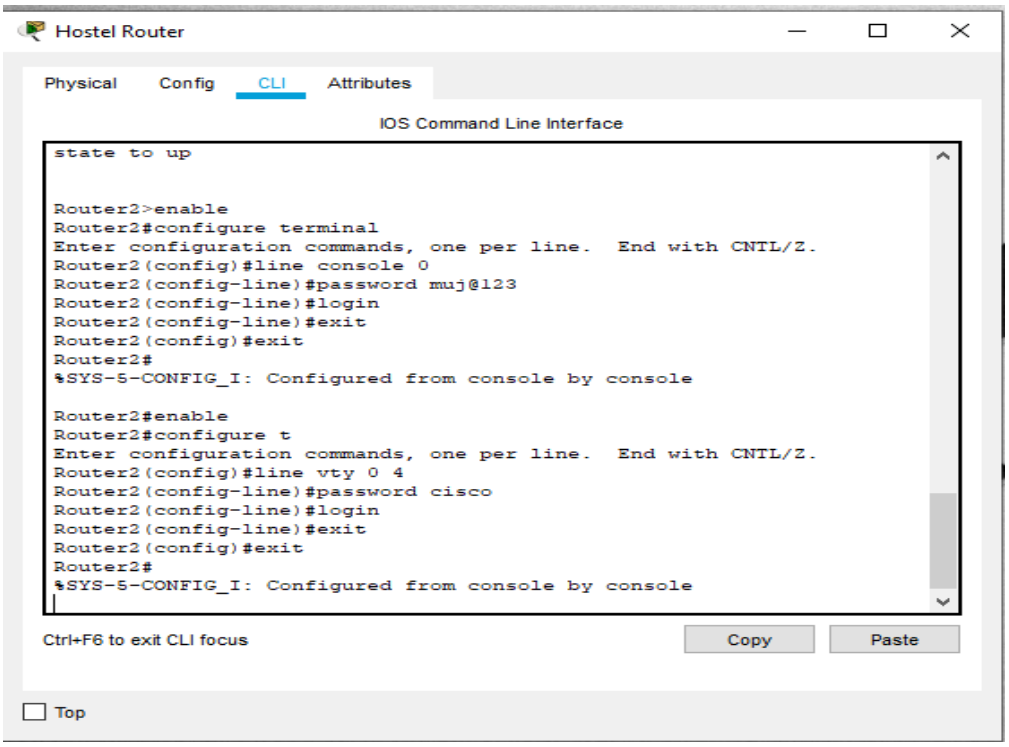


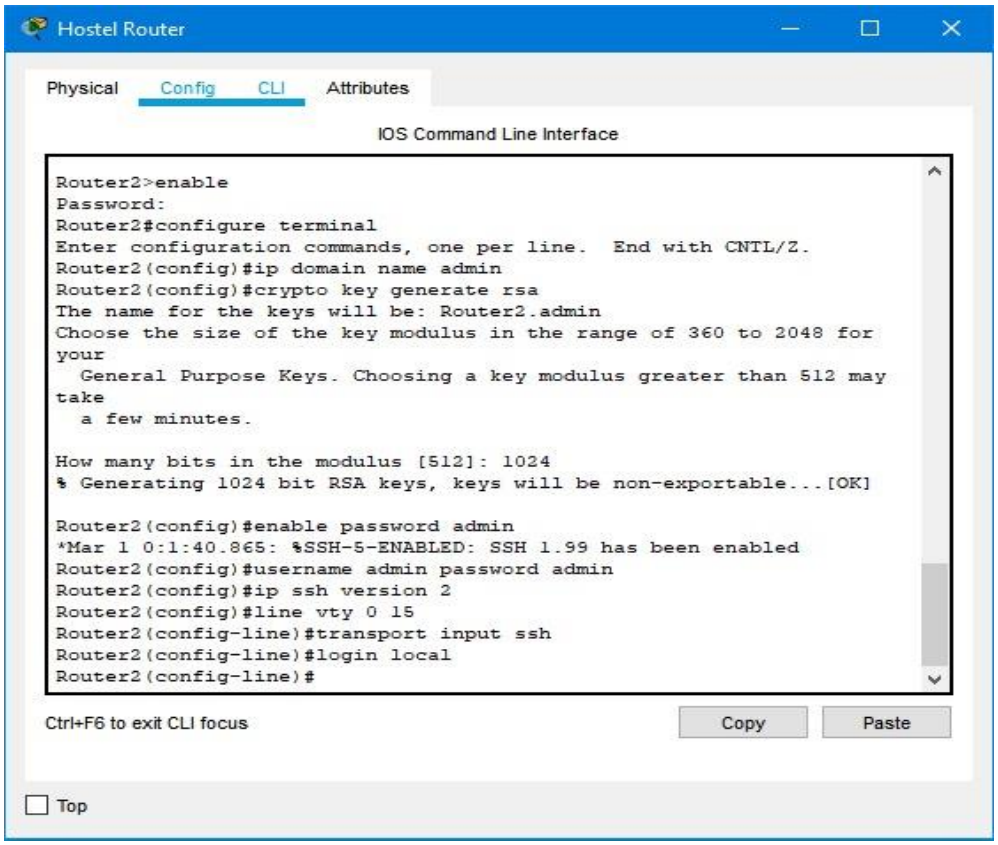
6. Securing the network

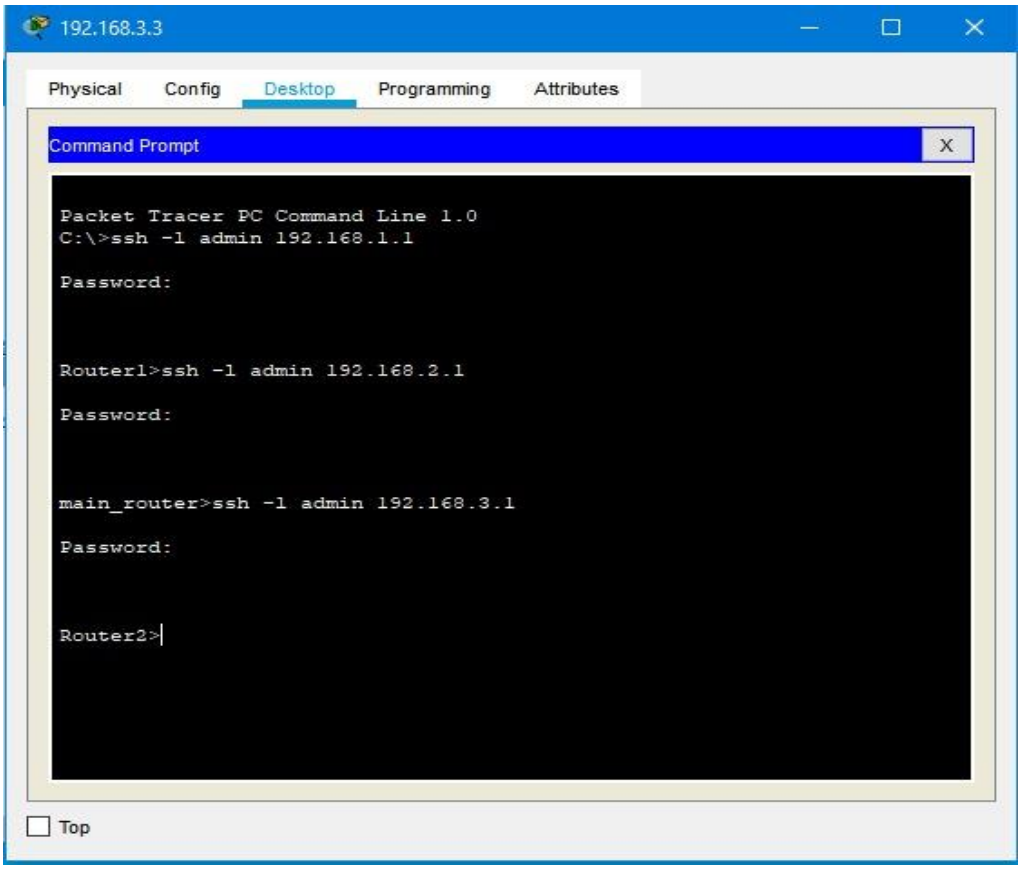
Passwords are used in accessing the router and all the wireless networks (mentioned in step 5 wireless access point) to make the access limited to University authorized users only.

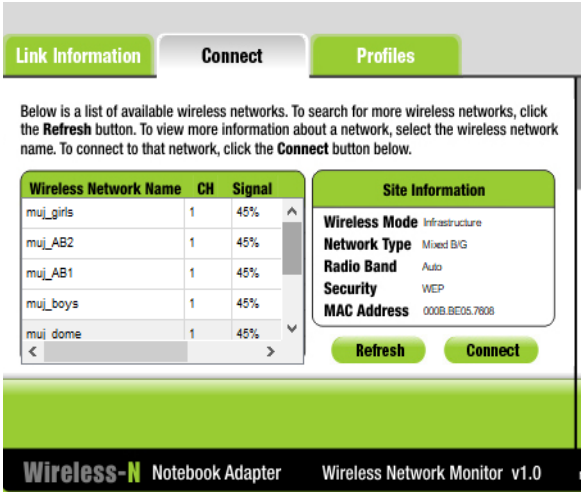
Routers are also secured with ssh (Secure Shell). Routers and their assigned passwords are mentioned below:

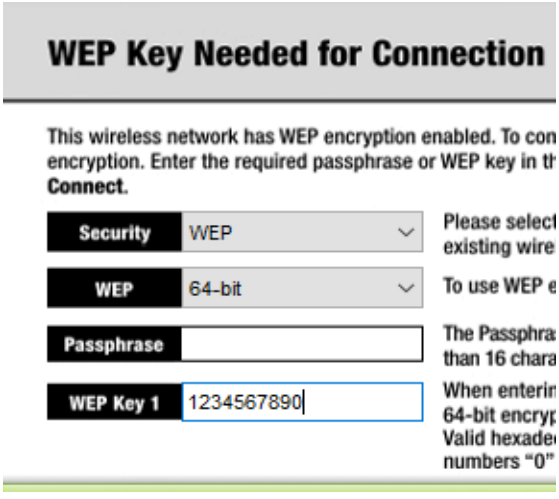
Router Name	Passwords
1)main_router	Console password: cisco ssh password: admin
2)Router1(College Router)	Console password:muj@123 ssh password: admin
3)Router2(Hostel Router)	Console password:muj@123 ssh password: admin


Hostel Router
Physical
Config
CLI
Attributes
IOS Command Line Interface
state to up
Router2>enable
Router2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#line console 0
Router2(config-line)#password muj@123
Router2(config-line)#login
Router2(config-line)#exit
Router2(config)#exit
Router2#
%SYS-5-CONFIG_I: Configured from console by console
Router2#enable
Router2#configure t
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#line vty 0 4
Router2(config-line)#password cisco
Router2(config-line)#login
Router2(config-line)#exit
Router2(config)#exit
Router2#
%SYS-5-CONFIG_I: Configured from console by console
Ctrl+F6 to exit CLI focus
Copy
Paste
Top


Hostel Router
Physical
Config
CLI
Attributes
IOS Command Line Interface
Router2>enable
Password:
Router2#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router2(config)#ip domain name admin
Router2(config)#crypto key generate rsa
The name for the keys will be: Router2.admin
Choose the size of the key modulus in the range of 360 to 2048 for
your
  General Purpose Keys. Choosing a key modulus greater than 512 may
take
  a few minutes.
How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]
Router2(config)#enable password admin
*Mar 1 0:1:40.865: %SSH-5-ENABLED: SSH 1.99 has been enabled
Router2(config)#username admin password admin
Router2(config)#ip ssh version 2
Router2(config)#line vty 0 15
Router2(config-line)#transport input ssh
Router2(config-line)#login local
Router2(config-line)#
Ctrl+F6 to exit CLI focus
Copy
Paste
Top



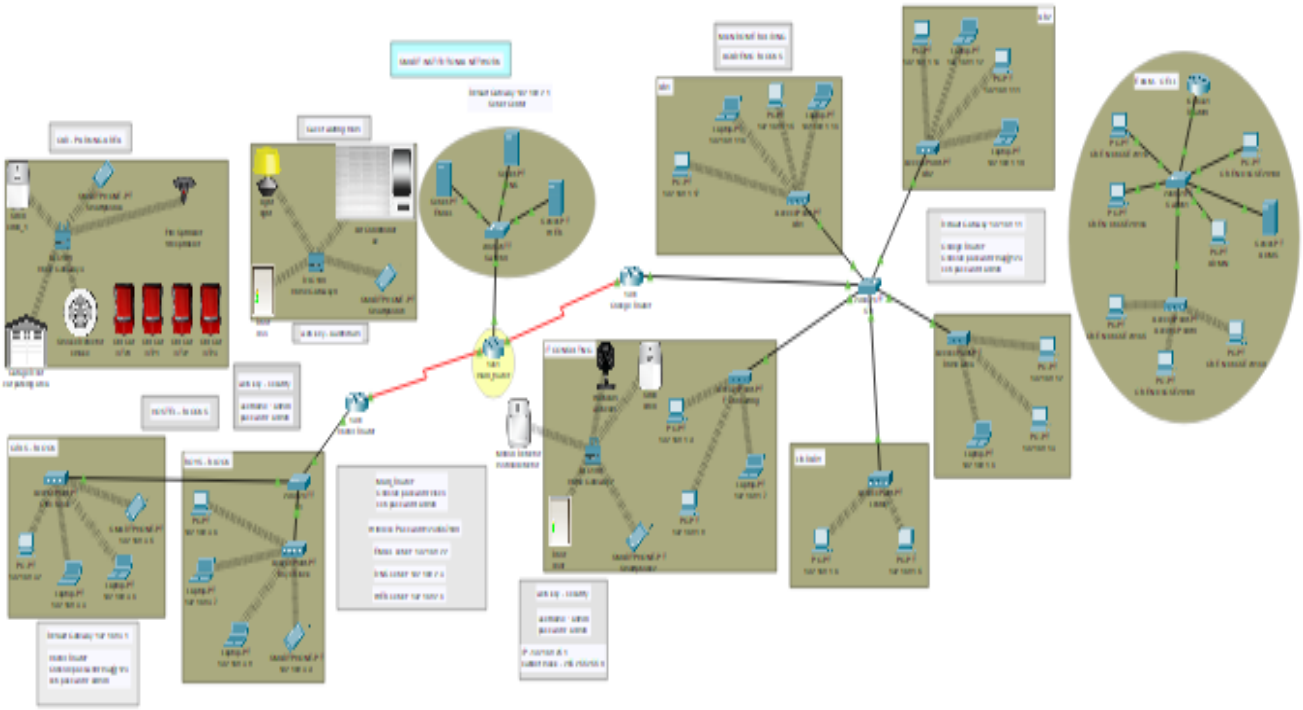




Connectivity of wireless network on computing devices .

iv)RESULT & DISCUSSION

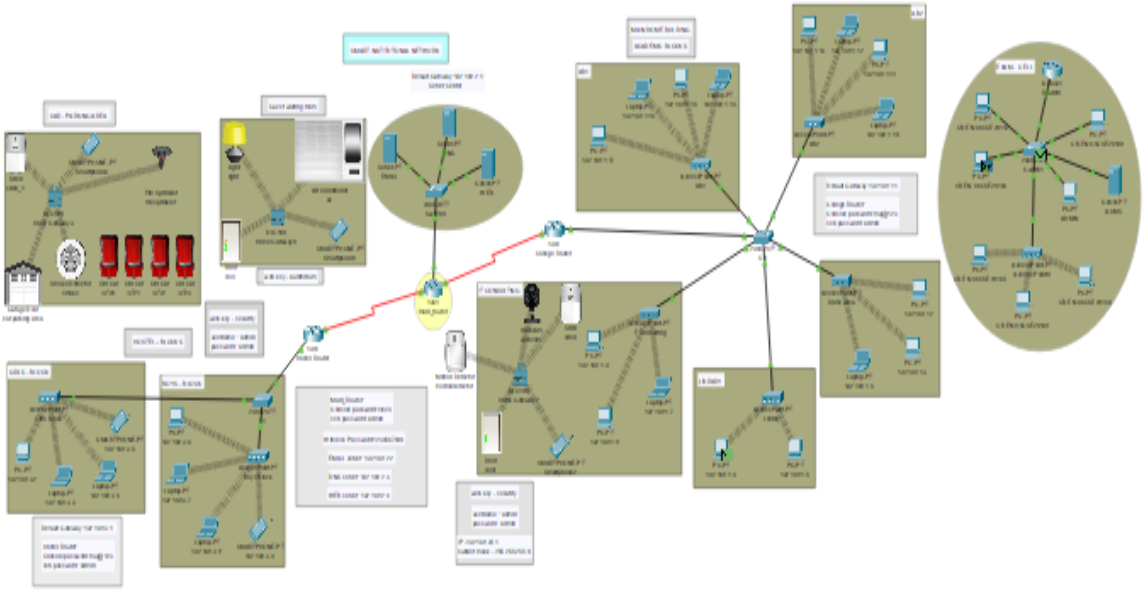
Finally, we have combined all the steps as mentioned in (work done) and implemented the desired wireless network for University. We have the complete network providing various facilities to the teaching staff, non-teaching staff, and students.



- Final Simulation

In Simulation Mode, you can watch your network run at a slower pace, observing the paths that packets take and inspecting them in detail. The proposed architecture, when simulated on Cisco Packet Tracer, produced results which are demonstrated as follows:

Final simulation for the network system to check all the connections



Simulation Panel

Event List

Vis.	Time(sec)	Last Device
	0.013	S0
	0.013	S0
	0.013	S0
	0.013	S0
	0.013	--
	0.014	Access Point0
	0.014	Access Point0
	0.014	Access Point0
	0.015	--
	0.016	192.168.3.7
	0.017	Boys Block
	0.018	S1
	0.018	--

Reset Simulation | Constant Delay | Capturing...

Play Controls

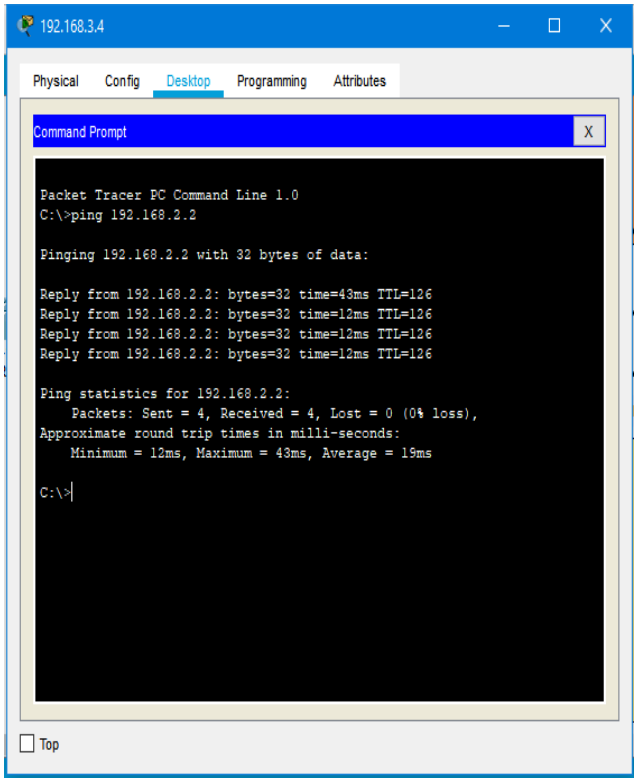
Event List Filters - Visible Events

ACL Filter, ARP, BGP, Bluetooth, CAPWAP, CDP, DHCP, DHCPv6, DNS, DTP, EAPOL, EIGRP, EIGRPv6, FTP, H.323, HSRP, HSRPv6, HTTP, HTTPS, ICMP, ICMPv6, IPSec, ISAKMP, IoT, IoT TCP, LACP, LLDP, NDP, NETFLOW, NTP, OSPF, OSPFv6, PAgP, POP3, PPP, PPPoED, PTP, RADIUS, REP, RIP, RIPng, RTP, SCCP, SMTP, SNMP, SSH, STP, SYSLOG, TACACS, TCP, TFTP, Telnet, UDP, USB, VTP

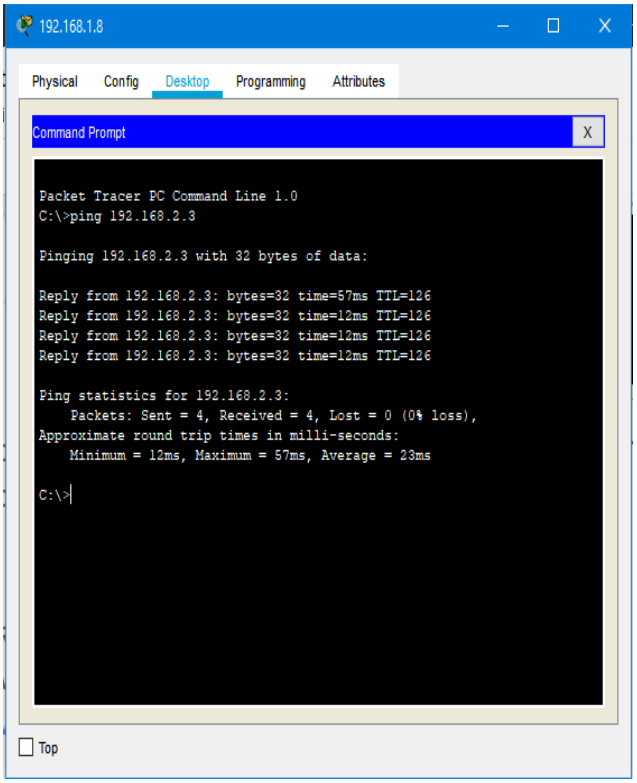
Edit Filters | Show All/None

Event List | Realtime | Simulation

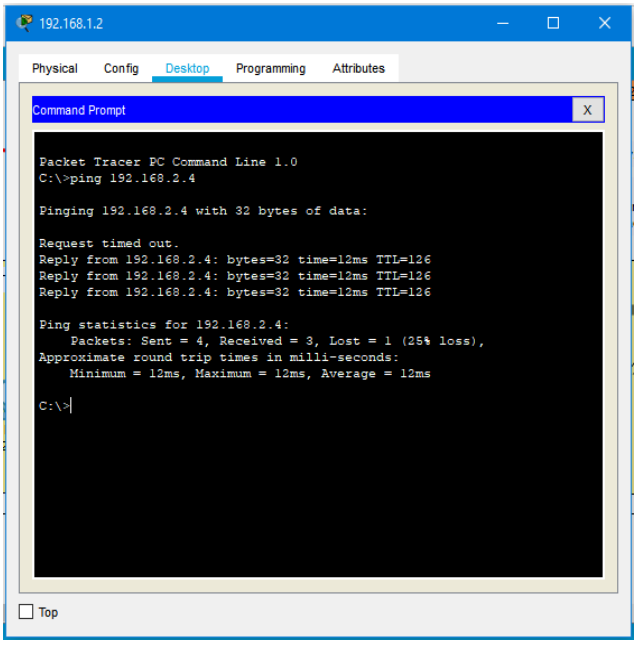
- Ping Test: Network connectivity and communication can be tested using the ping command, followed by the domain name or the IP address of the device (equipment) whose connectivity one wishes to verify.



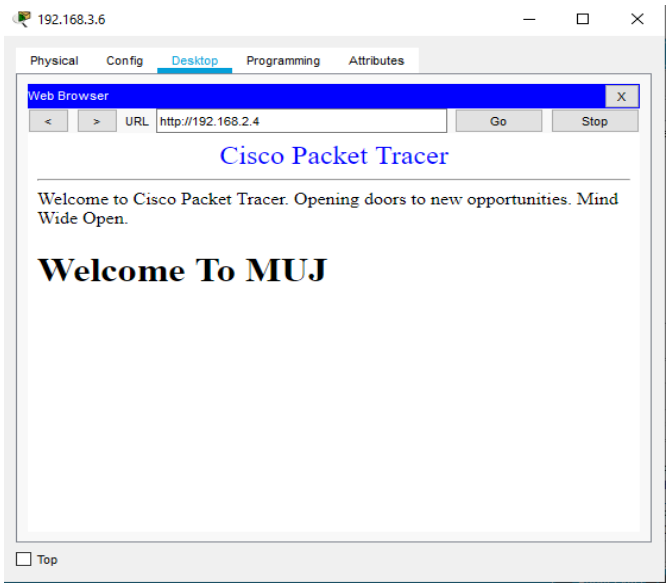
Ping Test for EMAIL server



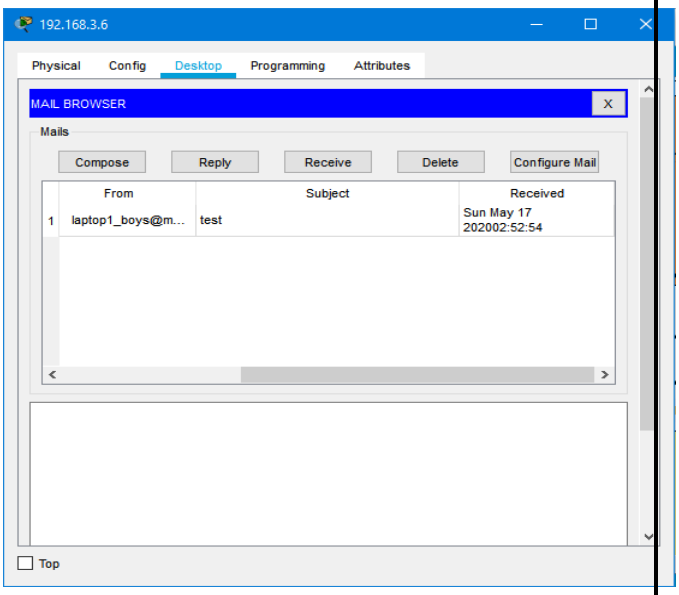
Ping Test for DNS server



Ping Test for WEB server



Website accessed through Web Browser in Packet Tracer



Email received on device sent through EMAIL server

v)CONCLUSION AND FUTURE WORK

- Conclusion

We started our discussion with the word “digitalization” and in order to achieve it, we aimed to start with an educational institute, and finally, we designed a network for a University, which is wireless. As we mentioned, mobility and efficiency are the key aspects of wireless networks, which were our main goal, and hence, we decided to shift to a wireless network instead of a wired one, making our network clean and less chaotic.

In this project, we designed a University Network using Cisco Packet Tracer that uses a networking topology implemented using servers, routers, switches, and end devices in a multiple area networks. We have covered all the necessary features that are required for a network to function properly. We have included a DNS server and a web server for establishing a smooth communication system between different areas of our network and specifically for the communication between students and teachers. We have included an email server to facilitate intra university communication through emails within the domain. We have used console passwords and ssh protocol to ensure a safe and secure transfer of data.

- Future Work

The configuration and specifications are for the initial prototype and can further be developed and additional functionality can be added to increase support and coverage of our existing network.

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