WIRELESS HOSPITAL NETWORK DESIGN

18CSS202J- Computer Communication

Project Report

Submitted by-

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in partial fulfilment of the requirements for the degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE ENGINEERING

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BONAFIDE CERTIFICATE

Certified that 18CSS202J project report titled "WIRELESS HOSPITAL NETWORK DESIGN" is the bonafide team work of Mr. **B. SAI SRI VEER (RA2111003011789), Mr. V. VENKAT ADITYA (RA2111003011799), Mr. K. JAYANTH (RA2111003011802), Mr. A. VENKATA DILEEP (RA2111003011816), Mr. P. LINGESWARA REDDY (RA2111003011842)** who carried out the project work under my supervision along with the faculty mentor. Certified further, that to the best of my knowledge the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The network design is a major part of the infrastructure of a hospital. Internet speed is a major component of ensuring that healthcare providers and other professionals achieve timely access to pertinent information. The main aim of this paper is to design a hospital network which meets the requirements of a hospital network like electronic health records, on-call doctors via video communication, billing department records, keeping track of the research in progress, etc. The aim is to provide secured LAN and WLAN network. The network is designed by keeping in mind of upcoming technology in medical field. This will increase the quality of hospital service along with patient safety and clinical effectiveness.

This research paper is related to a project that uses networking in hospitals and has examined various recommendations and techniques for using the hospital network's private addressing schemes. We switched quickly between the LANs and ensured a secure WLAN network was provided. This will contribute to health promotion, which together with patient safety and clinical effectiveness is a core dimension of quality in hospital services.

This study will dissect and analyse different parts of the network of a hospital, uncovering substandard practices and problematic weaknesses that commonly result in a general decline in the quality of healthcare provided to patients, and adversely affecting hospital and healthcare facilities' business operations.

OBJECTIVES

The primary objective of this research paper is to provide state of the art networking facilities for the IP-based medical devices, doctors, nurses, visitors and working staff of the hospital. Given below the points to throw light on the subject matter:

- Providing remote medical consultancy or to supervise the surgery/operation from remote location.
- Uninterrupted high speed internet connectivity.
- Provide better medical facilities to the patients.
- Organised health records for future use.
- Uninterrupted communication between different departments of the hospital.
- Reducing the workload at nurse station, account department, reception desk.
- Keeping the research work of the doctors and medical records of patients secure.

Providing limited internet access for the visitors.

INTRODUCTION

The field of Information Technology and Network Infrastructure Management has become a crucial component inside the healthcare industry. Medical experts are working along with the IT departments to create more medical devices that can be connected to the network, hence providing doctors the facility to monitor patients easily over internet. Also, hospitals have initiated the method of electronic health records which are easy to access for doctors as well as the patient's family members. There are several times when a doctor can't be present and this factor has already been overcome by video communication. The hospital network has to be made secure as well so that essential data like medical records and research work does not fall into the wrong hands.

In general, in designing and maintaining the performance, efficiency, architecture and security of the hospital network, the IT manager faces a lot of challenges. An important consideration of network design for today's networks is creating the potential to reliably, scalably and securely support future expansion.

We need to design a network topology that is easy to understand, easy to manage, easy to troubleshoot and is adaptable to change in future according to the new medical equipment's. Among the various topologies like bus topology, ring topology, mesh topology, star topology, etc, Hierarchical topology would best meet our demands. The hierarchical network design model serves to help us develop a network topology in separate layers. Each layer focuses on specific functions, enabling us to choose the right equipment and features for the layer. A hierarchical design avoids the need for a fully meshed network in which all network nodes are interconnected and thus making it simple and easy to understand.

REQUIREMENTS

The proposal is to design a state-of-the-art network for a district level hospital. The hospital consists of various departments separated among three buildings. The distance between two buildings is 50 meters. Each building has four floors. Each building has its own reception desk on the ground floor with two desktops, one central medical store and medical store room having two desktops. Each floor has three wings, and each wing has its own nurse stations containing one desktop. Apart from this there were medical instruments requiring both wired and wireless internet connectivity. Visitors of the hospitals would get limited wireless connectivity.

FEATURES AND SERVICES

- DHCP
- DNS
- Subnetting
- HTTPS
- SSH
- SMTP
- FTP
- WIFI

COST OF NETWORK

- **Cisco Switch**
  250$ Each
  1250$ Cost of 5 Switch

- **Cisco Router**
  350$ Each
  2100$ Cost of 6 Router

- **Cisco Server**
  400$ Each
  800$ Cost of 2 Server

- **Computer Cost**
  125$ Each
  1500$ Cost of 12 Computer

Total Cost = 5650$

This report describes the network design of Health care management or Hospital. In this network topology the nodes (i.e., computers, switches, routers or other devices) are connected to a local area network (LAN) and network via links (twisted pair copper wire cable or optical fiber cable). We have used Cisco Packet Tracer for designing the network topology It's a general design which can be implemented at any higher level to manage network system.

NETWORK REQUIREMENTS

In Health care Network topology, we have desktop Computer, laptops, smart phone. There is a data flow between the devices within the system. We have divided our network into segments like for Hospital wards, clinical area etc. We have also used SSH for security. Our network requirements include network devices like routers, switches, server.

HOSPITAL SEGMENTS

1. General ward
2. Private ward
3. Clinical Area
4. IT Department
5. Entrance Reception
6. Lobby and Parking

DEFINITIONS

- ## DHCP

  The Dynamic Host Configuration Protocol (DHCP) is a network management protocol used on UDP/IP networks whereby a DHCP server dynamically assigns an IP address and other network configuration parameters to each device on a network so they can communicate with other IP networks.

- ## DNS

  The Domain Name System is a hierarchical and decentralized naming system for computers, services, or other resources connected to the Internet or a private network.

- ## SUBNETTING

  A subnetwork or subnet is a logical subdivision of an IP network. The practice of dividing a network into two or more networks is called subnetting.

- ## HTTPS

  Hypertext Transfer Protocol Secure is an extension of the Hypertext Transfer Protocol. It is used for secure communication over a computer network and is widely used on the Internet. Hypertext Transfer Protocol Secure is an extension of the Hypertext Transfer Protocol. It is used for secure communication over a computer network and is widely used on the Internet.

- ## SSH

  Secure Shell is a cryptographic network protocol for operating network services securely over an unsecured network.

- ## SMTP

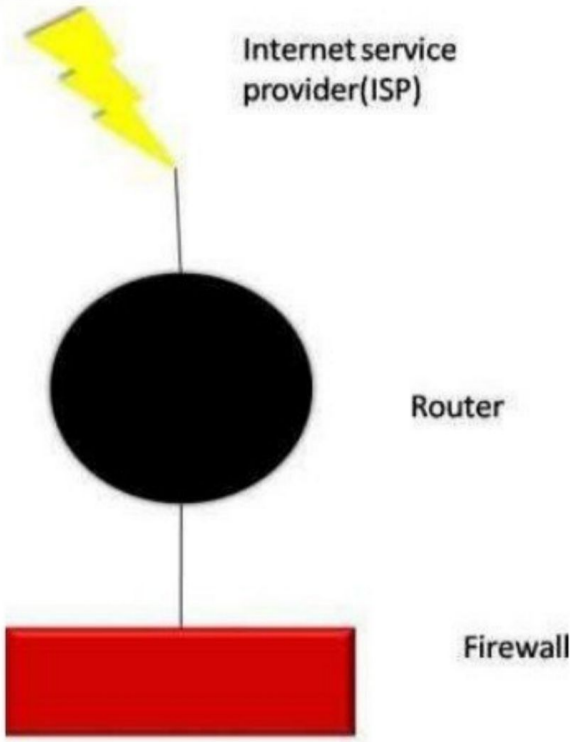
  The Simple Mail Transfer Protocol is a communication protocol for electronic mail transmission.

- ## FTP

MODEL STRUCTURE

This model improves the construction of a structure which is dependable, versatile, and more affordable various levelled internetwork in light of the fact that instead of concentrating on packet construction, it centres around the three functional area, or layers, of your system:

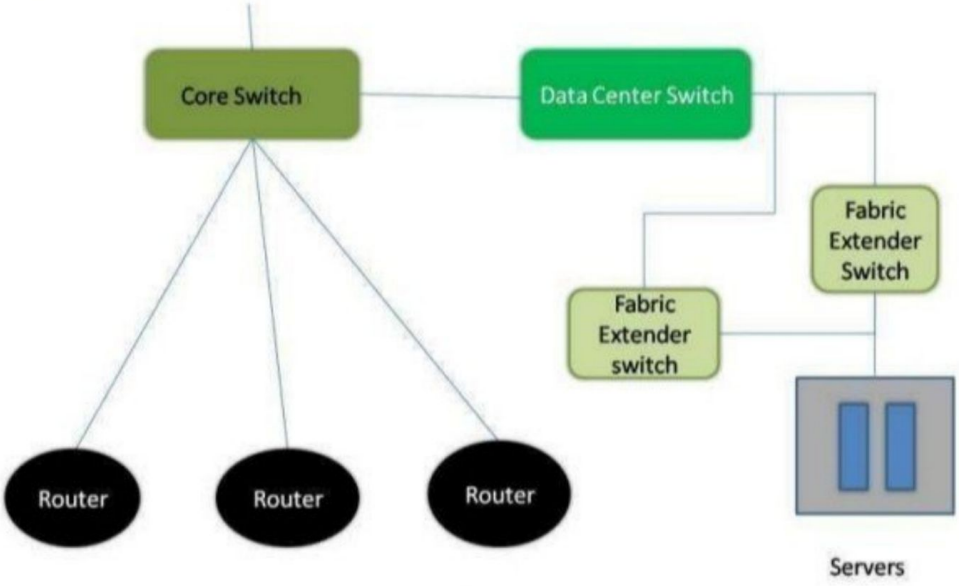
CORE LAYER: This layer is viewed as the foundation of the system and incorporates the top-ofthe-line switches and rapid links or cables, for example, fibre cables. In core layer packets are neither manipulated nor does it route traffic at LAN level. The core layer is solely in charge of quick and dependable transportation of data over a network. The main Aim of this layer is to reduce the latency rate while delivering a packet.



Core Layer

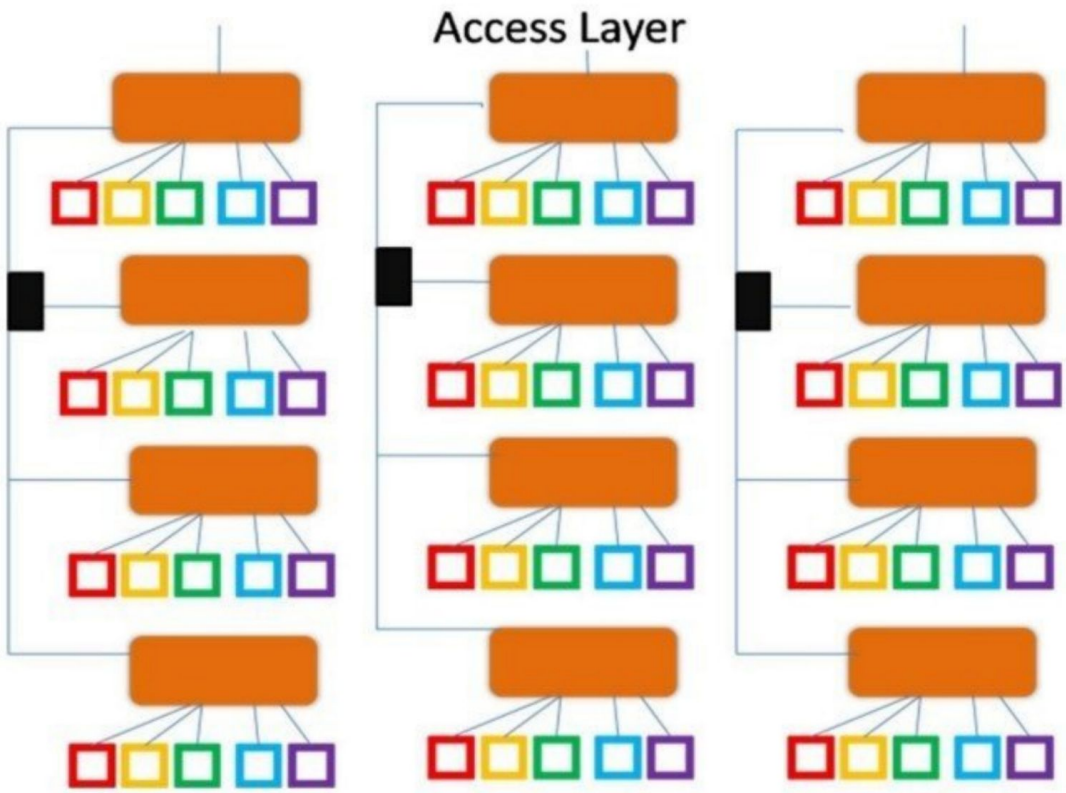
DISTRIBUTION LAYER: The distribution layer is in charge of directing the packets. It additionally gives protocol-based network connectivity. It is at this layer where you start to apply authority over network transmissions, incorporating what comes in and what leaves the network. This layer incorporates LAN-based routers and layer 3 switches. This layer guarantees that data packets are legitimately directed among

subnets and VLANs in your endeavour. This layer is likewise called the Work-group layer.

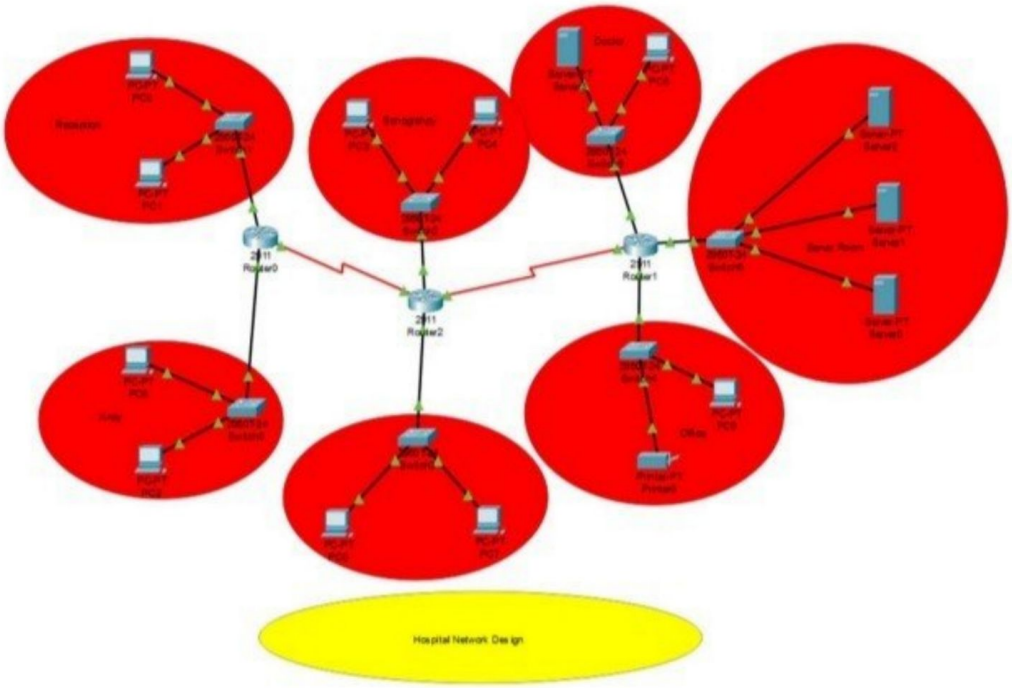


Distribution Layer

ACCESS LAYER: The Access layer contains gadgets that permit work-groups and clients to utilize the role played by the core and distribution layers. In the access layer, you can extend or contract network areas utilizing a repeater, standard switch or a hub. This layer is additionally called the work area or desktop layer since it centres around associating end users, for example, computer system to the network. This layer guarantees that data bundles are conveyed to end client PCs.


Access Layer

IMPLEMENTATION



Addressing Table:

Device	Interface	IP Address	Subnet Mask	Gateway
PC0	Fa0/0	192.168.10.2	255.255.255.224	192.168.10.1
PC1	Fa0/0	192.168.10.34	255.255.255.224	192.168.10.33
PC2	Fa0/0	192.168.10.98	255.255.255.224	192.168.10.97
PC3	Fa0/0	192.168.10.130	255.255.255.224	192.168.10.129
Router0	Gigabit 0/0	192.168.10.1	255.255.255.224	-
Router0	Gigabit 0/1	192.168.10.33	255.255.255.224	-
Router0	Se0/1/0	192.168.10.65	255.255.255.224	-
Router1	Gigabit 0/0	192.168.10.97	255.255.255.224	-
Router1	Gigabit 0/1	192.168.10.129	255.255.255.224	-
Router1	Se0/1/0	192.168.10.66	255.255.255.224	-

CONFIGURATION

The diagram is properly commented. We have divided the diagram into 6 segments as named above. Hospital Segments representing different departments of hospital. Following are the running configuration of routers and switches related to different segments of hospital respectively:

General Ward Switch	General Ward Router

Private Ward Switch	Private Ward Router

Clinical Area Switch	Clinical Area Router

IT Department Switch	IT Department Router

Entrance Switch	Entrance Router

IT_Switch 192.168.1.5

Physical Config CLI Attributes

IOS Command Line Interface

```
Cisco IOS Software, C2960 Software (C2960-LANBASE-M), Version 12.2(25)FX,
RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 12-Oct-05 22:05 by pt_team

Press RETURN to get started!


%LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed
state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed
state to up

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up

%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed
state to up
```

IT_router 192.168.1.1

Physical Config CLI Attributes

IOS Command Line Interface

```
%SYS-5-CONFIG_I: Configured from console by console

Router(config)#
Router(config)#
Router(config)#
Router(config)#
Router(config)#router rip
Router(config-router)#
Router(config-router)#end
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
%SYS-5-CONFIG_I: Configured from console by console

Router(config-if)#exit
Router(config)#
Router(config)#
Router(config)#router rip
Router(config-router)#
Router(config-router)#end
Router#configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)#interface FastEthernet0/0
Router(config-if)#
%SYS-5-CONFIG_I: Configured from console by console

Router(config-if)#exit
Router(config)#interface FastEthernet1/0
Router(config-if)#
```

Private_router

Physical Config CLI Attributes

IOS Command Line Interface

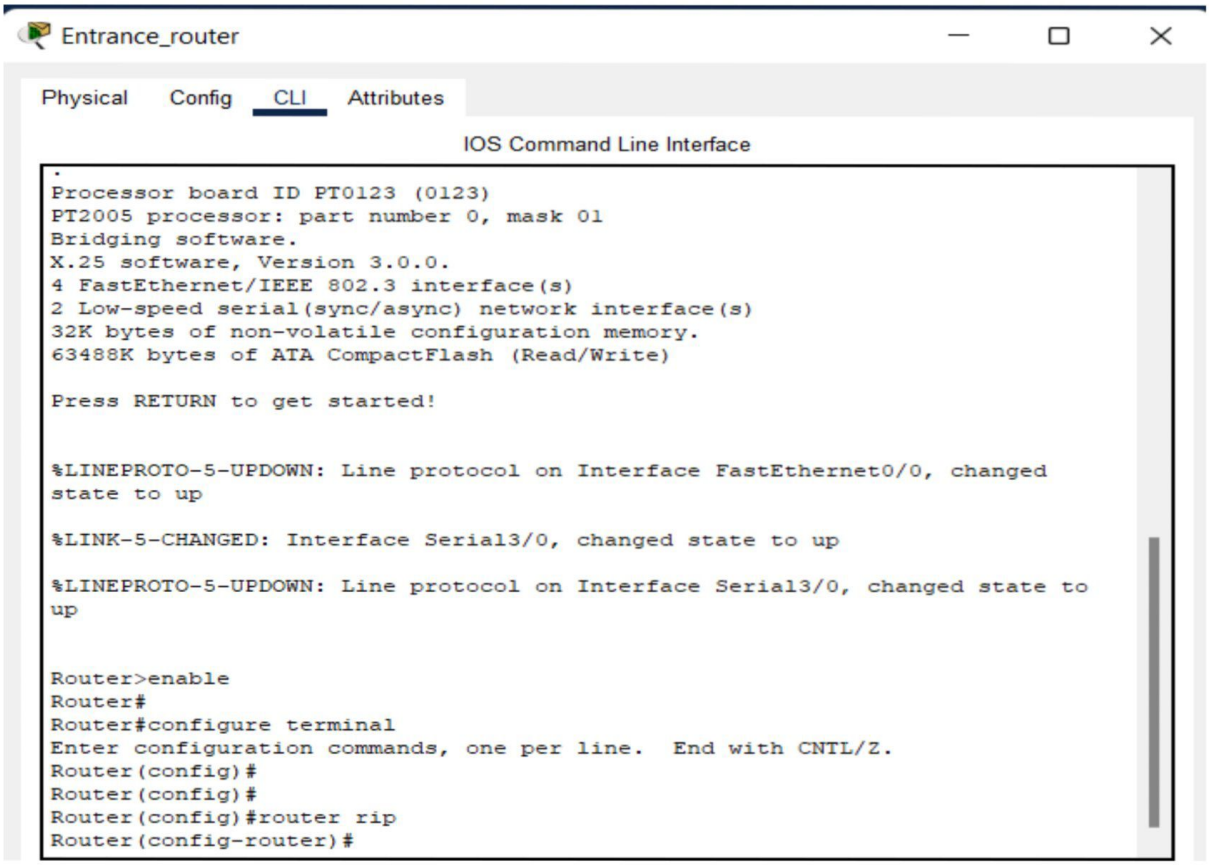
```
Cisco Internetwork Operating System Software
IOS (tm) PT1000 Software (PT1000-I-M), Version 12.2(28), RELEASE SOFTWARE
(fc5)
Technical Support: http://www.cisco.com/techsupport
Copyright (c) 1986-2005 by cisco Systems, Inc.
Compiled Wed 27-Apr-04 19:01 by miwang

PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of
memory
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
4 FastEthernet/IEEE 802.3 interface(s)
2 Low-speed serial(sync/async) network interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!


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

%LINK-5-CHANGED: Interface Serial2/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to
up
```

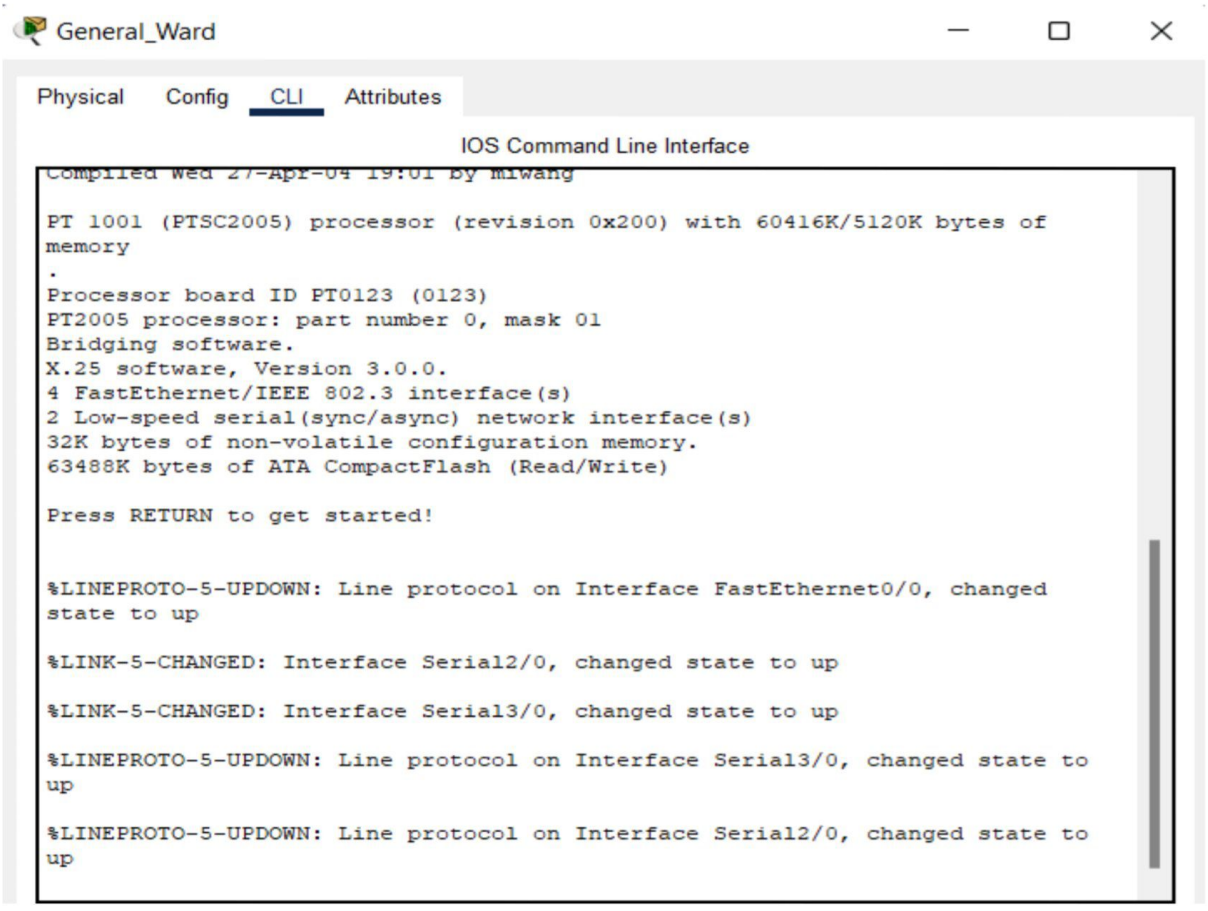
Private_switch

Physical Config CLI Attributes

IOS Command Line Interface

```
Switch    Ports  Model              SW Version              SW Image
------    -----  -----              ----------              ----------
*    1    26     WS-C2960-24TT      12.2                    C2960-LANBASE-M

Cisco IOS Software, C2960 Software (C2960-LANBASE-M), Version 12.2(25)FX,
RELEASE SOFTWARE (fc1)
Copyright (c) 1986-2005 by Cisco Systems, Inc.
Compiled Wed 12-Oct-05 22:05 by pt_team

Press RETURN to get started!


%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed
state to up

%LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed
state to up
```


Entrance_router
Physical
Config
CLI
Attributes
IOS Command Line Interface
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
4 FastEthernet/IEEE 802.3 interface(s)
2 Low-speed serial(sync/async) network interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)
Press RETURN to get started!
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up
Router>enable
Router#
Router#configure terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#
Router(config)#
Router(config)#router rip
Router(config-router)#


General_Ward
Physical
Config
CLI
Attributes
IOS Command Line Interface
Compiled Wed 27-Apr-04 19:01 by miwang
PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of memory
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
4 FastEthernet/IEEE 802.3 interface(s)
2 Low-speed serial(sync/async) network interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)
Press RETURN to get started!
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/0, changed state to up
%LINK-5-CHANGED: Interface Serial2/0, changed state to up
%LINK-5-CHANGED: Interface Serial3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to up

Clinical_router

Physical Config CLI Attributes

IOS Command Line Interface

```
Compiled Wed 27-Apr-04 19:01 by miwang

PT 1001 (PTSC2005) processor (revision 0x200) with 60416K/5120K bytes of
memory
.
Processor board ID PT0123 (0123)
PT2005 processor: part number 0, mask 01
Bridging software.
X.25 software, Version 3.0.0.
4 FastEthernet/IEEE 802.3 interface(s)
2 Low-speed serial(sync/async) network interface(s)
32K bytes of non-volatile configuration memory.
63488K bytes of ATA CompactFlash (Read/Write)

Press RETURN to get started!


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

%LINK-5-CHANGED: Interface Serial3/0, changed state to up

%LINK-5-CHANGED: Interface Serial2/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial2/0, changed state to
up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial3/0, changed state to
up
```

Clinical Switch

Physical Config CLI Attributes

IOS Command Line Interface

```
Press RETURN to get started!


%LINK-5-CHANGED: Interface FastEthernet0/4, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/4, changed
state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan1, changed state to up

%LINK-5-CHANGED: Interface FastEthernet0/5, changed state to up

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

%LINK-5-CHANGED: Interface FastEthernet0/1, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed
state to up

%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed
state to up

%LINK-5-CHANGED: Interface FastEthernet0/3, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/3, changed
state to up
```

MODEL ANALYSIS

ISP: A network is of little of no use without internet. For the project as big as this consisting almost 400-500 end users accessing internet at the same time, we need a high-speed internet service provider. We cannot compromise on internet speed as people lives on stack. Here we choose a connection of 100mbps bandwidth from a reputed Internet Service Provider. The reasons behind doing so are

- Providing high speed internet for uninterrupted high quality video communication in various operation theatres.
- Various hospital employees accessing working on their workstations at the same time.
- Providing fixed bandwidth for visitors as they might surf videos or browse sites while waiting in the waiting area.
- Considering near future expendability.

Router: In our network we have routers at two levels, one at the core level and one at the distribution layer. We need to handle the bandwidth of 100mbps for now. To handle this bandwidth, we are choosing Cisco 4351 router at the core layer. The reasons behind choosing it are:

- Cisco 4351 can smoothly give throughput of 200mbps.
- It can be upgraded to 400mbps if required.
- It has 3 onboard LAN/WAN ports.
- It has 48 Maximum switched Ethernet ports.

Firewall: Firewall is a system designed to prevent unauthorized access to or from a private network. Firewall prevents unauthorized internet users to access private network connected to internet, especially intranet. All the packets coming or leaving the network has to pass through firewall. It checks and examines every data packet and prevents access if fails to meet security criteria set by the network admin. Firewall can be implemented both at hardware and software level. Here we have installed packet filtering firewall and web application firewall. Former will examine the data packets and later will allow only specific web application to be used by the employees. Our router is capable of filtering the data packets and restricts web applications according to the protocols configured by the admin.

Core switch: Core switch comes at the top of distribution switch. It is also known as tandem switch or backbone switch. The main role of core switch in our network is to increase the speed of delivering data packets in the centre of network. Here for our network, we have chosen Cisco 6000 series. The reasons behind doing so are

- It has very less failure rate.
- It has very high scalability.
- Upgradable.

Data centre switch: The data centre switch is emerging as a new class of switch since data centre networking infrastructures become more disaggregated. Unlike the network switch for traditional three-tier hierarchical networks, data centre class switches are designed to support data and storage for mission critical applications. Here we have chosen Cisco 5548 data centre switch and the reasons behind having a data centre switch in our network are

- They can handle both north-south and east-west traffic flows.
- They support high-bandwidth interconnections using both standard LAN Ethernet protocol and SAN protocols. For example, Fibre Channel and Fibre Channel over Ethernet.
- They have extensive high availability and fault tolerance systems in the hardware and software. Therefore, provide better uptime for mission-critical applications.

Fabric extender switch: In our network we have chosen this fabric extender purely for future use. As hospital is planning to build two more blocks and if government plan to connect different district level hospitals, then traffic will be huge while accessing servers.

Server: Server is a central system used for storing and managing data of entire network. Here in our network, we have installed three dedicated servers i.e., FTP server, mail server, web server.

Hub: In a network, a hub is a port that broadcasts to every end device or Ethernet-based device connected to it. Here in our model, we used hubs to connect switches of different floor. The reason behind doing is to increase the reliability. We can easily figure out the fault if any floor is not receiving internet connection.

Wireless Access Point (WAP): Wireless Access Points are basically devices which allow wireless devices to connect with either the help of WI-FI or Bluetooth medium. We are using two WAP at each floor to provide maximum internet connectivity to wireless medical devices, smart phones, smart mobile tablets, laptops, etc.

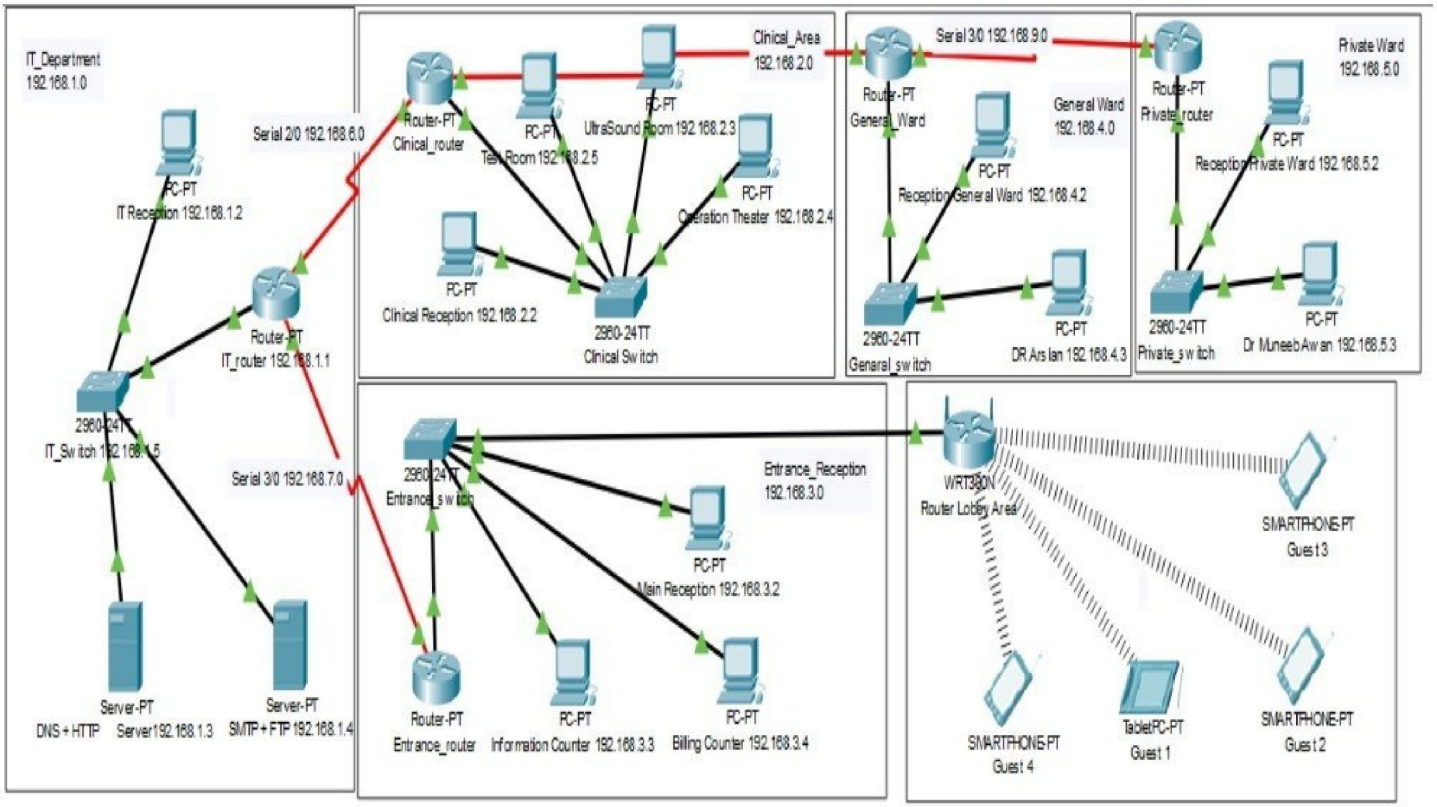
Access switches: Access switches come at the Access layer of a network. It brings the distribution network inside the building. It is the most commonly used gigabit

Ethernet switch which communicates directly with public internet. These switches are responsible for establishing connection with end devices like computers, laptops, mobile phones with both wired and wireless medium. Here in our network, we have used one access switch at every floor of our building. In our network we have used Cisco 4510 idf's. The reasons behind it are

- Number of ports.
- High performance.
- Great efficiency.

Cables: Last but also the very important part is cabling the entire network. Without connecting one component of a network with other it is pretty much useless. Here in our model, we had used Unshielded Twisted Pair (UTP) cables to connect network to router, routers to switch, switch to servers, switch to end devices. WE chose UTP cables because of its interference cancelling capabilities. To be very particular we used cat-6 grade cables because of its maximum transmission speed of 1000mbps/100 meters. There is not much cost difference between cat5e and cat-6 grade cable. So, it is a vice choice to choose cat-6 cable for our network.

NETWORK DIAGRAM



CONCLUSION

With the growth of Information Technology in every sector and the explosion of medical IOT devices, the design of a network of any hospital has become very essential factor. The hospitals need to have a reliable, secure and scalable network design in order to keep the patient's information, doctor's research work safe, convenient communication between various departments, etc. as well as keep it ready for any new IOT medical equipment's that may be introduced in the future. The hierarchical model of networking best suits our needs along with providing additional features like easy maintenance, high security, simplified troubleshooting and effective performance.

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