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## **Introduction**

In this report, I will be talking about different network topologies, protocols, servers and devices using the comparison way and which fits to be used for the MoH project

Recommended Network types, topologies will be **highlighted** so it will be used in the project. And I will include a conclusion so we can know what devices and servers and protocols and topologies we will be using in our project. It is very common to use the advantages and disadvantages to understand any concept, There are many ways to use those protocols, devices, etc.. for the project but there is the easy and there is the hard way, so is there also the better and the worst. All of this will be discussed and chosen in a good and easy way.

## **Types of Network**

Network is used for everything from connecting to the internet to printing a documents to downloading any attachment from an email. Networks now is the backbone of all businesses. They could be a small handful device in a single room to millions of devices across and entire planet.1

**Here are some types of networks:**

**1. Metropolitan Area Network (MAN):1**

This type of network is smaller than the Wide Area Network (WAN) and larger than the Local Area Network (LAN).1

MANs span the whole geographic area (could be a city or a town, but usually it’s a campus).1

Maintenance and Ownership are usually handled by a company or a single person (it depends on how the local council is).1

**Benefits:**

**1- MANs are less expensive:** MANs give a good efficiency of data and its less expensive to attach it with WAN. So as you can easily manage in a centralized way.2

**2- You can send local emails:** While using the MAN, you can easily send local emails fast and for free.2

**3- You can convert from LAN to MAN easily:** In a fast way, you can connect two fast LANs together using MAN. Because of the fast configuration of links.2

**Constraints:**

**1- Difficulty of managing:** MANs will get more difficult when it became bigger. This is because of a security problems and other extra configurations.2

**2- This type requires more wires:** MANs needs additional cables to connect two LANs.2

**3- Requires technical people to set up the network:** MANs require technical people so they could set up the MAN. And technical people are network troubleshooters and administrations.2

**Types of Network**

**3. Local Area Network (LAN):1**

This type of network is the most common, and the most original and simplest types of networks. Local Area Network connect groups of computers together in a short distance maybe in one, two or three building close to each other. so, they can share information, data and resources.1

Local Area Network is a network that connects computers and other computers accessories with each other. Computer accessories which is scanners, printers, etc…1

LAN is basically used to connect computers within one building. But, to make that connections we should use the communication devices and cables such as; Hubs, switches and also routers. And the we use Ethernet cables that is used in the hubs, switches, etc. that has an rj45 ports so it could make this connection between routers or switches or hubs with the workstation/servers or network printer.1

**Benefits:**

**1- Internet can be shared:** In the local Area Network that is used in the offices or network cafes. All computers are shared within the same internet connection. So this type of network with the main internet cable is linked to one server and used in the computers by operating system.3

**2- Communication is fast and saves time:** In the LAN computers they can share or exchange data fastly and it saves time because they are connected between to one server, so the data is shared in the same cable and every computer can share massages and data to any other computer that is in the same LAN. And every user logged in in the LAN can access some of the data that is places on the server.3

**3- Identity of the computers:** Each computer has a MAC address and it is stored in the router or switch in the communication period during period of time. So, all of the computer are identified by MAC addresses and used to share and receive data. MAC Addresses are found in the motherboard of each computer. Modern computers come with build in motherboard so the network adapters weren’t built in with motherboards.3

**Constraints:**

**1- Limit distance:** LANs is usually made for a building or a nearby one and it cannot extend to a wide area.3

**2- If the server crashed it may affect all computers:** If any file on the server is corrupted all the computers on the LAN will have problems.3

**3- LAN is expensive:** LAN is expensive because they need a special software to make the server and to have the communication devices like switch, hubs, etc. needs money.3

## **Types of Network**

**4. Wide Area Network (WAN): 1**

This type of network makes a transmission of data like voice, images and videos, etc. in a wide area not like the (LAN) that is used in a small area. Wide Area network is made from Local Area Network and Metropolitan Area Network. And the transmission of the data gets help from the switches, fiber optics, modem and routers. But in this type of network we should use some technologies so we could transfer data from any computer here is three of the technologies:4

**1. ISDN (Integrated service digital network)4**

**2. SMDS (Switched multimegabit data server)4**

**3. SONET (Synchronous optical network)4**

**Benefits:**

**1- Covers a large area:** WAN have an area of 1000 km or more. So you can use it if you want to connect your office in some country to another office in other country. And you can use the ISP (Internet service provider) to give you leased lines so you can connect different offices together.4

**2- Get updated files and data:** Usually software companies work over the live servers so they can share and receive updated files. So all the members in the office can get an updated file with a short period of times within seconds.4

**3- Sharing of software and resources:** In the LAN we could share software applications and resources like RAM and hard drive to other users on the internet. So is the WAN, we can share computer resources among many websites.4

**Constraints:**

**1- Security problems:** WAN isn’t as secured as LAN and MAN because WAN has many technologies combined to each other so it could create a security gap.4

**2- High cost of the setup:** To have a WAN in offices costs more money because you usually need to buy routers, switches and software for security.4

**3- Disconnection issues and server down:** In some areas, ISP could have problems for bad lines structure. So the internet will be slow. You should buy a dedicated line from ISP.4

**Network Topologies**

Before looking at the Network topologies we should know what is the network topology so we could know what would fit us to the project.

Network topology is: ”The physical topology of a network refers to the configuration of cables, computers, and other peripherals. Physical topology should not be confused with logical topology which is the method used to pass information between workstations. Logical topology was discussed in the Protocol chapter”5

There are main types of network topologies so it is the way of how the devices are connected to a network. But I shouldn’t be as the same as the actual physical shape. Example: computers at home LAN maybe are arranged in a circle shape but they would be in an actual ring topology.5

There is also a more complex networks they are built as hybrids or two or more than from the basic ones.5

Here are some of the network topologies:

**1. Star Topology:5**

Star Topologies is used in many homes so a star network has a center connection point called a “Hub” but “Hub” could be a hub, switch or a router.5

The protocols that are usually used with star configurations are LocalTalk or Ethernet.5

There is a topology that looks like the star topology it is called the star-wired ring.5

**Benefits:**

1- Star topology is easy to install and to wire too.5

2- Star topology can detect easily faults and remove parts.5

3- There is no disruptions for the network than removing parts or connecting.5

**Constraints:**

1- Needs more length cables than a linear topology.5

2- Nodes attached will disable if the hub or concentrator fails.5

3- It is more expensive than linear than the bus topology (Will be explained next) because the cost of the concentrators.5

## **Network Topologies**

**2. Bus Topology:5**

This type of topologies uses like a backbone to connect the devices. It has a single cable. If a device wanted to communicate with other device on the network, they should send a broadcast message into the wire but all other devices will see that message if they accepted it.5

And bus topologies are easy to install and they don’t need much cabling like the alternatives.

Example: 10Base-2(“ThinNet”) And 10Base-2 (“ThickNet”) were popular Ethernet cabling options in the last years for the bus topologies.5

**Benefits:**

1- Bus topologies are easy to connect to a computer to a linear bus.5

2- It don’t need a long cable like the star topology.5

**Constraints:**

1- If there was a break in the main cable the entire network will shut down.5

2- If the entire network shuts down, they are difficult to identity the problem.5

3- Bus topologies are not used as a stand- alone solution in a huge building.5

**Comparison between Star and Bus topologies:5**

1- Star topologies needs more cable than the bus topologies.5

2- A failure in any star network cable will take only a one computer not the entire line, opposite the bus network if there was a break on the main/backbone cable, the entire network will shut down.5

3- Star topologies are more expensive than the bus topologies because the cost of the concentrators.5

4- Bus topologies don’t need as long cable as the star topologies.5

## **Network Topologies**

**3. Tree Topology:5**

Tree Topologies have a multiple star topologies together onto a bus, so actually it is a bus and star topologies together. And only hub devices can be connected directly to the tree bus, and each of the hubs are functions as the root of any tree of devices.5

And this topology is better than a bus or a star topology because the bus has a limit in the number of devices in the broadcast traffic and the star has a limit of number of hub connection points.5

**Benefits:**

1- Tree topologies has a point to point wiring for an individual segments.5

2- They are supported by man hardware and software venders.5

**Constraints:**

1- Also in this topology the entire segment will break down of the backbone line breaks because it has a bus topology in it and it has a backbone. Example (Human body have many parts but if the backbone of an body breaks the body can’t move).5

2- It is more difficult to configure and wire than the other network topologies.5

3- Overall length of each segment is limited according to the cabling used.5

## **Network Devices**

An office connected to internet consists a variety of hardware and software components.6

We should know what various components we need to create a computer network and connect it to the internet.6

The devices we use to connect computers and other devices together on an Ethernet network are:6

**1. Network Hub:6**

A hub is used to connect more than one computer together.6

Hubs are multi-port repeaters and they operate at the level one physical layer. Also, they don’t examine the network traffic. So, nowadays they are being replaces with switches Usually, the smallest is 4 port.6

**2. Network Bridge:6**

Bridges connect two network segments together and it is a selective repeater.6

Bridges examine the MAC address of the traffic that it detects and knows which network segments contains the various MAC ADDRESS.6

Bridges work at data link level so they’re at level two and they transmit broadcasts.6

Basically, bridges uses information to decide when it should repeat the traffic on a network segment.6

Bridges nowadays are being replaces with switches also.6

## **Network Devices**

**3. Network Switch:6**

Network switches connect two or more than two computers together.6

Nowadays switches are being used in preference to a bridge or hub.6

It’s like bridges. Switches learn about the MAC ADDRESS that is connected to each port and will send only data on this port that is addresses to the MAC ADDRESSES.6

We can say that a network switch is basically a bridge but with more ports.6

And when we are using switches usually it speeds up the network, but for sure, it depends on the configurations of the network.6

**4. Wireless access point:6**

This type of devices connects wireless devices to an Ethernet network, and connects wireless devices together also. Mainly, it does like a hub or a switch but for wireless devices.6

**5. Routers:6**

Routers connect networks together. And they operate at the networking level of the TC protocol stack.6

On office networks, routers are responsible for the connection between the office network and the internet.6

It provides several networking services like:6

**1.”** Dynamic Host Configuration Protocol (DHCP) enables users to dynamically and transparently assign reusable IP addresses to clients. Cisco IOS Easy IP Phase 2 includes the Cisco IOS DHCP Server, a RFC 2131-compliant DHCP server implementation on selected routing platforms”.7

**2.** “Domain Name System (DNS) is the system in the Internet that maps names of objects (usually host names) into IP numbers or other resource record values. The namespace of the Internet is divided into domains, and the responsibility for managing names within each domain is delegated, typically to systems within each domain”.7

Most office routers provide Ethernet and Wi-Fi connections. And they provide NAT (Network access translation) services. They are known as hubs in their networking role.6

## **Network Protocols**

Before looking at the different network protocols we should know what a network protocol is.

In our technology world, there are many numbers of users that communicate with different devices in different languages and countries. Communication worldwide won’t be possible if there wasn’t ‘standards’ that will give the way to user communications for data, so the way our devices treats those data too.8

And a protocol is a set of rules that help a particular technology that will communicate. It can be said that protocols are digital languages implemented in the form of networking algorithms. And there’s many protocols for different usage.8

Here are some of network protocols may be used to communicate different devices across the network:8

**1. Transmission Control Protocol (TCP):** TCP is a popular are very known as a communication protocol which is used to communicate over a network. It divides any message into series of packets that will be sent from source to destination and there it gets reassembles at the destination.8

**2.**  **Internet protocol (IP):** IP is designed explicitly as an addressing protocol. It is usually used with TCP. IP addresses in packets help in routing them through different nodes in a network until it reaches the destination system. TCP/IP is the most popular/known protocol connecting to networks.8

**3. User Datagram Protocol (UDP):** UDP is an exchange communication protocol to TCP implemented primarily to create low-latency and loss-tolerating linking between different applications.8

**4. Post Office Protocol (POP3):** This protocol is designed to receive incoming E-mails.8

**5. Simple mail transport Protocol (SMTP):** This protocol is designed to send and distribute outgoing Emails.8

**6. File Transfer Protocol (FTP):** this protocol allows the users to transfer files from one machine to another one. And these files include program files, text files, multimedia files and documents, etc..8

## **Network Protocols**

**7. Hyper Text Transfer Protocol (HTTP):** This protocol is used for transferring data between the client browser (request) and the web server (response) in the hypertext format, and it’s designed to transfer hypertexts through two or more systems. But, HTML tags are used to create links and these links may be in any form like images or texts. And HTTP is designed also on Client-server principles which allow a client system for establishing a connection with the server machine so it could make a request. The server acknowledges the request initiated by the client and replies accordingly.8

**8. Hyper Text Transfer Protocol Secure (HTTPS):** This protocol is a standard protocol to secure the communication through two computers while one is using the browser and the other is fetching data from the web server. HTTP is used as same as the HTTPS except that transferring of data is done in an encrypted format. So it could be said that HTTPS prevent hackers from the interpretation or modification of data throughout the transfer of packets.8

**9. Telnet:** Telnet is set of rules designed to connect one system with another. The connecting process here is termed the same as remote login. The system which requests for the connection in the **local computer** and the system which accepts the connection request is the **remote computer**.8

**10. Domain Name System (DNS):** DNS is a protocol that translates hostnames into IP addresses. DNS is not required to establish a network connection. So for example you can access Google homepage by typing **216.58.207.206** but it’s much easier to type [**www.google.com**](http://www.google.com)**.9**

**11.** Dynamic Host Configuration Protocol **(DHCP):** Dynamic Host Configuration Protocol is a **“a network protocol that is used to assign various network parameters to a device. This greatly simplifies administration of a network, since there is no need to assign static network parameters for each device”.9**

And it is a client server protocol. As client is a device that’s configured to uses DHCP to request network parameters from the DHCP server. And the DHCP server maintains a group of IP Addresses and assigns one of them to the host. DHCP can provide these parameters too:9

1. Subnet mask.9

2. Default Gateway.9

3. Domain Name.9

4. DNS server.9

## **Types of Server**

Before looking at different server types, we should know what a server is.

**A Server is** a computer or a device on any network and it manage the network resources. For example: a computer and a storage device that stores files for any user on the network and that can store files on the server is a **file server**. And a computer that manages one or more than one printer on the network server that also manages network traffic is a **print server.10**

Servers are often specific and dedicated. So the perform no other tasks besides their server tasks. On a multiprocessing operating systems, one computer can execute several programs at the same time. So, we can say that a server is a program that manages resources rather than an entire computer.10

When we are talking about servers we should consider the **Server Platform.**

And it is a term that is used synonymously with an operating system. And a platform is basically the hardware or the software for a system and is the engine that runs the server.10

We have many servers for several specific things here some of them that might be used in the project:10

**1. Application Servers:** When we are talking about **a middleware**, **application servers**, we consider a chunk of computing territory between the end user and the database servers and they usually connect both of them.10

And **Middleware** is a software that connects two separated applications such as; there is a number of middleware products that link a database system to a web server, so, this will allow users to request data from the database using forms that is shown on the web browser and it enables the web server to return dynamic web pages based on the user requests and their profile.10

And middleware sometimes called plumbing because it connects the two sides of an application and it passes data between them. Here are some of the **common middleware:10**

**1. TP monitors.10**

**2. Message passing.10**

**3. Data base access systems.10**

**4. Object request brokers.10**

There are many of them and each one has a specific task in the middleware.10

**2. Audio or video Servers:** This type of servers brings multimedia capabilities to web sites by enabling them for broadcast streaming multimedia content. Streaming is a technique for transferring data such that it could be processed as a continuous and steady stream. To stream, the client side that is receiving the data should be able to collect the data and send it as a steady for the application that is going to process the data and converting it to sound or pictures.10

## **Types of Server**

**3. Fax Servers:** Fax servers is an ideal solution for or the organizations to reduce incoming and outgoing telephone resources but that need to fax documents.10

**4. File Transfer Protocol Server (FTP Servers):** One of the oldest internet services, FTP makes it possible to move one or more files securely between the computers while providing file security and the organization and transfer control.10

**5. Groupware Servers:** A groupware server is designed to enable users for collaboration, without looking at the location, using the internet or a corporate intranet and to work together in a virtual atmosphere.10

**6. Mail Servers:** Almost as ubiquitous and crucial as mail servers move and store mail over corporate networks using LANs and WANs and across the internet and Web servers too.10

7**. Web Servers:** a web server serves static content to a web browser by loading a file from a disk and serving it across the network to a user web browser. The server and the browser talking to each other using HTTP through this entire exchange.10

Now, we will Discuss the inter-dependences of workstation hardware with relevant networking software. Firewall for example. **Firewalls is** “a network security device that monitors incoming and outgoing network traffic and decides whether to allow or block specific traffic based on a defined set of security rules”. And firewalls have been a first line of defense in the network security for like 25 years, and they have established a barrier between controlled and secured internet networks that can be trusted inside networks and of course untrusted outside networks, like the internet. So firewalls can be **hardware and software of both.11**

Firewalls as mentioned before are software or hardware or both so it allows users to control traffic and protect against hackers operating on the internet so firewalls use a variety of techniques that protects against any attack such as proxy servers.12

Hardware firewalls provides more complete protections than the software firewalls and the hardware firewalls don’t effect system performance and they don’t depend on operating systems and software applications.12

The software firewalls are cheaper and they are ideal for personal or home use and they can be configured easily.12

But, dedicated hardware firewall costs more than a software firewall and it is difficult to install and upgrade so it takes up physical spaces and it needs wiring and the software firewalls takes up system resources and it is difficult to remove the firewall or uninstall it.12

Configuring and maintaining the firewall could be difficult and the network firewall can be less secure and encouraging them not to maintain security at the machine level.12

**Network interface controller (NIC) is** a computer hardware component that it used to connect two any computer to the computer network.16

NICs implements the electronic circuity that is required to communicate using a physical layer and the data link such as the Ethernet or the Wi-Fi and this provides a base for the full network protocol stack and it allows communication among the computers on the same local area network (LAN) and large scale network communication through a routable protocols such as IPs.16

## **OSI Protocols**

**OSI Protocols are** a group of standards for information exchange. These were designed and developed by the (ISO) **International Organization Of Standardization.** In **1977,** the ISO model was introduced which are consisted of different seven layers. And each layer of the ISO has its own functions and protocols and the OSI protocol stack was later adapted into the TCP/IP stack. So, in some networks and protocols are still popular using the data link and network layers of the OSI model only.13

These are the OSI protocols used in the seven layers in the OSI model:13

**1. Layer 1, The Physical Layer:** layer 1 deals with the hardware of the networks such as cabling and the major protocols that is used by this layer includes: **Bluetooth, etc..13**

**2. Layer 2, The Data link layer:** layer 2 receives data from the physical layer and it compiles it to a transform form that is called frame or framing and the protocols that is used by the data link layer is: **ATMs, etcc.13**

**3. Layer 3, the network layer:** layer 3 is the most important layer for the OSI model, which is performed in real time processing and it transfer data from time to time so routers and switches are the devices that is used for the network layer and the network layer includes protocols such as: **Internet protocol (IPV4), Internet protocol (IPV6), etc..13**

**4. Layer 4, the transport layer:** layer 4 works on two specified communications modes: connectionless and connection oriented. Layer 4 transmits data from the source to the destination node. And this protocol uses these important protocols of OSI protocol group: **Transmission Control protocol (TCP), UDP.13**

**5. Layer 5, the session layer**: layer 5 creates a session between source and the destination nodes and it terminates sessions on the completion of the communication process and the protocols and the protocols are used is: **NetBIOS, PPTP, etc..13**

**6. Layer 6, the presentation layer:** the functions of encryption and the decryption that is defined on layer 6 converts data formats into a format that is readable from the application layer (layer 7) and the presentation layer that is used by these protocols: **TLS, SSL, etc..13**

**7. Layer 7, the application layer:** layer 7 works at the user end to interface with user applications, and file transfer and emails are the popular major services for the application layer and it has quality of service and the application layer uses these protocols: **HTTP, HTTPS, HTTPS, SMTP, DHCP, FTP, Telnet, DNS, POP3, etc...13**

**Port numbers:** They are the identifiers that is given to all protocols numbers so they can easily be accesses. Here are some port numbers and the transport protocols for the protocols I mentioned before:14

**Protocol/Port number/Transport protocols**

**1. FTP / 20 and 21 / TCP.14**

**2. Telnet / 23 / TCP. 14**

**3. SMTP / 25 /TCP.14**

**4. DNS / 53 / TCP and UDP.14**

**5. HTTP / 80 / TCP.14**

**6. DHCP 67 and 68 / UDP.14**

**7. POP3 / 110 / TCP.14**

**8. HTTPS / 443 / TCP.14**

Now, these are the devices in each layer:15

Hubs, Repeaters, cables and wireless are **in the Physical layer.15**

Bridges, Modems, Network cards and 2- layer switches **are in the Data link layer.15**

Routers and 3-layer switches **are in the Network layer.15**

Gateways and firewalls **are in the Transport layer.15**

Gateways, firewalls and PC’s **are in the session layer.15**

Gateways, firewalls and PC’s **are in the Presentation layer.15**

Gateways, firewalls, PC’s and all end devices like phones, servers…. **are in the Application layer.15**

**In Conclusion:** This report will be advanced to an application assignment and all the devices, protocols, network types, network topologies, devices and servers will be used. Also will use the workstation of hard wares and soft wares and which is better to use. In the next part. For the network types I will be using the LAN for the same office to connect devices to the internet and the WAN to connect more than one office not within the same area to the same internet. For the network topologies I will be using the star or the tree topology because the tree topology is more than a star topology within the same bus so it’s the advanced way for the star topology. I will be using different devices for different purposes (depends on what I need) for example if I want to connect computers together I would use the hub or the switch. We will focus on the application layer the most I think because it is an application assignment we need to apply what we researched for in this report. We should know that we have more than one office in different located offices so we should connect them to our project applications that has the center data connection within the head quarter.

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**NOTE**: Reference number will apply the paragraph/points numbers

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