Components and means of communication within the Local Area Network: An analytical study

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Abstract

The Local Area Network (LAN) is one of the most important types of information networks in providing communication within a limited community such as universities and institutions. The LAN consists of an interconnected group of computers and other communication devices, which are connected to each other through an integrated engineering system. They are distributed within relatively small geographical areas and characterized by high speed and lack of errors in communication. Thus, the local area networks are a mixture of interrelated devices, equipment and institutions, where they form a fabric called networks, these networks mainly rely on essential physical components and software to operate efficiently. The present analytical study seeks to understand both the basic components of the operation of local networks and to recognize and define the role of each of the means of communication adopted within the local network in order to construct and operate the LAN.

Key words:

LAN, communication equipment; communication protocols; LAN components; LAN software.

1. Introduction

There is no doubt that we are living in the information revolution era. This era is linked to information technology that has become part of the information revolution. This helped to connect the world and turned it into a small village. The present study aims to understand and analyse the components of the LAN and the means of communication within it.

There are many foundations that are classified by computer networks, which are as follows:

Geographic area that is divided into:

- LANs.
- Certified networks (WAN).
- Internet.

Access to network services that is divided into:
- Intra network.
- External network.

Type of relationship between devices that is divided into:
Peer-to-peer networks.
- Client and server networks.

The followed structure that is divided into:
- Physical structural networks.
- Point-to-point structural networks.
- Star Structure Networks.
- Ring structure networks.
- Complete structure networks.
- Hybrid Structure Networks.

This study tackled the main concepts, terminology, basic components, software and means of communication within the LAN, which nowadays has become the main focus for obtaining information and making it available to beneficiaries within universities, institutions and social sites.

1.1 Research Problematic

In the age of globalization, it is necessary to create channels of communications in order to share material, human, scientific and intellectual resources. This was achieved by the local information networks, which resulted in saving time and effort on the one hand, limiting information exchange on the other hand and providing the best services for beneficiaries within institutions, universities and publishing houses on the Internet.

The study's problem is that the studies on the components of the LAN are few and insufficient and do not provide all the aspects related to each of its basic components and communication tools and software in a comprehensive manner. So the researcher aims to study this subject in a thorough and integrated way to know exactly the basic aspects of the LAN components.

1.2 Research Questions

- What are the basic components of the LAN?
- What is the basic software for operating the LAN?
- What are the essential means of communication, equipment and protocols that are needed within the

LAN?

1.3 Significance of the study

It is evident that today's development of humanity is mainly due to the development of information technology which is based on interconnections (networks). LANs are of great importance in the delivery of information to meet the needs and demands of the relatively small communities. This Importance is highlighted and exposed in the present study as much as possible to researchers as follows:

- Connect very expensive devices to many computers, such as connecting the laser printer and the Data Show through this network.
- The ability to transfer data to other networked devices, without the need to transfer this data by CD and flash memory, which reduces time and effort during the transfer. In addition, it helps to manage data, for they can be put in a file known as the database that is frequently used to connect the devices of media organizations, which saves files under a date and name for easy reference when needed.
- Internet connectivity, which contributed to the development of technology. This network links users from all over the world. Through this network, users can access an infinite number of information, and talk to people in different places.
- Many new graduates and job seekers have become able to send CVs to different companies inside and outside the country and have interviews. They no longer need to buy newspapers and see ads then go to company headquarters to conduct the interview. So the internet saved peoples' money and effort.
- File sharing: Data can be easily shared between different users, or accessed remotely if it is saved on other geographically distant devices.
- Increasing storage: Access to files and multimedia, such as: images, music stored on other devices within the network. This provides a lot of storage space on many devices, because the required files are only on one machine.

1.4 Research objectives

The main objectives that we will try to reach through this study are as to:

- Understand the concept of LANs.
- Identify the necessary hardware and software components to operate the LAN.
- Identify the means of communication types within

the LAN.
- Identify of operating protocols within the LAN.

2. Discussion and analysis

2.1 Components of the LAN

It is a set of components through which the process of communication between network elements takes place. It consists of a bunch of crucial hardware and software to operate the network.

2.2 Hardware components

They consist of a set of devices and equipment. For instance, the server is the largest and most efficient device in the network. It usually stores important databases, so that any participant network can benefit. This device is characterized by the ability to control operations and has the authority to view the data of all users of the network through the use of some special programs.
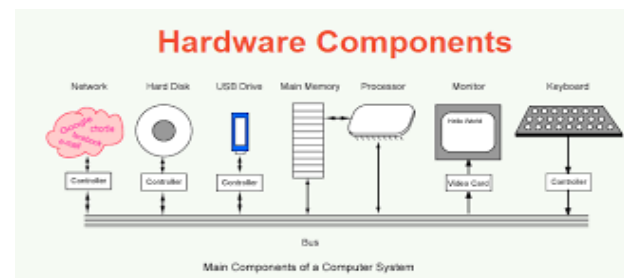

Fig. 1 Network Hardware Components

Network Hardware is an integral part of connecting network devices to each other. It is a transport medium between network devices. It increases the efficiency of its operation, such as the network card, connector, which is available in many types' namely coaxial cable, double-scheduled, fibre optic cables. There are a set of criteria that must be taken into account when choosing the medium of data transmission:
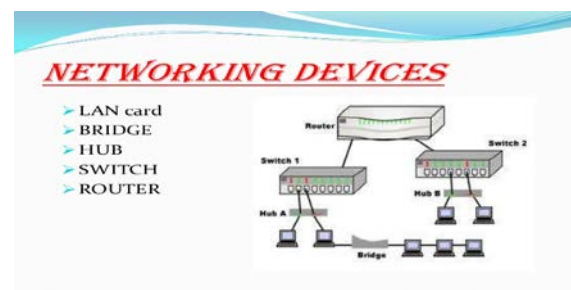

Fig. 2 Networking Devices

- Data transfer at the appropriate speed.
- Appropriate cost.
- Places to use.

They belong to the following categories:

2.2.1 Communication media

It includes all the media that is responsible for transmitting signals of exchanged data between the different network elements, whether wired or wireless. All types of cables are considered as wired media, whereas Microwaves in the air represent wireless media. [1]
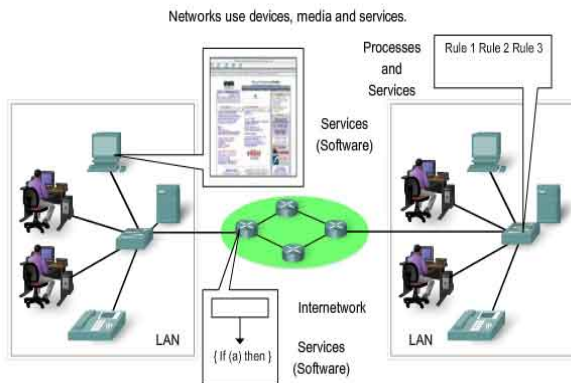

Fig. 3 Communication Media

2.2.2 Communication Devices

It is a group of different functions that operate as follows:

- Increase the number of the connected nodes to the network
- Expand the geographic spread of the network
- Control the signals between the different network nodes
- Isolating network problems, limiting them to a specific location and preventing their spread in other parts of the network

Some of the equipment may be in the form of a panel of electronic circuits inserted into the computer through Expansion Slots, such as network interface cards, which represent the computer ports to the network.

The equipment may also be in the form of independent devices that are connected to the network to perform a specific function such as Routers, Repeaters, and Hubs. [2]
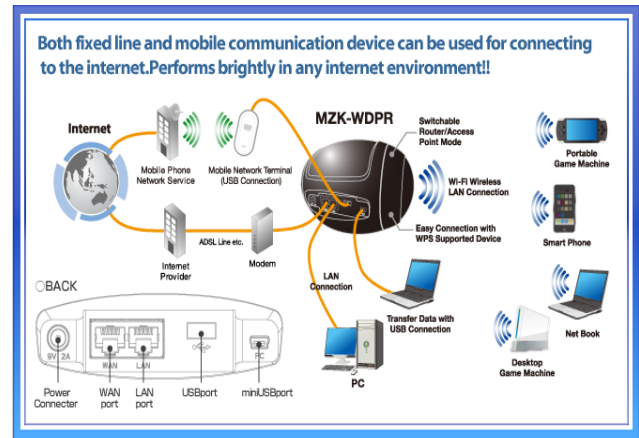

Fig. 4 Communication Devices

3. Software

It consists of specialized programs in management, control and implementation of communication operations across different parts of the network. It includes the following programs:

3.1 Device and communication equipment drivers

They are programs that operate these attached devices to the network and ensure their sophisticated performance. They as well include programs for routers, complexes and repeaters. [3]

3.2 Communication programs

These are programs that manage connections between different network nodes such as Windows 2000, Windows NT, Novell, Netware, UNIX.

3.3 Operations implementation programs

These programs are based on the identification of the rules and principles that must be adhered to in the implementation of communications between network elements, which is the standard language through which the two parties communicate, and this type of programs is called (Protocols).[4]

4. communication media within the Local Area Network

In order to achieve communication between the elements of the enterprise information network, the elements have to be linked by the use of cables to pass signals between the equipment and the network computers. The quality of the used cables to connect the network elements plays an

essential role in the efficiency of performance. Cables are not the only connection used in the enterprise network, but also wireless technology is used to connect the network elements to each other. [5]

4.1 Communication equipment

In order to connect the enterprise information network elements, computers are connected through an interface, which plays the role of the computer gateway to enter the network. This interface is in the form of a network card, which can be named a Network Adapter or Network Interface Card (NIC). The card could be added to the computer through one of the Adapter Slot pores on the motherboard.

In addition to the network card, there are many devices that exist within the network structure according to the need of the network in order to perform a particular activity. Over and above that, these devices share the service of communication processes and expansion of the network scope and possibilities. These types can be identified as follows:

4.1.1 Network Interface Card

The transmission of data between the CPU and the internal computer parts, including the graphics card is carried out through a series of parallel transmission lines called BUSs. This type of connection is made up of chunks, which depend on a number of lines to connect the processor and the network card.

One of the most important functions of the network card is to receive data from the central processor in parallel and serialize it to be transmitted over the network lines. Another key function of the network card is storing the data passing through the buffer, which ensures the balance between two different elements in the speed of communication.

Fig. 5 Network Interface Card

4.1.2 Repeaters

The transmitted signal through the network lines and their devices is susceptible to weakness after being extended over long distances. For this reason, the frequency devices are used to purify these signals, amplify them and then re-

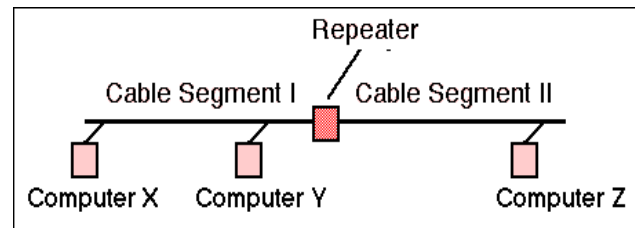transmit them over the network. They also expand the network and increase its nodes.

Fig. 6 Repeater

However, the use of frequencies in the network may cause a Propagation Delay. The more the number of network nodes and data transferred between these nodes increase, the more risk of delay increases. [6]

4.1.3 Hubs

Hubs consist of connection devices used to link a set of nodes in the information network through many ports. They operate like repeaters, but they differ in terms of ports multiplicity. The hub receives data only from one port and distributes them without study and analysis to all other ports; otherwise a Collision Domain occurs between data.

Fig. 7 Hub

The hub is characterized by its capability of preserving the same performance of the other lines, if an error takes place in a connected line. In case of data arrival through a connected line to the hub, it propagates it to all other lines.

4.1.4 Bridges

Bridges belong to non-quantitative engineering sciences and are used to divide the components of the network, but they cannot transmit data through multiple networks. They do not connect to another non-similar network, unless there is a router. Although bridges choose non-smart paths, they are still better than repeaters. For example, if two hundred users are on a single Ethernet switch, the performance of this piece will be weakened and moderated, because of the number of computer workstations that transmit data. In order to solve this problem, the segment is divided into 100 substations, which reduces pressure and increases production. Added

to that, if the destination is known, the band will be sent and if not it will be sent to all sub-computer stations. It should be noted that bridges are better from repeaters in filtering noise.
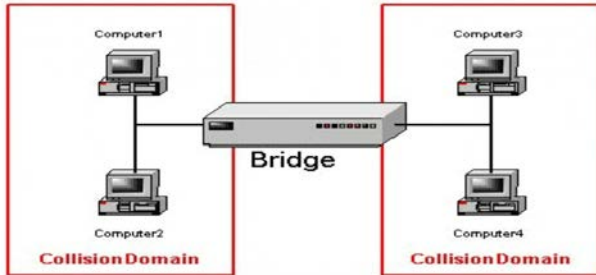

Fig. 8 Bridges

Bridges are thus frequency-like devices that receive incoming signals, strengthen [7] them and send them back to their target. They are able to transmit one signal each time after examining and analysing data in order to determine the destination of transmission. This affects the movement of data in each section of the network. Bridges also work in the second layer of the open system handling different transmissions of the same geometric environment that match the data link layer.

4.1.5. Switches

Switches are bridge-like devices, for they operate in the second layer of the open system, so that they deal with the protocols and addresses of the data link layer. They connect two or more computers or several sections of the network that use the same protocols as the data and network link layers. Switchers enable to connect two similar or different types of cables. [8]
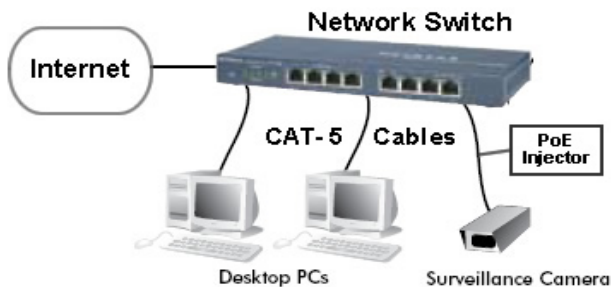

Fig. 9 Network Switch

Switches are characterized by the following:

1. Data processing in the switch is carried out through the physical entity in the bridges. While bridges keep their address tables in the random memory, switchers are programmed to process

data by building the address tables in specific electronic circuits. This provides a distinguishing performance of switchers in transmitting data frames faster than bridges. [9]

2. Most switches have the ability to use all ports at the same time so that these ports can be active and efficient in sending and receiving data at any given moment. This makes switchers faster than bridges and hubs, and has more than one collision domain. [10]

3. Unlike bridges, switches don't directly examine fixed addresses in the imported frames from the connected devices because the addresses of these bridges connected to the switch ports are already known by the port. However, bridges and switches are similar in retransmitting bands that contain specific addresses for all network segments except for the section from which the band came.

4.1.6 Routers

The router is the backbone of the computer network. It transfers data bands to their destinations. The router has to be connected to the two networks at the same time, for it is responsible for transferring data bands from a network to another third layer of the OSI model. [11]
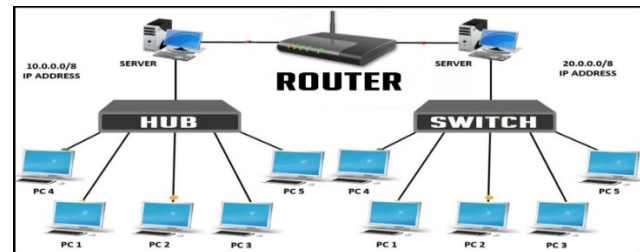

Fig. 10 Network Routing

Routers are devices that are used to connect two or more networks to generate a larger Internet work. This is due to the long distance between the buildings of the institution's colleges. They help to benefit from available resources and exchange information by providing several communication paths between these networks. Routers are able to work in the third layer (network) of the open system, deal with different types of cables and link between networks with different topologies. What most characterizes routers is their ability to choose the best path that the band can take to reach its goal. [12]

While bridges return the bands that contain an address for an unknown target network to all network segments except for the segment from which the packet came, routers destroy such bands.

4.1.7 Brouters

They combine the functions of routers and bridges together. They function as routers by choosing the best path for the bands and then orient them to their target. When the device receives non-oriented bands, it operates like a bridge by transferring the band towards its target based on the physical address. [13]
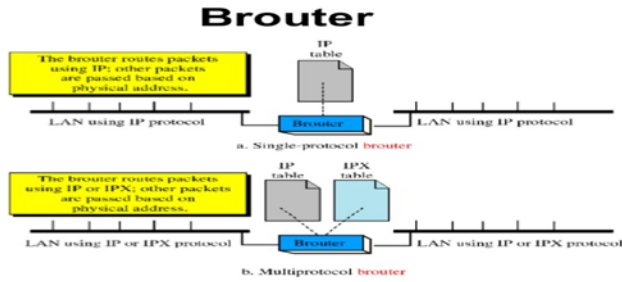

Fig. 11 Network Bridge Router (Brouter)

4.1.8 Gateways

Gateways are responsible for the entrance and transfer from one network to another, according to the orientation terms. The network consists of two nodes:

Gateways node: they consist of computers that control data traffic over the Internet, or through the local ISP. [14]
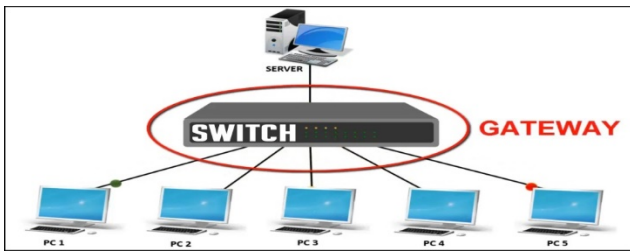

Fig. 12 Network Gateways

Host nodes: They are private computers specialized for network users, as well as devices that run content servers, such as web pages. They are used to connect two networks in the enterprise regardless to their physical structure and the types of cables used to connect network elements. So, Gateways have the ability to connect two networks using different protocols in their third layer according to the open system.

The portals translate the protocols used in the first network into the protocols used in the second network, and vice versa, when the portals are used to connect two networks, also characterized by being a computer that has more than one network card with special port management software. [15]

4.1.9 Modem

The term Modems is a word that is coined of two words (modulator and demodulator). The modem converts digital signals from the computer to analogue signals so that they circulate through the telephone lines. [16]

It is therefore a device used to transmit data over traditional telephone lines to long distances that is why it is called Broad Band Transmission. This allows easy analogical communication between computers via telephone.
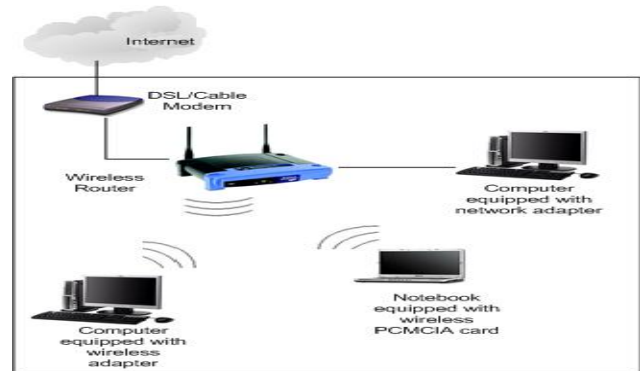

Fig. 13 Network Modem

The modem has two basic functions:

- When transmitting, the modem is called Modulation, which means transmitting the signal by a Carrier from low frequencies to high frequencies. In this case, the modem converts the digital signal used in the computers to an analogical signal that can be managed by telephone lines.
- when receiving, the process is called Demodulation, which means the transmission of the received signal from the high frequencies to the original frequencies of the signal before being sent by the modem. In this respect, the modem converts the analogical signal coming from the telephone lines to a digital signal that can be handled by computers.

4.1.10 Multiplexers / De-multiplexers

Devices that receive signals from multiple sources within the network, collect them and send them via a single transmission line are called transmitting Multiplexers. However, devices that are located at the other end of the transmission line, split the received data and distribute them to several transmission lines are called receiving Multiplexers. [17]
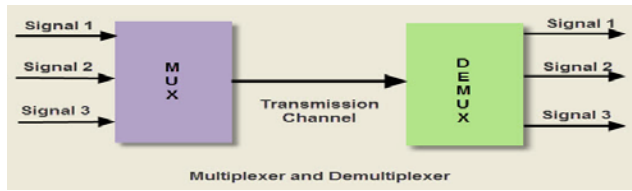
Fig. 14 Multiplex and De-multiplexer Devices

The advantage of using Multiplexers is to reduce costs and increase the speed of data transmission by eliminating the connection of each node of the source in a separate line with the target. They also enable to use the main joint line between the transmitter and receiver multiplexers in a fast way.

5. Communication Protocols

Protocols are set of rules and procedures that must be adhered to when linking computers in a network. [18]

When connecting a computer to the network, it must be able to communicate with other devices in the network. This communication need to comply with rules on how to be implemented, to translate the exchanging signals and to define the device and other devices to the network.
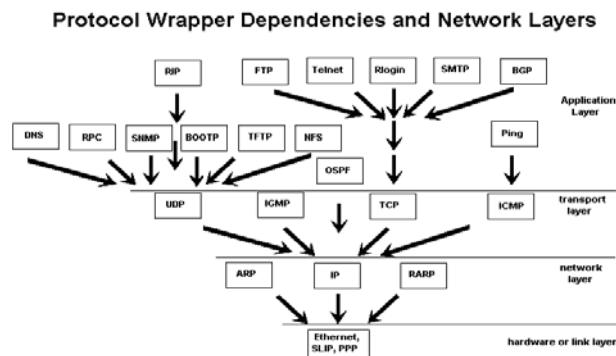

Fig.15 Network Protocol

Depending on the manner followed by protocols in the transmission and distribution management of data through the different network elements, they can be divided into two types:

5.1 Connectionless Protocols

These protocols manage the communication process by broadcasting and distributing data bands in the network lines without notifying the target computer that it has already transmitted the bands. It is assumed that data pass through the network lines like placing letters in the mailbox without telling us in advance.

In spite of the lack of reliability of these types of protocols due to the loss of some messages during transmission, they are characterized by their speed in transmission.[19]

5.2 Connection Oriented Protocols

This type of protocols is designed to notify the target computer of the sending computer in advance, informing it that it will initiate the process of communication and transmission of data through the network. Therefore, there is a need for synchronization between the sender and the receiver so that whenever a band reaches its target, the sender receives a notification from the target that the band is intact. However, if the band is not intact, the target computer sends a notification to the source requesting that it has to be sent back. The connection ends after all bands accurately reach their target.

6. Conclusion

The Local Area Network (LAN) facilitates communication within a limited community such as universities and institutions. The LANs are a mixture of interrelated devices, equipment and institutions. They form a fabric of networks that rely on essential physical components and software to operate efficiently. This study sought to understand the basic components of the local networks operation and define the role of the means of communication adopted within the local network in order to implement the LAN. In order to answer the research questions, components through which the process of communication between network elements takes place were defined as a bunch of crucial hardware and software to operate the network. The software consists of specialized programs in management, control and implementation of communication operations across different parts of the network. In order to achieve communication between the elements of the enterprise information network, the elements have to be linked using cables to pass signals between the equipment and the network computers. Finally, Communication Protocols were introduced, which are set of rules and procedures that must be complied with when linking computers in a network.

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