

**TCS 111: INTRODUCTION
TO
TELECOMMUNICATION
(2 Credits)**



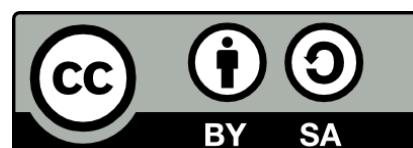
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From the Vice Chancellor

Courseware development for instructional use by the Centre for Open and Distance Learning (CODL) has been achieved through the dedication of authors and the team involved in quality assurance based on the core values of the University of Ilorin. The availability, relevance and use of the courseware cannot be timelier than now that the whole world has to bring online education to the front burner. A necessary equipping for addressing some of the weaknesses of regular classroom teaching and learning has thus been achieved in this effort.

This basic course material is available in different electronic modes to ease access and use for the students. They are available on the University's website for download to students and others who have interest in learning from the contents. This is UNILORIN CODL's way of extending knowledge and promoting skills acquisition as open source to those who are interested. As expected, graduates of the University of Ilorin are equipped with requisite skills and competencies for excellence in life. That same expectation applies to all users of these learning materials.

Needless to say, that availability and delivery of the courseware to achieve expected CODL goals are of essence. Ultimate attention is paid to quality and excellence in these complementary processes of teaching and learning. Students are confident that they have the best available to them in every sense.

It is hoped that students will make the best use of these valuable course materials.

**Professor S. A. Abdulkareem
Vice Chancellor**

Foreword

Courseware remains the nerve centre of Open and Distance Learning. Whereas some institutions and tutors depend entirely on Open Educational Resources (OER), CODL at the University of Ilorin considers it necessary to develop its own materials. Rich as OERs are and widely as they are deployed for supporting online education, adding to them in content and quality by individuals and institutions guarantees progress. Doing it in-house as we have done at the University of Ilorin has brought the best out of the Course Development Team across Faculties in the University. Credit must be given to the team for prompt completion and delivery of assigned tasks in spite of their very busy schedules.

The development of the courseware is similar in many ways to the experience of a pregnant woman eagerly looking forward to the D-day when she will put to bed. It is customary that families waiting for the arrival of a new baby usually do so with high hopes. This is the apt description of the eagerness of the University of Ilorin in seeing that the centre for open and distance learning [CODL] takes off.

The Vice-Chancellor, Prof. Sulyman Age Abdulkareem, deserves every accolade for committing huge financial and material resources to the centre. This commitment, no doubt, boosted the efforts of the team. Careful attention to quality standards, ODL compliance and UNILORIN CODL House Style brought the best out from the course development team. Responses to quality assurance with respect to writing, subject matter content, language and instructional design by authors, reviewers, editors and designers, though painstaking, have yielded the course materials now made available primarily to CODL students as open resources.

Aiming at a parity of standards and esteem with regular university programmes is usually an expectation from students on open and distance education programmes. The reason being that stakeholders hold the view that graduates of face-to-face teaching and learning are superior to those exposed to online education. CODL has the dual-mode mandate. This implies a combination of face-to-face with open and distance education. It is in the light of this that our centre has developed its courseware to combine the strength of both modes to bring out the best from the students. CODL students, other categories of students of the University of Ilorin and similar institutions will find the courseware to be their most dependable companion for the acquisition of knowledge, skills and competences in their respective courses and programmes.

Activities, assessments, assignments, exercises, reports, discussions and projects amongst others at various points in the courseware are targeted at achieving the objectives of teaching and learning. The courseware is interactive and directly points the attention of students and users to key issues helpful to their particular learning. Students' understanding has been viewed as a necessary ingredient at every point. Each course has also been broken into modules and their component units in sequential order.

At this juncture, I must commend past directors of this great centre for their painstaking efforts at ensuring that it sees the light of the day. Prof. M. O. Yusuf, Prof. A. A. Fajonyomi and Prof. H. O. Owolabi shall always be remembered for doing their best during their respective tenures. May God continually be pleased with them, Aameen.

Bashiru, A. Omipidan
Director, CODL

INTRODUCTION

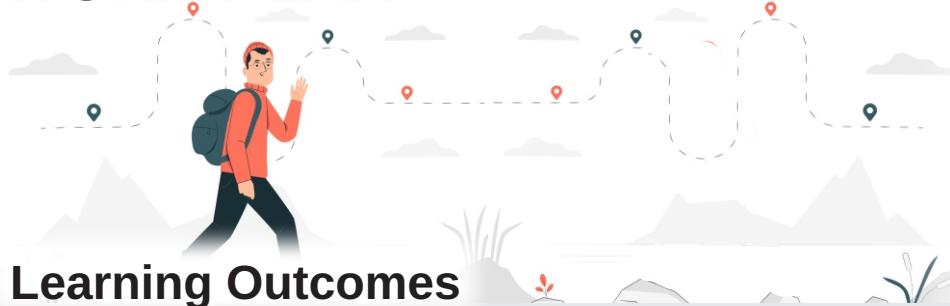
Introduction to Telecommunication is a Harmattan semester course, designed to introduce students to the field of telecommunications. In this course, students will be made to understand the evolution of telephony? and the history related to and the roles played by earlier researchers in the development of telecommunications. The roles telecommunication plays in the development of our society and the global economy? The students are expected understand the concept of analog and digital systems and some others, related to computer and computer networking. This course will also serve to introduce the students to the concept of OSI and TCP/IP model.

Course Goal

The course is designed to introduce students in the Physical Sciences and Engineering to the application of statistics in their discipline. This course is to intimate the students with the usefulness of statistics in their various field of studies. This course is to enlighten the student on the importance of statistics in carrying out researches in their various areas of study. This course is also to develop in students the ability to apply their knowledge and skills to the solution of theoretical and practical problems in Statistics.



WORK PLAN



Learning Outcomes

At the end of this course, you should be able to:

- I. Understand what telecommunication is about
- II. State the history and the evolution of Telephony?
- III. State and explain the telecommunication industry and their functions
- IV. Importance of Telecommunication and the world economy
- V. Explore different types of Telecommunication systems media
- VI. Define and differentiate between Analog and Digital Transmission

Course Guide

Module 1

History of Telecommunications

Unit 1 - Definition and historical evaluation of Telecommunications

Unit 2 - The Telephone industry and Inventors

Unit 3 - Telecommunications Industry and Association

Unit 4 - Basic Telephony



Module 2

Basic Components of Telecommunications and Impact on individual and global society [revise]

Unit 1 - The importance of Telecommunication

Unit 2 - Telecommunication Nigeria and U.S. Economy

Unit 3 - Telecommunication and Global Competitiveness

Unit 4 - Exploring different types of Telecommunication systems



Course Information

This is a compulsory course for students in Departments of Chemistry, Industrial Chemistry, Geology, Mathematics, Computer Science. Students are expected to participate in all the course activities and have minimum of 75% attendance to be able to write the final examination

Pre-requisite



CSC 326
Operations Research

- VII. Differentiate different types of multiplexing techniques
- VIII. Define and state the difference between OSI Model and TCP/IP Model
- IX. Ensure each of I-VIII links to the opening sentence, ending with a full colon



Module 3

Introduction to analog and digital transmissions

Unit 1 - Introduction to Analog and Digital Transmission

Unit 2 - Analog transmission and Digital transmission

Unit 3 - Multiplexing Techniques



Module 4

Introduction to networking internet and Network

Architecture

Unit 1 - Introduction to network and internet

Unit 2 - Computer Networking



Module 5

OSI model and TCP/IP protocol suites/Network topologies/ Introduction to Network devices

Unit 1 - Introduction to OSI model/ the OSI and TCP/IP Model

Unit 2 - Introduction to Network topologies/ Different types of Network topologies

Unit 3 - Introduction to Network devices

Course Requirements

Requirements for success

The CODL Programme is designed for learners who are absent from the lecturer in time and space. Therefore, you should refer to your Student Handbook, available on the website and in hard copy form, to get information on the procedure of distance/e-learning. You can contact the CODL helpdesk which is available 24/7 for every of your enquiry.

Visit CODL virtual classroom on <http://codllms.unilorin.edu.ng>. Then, log in with your credentials and click on TCS 111. Download and read through the unit of instruction for each week before the scheduled time of interaction with the course tutor/facilitator. You should also download and watch the relevant video and listen to the podcast so that you will understand and follow the course facilitator.

At the scheduled time, you are expected to log in to the classroom for interaction. Self-assessment component of the courseware is available as exercises to help you learn and master the content you have gone through.

You are to answer the Tutor Marked Assignment (TMA) for each unit and submit for assessment

Embedded Support Devices

Support menus for guide and references

Throughout your interaction with this course material, you will notice some set of icons used for easier navigation of this course materials. We advise that you familiarize yourself with each of these icons as they will help you in no small ways in achieving success and easy completion of this course. Find in the table below, the complete icon set and their meaning.

		
Introduction	Learning Outcomes	Main Content

		
Summary	Tutor Marked Assignment	Self Assessment
		
Web Resources	Downloadable Resources	Discuss with Colleagues
		
References	Futher Reading	Self Exploration

Grading and Assessment



TMA



CA



Exam



Total





Picture: A Telephone Booth

Photo: Markus Winkler from Pexels



Module 1

History of Telecommunications

Units

- 1 - Definition and historical evaluation of Telecommunications
- 2 - The Telephone industry and Inventors
- 3 - Telecommunications Industry and Association
- 4 - Basic Telephony



02 | The West African talking drum once served as a means of communication long before phones.

source: Pius Utomi Ekpei

UNIT 1

Definition and historical evaluation of Telecommunications



Introduction

In this unit we will cover the introduction to telecommunication and its definition, the historical development over the years as well as its classification.

At the end of this unit, you should be able to



Learning Outcomes

- 1 Define telecommunication
- 2 Lists four components of telecommunication
- 3 Describe the development of telecommunication over the years
- 4 List the names of at least five telecommunication researchers
- 5 Mention at least five importance of telecommunication to the society



Main Content



SAQ 1



SAQ 2

Definition of Telecommunication

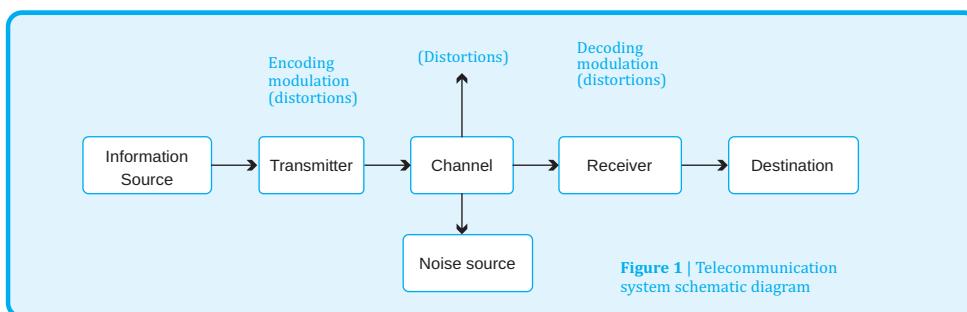


| 4 mins

Telecommunication can be defined as the transmission of information over a distance. The exchange of information by video, voice or data or any other type of information. The modern means of telecommunication we have today includes fiber optics, satellites, telephone, radio broadcasting, TV broadcasting, Internet and telegraphs.

Telecommunication can also be defined as an act of transmitting units of information or messages, signals and data of any nature over a channel either wired or wireless from the transmitter or sender to the receiver or information user. It can be transmitted either electrically over physical media, such as cables, or via electromagnetic radiation.

The path taken by information between you as the sender and the receiver is called channel. From the definition, the telecommunication system can be represented with the figure 1 below:



SAQ 3

Components of a Telecommunication System

Telecommunication system includes a transmitter which receives the message from information source and convert it to a signal. The transmitter performs signal processing techniques on the received signal such as encoding and modulation. A transmission medium or channel is used to convey the information signal and a receiver to take the signal and convert it back to usable or decodable information.

We can describe modern day telecommunication system in terms of a computer networks. The basic components of a telecommunications network can be sub-divided into six main parts:



- **Input and output devices:**

This is also referred to as input/output terminals: These provide the starting and termination points of all communication systems. A telephone system is a good example of a telecommunication terminal. In computer networks, these devices are commonly referred to as nodes and consist of computer and peripheral devices.

- **Telecommunication channels:**

This is the medium through which transmitted data are conveyed to the receiver terminal. The channels can be wired or wireless. The wired channel uses cables such as two-pair wire, coaxial and optical fiber while wireless channel uses radio frequencies.

- **Telecommunication processors:**

In this terminal, control and support functions are provided to the information transmitted from transmitter to the receiver. Some of the functions you are provided with are, coding of information signal, and conversion from analogue to digital and vice versa.

- **Control software:**

This is responsible for controlling the functionality and activities of the telecommunication network.

Message:

This represent the actual data or information being sent between the two communication ends (transmitter and the receiver). Considering the mobile telephony network, the transmitted

- messages can comprise of audio, text and as well as data.

Protocols:

This is a computer program that specifies how each type of telecommunication system handles the messages. For example, GSM and 3G are protocols for mobile phone communications, while transmission control protocol/ Internet protocol (TCP/IP) is a protocol used for communications over the Internet.

Information source

An information source is the generator of the information to be transmitted. It can be from a person, thing, or place from which it comes, arises or obtained. Information sources are categorized into primary, secondary and tertiary.

Transmitter:

In a telecommunication system, a transmitter is an electronic device which produces radio wave with an antenna. This device generates a radio frequency which when excited by alternating current, radio waves will radiate in consonance with the type of antenna used. Transmitters are necessary component parts of all electronic devices that communicate by radio, such as radio and television broadcasting station, cell phones, wireless computer networks, Bluetooth enabled devices and some other radar and navigation devices.

Communication channels:

A communication channel or simply channel refers either to a physical transmission medium such as a wire, or to a logical connection over a multiplexed medium such as a radio channel in telecommunication and computer networking. A channel is used to transfer an information signal, for example a digital bit stream, from one or several transmitters to one or several information receivers. A channel has a certain capacity for transmitting information, often measured by its bandwidth in Hz or data rate in bits per second.



04 | Telecommunications masts
are used to transmit and intercept signals
source: pexels.com

Communications receiver:

These are devices receiving the decoded messages from the sender. This is in contrast to a broadcast receiver which is used to receive radio broadcast. A communication receiver receives parts of the radio spectrum not used for broadcasting that includes military, aircraft, marine and any other bands.



Fig 2: Components of a telecommunication system

The Historical Development of Telecommunications



3 mins



SAQ 4

Telecommunication history as we have it began with the use of smoke signal, drums, other forms of symbols, and the likes in Africa, America, and larger parts of Asia. In the early 70s, the fixed semaphore system (conveying information utilizing visual signals., using towers with pivoting shutters) emanated from Europe.

The advent of electrical communication started in 1800s and since then there has been significant changes in communication technologies which is in tandem with shifts in political and economic systems of the society, and by extension, systems of government.

Communication varies from the mode which ranges from one to one communication in a subtle process of exchange, to full conversations and mass communication over large number of individuals.

The imperfection of the nature of speech transmitted over the channel which nonetheless allowed easier dissemination of ideas and stimulated inventions, eventually resulted in the creation of new forms of communication, improving both the range at which communication can exist between us and the longevity of the information.

Ancient Systems And Optical Telegraphy



05 | Drumming is also an ancient form of communication
source: shutterbouy from unsplash

Do you know that in the olden days the means of communication includes the use of smoke signals, the beating of drums, and bells? Yes, talking drums were commonly used by Chinese, Americans and Africans. The use of all these signs and symbols have many interpretations and meanings to the natives which include announcement of presence of military camp, breaking the news on the demise of the king and many others.

In Judaism culture, communication was initially existed by the use of flags at intervals along the ways to the high priest if the goat had been sacrificed. Also, there are quite a number of methods that were employed

to pass the information to both the king and the populace.



06 | Transmitter, part of Reis telephone made in 1863.
source: Science Museum Group Collection



07 | Receiver, part of Reis telephone made in 1863
source: Science Museum Group Collection



08 | Receiver, part of Reis telephone made in 1863
source: Science Museum Group Collection

Johann Philipp Reis (1834–1874)

was a German physicist and schoolmaster. In 1861, he performed an experiment by using a vibrating membrane that touched a needle and reproducing the sound from the needle connected to an electromagnetic hitting wood box. His invention could not be patented because he lacked sufficient scientific background to justify his work.

Alexander Bell

Alexander Bell was a Scot born in Edinburgh in the early 1847 and died in 1922. He was a scientist, inventor, engineer, innovator who is credited with inventing the first practical telephone. He is the founder of the American Telephone and Telegraph Company (AT &T) in 1885. Alexander Bell comes from a family that has been associated with many research work related to elocution and speech. His effort in speech and hearing led him to be awarded the first U.S patent for the telephone in 1876.

Alexander Bell carried out some experiment with his assistant Thomas Watson in 1875 which led to the invention of the sound-powered telephone which could transmit indistinct, voice-sound speech but has some interference which makes the voice inaudible.



09 | Replica of Bell's harmonic telegraph receiver, 1875.
source: Science Museum Group Collection

Theodore Newton Vail (1845 – 1920)

Theodore Newton Vail (1845 – 1920) was elected president of American Telephone and telegraph between 1885 and 1889. Vail saw telephone service as a public utility and started the process of consolidating telephone networks under the Bell's system.

Vail worked with Gardiner Hubbard, a lawyer, and lobbyist, and he was convinced that the telephone would revolutionize the world's means of communication systems. The synergy between Vial and Hubbard led to the invention of the use of copper wire in the telephone and the telegraph lines.

- •Summary

In this unit, you have learnt that:

- The definition of telecommunication
- How to represent telecommunication using schematic diagram
- The component of telecommunication systems
- The historical development of telecommunication evolution



Self Assessment Questions



1. Explain the concept of telecommunication
2. State the components of Telecommunication
3. Draw a diagram to represent simple communication system
4. List five names of researchers involved in the evolution of telecommunication system
5. Write short notes on each of the following people contribution to telecommunication
 - a. Theodore Newton Vail b. Alexander Bell c. Johann Philipp
6. Identify end-users.



Tutor Marked Assessment

- ● - State the contribution(s) of John von Neumann and two (2) other persons to the development of Computer



Further Reading

- <https://marketbusinessnews.com/telecommunications-definition-meaning/>
- <https://www.nap.edu/read/11711/chapter/3>
- <https://www.collinsdictionary.com/dictionary/english/telecommunications>
- <https://www.mitel.com/articles/history-telecommunication>
- <https://onlinelibrary.wiley.com/doi/pdf/10.1002/0471722243.fmatter>
- <http://www.computerhistory.org/babbage/engines/>
- <https://www.computerhope.com/jargon/p/punccard.htm>
- <https://www.computerhistory.org/revolution/early-computer-companies/5/100>



References

- Egbewole, W. and Jimoh R. (Eds.). (2017) Digital Skill Acquisition. Ilorin, Nigeria: Unilorin
- Dale, N. (2005), Computer Science Illuminated. London: Jones and Bartlett
- French C. (2001). Introduction to Computer Science. London: Continuum.



01 | communications satelite
source: pexels.com

UNIT 2

Telecommunication Industry, Associations, and Standard Organization



Introduction

In this unit, we will cover the importance of the telecommunication industry, the evolution, the relevant industry, and the roles played in the development of the telecommunication industry by the standard organization.

At the end of this unit, you should be able to



Learning Outcomes

- 1 Describe the telecommunication industry
- 2 state four types of service rendered by the telecommunication industry.
- 3 list at least five opportunities available in the telecommunication industry
- 4 Explain the standard and standard organization in the telecommunication industry

Telecommunication Industry, Associations, and Standard Organization



| 6 mins

The Telecommunication Industry Association (TIA) is accredited by the American National Standard Institute (ANSI) to develop, voluntary, consensus-based industry standards for a wide variety of Information and Communication Technologies (ICTs) products, and currently represents nearly 600 companies in the ICTs world. TIA provides most of the guidelines used by many standard organizations which are regulating the activities of major vendors in radios, television and communication equipment manufacturer for private radio equipment, cellular tower industries, satellites companies, data terminals, telephone terminals equipment, VOIP devices, structured cabling, data centers, mobile devices communications, multimedia multicast, healthcare, ICT device-to-device (D2D) communication and smart networks.



01 |National Communications Commission Headquarters
source: Pinterest.co.uk

Nature of Services provided by Telecommunication Industry



SAQ 1

Goods and Service:

This industry delivers telecommunication tools and apparatus such as telephone, television, internet, facsimile, and some other services to us. The telecommunication

industry provides the primary means of interacting between businesses, individual, and some other services such as wired, wireless, broadband, and mobile services, and satellite TV among others,

Industry Organizations:

The telecommunication industry is majorly divided into four sectors which are wireless, wired, satellite, and other telecommunication establishments. The major sector in this industry is wired which provides services such as landline telephone, digital subscriber line (DSL), Internet services.

This industry route voice, video (TV) wired, data over network wires, and have sole control over the network. The industry may own and maintain the networks, lease or share the network with other organizations in the industry but they did not own or have propriety right over the content of the transmitted message. Wired telecommunication also includes direct-to-home satellite, free-to-air satellite, and a variety of other services.

Wireless telecommunication:

Study Tips

The telecommunications industry is one of the backbones of internet revolution in the world. to better understand the

nature of services provided by this industry, start by identifying the services offered in your local area and observe how they are inter-related.

for example, Huawei specialises in manufacture and sales of telecomms equipments. while MTN specialize in provision of mobile and internet services

These are the service provider that provides Internet, voice over IP telephony services to the prospective customer through transmission over the radio. The signals are transmitted through an antenna directly to us the customers, who use devices such as mobile phones and computers, to receive, interpret, and send information. The majority of companies in the industry provide cellular phones and mobile internet services.

Satellite telecommunications:

These are the establishments that are made up mostly by government and private organizations that transmit a variety of data/information through satellites. This service can provide an aerial view of the earth and have high application in disaster management, weather forecasting, direct-to-home-satellite TV providers, and monitoring of land border and security applications.

Transmission Capacity

Due to recent development in semi-conductor electronics and an increase in the number of signals we transmit daily, the telecommunication industry had an increase in the capacity of the signal transmitted with the use of optical fiber cable instead of twisted pair cable. In some advanced countries, some network carriers extending the fiber-optic cable to residential houses enabling them to enjoy high-speed internet services such as video-on-demand and streamless online television.

Wireless communication carriers are deploying several new technologies to allow faster data transmission and better internet access to make them more competitive in a global market that includes wired internet carriers. With faster connection speed, wireless carriers can transmit music, video, applications, and other content that can be downloaded and played on cellular phones, giving users mobile access to large amounts of data.

Besides, as the use of this mobile technology increases, wireless companies continue to evolve the next generation of technologies that will allow faster data transmission and a higher data rate of downloading and uploading of information and resources.

Opportunities in the Telecommunication Industry



Employment Opportunity

According to the information available to us, we knew that telecommunication

industries had provided over 15 million jobs in the last 20 years in Nigeria. Wired telecommunications carriers accounted for about 54% while the wireless industry accounts for the remaining 46%. Telecommunication jobs and opportunities are available in every part of the country either directly or indirectly, but most of the employee's available works can be found in the urban area which has large concentrations of industrial and business establishments.

Occupations opportunity

Although the employment opportunities in the telecommunication industry are very wide however, the majority of the employment is available in maintenance, installation, and repair occupations or office and administrative support services.

Telecommunications craftworkers install, repair, and maintain telephone equipment, cables and access lines, and telecommunication systems. These workers are categorized based on the type of services they rendered.

In the industry, telecommunication equipment installers and repairers maintain the arrays of increasingly and complex and sophisticated communication equipment, their work includes setting up, rearranging, and removing the complex switching and routing equipment used in the central offices. They may also solve network-related problems.

Training and Advancement

Due to rapid changes in technological advancement and the introduction of new technologies and services. The telecommunication industry is among the most changing industry that is growing faster in recent times with current trends, hence, the IT professional and other workers in the field must be up-to-date so that can able to cope with recent trend and changes in the industry. Telecommunications industry employers are now looking for workers who are expert in the field of communication and with knowledge and skill in computer programming and software design, voice telephony technology, laser and fiber optics technology, wireless and mobile technology, and data compression, security and cryptography techniques.

Outlook

Despite the increase in demand and deployment of telecommunication services in recent times, the fear of losing jobs and a decrease in employment in the coming days ahead. With rapid development in technology, the opportunity is available for those with up-to-date technical skills. More so, despite increasing demand for wireless Internet, cable television, and mobile technologies, productivity will result in reduced demand for workers.

As telecommunication infrastructure is more becoming resilient and reliable, few workers will likely be required to make repairs and replace the existing equipment in case they are faulty. Wireless companies are expected to continue to introduce new technologies and services and provide faster internet access for teaming users.

Employment in the industry is expected to drop by 1 percent over 10 years as demand will decrease in installation, maintenance, and repairs due to the nature of the equipment used, and upgrading existing equipment is less labor-intensive than installing new equipment. Some occupation, however, will not see such declines for customer service representatives will grow as these workers will be needed to accommodate an increase in customers. Also, computer specialists will not see declines because these workers will be needed to develop new technologies.

International Telecommunication Organization



7 mins



03 | International Telecommunication Union (ITU) Buildings, Geneva, Switzerland
source: wikipedia.org

Study Tips

It may interest you to know that the international Telecommunication Union was formed in 1865 in Paris,

The International Telegraph Union (ITU), is an agency of the United Nations (UN) that is responsible for the management of Information and Communication Technologies. The ITU coordinates the general use of radio spectrum, promotes international cooperation in assigning satellite orbits, works to improve telecommunication infrastructure in the developing world, and assists in the development and coordination.

The ITU is also involved in many other areas including broadband internet, latest-generation wireless technologies, aeronautical and maritime navigation, convergence in fixed-mobile phone, internet access, data, voice and TV broadcasting and next-generation networks.

It is necessary to make you know that the head office of ITU is based in Geneva, Switzerland and is a member of the United Nations Development Group. ITU has been an intergovernmental public-private partnership organization since its inception. It has about 193 members and about 800 public and private sectors companies and academic institutions as well as universities and regional telecommunication entities, known as Sector Members and Associates, which undertake most of the work of each sector.



SAQ 2



04

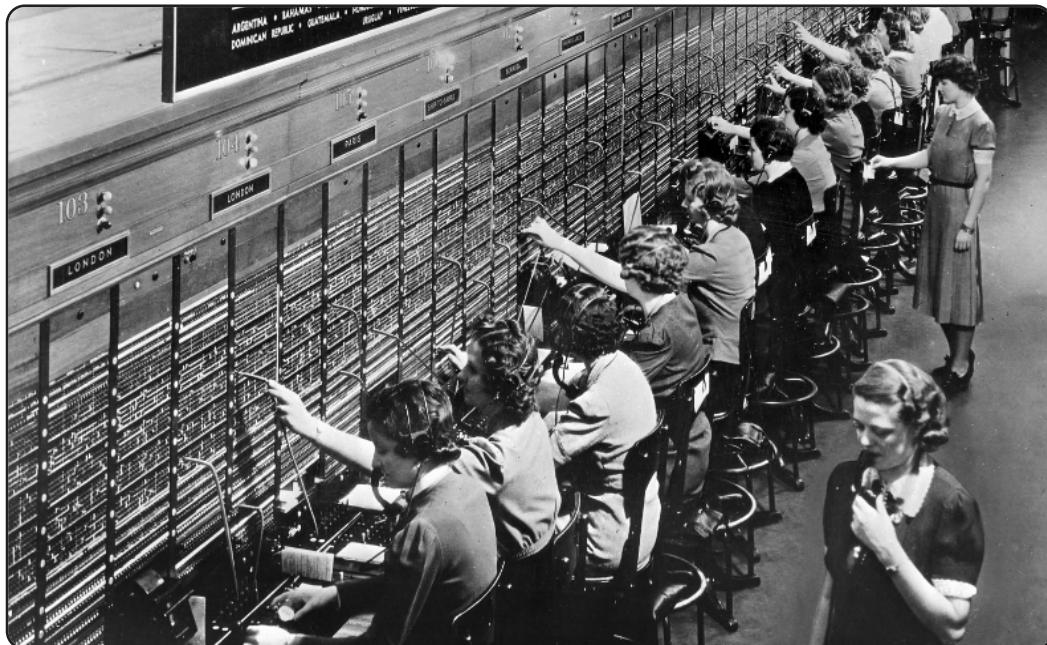


04 | World Summit on the Information Society (WSIS) Forum 2019
source: ITU

05 | ITU study group meetings
source: ITU



05



06 | High seas and overseas radio operators at AT&T's New York City switchboard in 1943 handled calls through station WOO. AT&T photo.
source: workboat.com

Telecommunications: An Evolving Definition



SAQ 3

Before the advent of the internet and other data services, the telephone and the telegraph were an application of technology that allowed people to communicate at a distance by voice, and telephone service was provided by PSTN. In the United States, the major share of their network was owned and operated by American Telephone and Telegraph (AT & T); while the rest are shared by other smaller and independent companies.

In the 1960s, facsimile and data services were overlaid on the PSTN, due to ability of PSTN line, the capacity to communicate documents and data at a distance. In the recent times as we have today, the communication has expanded to include data, transport which can be used for video conferencing, e-mail messaging services, web browsing and various forms of distributed collaboration, enabled by transmission media that have also expanded to include microwave, terrestrial wireless, satellite, hybrid system, fiber/coaxial cable and broadband fiber transport system.

Nowadays, we the telecommunication product users look at telecommunication in

terms of both the products and services. The technologies used in telecommunication is changing over the period of about 50 years since the research into the semiconductor and digital electronics by the expert in the field of telecommunication.

The biggest consequences have been that all types of media can be represented in the same basic form and therefore handled uniformly within common infrastructure (most commonly as Internet Protocol, or IP, data streams). Perhaps the most fundamental changes, both in terms of technology and its implications for the industry structure reveal in the architecture of telecommunication networks.

Architecture refers to the functional description of the general structure of the system as an entity and how the different parts of the network relate with each other. Previously, the PSTN, cable and data network coexisted as separately owned and operated networks carrying different types of communication, although they often shared a common technology base such as point-to-point digital communication and some other facilities such as high-speed digital pipes shared by different networks.

More so, the networks are built in layers from physical layer, which deals with optical, electrical and mechanical functions for managing network connection to the other layer in the network OSI model layer that participate in data transmission from one system to another and ensuring end-to-end connections in a way that the data is delivered reliably and safely at the application layer.

The ways we apply information technology ranges from word processing to voice communication which later graduated to internet world. Some other new data-based features and integrates important trend is machine-to-machine communication which states that telecommunication has gone beyond the communication between being alone

Telecommunications Standards and Organizations

What do I mean by standards and organization? A standard organization is a body whose primary activities are developing, coordinating, promulgating, revising, amending, reissuing, interpreting or otherwise producing technical standard that are intended to address the needs of a set of groups. Most standards are voluntary in the



SAQ 4

sense that they are offered for adoption by people or industry without being mandated in law. Some standards become mandatory when they are adopted by regulators as legal requirements in particular domains. Standards can be categorized into formal, de jure and de facto. The formal standard refers specifically to a specification that has been approved by a standards setting organization while de jure standard refers to a standard mandated by legal requirements or refers generally to any formal standard. In contrast, the de facto standard refers to a specification that has achieved widespread use and acceptance often without being approved by any standards organization. Normally, the term standards organization is not used to refer to the individual parties participating within the standards developing organization in the capacity of founders, benefactors, stakeholders, members or contributors, who themselves may function as the standards organizations.



07 | ITU Telecom world summit 2018

source: ITU

Currently, telecommunication carriers are developing the new architectures and networks to improve wireless broadband throughput. Presently, the network providers are using:

Some of the standard organizations

Third Generation telecommunication (3G)

This meets the International Mobile Telecommunication (IMT) 2000 technical standards for reliability and data transfer rates. This includes wide area wireless telephone, mobile internet access, video call and mobile television. This can provide you a data rate of up to 56 Mbit/s in the downlink and 22 Mbit/s in the uplink.

Some of the standard organizations...

**Fourth Generation
telecommunication
(4G)**

This allow ultra-broadband internet services for devices with USB wireless modem, IP telephone, high-definition television conferencing and the use of long-term evolution (LTE) standard, IMT 2000 technical standards, IEEE 802.16m or wireless-MAN-advanced standards

Alliance for Telecommunication Industry Solution (ATIS)

It is necessary for you to know that ATIS is one of the leading technical planning and standards development organization committed to the rapid development of global, market driven standards for the information, entertainment and communication industries. More than 200 companies are actively involved in standard formulation in ATIS' committee covering several area of communications such as IP-Based and wireless technology, IPTV, cloud services, energy efficiency, quality of service, billing and operation support, emergency services, architectural platform and emergency networks.

Also, the alliance provides standard for the following services: numerous incubator, smart-grid, machine-to-machine communication, networked car, security and policy management. ATIS focus on the effort in mobile healthcare. The ATIS mhealth initiative focuses primarily on protocols and enhancements to wireless networks and the Internet Protocol (IP) Multimedia Subsystem (IMS) to securely transport medical information of the patient.

Bluetooth Special Interest Group

You must have used the Bluetooth technology at one time or the other. The SIG, Bluetooth Special Interest Group (SIG) is a non-profit trade association which is privately owned which was founded in 1998. The SIG members are the leading vendors in the telecommunication, computing, automotive, music, apparel, industrial automation and network industries but they are not manufacturer of product. SIG

**A Zigbee module**

Physical range: 10 to 20 meters
For wireless connections

Study Tips

Zigbee is an IEEE 802.15.4-based specification for a suite of wireless protocols used to create personal area networks with small, low-power digital radios, such as for **home automation**, medical device data collection, and other low-power low-bandwidth needs, designed for small scale projects which need wireless connection.

members drive development of Bluetooth wireless technology, and implement and market the technology to the prospective users. The main task for the Bluetooth SIG is to publish Bluetooth specification program,

ZigBee Alliance

The ZigBee Alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked, monitored and controlled products based on an open global standard.

The ZigBee was able to achieve the desire of providing consumer with ultimate flexibility, mobility, and ease of use by building wireless intelligence and capabilities into every wireless device. ZigBee technology will be embedded in a wide range products and applications across consumer, commercial users, and industrial and government markets worldwide.

Wi-Fi Alliance

The Wi-Fi Alliance is a global non-profit organization which comprises of conglomerate of industries devoted to the proliferation of Wi-Fi technology across devices and market segments.

Wi-Fi Alliance is also an organization made up of leading wireless equipment and software providers with the mission of certifying all 802.11-based products for interoperability and promoting the term Wi-Fi as the global brand name across all markets for any 802.11 based wireless LAN product which we all use today.

The WI-Fi certified program was launched in 2000 to train IT professionals which provides a widely-recognized designation of interoperability and quality, it also helps to ensure that Wi-Fi enabled products deliver the best user experience.



- ● Summary

So far, I have taught you in this unit

- the meaning of telecommunication industry
- the nature of telecommunication industry
- the available opportunities in telecommunication industry
- the meaning and importance of telecommunication organization
- telecommunication evolution



Self Assessment Questions



1. Explain in detail, the telecommunication industry
2. Explain the evolution of telecommunication industry
3. List and explain at least six benefit obtained by the evolution of telecommunication industry
4. Describe in details the telecommunication organization
5. List at least five standard organizations and explain their roles in telecommunication industry



Tutor Marked Assessment

- Explain in detail, the telecommunication industry
- Explain the evolution of telecommunication industry
- List and explain in detail the benefit obtained by the evolution of telecommunication industry
- What are the opportunities associated with the telecommunication organization?



Further Reading

- <https://www.proshareng.com/news/Mobile-Money-and-Telcos/The-Nigerian-Telecommunication-Sector---/36424>
- <https://collegegrad.com/industries/telecommunications>

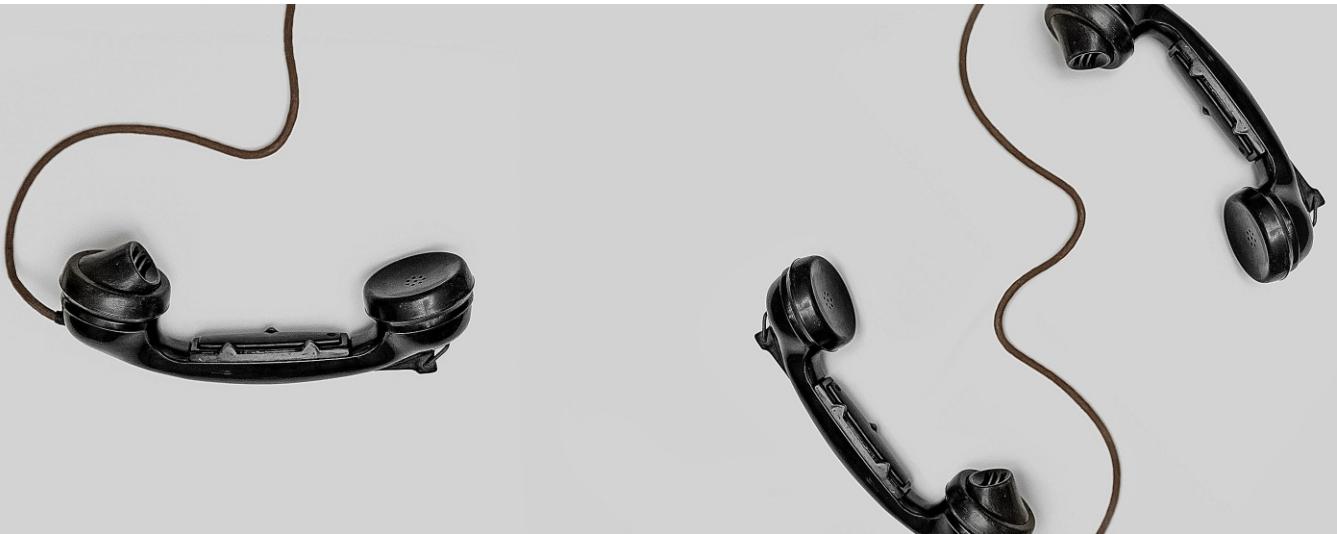
Further Reading...

- <https://www2.deloitte.com/us/en/pages/technology-media-and-telecommunications/articles/telecommunications-industry-outlook.html>
- <https://www.marketwatch.com/press-release/global-telecommunication-market-size-share-segmentation-structure-companies-trends-outlook-and-industry-profile-forecast-2019-to-2026-2019-04-03>
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UNIT 3

Telephony Fundamentals: An Introduction to Basic Telephony Concepts



Introduction

In this unit we will cover the basic concept of telephony, the telephony fundamental and importance of telephone in the development of telecommunication industry

At the end of this unit, you should be able to

Learning Outcomes

- 1 Explain the basic principle of basic telephony
- 2 Explain the relevance of Telecommunication and Networks as related to basic telephony
- 3 Describe the simple telephone connection
- 4 Explain the telephone network
- 5 Describe the concept of Traffic Engineering

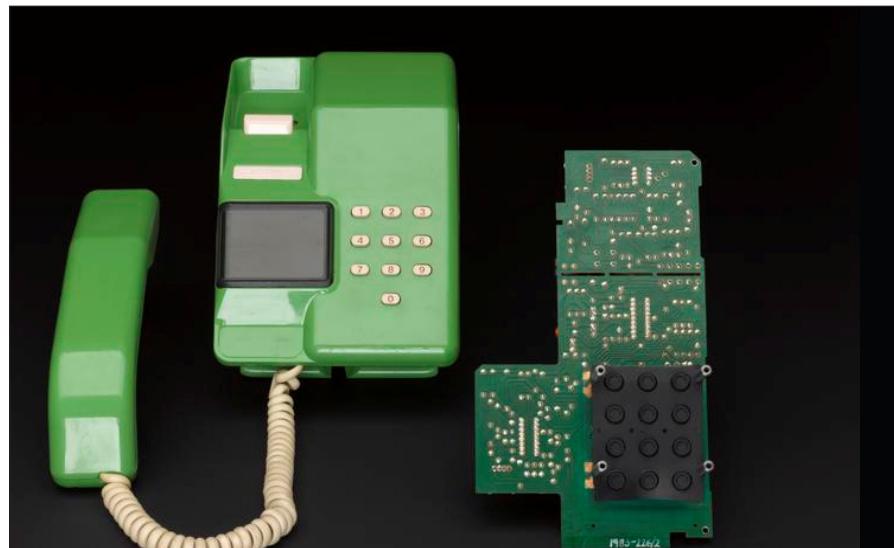


Main Content

Telephony is an act of communication system between two users for example you and your friend at a distance to each other with the use of electrical wires, the service provider may be private or open to public correspondence. Example of the latter is a government-owned telephone company which sell their service publicly. As telecommunications has moved from proprietary to open, standard based, advanced voice solutions have grown richer and more cost effective. The formers are private individual that invested their fund in establishing communication industries which provide telephony services to the public

Additional Info

The Viscount telephones were part of a range of home telephones introduced after the standardisation of telephone sockets in 1981. This standardisation ended the General Post Office monopoly on telephone designs, and gave consumers a wider choice. This telephone operated with digital exchanges rather than electric ones.



10 | Printed circuit board for a Viscount 9501R telephone, made by Standard Telephones and Cables for the British Post Office, British, 1982-1983.

source: Science Museum Group Collection

Basic Telephony

Telephone is an electrical device that consist of handset and its cradle with a signalling device, consisting of either a dial or push button. The handset you have is made up of two electroacoustic transducers, the earpiece and the mouthpiece.



Their circuit is also consisting of side-tone device that allows some transmitted energy into electric energy by means of carbon



12



13

11 | Strowger table pattern telephone, manufactured by the Automatic Electric Company, Chicago, United States, 1901-1910.
source: Science Museum Group Collection

granule transmitter. The transmitter works with direct current (DC) which is usually between 3-5V, across its electrodes and in modern telephone system, it is supplied over the line from the switching centre and it has been standardized at -48V (DC).

The current generated from the battery flows through the carbon granules or grain when the telephone handle is lifted from its cradle. When the sound impinges on the diaphragm of the transmitter, variations of air pressure are transferred to the carbon and the resistance of the electrical path through the carbon changes in proportion to the pressure.

The diaphragm consists of soft iron magnetic material placed in a steady magnetic field supplied by a permanent magnet and varying magnetic field caused by voice currents flowing through the voice coils. Such current is fluctuating in nature and originate at the far end of the telephone transmitter.

These currents cause the magnetic field of the receiver to alternately increasing and decreasing making the diaphragm move and respond to the variations, thus an acoustic pressure wave is set up more or less exactly

12 | An opened telephone box
source: Alex Andrews from pexels

13 | Automatic telephone wall set made by Automatic Electric Company, Chicago, United States, 1900-1910.
source: Science Museum Group Collection

reproducing the original sound wave from the distance telephone transmitter.

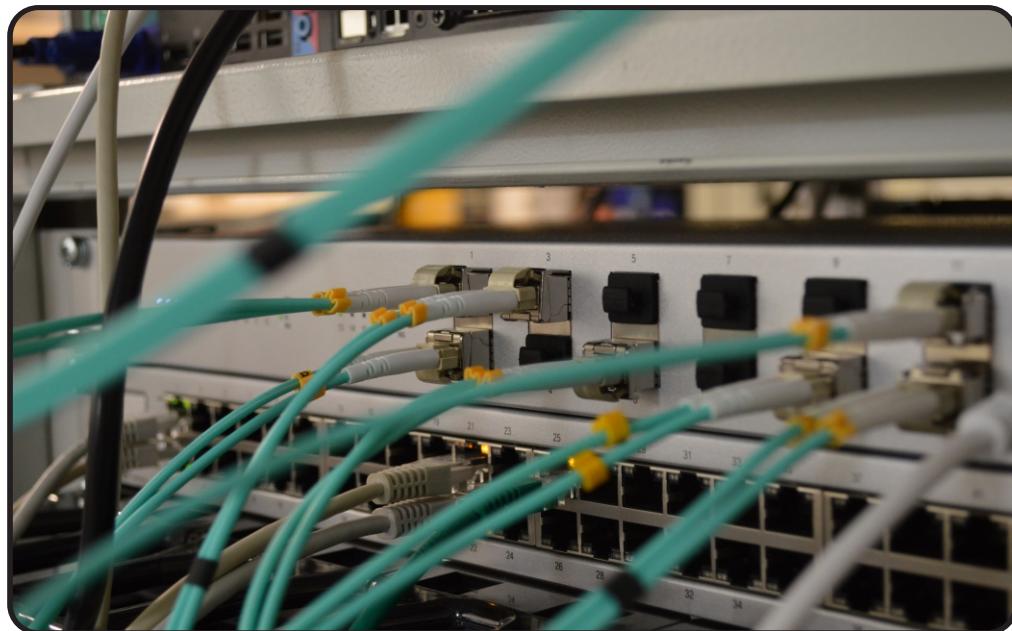
The efficiency of this type of telephone is very low of about 2-3% and the problem of side-tone is prevalent is also high. In order to remove side-tone effect, the talker should reduce or lower his or her voice because if the side-tone is high the output of the transducer will be low and vice versa.

Telecommunication Networks



The public switched telecommunication networks (PSTN) are immense. It consists of hundreds of smaller units of interconnected both mobile and fixed lines. Wired and wireless networks can co-exist in a certain and one can serve as backbone for the other in case there is a failure. These networks either it is wired or wireless or mobile or fixed, they have been traditionally used for voice communication, meanwhile another type of network that had been recently discussed is called enterprise network.

The enterprise network supports the government enterprise as a private business. Its most common configuration is a local area network (LAN) and it is optimized for data services. Also, wide area network (WAN) and other networks associated



14 | Unifi 16XG ethernet switch in homelab rack
source: Thomas Jensen on Unsplash

The Simple Telephone Connection



SAQ 3

The conventional telephones have a jack where the cable is plugged, the phone jack is connected to the wall jack which is connected to the telephone company's wiring. The phone jack is lined with a conductor that recognizes the wire inside the cord and establishes connection with the line.

In case of two-line phone jack, the phone jack automatically recognizes all four wires and thus both phone lines, the contacts in a single-line phone jack only recognize the first line. So even if two phone lines are connected, up and running and the two lines are connected into a single-line phone jack, it is the only first phone that call can only be received from it.

In case of two-line phone, it will instantly recognize both phone lines and detect which one is ringing. It is possible to use two phone line without using a two-phone line but all it needed is to either rewire the wall jack or using two-line splitter.

These devices plug into a standard two-line jack and split the line, directing the first line to one jack and the second line to the other jack. With a splitter, you'll just have two single-line phones coming off the same jack. One of the phones will receive calls from line one, and the other will receive calls from line two.

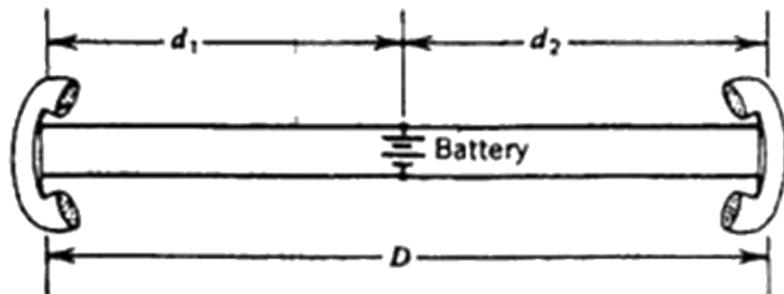


Figure 1: Simple diagram showing two telephone connected together

From the diagram above, the distance D is the separation between the handsets and is the sum of distances d_1 and d_2 . d_1 and d_2 are the distances from each handset to the central power supply.

The length of these wire to the battery causes voltage drop which limits the voltage across the handset transmitter, and thus caused attenuation. For a 19-gauge wire, the limiting distance is about 30 km. This limitation can be overcome by using line amplifier and this will also lead to increase in battery voltage.

With the telephone system depicted in Figure above only two people can

communicate. As the number of telephone users increases, the problem of crosstalk arises, these can be corrected by providing each person with two handsets and these will increase the number of handsets holding by individual and making the whole system complex and cumbersome.

Essentials of Traffic Engineering



SAQ 5

In telephoning communication system, an important feature for you to determine the number of trunks require to connect between two exchanges.

In order for us to get the correct dimension of the user that will connect to the trunk at certain time to avoid network congestion, this led us to the concept of traffic or telegraphic engineering. We can define Traffic engineering as using two parameters which are:



- The calling rate or the number of times a traffic path is used per unit time.
- The holding time or occupancy period by a call.

A traffic path is a channel time slot, frequency band, line, trunk, switch or circuit over which individual communications pass in sequence. To dimension a traffic path or size a telephone exchange, we must know the traffic intensity representative of the normal busy season.

Busy Hour:

This refers to the traffic volume or number of call attempt for a continuous 1-h time interval concern for which this call attempt is made. The peak busy hour is the number of call attempt made over the period of 24 hours while the time consistent busy hour simply means the time of each day for which the average call attempt count of the days under consideration.



- •Summary

In this unit, I have taught you the following:

- the basic principle of telephony
- telecommunication and networks as related to basic telephony
- description of the simple telephone connection
- basics of telephone network
- concept of traffic engineering
- concept of busy hour
- the factors responsible for busy hour



Self-Assessment Questions



1. Explain the principle of basic telephony
2. Explain the relevance of Telecommunication and Networks as related to basic telephony
3. Describe the simple telephone connection
4. Explain the telephone network
5. Describe the concept of Traffic Engineering



Tutor Marked Assessment

- Differentiate between one-way and both-way circuits.
- What is the drawback of one-way circuits and both-way circuits?
- Hierarchical networks are used universally in national and international telephone networks. Differentiate between high-usage (HU) connectivity and final route.
- What is on hook and off hook? When a subscriber subset (the telephone) goes “off hook,” what occurs at the serving switch? List two items.
- Suppose that the sidetone level of a telephone is increased. What is the natural reaction of the subscriber?



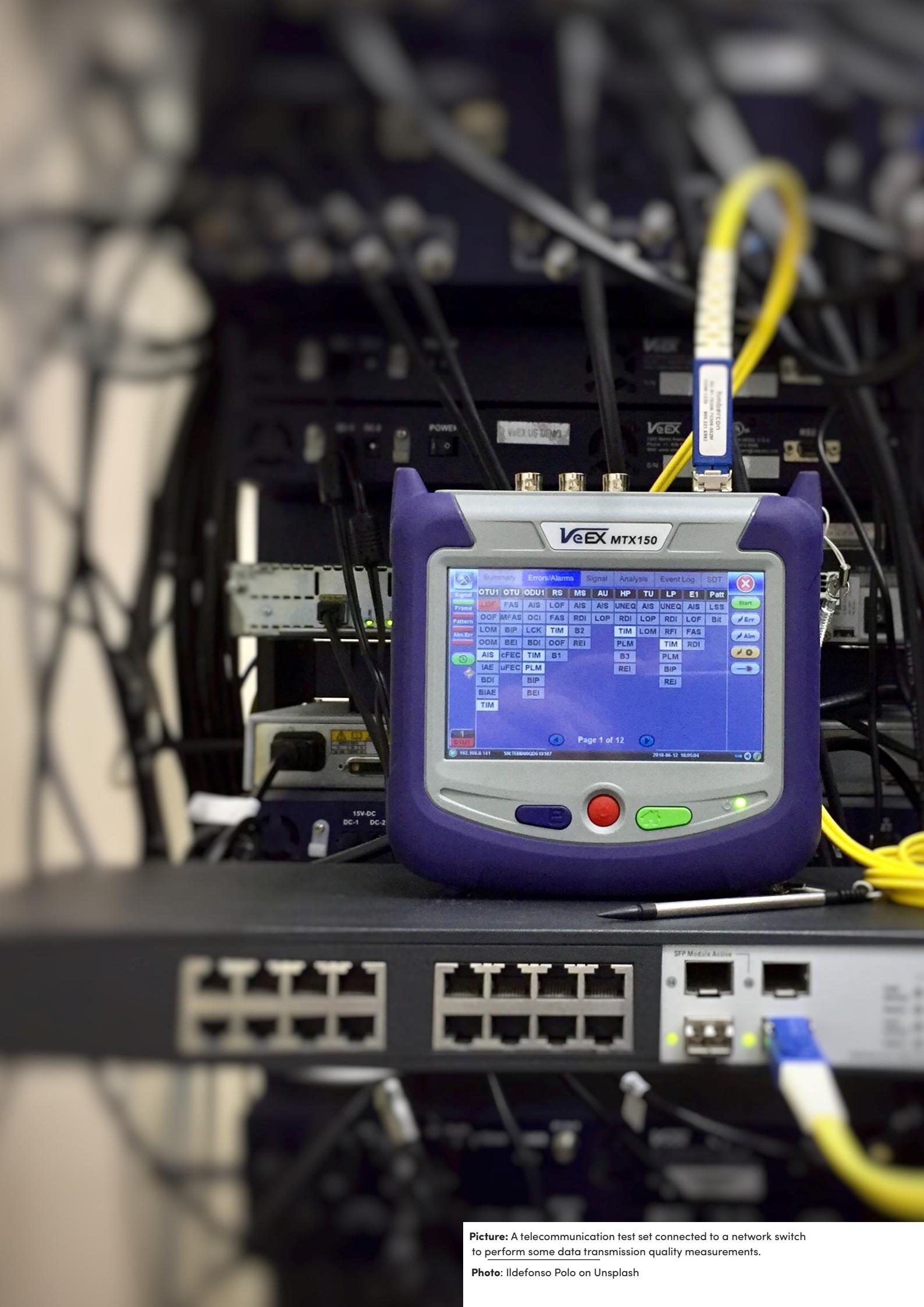
Further Reading

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- https://www.google.com/search?q=simple+telephone+connection&source=lnms&tbo=isch&sa=X&ved=0ahUKEwiKuvXt8JHlAhWWi1wKHY-lBnQQ_AUIESgB&biw=1525&bih=730#imgrc=rHntpw8ZWRYW0M
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Picture: A telecommunication test set connected to a network switch to perform some data transmission quality measurements.

Photo: Ildefonso Polo on Unsplash

Module 2

Basic Components and Benefits of Telecommunications and Impact on Individual and Global Society

Units

- 1 - The importance of Telecommunication
- 2 - Telecommunication Nigeria and U.S. Economy
- 3 - Telecommunication and Global Competitiveness
- 4 - Exploring different types of Telecommunication systems



UNIT 1

Benefits of Telecommunications and Impact on individual and global society



Introduction

In this unit I will expose you to the benefit of telecommunication, the impact and its advantages to an individual, community and the global society as a whole which we all belong to. I will also teach you the benefit/importance of telecommunication on Nigeria and some other developing countries economy and know the types of telecommunications that existed and their different features

Learning Outcomes

At the end of this unit, you should be able to

- ① State the benefit of telecommunication
- ② Explain the impact of Telecommunication on the development of the economy
- ③ Discuss at least four ways telecommunication help the global society
- ④ List at least five types of telecommunications existed and their different features



Main Content

Telecommunications and Society



6 mins



SAQ 1

We have seen a lot of breakthrough in technological world in the last decade, amidst all that, the expansion of technology infrastructure has been amazing due to the rate of expansion.

The use of wire-line communication network allow larger part of the world population have access to communication in form of telephony system via fixed-line telephony. The introduction of first- and second-generation mobile communication systems in the early 80 had revolutionize the telecommunication industry. However, the progress in ICTs world is not limited to mobile telephony only.

Broadband internet technologies such as digital subscriber line (DSL) or cable internet have created enormous opportunities for worldwide data transmission. In the previous years, the deployment of next-generation networks has facilitated by use of optic fiber based wireline technologies such as fiber to x technologies while x stands for (home, hub, office, cub, building, etc) or hybrid fiber-to-the-cabinet (FTTC) and fiber-to-the-node (FTTN) technologies have started to replace the use of copper or coaxial cable based broadband networks.

The introduction of fourth generation (4G) mobile broadband technology, long term evolution (LTE) and advanced-LTE (LTE-A) have brought a substantial speed improvement to the wireless communication systems. Due to these advantages, broadband have gained the attention of policy makers in recent times which had also increase the employment opportunities in the telecommunication industry. While achieving these goals, it also brought considerable economic returns they also go along with substantial costs, in particular for the construction of the necessary new communications infrastructure which is partly or entirely fiber-based.

It is hence a necessity to carefully evaluate whether these returns will exceed the accompanying costs or whether the expansion of new (high-speed) broadband networks will go along with economic losses.

I note some of the key areas of impact of telecommunication in our daily activities below:

- Telecommunication provides a technological foundation for societal communications. Communication plays a central role in the fundamental operations of any society from a micro society to larger ones. In fact, communication among people is the essence of what distinguishes an organization, community, or society from a collection of individuals. The use of communication from Web browsing to cell phone calling to instant messaging has become increasingly integrated into how we work, play, and live.
- Telecommunication enables participation and development. Also, telecommunication plays an increasingly vital role in enabling the conducive environment for participation and development of people in communities and nations disadvantaged by geography and topology whether in rural area or in developing nations in the global society and economy.
- Telecommunication provides vital infrastructure for national and individual security. From natural disaster recovery to homeland security, communication of intelligent information to continue military operation. When the issue is countering an adversary, it is essential not only to preserve telecommunications capability, but also to have a superior capability. These are potential risks associated with a reliance on foreign sources for innovation, technologies, services and applications

Telecommunications and its impacts on Nigeria Economy



SAQ 2

Do you know that Nigeria telecommunication industry has grown since 2001 when the first global system for mobile communication (GSM) licenses were issued to mobile network provider to introduce mobile communication to Nigeria markets? The number of

subscribers has been skyrocketed from a paltry 400,000 by December of the same year to a staggering 120,748,754 by the end of March 2018.

In other words, the subscriber base has grown by 300% in the last 17 years. With a population of more than 170 million, Nigeria's subscriber base represents a tele-density of 88.97% over the same period. Teledensity is a measure of the percentage of the population that owns or has access to a phone, measured per hundred people. In terms of sheer numbers, Nigeria is the largest telecommunications market in Africa and the Middle East.

But even more interesting, it still has the ability to increase its figures; there are roughly about 34 million unconnected Nigerian to mobile communication network due to their location, topology, insecurity and some other reasons. Even with these numbers, Nigeria's telecommunications industry is the fastest growing in Africa.

Besides basic telephony services, Nigeria has a very large market for internet service which majority are yet to be tapped. The number of internet users keeps on increasing every day which stand over 80 million subscriber which still less than half of total number of telephone line subscribers. Here then lies a hotly contested market segment that is attracting foreign investment in droves because of its great commercial potential.

Nigeria's telecommunications industry currently contributes about 8.53% to the Gross Domestic Product (GDP), and is thus a major player in driving the Nigerian economy. There are currently four dominant players, namely, Airtel, 9 mobile, Globacom and MTN in cellular communications, and while similar patterns in dominance by these 4 are observed in internet services, numerous opportunities exist especially in the ICT subsector of the economy, such as development of 4G networks, cloud computing services, and the provision of faster-than average internet speed using fiber-optic cable.

Nigeria already has fiber-optic links at its shores, namely Main One, Glo 1, and WACS, and numerous opportunities exist in providing the necessary infrastructure to ensure these cables are fully utilized.

One of the greatest problems ailing Nigeria's telecommunication industries are the one that tends to cut across all sectors of economy such as corruption, problem with ease of doing business, power outages which usually cause the inflating the cost of telecommunication equipment and infrastructure.

If all the problems I have mentioned above are addressed, by the government and as promised by National Integrated Power Project, which intends to commission 10 power plants by mid next year, the returns from investing in the industry are expected to increase tremendously.

Concomitant with an improvement in telecommunication industry in the country, there will be a greater economic progress as telecommunication industry will facilitate many other industries which will making direct contributions to the economy.



03 | underground installation of fibre-optic cables accross the city.

Telecommunications and Global Competitiveness



SAQ 4

In this era of globalization that we are today, many companies are multinational with operations including research and development conducted across the globe such as HP, Huawei, Qualcomm and Microsoft.

Increasing numbers of business globally, all these companies tried to create a segment and niches for themselves to remain relevant in the global markets. Both Asian and European nations are continuing to pursue strategies that exploit perceived U.S.

weakness in telecommunications and telecommunications related research area as a way of improving their competitiveness in telecommunications industry, as well as in information technology more broadly. Leapfrogging from the advanced world, telecommunication has been an explicit and state strategy for a number other countries in the past decades.

These efforts have aimed to stimulate the rapid penetration of physical-layer technologies for residential access (broadband access, especially in Asia) and wireless and mobile access (cellular networks, especially in Europe).



- • Summary

At this stage, you have learnt that:

- the importance of Telecommunication and its impact on the society,
- the evolution of telecommunication in the USA and its importance
- evolution and growth of telecommunication in Nigeria and its effect economically and
- the global competitiveness among the leading world economies in relation to telecommunication industry.



Self-Assessment Questions



1. Explain the benefit of telecommunication
2. Highlight the gains the telecommunication explosion have brought to Nigeria economy in the past 20 years
3. List and explain the three major impact telecommunications had brought to the society
4. What is the impact of telecommunication on American economy?
5. List four types of telecommunication systems and their features



Tutor Marked Assessment

- Explain the roles play by ITU-R, ITU-T into telecommunication development.
- In this era of global competitiveness, many telecommunication industries are in major competition to dominate the market, what are the major areas of their focus to out-smart their competitors?
- Highlight the gains the telecommunication explosion have brought to Nigeria economy in the past 20 years
- List and explain the three major impact telecommunications had brought to the society
- What is the impact of telecommunication on American economy
- What is the effect of teledensity on economic growth in Nigeria?
- What is the relationship between telecommunication sector revenue and economic growth in Nigeria?
H.What impact does investment in telecommunication sector have on economic growth in Nigeria?



Further Reading

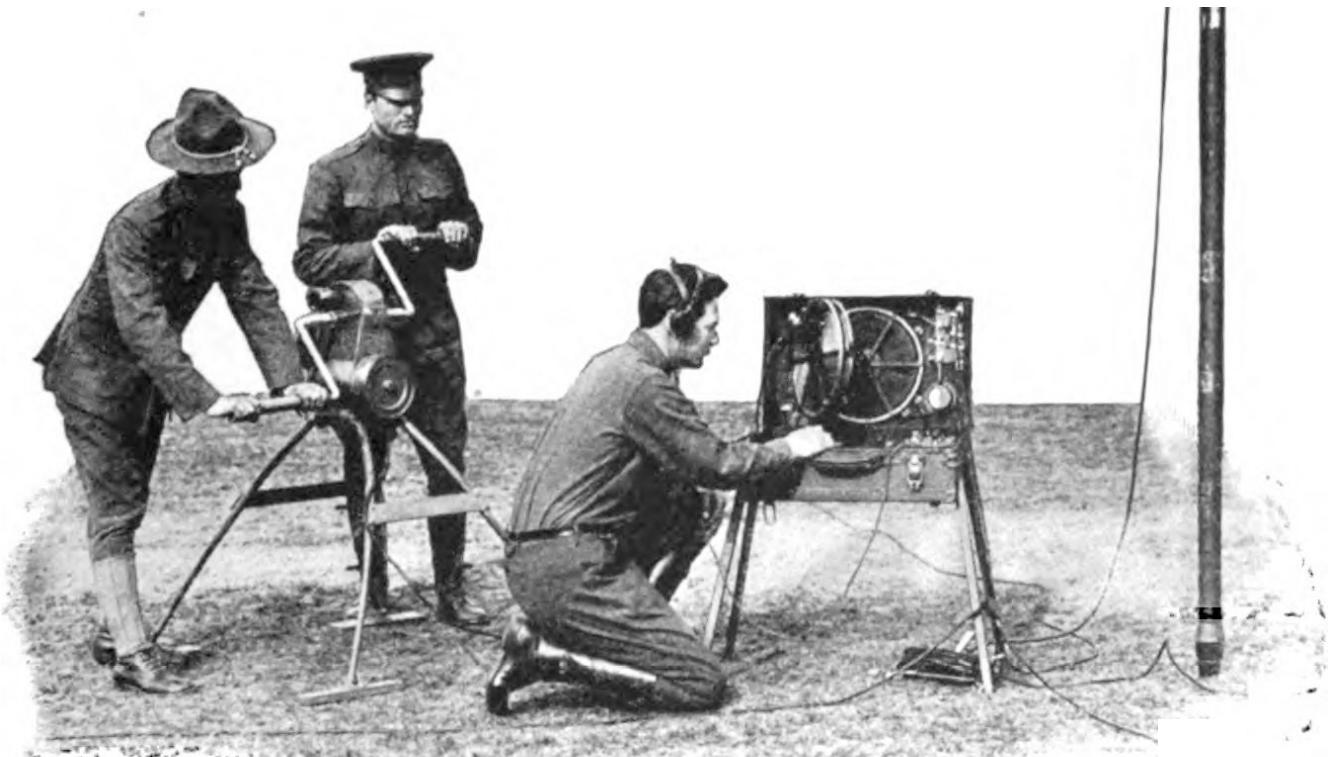
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- The Importance of Telecommunications and Telecommunications Research." National Research Council. 2006. Renewing U.S. Telecommunications Research. Washington, DC: The National Academies Press. doi: 10.17226/11711.



01 | National Guard operating portable radio station 1922
Source: Wikimedia commons

UNIT 2

Telecommunication Transmission Media



Introduction

Different types of telecommunication media, their significance and importance are the things we will cover in this unit.

At the end of this unit, you should be able to



Learning Outcomes

1. explain at least five types of telecommunication media.
2. highlight the area of application of at least five types of telecommunication media
3. explain the meaning of simplex, half-duplex and full-duplex telecommunication system
4. list the modern telecommunication systems



Main Content

Definition and Concept



8 mins

As a matter of fact, the main aim of telecommunication service provider to us is to produce high quality voice signal, video and data communication between the transmitter and receiver irrespective of distance, whether the distance is near or far. The distances between the transmitter and the receiver usually determine the type of transmission method to be used and the nature of medium of information transmission to be employed.

Communication over a distance of few meters, such as within the locality can be done by using twisted pair cable or small aperture radios. If routing of information is done within the building, this is done by a switch which is called private branch exchange (PBX).

As the distance of information transmission increases, to town or city, the local telephone network is usually involved in transmission process. In the early period of information transmission, all interexchange was done using numerous pair of cables which are normally copper in nature (one pair for each connection).

This is very cumbersome and becoming complex as the number of telephone lines involved becoming more increasing, and such connections required hundreds or thousands of copper pairs. The concept of multiplexing was introduced for passing multiple simultaneous telephone calls down from one pair of copper wires.

Considering that the internet and telephone are considered two of the most important telecommunication systems, there are also many other advanced and evolving technologies that joins these two innovative technologies, which all were designed with the intent to enhance the human capability of the future, as well as everything it has to offer.

The technology used by satellite communications overlaps terrestrial microwave radio technology to a large extent. The radio nature and operating frequency are the same but only differs in the scale of the component used. Because the satellite link is over 36,000 km long, high-power transmitters and very low-noise receivers are necessary.

Also, the size and weight of the satellite electronics must be kept to an absolute minimum to minimize launch costs. Considerable attention has been recently devoted to very small aperture terminal (VSAT) satellite technology.

As the definition of VSAT implies, this system has earth station terminals that uses antenna of only 1 to 4 meter in diameter which brings about significant reduction from 30 metre diameter antennas used by the original earth station deployed in the olden days.

Types of Telecommunication Media

1 | The Optical Fiber Transmission System



SAQ 1

Optical telecommunication can be defined as the use of light to transmit information over a distance between the transmitter and the receiver. Some of notable and familiar example of optical communication system include navigation lights, flare, semaphore communication and smoke signals.

Fiber-optics and infrared sensors are also types of optical communication. Fiber-optics has some similarities with microwave link as can be seen in the **figure 1 below**. Both systems transmit the same output from the digital multiplexer, the bit stream in the case of optic-fiber system can be used directly to power on and off the laser to send the light pulses to the fiber cable.

Study Tips

It may interest you to know that one of the oldest and most common forms of communication system used in the olden days is optical communication.

Eventually, optical fiber systems might use a heterodyning or homodyning technique to improve the overall performance of the system. Regenerators are used at intervals to boost the signal, as in the microwave radio system. The distance between regenerators is gradually increasing for optical fiber system as optical amplifier technology improves. Conversely, the line-of-sight microwave radio system regenerator spacing is limited by a physical, not a technological, constraint.

The spacing of optical regenerators is limited by the dispersive characteristic of the optical fiber used. The receiver incorporates detector or demodulator, an amplifier, and a means of restoring the original baseband bit stream ready for demultiplexing to voice, video, data or TV signal. The error performance is significantly superior to radio. It is widely believed that fiber optics is not only here to stay, but has the potential to transform our lifestyles in the decades to come.

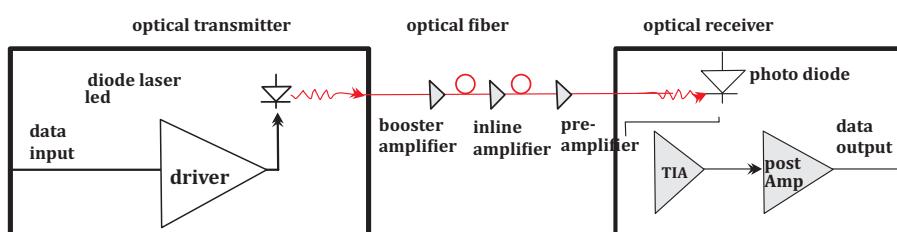


Figure 1. The optical Fiber link

Study Tips

In radio communications, a radio receiver, also known as a receiver, a wireless or simply a radio, is an electronic device that receives radio waves and converts the information carried by them to a usable form. It is used with an antenna.

An optical fiber patching cabinet. The yellow cables are single mode fibers; the orange and blue cables are multi-mode fibers: 62.5/125 μm OM1 and 50/125 μm OM3 fibers, respectively.

source: Wikimedia Commons



2. Mobile Radio System

Radio telecommunication is a tool that is widely used by us today, one of the primary advantages of radio communication is that it can be used to communicate with individuals over long distances.

radio communication has been implemented on both a professional and consumer grade level, which further expands the reach of this versatile technology. The term radio does not solely cover devices such as radios, the standard cable television is a form of popular radio



SAQ 2

telecommunication that many individuals use on a daily basis.

The use of radio wave for communication has limitation due to large attenuation as they travel through the atmosphere, so in order to keep the required customer transmitter power to an acceptable low level, the distance between the receiver and the transmitter should be kept as small as possible.

This has led to the need for numerous base stations arranged in a type of honeycomb, otherwise known as the cellular structure. In early mobile systems, each customer used a particular communication frequency for the duration of each call.

Because of the limited frequency spectrum available, the number of subscribers able to use the systems simultaneously would appear to be quite small. However, the cellular system lends itself to frequency reuse, whereby subscribers in different areas use identical frequencies for communication and by careful design, the problem of signal interference and crosstalk is avoided.

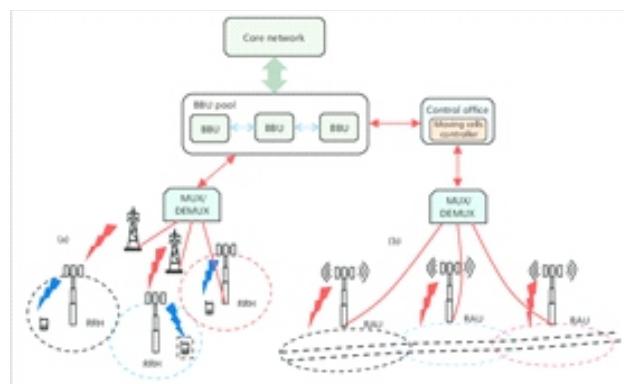


Figure 2: Mobile Radio Link

A mobile radio telephone

source: Wikimedia Commons



Other types of Communication Systems

Modern method of communication had evolved due to the development of modern technology, likewise, improvements and additions are constantly being made to the existing methods used for communication. There are new methods which depends on our choices as users and what type of message to be sent, the financial capacity of the sender and the location of the sender.

1 | Mobile Cellular Phones

Obviously, capabilities of cellular phones have continued to increase since the introduction into the market in early 1980s. The features possessed by the mobile phone such as text messaging and wireless phone conversations, many mobile phones are equipped to enable their users to send and receive email, pictures and recorded videos. Spread spectrum technology has further increased the ability to use cell phones, allowing talkers to engage themselves hands-free with the use of a small, one-sided headset.



01

01

2 | Skype

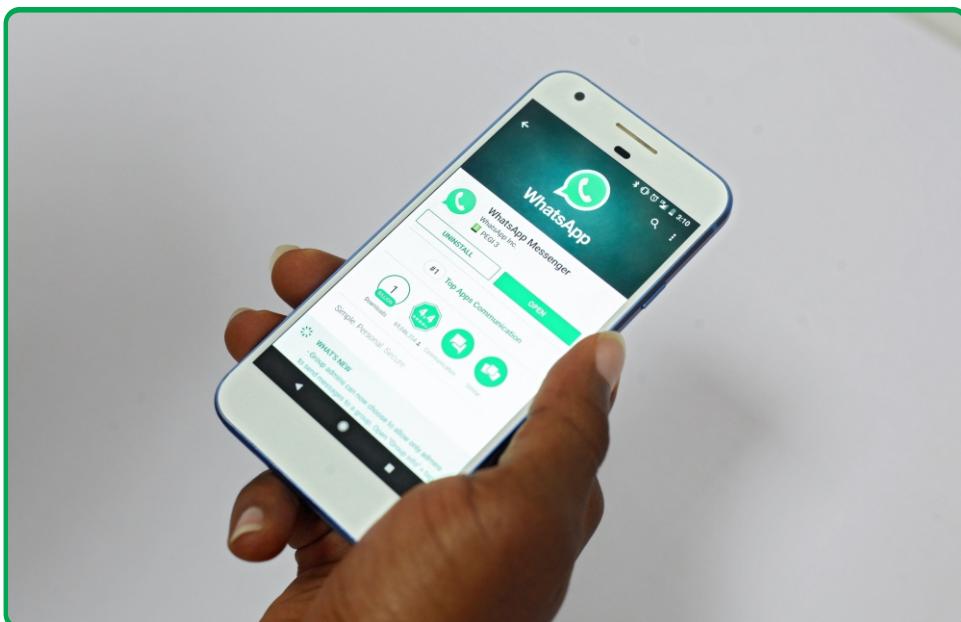
Skype is a software downloadable that enables us to make free phone calls and send messages via the internet. The service also offers video calling so that users can see each other. Use of Skype's free features requires a broadband Internet connection as does its paid features. Both businesses and private individuals have benefited from the convenience and immediacy of Skype's communication services. Some other applications can perform similar functions as Skype such as QQ, WeChat, etc.

01 | Nokia 3510i mobile phone, with GPRS mobile internet capability, c. 2002
source: Science Museum

01 | Motorola Timeport 250 mobile phone, manufactured by Motorola, British, 2001-2005
source: Science Museum

2 | Instant Messaging

This application allows users to communicate with each other using internet via short written or spoken messages which almost no delay as message being sent. This is less cumbersome than other methods of communication as well it is faster way facilitating complete conversation in real time. Some of applications offer similar services are MSN, Yahoo, Facebook, WhatsApp, America online (AOL) and many others



01 | Whatsapp messenger on android smartphone
source: benjamin Dada on unsplash

Additional Types of Telecommunication Systems



SAQ 3

1 | Simplex

Simplex communication method is the type of communication method that exists between the sender and the receiver that occurs in only one direction. Suppose you are the sender, you can only send the data, and the receiver can only receive the data. Simplex transmission

is similar to a one-way road in which traffic travels only in one direction and not vice versa. Another example is by using keyboard / monitor relationship, keyboard can only send the input to the monitor, the monitor receives the input and displays it on the screen but it cannot reply.



Figure 4: Simplex Communication System

1 | Half Duplex

In this type, communication between the receiver and the sender exist in both directions but not simultaneously, i.e. the sender and the receiver can both transmit and receive information from each other one after the other. Half duplex is still considered a one-way road, in which a vehicle traveling in the opposite direction of the traffic has to wait till the road is empty before it can pass through. Also, the use of walkie-talkies where both the speakers can speak from both ends but not simultaneously.

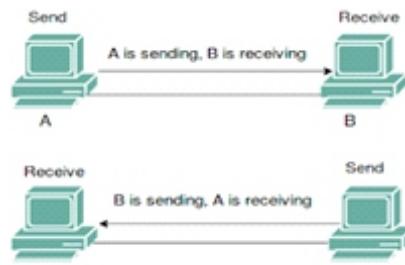


Figure 5: Half-duplex Communication System

1 | Full Duplex

In full duplexing communication, the communication between the sender and the receiver can occur simultaneously. The sender and receiver can both transmit data/information to each other at the same time.

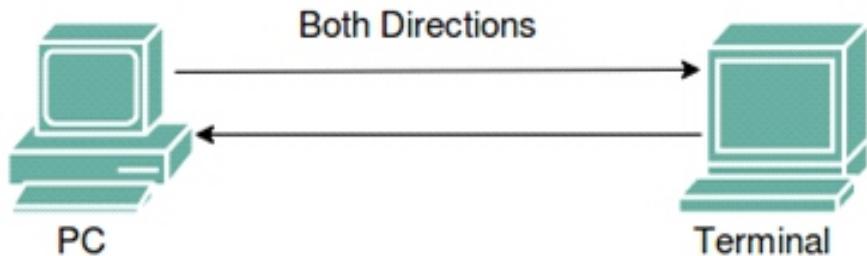


Figure 6: Full duplex Communication System



•Summary

In this unit, you have learnt:

- the meaning of transmission media
- the different type of transmission media
- the meaning of optical and mobile radio communication
- modern transmission techniques
- the difference between simplex, half-duplex and full-duplex transmission



Self-Assessment Questions

1. List at four transmission media and explain them briefly
2. In order to exchange information between two distance places, choose a particular transmission media and state the reason why choosing such.
3. Distinguish between simplex, half-duplex and full-duplex with the aid of neat diagram
4. **Write a comprehensive note on the following**



- I. Optical transmission system ii. mobile radio system



Tutor Marked Assessment

- In order to exchange information between two distance places, choose a particular transmission media and state the reason why choosing such.
- Distinguish between simplex, half-duplex and full-duplex with the aid of neat diagram
- Write a comprehensive notes on the following
 - I. Optical transmission system
 - ii. mobile radio system
- With the aid of clear diagram, explain the process of sending information between two locations.



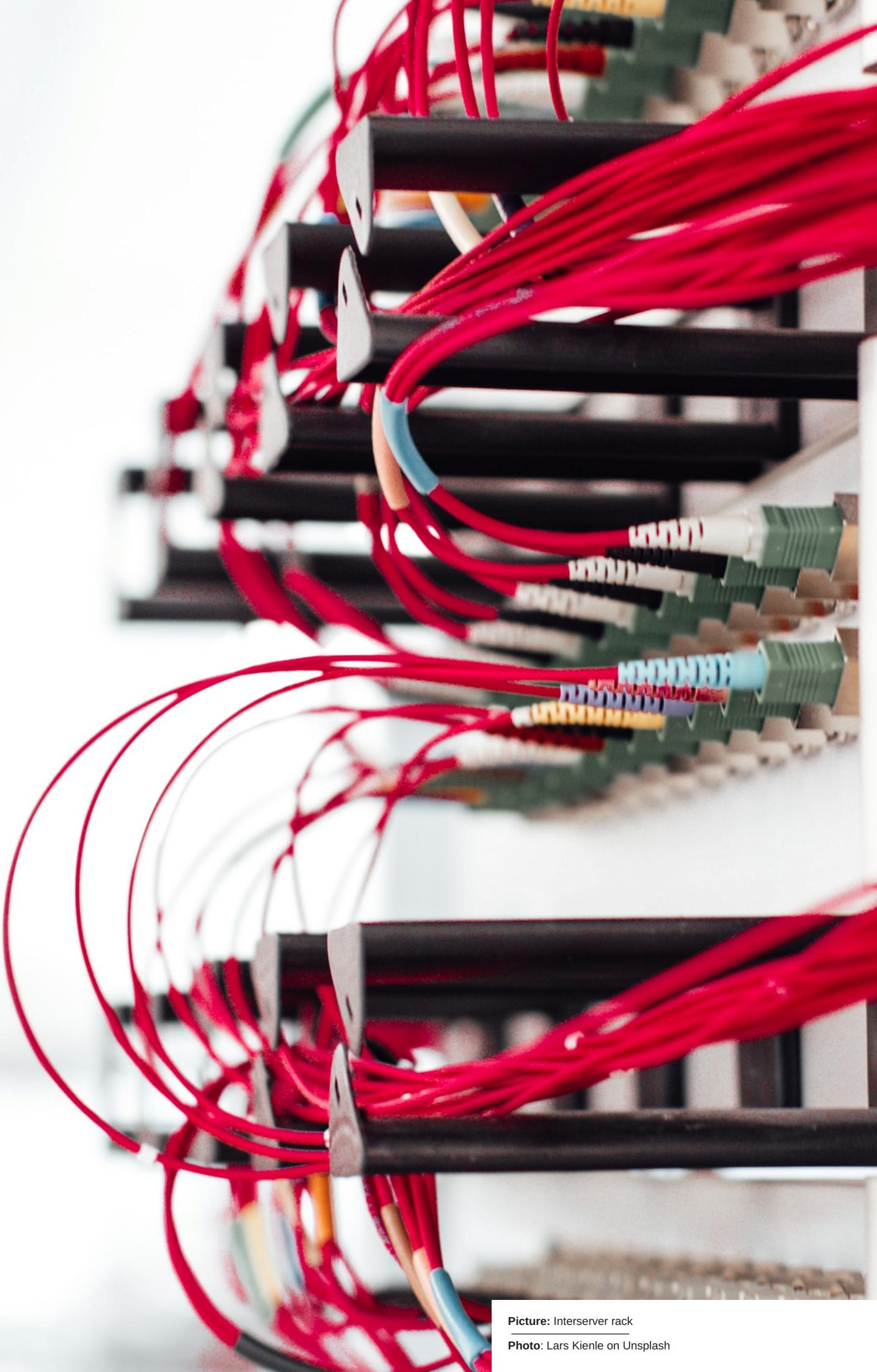
Further Reading

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- <https://www.emeraldinsight.com/doi/abs/10.1108/03068290010336397>



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Picture: Interserver rack

Photo: Lars Kienle on Unsplash

Module 3

Introduction to Analog and Digital Transmissions



Units

- 1 - Introduction to Analog and Digital Transmission
- 2 - Analog transmission and Digital transmission
- 3 - Multiplexing Techniques



01 | Unifi 9 port switch on rack shelf
source: Thomas Jensen on Unsplash

UNIT 1

Introduction to Analog and Digital Transmissions



Introduction

We will be covering the introduction and definition basic components and benefits of analog and digital communications

At the end of this unit, you should be able to



Learning Outcomes

- 1 define analog and digital communication
- 2 list the advantage of digital transmission
- 3 state the basic digital modulation technique in digital communication
- 4 list the difference between analog and digital transmission
- 5 list at least four advantages of digital transmission
- 6 explain at least five disadvantages of digital transmission



Main Content

Data transmission



7 mins

Data transmission is concern with the process by which information is being exchanged between the transmitter and receiver electronically by converting the message into binary form or into bits. In a broadband system, all communications are performed through the use of transmission cable be it twisted-pair cable, coaxial cable or fiber-optic cable.

The existing telephone or telegraphic network may also be used for connecting computers located in remote locations. The information transmits in the form of electromagnetic signals through a transmission medium.

Whether you are collecting numerical statistics from other computers, whether you are sending animated graphics from a design station or ringing a remote control center, information is being transmitted over network connections.

The information can be a voice, image, numeric data, characters or codes, any message that is legible and has meaning for the target user, whether it is human or a machine. There are 2 broad types of signals which are categorized as analog and digital transmission.

Analog Transmission



SAQ 1

Analogue signal is a continuous waveform that changes smoothly over the period of time. As the wave moves from one terminal to another it moves through an infinite number of values. The wave can be generated if the voice signal is generated which when captured the microphone which converts it to analog signal, and travels through the cable to the receiver.

Information to be transmitted is firstly converted to electrical signal which we can refer to as baseband signal. The transmission occurs by sending the baseband signal directly to the receiver through the cable. A unique process called modulation is used in the analog transmission to accommodate more than one information signal into a single channel.

Modulation means varying any one of the parameters of a high-frequency

waveform proportional to the amplitude of the baseband signal. The parameters of the carrier often used for the modulation are amplitude, frequency, and phase. Analog signal is characterized by being a continuous varying signal along with amplitude and frequency.

In a telephoning system, the voice from speaker's mouth insert the air pressure on the transducer which changes the air pressure around the mouth of the speaker. Those changes in air pressure are amplified and causes either the current or voltage changes. The fluctuation cause in current or voltage are the actual pattern of voice from the source in analog form.

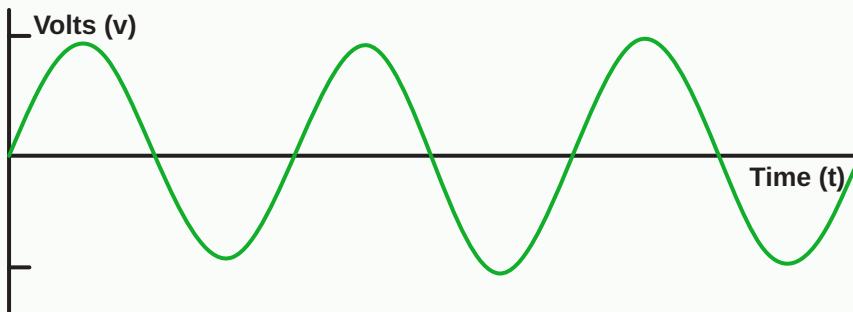


Fig 3.1: Analog signal waveform

In analog circuitry, the frequency band at which the transmission occur are normally known. The frequency of transmission by human voice lies between 100 Hz and 10 KHz for a bandwidth of 9,900 Hz. Analog system has a low rate of transmission which is about 33.6 Kbps and it has a limited bandwidth which explain why analog system cannot support high-speed data transmission.

Another characteristic of analog is that noise is accumulated as the signal traverses the network. As the signal moves across the distance, it loses power and becomes impaired by factors such as moisture in the cable, and signal loss due to cable attenuation.

At the receiving end, the signal has been attenuated by the obstacles encountered during transmission, it is also become noisy. Also another problems with a basic amplifier is that it is a dumb device. But along with an increased signal, the amplifier passes along an

increased noise level. So in an analog network, each time the transmitted signal passes through the amplifier, it amplifies the accumulated noise that mixes with the signal which is difficult to separate and thus resulting in high error rates at the receiver.

Digital Transmission



SAQ 2

This is an act of transmitting signal from the transmitter to the receiver over the transmitting medium in discrete form. As known that the analog signal is continuous in nature, it comprises of series of discrete pulses representing in one and zero bits. Each digital system uses a coding scheme to define what combinations of ones and zeros constitute all the characters in a character set.

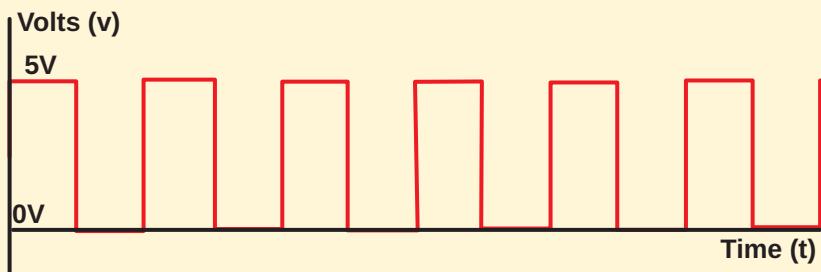


Figure 3.2 Digital transmission

The mode at which the zeros and ones are physically transmitted through the network depends on the type of network either it is electrical or optical networks.

If you consider the electrical network, high voltage is represented by one bit while low voltage is denoted using zero bit while in optical networks, one bits are represented by the presence of light, and zero bits are denoted by the absence of light.

Because a digital signal is easier to reproduce than an analog signal, we can treat it with a little less care in the network. In digital transmission, the use of dumb amplifiers, digital networks use regenerative repeaters.

The digital pulse, like an analog signal, is eroded by impairments in the network. But the weakened and impaired signal enters the regenerative

repeater, where the repeater examines the signal to determine the state of the digital signal either it is one or zero.



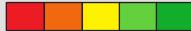
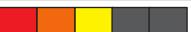
SAQ 4

New signal is regenerated by the repeater which is forwarded to the next network devices, this is used to remove the noises in the transmitted signal, and hence the error rate of digital signal is lower than the corresponding analog signal.

Analog versus Digital Transmission

The table below I summarized the characteristics of analog and digital networks.

Features	Analog signal characteristics	Digital signal characteristics
Signal	Continuously variable, in both amplitude and frequency	Discrete signal, represented as either change in voltage or changes in light levels
Traffic measurement	Hz (for example, a telephone channel is 4KHz)	Bits per second (for example, a T-1 line carries 1.544Mbps)
Bandwidth	Low bandwidth (4KHz), which means low data transmission rates (up to 33.6Kbps) because of limited channel bandwidth	High bandwidth that can support high-speed data and emerging applications that involve video and multimedia
Network capacity	Low; one conversation per telephone channel	High; multiplexers enable multiple conversations to share a communications channel and hence to achieve greater transmission efficiencies
Network manageability	Poor; a great work is needed for network maintenance and control because	Good; smart devices produce alerts, alarms, traffic statistics and performance measurements, and technicians at a network control center (NCC) can remotely monitor and manage the various network elements

Features	Analog signal characteristics	Digital signal characteristics
Power requirement	 High because the signal contains a wide range of frequencies and amplitudes	 Low because only two discrete signals (0 or 1) are transmitted
Security	 Poor; when you tap into an analog circuit, you hear the voice stream in its native form,	 Good; encryption can be used
Error rates	 High; 10 ⁻⁵ bits (that is, 1 in 100,000 bits) is guaranteed to have an error	 Low; with twisted-pair, 10 ⁻⁷ (that is, 1 in 10 million bits per second) will have an error, with satellite, 10 ⁻⁹ (that is, 1 in 1 billion per second) will have an error, and with fiber, 10 ⁻¹¹ (that is only 1 in 10 trillion bits per second) will have an error



SAQ 4

Advantages of digital signals

1. Due to attenuation effects on signal transmitted, digital signal can be amplified, rebuilt due to signal regeneration properties.
2. It can detect and correct errors at the receiving end.
3. Due to ease of modification, digital signal can be transformed to any desirable format.
4. Ambient temperature and noise does not affect the performance of digital signal.

Disadvantages of Digital Signals

1. The sampling process in digital signal is very complex and time consuming
2. Digital signal requires precise synchronization between the clock time of the transmitter and the receivers
3. The digital signal consumes more bandwidth than analog signal



- • Summary

In this unit, I have thought you the following:

- the meaning of analog and digital transmission
- definition of analog transmission
- definition of digital communication
- the difference between analog and digital transmission



Self-Assessment Questions



1. Distinguish the difference between analog and digital transmission.
2. Clearly explain the advantages of using digital techniques in information transmission.
3. State at least five differences between analog and digital transmission
4. State at least five advantages of digital signal transmission
5. State at least three disadvantages of digital signal transmission
6. List four types of telecommunication systems and their features



Tutor Marked Assessment

- Distinguish the difference between analog and digital transmission.
- Clearly explain the impact of multiplexing to information transmission.
- Highlight the multiplexing techniques required in signal transmission
- In tabular form, distinguish between digital and analog transmission
- List the advantages and disadvantages of digital signals
- What impact does investment in telecommunication sector have on economic growth in Nigeria?



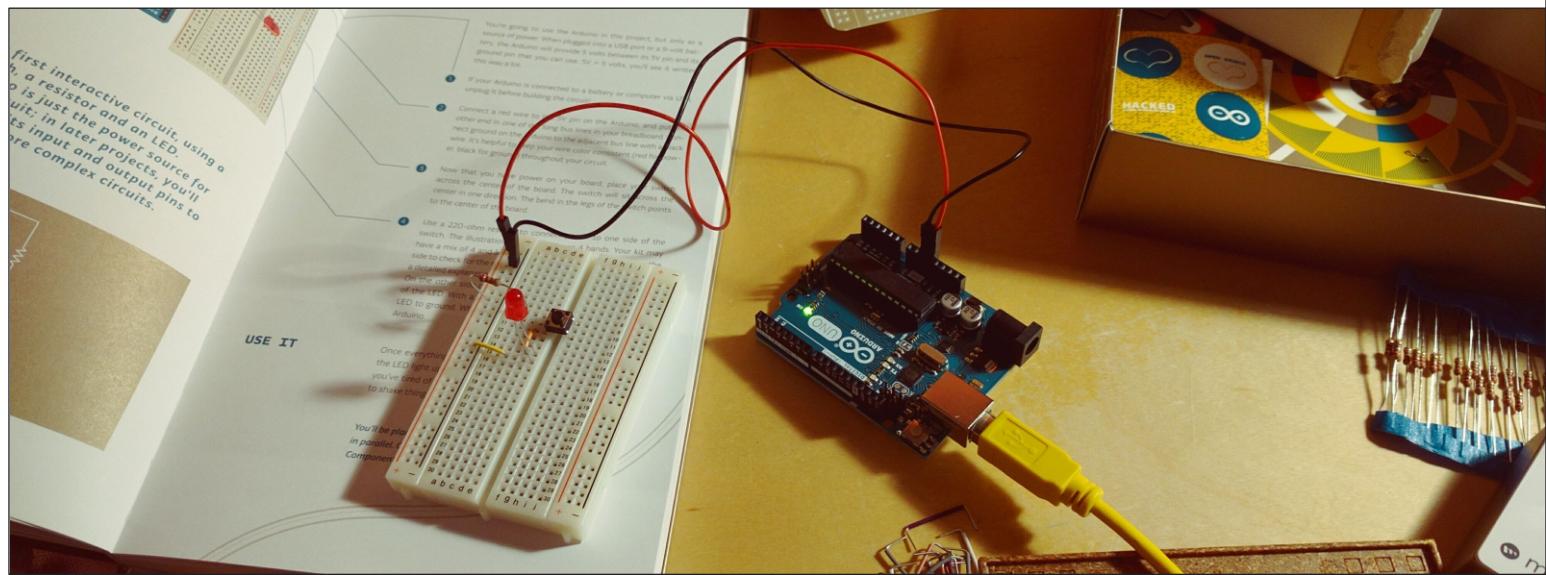
Further Reading

- <http://www.informit.com/articles/article.aspx?p=24687&seqNum=4>
- <https://benthamscience.com/journals/international-journal-of-sensors-wireless-communications-and-control/>
- <https://www.emeraldinsight.com/doi/abs/10.1108/03068290010336397>
- <https://learn.sparkfun.com/tutorials/analog-vs-digital/digital-signals>
- <http://ecomputernotes.com/computernetworkingnotes/communication-networks/analog-versus-digital>



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UNIT 2

Introduction Multiplexing



Introduction

This unit I will teach you multiplexing technique and its use in digital communications.

At the end of this unit, you should be able to



Learning Outcomes

- 1 explain the concept of multiplexing
- 2 list at least six types of multiplexing
- 3 explain the concept of digital modulation techniques
- 4 list at least four types of digital modulation



Main Content



7 mins



16-channel Digital Multiplexer board

Multiplexing

Multiplexing is a method by which signals either analog or digital are combined into one signal over a shared communication channel or medium. The major aims of using multiplexing technique is to reduce network costs by minimizing the number of communication links needed between the transmitter and the prospective receiver(s).

Multiplexers are useful in telecommunication. Multiplexers are involving process in telecommunication system where each generation of multiplexer has additional features which brings more benefits. Some of the benefits are as listed below:

- I. The capability for data compression and error detection and correction between to ensure data integrity and accuracy.
- ii. Multiplexer has the ability to solve the problem of data rerouting priority information if the need arises.
- iii. The more intelligent the multiplexer, the more actively and intelligently.

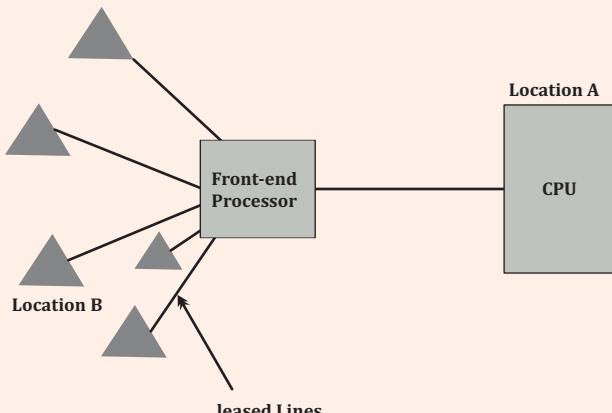


Figure 3.3 Network without multiplexer

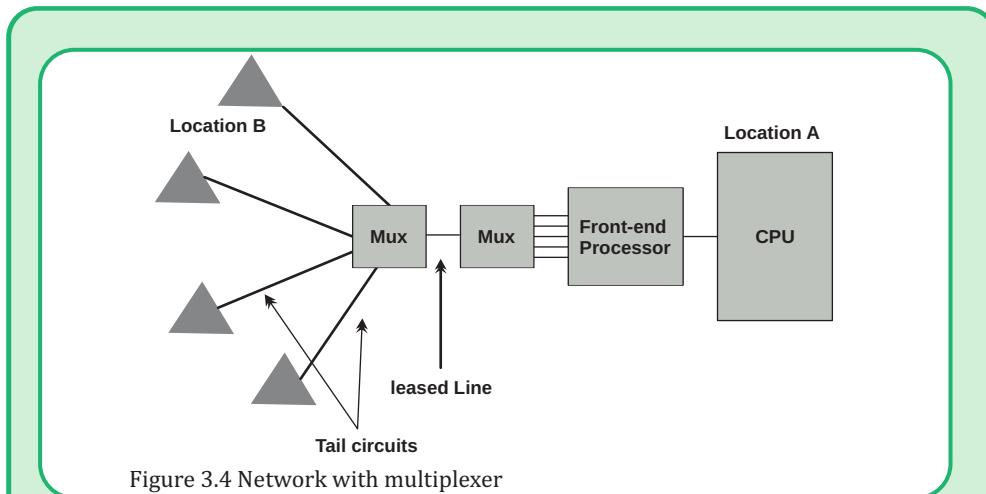


Figure 3.4 Network with multiplexer

Figure 3.3 illustrates a network without multiplexers. Assuming the network is for a department store.

The CPU is at Location A, a data centre that's in another location that manages all the credit authorization functions for all these stores.

Location B, has another branch of Bob's stores in different locations. Many customers will want to make purchase by using store credit cards, hence there is need to establish a communication link with the credit authorization center so that card validation can be done.

It is good for you to note that the use of leased line is expensive type of network connection because the line has been reserved for the user only and no one has access to that bandwidth.

The use of lease line in the present area, though it is the most expensive approach to networking but it gives the owner the power to control the bandwidth use.

The problem of lease line can be resolve with the use of multiplexer as shown in figure 3.4. Multiplexers always come in pairs, so if you have one at one end, you must have one at the other end. Multiplexers are identical hardware devices and also symmetrical.

Various multiplexing techniques



SAQ 2

There are various types of multiplexing techniques which includes

1. Frequency Division Multiplexing (FDM)
2. Time Division Multiplexing (TDM),
3. Statistical Time Division Multiplexing (STDM),
4. Intelligent Multiplexing (IM),
5. Inverse Multiplexing (InM),
6. Wavelength Division Multiplexing (WDM), and
7. Dense Wavelength Division Multiplexing (DWDM).

Frequency Division Multiplexing (FDM)

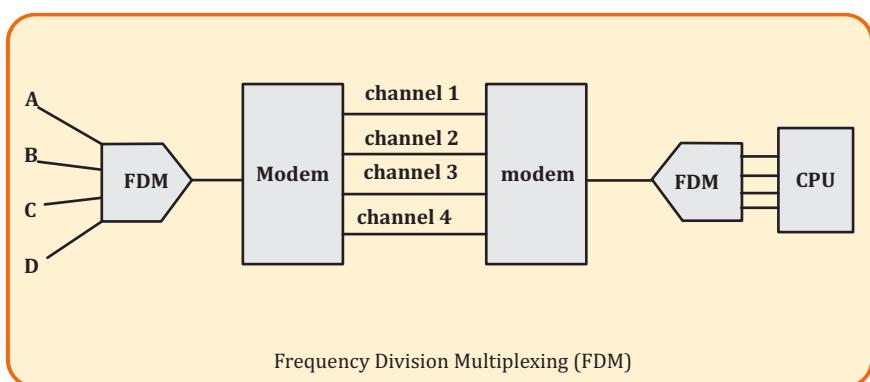
FDM is a technique by which the total available bandwidth in a communication medium is divided into series of frequency band that are not overlap one another.

Each of non-overlapping frequency band are used to carry separate signal. as shown in Figure 3.5 . Each signal is assigned to a different frequency and signal travels all in parallel over the same communication channel but they are divided by frequency. Frequency been an analog parameter implies FDM is a type of analog transmission. A disadvantage of frequency division multiplex is that they can be difficult to reconfigure in an environment which there is frequent changes.

Study Tips

An analog multiplexer (also known as a MUX or data selector) is a device used to select one of many input signals and connect that selected input to a single output / transmission line. ...

In other words, a single line can be shared by multiple signals at different times. Likewise, a demultiplexer does the reverse.





02 | Nortel Aa1402006, 8082 Cwdm Optical Add Drop Mux 1550Nm Wavelength Multiplexer
source: PicClick



02



02

Time Division Multiplexing (TDM)

Time division multiplexing (TDM) is a technique we use for transmitting and receiving independent signal over a common communication medium so that each signal is transmitted only during the period of time allocated to them. We can use this method when the bit rate of the transmission medium is higher than the signal to be transmitted. This method is commonly used for digital signal but it may be applied in analog multiplexing transmission. The time domain is divided into several time slots of fixed length in which each is allocated to sub-channel. Each TDM frame usually consists of one time slot per sub-channel plus synchronization channel and mostly error correction channel can be added to the data to be transmitted

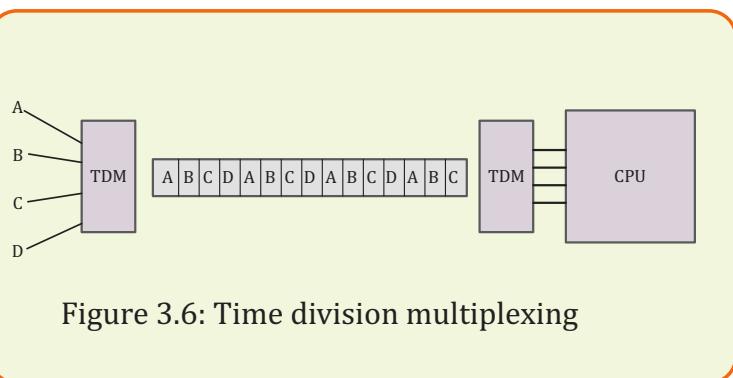


Figure 3.6: Time division multiplexing

02 | Four channel multiplexer, type A0680945, S.no. DCB2109, for use with fibre optic transmission cables, made by Nortel Networks, 1999
source: Science Museum Group

02 | Nortel NT0H30AA 04 OPTera 80 Optical Multiplexer Demultiplexer (OMX 4CH - B1)
source: from ebay

FDM and TDM can be combined. For example, you could use FDM to carve out individual channels and then within each of those channels apply TDM to carry multiple conversations on each channel. In fact, this is the way that some digital cellular systems work (for example, Global Systems for Mobile Communications [GSM]).

Statistical Time Division Multiplexing (STDM)

This multiplexing technique was introduced to overcome the limitation of TDM in which the allocated time slot cannot be reused by another user.

STDM dynamically allocate the time slots among the active users which translates that a particular user can have more time slots. In case of all the time slots are occupied, the excess data goes into a buffer.

By dynamically allocating the available time slot, the bandwidth is efficiently used since no bandwidth will be left unused at any particular time.

Also, because these are smaller multiplexes, they have additional intelligence which can also perform data compression and error control features. However, there can be a problem of signal delay and data loss if the STDM device is overloaded with signal.

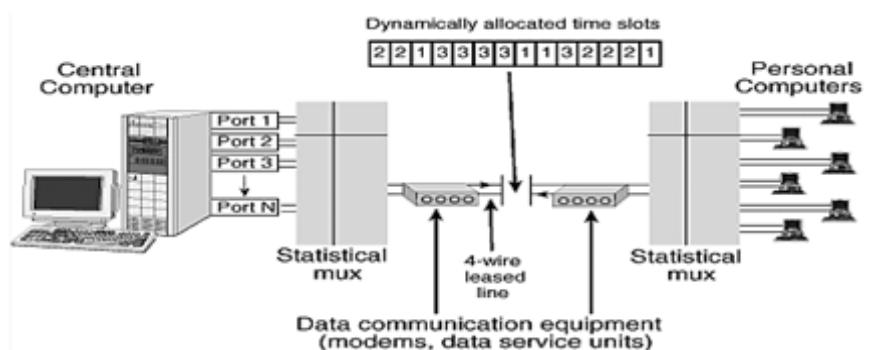


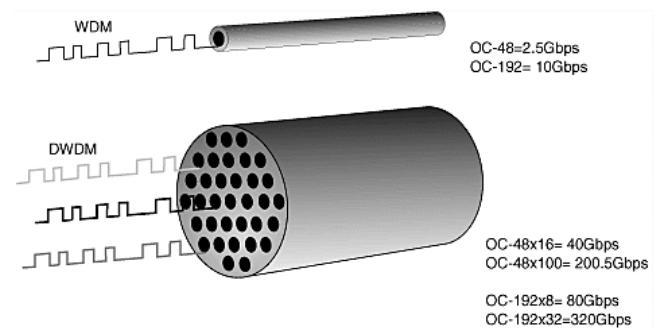
Figure 3.7: Statistical Time Division Multiplexing

Wavelength Division Multiplexers (WDM)

This type of multiplexing technique was developed for use with fiber optics. In the past, we could use only a fraction of the available bandwidth of a fiber-optic system.

This was mainly because we had to convert the optical pulses into electrical signals to regenerate them as they moved through the fiber network. And because repeaters were originally electronic, data rates were limited to about 2.5Gbps.

Due to the advancement in research activities, optical amplifier called erbium-doped fiber amplifier (EDFAs) was invented. As the light pulse passes through the Erbium, the light is amplified and continues to travel without having to stop and process electrical signal. This development of Erbium opened the opportunity to make use of fiber optics system operating at 10 Gbps.



Wavelength Division Multiplexers (WDM)

Digital modulation

Digital Modulation is a generic name we use for modulation techniques that uses discrete signals to modulate a carrier wave. In comparison, FM and AM are analog techniques while Frequency Shift Keying (FSK), Phase Shift Keying (PSK) and Amplitude Shift Keying (ASK) are examples of digital modulation.

Digital modulation eliminates transmission noise and offers improved robustness to signal interference. However, it is not uncommon for DM to introduce time delay due to the processing required.

Digital modulation provides us more information capacity, high data security, high quality communication and enhance information capacity. Hence, digital modulation techniques have a greater demand, for their capacity to convey larger amounts of data than analog modulation techniques.

There are many types of digital modulation techniques depending on what we need it for. Some of digital modulation techniques are:

i | **Amplitude Shift Keying:**

The amplitude of the resultant output depends upon the input data whether it should be a zero level or a variation of positive and negative, depending upon the carrier frequency.

ii | **Frequency Shift Keying:**

In this digital modulation technique, the frequency of the output signal will be either low or high depending upon the nature of input signal applied.

iii | **Phase Shift Keying:**

In phase shift keying, the phase of the output will be shifted depending on the input. The phase shift keying can be either Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK)

iv | **M-ary Encoding**

M-ary encoding techniques are used where more than two bits are made to transit simultaneously on a single signal. This techniques helps to reduce the bandwidth consumed.



-Summary

So far in this unit, I have taught you the following:

- definition of analog transmission
- definition of digital communication
- the difference between analog and digital transmission
- the meaning of multiplexing and
- different types of multiplexing



Self-Assessment Questions



1. Distinguish the difference between analog and digital transmission.
2. Clearly explain the impact of multiplexing to information transmission.
3. Highlight the multiplexing techniques required in signal transmission



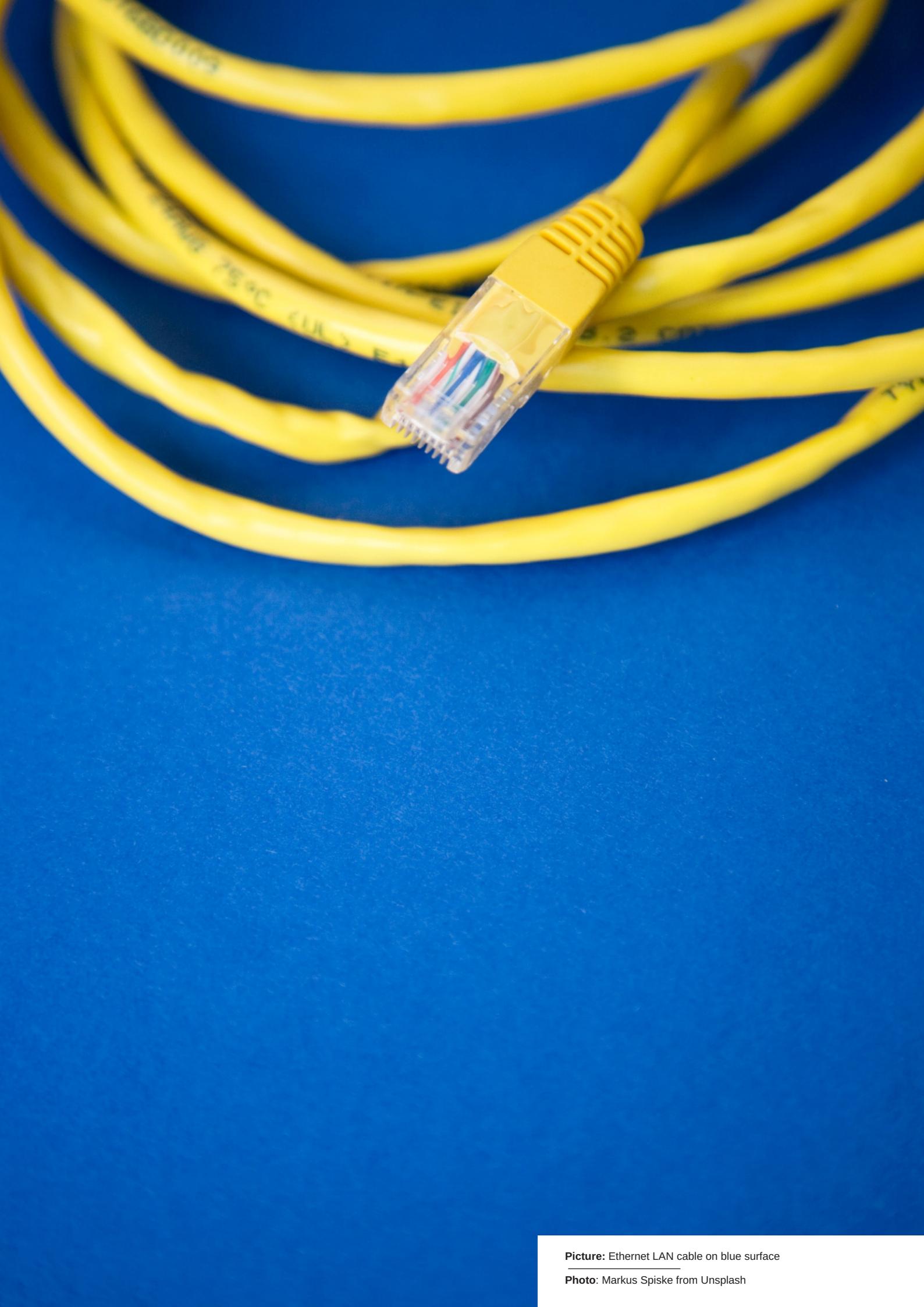
Tutor Marked Assessment

- With the aid of diagram, explain the frequency division multiplexing
- With the aid of clear diagram, inverse and intelligent multiplexing.



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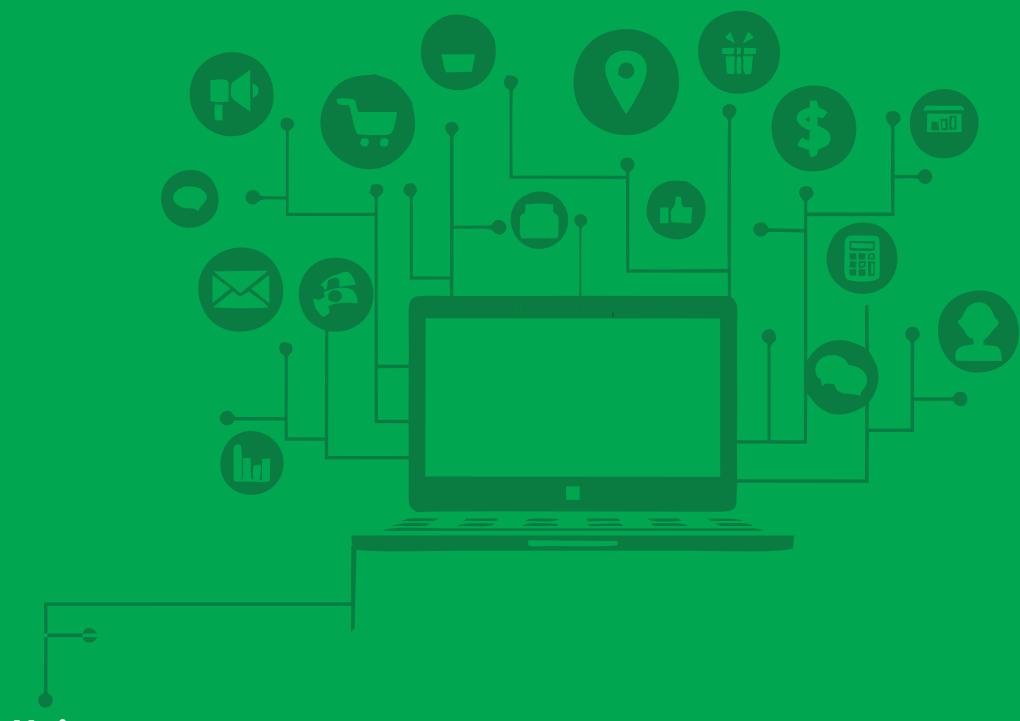


Picture: Ethernet LAN cable on blue surface

Photo: Markus Spiske from Unsplash

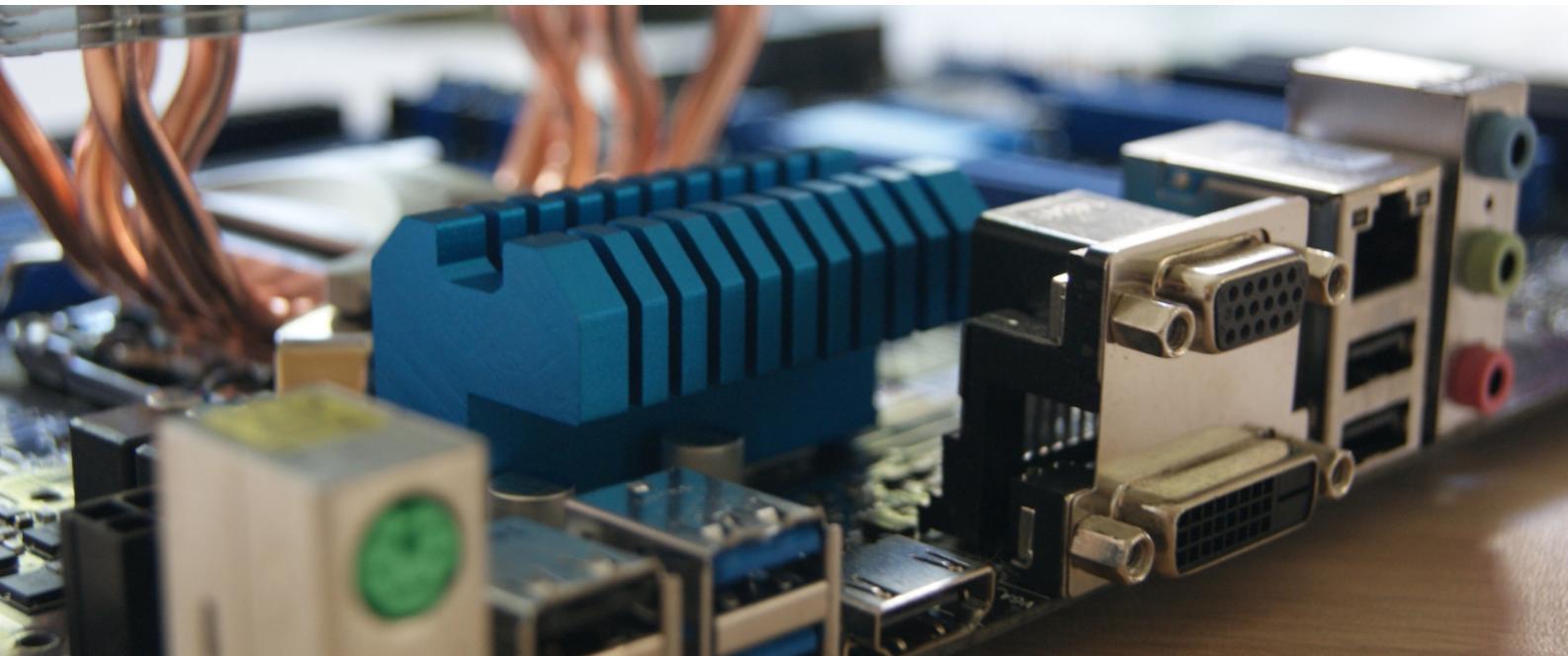
Module 4

Introduction to Networking, Internet, Network Architecture



Units

- 1 - Introduction to network and internet
- 2 - Computer Networking



Unit 1

Introduction to network and internet



Introduction

In this unit covers the introduction and definition basic components of networking and internet

At the end of this unit, you should be able to



Learning Outcomes

- 1 I.Define computer networking
- 2 II.Identify the at least five types of networks
- 3 III.Define the internet

Main Content

Computer Network



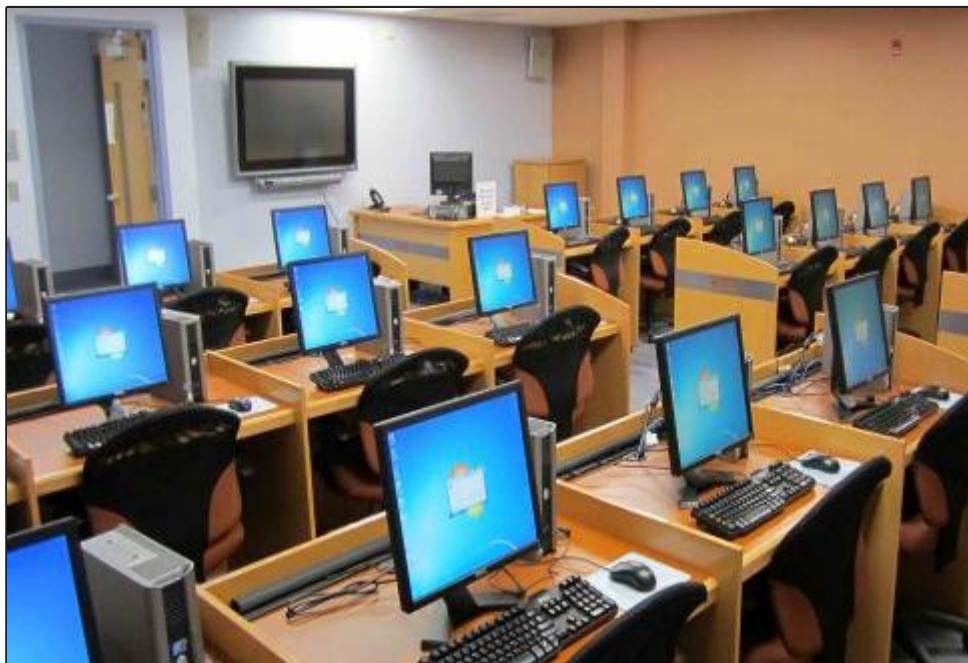
7 mins



SAQ 1



SAQ 2



A computer networks or data network is a digital transmission technique which allows several nodes to share resources among themselves. In computer networks, computing devices exchange data with each other using connections (data links) between nodes.

It may interest you to know that network consists two or more computers that are linked in order to share common resources such as printers, exchange file or allow electronic communication between the two computers.

The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

The very common types of networks include: Local Area Network (LAN) and Wide Area Network (WAN), Metropolitan Area Networks (MAN), a Wireless LAN (WLAN), or a Wireless WAN (WWAN).

Local Area Network

A Local Area Network (LAN) is a network that is confined to a relatively small area and it is generally limited to a geographic area such as student computer laboratory, faculty building or offices. Computers connected to a network are broadly categorized as servers or workstations.

Servers are generally not used by human directly but rather run continuously to provide seamless services to the computers on the network. Services provided can include printing and faxing, software hosting, file storage and sharing, messaging, data storage and retrieval, complete access control for the network's resources, and many others.

Workstations are called such because they typically do have a human user which interacts with the network through them. Workstations were considered as desktop consisting of a computer CPU and its peripheral such as keyboard, display monitor and mouse.

The Servers tend to be more powerful than workstations, although configurations are guided by needs. However, the size and speed of the server's processor(s), hard drive, and main memory might add dramatically to the cost of the system. On a single LAN, you may connect computers and servers by cables or wirelessly. Wireless access to a wired network is made possible by wireless access points (WAPs).



Study Tips

Some examples of LAN are :
Networking between 2 computers.
Networking in the home, school, library, laboratory, college/ university campus, or office.

These WAP devices provide a bridge between computers and networks. A typical WAP might have the theoretical capacity to connect hundreds or even thousands of wireless users to a network. Servers are always connected to the network by cables to the network, because the cable connections remain the fastest.

Workstations which are stationary computer system that are always connected by a cable to the network, although the cost of wireless adapters has dropped to the point that, when installing workstations in an existing facility with inadequate wiring, it can be easier and less expensive for you to use wireless for a desktop but the problem of network fluctuation is the major project.

2 | Metropolitan Area Network

Study Tips

- MANs typically combine the networks of multiple organizations, instead of being managed by a single organization.
- Most MANs use fiber optic cables to form connections between LANs.
- Because MANs are smaller, they are usually more efficient than WANs, since data does not have to travel over large distances.

A metropolitan area network (MAN) is a class of wireless network which covers a large geographical area that spans between 5km to 50km radius.

The area covered includes several buildings, colleges, schools, and hospital and government establishments or an area as large as a city. These networks are larger than LAN, but smaller than WAN, and it is generally providing communication using optic-fiber cable, and mostly operated within data link layer of OSI model.

An example of a MAN is the cable television network we use at home which can be found in many cities. Cable TV grew from a community antenna system which normally has a poor signal reception.

In early development of MAN technology, an antenna with large radius were normally placed at the top of the hill and the signals captured were piped to various subscribers' houses. The channels then were usually a specialized channel where only specialized programs such as all sport, all news and the likes.

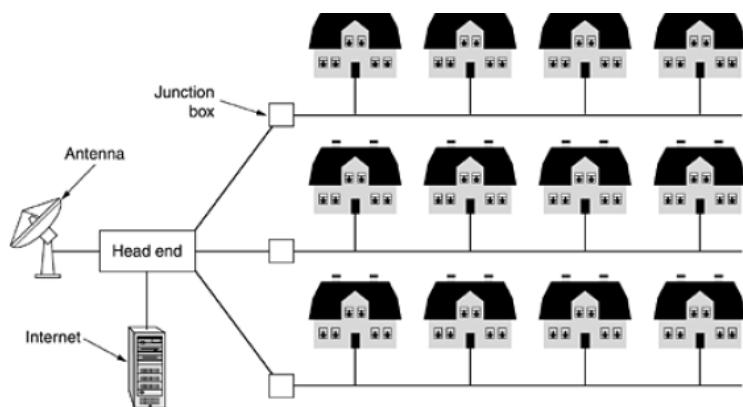


Figure 4.1: Metropolitan Area Network
[Source: Andrew S. Tanenbaum]

3 | Wide Area Network

Wide Area Networks (WANs) connect networks in larger geographic areas, such as between cities or continent. There are always a dedicated transoceanic cabling or satellite uplinks may be used to establish connection in this type of global network A WAN is complicated.

It uses multiplexers, bridges, and routers to connect local and metropolitan networks to global communications networks like the Internet. To us as users, however, a WAN will not appear to be much different than a LAN. A WAN provides coverage far greater than MAN can provide. A WAN connects LANs and MANs

4 | Internet



SAQ 2

As we have it today, Internet is the global system of interconnected computer networks that uses internet protocol suite (TCP/IP) to link devices worldwide. Internet comprises of network that are used by private, public, academic, business, and government linked by a broad array of electronic, wireless and optical networking technologies.

The Internet carries a vast range of information resources and services, such as the inter-linked hypertext documents and applications of the World Wide Web (WWW), electronic mail, telephony and file sharing. The use of internet seems pretty easy to us but it involves the use of complex software and hardware before the internet usage become or seem simple.

The design of the technologies that make today's Internet work started in the 1960s, and there were over 20 years of research into how to build internetworking technologies before the first "Internet" was built in the late 1980s by academics in a project called NSFNet.

Since then, the research efforts to improve the development of internet access by everyone has continued as networks have become larger and faster and globally distributed over billions of interconnected computers.



-Summary

So far in this unit, I have taught you the following:

- the meaning and definition of computer network and internet
- the numbers of network and their characteristics
- the meaning of internet



Self-Assessment Questions



- Define the computer networks
- List at least four types of computer networks
- Explain at least four types of network
- Explain the concept of internet



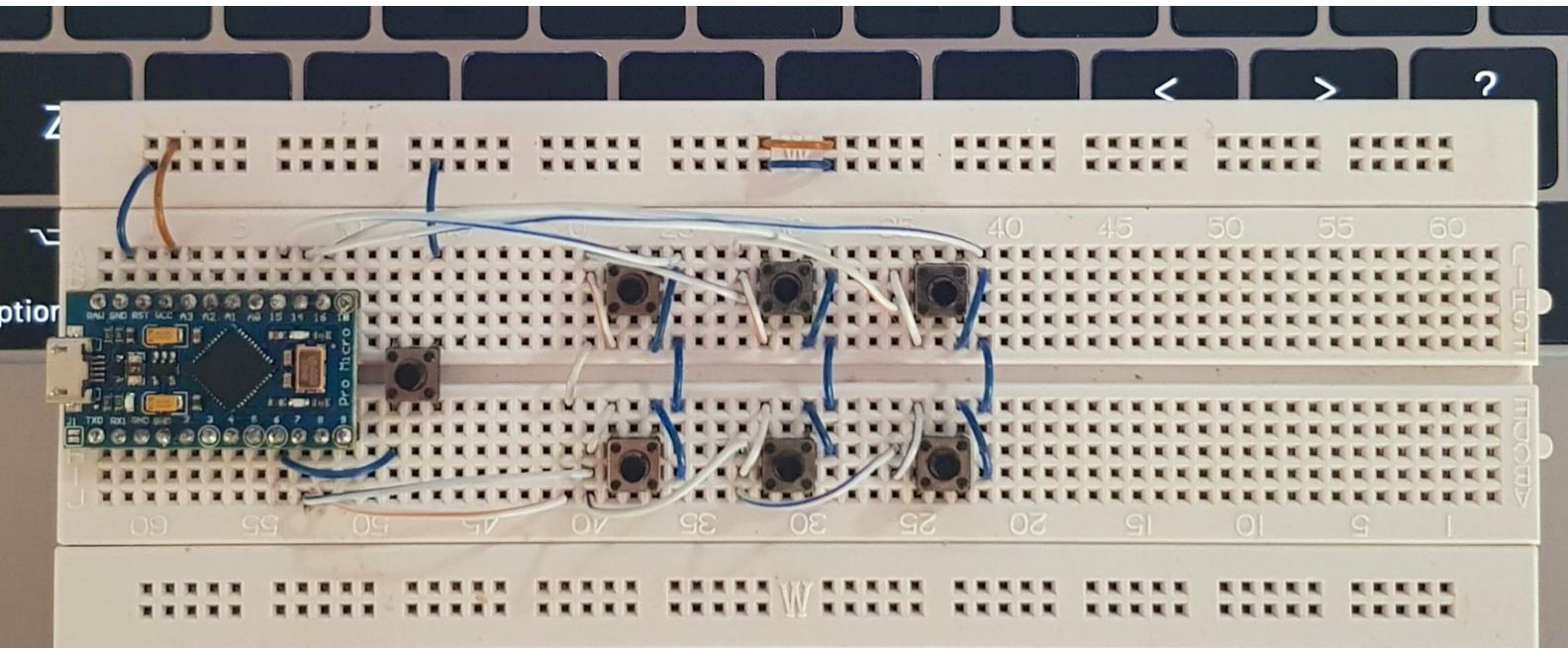
Tutor Marked Assessment

- Differentiate between Computer network and Internet
- Explain the meaning of all types of computer network
- Explain the following briefly
 - i. MAN
 - ii. WAN
 - iii. PAN



Further Reading

- CCNA INTRO: Introduction to Cisco Networking Technologies Study Guide: Exam 640-821: Sybex, 2006, 9780470068502
- Communications and Networking: An Introduction (Computer Communications and Networks) Author(s): John Cowley: Springer, Year: 2007
- <https://learn.saylor.org/course/cs402>
- Introduction to Computer Networking, Author(s): Thomas G. Robertazzi: Springer International Publishing, Year: 2017
- Introduction to networking: Author: Saravanan A.M researchgate.net/publications.2018
- Introduction to computer networking Varna Free University “Chernorizec Hrabar” Institute of Technology, Author: Prof. T. Bakardjieva



Unit 2

Introduction Multiplexing



Introduction

In this unit I will cover the introduction and definition of computer networking, the architecture and various software's that aid the successful operation of a network.



Learning Outcomes

At the end of this unit, you should be able to:

- 1 explain the concept of computer networking
- 2 explain the operation of computer networking
- 3 explain the concept of architecture of computer networking



Main Content

Computer Networking



7 mins



SAQ 1



Computer networking is an engineering discipline that aims at studying and analyzing the communication process that take place among various devices or computer system that are networked together for the purpose of information exchange and sharing of resources such as files, applications, printers and software are common information shared in a networking.

We can see clearly the advantage of networking in terms of security, efficiency, manageability and cost effectiveness as it allows collaboration between users in a wide range. Basically, network consists of hardware components such as computer, hubs, switches, routers and other networks devices. These are the active devices that play an important role in data transfer from one place to another using different technologies such as radio wave and wires.

We have many types of network available in the networking industries today and the most common network are Local Area Network (LAN) and Wide Area Network (WAN). LAN network is made up of two or more computers connected together in a short distance usually at home, office buildings or school. WAN is a network that covers wider area than LAN and usually covers cities, countries and the whole

Study Tips

CSMA stands for carrier sense multiple access, which means that every node on the network must monitor the bus for a period of no activity before trying to send a message on that bus (carrier sense).

world.

You can connect several major LAN together to form a WAN. As many devices are connected to network, it is important to ensure data collision are avoided when these devices attempt to use channel/link simultaneously. A set of techniques are employed in the network to detect and prevent collision in network called Carrier Sense Multiple Access / Collision detection

Carrier Sense Multiple Access (CSMA)



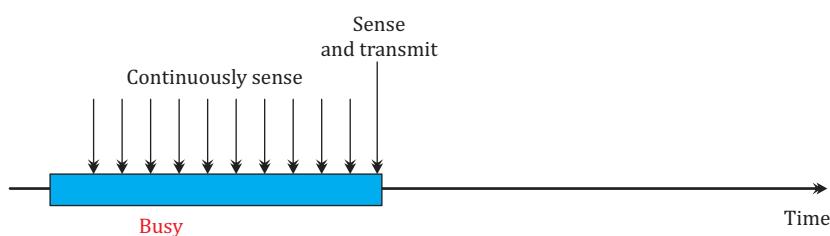
SAQ 2

Carrier Sense Multiple Access is one of the popular ways we can use to transmit information packets across networks. Packets is referred as data bits which are sent over a network.

CSMA will ensure that the channel is free by checking that the line is not being used by another user before data is sent otherwise it will wait until the line is idle before proceeding with data transmission. Example of CSMA is the method by which Ethernet network use in sending information packet.

Collision occurs when multiple computers attempt to send information to each other at the same time. With the application of CSMA, collision can be reduced as it will hold the data and wait until the line is clear before data is transmitted to the particular computer and user.

CSMA actually uses several different methods where they wait for the medium to become idle, known as the persistence strategy. Persistence strategy defines the procedures for a station that senses a busy medium. Figure 4.1a&b illustrated three persistent strategy



a. 1-Persistent

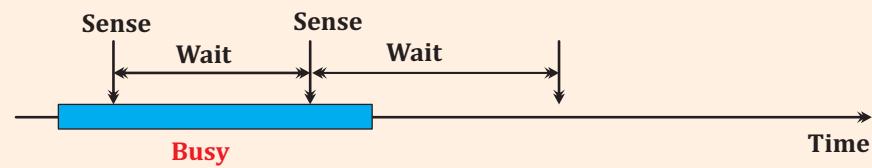
**b. Non persistent**

Figure 4.1a: Persistent Strategy Behavior
 [Source: Saravanan A.M 2018]

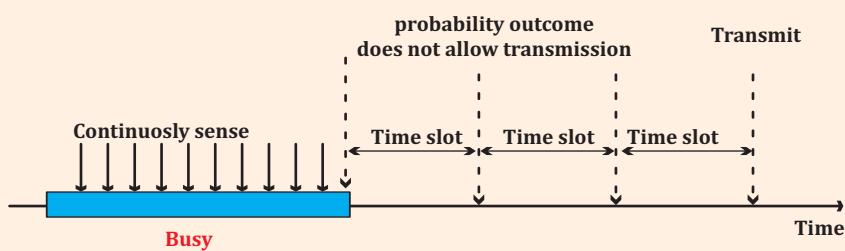
**c. p - persistent**

Figure 4.1b: Persistent Strategy Behavior
 [Source: Saravanan A.M 2018]

1 | 1-Persistent method

In this strategy, the transmitting station will observe the channel and can only transmit packets immediately if the channel is sensed free. If the medium is busy, it will wait until the channel becomes idle. 1-persistent will send the data with probability of 1.

2 | P-persistent method

In this protocol, the sender will only transmit the packet with the probability of p but if the line is busy, the sender will wait until the channel is free and transmit with the probability p . The strategy is what we use in Wi-Fi and packet radio systems.

3 | Non-persistent method

This is a non-aggressive type of CSMA protocol that operates in Medium Access Control (MAC) layer. When more than one user sends and receive data through a shared medium that may be a single cable or optical fiber connecting multiple nodes, or a portion of the wireless spectrum.

In non-persistent method, the sender usually waits for a random period of time without sensing the channel before the data is retransmitted. The advantage of this strategy is that, it reduces the chances of collision since it is out of ordinary for two station to wait for the same period of time before retrying concurrently.

Carrier Sense Multiple Access (CSMA)



SAQ 3

Just as we have discussed when studying CSMA, data is transmitted over the channel when the channel has been sensed and find out that it is available. The problem of collision can occur when computers tend to communicate with one another concurrently.

This problem can be reduced if the station can detect if the data transmission deteriorates a collision during the transmission. Instead of randomly transmitting data which has collided with others, the collision can be detected by a station which could immediately halt the collided transmission to reduce the duration of collision.

The protocol which perform this action is called Carrier Sense Multiple Access with Collision Detection or CSMA/CD. This is a protocol used to ensure only one network node is transmitted at one time while the other is waiting for free channel. This is the technique used to access the 802.3 Ethernet network channel.

collision detection means when two devices try to send data simultaneously at the same time. CSMA/CD operates in the same manner with CSMA except the moment collision is detected, the operation of data transmission will be aborted immediately.

The collision that occurs on the shared media are detected when the devices in the listening mode. When the device is in listening mode, it can detect collision that occurs on the shared media.

This can be known when there is increase of amplitude above the normal level. Once the increase in the signal amplitude detected all the transmitting devices will transmit to assure devices in network detect the collision.

Retransmission

The retransmission is performed after the collision is detected, and the node back off for a period of time. If the retransmission is successful, the node clears its collision counter. The flow diagram below explain the operation of CSMA/CD. The operation of CSMA/CD are same with CSMA before the collision detection starts as shown in the diagram. The transmission is successful if there is no collision is detected otherwise the transmission will be aborted. the jamming signal will be sent and all the stations involved will be back off.

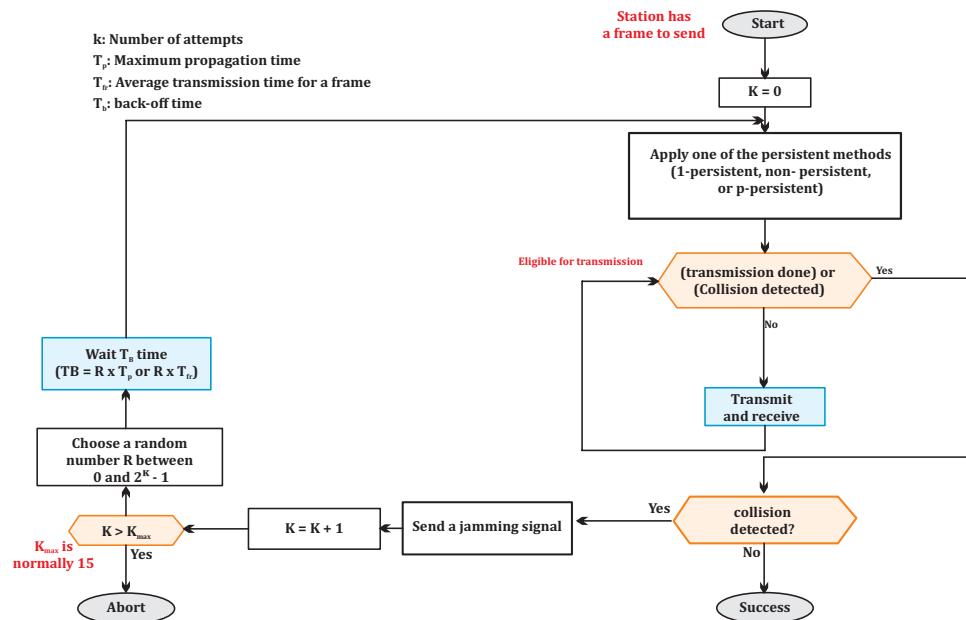
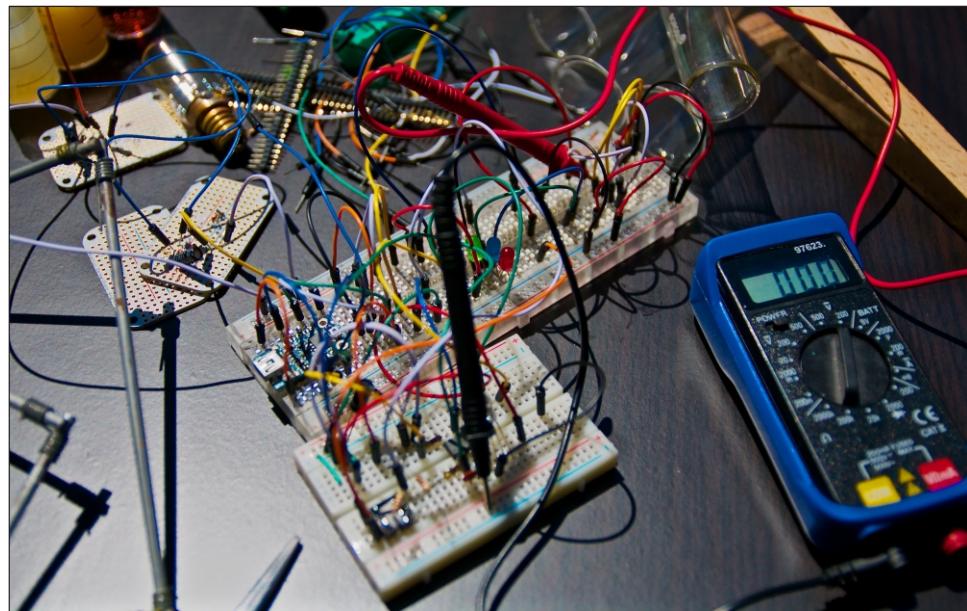


Figure 4.2: Flow diagram for CSMA/CD,
[Source: Saravanan A.M, 2018]



Architecture of Computer Networking

These are ways at which network devices are being configured, which can be broadly categorized into two types of network configuration, namely; peer-to-peer networks and client/server networks.

I | Peer-peer Networking:

Peer-to-peer networks: We can implement this type of networking where less than ten computers are involved and there is no strict rule about the data security.

Files such as word processing or spreadsheet documents can be shared across the network and all the computers on the network can share devices such as printers, scanners which are connected to any one computer.

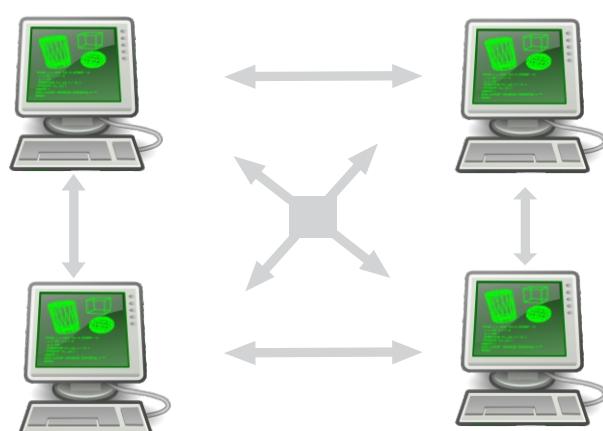
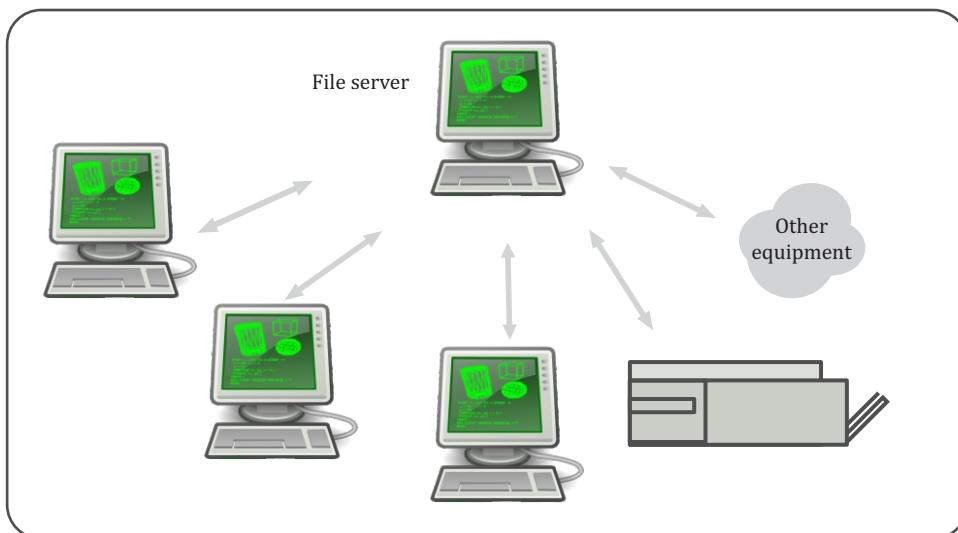


Figure 4.3: Peer-to-peer networking
[Source: T. Bakardjieva]

2 | Client/Server Networks

These are more suitable for larger networks for more than 50 computers that are interconnected. A central computer acts as the storage location for files and applications shared on the network. Usually the server is a higher than average performance computer. It is worthy to note that the server also controls the networks access of the other computer which are referred to as client computers.



-Summary

So far in this unit, I have taught you the following:

- the meaning of computer networking
- the operation of computer networking
- at least the three persistent behavior of computer networking
- the operation of computer networking architecture



Self-Assessment Questions

1. define in brief computer networking
2. state the operation of three persistent behavior of computer networking
3. explain, the concept of jamming signal back off algorithm and retransmission





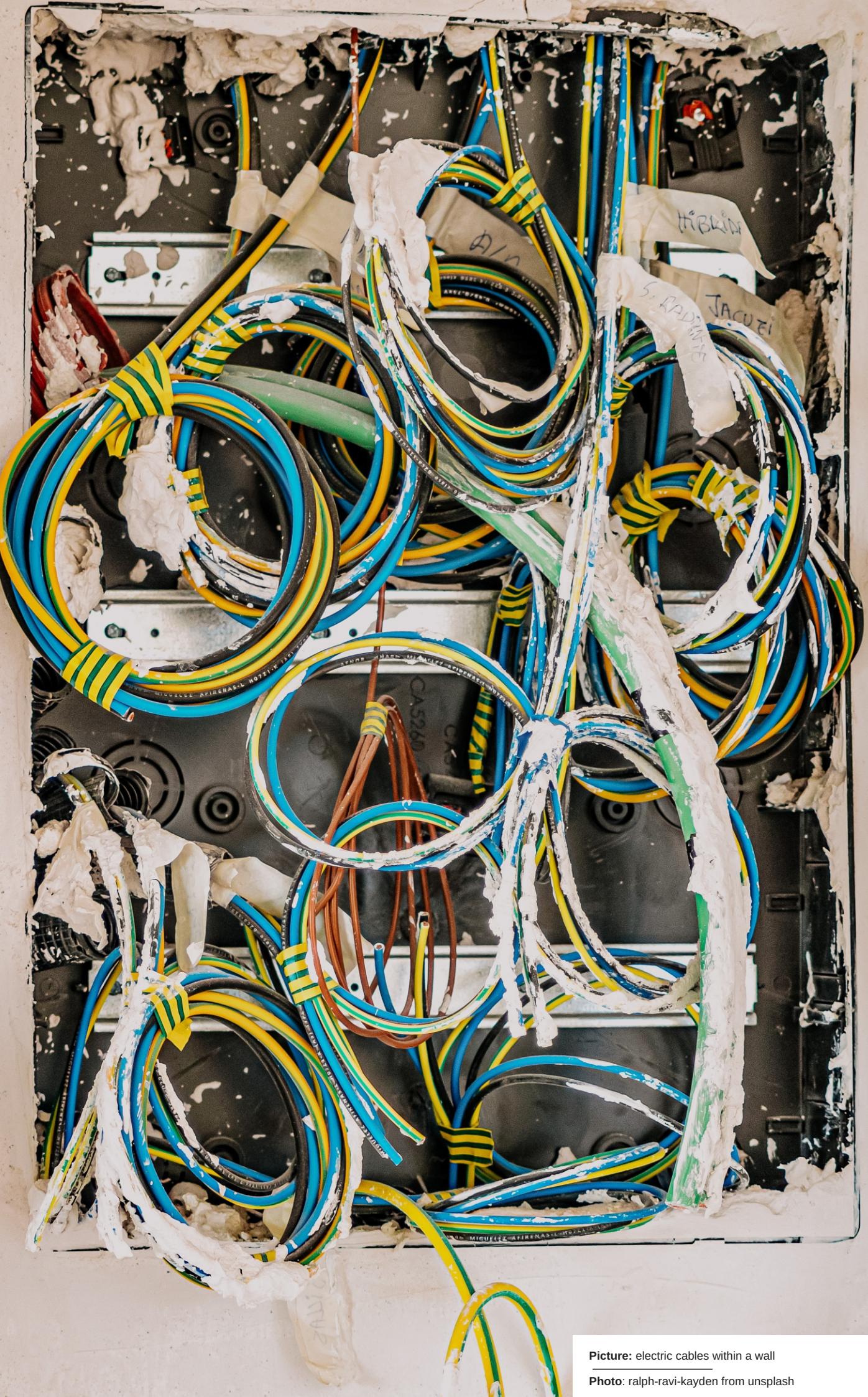
Tutor Marked Assessment

- With the aid of diagram, explain in details CSMA/CD
- Explain with the aid of diagram the architecture of computer networking



Further Reading

- CCNA INTRO: Introduction to Cisco Networking Technologies Study Guide: Exam 640-821: Sybex, 2006, 9780470068502
- Communications and Networking: An Introduction (Computer Communications and Networks) Author(s): John Cowley: Springer, Year: 2007
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- Introduction to networking: Author: Saravanan A.M researchgate.net/publications. 2018
- Introduction to computer networking Varna Free University “Chernorizec Hrabar” Institute of Technology, Author: Prof. T. Bakardjieva



Picture: electric cables within a wall

Photo: ralph-ravi-kayden from unsplash

Module 5

OSI model and TCP/IP protocol suites/Network topologies/ Introduction to Network devices



Units

- 1 – Introduction to OSI model / the OSI and TCP/IP Model
- 2 – Introduction to Network topologies / Different types of Network topologies
- 3 – Introduction to Network devices



Unit 1

Introduction to OSI model and the TCP/IP Model



Introduction

In this unit, we will look into the introduction and definition basic components of OSI model and their characteristics

Learning Outcomes

At the end of this unit, you should be able to:

- 1 list at least five layers in OSI model
- 2 state the property of each layer in OSI model
- 3 explain the concept of TCP/IP model
- 4 compare the OSI model and TCP/IP model



Main Content

The OSI Model

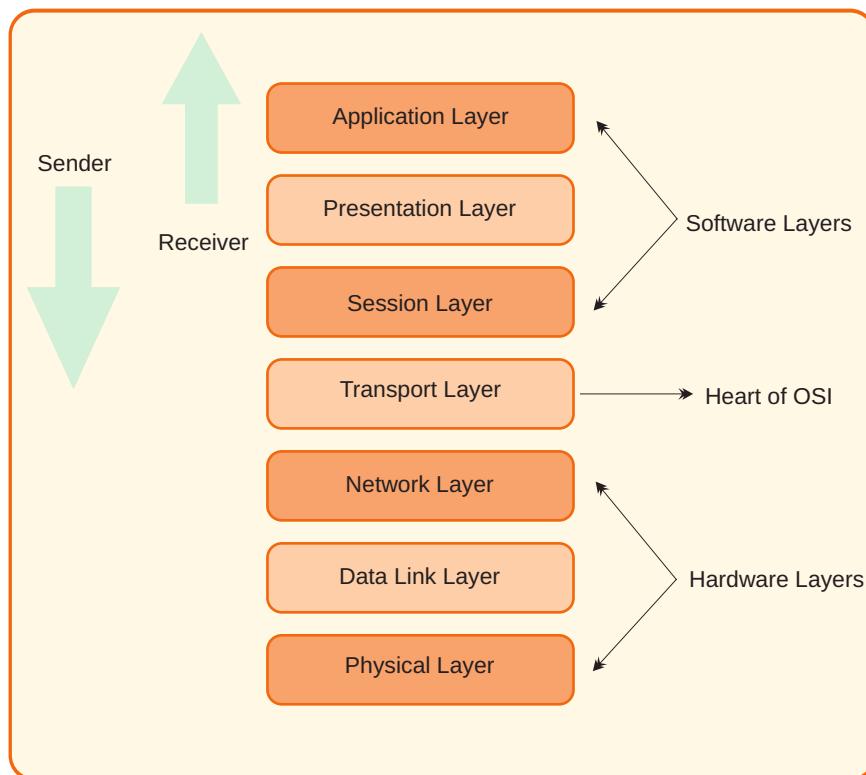


9 mins



Study Tips

It may interest you to know that the open systems interconnection model (OSI Model) is a conceptual model that standardizes the communication functions of a telecommunication or computing system without regards to its underlying internal structure and technology.



In a communication world, the OSI model and the TCP/IP model serve two different purposes. The OSI model is more of an abstract model that can be used to understand a wide range of network architectures while TCP/IP is the mostly wide used network today. The OSI model has seven layers instead of the four layers of the TCP/IP model. Listing the OSI model from the bottom of the table, the layers: (i) Physical, (ii) Data link, (iii) Network, (iv) Transport (v) Session, (vi) Presentation, and (vii) Application layers.

i | Peer-peer Networking:

The physical layer of OSI model deals with attributes of the actual wired, wireless, fiber-optics and other types of connections that are employed to transport the data across the link to data link layer. The Physical layer also defines the shapes of the connectors and type of media which can be used. Physical layer also deals with the type of

ii | Data Link Layer

In the OSI model, the data link layer is concerned on how the systems using physical link cooperate with one another and work together as an entity. The data link layer defines the special sequences to indicate the starting and end of the data when it is broken into packets.

As seen above, data link layer is the second layer of the seven-layer OSI model. Data link layer is a protocol layer that deals with exchange of data between terminals on a network across the physical layer. The data link layer provides the process by which data be transfer between network entities and might provide the ways to detect and possibly correct any error that may arise in the physical layer.

Data link layers also have some form of checksum to detect and/or to correct for errors in the transmitted data across the network. The design problems solved in the Physical and Data Link layers of the OSI model are addressed by the Link layer of the TCP/IP model.

iii | Network Layer

This is the third layer of OSI model and this layer is responsible for packet forwarding including routing through the intermediate routers. Network layer governs how routers forward packets across multiple hops to get from their source to their destination.

Like the IP layer, the network layer does not have any process that deal with error detection and correction in the data being routed through it as it assumes that lost data will be detected and retransmitted at the next layer up.

iv | Transport layer

In computer networking, the transport layer which provide host-to-host communication services for applications. Some of the services provided by layer 4 of the OSI model are connection-oriented communication, reliability, flow-control, and multiplexing. The transport layer also manages packet loss and retransmission as well as flow control and window size. The rest of the functionality of the TCP/IP Transport layer is handled in the Session layer in the OSI model.

v | Session (Layer 5)

This is the fifth-layer of seven-layer OSI model of computer networking. This layer provides the mechanism for opening, closing and managing the session between end-user application processes. Communication sessions consist of requests and responses that occur between applications.

Session layer handled some aspects of secure transmission of the data transmitted in the network in the service layer of the OSI model network architecture, the session layer responds to service request from presentation layer and interface with the request to the transport layer.

vi | Presentation (Layer 6)

This is the sixth layer in OSI model, the presentation layer focuses on the presentation of data and the encoding techniques used for transmission across the network. As an example, the Presentation layer would describe how to encode the pixels of an image so that the receiving application can properly decode the data. The Presentation layer also handles data encryption and decryption.

vii | Application (Layer 7)

This is the last layer we have in OSI model which deals with abstraction that specifies the shared communication protocols and interface methods used by hosts in a communication network. . The application layer in OSI model is similar to the application layer of TCP/IP model. Some applications are client based that initiate connection while some are server based which respond to those initiated connection request. The various pairs of applications have protocol standards that define interoperability between multiple clients and multiple servers from different vendors.

Comparing the OSI and TCP/IP Models



SAQ 2

The OSI model provide an alternative view to TCP/IP model by breaking the network functionality to layers while TCP/IP the functionality to layer.

1 | Link Layer (TCP/IP)

This layer performs the similar function as physical and data link layers in OSI model. Both the physical and data link layers are implemented in hardware product like Ethenet, Wi-Fi devices or fiber-optic hardware devices implement in a network driver that are plug to the back of the computer or router.

The network driver card generally implements both the physical and the data link aspects of the connection in the hardware on the card. In most cases, the data link layers are tuned to the limitations and requirements of their corresponding physical layers.

Since it can be hard to separate the physical and data link aspects for a

2 | Internet work Layer (TCP/IP)

One place that maps pretty cleanly between the two models is the OSI Network and TCP/IP Internet work layers. They perform the same functions of creating a globally routable address space and building routers to insure that packets properly find their way from the source to the destination across multiple hops.

3 | Transport Layer (TCP/IP)

This layer creates a virtual transfer control protocol (TCP) or user datagram protocol (UDP) connection between network hosts. This layer sends and receives data to and from the applications running on its host. This layer is used to assign port numbers to the processes running in applications on the host and add TCP or UDP header to the messages received from the application detailing the source and destination port numbers. The OSI Transport layer deals with flow control and packet retransmission, while the OSI Presentation layer deals with multiple applications running on multiple

ports as well as session establishment and teardown. The secure socket layers (SSL) in the TCP/IP model correspond to the session and presentation layers in the OSI model.

4 | Application Layer (TCP/IP)

In the application layer in TCP/IP model it combines the non-security features of the OSI presentation layer and OSI application layer. In TCP/IP model, the application layer deal with the issues like data encoding and decoding, data formatting. Some of the functions of the application layer performs are:

It facilitates the development of network-based application

It provides end user services like message formatting, e-mails, file transfer between nodes, and

It allows the users abilities to use the network



SAQ 3

Diagram Representation of OSI Model with TCP/IP Model

In the OSI network model, we have seven layers as compared to four layers in TCP/IP. TCP/IP was later launched after the development of OSI protocol, was published but there is a linkage between OSI model and TCP/IP standards. The OSI protocol has been very essential and influential in the growth and development of TCP/IP standard, hence both has interrelated in the working principle.

In the figure below I compared the TCP /IP and OSI network models and as you can see from the figure below, presentation and session layers are not there in TCP/IP model. It should be noted that the network layer in TCP/IP model combines the functions and functionality of data link and physical layers in OSI model.

Fig. 5.1 Comparing OSI Model with TCP/IP Mode	
OSI	TCP/IP
Application Layer	
Presentation Layer	Application Layer
Session Layer	
Transport Layer	Transport Layer
Network Layer	Internet Layer
Data Link Layer	
Physical Layer	Network Access Layer

The TCP/IP Layer

This layer consist of four distinct level which is equivalent to seven layers of OSI model, the layers are:

a | Application Layer

This is the topmost layer of TCP/IP model. This layer includes all the higher-level protocol such as Domain Naming Server (DNS), Telnet, SSH, File Transfer Protocol (FTP), Trivial File Transfer Protocol (TFTP), SNMP. The role perform by application layer is similar to the combined function of session, presentation and application layer in OSI model.

b | Transport Layer

This is the third out of the four layers of TCP/IP model. It lies between the application and internet layer. the transport layer allows the communication or exchange of information to exist between the devices on the source side and at the destination host to have the capacity to exchange conversation.

Transport layer perform the same function both in OSI model and TCP/IP network model. The main protocols in the transport layer are User Datagram Protocol (UDP) and Transmission Control Protocol (TCP).

c | Internet Layer

Internet layer of TCP/IP protocol stack is the same as network layer in OSI model. This layer aggregates the data into data packets known as IP datagram, which contain source and destination address (logical or IP address) information that is used in forwarding the datagrams between the hosts and across the networks.

Also, this layer is also responsible for routing of IP datagrams. The main protocols included at this layer are Internet Protocol (IP), Internet Control Message Protocol (ICMP) and IGMP (Internet Group Management Protocol).

d | Network Access Layer

Network layer is the first layer of the four-layer TCP/IP model which equates to both the physical and data link layer in OSI model. Network layer defines the details on how data is sent through the network, including how bits are electrically or optically signaled by hardware devices that interface directly with a network medium, such as coaxial cable, optical fiber, or twisted pair copper wire. the protocols available at the network layer are token Ring, Ethernet, Frame Relay etc.



-Summary

In this unit, I have thought you the following:

- the meaning of OSI model
- the layer that comprises of OSI model
- the comparison between OSI model and TCP/IP model
- the property of each of OSI model layer



Self-Assessment Questions



1. List all the OSI model layer and explain their roles in internetworking.
2. Explain in detail the relationship between OSI and TCP/IP model
3. Draw a clean diagram of OSI model



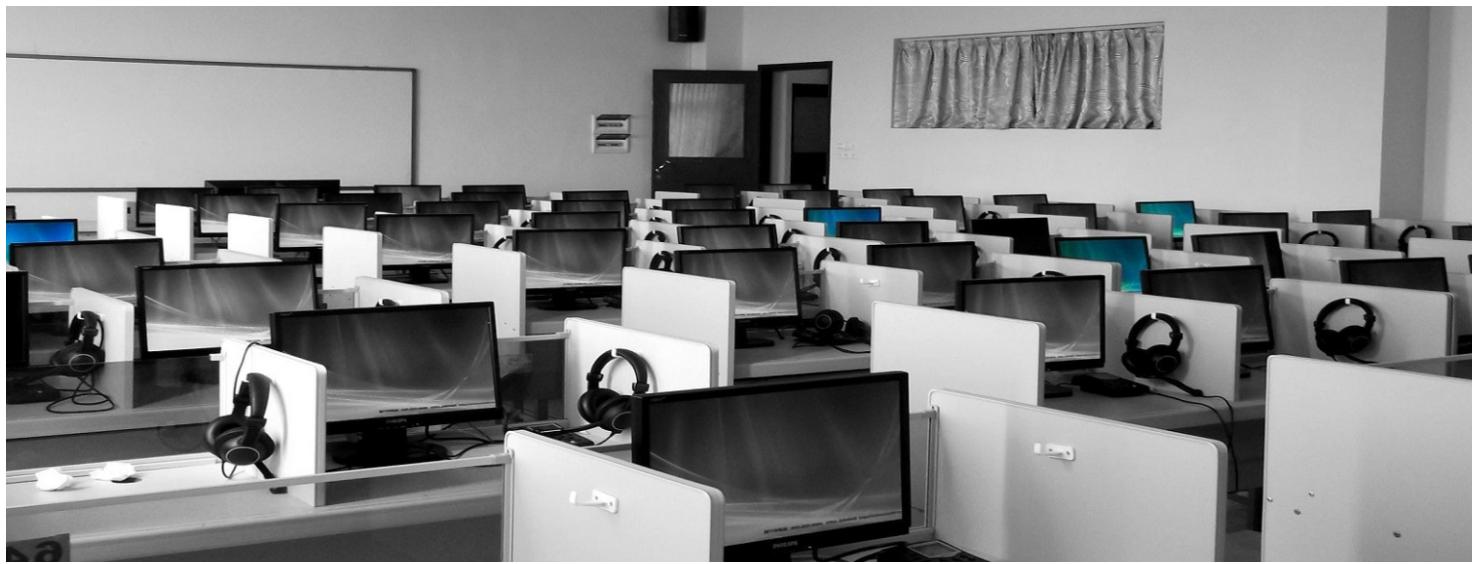
Tutor Marked Assessment

- With the aid of diagram, explain in detail the OSI model
- Explain the difference between OSI and TCP/IP model with the aid of diagram



Further Reading

- CCNA INTRO: Introduction to Cisco Networking Technologies Study Guide: Exam 640-821: Sybex, 2006, 9780470068502
- Communications and Networking: An Introduction (Computer Communications and Networks) Author(s): John Cowley: Springer, Year: 2007
- <https://learn.saylor.org/course/cs402>



Unit 2

Introduction to Network Topologies



Introduction

In this unit, I will teach you the basic components of network topologies, its meaning and their various configurations.

At the end of this unit, you should be able to:



Learning Outcomes

- 1 define network topology
- 2 state the different types of network topology
- 3 identify the area of applications of each
- 4 list the merit and demerit of each network topology



Main Content



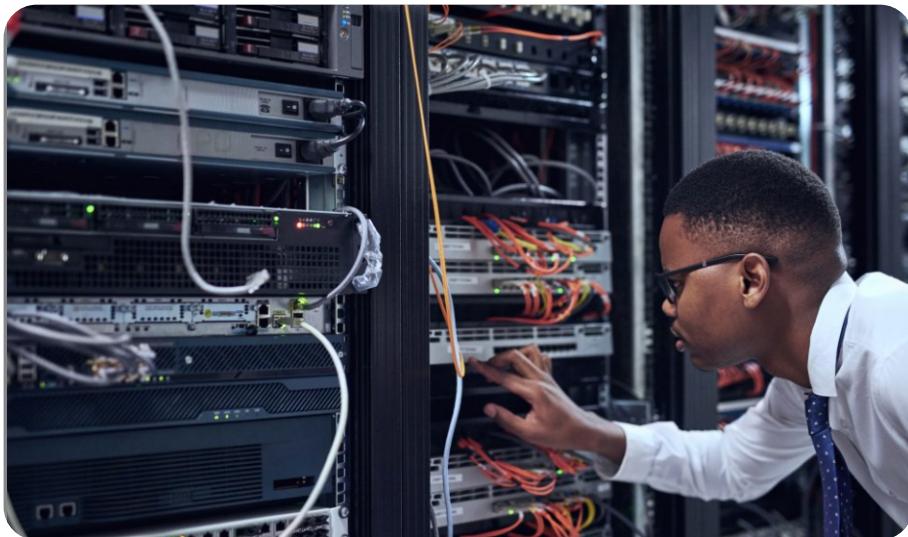
Study Tips

It may interest you to know that the open systems interconnection model (OSI Model) is a conceptual model that standardizes the communication functions of a telecommunication or computing system without regards to its underlying internal structure and technology.

Network topologies



6 mins



When we talk about network topology, we are referring to the arrangement of network including its nodes and connecting links. We can therefore categorize network topology into physical topology and logical topology. Network topology can also be defined as the arrangement of the elements or various type of a communication network, including command and control radio networks, industrial field busses, and computer networks.



SAQ 2

Types of Network Topologies

Network topologies are categorized into the following basic types:

- i. Bus
- ii. Ring
- iii. Star
- iv. Tree
- v. Mesh

I | Bus Topology

A bus topology is a topology in which all nodes are connected to a single cable. The cable to which we connect the nodes is called backbone. If the backbone is broken, the entire network fails. Bus topology is relatively easier to install and require less cabling. Bus topology is used for small workgroup local area network whose computers are connected using thinnet cable.

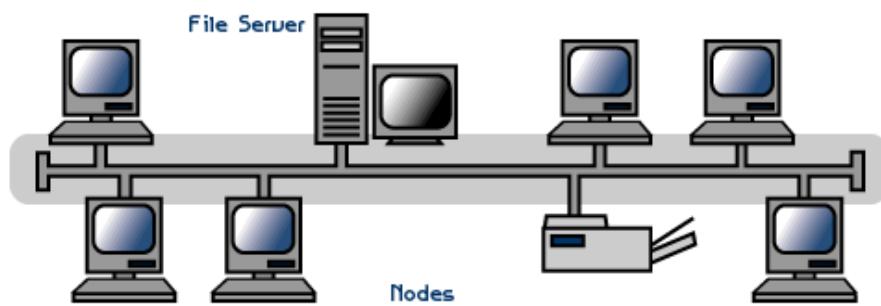


Figure 5.1: Bus topology

Advantages of Bus Topology

- I. Easy to connect a computer or peripheral to a linear bus.
- ii. Bus topology requires less cable as compared to star topology.

Disadvantages of Bus Topology

- I. The entire network will shut down if there is a break in the main cable
- ii. Difficult to troubleshoot in case of failure
- iii. Not useful in a standalone system
- iv. Terminators are required at both ends

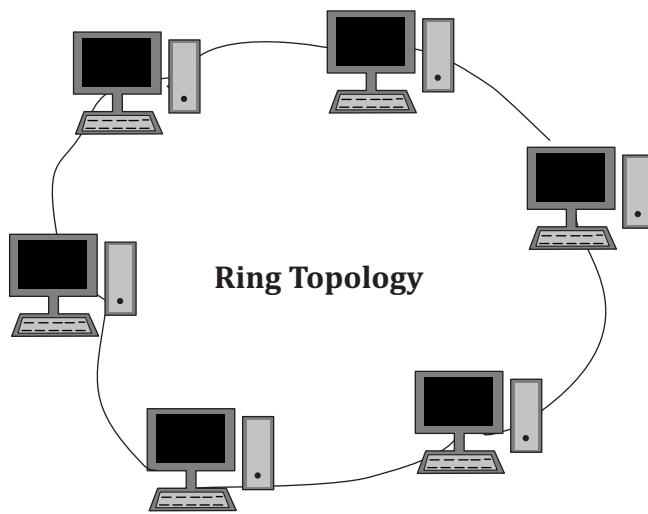
2 | Ring Topology

In a ring network, every device you put on it has exactly two neighbours for communication purposes. All messages travel through a ring in the same direction (either "clockwise" or "counterclockwise").

In ring topology, a failure or break in cable or any of the network devices breaks the loop and can shut down the entire network.

To implement a ring network, one typically uses FDDI, SONET, or Token Ring technology. Ring topologies are found in some office buildings or school campuses. In a ring network, packet of data travel from one device to the next until they reach their destination.

Most ring topologies allow packets to travel only in one direction, called a unidirectional ring network. Others permit data to move in either direction, called bidirectional. Ring topology may be used in either LAN or WAN depending on the type of network card in each computer. A coaxial cable or RJ-45 network cable is used for connecting computers



Advantages of Ring Topology



SAQ 3

- I. The chance of packet collision is reduced since all data travels in the same direction
- ii. Network server is not needed to control network connectivity between each workstation
- iii. The speed of transmission is high compared to star topology
- iv. Adding another workstation does not impact the performance of the network using ring topology configuration.

Disadvantages of Ring Topology

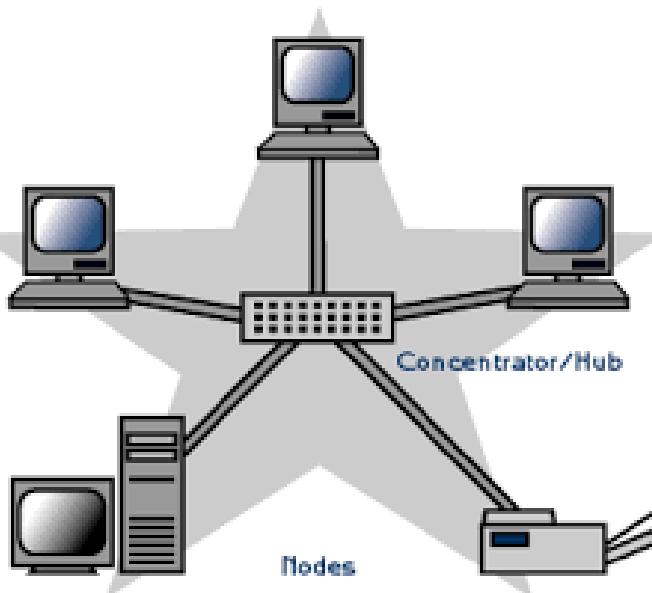
- I. The data transmitted in ring topology is slower
- ii. The entire network feels the effect if one workstation shut down
- iii. The ring topology is expensive because more hardware are needed to connect the network devices in the networks.

3 | Star Topology

All traffic emanates from the hub of the star. The central hub is usually consisting of fast server or computer and it is responsible for routing all traffic to the other nodes. The main advantage of a star network is that the failure of one of the computers does not affect the other systems in the network. However, the main bottleneck and failure you need to note here is the failure of the central server which will affect the entire systems in the network. Star Topology requires more cable length than a linear topology. If the hub, switch, or concentrator fails, nodes attached are disabled. More expensive than linear bus topologies because of the cost of the hubs, etc.

Do you know that a star topology is a form of topology used in LAN in which all nodes are individually connected to the central server?

A star topology takes more cable than bus and tree topology.



4 | Tree Topology

A tree topology joins multiple star topologies together onto a bus where hub devices connect directly to the tree bus, and each hub functions as the root of a tree of devices. This bus/star hybrid approach supports future expansion of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub connection points) alone.

Some of the usage of tree topology are: it is easy to identify in the network and also connect to larger network, it can share information across larger network, it allows the installation of multiple servers, and it reduces network traffic

Advantages of Tree Topology

- i. Flexibility: computers can be added by simply adding another hub into the network topology
- ii. Centralised monitoring is possible due to nature of tree topology configuration
- iii. Point-to-point connection: In tree topology each computer is connected to the hub and also each part of a network is connected to the main cable.
- iv. Tree topology is supported by many hardware and software vendors.
- v. In tree topology it is easy to add a computer by simply extending using cables to connect computers.

Disadvantages of Tree Topology

- I. Single point of failure: In tree topology, if the backbone of the entire network breaks both part of the network may not communicate to each other but a part of the network continues to communicate alone.
- ii. It is difficult to configure.

The length of available cable determines the length of the network.

Usage of Tree Topology

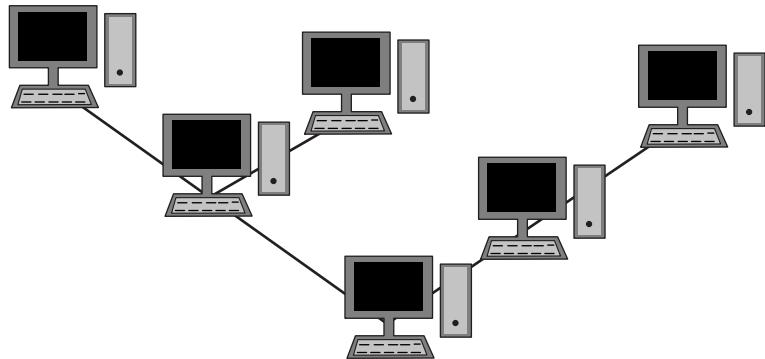


Figure 5.4: Tree Topology



SAQ 5

5 | Mesh Topology

Mesh topology introduces to us the concept of routes. Compare to previous topologies, message sent using mesh network can take any several possible paths from the source to the destination. Some WANs, most notably the Internet, employ mesh routing. A mesh network in which every device connects to every other is called a full mesh. As shown in the Figure below

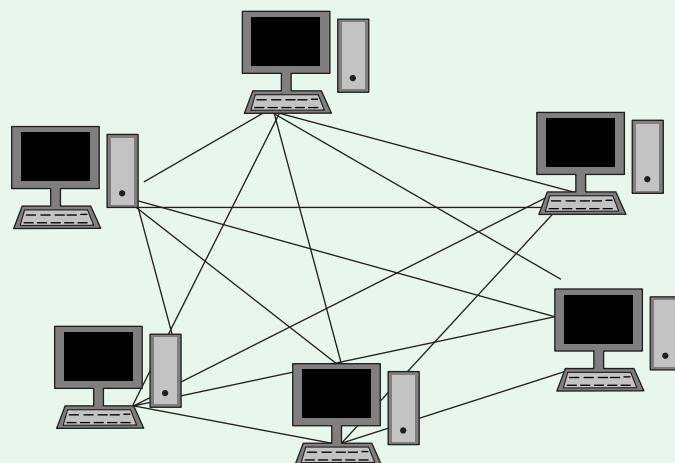


Figure 5.5: Mesh Topology

Advantages of Mesh Topology

- I. The topology is flexible, so adding and removing any device will not affect the network. It is easy to diagnosed fault.

ii. Mesh topology have better security and privacy feature.

iii. It is relatively power efficient.

Disadvantages of Mesh Topology

I. In case of wired network, mesh topology requires cables in bulk.

ii. The cost of installation was high as compare to other topologies.

iii. Installation can be complex due to nature of mesh topology



Summary

In this unit, I learnt a lot about:

- I. The meaning of network topology
- ii. The different types of topology configurations
- iii. The advantages and disadvantages of each configurations



Self-Assessment Questions



1. Define network topologies.
2. List at least five types of network topologies
3. State four features of
 - Bus
 - Mesh
 - Ring topology
4. List the advantages of Ring topology
5. State at least four disadvantages of mesh topology



Tutor Marked Assessment

- With the aid of diagram, explain in detail the bus, mesh and tree topologies
- Explain the difference between ring and mesh topology
- As a network engineer, kindly recommend with reason the most suitable kind of topology for a large governmental organization



Further Reading

- Ad-hoc Networks: Fundamental Properties and Network Topologies: Ramin Hekma: Springer, Year: 2006
- <https://study.com/academy/lesson/how-star-topology-connects-computer-networks-in-organizations.html>
- An Introduction to Computer Networks
- Introduction to Distributed Computer Systems : Principles and Features: Ludwik Czaja : Lecture Notes in Networks and Systems: Springer International 2018



Unit 3

Introduction to Network devices



Introduction

This unit covers the introduction to network devices, how it operates and its layer representation.

At the end of this unit, you should be able to:

- ✓ --- 1 List at least four types of available network devices
- 2 State five major differences between the types of network devices
- 3 Identify the area of applications of each network devices
- 4 List the merits of network interface card
- ✓ --- 5 State four major demerits of each network devices



Learning Outcomes



Main Content

Network Devices



9 mins



Study Tips

It may interest you to know that the open systems interconnection model (OSI Model) is a conceptual model that standardizes the communication functions of a telecommunication or computing system without regards to its underlying internal structure and technology.

A network device is a physical hardware that is interconnected together to establish a desired network. There are various types of network devices which we will discuss below:

Types of Network Devices

In computer networking, there are different types of networking devices

- i. Workstation
- ii. Network Interface Card (NIC)
- iii. Hubs
- iv. Switches
- v. Routers
- vi. Cables

1 | Workstations

A workstation is a high-end computer to be accessed by a single individual at a time. They are usually connected to a local area network (LAN) which normally runs on multi-users operating systems. Workstations offered higher performance than mainstream personal computers, especially with respect to CPU and graphics, memory capacity, and multitasking capability.



Sun Ultra 20 with AMD Opteron processor and Solaris 10

2 | Network Interface Card (NIC)

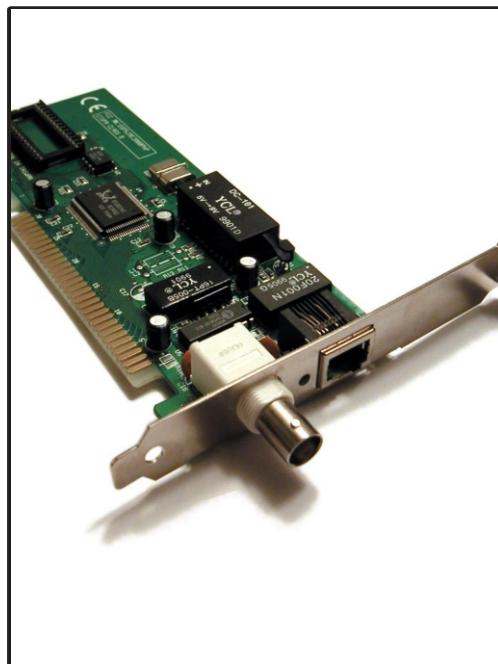


SAQ 1



SAQ 2

A network interface card (NIC) is a device that connects computer to the cabling which in turn links all the computers on the network together. Each computer you put on this network must have a NIC card. Most modern network cards are 10/100 NICs and can operate at either 10Mbps or 100Mbps. Computers with a wireless connection to a network also use a network card.



Example of a Network Interface Card



8-port Ethernet hub with one 10BASE2 connector and eight 10BASE-T ports

4 | Switch

A hub is a network device used to connect a PC to the network. The function of a hub is to channel the information around the network, establishing communication between all the interconnected devices.



Fig 5.8: Examples of 24 port switches

How Switch Works

You can use a switch to connect multiple network devices together such as computers, wireless access point, printers and servers on the same network within a building or campus so as to allow the connected devices to share information and talk to each other.

Switch can improve the performance of the network in two ways. First by creating a direct path between two devices and controlling their communication which can reduce the number of collisions on the network.

Secondly, switch can allow full duplex communication to exist between the transmitter and the receiver. Full duplex is the process by which both the transmitter and receiver can send and receive packets of data at the same time. Also, half duplexing communication can exist by using network switch.

Irrespective of whether a connection is at full or half duplex, the method of switching dictates how the switch deals with the data it receives. The following is a brief explanation of each method:



Cisco small business
SG300-28 28-port Gigabit
Ethernet rackmount switch
and its internals

a | Cut-through

In a cut-through switching method, the packet begins to be forwarded as soon as it is received. This method is fast but it can introduce error propagation through the network since no error

**Store-and-forward switching of a packet.**

- (a) First router makes the routing decision.
- (b) The packet had performed the first hop to the second router after it has been copied to the output buffer of the first router.
- (c) The whole packet is received after the second hop .

b | Store-and-forward

Unlike cut-through, the entire packet is received and errors are checked before being forwarded the advantage the method is that errors are not propagated through the network but it error checking process relatively taking longer time, thus the switching process is

c | Fragment Free

In fragment switching environment, packets are read so that switching can determine whether the packet has been involved in a collision. As soon as the collision status has been determined, the packet is forwarded.

5 | Routers

A router is hardware device designed to receive, analyze, and forward incoming packets of data to another network. Router can also be used to convert the packets to another network interface, drop the packet and perform any other action relating to the network. A router has a lot of capabilities more than any other network devices. Router are commonly used in home network to share a single internet connection between multiple computers. Routers have different types with different applications such as wireless router, which provides Wi-Fi access to smartphones, laptops, and other devices with WI-Fi network capabilities. Brouter which is a short form for a bridge and router which is another networking device that can serve as bridge and a router in a same network. Another is a core router which can facilitates the routing of data within but not between the networks. Others are Edge router, virtual router

Routers will read the head of the packet received to determine the destination address. After determining the address, router will check the routing table to know the best route it will take the packet to reach its final destination. SwRouting tables play a very important role in the routing process. They are the means by which the router makes its decisions. For this reason, a routing table needs to be two things. It must be up-to-date, and it must be complete. There are two ways that

the router can get the information for the routing table through static routing or dynamic routing.



Fig 5.9: Examples of a managed router



Summary

In this unit, you have learnt that

- The meaning of network devices
- Types of network devices
- Explain in details how Switches Operates
- Explain how a router operates



Self-Assessment Questions



1. Explain using diagram the network interface system
2. List four types of network interface cards
3. State the area of application of different network interface card
4. List three major advantages of network interface card
5. State four major demerits of each network devices



Tutor Marked Assessment

- With the aid of diagram, explain in detailed CSMA/CD
- Explain the concept of computer networking



Further Reading

- CCNA INTRO: Introduction to Cisco Networking Technologies Study Guide: Exam 640-821: Sybex, 2006, 9780470068502
- Communications and Networking: An Introduction (Computer Communications and Networks) Author(s): John Cowley: Springer, Year: 2007
- <https://learn.saylor.org/course/cs402>
- Introduction to Computer Networking, Author(s): Thomas G. Robertazzi: Springer International Publishing, Year: 2017
- Introduction to networking: Author: Saravanan A.M researchgate.net/publications. 2018
- Introduction to computer networking Varna Free University “Chernorizec Hrabar” Institute of Technology, Author: Prof. T. Bakardjieva