African Virtual University

Applied Computer Science: CSI 2102

DATA COMMUNICATION AND COMPUTER NETWORKS

Janvier Gasuhuke

Foreword

The African Virtual University (AVU) is proud to participate in increasing access to education in African countries through the production of quality learning materials. We are also proud to contribute to global knowledge as our Open Educational Resources are mostly accessed from outside the African continent.

This module was developed as part of a diploma and degree program in Applied Computer Science, in collaboration with 18 African partner institutions from 16 countries. A total of 156 modules were developed or translated to ensure availability in English, French and Portuguese. These modules have also been made available as open education resources (OER) on oer.avu.org.

On behalf of the African Virtual University and our patron, our partner institutions, the African Development Bank, I invite you to use this module in your institution, for your own education, to share it as widely as possible and to participate actively in the AVU communities of practice of your interest. We are committed to be on the frontline of developing and sharing Open Educational Resources.

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The following institutions participated in the Applied Computer Science Program: (1) Université d'Abomey Calavi in Benin; (2) Université de Ougagadougou in Burkina Faso; (3) Université Lumière de Bujumbura in Burundi; (4) Université de Douala in Cameroon; (5) Université de Nouakchott in Mauritania; (6) Université Gaston Berger in Senegal; (7) Université des Sciences, des Techniques et Technologies de Bamako in Mali (8) Ghana Institute of Management and Public Administration; (9) Kwame Nkrumah University of Science and Technology in Ghana; (10) Kenyatta University in Kenya; (11) Egerton University in Kenya; (12) Addis Ababa University in Ethiopia (13) University of Rwanda; (14) University of Dar es Salaam in Tanzania; (15) Universite Abdou Moumouni de Niamey in Niger; (16) Université Cheikh Anta Diop in Senegal; (17) Universidade Pedagógica in Mozambique; and (18) The University of the Gambia in The Gambia.

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Course Overview

Welcome to Data Communication and Computer Networks

Progressively more, people and organizations depend on the availability of computer networks to carry out various activities such as professional, academic or leisure. Computer networks have become a critical piece of any information system.

Imagine a single computer without being connected to any other computer: this machine will only have access to your information (found on your Hard Disk) or information that may come from floppies, flashes, CD's and DVD's.

When a computer is connected to a computer network, you can have access to information that comes to you and to present information on other computers connected to the same network, allowing a much larger number of possible information to access through that computer. However, it must recognize that computer networks today have little to do with networks used for several years, taking advantage of technological advances in transmission capacity of the physical, logical means, processing capacity of the equipment and functionality of the protocols and applications.

Throughout the module will use the term "computer network" when we want to mention a collection of autonomous computers connected by a single technology. Two computers are interconnected when they can exchange information. The connection do not need to be made by a copper wire; they can also use optical fibers, microwaves, infrared waves, and communication satellites. There are networks in many sizes, shapes and forms, as we shall focus on.

Prerequisites

Introduction to Applied Computing

Principles of programming

Materials

The materials required to complete this course are:

1. GNS3
2. Routers
3. Switches
4. Hubs
5. Cable
6. Connectors
7. Operating system like windows server

Books:

1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th ed. James F. Kurose, Keith W. Ross; Pearson, 2013
2. Computer Networks: A Systems Approach, 5th edition; Morgan Kaufmann; Larry Peterson and Bruce Davie, 2011
3. Data and Computer Communications, 8th ed. William Stalllings, Pearson Education International, 2007
4. Network Fundamentals, CCNA Exploration Companion Guide, Mark A. Dye, Rick McDonald, Antoon W. Rufi, CISCO Press, 2008
5. Communication Networks: Fundamental Concepts and Key Architectures, 2nd ed. Albarto Leon-Garcia, Indra Widjaja, McGraw Hill, 2004

Course Goals

Upon completion of this course the learner should be able to:

1. Provide Hardware Technical Support
2. Managing Communication Networks;
3. Share common network utilities with Network Communications Technician
4. Describe and Design Communication Networks
5. Analyze and support Communications and Network projects

Units

Unit 0: Diagnosis

Communication with computers is probably the largest engineering system ever created by humanity, with hundreds of connected computers, communication links and switches; hundreds of thousands of users that sporadically connect through mobile phones and PDAs; and device as sensors, console games, being connected to the Internet

Unit 1: Computer Networks and the Internet

Computer networks comprise many different types of networks, large and small. They have different goals, scales and technologies.

In this unit, the emergence of computer network would be described and the Internet as the best known network, its study, its history, its evolution and its technology would be included.

Unit 2: Data Communication

Data Communication is defined as the exchange of data between two devices via some form of transmission medium such as a wire cable. The communicating devices must be a part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

To reduce design complexity, most networks are organized as a stack of layers or levels, placed one above the other. The number of layers, the name, content and function of each layer differ from network to network. This unit will cover OSI reference models and model of Internet.

Unit 3: Basic configuration of CISCO Switch

In this unit we will see how to configure the 2950 model. In fact, all the settings applied to the model 2950, can be made exactly the same way in other lines of Cisco switches

Unit 4:Router Basic Configuration

The Cisco IOS is the core routers and much of the Cisco switches. Almost all Cisco devices use the Cisco IOS system, however, this study unit configuring the 3700 model; can be made exactly the same way in other lines of Cisco Routers.

Assessment

Formative assessments, used to check learner progress, are included in each unit.

Summative assessments, such as final tests and assignments, are provided at the end of each module and cover knowledge and skills from the entire module.

Summative assessments are administered at the discretion of the institution offering the course. The suggested assessment plan is as follows:

1	Consultation of materials and other resources	04 values
2	Practical exercises	10 values
3	Formative assessment and report on activities	06 values

Schedule

Unit	Activities	Estimated time
Diagnosis	Diagnosis Test	4 hours
Computer networks and the Internet	Exercises	8 hours
Data Communication	Exercises	10 hours
Switch basic configuration	Exercises	18 hours
Router basic configuration	Exercises	20 hours

Readings and Other Resources

The readings and other resources in this course are:

Unit 0

Required readings and other resources:

- Computer Networking: A Top-Down Approach Featuring the Internet, 6th ed. James F. Kurose, Keith W. Ross; Pearson, 2013.
- Computer Networks: A Systems Approach, 5th edition; Morgan Kaufmann; Larry Peterson and Bruce Davie, 2011.
- Data and Computer Communications, 8th ed. William Stalllings, Pearson Education International, 2007.

Optional readings and other resources:

- Computer Networks, José Gouveia, Alberto Magalhães, 8ª Edition, Ed. FCA, 2009.
- Engineering computer networks, Edmundo Monteiro, Fernando Boavida, Ed. FCA 2000.
- CISCO networking for professionals, Véstias Mario, 4ª Edition, Ed. FCA, 2009

Unit 1

Required readings and other resources:

- Computer Networking: A Top-Down Approach Featuring the Internet, 6th ed. James F. Kurose, Keith W. Ross; Pearson, 2013.
- Computer Networks: A Systems Approach, 5th edition; Morgan Kaufmann; Larry Peterson and Bruce Davie, 2011.
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- Computer Networks, 5th Ed, Andrew S.Tanenbaum, David J. Wetherall; Prentice Hall, 2011.
- CCNA 4.1 - Guia Completo de Estudo: Marco Aurélio Filippetti, Editora Visual Book, 2008.
- http://dl.acm.org/
- http://scholar.google.com/?hl=pt
- http://scholar.google.com/?hl=en

Unit 2

Required readings and other resources:

- Computer Networking: A Top-Down Approach Featuring the Internet, 6th ed. James F. Kurose, Keith W. Ross; Pearson, 2013.
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Unit 4

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- Computer Networks: A Systems Approach, 5th edition; Morgan Kaufmann; Larry Peterson and Bruce Davie, 2011.
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Optional readings and other resources:

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- Engineering computer networks, Edmundo Monteiro, Fernando Boavida, Ed. FCA 2000.
- CISCO networking for professionals, Véstias Mario, 4ªEdition, Ed. FCA, 2009

Unit 0: Diagnosis

Unit Introduction

The purpose of this unit is to determine your grasp of knowledge related to this course .

Communication with computers is probably the largest engineering system ever created by humanity, with hundreds of connected computers, communication links and switches; hundreds of thousands of users that sporadically connect through mobile phones and PDAs; and device as sensors, console games, being connected to the Internet.

Unit Objectives

Upon completion of this unit you should be able to:

1. Recognize the emergence of computer networks
2. Describe the importance and advantages of computer networks
3. Identify major Internet services

Key Terms

Data communication: information transfer between functional units through data transmission, according to a protocol

LAN: computer network located in the private domain of a user and limited geographically

Share: simultaneous use of a resource by different processes

Protocol: A set of semantic and syntactic rules governing the behavior of functional units during communication

Network topology: physical arrangement of the links and nodes of a network

Unit Assessment

Check your understanding!

Diagnostic Test

Instructions

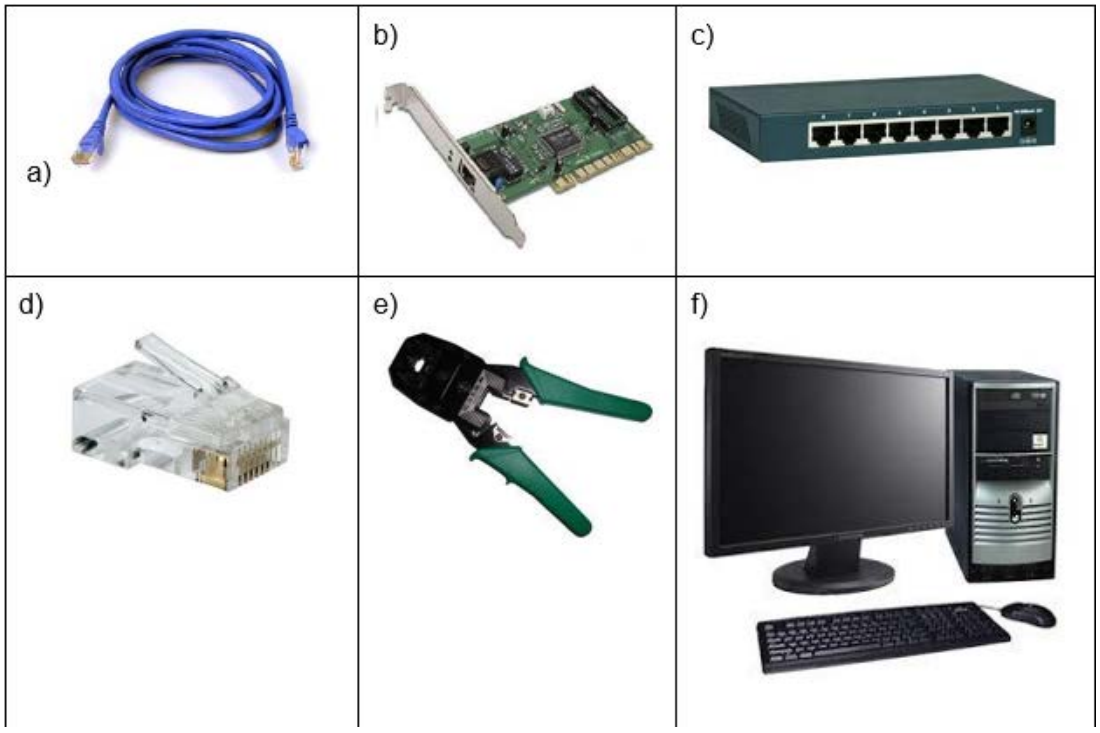
This diagnostic test will check the knowledge of students in relation to the module. This can help guide the activities and rearrange them

Grading Scheme

The assessment should take place in an ongoing, systematic and regular basis. The type of assessment corresponds to the stated objectives.

Feedback

1. Identifies the following components:



a)_____

b)_____

c)_____

d)_____

e)_____

f)_____

2. What is a switch?

3. What are the means of transmission?

4. What is a Protocol?

5. What is a client / server?

6. What is a computer network?

7. What is an Operating System. Name three examples.

8. Name three advantages of using a computer network

9. What is the importance of a network card in a networked computer?

10. What is needed so you can have the Internet on your computer?

Feed back

1. a) UTP

   b) Network Card

   c) Switch

   d) RJ45 connector

   e) Crimping pliers

   f) Computer

2. What is a switch? is an equipment level 2 of the OSI model that connects computers on a network, the network cables to each computer are connected to it, which then directs the data sent from a computer specifically for another.

3. What are the means of transmission? It is a medium used to transfer data

4. What is a Protocol? : Set of rules used to transfer data from one device to another device

5. What is a client / server? : It is a model where the client requests services from the server

6. What is a computer network? :It is a collection of different devices connected to share some resources

7. What is an Operating System.: it is a software that manages system resources Name three examples.windows, lunix,ubuntu

8. Name three advantages of using a computer network: share data, devices,communication

9. What is the importance of a network card in a networked computer? : allows it to be connected with other devices.

10. What is needed so you can have the Internet on your computer?: modem

Unit Readings and Other Resources

The readings in this unit are to be found at the course-level section "Readings and Other Resources".

Unit 1: Computer Networks and the Internet

Unit Introduction

The Internet is the world's largest computer network that connects millions of computer devices spread around the world in an integrated manner, enabling connectivity regardless of the type of machine that is used. It is therefore the largest repository of information accessible to anyone who accesses the network from anywhere in the world. What makes the Internet so different from other human inventions is insignificant period of time it needed to be used by millions of people. The electricity (1873), for example, has 50 million users after 46 years of existence. The phone (1876) took 35 years to reach the same number.

- The car (1886), 55 years.
- The radio (1906), 22 years.
- Television (1926), 26 years.
- The microwave oven (1953), 30 years.
- The microcomputer (1975), 16 years.
- The mobile (1983), 13 years.
- The Internet (1995), in turn, took only four years to reach 50 million users worldwide!

Unit Objectives

Upon completion of this unit you should be able to:

1. Analyze the fundamental concepts of computer networks
2. The history and the rise of the Internet
3. Identify the theory and practice of the Internet functionality.
4. Identify the services provided by communication by computers.

Key Terms

Domain: Part of a computer network where data processing resources are under the same control.

Server: Data Station that a local network, provides services to other data stations.

Computer: programmable functional unit consisting of one or more processing and associated peripheral equipment, which is controlled by programs stored in its internal memory that is capable of performing significant computations, including various arithmetic and logical operations without human intervention.

E-mail: System that allows sending messages electronically by computers through communication channels.

Learning Activities

Activity 1 - History of the Internet

Introduction

In this unit, the emergence of computer network would be described and the Internet as the best known network, its study, its history, its evolution and its technology would be included.

Activity Details

Internet

The Internet is a wide range of different networks that use certain common protocols and provide certain common services, it is considered as unusual system in order to not have been planned or being controlled by anyone. The following is its beginning and how and why it has been developed.

ARPANET

In the late 1950, the US Defense Department wanted a monitoring network and command able to survive a nuclear war. At that time, all military communications passed through the public telephone network, considered vulnerable. The reason for can be seen in Figure 1. In this figure, points B and C represent telephone switching centers, each of which is connected to thousands of phones. In turn, these were connected central switching the central switching highest level of A, form a nationwide hierarchy with only a small redundancy. The vulnerability of the system was the fact that the destruction of some important long-distance stations could fragment the system into many isolated islands.

By 1960, the US Department of Defense signed a contract with the RAND Corporation to find a solution. One of his employees, Paul Baran, presented the highly distributed and fault-tolerant design of Figure 2. In order that the paths between any two switching offices were now much longer than the distance the analogue signals could travel without distortion Baran proposed the use of digital technology packet-switched throughout the system. Baran sent several reports to the US Defense Department describing his ideas in detail. Staff at the Pentagon liked the concept and asked AT & T, then the company that held the national telephone monopoly in the United States to build a prototype. AT & T dismissed Baran's ideas. After all, the largest and richest corporation in the world could not allow a pretentious young teach him to set up a telephone system. The company said that Baran's network could not be built, and the idea was abandoned.

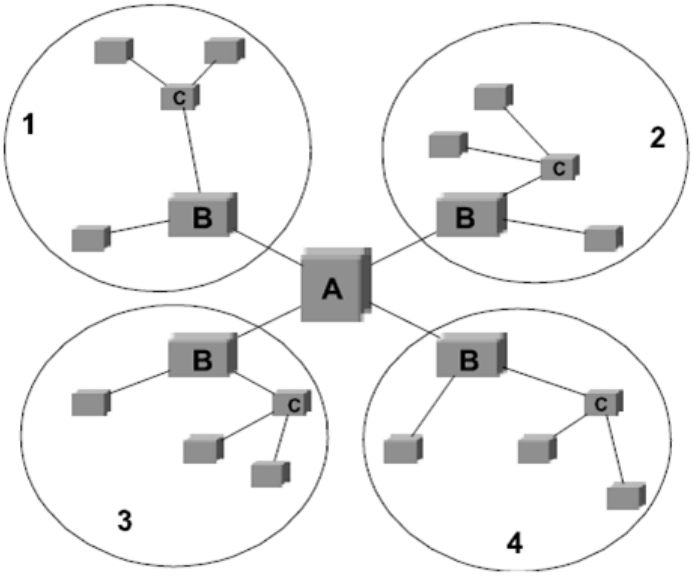


Figure 1: Structure of the telephone system

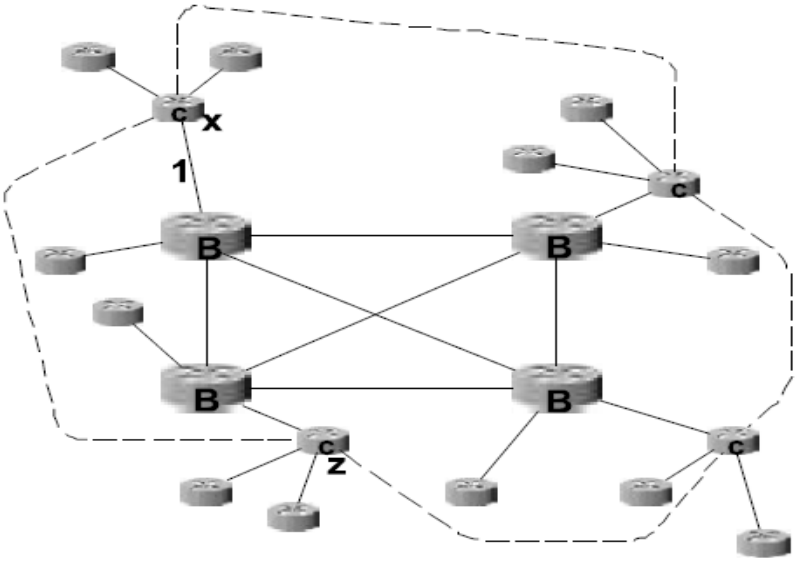


Figure 2: Proposed distributed switching system

Several years passed and the US Defense Department has not had a better system of command and control, the US president at the time, President Eisenhower ended up detecting the dispute between the Army, Navy and Air Force by the research budget the Pentagon. His immediate response was to create a single defense research organization, ARPA, or the Advanced Research Projects Agency.

During the early years, ARPA tried to figure out what should be its mission but in 1967, the then director of ARPA's attention, Larry Roberts, turned to networks. He has contacted various experts to decide what to do. One Wesley Clark suggested the creation of a sub-packet-switching network

After some initial scepticism, Roberts bought the idea and presented a paper somewhat vague about it in SIGOPS ACM Symposium on Operating System Principles held in Gatlinburg, Tennessee, at the end of 1967 (Roberts, 1967). Much to Roberts' surprise, another document at the conference described a similar system, which had not only been designed but actually had been implemented under the direction of Donald Davies of the National Physical Laboratory in England. The NPL system was not a national system (it just connected several computers on the NPL campus), but it demonstrated that packet switching could work. In addition, he cited the work previously disposed of Baran. Roberts returned from Gatlinburg determined to build what later became known as ARPANET.

The subnet would consist of minicomputers called IMPs (Interface Message Processors) connected by 56-kbps transmission lines. To ensure its high reliability, each it would be connected to at least two other IMPs. The subnet had to be a datagram subnet, so that if some rows and some IMPs were destroyed, messages could be automatically forwarded to alternative paths.

NSFNET

In the late 1970s, NSF (National Science Foundation) realized the enormous impact the ARPANET was having on university research in the United States, allowing scientists around the parent share information and work together on research projects. However, to enter the ARPANET, a university had to have a research contract with the US Department of Defense, privilege that many had not. The NSF response was to develop a successor to the ARPANET that would be open to all university research groups. To have something concrete to start with, NSF decided to build a backbone network to connect its six supercomputer centers, located in San Diego, Boulder, Champaign, Pittsburgh, Ithaca and Princeton.

The NSF also funded about 20 regional networks that were connected to the backbone so that users from thousands of universities, research laboratories, libraries and museums have access to one of the supercomputers and to communicate with each other. The complete network, including backbone and regional networks, was called NSFNET. ARPANET connected through a connection between an IMP, and a fuzzball at the central processing Carnegie Mellon data. The first NSFNET backbone is illustrated in Figure 3.

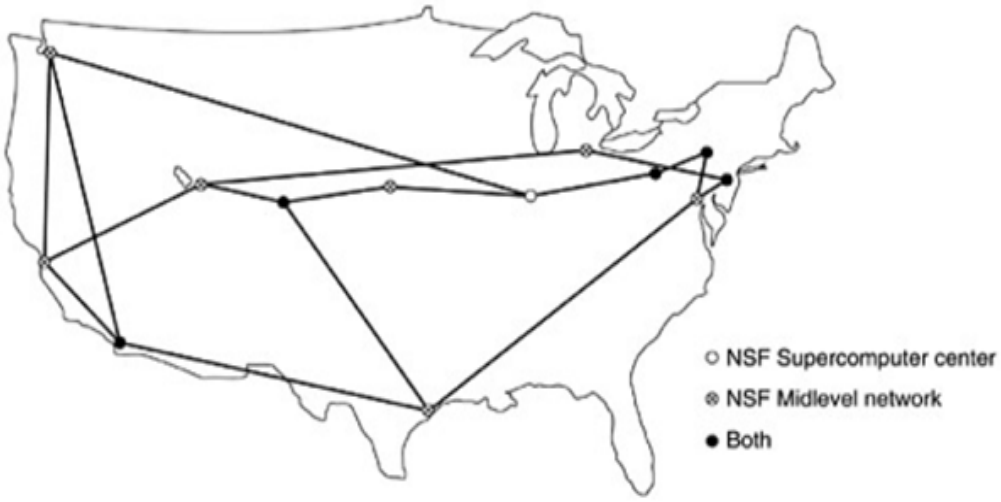


Figure 3: The NSFNET backbone in 1988

Internet use

The number of networks, machines, and users connected to ARPANET grew rapidly after TCP / IP became the only official protocol on 1 January 1983. When NSFNET and the ARPANET were interconnected, the growth became exponential. Many regional networks have been integrated, and connections were established with networks in Canada, Europe and the Pacific.

In the mid-1980s, people began to see a set of networks as an internet and, later, as the Internet. The elements based on the foundation of the Internet are the reference model TCP / IP and the TCP / IP protocols. The TCP / IP enables the creation of a universal service and can be compared to the telephone system and the adoption of standard measure by the railroads in the nineteenth century or the adoption of common signaling protocols by all the telephone companies.

So what it means to be on the Internet? A machine is on the Internet when you run the TCP / IP protocols and has an IP address, send IP packets to all machines on the Internet.

Traditionally (which means 1970-1990), the Internet and its predecessor had four major applications:

Electronic mail (e-mail). The ability to send and receive e-mail messages, is a reality already established in early ARPANET and is enormously popular. Many people get dozens of messages a day and do e-mail your primary form of interaction with the outside world, using it much more often than the telephone and traditional mail. Nowadays, e-mail programs are available in almost all types of computers.

Newsgroups. Newsgroups are specialized forums in which users with common interests can exchange messages. There are thousands of newsgroups dedicated to technical and non-technical topics, including computers, science, entertainment and politics. Each newsgroup has its own manners (rules for use of the service), their style and their customs; people who violate could even be expelled.

Remote login. Using the telnet program, rlogin or ssh, users from anywhere on the Internet can connect to any other machine on which they have an account.

File transfer. Using the FTP program, and can copy files between machines connected to the Internet. This way, you can have access to numerous articles, databases and other information

Activity 2 - Computer Networks Uses

1. Introduction

This sub-unit explains why people are interested in computer networks and for what purposes these networks can be used. After all, if no one was interested in computer networks, few of them would be prepared. Traditional uses at companies and individuals, and then home networks are described.

2. Commercial Applications

Many companies have a significant number of computers. For example, a company may have computers to monitor production, test the products and prepare the payroll. Initially, each of these computers worked isolated from others but, at a certain time, there was a need to connect them in order to extract and correlate information about the entire company.

The issue is the sharing of resources, and the goal is to make all programs, equipment, and especially data available to everyone on the network, regardless of the physical location of the resource and the users. An obvious and quite widespread example is a group of office workers who share a common printer. None of the subjects really needs a private printer, and a large capacity networked printer is often more economical, faster and easier to maintain a large set of individual printers.

For smaller companies, all the computers probably are in a single office or perhaps a single building; however, for larger companies, computers and employees may be scattered over dozens of offices and factories in many countries. However, a seller at one place sometimes might have needed to access a product database located from far to his/her place. In other words, the fact that a user be 15,000 kilometers (and so on) from their data should not stop you from using this data as they were local data. In few words, it is an attempt to end the "tyranny of geography."

It is possible to imagine that the information system of an enterprise consists of one or more databases and some number of employees who need to access them remotely. In this model, the data is stored on powerful computers called servers. Often these machines are installed and maintained in a central location by a system administrator. In contrast, employees have simpler machines, called clients, with which they gain access remote data. Sometimes we will refer to the human user of the client machine as the "client", but it should be clear from the context whether we mean the computer or its user. The client and server machines are interconnected by a network, as illustrated in Figure 4.

3. Home applications

In 1977, Ken Olsen was president of Digital Equipment Corporation, then the second largest supplier of computers around the world (after IBM). When asked why Digital was not following the trend of the PC market, he said: "There is no reason for any individual to have a computer at home." History has shown otherwise and Digital no longer exists. Why do people buy computers for use at home? Firstly, for word processing and games; however, in recent years, this trend has changed radically. Maybe now the biggest motivation is Internet access. Some of the most popular uses of the Internet for home users are: access remote information, communication between people, Interactive Entertainment and E-commerce.

Access to remote information comes in many forms. It can mean surfing the World Wide Web for information or just for fun. Available information includes arts, business, cooking, government, healthcare, history, hobbies, leisure, science, sport, travel and many others.

Many newspapers are published online and can be customized. For example, sometimes it is possible to order all information about corrupt politicians, big fires, scandals involving celebrities, and sport.

The next step beyond scientific magazines newspapers is digital library online. Many professional organizations such as ACM (www.acm.org) and IEEE Computer Society (www.computer.org), already have many journals and online conference proceedings. Other groups are following this trend quickly. Depending on the cost, size and weight of notebook with dimensions of books, printed books may become obsolete.

All of the above applications involve interactions between a person and a remote data base full of information. The second category of use of networks is the communication between people, basically the response of the XXI century the phone nineteenth century. Electronic mail (e-mail) is already used daily by millions of people around the world and its use is growing rapidly. In general, it already contains audio and video as well as text and images

Activity 3 - Computer Networks

1. Introduction

Progressively more, people and organizations are dependent on the availability of computer network to carry out various activities, in this sub-unit the types of networks and their classification are described.

2. Network Types

The connectivity of networked computers can occur at different scales. From the point of view of how data will be shared on the network, there are two basic types of network: Peer to peer and Client / server network

3. Peer-to-peer network

A peer to peer model (see Figure 4), computers are linked together so that other users can share resources. There is no central location for user authentication, file storage, or accessing resources. This means that users must remember which workgroup computer is the resource or shared information they wish to access. This also means that users have to login on each computer to access the resources shared on specified computer.

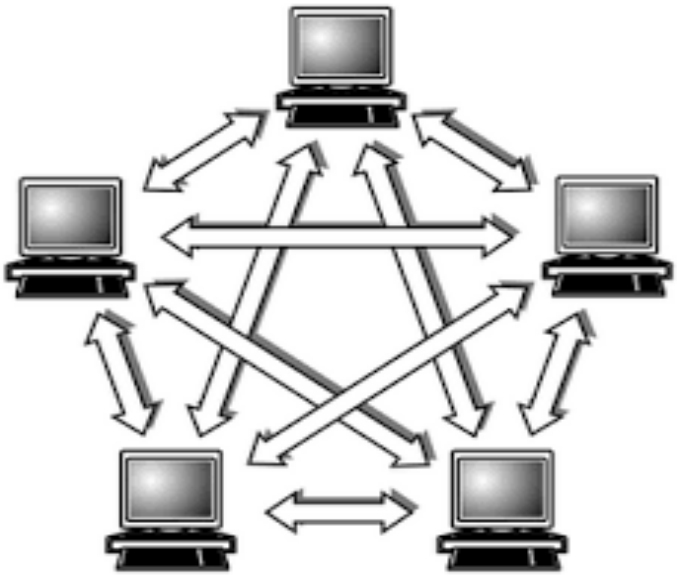


Figure 4: Peer to Peer Network Model

Client / Server network

It is a network whereby there are two basic modules on the network: Server and Clients. The server is any machine on the network that is responsible for serving customers network with what is requested. It is a specialized machine in one type of task, not being used for another purpose as in peer-to-peer, where the same computer that is sharing a resource for the rest of the network is being used by a user to another task. Clients are machines that request information that is contained on the server. Figure 5 illustrates client / server network.

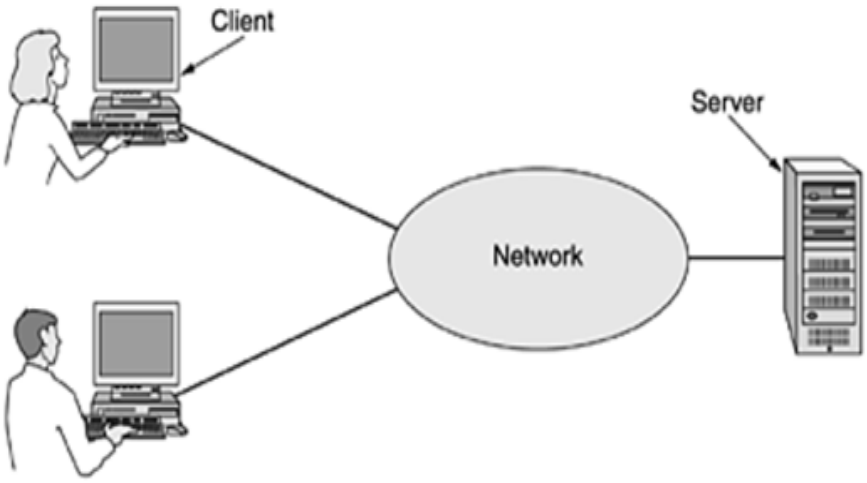


Figure 5: A network with two clients and one server

3. Classification of Networks

Computer networks can be classified according to different criteria, for example, the output (which can be low, medium, high and very high), the topology (which can be bus, ring, star, hybrid) the transmission media (which may be copper, twisted pair, fiber optic, microwave, infrared), the support technology (circuit switching, packet switching, etc.), or even the applicable environment intended (office networks, industrial networks, military networks, etc.) One of the most common ratings is based on the area - geographic or organizational - covered by the system:

- LAN (Local Area Network) is the type of networks most used. Through a LAN can connect computers, servers and other network interconnection devices in a limited geographical area of a building or set of buildings nearby.
- PAN (Personal Area Network or Personal Area Networks) are networks using wireless technologies to link computers, peripherals and voice equipment in a restricted area.
- MAN (Metropolitan Area Networks) are generally used to interconnect local networks located in different parts of a city. For example, they can be used to connect all government ministries or all universities within the city.
- WAN (Wide Area Network) are great within networks that enable the interconnection of devices, local area networks and metropolitan networks spread over a large geographical area (a country, a continent or even different continents)

Other common terms are:

Intranet

Today in communication, internal (between departments) and external (customers and suppliers) is very important for all businesses. It is a tool that can aid in communication and with a low cost.

Is a network of similar computers to the Internet, but is for the exclusive use of a particular organization, or only the company computers can access it for example, a database system, supermarket, etc.

Extranet

In some cases, organizations need to provide information to other entities. For example, the case of companies those have close relationships with a limited number of other suppliers or customers, or the organizations that collaborate in the implementation of projects. In such cases, the interconnection of several Intranets of the entities involved can be convenient, thus constituting what is called Extranet.

4. Network Topology

The choice of computers connected in a network can be a critical issue; a bad choice of the physical topology may later lead to unnecessary costs as well as a poor utilization of network resources. The five most common physical topologies are: Bus, Star, Ring, Mesh and Wireless.

Activity 4 - Components of a Network

1. Introduction

A network needs a set of devices, some linked to each other; these allow taking advantage of the full potential of networks.

2. Data Transmission

The data channels over which the signal is sent over a network can operate in the following three modes: simplex, half-duplex and full-duplex

Simplex: Transmission of the information is performed only in one way.

Figure 6: Simplex Transmission

Half-duplex: This type of data transmission is bi-directional but because they share the same communication channel, you can not transmit and receive data at the same time.

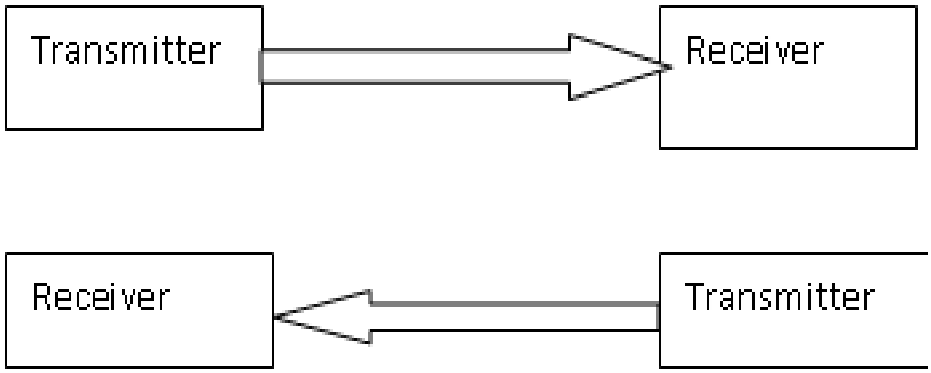


Figure 7: Transmission Half-duplex

Full-duplex: It's a bi-directional communication. Transmission and reception of data can be simultaneously.

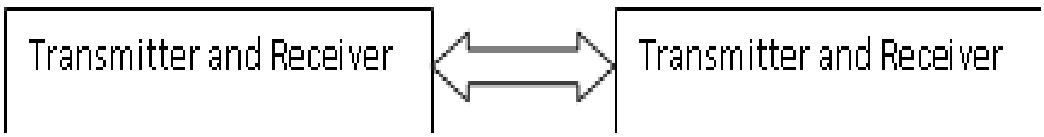


Figure 8: Full-duplex transmission

3. Analogue System

In the real world, information is analogue, i.e., they may take any value over time. Sound and light are good examples of analogue signals. The figure illustrates an example of an analogue system.

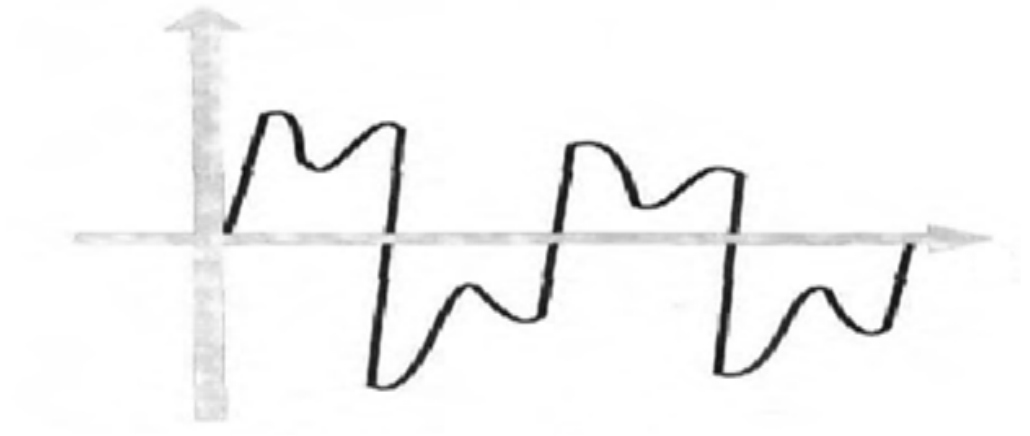


Figure 9: Analogue signals

4. Digital System

Computers use a digital system, which are only two possible values: 0 and 1. The receiver can simply discard any value other than 0 and 1 receiving.

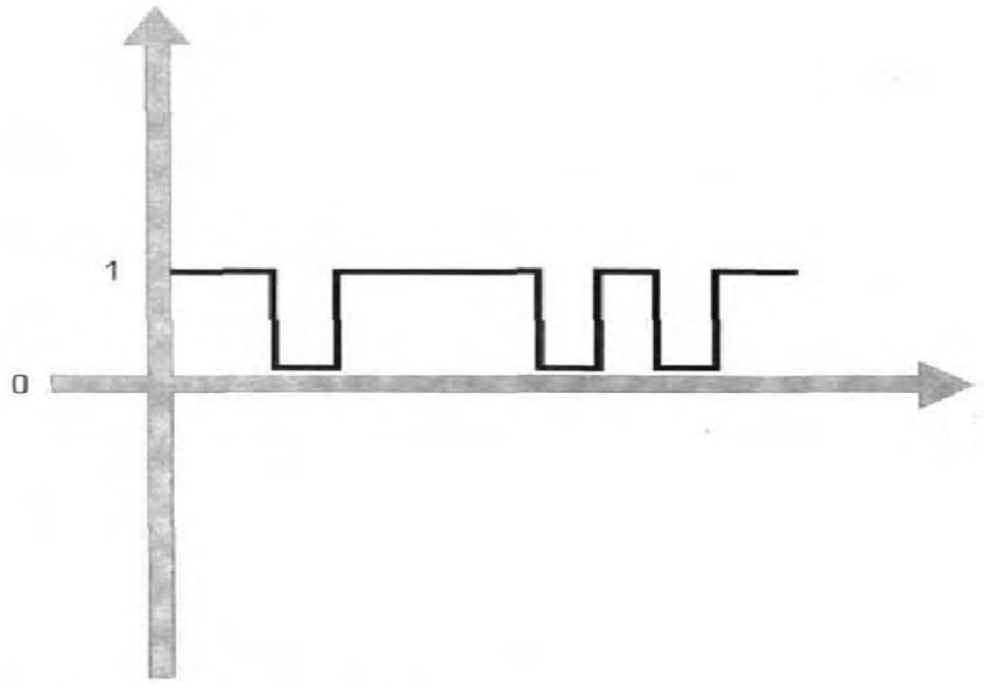


Figure 10: Digital signal

5. Analogue vs. Digital

The digital numbers are transmitted in the form of electrical pulses, optical, or radio waves, depending on the medium used for the interconnection of computers (for example, electrical cables, optical fiber and wireless transmission). Eventually handled by computer digital signals need to be converted into analogue signals.

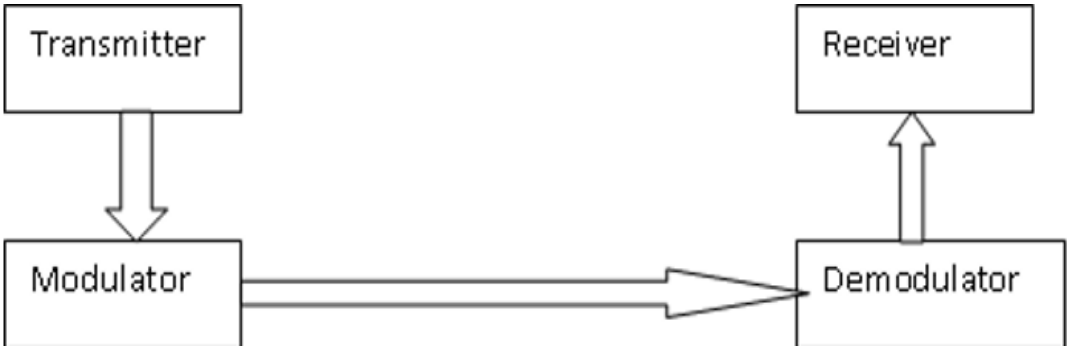


Figure 11: Signal Modulator

6. Binary numbers

Each binary digit is called bit (contraction of binary digit). Binary numbers have only two digits (0 and 1), its representation is made on the base 2. Thus, when we talk 'transmitting a byte "is equivalent to say" eight-bit transmission',that is the transmission of a sequence of eight zeros and ones.

Parallel Transmission: In parallel transmission, the data bits are transmitted at once to the receiver. Only it depends on numbers of bits to a transmitter and a receiver supports.

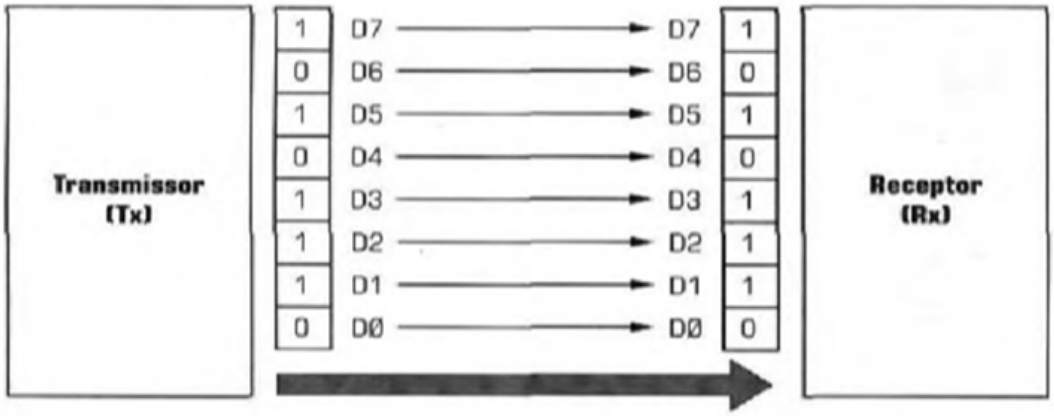


Figure 12: Parallel Transmission

Transmission series: In transmitting serial, only one wire is needed to transmit data. The bits are transmitted one by one.

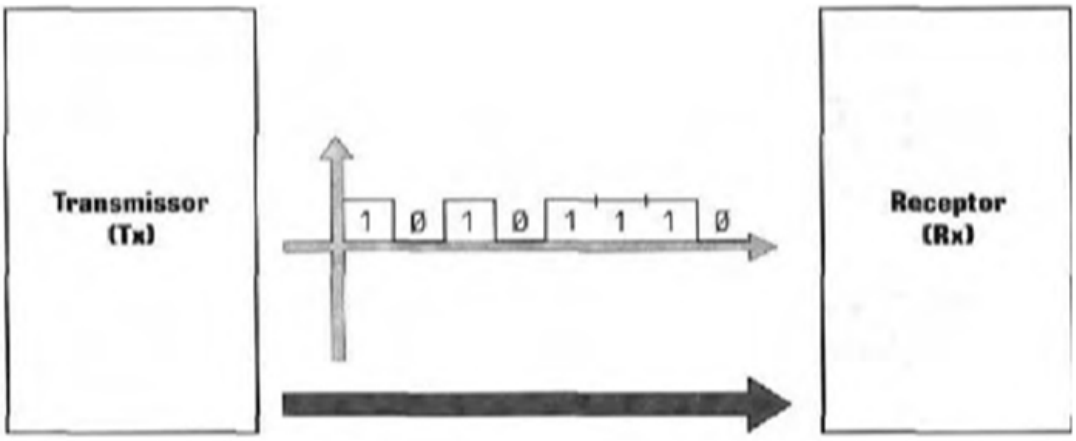


Figure 13: Serial Transmission

Transmission in parallel versus in serie

Note that the transmission in series is slower than the transmission in parallel. In parallel transmission, the transmitter sends to the receiver numbers of bits at one time, while in serial transmission, the transmitter sends one bit at a time. The local networks use serial transmission, the communication speed measurement unit is in series bps (bits per seconds) is the number of bits per second that the transmitter can send to the receiver.

7. Methods of propagation

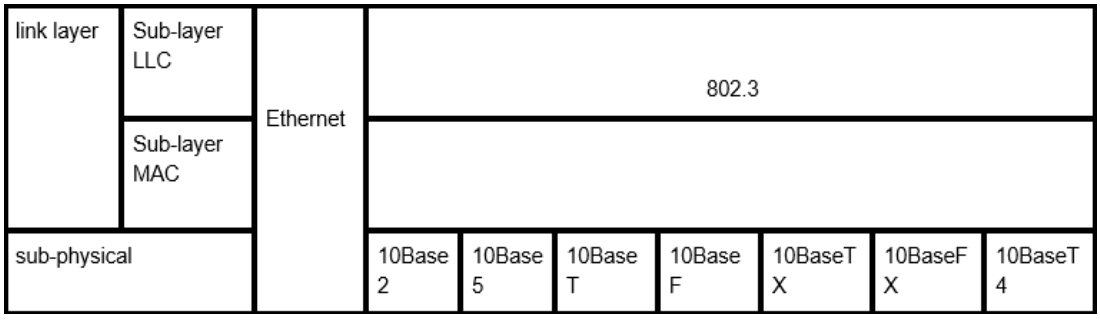
An initial project on cable paths of the installation may prove to be useful, both for installers and for the installation of future expansions of the network or Troubleshooting. All the identification of cables should be documented and should discriminate with detail referred to the cables, putting shapes and colors labels.

The Ethernet 10 Base-T technology was originally developed in the mid-1970s, the 10 Base-T rule indicates that the transmission is 10 Mbps over twisted pair cable. I.e,

[maximum transmission rate] [type of transmission] [maximum cable length]

For example: 10 Base-2

[10Mbps] [Baseband] [Approximate to 200 meters (185 meters)]



8. Hubs

Hubs are used to connect the various devices that make up a network, computers, printers or other, the hubs can be used to extend a network, but it makes circulate on the network quite unnecessary traffic, since it sends the same information to all network devices.

9. Switches

As a hub, the switch connects several segments of a network, but with a rather important difference: while a hub distributes information for all ports simultaneously, the switch establishes a direct link between the transmitter and receiver devices.

10. Bridge

A bridge is a device capable of dividing a network into sub-networks in order to reduce traffic on different networks. The primary function of the bridge is to keep separate traffic on both sides. Traffic only passes if it is addressed to a post on the opposite side.

11. Router

The router is a device that connects multiple usually different segments of a network, a single inter network. The router, once connected, you can get the data to its destination decisions, based on information it gets from the network itself.

Unit Summary

This unit has described the history of the emergence of computer networks, use of computer networks, classification of computer networks as its geographical location, transmission media and physical layout (topologies) and components of computer networks.

Unit Assessment

Check your understanding!

Instructions

These exercises allowed us to verify the state of knowledge of the students from the first unit. This can help guide the assimilation of the unit's contents.

Grading Scheme

The assessment should take place in an ongoing, systematic and regular basis. The type of evaluation correspond to the objectives defined in the unit.

Evaluation

What are some physical means used to install the Ethernet

Unit Readings and Other Resources

The readings in this unit are to be found at course level readings and other resources.

Unit 2: Data Communication

Unit Introduction

Data Communication is defined as the exchange of data between two devices via some form of transmission medium such as a wire cable. The communicating devices must be a part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

To reduce design complexity, most networks are organized as a stack of layers or levels, placed one above the other. The number of layers, the name, the content and function of each layer differ from network to network. This unit will cover OSI reference models and model of the Internet (TCP / IP).

Unit objectives

Upon completion of this unit, student should be able to:

1. Analyze the fundamental concepts of the layer stack
2. Analyze the relationship between OSI reference model and TCP / IP
3. Mastering the theory and practice of the operation of the TCP / IP model.

Key Terms

TCP / IP: Protocol family forms the basis of the Internet protocol.

OSI: is a reference model, i.e, it defines how data generated by an application on a given machine to be transmitted through a specific means to an application on another machine.

ETHERNET: This is a method of accessing the media that allows all devices (hosts) on an Ethernet network to share the same bandwidth of a connection.

Learning activities

Activity 1- Data Communication

1. Need for Communication

A communication service enables the exchange of information between users at different locations. Communication services & application are everywhere. Some examples are:

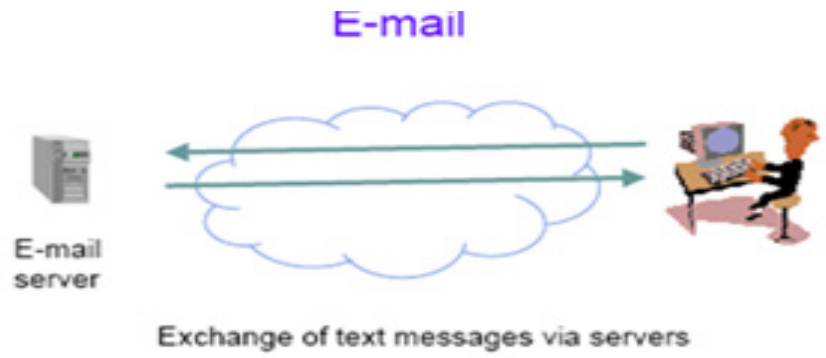


Figure 14: Exchange of text messages

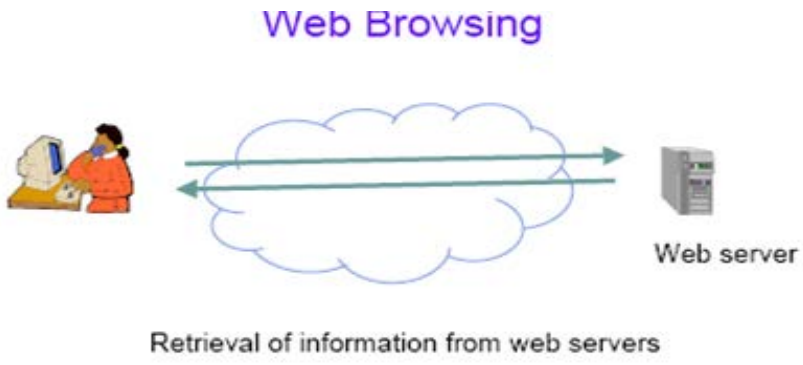


Figure 15: Retrivial of Information

Need for Computer Communication over Distances

Computer communication has become essential for the following reasons:

a) Computers can send data at a very fast speed over long distances using satellite and microwave links. Therefore, the cost of transfer of documents using computers is cheaper than other conventional means like telegrams.

b) The time taken to transmit the messages is very small. Hence different computers can be connected together and the users can work together as a group. Software packages have been developed for group working in Data Base Management (DBMS) and graphic works.

c) Different departments of an organization may be separated physically being at distant places but their data could be stored on a central computer. This data is accessed by computers located in different departments. The data at the central computer may be updated from time to time and accessed by all users.

2. Data Communication

Data Communication is defined as the exchange of data between two devices via some form of transmission medium such as a wire cable. The communicating devices must be a part of a communication system made up of a combination of hardware (physical equipment) and software (programs).

Characteristics of data Communication :

The effectiveness of a data communication depends on three characteristics

1. Delivery
2. Accuracy
3. Timeliness

Delivery: The system must deliver data to correct destination.

Accuracy: The system must deliver data accurately.

Timeliness: The system must deliver data in a timely manner. Data delivered late are useless. Timely delivery means delivering data as they are produced, in the same order that they are produced and without significant delay. This kind of delivery is called real time transmission.

Components

The components of a data communication are

Message

Sender

Receiver

Medium

Protocol

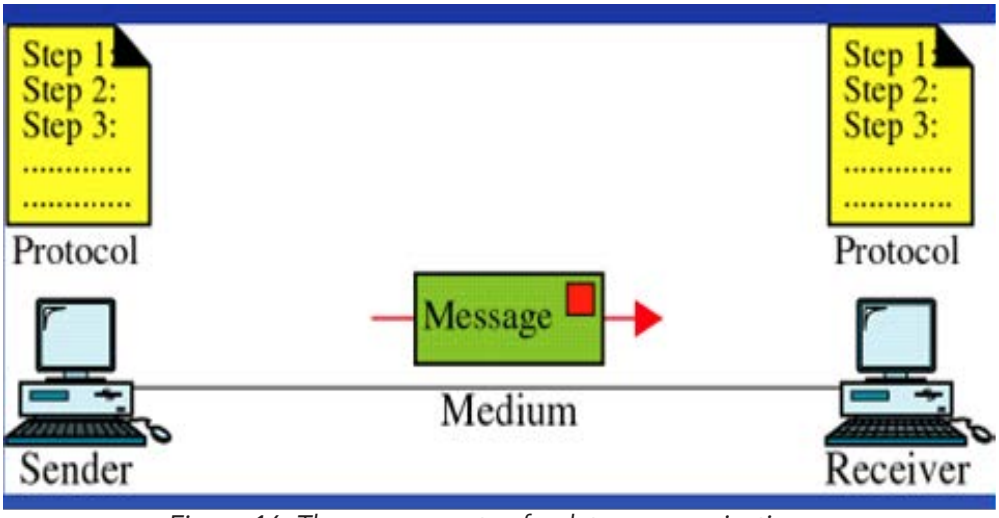


Figure 16: The components of a data communication

Message: The message is the information to be communicated. It can consist of text, pictures, numbers, sound, video or audio.

Sender: The sender is the device that sends the data message. It can be a computer or workstation telephone handset, video camera and so on…

Receiver: The receiver is the device that receives the message. It can be a computer or workstation telephone handset, video camera and so on…

Medium: The transmission medium is the physical path by which a message travels from sender to receiver. It could be a twisted pair wire, coaxial cable, fiber optic cable, or radio waves.

Protocol: A protocol is a set of rules that governs data communications. It represents an agreement between the communicating devices.The key elements of a protocol are syntax, semantics and timing

Syntax

It refers to the structure or format of the data. This refers the order in which the data are presented.

Example

- The first 8 bits of data to be the address of the sender.
- The second 8 bits to be the address of the receiver.
- The rest of the stream may be the message itself

Semantics

It refers to the meaning of each section of bits. How a particular pattern to be interpreted

What action is to be taken based on that interpretation

Example

An address specifies the route to be taken or the final destination of the message.

Timing

It refers to two characteristics

When data should be sent and how fast they can be sent.

Example

If a sender produces data at 100 Mbps and the receiver process data at only 1 Mbps, it will overload the receiver and data will be lost.

3. Standards

Why do we need standards ?

- To create and maintain an open and competitive market for equipment manufacturers
- To guarantee national and international interoperability of data, telecommunication technology and process
- To give a fixed quality and product to the customer
- To allow the same product to be re used again elsewhere
- To aid the design and implementation of ideas
- To provide guidelines to manufacturers, vendors, government agencies and other service providers to ensure kind of interconnectivity.

Data communication standards are divided into two categories:

De facto(from the fact):

- Standards that have not been approved by an organized body.
- It have been adopted as standards through widespread use.
- This is often established originally by manufacturers to define the functionality of a new product or technology.

De jure (by law):

Those that have been legislated by an officially recognized body.

Standards organizations

Standards are developed through the cooperation of standards creation committees, forums, and government regulatory agencies.

Standards Creation Committees

ITU, International Telecommunications Union (ITU):

It a standard for telecommunication in general and data systems in particular.

ISO, International Standards Organization:

It is active in developing cooperation in the realms of scientific, technological and economic activity.

ANSI, American National Standards Institute:

·It is a private nonprofit corporation and affiliated with the U.S federal government.

IEEE, Institute of Electrical and Electronics Engineers:

It aims to advance theory, creativity, and product quality in the fields of electrical engineering, electronics radio and in all related branches of Engineering.

It oversees the development and adoption of international standards for computing and communications.

EIA, Electronic Industries Association:

- It is a non-profit organization devoted to the promotion of electronics manufacturing concerns.
- It also made significant contributions by defining physical connection interfaces and electronic signaling specifications for data communication.

Forums

- It works with universities and users to test, evaluate, and standardize new technologies.
- The forums are able to speed acceptance and use of those technologies in the telecommunications community.
- It presents their conclusions to standard bodies.

Regulatory Agencies:

- Its purpose is to protect the public interest by regulating radio, television and wire cable communications.
- It has authority over interstate and international commerce as it relates to communication.

Internet Standards

- It is a thoroughly tested specification that is useful to and adhered to by those who work with the internet.
- It is a formalized regulation that must be followed.
- A specification begins as an internet draft and attains Internet standard status.
- An Internet draft is a working document and it may be published as Request for Comment (RFC). RFC is edited, assigned a number, and made available to all interested parties.

4. Transmission Media

Transmission media are actually located below the physical layer and directly controlled by the physical layer.

Transmission media can be divided into two broad categories

- Guided &
- Unguided
- Guided media

It includes twisted-pair cable, coaxial cable, and fiber-optic cable

Unguided media

It is usually air.

Guided media

Guided media: are those that provide a conduit from one device to another.

Coaxial cable

- Coaxial cable carries signals of higher frequency ranges than twisted pair cable.
- It has a central core conductor of solid or stranded wire enclosed in an insulating sheath. This in turn encased in an outer conductor of metal foil, braid or a combination of the two.
- The metallic wrapping serves both as a shield against noise and as the second conductor completes the circuit.
- The outer conductor is also enclosed in an insulating sheath and the whole cable is protected by a plastic cover.

Applications

- Coaxial cable is used in analog telephone network where a single coaxial cable could carry 10,000 voice signals.
- It is also used in digital telephone network where a cable could carry digital data up to 600 Mbps.
- Cable TV networks also used RG-59 coaxial cables.
- It is also used in traditional Ethernets.

Fiber Optic Cable

A fiber optic cable is cable with core made of glass and transmits signals in the form of light.

Properties of light

Light travels in a straight line as long as it moves through a single uniform substance. If array traveling through one substance suddenly enters another ray changes direction.

5. Propagation Modes

There are two modes for propagating light along optical channels; each requires fiber with different physical characteristics

- Multimode
- Single mode

Multimode

Multiple beams from a light source move through the core in different paths.

Single-Mode

- The Single-Mode fiber itself is manufactured with a smaller diameter than that of multimode fiber and with lower density.
- All the beams arrive at the destination together and can be recombined with little distortion to the signal.

Performance:

- Attenuation is flatter than in the case of twisted pair cable and coaxial cable.
- Few repeaters are needed when we use fiber optic cable.

Application

It is used in cable TV and LAN

Advantages

Higher bandwidth: It can support higher bandwidth than twisted pair or coaxial cable.

Less signal attenuation: Transmission distance is greater than that of other guided media. Signals can be transmitted for 50 km without requiring regeneration.

Immunity to electromagnetic Interference: Electromagnetic noise can not affect fiber-optic cables

Resistance to corrosive materials: glass is more resistant to corrosive materials.

Light-weight: It is of less weight than the copper cables.

Disadvantages:

Installation/Maintenance: Installation/Maintenance need expertise since it is a new technology.

Unidirectional: Propagation of light is unidirectional. Bidirectional communication is achieved by means of two optical fibers.

Cost: It is more expensive and the use of optical fiber cannot be justified if the need for bandwidth is not high.

Activity 2 - OSI Reference Model

1. Introduction

As computer networks have emerged, the solutions were most often proprietary, that is, a particular technology was supported only by its manufacturer. To facilitate the interconnection of computer systems, the ISO (International Standards Organisation) has developed a reference model called OSI (Open Systems Interconnection) so that manufacturers could create protocols from that model.

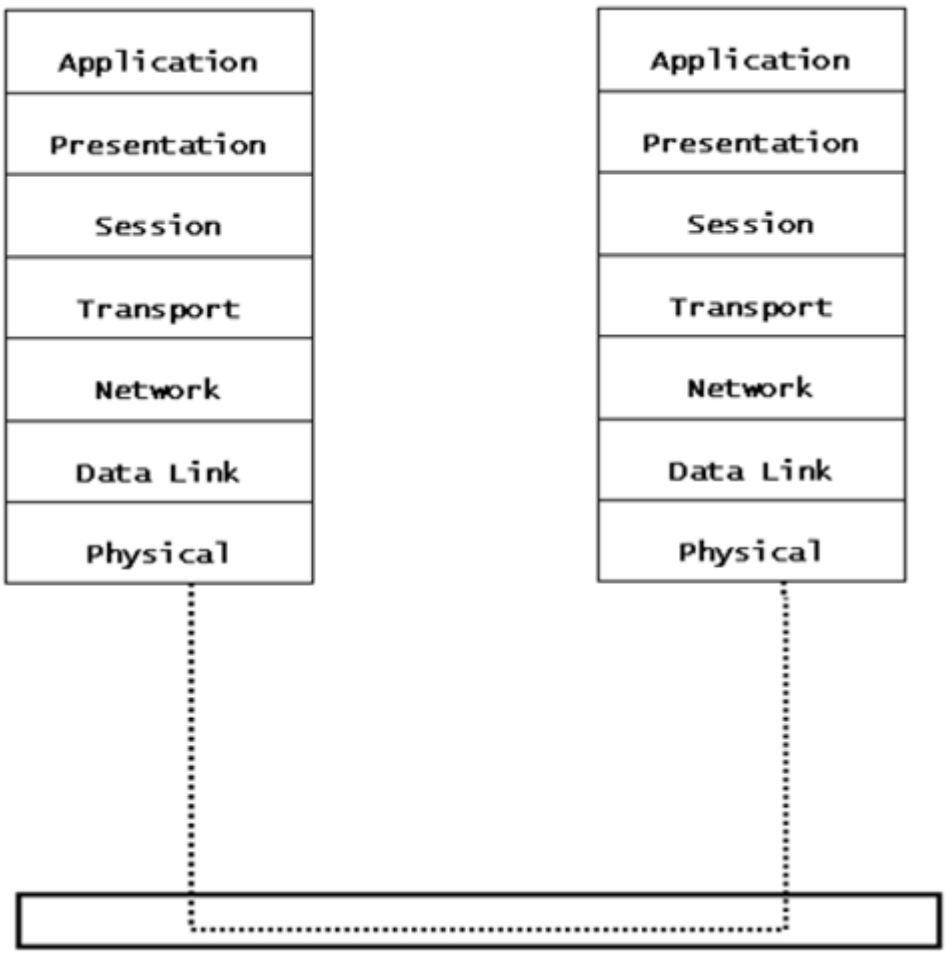


Figure 17: Flow of information

2. The OSI Reference Model

The model "Open Systems Interconnection" is mainly used as a reference for the development of other models nowadays, hence the designation of reference model. The OSI model has seven layers. Hence, the main advantages of adopting a layered reference model would be:

- Division of complex network operations in individually manageable layers (it's easier to focus on a part of that whole)
- Ability to change elements of a layer without changing other elements
- Definition of a standard, enabling interoperability between different manufacturer

3. Function of the layers

Note that the OSI model itself is not network architecture because it does not specify the exact services and protocols to be used in each layer. It just specifies what each layer should do.

Let's clarify each of the model layers.

Application Layer	It is responsible for identifying and establishing the availability of the application on the recipient machine and provides the resources for such communication to take place, examples of existing applications and services in this layer: • Browsers (Internet Explorer, Netscape and Mozilla) • Web Server (Apache)
Presentation Layer	This layer is concerned with the syntax and semantics of the data transmitted, for example, after receiving data from the application layer, it may need to convert the data from its original format to an understood and acceptable format for other layers of the model, sample formats. They include ASCII, EBCDIC and ASN.1
	In addition to format and interpret data, it includes data compression and security of the information transmitted; Tasks such as compression, decompression, encryption and decryption. The compression and security features, however, are not unique to the presentation layer
Session Layer	It is responsible for the establishment, management and completion of sessions between the transmitting entity and the receiving entity. It basically maintains the data of different applications apart from each other. Example protocols of this layer are: Network File System, Structured Query Language, Remote Procedure Call ... etc.

Transport Layer	The services defined in the transport layer are responsible for segmentation and reconstruction data streams from the upper layers. They come from point to point communication, and may establish a logical connection between the application source and application destination on a network
	It is also responsible for providing multiplexing mechanisms upper layers of data and the establishment and termination of virtual circuits (logical)
Network Layer	The network layer is responsible for addressing the packets by converting logical addresses into physical addresses so that data packets to arrive correctly at the destination. It also determines the path that the packets will follow to reach the destination.
Data Link Layer	The data link layer receives data from the network layer and formats them in designated tables units. The table contains an identifier that indicates the start and end of the same, as well as other fields of control and addressing.
Physical Layer	The physical layer gets the frames sent by the data link layer and turns them into signals compatible with the environment where the data should be transmitted.

Application Layer: It is responsible for identifying and establishing the availability of the application on the recipient machine and provides the resources for such communication to take place, examples of existing applications and services in this layer:

- Browsers (Internet Explorer, Netscape and Mozilla)
- Web Server (Apache)

Presentation Layer: This layer is concerned with the syntax and semantics of the data transmitted, for example, after receiving data from the application layer, it may need to convert the data from its original format to an understood and acceptable format for other layers of the model, sample formats. They include ASCII, EBCDIC and ASN.1

In addition to format and interpret data, it includes data compression and security of the information transmitted; Tasks such as compression, decompression, encryption and decryption. The compression and security features, however, are not unique to the presentation layer

Session Layer: It is responsible for the establishment, management and completion of sessions between the transmitting entity and the receiving entity. It basically maintains the data of different applications apart from each other. Example protocols of this layer are: Network File System, Structured Query Language, Remote Procedure Call ... etc.

Transport Layer: The services defined in the transport layer are responsible for segmentation and reconstruction data streams from the upper layers. They come from point to point communication, and may establish a logical connection between the application source and application destination on a network

It is also responsible for providing multiplexing mechanisms upper layers of data and the establishment and termination of virtual circuits (logical)

Network Layer: The network layer is responsible for addressing the packets by converting logical addresses into physical addresses so that data packets to arrive correctly at the destination. It also determines the path that the packets will follow to reach the destination.

Data Link Layer: The data link layer receives data from the network layer and formats them in designated tables units. The table contains an identifier that indicates the start and end of the same, as well as other fields of control and addressing.

Physical Layer: The physical layer gets the frames sent by the data link layer and turns them into signals compatible with the environment where the data should be transmitted.

Activity 3 - TCP / IP Model

1. Introduction

One of the TCP / IP advantages is that, it has an open architecture and any manufacturer can adopt. In this sub-unit, the Internet model (TCP / IP) is described.

2. TCP / IP Model

The functionality of TCP / IP model is similar to the OSI model. The only difference is that the services of the three upper layers of the OSI model are performed by a single layer in the TCP / IP model.

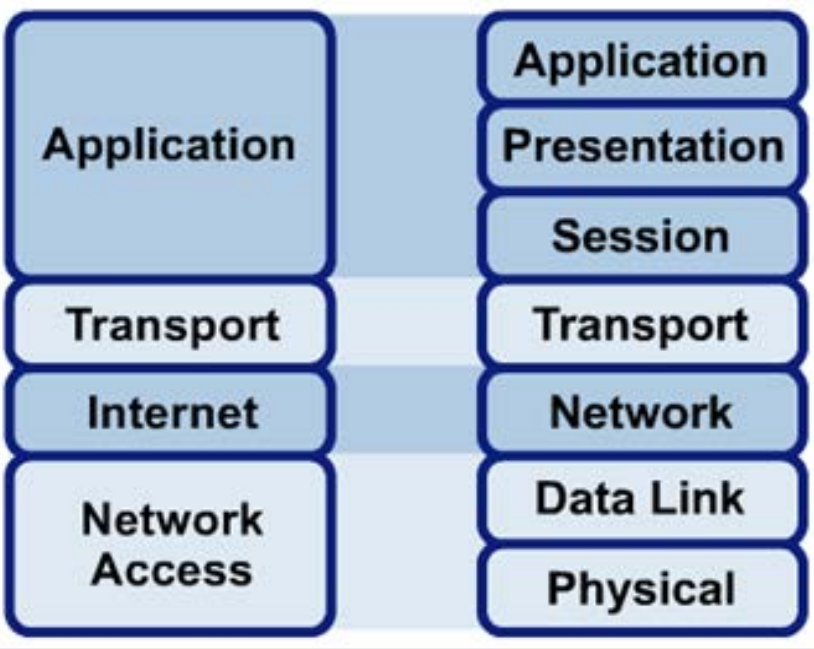


Figure 18: The difference between OSI and TCP / IP model

3. Role of layers

The default TCP / IP was created by the US Department of Defense (DoD) to ensure the preservation of data integrity, and maintain the data communication. A wide range of protocols acts in the implementation of the TCP / IP layer model, similar to those of the three layers of the OSI Model equivalents (Application, Presentation and Session).

Let us clarify each of the layers of the model.

Application Layer	It is responsible for defining the protocols necessary for communication point to point by applications, as well as the control and interface specifications with the user. There are several protocols that operate at the application layer, eg HTTP, SMTP, FTP, SNMP, DNS, NFS, DHCP, and Telnet.
Transport Layer	This layer is responsible for tasks such as creating a connection point to point and reliable delivery of data, watching over its integrity. This layer is also responsible for scheduling of data packets. Some protocols that operate at this layer: TCP- Transmission Control Protocol and UDP - User Datagram Protocol.

Internet Layer	It is similar to the network layer in the OSI model, protocol responsible for assigning logical packet transmission through the network.
	This layer is responsible for logical addressing of devices, assigning them IP addresses.
	This layer is also responsible for forwarding packets over the network and data flow control during the process of communication between two devices. There are several protocols that can operate at this layer, for example: IP - Internet Protocol, ICMP - Internet Control Message Protocol, ARP - Address Resolution Protocol and RARP - Reverse Address Resolution Protocol.
Network Access Layer	This is equivalent to layer 1 and layer 2 of the OSI model is responsible for sending the received frame over the Internet layer. At the layer are also defined protocols for transmission of data through physical means as well as the application and analysis of hardware addresses.

4. A comparison of the reference models OSI and TCP / IP

The OSI reference model and TCP / IP have a lot in common. Both are based on the concept of a stack of independent protocols. In addition, the layers have substantially the same functions. For example, in both models are present which comprise layers to the transport layer in order to provide a transport service to network independent processes wishing to communicate. These layers form the transport provider. Again, in both models, the layers above the transport layer relates to user-oriented applications.

Activity 4 - Internet Protocol - IP

1. Introduction

A first key aspect of a communication protocol is to define a way to identify the members of the network. For example the NETBEUI protocol performs this function by assigning names to computers on the network. In TCP / IP this function is performed by the IP (Internet Protocol) with an identification element which is designated IP Address. A special feature of the IP address is not assigned to a computer but to an INTERFACE. Thus a single computer can have multiple IP addresses. This sub-unit IP addressing is described.

2. IP Address

The IP address is the element that identifies a form of a SINGLE interface on the network where it operates, even if it is over the Internet. The IP address is usually represented by a sequence of four numbers separated by periods.

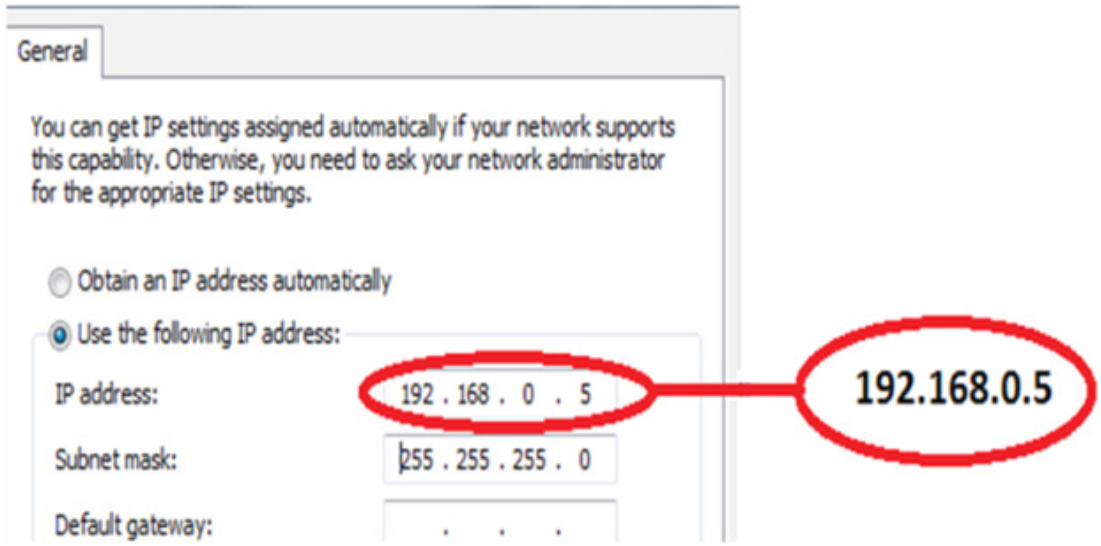


Figure 19: IP address configuration

3. Determining Intervals

The IP address is separated into two parts. Identification of the network (Network ID), and the computer identifier (host ID Consider the following IP model number:. WXYZ, where each of the values is designated octet, thus we have 4 bytes. They are called octet because they have only 8 bits for displaying the values and binary values start to 00000000 (0 in decimal) and 11111111 (255 in decimal). According to the IP address format, the network address and device address have variable size but the sum of the numbers of bits of both is always equal to 32 bits, therefore, there network 5 classes (Class A, B, C, D and E).

Class	Network No.	Network addresses valid	Host No.	Addresses of valid Hosts
A	2^7-2 =126	1.0.0.0 to 126.0.0.0	2^{24}-2 =16,777,214	X.0.0.1 to x.255.255.254
B	2^{14}-2 =16,384	128.0.0.0 to 191.255.0.0	2^{16}-2 =65,534	X.X.0.1 to x.x.255.254
C	2^{21}-2 =2,097,152	192.0.0.0 to 223.255.255.0	2^8-2 =254	X.X.X.1 to X.X.X.254

- Class D is used for multicast addresses. A class D address has the first four bits of the network address equal to 1110.
  1110xxxx xxxxxxxx.xxxxxxxx.xxxxxxxx
- Class E is used for scientific or research purposes. A class E address has the first five bits equal to 11110.
  11110xxx xxxxxxxx.xxxxxxxx.xxxxxxxx

4. Subnets

First of all, it is important to know the benefits achieved with the creation of subnets (subnet):

- Network Traffic Reduction;
- Network performance optimization;
- Network management simplification;
- Consistent Distribution of LANs over large distances

We discussed previously how to define and identify valid ranges for addressing devices on networks belonging to classes A, B, C, D and E.

LAN's consistent distribution over large distances

Once the WAN links (Wide Area Network) is considerably slower than LAN connections, only one huge network and reaching great distances is more likely to cause problems in each of the points listed above. The connection of smaller networks makes the system work more efficiently.

Steps to a Successful subnets Implementation

To create subnets, separate bits portion of an IP address aimed at addressing hosts and set aside for defining a subnet. This means fewer bits for addressing hosts, Therefore, the more subnets defined, the fewer bits for addressing the devices.

Network masks or subnet (Subnet Masks)

For the subnet addressing scheme to function properly, all attached devices need to know which part of the host address that will be allocated to the address of the subnet. This is achieved by assigning a network mask to each device.

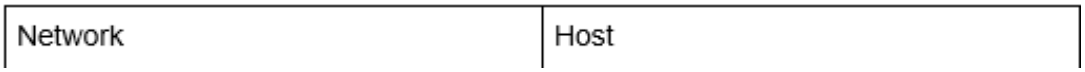
- This mask is a 32-bit value that enables the IP packet's distinguish between network and host portions of an IP address
- The 32-bit network mask is composed of 0s and 1s. The occurrence positions of 1s is referred to the network address or subnet
- Not all network addresses that need a subnet is created. In such cases, a standard network mask (default subnet mask)
- Standard Network masks used for address classes A, B and C.

Class	Class Network Mask
A	11111111.00000000.00000000.00000000 = 255.0.0.0
B	11111111.11111111.00000000.00000000 = 255.255.0.0
C	11111111.11111111.11111111.00000000 = 255.255.255.0

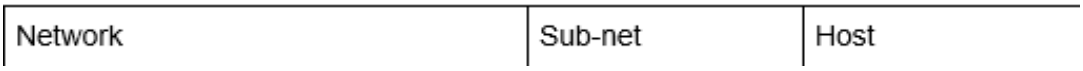
Table 1: The standard network masks used stop classes A, B and C.

5. Definition of subnets

To create multiple subnets within a single network, you must assign different addresses to each of the subnets from the original network address.



Address original



Address divided in sub-network

- When faced with a network mask, and we need to determine the number of subnets, valid hosts and broadcast addresses the mask sets, all we have to do is to answer five questions:
- It is important at this point that Take Back power base 2. Let's look at the definition of Class C Subnet practical method to determine the answer to each of the five issues

6. Steps for defining subnets

a. How many subnets? 2x - 2 = number of subnets, where "x" represents the number of bits "masked" or the number of 1s. For example: 11111111.11111111.11111111.11000000 would be 22-2 = 2. In this case, there would be two possible sub-networks with such a mask.

b. How many valid hosts per subnet? 2y - 2 = the number of valid host, where "y" is the number of bits available for manipulation of host addresses or the number of 0s. For example, 11111111.11111111.11111111.11000000 would be 26-2 = 62 In this case, there are 62 valid addresses to hosts per subnet.

c. What are the valid subnets? 256 - Network mask = value of the base subnet. In this result, adds to the value obtained until it reaches the mask number (which would be invalid). Following our example: 256-192 = 64 (base number and first valid subnet), 64 + 64 = 128 (second valid subnet), 128 + 64 = 192 (mask value = invalid subnet). Therefore, the valid subnets would be 64 and 128.

d. What is the broadcast address for each subnet? The broadcast address would be the value immediately prior to the next subnet (or the mask, if we are talking about in the last subnet sequence). In our example, we have subnets 64 and 128. The broadcast address of the first would be 128-1 = 127. Since the second 192-1 = 191

e. What are the valid hosts? Valid values would be comprised between subnets. The best way of identifying these values is discovering the valid subnets and broadcast addresses for each. In our example, the valid hosts would be included in the ranges between 65 -126 for the first subnet 129 and -190 for the second subnet (for 64 and 128 are the values that define the respective sub-networks and can not be used in addressing hosts)

Activity 5 - IEEE 802 standard

1. Introduction

The IEEE (Institute of Electrical and Electronic Engineers) created a series of protocol standard, the most important was the number 802. The IEEE 802 protocols have three layers, equivalent to layers 1 and 2 of the OSI model. Layer 2 of the OSI model 802 in the IEEE model is divided into two: Logic Link Control (LLC) and Media Access Control (MAC).

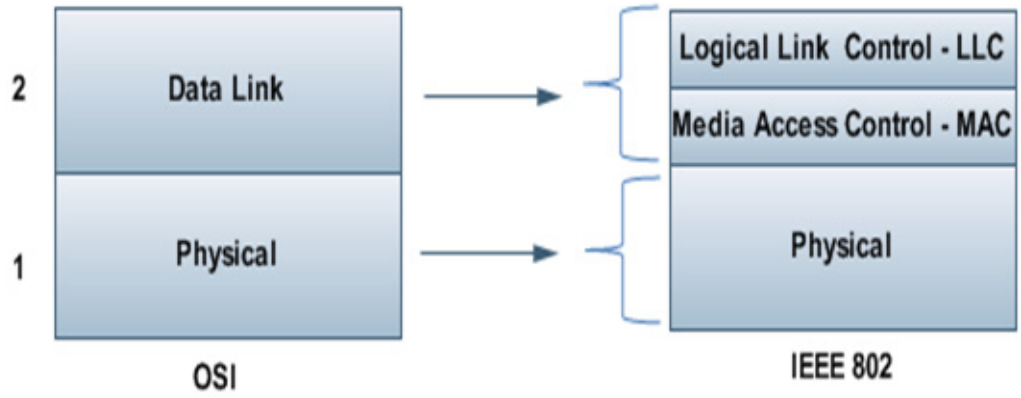
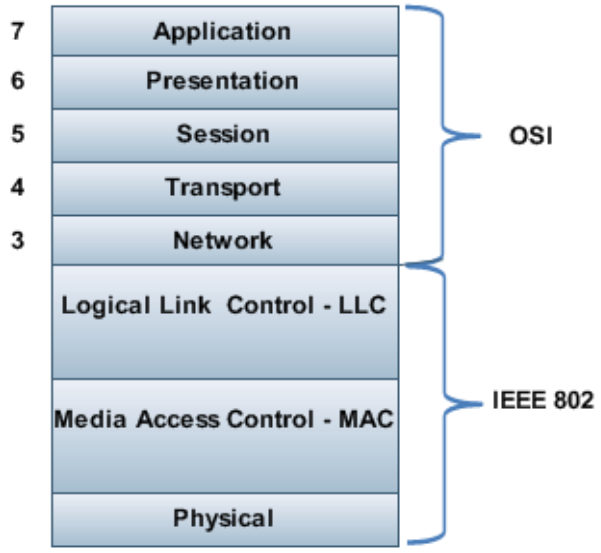


Figure 20: The OSI layer 2 divided into two in the IEEE 802 standard

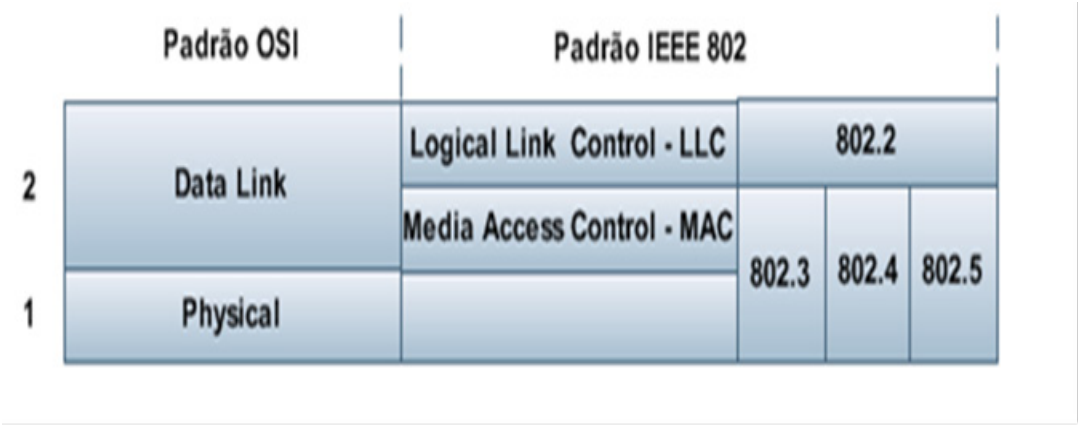
2. OSI Model & Standard IEEE 802

There are various IEEE 802 standards, for example IEEE 802.1 and 802.2. The IEEE 802.2 standard specifies the operation of the layer Logical Link Control - LLC and other IEEE standards operate at Layer Media Access Control - MAC and Physical.



3. Comparison of the OSI Model & Standard IEEE 802

Comparing since the IEEE 802 and the OSI model, the IEEE 802.2 standard is equivalent to part of the layer 2 (data link), as standards such as 802.3, 802.4 and 802.5 are equivalent to part of the layer 2 (data link) and Layer 1 (physical).



4. IEEE 802.3 (Ethernet)

Ethernet (802.3) is a method of accessing the media allowing all devices (host) on an Ethernet network to share the same bandwidth of a link. It uses the concept of collision detection, called CSMA / CD (Carrier Sense Multiple Access with Collision Detection). All network computers share the same cable, that is, computers can only send data to the network when the cable is free.

If two computers try to send packets at the same time on the network, there is a collision and the NIC expect a period of random time and try to resend the packet to network cable.

5. Media Access Control (MAC)

The Media Access Control defines the use of a MAC address in each network adapter. Each network adapter has a unique address recorded in hardware, known as MAC address. Each existing card on a device connected to the network has a unique MAC address, which is stored in hardware and theoretically there is no change

Figure 21: Network card

The MAC address of the IEEE standard consists of the first three bytes are the Unique Identifier addresses which indicate the card manufacturer and the last three bytes are controlled by the manufacturer of the network card. Thus, each manufacturer must register with IEEE

Defined by by IEEE and

Indicates who the manufacturer

Defined by manufacturer

1 byte	1 byte	1 byte	1 byte	1 byte	1 byte

Figure 22: MAC Address Format

6. Logic Link Control (LLC)

The logic link control layer allows more than one protocol used above it, i.e., layer 3 protocols, network, the OSI model. This layer defines the communication points between the transmitter and receiver known for Service Access Point (SAP).

The role of the LLC layer is added to the data received information of who sent this information, i.e. the protocol responsible for passing this information so that, at the receiver, the LLC layer can deliver information to the destination protocol.

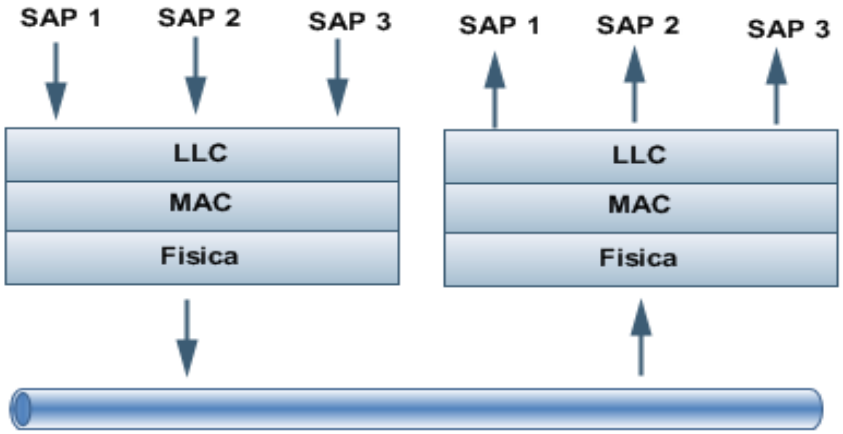


Figure 23: Layer LLC (fisica: physical)

Readings:

Computer Networking: A Top-Down Approach Featuring the Internet, 6th Ed James F. Kurose, Keith W. Ross;. Pearson, 2013.

Computer Networks, 5th Ed, Andrew S. Tanenbaum, David J. Wetherall; Prentice Hall, 2011.

CCNA 4.1 - Complete Study Guide Marcus Aurelius Filippetti, Editor Visual Book, 2008.

Unit Summary

This unit has addressed OSI communications protocols and TCP / IP, that is, the OSI communication protocol is the reference model because this model was not implemented but it served as a reference for communication models manufacturers as compared to model TCP / IP, this communication model is used in the world wide internet. Through the IP protocol are identified network members. For example the NETBEUI protocol performs this function by assigning names to computers on the network and at the end was approached IP addressing process.

Unit Assessment

Check your understanding!

Exercises

Instructions

These exercises allowed us to verify the state of knowledge of students regarding the reference model unit.

Assessment

1. What is the TCP layer / IP responsible for packet forwarding?

2. How an IP address is interpreted?

3. Indicate four services performed by the network layer of the TCP / IP?

4. What is an ICMP ?

5. What is the ARP protocol and how it works?

6. The address 192.168.100. 2 is a public or private address? Explain

7. How many addresses classes are used on the Internet?

8. Given the address 193.10.10.127 with mask 255.255.255.224, What is number of subnet?

9. Given the address 10.40.35.78 with mask 255.255.0.0, which is the number subnet?

10. Given network address 172.16.10.35 with mask 255.255.255.224, which is the broadcast address of the subnet?

Feedback

1. What is the TCP / IP layer responsible for routing packets?

The network layer or Layer 3 level, by comparison with the OSI model

2. How is an IP address interpreted?

an IP address is interpreted as having two fields: identification field of network and device identification field. the size of each field depends on the class to which the address belongs, according to the first byte of the address. after the introduction of the network mask, the size of each of the fields has come to be identified by the network mask. The network field are every bit address identified by the network mask with the bit 1 and the device field are bits identified with bit 0.

3. Indicate four services provided by the network layer of the TCP / IP?

Quality of service, packet forwarding, addressing and fragmantacao packages.

4. What is an ICMP?

ICMP is a network protocol used to send messages related to problems occurring on the network during data transmission.

5. What is the ARP protocol and how it works?

The ARP protocol is used to determine the physical address of a device from your IP address. to determine this correspondence, ARP starts by consulting your table with the most commonly used physical addresses (ARP table or ARP cache). if not find the address, it sends a broadcast message with the IP address. The device with the logical address on the ARP message should respond with an ARP message with its physical address. the new address is added to table. After a certain period without being used, the entries in the ARP table (ARP cache) are removed.

6. The address 192.168.100. 2 is a public or private address?

Private addresses are all belonging to the following networks ranges:

Class A 10.0.0.0 - 10.255.255.255

Class B 172.16.0.0 - 172.31.255.255

Class C 192.168.0.0 - 192.168.255.255

we find that the address 192.168.100.2 is private and 193.3.99.98 is public.

7. How many address classes are used on the Internet?

Currently, they are used only classes A, B and C. Class D is used for multicasting and class E is used for testing.

8. Given the address 193.10.10.127 with mask 255.255.255.224, which is number of the subnet?

We will solve the problem with binary method, converting the address and mask to binary, we have:

193.10.10.127 = 11000000.00001010.00001010.01111111

255.255.255.224 = 11111111.11111111.11111111.11100000

Considering only the address bits whose corresponding bits in the mask are equal to 1, we conclude that the address of the subnet is: 11000000.00001010.00001010.01100000 = 193.10.10.96. as the bits of the device identification field are all equal to 1, we see that it is the broadcast address.

9. Given the address 10.40.35.78 with mask 255.255.0.0, which is the number of the subnet?

We will solve the problem with binary method, converting the address and mask to binary, we have:

10.40.35.78 = 00001010.00101000.00100011.01001110

255.255.255.192 = 11111111.11111111.11111111.11000000

Considering only the bit address whose mask bits are 1, we conclude that the address of the subnet is 00001010.00100000.00000000.00000000 = 10.32.0.0

10. Given the network address 172.16.10.35 with mask 255.255.255.224, which is the broadcast address of the subnet?

This is a class B network with subnets. The address belongs to the subnet 172.16.10.32. The range address of 172.16.10.33 will even 172.16.10.62. The broadcast address is

172.16.10.63.

Unit 3: Cisco Switch Configuration

Unit Introduction

In this unit we will see how to configure the 2950 model, In fact, all the settings that we will see here, applied to the model 2950, can be made exactly the same way in other lines of Cisco switches

Unit objectives

Upon completion of this unit, students should be able to:

1. Set owner password and privileged mode
2. Configure the switch name
3. Set IP address on the switch
4. Check the IP connectivity
5. Configure VLANs

Key terms

switch: switch is a device that connects several segments of a network, but with significant difference: while a hub distributes information for all ports simultaneously, the switch establishes a direct link between the transmitter and receiver.

IOS: Data Station that a local network, provides services to other data stations.

VLAN: Virtual Local Area Network

Learning activities

Activity 1 - Switches Configuration Catalyst 2900

1. Introduction

This unit covers fundamentals of operating systems Cisco switches. We will see how to configure the 2950 model. All settings are applied to the model 29500, can be made exactly the same way in other lines of Cisco switches (eg. 3560 and 3750).

2. Switch Components 2950

The Catalyst 2950 switch is one of the basic models within the Cisco Catalyst family. There are 6 different models yet sold, within this family: 12-2950G, 2950G-24, 48-2950G, 2950G-48DC, 2950C-24 and 2950T-24. All available models have at least port 10 / 100 and therefore accept trunking settings on all ports. Note that this line only supports IEEE 802.1.

3. Features Switch 2950

The line 2950, as well as routers seen before, allows its configuration via Command Line Interface (CLI). Even today, there are two types of operating systems that can run on Cisco Catalyst switches:

- IOS: In this case, the switch configuration process is very similar to a router. Catalyst switches 29x0, 35xx, 36xx, 37xx, among others, can run IOS systems.
- CatOS: This system uses an older CLI command series (set-based). The switches are configured via CLI set-based are the oldest, such as 2926, the 2948G and the 5000 line, but more recent swiches as the 45xx and 65xx lines can also run this system. In fact, switches 45xx and 65xx lines can run either as CatOS IOS.

4. Slots GBIC (Gigabit Interface Converter)

The line 2950 as well as superiors lines (35xx, 37xx, etc.), provides GBIC slots for uplink connection. GBICs (Gigabit Interface Converter) modules are typically used for interconnecting swithes and also for the connection that requires a higher band (GigabitEthernet) can use one of the existing GBIC slots. Among the existing modules, here are some that can be used on line 2950:

- 1000BASE-T (Gigabit UTP)
- 1000BASE-SX (Gigabit fiber);
- 1000BASE-LX / LH (Gigabit fiber)
- 1000BASE-ZX (Fiber Gigabit)

5. Connecting to the Console Port

The routers have a console port on its back. It is an RJ-45 port for connection to the terminal. Once connected the cable to switch and the terminal, it must boot an emulator program to end, as the hyper term, the Window A. The settings for this program must be the same used for the routers:

- 9600bps
- 8 data bits
- Parity None
- Stop Bits 1
- Flow Control None

.6. Startup Switch

Figure 24: Switch Catalyst 2950G-24

Before starting a switch, make sure of the following:

- All network cables are securely connected
- The terminal is located connected to the console port
- Software emulator to finish is if set up correctly

Once everything is checked the previous points, turn on the switch and observe the sequence of LEDs.

7. Startup Routine

Once a switch 2950 is booted, just as a router, it goes into test mode (POST). At the beginning, all the LEDs are green. These LEDs are turned off after the end of POST mode. If a fault is identified in a door during POST, both - the LED SYSTEM and the door in question - change color to amber. If no fault is identified, all LEDs flash and then go off. If you have a terminal connected to the switch, you can check the status of POST on the terminal screen:

Activity 2 - Access 2950 switch

1. Introduction

This sub-unit will see how to configure the 2950 model. All settings are applied to the model 29500, can be made exactly the same way in other lines of Cisco switches (eg 3560 and 3750).

2. Command Line Interface (CLI)

The most complete and most flexible way of a router configuration is via the command line interface (CLI - Command Line Interface) IOS operating system. The user can access the CLI by console port, the auxiliary port or one of the interfaces using the Telnet protocol.

• Use the Router Modes

When you first enter the switch, the user is placed in user mode, indicated by the prompt:

```
switch>

To access the privileged mode, use the enable command

Switch> enable

switch #

With the enable command, you enter privileged mode "#" [switch #] and
the disable command in user mode ">" [switch>].
```

In any of the modes (> or #), the user can switch the connection to terminal through the logout command.

Privileged Mode

In privileged mode, the user is allowed to do everything. However, configuration commands can only be applied within a sub mode of privileged mode, called configuration mode. To enter configuration mode, you use the command configure terminal.

```
switch # configure terminal

switch (config) #
```

The setup mode has several sub-modes. To enter any of these sub-modes, you must first enter the setup mode. Some of the most common are:

Interface Configuration Mode - in this configuration mode, the user will apply specific commands of interfaces.

```
switch (config) # interface fastethernet 0/0

switch (config-if) #
```

Configuration mode of the lines - in this configuration mode, the user will apply specific command lines (lines can be: vty, console, tty or async).

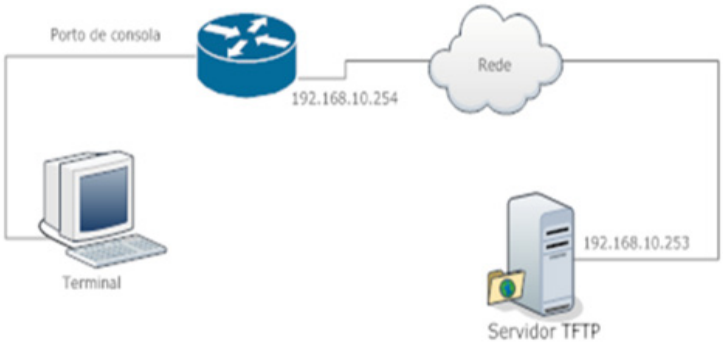
```
switch (config) # line console 0

switch (config-line) #
```

3. Image Management IOS

As with any other operating system at some point router cycle may be necessary to update your software. In addition to upgrading the IOS image, you can also change the configuration file to adapt the router to a new network configuration.

- From a TFTP server that contains the new IOS image or configuration file, you can upload the image or file over the network. To begin, you must configure the router with an IP address and connect it to a network with access to the TFTP rver



(porto de consola: Console port

rede:network

servidor: server)

- Create backup of the IOS image: For the creation of the backup operation, we will use the TFTP server as the backup repository, simply run the command switch # copy flash: tftp:
- Load the new IOS: loading IOS image to flash memory is also made with the copy command, but this time the source is the TFTP server and destination is the flash memory, simply run the switch command # copy tftp: flash :

4. Switch Configuration Management

The switches use two different configurations:

- Active configuration (running-config) - Active router configuration stored in RAM. All terminal for configuration commands operate on the active configuration.
- Startup configuration (startup-config) - A setting that is loaded into RAM when the router starts, through the active setting. Not to be missed, the startup configuration is stored in NVRAM

(porto de consola: Console port

rede:network

servidor: server)

- The settings can be copied between a TFTP server, RAM, and NVRAM with the copy command. For example, we copy the active configuration to the startup configuration:

```
switch # copy running-config startup-config
            or
switch # copy startup-config tftp:
```

5. Defining passwords and so privileged and User

Passwords on a Catalyst 2950 are configured in the same way as a router. Use the enable secret command to set the privileged mode password.

Here is an example of how to set up privileged mode passwords on a switch:

switch (config) # enable secret pongolane

switch (config) # exit

To set up a user password mode, the process is identical to that used on a Cisco router:

Island Line

```
switch (config) # line console 0
switch (config-line) # password fungafunga
switch (config-line) # login
```

VTY line

```
switch (config) # line vty 0 4
switch (config-line) # password mpandila
```

6. Hostname Configuration

For the hostname configuration on a switch, the procedure is to identify visa to a switch, as shown below:

```
switch # configure terminal

switch (config) # hostname Lichinga

Lichinga (config) #
```

7. IP Address Configuration

It is not mandatory configuring an IP address for the switch, but if you want to arrange the remotely configure it to use through a web-browser or via Telnet, an IP needs to be configured. Following the default settings of a Catalyst 2950 switch:

- The default gateway IP: 0.0.0.0
- CDP: Enables
- Switching Mode: Store and Forward
- 100Base0T Doors: Auto-negotiate duplex mode
- Spanning Tree: Enabled
- Console password: No

To configure an IP address and the default gateway address on a 2950 switch, use the following illustrated commands:

```
switch # configure terminal

switch (config) # interface vlan1

Lichinga (config-if) address 192.168.1.1 255.255.255.0 #ip

Lichinga (config-if) #ip default-gateway 192.168.1.254
```

Note that the IP address is configured on the interface VLAN1. The VLAN 1 is the native VLAN of the switch, that is, even if you have set up, it's already out. Configure to an IP address on this VLAN is actually assigning an IP address management to your switch.

8. Interfaces Configuration (Ports)

It is important to know how to access the ports on a switch. The switch 2950 uses the syntax {} {type of interface slot} / {port}, or FastEthernet0 / 1 references the first door switch (counting starts at 1). The line 2900, for not being modular, has only one slot (0).

To configure an interface on a switch 2950, simply go to global configuration mode and use the interface command. We describe the following process:

- **Descriptions of the Configuration Interfaces**

```
Switch> enable

switch # configure terminal

switch (config) # interface fastethernet 0/1

switch (config-if) #description Human Ressource_VLAN

switch (config-if) # no shutdown

switch (config-if) # exit


switch (config) # interface fastethernet 0/2

switch (config-if) #description TrunkParaSwitch2

switch (config-if) # no shutdown

switch (config-if) # exit
```

- **Descriptions of the Configuration Interfaces**

The configuration of VLANs is to define the number of VLANs to be created and users participating in each of them, VLANs can be created without problems. In a line switch 2950, you can create up to 250 VLANs.

```
Switch> enable

switch # vlan database

switch (vlan) # vlan 10 name Human Ressource

switch (vlan) # apply

switch (vlan) # vlan 20 name Finance

switch (vlan) # apply

switch (vlan) # exit
```

- **Associating interfaces to VLANs**

Below we illustrate the association of interfaces 2-6 to VLAN 10, and interface 10 to VLAN 20:

```
Switch> enable
switch # conf terminal
switch (config) # interface range fastethernet 2-6
switch (config-if-range) # switchport mode access
switch (config-if-range) # switchport access vlan 10
switch (config) # interface fastethernet 0/10
switch (config-if) # switchport mode access
switch (config-if) # switchport access vlan 20
switch (config-if) #no shutdown
switch (config-if) #exit
```

- **Transport Port Configuration (Trunk Links)**

For a switch port to behave as a transport link, or trunk, use the switchport mode trunk command in the desired interface. Below we illustrate an example of using this command:

```
Switch> enable
switch # conf terminal
switch (config) # interface fastethernet 0/24
switch (config-if) # switchport mode trunk
switch (config-if) # switchport trunk encapsulation dot1q
switch (config-if) #no shutdown
switch (config-if) #exit
```

Readings:

CCNA 4.1 - Complete Study Guide Marcus Aurelius Filippetti, Editor Visual Book, 2008.

Unit Summary

In this unit we address fundamentals of operating systems Cisco switches and line setting 2900. We have seen how to configure the 2950 model actually. All settings that we will see here, applied to the model 2950, can be made exactly the same way in other lines of Cisco switches.

Unit Assessment

Check your understanding!

Exercise

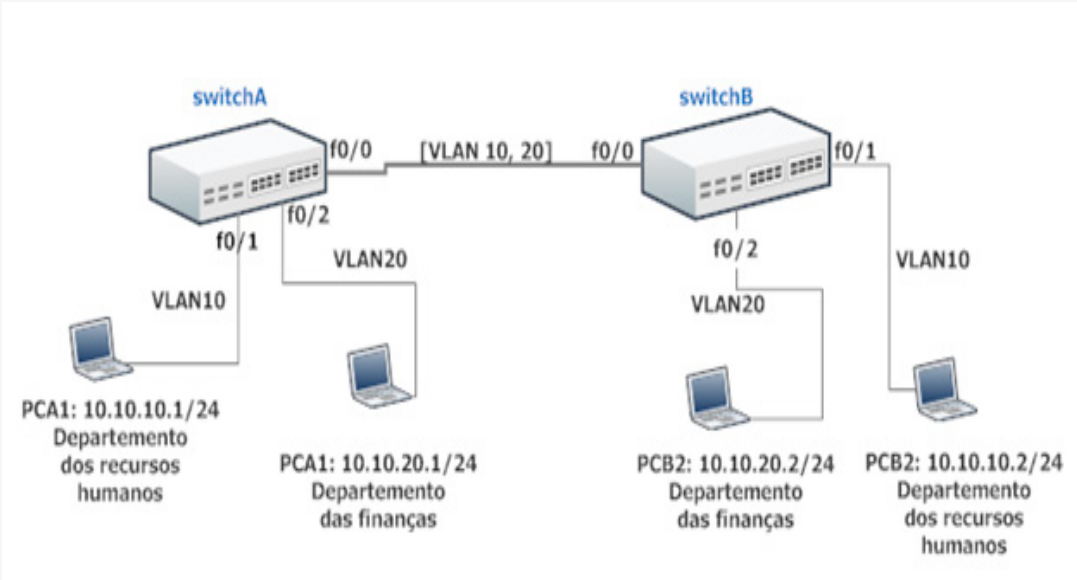
Instructions

The exercises allowed us to verify the assimilation of knowledge of students regarding the unit. To conduct this exercise students must install the simulation tool GNS3 or actual equipment usage so that they can practice the configurations of Cisco switches we saw earlier.

Grading Scheme

The assessment should take place in an ongoing, systematic and regular basis. The type of assessment corresponds to the stated objectives.

Assessment



(departemento dos recursor humanos: human resources department

departemento das financas: department of finances)

Unit Readings and Resources

Readings and other features of this unit are in readings and other course features list.

1. http://dl.acm.org/
2. http://scholar.google.com/?hl=pt
3. http://scholar.google.com/?hl=en

Unit 4. Cisco Router Configuration

Unit Introduction

The Cisco IOS is the core of routers and of most Cisco routers. Almost all Cisco devices run Cisco IOS system, however, not all the Cisco routers support (this because a few lines of switches were originally from other companies, such as Stratacom, which were acquired by Cisco). This unit will discuss the Cisco router configuration.

Unit objectives

Upon completion of this unit, students should be able to:

1. Set owner password and privileged mode
2. Configure the router name
3. Set IP address on the router
4. Check the IP connectivity
5. Set the Trunk Link

Key Terms

Router: A device that connects several typically different segments of a network in a single inter-network. The router, once connected, you can make smart how to get the data to its destination decisions, based on information it gets from the network itself.

IOS: Data Station that a local network, provides services to other data stations

Learning activities

Activity 1 - Cisco Router Basic Configuration

1. Introduction

This unit covers fundamentals of operating systems and the Cisco line of router configuration 3700. We will see how to configure the 3700 model. All settings are made exactly the same way in other Cisco router lines.

2. Router components

Cisco's operating system has an interface and a process for setting common to the majority of its assets equipment. Currently, the Inter network Operating System - IOS operating system is almost all Cisco routers.

The Router, like many other computer systems, have an operating system and system start microcode, along with a hardware platform with various types of memory, a processor, multiple interfaces and multiple ports.

3. Router Features

The router software consists of the IOS and several routines or microcode system:

- POST - Routine stored in ROM used to check basic functionality of the router and to detect their interfaces;
- ROM monitor – saved routine in ROM used in the manufacture, testing and debugging errors associated with the router;
- Mini-IOS - Designated RXBOOT, the mini-IOS is a small image of IOS stored in ROM to activate the basic functions of the router communication. In general ,this is used until it is shown to the router location of a new IOS image to be used during normal router operation.

5. Router Boot

AS connections to the router make it through port, All Cisco routers have a console port and mostly have an auxiliary port. The console port is typically an RJ-45 connection located on the back of the router, which allows for local access from an ASCII terminal or from a computer with a terminal emulator.

The router would not be complete without connection to the outside for packet forwarding, called interfaces, according to IOS terminology.

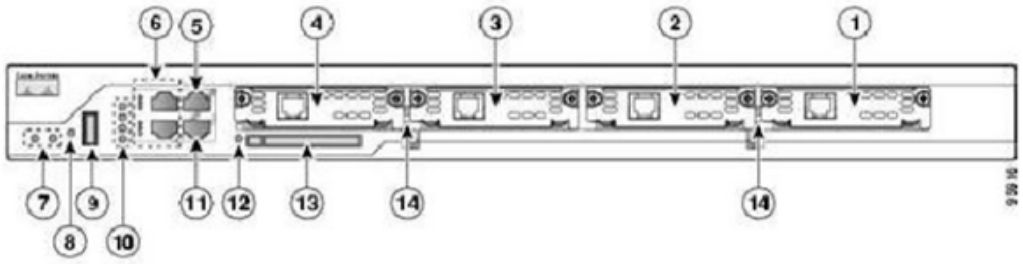


Figure 25: Illustration rear of the Cisco 2801 router

1	Slot 0 (VIC or VWIC, for voice only)	8	Auxiliary Power (AUX/PWR) LED
2	Slot 1 (WIC,VIC, VWIC, or HWIC)	9	Universal serial bus (USB) port
3	Slot 2 (WIC, VIC, or HWIC)	10	AIM/PVDM LEDs
4	Slot 3 (WIC, VIC, VWIC, or HWIC)	11	Auxiliary port
5	Console port	12	Compact flash (CF) LED
6	Fast Ethernet ports and LEDs	13	External Compact Flash memory card slot
7	System LEDs	14	Removable center card guides to allow double-wide HWIC-D installation

6. Startup Routine

Assuming that the configuration register is with the default value:

- The router starts to apply the POST (step 1) to confirm operation of all components.
- The post run from the ROMS and no problems arise during the POST, the bootstrap program stored in ROM, demand and loads the IOS image in flash memory (step 3).
- By default, the IOS is the flash memory. If you do not find a IOS image in flash memory, so look for the IOS image stored in ROM and is in start mode (boot) (step 2)

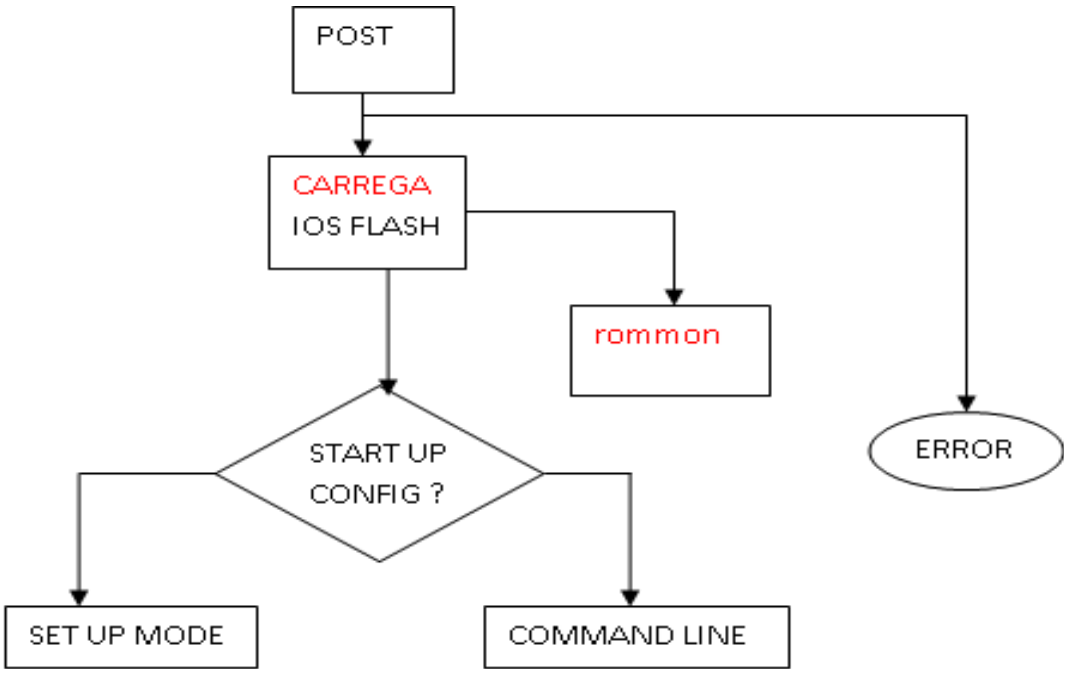


Figure 26: Startup routine

7. Connecting to the Console Port

The line 3700 has a console port on its back. It is an RJ-45 port for connection to the terminal. Once connected the cable to the router and the terminal, it must boot an emulator program to end, as the hyper term of the window. The settings for this program must be the same used for the switches:

- 9600bps
- 8 data bits
- Parity None
- Stop Bits 1
- Flow Control None

8. Numbering Interfaces

It is important to know how the numbering of interfaces occurs on a Cisco router, according to the new rules established by the company recently. If router 2801, for example, the interfaces have their numbering as follows:

Slot Number	Slot Type	Interface Numbering Range
Onboard ports	Fast Ethernet	0/0 and 0/1
0	VIC/VWIC (voice only)	0/0/0 to 0/0/3
1	HWIC /WIC / VIC/ VWIC	0/1/0 to 0/1/3 (single-wide HWIC)
		0/1/0 to 0/1/7 (double-wide HWIC)
2	WIC/VIC/VWIC	0/2/0 to 0/2/3
3	HWIC /WIC/VIC/ VWIC	0/3/0 to 0/3/3 (single-wide HWIC)
		0/3/0 to 0/3/7 (double-wide HWIC)

Table 2: Numeration of Interfaces

9. Study of the different Prompts CLI

As previously mentioned, it is of utmost importance to understand the different types of prompts that exist in IOS system, because then you can know exactly where you are when you are configuring a router. Always read the prompts to place a configuration:

Prompt	Description prompts
`>`	Access in User Mode
`#`	Access privileged mode
`(config) #`	global configuration mode
`(config-if) #`	interface configuration mode
`(config-subif) #`	sub interface configuration mode
`(config-line) #`	line configuration mode (AUX, CONSOLE or VTY)
`(config-router) #`	routing protocol configuration mode

Table 3: Summary of the prompts to be studied

Activity 2 - Access to the router 3700

1. Introduction

This sub-unit will see how to configure the 3700 model. All settings are applied to the model 3700, can be made exactly the same way in other Cisco router lines.

2. Command Line Interface (CLI)

The most complete and most flexible way of a router configuration is via the command line interface (CLI - Command Line Interface) IOS operating system. The user can access the CLI by console port, the auxiliary port or one of the interfaces using the Telnet protocol.

- **use the Router Modes**

When you first enter the router, the user is placed in user mode, indicated by the prompt:

```
router>
```

To access the privileged mode, use the enable command

```
router> enable

Router #
```

With the enable command, you enter privileged mode "`#" [router #]` and the disable command in user mode "`>" [router>]`.

In either mode `(> or #)`, you can disconnect from the switch through the logout command.

- **Privileged Mode**

In privileged mode, the user is allowed to do everything. However, configuration commands can only be applied within a sub mode of privileged mode, called configuration mode. To enter configuration mode, you use the command configure terminal.

```
Router # configure terminal

Router (config) #
```

The setup mode has several sub-modes. To enter any of these sub-modes, you must first enter the setup mode. Some of the most common are:

- **Interface Configuration Mode** - in this configuration mode, the user will apply specific commands of interfaces.

```
Router (config) # interface fastethernet 0/0

Router (config-if) #
```

• **Configuration mode of the lines** - in this configuration mode, the user will apply specific command lines (lines can be: vty, console, tty or async).

```
Router (config) # line <nome_da_linha>

Router (config) # line console

Router (config-line) #
```

3. Image management IOS

As with any other operating system at some point router cycle may be necessary to update your software. In addition to upgrading the IOS image, you can also change the configuration file to adapt the router to a new network configuration.

From a TFTP server that contains the new IOS image or configuration file, you can upload the image or file over the network. To begin, you must configure the router with an IP address and connect it to a network with access to the TFTP server

(porto de consola: Console port

rede:network

servidor: server)

Create backup of the IOS image: For the creation of the backup operation, we will use the TFTP server as the backup repository; simply run the command Router # copy flash: tftp:

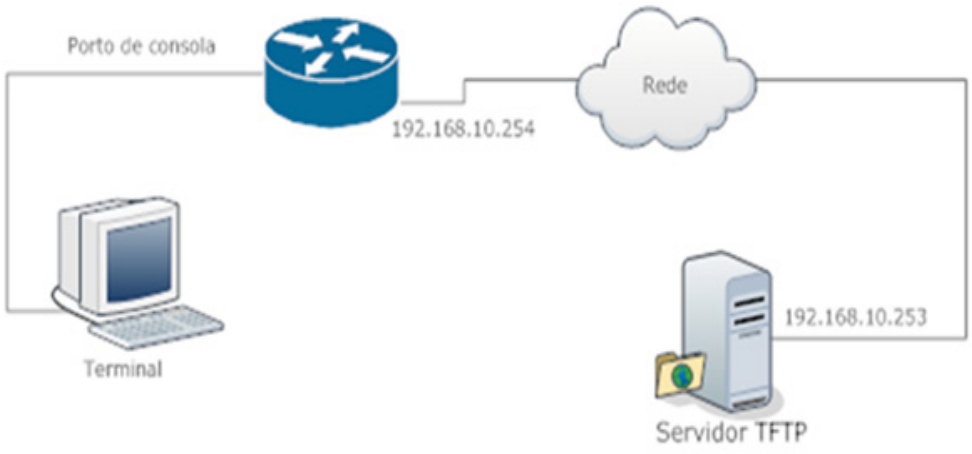
Load the new IOS: loading IOS image to flash memory is also made with the copy command, but this time the source is the TFTP server and destination is the flash memory, simply run the router command # copy tftp: flash :

4. Router Configuration Management

The switches use two different configurations:

Active configuration (running-config) - Active router configuration stored in RAM. All terminals for configuration commands operate on the active configuration.

startup configuration (startup-config) - A setting that is loaded into RAM when the router starts, through the active setting. Not to be missed, the startup configuration is stored in NVRAM



(porto de consola: Console port

rede:network

servidor: server)

The settings can be copied between a TFTP server, RAM, and NVRAM with the copy command. For example, we copy the active configuration to the startup configuration:

```
Router # copy running-config startup-config
```

or

```
Router # copy startup-config tftp:
```

5. Setting passwords

There are five types of passwords that can be created and applied to security of Cisco routers. The first two are used to restrict access to privileged mode (enable). Therefore, once applied, a password is requested every time the enable command is entered in user mode.

```
Router (config) #enable?
```

last-resort Sets enable action if no TACACS servers answered

password Assign the privileged level password

Assign secret the privileged level secret

use-tacacs

Use TACACS check to enable passwords

```
Router (config) #enable secret pongolane
```

```
Router (config) #enable fungafunga password
```

The other three are used to restrict access to the router through the console port, Telnet or Auxiliary:

Passwords on privileged mode (enable password)

Must be set in privileged mode. The following options are available:

Last-resort: must be used if the authentication is done through a TACACS server. This is only used if the TACACS server is in trouble. If it is OK, it is not used

Password: Used to privileged mode from setting passwords on routers running IOS system version prior to 10.3. It is used if the enable secret password configured on the router is used.

Secret: Encrypted password, set in privileged mode to restrict access to the router.

Use tacacs: Directs the router to perform the authentication process through a TACACS server.

If you try to configure the enable password and enable secret password to be the same, the router will present you a message (The enable password you have chosen is the same as your enable secret.). If you try to re-enter the same password, the router will accept, however, none of the passwords is working. So do not bother to set the enable password, unless you are using an old router.

Password User Mode (line passwords)

Must be set in privileged mode. You can set passwords on console lines, auxiliary and Telnet (VTY).

```
Router (config) #line?

<0-102> First Line number

aux Auxiliary line

Primary console terminal line

tty terminal controller

vty Virtual terminal

x / y Slot / Port for Modems
```

Auxiliary passwords (passwords auxiliary)

To configure the auxiliary password, you must be in global configuration mode (global configuration mode) and then typing the command line aux?. Note that only receives the alternative 0-0, since there is only one auxiliary door.

```
Router (config) #line aux?
 <0-0> First Line number
Router (config) #line aux 0
Router (config-line) #Password pongolane
Router (config-line) #login
```

Console passwords (console passwords)

To set the console password, must be in global configuration mode. Sets the line console command?. Note that only receives the alternative 0-0, since there is only one auxiliary port.

```
Router (config) #line console?
<0-0> First Line number
Router (config) #line console 0
Router (config-line) #Password fungafunga
Router (config-line) #login
```

Telnet passwords (Telnet passwords)

To set passwords for users to have access to your router via Telnet, use the line vty command. Routers that are not using the Enterprise version of Cisco IOS are limited to five Telnet ports (0-4). In our example, the 3700 router features 904 Telnet port (0-903). The best way to determine the amount of available ports Telnet is using the help facility (?).

```
Router (config) #line vty?
<0-903> First Line number
Router (config) #line vty 0903
Router (config-line) #Password mpandila
Router (config-line) #login
```

If you try to connect to a router that is not with a Telnet password (VTY) configured, you receive an error message saying the connection was refused because the password has not been set (connection refused because VTY is not set password). You can configure a router so that it accepts Telnet connections even if a password has been defined not through the login command.

After the routers have been properly configured with IP addresses, you can remotely connect to a router via Telnet application (just go to the DOS prompt and type telnet and the IP router, for example)

```
Router (config) #line vty?
<0-903> First Line number
Router (config) #line vty 0903
Router (config-line) # no login
```

6. Hostname Configuration

For the hostname configuration on a router, the procedure is to identify visa to a switch, as shown below:

```
Router # configure terminal
Router (config) # hostname core
core (config) #
```

7. IP Address Configuration

Configuring an IP address for the switch, but if you want to arrange the remotely configure it to use through a web-browser or via Telnet, an IP needs to be configured is not mandatory

To configure an IP address and the default gateway address on a router 2950, use the following illustrated commands:

```
router> enable
Router # configure terminal
Router (config) # interface fastethernet 0/1
Router (config-if) address 192.168.1.1 255.255.255.0 #ip
Router (config) default-gateway #ip 192.168.1.254
```

8. Interfaces Configuration (Ports)

It is important to know how to access ports on a router. The router 3700 using the syntax {} {type of interface slot} / {port}, or FastEthernet0 / 1 reference to the first router port (counting starts at 1). To configure an interface on a router 3700, just go to global configuration mode and use the interface command.

The following process are described:

- Descriptions of the Configuration Interfaces

```
Switch> enable

switch # configure terminal

switch (config) # interface fastethernet 0/1

switch (config-if) #description LAN

switch (config-if) # no shutdown

switch (config-if) # exit


switch (config) # interface fastethernet 0/2

switch (config-if) #description Trunk

switch (config-if) # no shutdown

switch (config-if) # exit
```

By default, all interfaces on a router are disabled (shutdown). To enable an interface, use the no shutdown command, and to deactivate it, type the command shutdown. If an interface is disabled, when you type the command show interface administratively down message appears, indicating that the interface is disabled by option administrator and not by hardware problem

- Transport Port Configuration (Trunk Links)

For a switch port to behave as a transport link, or trunk, use the switch port mode trunk command in the desired interface. Below we illustrate an example of using this command:

```
Switch> enable

switch # conf terminal

switch (config) # interface fastethernet 0/24

switch (config-if) # switchport mode trunk

switch (config-if) # switchport trunk encapsulation dot1q

switch (config-if) #no shutdown

switch (config-if) #exit
```

Activity 3 - IP Routing

1. Introduction

This sub-unit will discuss the IP routing process. This is a very important topic to be understood, since it is relevant to all routers and configurations that use the IP protocol. The three basic types of routing (static routing, default and dynamic) are described.

2. The referral process

The referral process is performed to transmit a device of a data packet on a network for other device. If a network has no routers, so it is not, in fact, forwarding packets. The role of routers is drive traffic to all networks in an inter-network. To be able shall conduct packet forwarding; the router must have knowledge of at least the following:

- Destination Address
- Routers neighbors
- Possible routes to remote networks
- Best route for each remote network
- How to maintain and verify information concerning the forwarding

The router "learns" about remote networks by communicating with neighboring routers (dynamic routing) or by administrator (static routing) or by administrator (static routing).

The router then creates a routing that describes how to find such remote networks. By default, the router already has knowledge about all networks that are directly connected, you must find the way to reach it, either via dynamic, static or default referral.

Static routing is the process of creating routing tables (routing tables) by the administrator manually. Already, dynamic routing uses routing protocols (routing protocols) to communicate with neighboring routers and automatically generate such a table.

3. Referrals Protocols Classification (Routing Protocols)

- Global Information Vs. Decentralized

Global:

- All routers have complete knowledge of the topology and cost of links
- Global knowledge of patching status (LS - "link state")

Decentralized:

- Router only knows neighbors (fisicam / on) and cost of links respectively
- An iterative computing process, information exchange with neighbors
- Distance vector algorithm (DV- "distance vector")

- Routing Protocols Rating: Static vs. Dynamic

Static:

- Routes do not change over time

Dynamic:

- Routes may change over time. For example:
- Periodic Update Process
- ... in response to changes in the cost of calls
- ... in response to network topology changes
- ... in response to network entities failures (routers, links, ...)

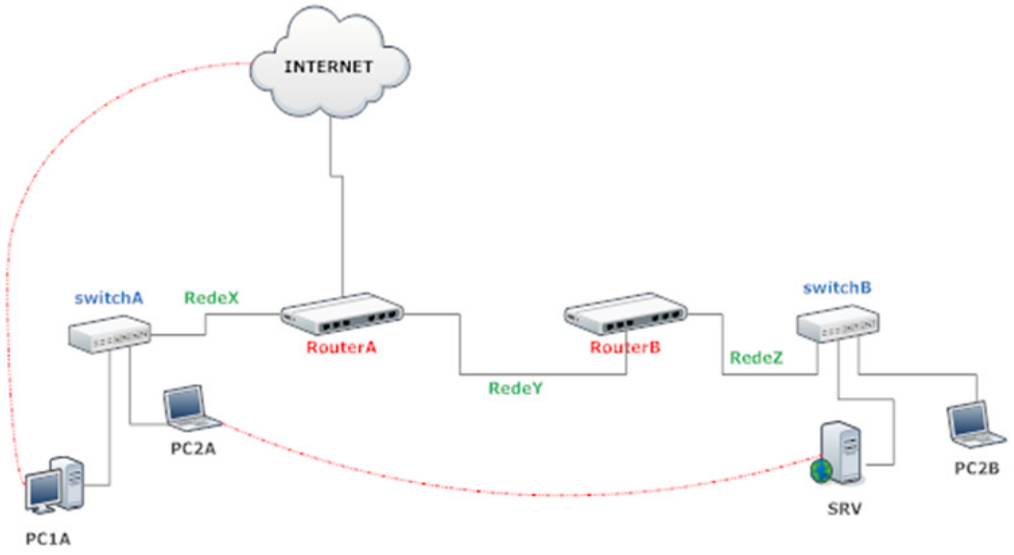
4. Routing Direct vs. Indirect

The indirect routing refers to situations where the target machine is in a different broadcast domain of the machine that originates the message.

- In this case the routing algorithm must identify the routing device which is connected to a network and is able to forward the message
- In the indirect routing, as the exact location of the recipient is unknown, the administrator is that you must create the rules necessary for the routing of packets
- For be created manually by the user, and therefore must be manually deleted by the user.

Static routing

In real life a computer network is more complex than a simple local area network, requiring creation of indirect routing rules.



(rede:network)

The implementation of routing rules is to create, for each destination or group of destinations, a table that identifies the device (PC or router) to which the packet should be sent and for the continuation of forwarding, commonly called GATEWAY:

- This table is called TABLE FORWARD
- Each rule contained in the table is called the ROTA

Each ROUTES should contain the following minimum information:

- DESTINATION: materialized by identifying the addresses of the recipients in the form of IP Address / Mask network we want to achieve (Destination Address)
- DOOR EXIT: materialized by the device ID that will be forwarding the package in the form of interface IP Address of this device connected to the network of our machine (gateway)

To properly understand the entire forwarding process is essential there is the slightest doubt about the concept of a NETWORK. IP PROTOCOL OF VIEWPOINT

- A network with an n-bit mask is the set of all IP addresses that have, in their binary representation, the first n bits equal.
- The IP protocol from the standpoint of a network is not a physical concept, but only one well defined range of addresses
- The IP addresses set that corresponds to a physical network broadcast domain is called
- There is no way that our machine to know the structure of a broadcast domain other than your

Activity 4 - 1˚ Case Study

1. Introduction

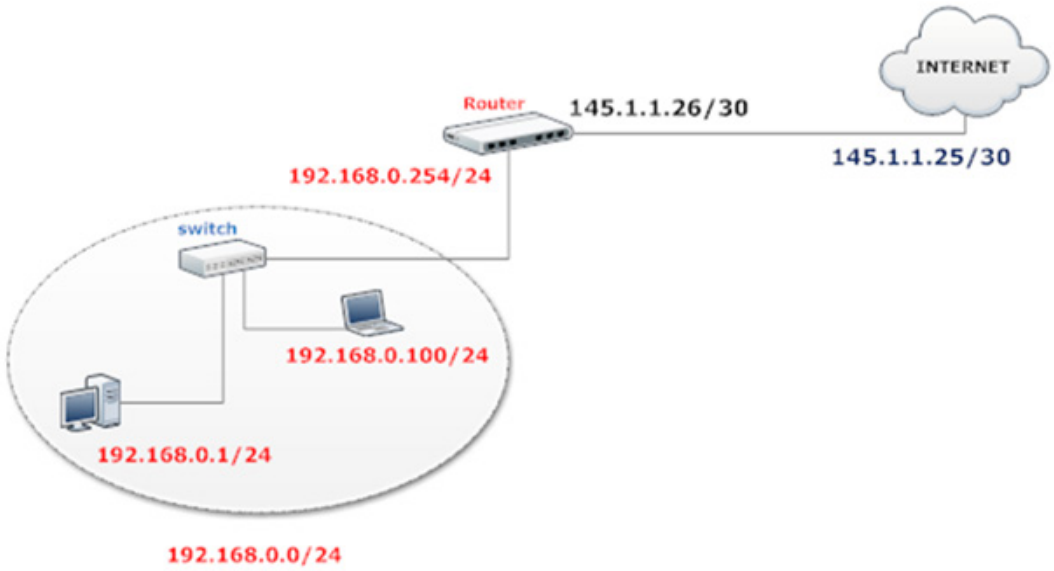
This sub-unit shows a network topology of computers and their IP addresses. The student will have to follow the process of creating referral routes for all network elements are communicable.

2. The referral process

We show you how to create necessary routes on the router and the computers so that all local network computers to be reached between them and all machines from local networks to access the Internet.

By default a computer only knows how to communicate with another computer that is on the same broadcast domain

- Communicates with all other computers on your network and therefore also with the router that is connected



For the computer 192.168.0.100 to communicate outside of your network, such as Internet

- Need to resort to an intermediate device able to forward your messages, and that belongs to your network
- In our case it is the router

We need to set the computer (192.168.0.100) a routing rule

- To use destination X.Y.W.Z gateway Z.W.Y.X

In our case, packages to any destination (except the network itself) should be sent to the gateway ROUTER

- A network covering any destination is the network 0.0.0.0/0
- The address is 192.168.0.254 access to ROUTER

The routing rule that is destined for the 0.0.0.0/0 network (all possible addresses) is the default route also called DEFAULT GATEWAY

The computer (192.168.0.100) will have to have the routing rule:

- To use destination 0.0.0.0/0 gateway 192.168.0.254
- Route the computer (192.168.0.100) ensures the forwarding of packets destined for the Internet only for the ROUTER

It is also necessary that the ROUTER forwards all packets addressed to any destination other than the networks to which it is connected, to the point where it connects to the Internet:

- To use destination 0.0.0.0/0 gateway 145.1.1.25
- To run the ROUTES are required:
- PC (192.168.0.100): destination 0.0.0.0/0 → gateway 192.168.0.254
- ROUTER: Destination 0.0.0.0/0 → gateway 145.1.1.25

In both devices there are direct routes (LANs), these routes "seem at odds" with the routes 0.0.0.0/0

This apparent conflict is resolved by priority rules

- The first priority rule says that a direct route is always preferred over an indirect route
- The 0.0.0.0/0 route will only be used to reach addresses that do not belong to their local networks.

Activity 5 - 2° Case Study

1. Introduction

This sub-unit, you will learn how to build a lab with GNS3 Cisco switching, although GNS3 can not emulate a Cisco switch. We will show how to use GNS3 with a NM-16ESW module on a router 3700 to emulate the features of the Cisco switch.

2. VLAN Configuration

The first part of our activity will show you how to set up a "Router 3700" to simulate the Cisco switch features through the NM-16ESW module. If you are interested in learning more about the NM-16ESW module, please visit the following link. http://www.blindhog.net/gns3-how-to-build-a-switching-lab/

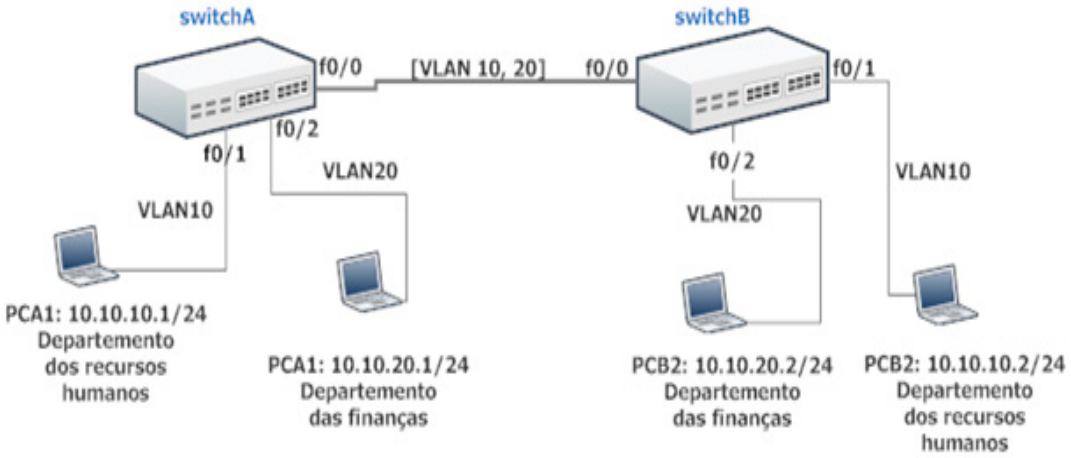


Figure 27: Network topology with two VLANs

(departemento dos recursor humanos: human resources department

departemento das financas: finances)= Configuring VLANs (10:20)

```
switchA> enable

switchA#

switchA#vlan database

switchA(vlan)# vlan 10 name deptFinance

switchA(vlan)# apply

switchA(vlan)# vlan 20 name deptHumanRes


switchB> enable

switchB#

switchB#vlan database

switchB(vlan)# vlan 10 name deptFinance

switchB(vlan)# apply

switchB(vlan)# vlan 20 name deptHumanRes

switchB(vlan)# apply
```

4. interface trunk mode setting

switchA#conf terminal

```
switchA(config)# interface fastEthernet 0/0
switchA(config-if)#switchport mode trunk
switchA(config-if)#switchport trunk encapsulation dot1q
switchA(config-if)#no shutdown
switchA(config-if)#exit

switchB#conf terminal
switchB(config)# interface fastEthernet 0/0
switchB(config-if)#switchport mode trunk
switchB(config-if)#switchport trunk encapsulation dot1q
switchB(config-if)#no shutdown
switchB(config-if)#exit
```

5. Access Mode Configuration of the interfaces

```
switchA> enable
switchA#
switchA#conf terminal
switchA(config)# interface fastEthernet 0/1
switchA(config-if)#switchport mode access
switchA(config-if)#switchport access vlan 10
switchA(config-if)#no shutdown
switchA(config-if)#exit
switchA(config)# interface fastEthernet 0/2
switchA(config-if)#switchport mode access
switchA(config-if)#switchport access vlan 20
switchA(config-if)#no shutdown
```

```
switchB> enable

switchB#

switchB#conf terminal

switchB(config)# interface fastEthernet 0/1

switchB(config-if)#switchport mode access

switchB(config-if)#switchport access vlan 10

switchB(config-if)#no shutdown

switchB(config-if)#exit

switchB(config)# interface fastEthernet 0/2

switchB(config-if)#switchport mode access

switchB(config-if)#switchport access vlan 20

switchB(config-if)#no shutdown
```

6. Configuring PCs

```
PCA1#conf terminal

PCA1(config)# interface fastEthernet 0/0

PCA1(config-if)#ip address 10.10.10.1 255.255.255.0

PCA1(config-if)#no shutdown

PCA1(config-if)#exit


PCA1(config)#ip route 0.0.0.0 0.0.0.0 10.10.10.254

PCA1(config)#exit

PCB1#conf terminal

PCB1(config)# interface fastEthernet 0/0

PCB1(config-if)#ip address 10.10.10.1 255.255.255.0

PCB1(config-if)#no shutdown

PCB1(config-if)#exit
```

```
PCB1(config)#ip route 0.0.0.0.0 0.0.0.0 10.10.10.254

PCB1(config)#exit

PCA2#conf terminal

PCA2(config)# interface fastEthernet 0/0

PCA2(config-if)#ip address 10.10.20.1 255.255.255.0

PCA2(config-if)#no shutdown

PCA2(config-if)#exit

PCA2(config)#ip route 0.0.0.0.0 0.0.0.0 10.10.20.254

PCA2(config)#exit


PCB2#conf terminal

PCB2(config)# interface fastEthernet 0/0

PCB2(config-if)#ip address 10.10.20.1 255.255.255.0

PCB2(config-if)#no shutdown

PCB2(config-if)#exit

PCB2(config)#ip route 0.0.0.0.0 0.0.0.0 10.10.20.254

PCB2(config)#exit
```

Activity 6 - 3˚ Case Study

1. Introduction

This is the second part of our activities. The first part, you have learned to use a NM-16ESW module for simulating many characteristics of a Cisco switch through the router 3700. In this second part, you will learn how to configure VLANs on the switch and how to route packets between VLANs with a "router on stick ".

2. on stick router

The second part of our activities will show you how to set up a "router on a stick". Stick on a router is basically when a router is configured to forward packets between two VLANs on a single physical connection. For learning more about the NM-16ESW module, please visit the following link. http://www.blindhog.net/gns3-switching-lab-part-2-router-on-a-stick/ and http://www.gns3-labs.com/2008/06/15/topology-vlan -trunking-GNS3-lab-8021q-router-on-a-stick /

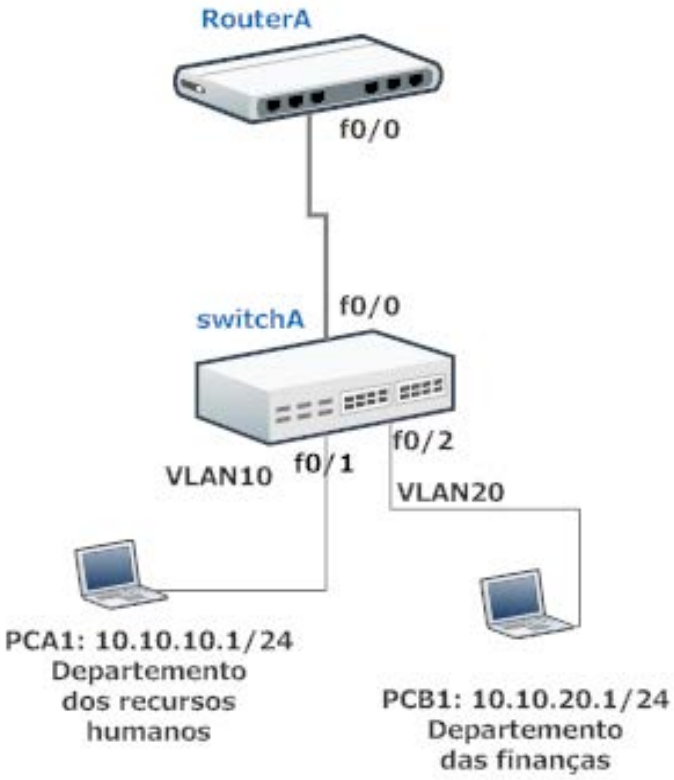


Figure 28: routing between VLANs

(departemento dos recursor humanos: human resources department

departemento das financas: finances)

3. Configuring VLANs (10:20)

```
switchA> enable

switchA#

switchA#vlan database

switchA(vlan)# vlan 10 name deptFinance

switchA(vlan)# apply

switchA(vlan)# vlan 20 name deptHumanRes

switchA(vlan)# apply
```

4. access mode interface configuration

```
switchA> enable

switchA#

switchA#conf terminal

switchA(config)# interface fastEthernet 0/1

switchA(config-if)#switchport mode access

switchA(config-if)#switchport access vlan 10

switchA(config-if)#no shutdown

switchA(config-if)#exit


switchA(config)# interface fastEthernet 0/2

switchA(config-if)#switchport mode access

switchA(config-if)#switchport access vlan 20

switchA(config-if)#no shutdown

switchA(config-if)#exit
```

5. interface trunk mode setting

```
switchA> enable

switchA#

switchA#conf terminal

switchA(config)# interface fastEthernet 0/0

switchA(config-if)#switchport mode trunk

switchA(config-if)#switchport trunk encapsulation dot1q

switch(config-if)#no shutdown

switch(config-if)#exit
```

6. Configuring PCs

```
PCA1#conf terminal

PCA1#conf terminal

PCA1(config)# interface fastEthernet 0/1

PCA1(config-if)#ip address 192.168.10.100 255.255.255.0

PCA1(config-if)#no shutdown

PCA1(config-if)#exit


PCA1(config)#ip route 0.0.0.0.0 0.0.0.0 192.168.10.254

PCA1(config)#exit

PCB1#conf terminal

PCB1#conf terminal

PCB1(config)# interface fastEthernet 0/1

PCB1(config-if)#ip address 192.168.10.100 255.255.255.0

PCB1(config-if)#no shutdown

PCB1(config-if)#exit


PCB1(config)#ip route 0.0.0.0.0 0.0.0.0 192.168.10.254

PCB1(config)#exit
```

7. Configuring VLANs on the router

```
routerA>enable

routerA#

routerA#vlan database

routerA(vlan)# vlan 10 name deptFinance

routerA(vlan)# apply

routerA(vlan)# vlan 20 name deptHumanRes

routerA(vlan)# apply

routerA(vlan)#exit
```

8. router configuration on Stick

```
routerA>enable

routerA#

routerA#conf terminal

routerA(config)# interface fastEthernet 0/0

routerA(config-if)#no shutdown

routerA(config)# interface fastEthernet 0/0.10

routerA(config-subif)#encapsulation dot1q 10

routerA(config-subif)#ip address 10.10.10.254 255.255.255.0

routerA(config-subif)#no shutdown

routerA(config-subif)#exit


routerA(config)# interface fastEthernet 0/0.20

routerA(config-subif)#encapsulation dot1q 20

routerA(config-subif)#ip address 10.10.20.254 255.255.255.0

routerA(config-subif)#no shutdown

routerA(config-subif)#exit
```

Readings:

CCNA 4.1 - Complete Study Guide Marcus Aurelius Filippetti, Editor Visual Book, 2008.

http://www.blindhog.net/gns3-switching-lab-part-2-router-on-a-stick/

Unit Summary

In this unit, fundamentals of operating systems Cisco, packet forwarding process and line router configuration 3700 have been developed. We saw this unit as is possible by simulation tools GNS3 simulate a lab environment using model 3700 router and through the NM module -16ESW simulate the functionality of Cisco switches. All the settings could be performed in exactly the same way physical environment of Cisco switches.

Unit Assessment

Check your understanding!

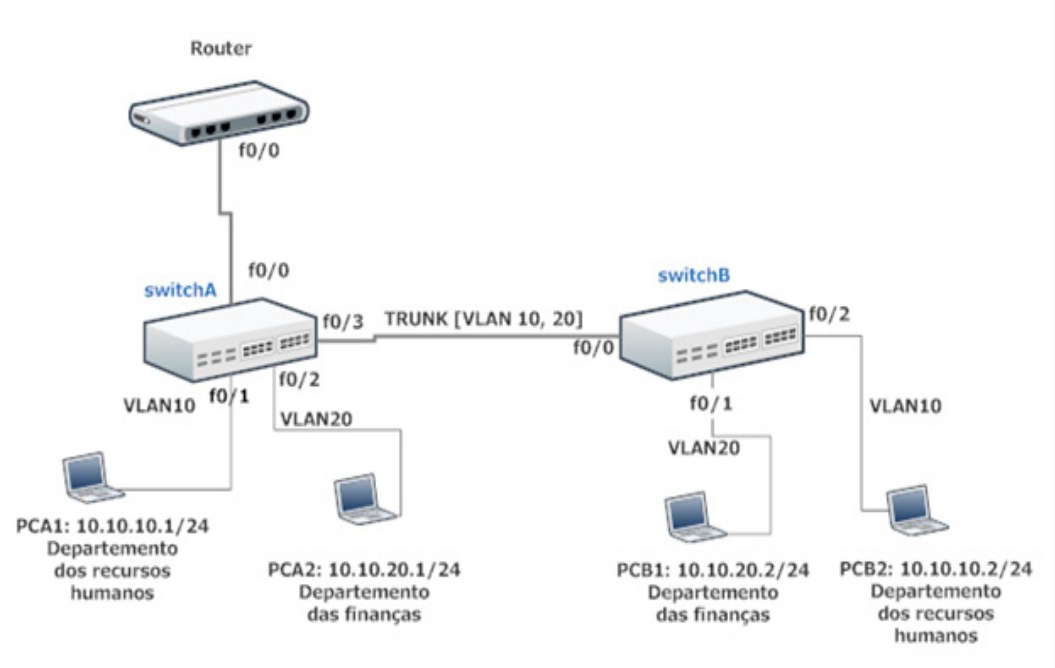
Instructions

The review exercises allowed us to verify the assimilation of state of knowledge of students regarding the units. To perform some exercises students must install the simulation tool as GNS3 or actual equipment usage so that they can practice or test the router commands or Cisco Switch

Grading Scheme

The assessment should take place in an ongoing, systematic and regular basis. The type of assessment corresponds to the stated objectives.

Assessment



(departemento dos recursor humanos: human resources department

departemento das financas: finances)

Readings and other resources

Readings and other features of this unit are in readings and other course features list.

1. http://dl.acm.org/
2. http://scholar.google.com/?hl=pt
3. http://scholar.google.com/?hl=en

Course Assessment

Review Exercises

Instructions

The review exercises allowed us to verify the assimilation of state of knowledge of students regarding the units. To perform some exercises students must install the simulation tool as GNS3 or actual equipment usage so that they can practice or test the router commands or Cisco Switch

Grading Scheme

The assessment should take place in an ongoing and systematic manner. The type of assessment correspond to the stated objectives.

1. PDUs (Protocol Data Units) at the network layer of the OSI model are called:

   a) Central

   b) Frames

   c) Packages

   d) Segments

   e) Access)

   f) Distribution

   g)Transportation

2. The process of segmentation of the data flow occurs on which OSI model layer?

   a) Physical c) Network e) data Link g) Application

   b) Session d) Transport f) Access

3. What layer of the OSI model is precupa with the semantics of the data?

   a) application c)Session e) data link g) Network

   b) Presentation d) Transportation f) Access

4. What are the three options using metallic cabling par-locked?

a) 100BaseFX c) 100VG-AnyLAN e) 100BaseSX

b) 100BaseTX d) 10BaseT

5. If network hubs have two 12-port 10/100 each, how many domains of broadcast domains and how many collision of this network have?

a) 24 and 1 c) 1 and 12 e) 1and 24

b) 12 and 12 d) 1 and 1

6. What is the protocol that operates at Layer Transport and allows no communication oriented connection between hosts?

a) IP c) TCP e) PARP

b) ARP d) UDP

7. What is the protocol that acts on the Transport layer and sets out circuits between virtual hosts before the start of data transmission?

a) IP c) TCP e) PARP

b) ARP d) UDP

8. What is this Protocol in the Network Layer (Internet) is not oriented connection, but it is responsible for communicating logic between two hosts?

a) IP c) TCP e) BGP

b) ARP d) UDP

9. Given the IP address 172.16.10.22/28. What is the valid range of hosts?

a) 172.16.10.20 to 172.16.10.22

b) 172.16.10.1 to 172.16.10.255

c) 172.16.10.23 172.16.10.16

d) 172.16.10.31 172.16.10.17

e) 172.16.10.30 172.16.10.17

10. Which of the following is the broadcast address sent to a class network B, using the standard network masks set for this class?

a) 172.16.10.255

b) 172.16.255.255

c) 172 255 255 255

d) 255 255 255 255

11. What is the broadcast address of the subnet that the address 10.254.255.19 255.255.255.248 belong?

a) 10.254.255.23

b) 10.254.255.24

c) 10,254,255,255

d) 10.255.255.255

12. What subnet mask would use for 12 subnets in a classful network / 24?

a) 255 255 255 255

b) 255 255 255 248

c) 255 255 255 240

d) 255 255 255 255

13. When a Cisco router is booted for the first time, where IOS is loaded by default?

a) Boot ROM

b) NVRAM

c) Flash

d) ROM

14. What is the command displays the version of iOS that is being used in the router?

a) show flash

b) show flash file

c) show ip flash

d) sh ver

15. How to setup all Telnet lines with a password "LabAvu"?

a) line vty

Login

password LabAvu

b) line vty 0 4

Login

password LabAvu

c) line vty 1

Login

password LabAvu

d) line vty 0 4

password LabAvu

Login

16. What is the command that prevents messages from overwriting console commands you are typing?

a) no logging

b) logging

c) logging asynchronous

d) logging synchronous

17. What type of Ethernet cable should be used in the connection between two ports on a switch?

a) Straight-through

b) Rolled

c) Crossover

d) Fibre-Optics

Review questions of all Units

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Unit 0

Readings and other required resources:

- Computer Networking: A Top-Down Approach Featuring the Internet, 6th ed. James F. Kurose, Keith W. Ross; Pearson, 2013.
- Computer Networks: A Systems Approach, 5th edition; Morgan Kaufmann; Larry Peterson and Bruce Davie, 2011.
- Data and Computer Communications, 8th ed. William Stalllings, Pearson Education International, 2007.

Readings and other optional features:

- Computer Networks, José Gouveia, Alberto Magalhães, 8ªEdition, Ed. FCA, 2009.
- Engineering of computer networks, Edmundo Monteiro, Fernando Boavida, Ed. FCA 2000.
- CISCO Networking for professionals, Véstias Mario, 4ªEdition, Ed. FCA, 2009

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