Module 5: Communication Principles

Networking Essentials (NETESS)

Module Objectives

Module Title: Communication Principles
Module Objective: Explain the importance of standards and protocols in network communications.

Topic Title	Topic Objective
The Rules	Describe network communication protocols.
Communication Standards	Describe network communication standards.
Network Communication Models	Compare the OSI and TCP/IP models.
Ethernet	Explain the OSI model Layer 1 and Layer 2 functions in an Ethernet network.

5.1 The Rules

The Three Elements

The primary purpose of any network is to provide us with a method to communicate and share information. All communication begins with a message, or information, that must be sent from one individual or device to another.

All communication methods have three elements in common:

- The first of these elements is the message source, or sender. Message sources are people, or electronic devices, that need to communicate a message to other individuals or devices.
- The second element of communication is the destination, or receiver, of the message. The destination receives the message and interprets it.
- The third element is called a transmission medium, or channel. It provides the pathway over which the message can travel from source to destination.

Communication Protocols

Before beginning to communicate with each other, we establish rules or agreements to govern the conversation:

- What method of communication should we use?
- What language should we use?
- Do we need to confirm that our messages are received?

These rules, or protocols, must be followed for the message to be successfully delivered and understood:

- An identified sender and receiver
- Agreed upon method of communicating (face-to-face, telephone, letter, photograph)
- Common language and grammar
- Speed and timing of delivery
- Confirmation or acknowledgment requirements

Why Protocols Matter

Protocol Characteristic	Description
Message format	When a message is sent, it must use a specific format or structure. Message formats depend on the type of message and the channel that is used to deliver the message.
Message size	The rules that govern the size of the pieces communicated across the network are very strict and can be different, depending on the channel used. It may be necessary to break a longer message into smaller pieces in order to ensure that the message can be delivered reliably.
Timing	Many network communication functions are dependent on timing. Timing determines the speed at which the bits are transmitted across the network. It also affects when an individual host can send data and the total amount of data that can be sent in any one transmission.
Encoding	Messages sent across the network are first converted into bits by the sending host. Each bit is encoded into a pattern of sounds, light waves, or electrical impulses. The destination host receives and decodes the signals in order to interpret the message.
Encapsulation	Each message transmitted on a network must include a header that contains addressing information that identifies the source and destination hosts. Encapsulation is the process of adding this information to the pieces of data that make up the message.
Message pattern	Some messages require an acknowledgment before the next message can be sent. This type of request/response pattern is a common aspect of many networking protocols.

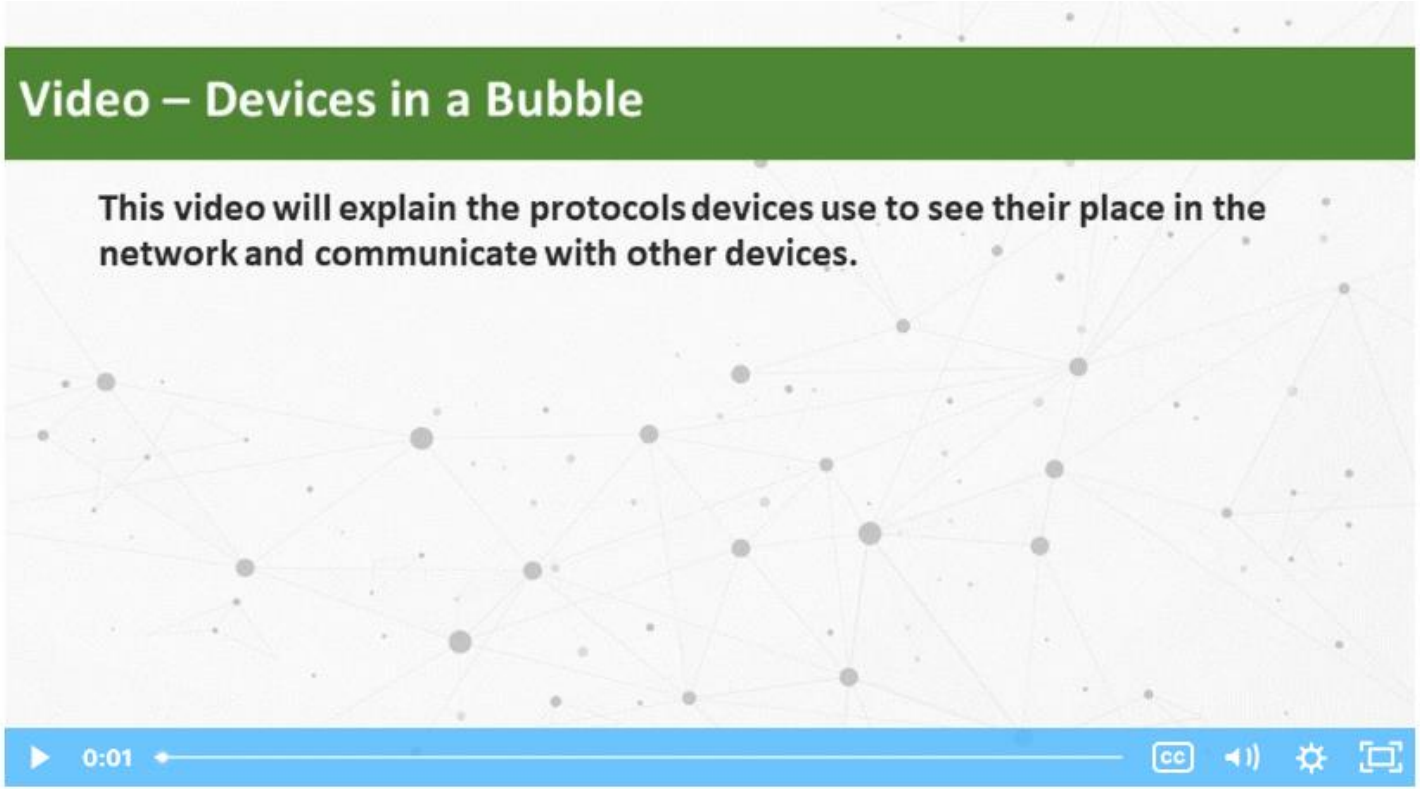
Lab - My Protocol Rules

In this lab, you will complete the following objectives:

- Relate computer network protocols to the rules that you use every day for various forms of communication.
- Define the rules that govern how you send and interpret text messages.
- Explain what would happen if the sender and receiver did not agree on the details of the protocol.

5.2 Communication Standards

Video - Devices in a Bubble



The Internet and Standards

A standard is a set of rules that determines how something must be done.

Networking and internet standards ensure that all devices connecting to the network implement the same set of rules or protocols in the same manner.

Using standards, it is possible for different types of devices to send information to each other over the internet.

For example, the way in which an email is formatted, forwarded, and received by all devices is done according to a standard:

- If one person sends an email via a personal computer, another person can use a mobile phone to receive and read the email as long as the mobile phone uses the same standards as the personal computer.

Network Standards Organizations

An internet standard is the end result of a comprehensive cycle of discussion, problem solving, and testing.

These different standards are developed, published, and maintained by a variety of organizations.

When a new standard is proposed, each stage of the development and approval process is recorded in a numbered Request for Comments (RFC) document.

- RFCs for internet standards are published and managed by the Internet Engineering Task Force (IETF).

Other standards organizations that support the internet are shown in the figure.

5.3 Network Communication Models

Video - Network Protocols

Video - The Protocol Stack

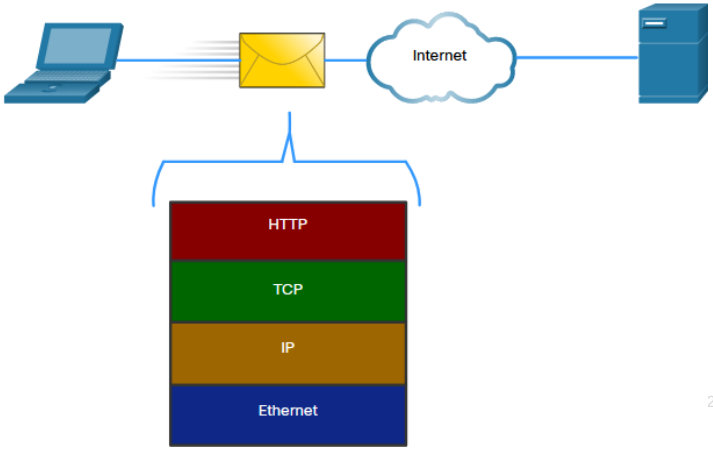
The Protocol Stack

Successful communication between hosts requires interaction between a number of protocols. These protocols are implemented in software and hardware that are installed on each host and networking device.

The interaction between the different protocols on a device can be illustrated as a protocol stack, as shown in the figure.

A stack illustrates the protocols as a layered hierarchy, with each higher-level protocol depending on the services of the protocols shown in the lower levels.

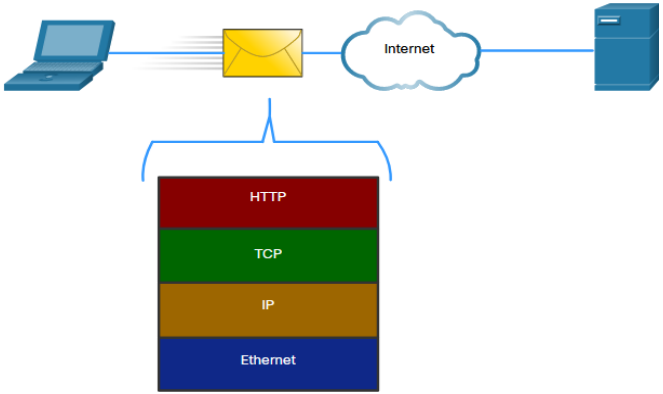
The separation of functions enables each layer in the stack to operate independently of others



The Protocol Stack (Cont.)

The protocols in the figure are described as follows:

Hypertext Transfer Protocol (HTTP) – This protocol governs the way a web server and a web client interact.
HTTP defines the content and formatting of the requests and responses that are exchanged between the client and server.
Transmission Control Protocol (TCP) – This protocol manages the individual conversations. TCP is responsible for guaranteeing the reliable delivery of the information and managing flow control between the end devices.
Internet Protocol (IP) – This protocol is responsible for delivering messages from the sender to the receiver. IP is used by routers to forward the messages across multiple networks.
Ethernet – This protocol is responsible for the delivery of messages from one NIC to another NIC on the same Ethernet local area network (LAN).



The TCP/IP Model

A layered model depicts the operation of the protocols occurring within each layer, as well as the interaction with the layers above and below it.
The layered model has many benefits:

- Assists in protocol design, because protocols that operate at a specific layer have defined information that they act upon and a defined interface to the layers above and below.
- Fosters competition because products from different vendors can work together.
- Enables technology changes to occur at one level without affecting the other levels.
- Provides a common language to describe networking functions and capabilities.

TCP/IP Model Layer	Description
Application	Represents data to the user, plus encoding and dialog control.
Transport	Supports communication between various devices across diverse networks.
Internet	Determines the best path through the network.
Network Access	Controls the hardware devices and media that make up the network.

The OSI Reference Model

OSI Model Layer	Description
7 - Application	The application layer contains protocols used for process-to-process communications.
6 - Presentation	The presentation layer provides for common representation of the data transferred between application layer services.
5 - Session	The session layer provides services to the presentation layer to organize its dialogue and to manage data exchange.
4 - Transport	The transport layer defines services to segment, transfer, and reassemble the data for individual communications between the end devices.
3 - Network	The network layer provides services to exchange the individual pieces of data over the network between identified end devices.
2 - Data Link	The data link layer protocols describe methods for exchanging data frames between devices over a common media
1 - Physical	The physical layer protocols describe the mechanical, electrical, functional, and procedural means to activate, maintain, and de-activate physical connections for a bit transmission to and from a network device.

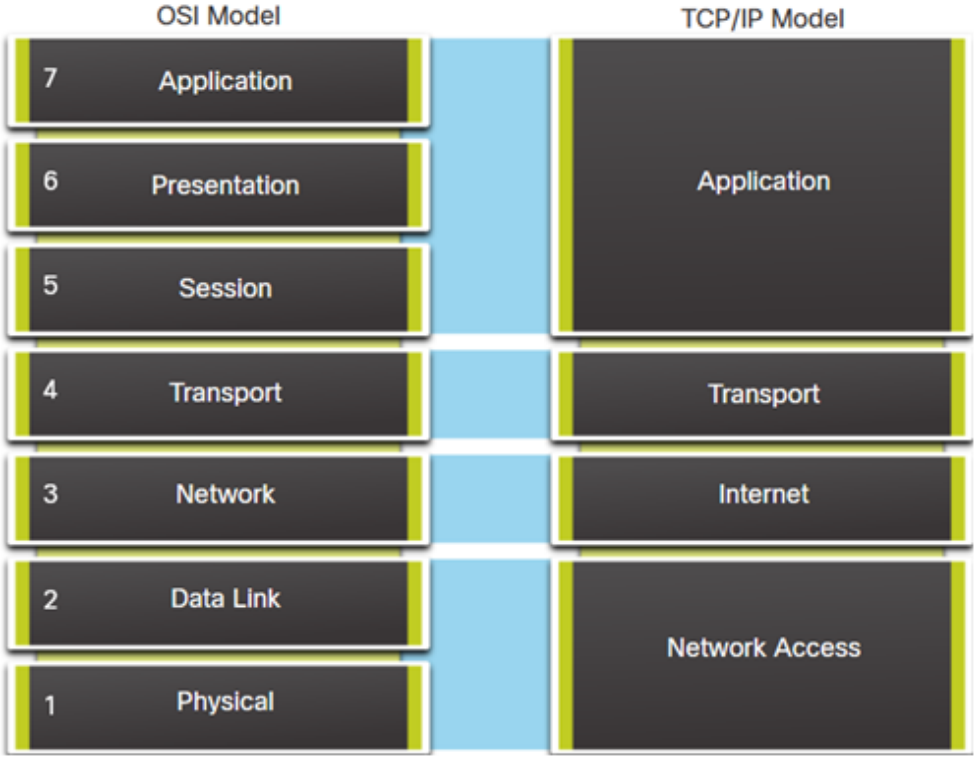
Upper and Lower Layers of the OSI Model

Group	Layer Number	Layer Name	Common Network Components Associated with this Layer
Upper Layers	7	Application	•Network aware applications •Email •Web browsers and servers •File transfer •Name resolution
	6	Presentation	
	5	Session	
Lower Layers	4	Transport	•Video and voice streaming mechanisms •Firewall filtering lists
	3	Network	•IP addressing •Routing
	2	Data Link	•Network interface cards and drivers •Network switching •WAN connectivity
	1	Physical	•Physical medium (copper twisted pair, fiber-optic cables, wireless transmitters) •Hubs and repeaters

OSI Model and TCP/IP Model Comparison

The protocols that make up the TCP/IP protocol suite can be described in terms of the OSI reference model:

- The functions that occur at the internet layer in the TCP/IP model are contained in the network layer of the OSI Model.
- The transport layer functionality is the same between both models.
- The network access layer and the application layer of the TCP/IP model are further divided in the OSI model to describe discrete functions that must occur at these layers.



5.4 Ethernet

The Rise of Ethernet

In the early days of networking, each vendor used its own proprietary methods of interconnecting network devices and networking protocols.

As networks became more widespread, standards were developed that defined rules by which network equipment from different vendors operated.

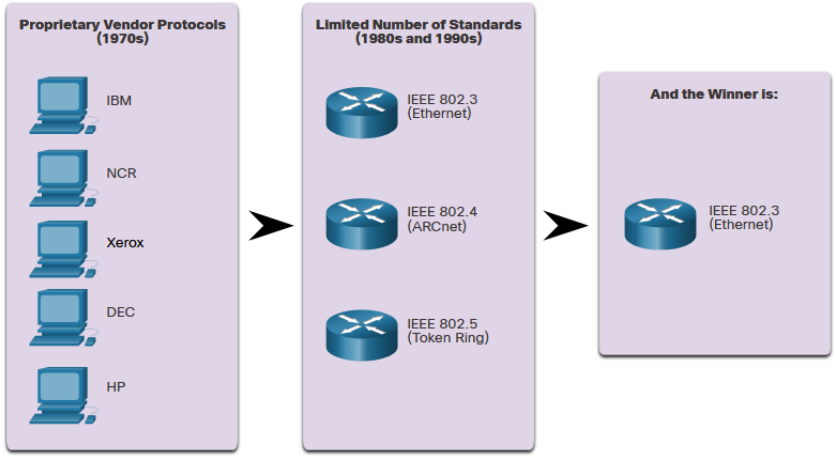
Standards are beneficial to networking in many ways:

- Facilitate design
- Simplify product development
- Promote competition
- Provide consistent interconnections
- Facilitate training
- Provide more vendor choices for customers

The Rise of Ethernet (Cont.)

There is no official local area networking standard protocol, but over time, Ethernet has become the most common.
Ethernet protocols define how data is formatted and how it is transmitted over the wired network.
The Ethernet standards specify protocols that operate at Layer 1 and Layer 2 of the OSI model.

Ethernet has become a de facto standard, which means that it is the technology used by almost all wired local area networks, as shown in the figure.



Ethernet Evolution

The Institute of Electrical and Electronic Engineers, or IEEE, maintains the networking standards, including Ethernet and wireless standards.

Each technology standard is assigned a number that refers to the committee that is responsible for approving and maintaining the standard.

The committee responsible for the Ethernet standards is 802.3.
Each version of Ethernet has an associated standard. For example, 802.3 100BASE-T.
This standard notation translates as:

- 100 is the speed in Mbps
- BASE stands for baseband transmission
- T stands for the type of cable, in this case, twisted-pair cable standards.

Early versions of Ethernet were relatively slow at 10 Mbps. The latest versions of Ethernet operate at 10 Gigabits per second and more.

Video - Ethernet Addressing

The Ethernet MAC Address

All communication requires a way to identify the source and destination.

The source and destination in human communication are represented by names.
When your name is called, you listen to the message and respond. Other people in the room may hear the message, but they ignore it because it is not addressed to them.

On Ethernet networks, a similar method exists for identifying source and destination hosts. Each host connected to an Ethernet network is assigned a physical address which serves to identify the host on the network.

Every Ethernet network interface has a physical address assigned to it when it is manufactured. This address is known as the Media Access Control (MAC) address.

The MAC address identifies each source and destination host on the network.

Lab - Determine the MAC Address of a Host

In this lab, you will complete the following objectives:

- Determine the MAC address of a Windows computer on an Ethernet network using the **ipconfig /all** command.
- Analyze a MAC address to determine the manufacturer.

5.5 Communication Principles Summary

What Did I Learn in this Module?

- All communication methods have three elements in common.
  - The first of these elements is the message source, or sender.
  - The second element of communication is the destination, or receiver, of the message.
  - The third element is called a transmission medium, or channel.
- Protocols are required for computers to properly communicate across the network.
  - Networking protocols define many aspects of communication over the local network which include message format, message size, timing, encoding, encapsulation, and message patterns.
  - Successful communication between hosts requires interaction between a number of protocols that are implemented in software and hardware on each host and networking device.
- A layered model depicts the operation of the protocols occurring within each layer, as well as the interaction with the layers above and below it.

What Did I Learn in this Module? (Cont.)

- Networking and internet standards ensure that all devices connecting to the network implement the same set of rules or protocols in the same manner.
- The most widely known internetwork reference model was created by the Open Systems Interconnection (OSI) project and is commonly referred to as the OSI model.
  - The OSI model breaks network communications down into multiple processes. Each process is a small part of the larger task.
  - The OSI model helps us troubleshoot by focusing on a specific layer to identify and resolve network problems.
  - The protocols that make up the TCP/IP protocol suite can be described in terms of the OSI reference model.
- Ethernet is the technology used by almost all wired local area networks and Ethernet standards specify protocols that operate at Layer 1 and Layer 2 of the OSI model.
  - Each host connected to an Ethernet network is assigned a physical address, known as a MAC address, which serves to identify the host on the network.

Module 5 – New Terms and Commands

- Message format
- Message size
- Timing
- Encoding
- Encapsulation
- Message pattern
- Standards
- Standards Organizations
- TCP/IP Model
- OSI Reference Model
- HTTP
- TCP
- Ethernet
- MAC address

Module 5 - Communication Principles Quiz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