



Chapter 2

Communicating Over The Network

Note for Instructors

- These presentations are the result of a collaboration among the instructors at St. Clair College in Windsor, Ontario.
- Thanks must go out to Rick Graziani of Cabrillo College. His material and additional information was used as a reference in their creation.
- If anyone finds any errors or omissions, please let me know at:
 - tdame@stclaircollege.ca.

Communicating Over the Network

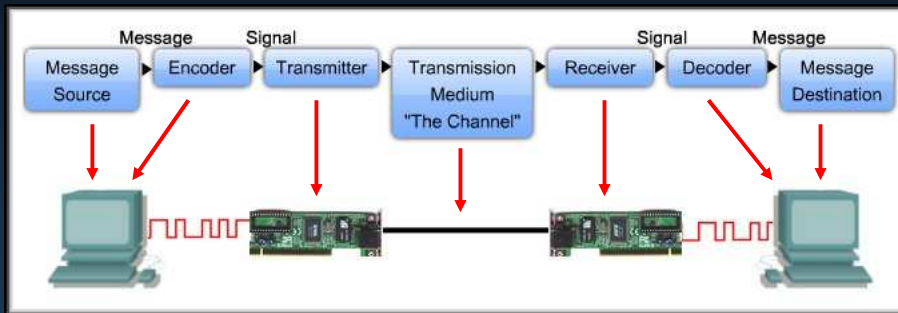
The Platform for Communications

Elements of Communication

- People communicate in many different ways.
 - Vocal, a look, a hand signal, body language...
- All of the methods have **three things in common**.
 - There is **source** for the message or a **sender**.
 - There is a **destination** for the message or a **receiver**.
 - There is a **channel** that consists of the media that provides the pathway for the message.

Elements of Communication

- Devices communicate in exactly the same way.

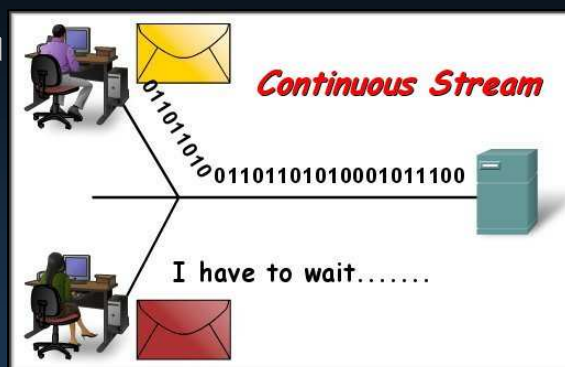


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Communicating the Messages

- In theory, a network communication could be sent as one continuous stream of 1's and 0's.
- No other device would be able to send or receive messages on the same network.
 - Significant delays
 - Inefficient use of the channel
 - A lost message entirely retransmitted.

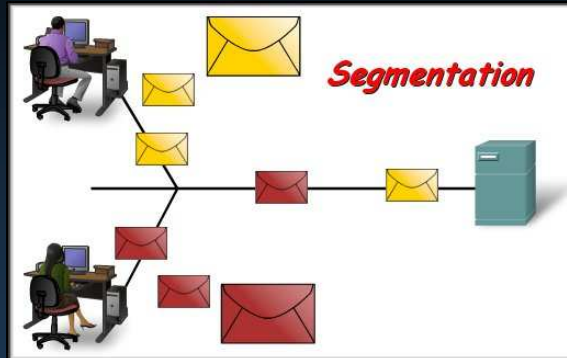


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Communicating the Messages

- A better approach is called **Segmentation**.
- The data stream is divided into smaller, more manageable segments.
- Segmentation has two benefits:
 - **Multiplexing:**
 - Different transmissions can be interleaved on the network.
 - **Reliability**

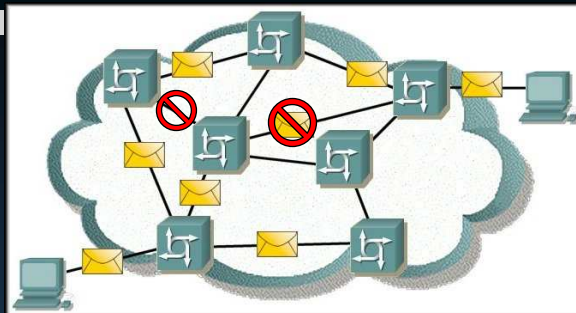


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Communicating the Messages

In a packet switched network like the Internet.

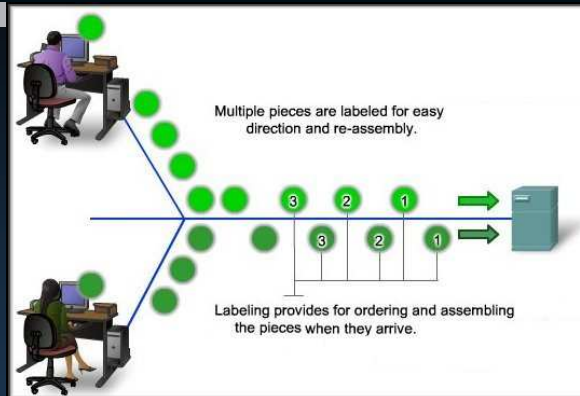


- **Segmentation and Reliability:**
 - Increases the reliability of network communications.
 - **Separate pieces** of each message can travel across **different paths** to destination.
 - **Path fails** or congested, **alternate path** can be used.
 - Part of the message fails to make it to the destination, **only the missing parts need to be retransmitted.**

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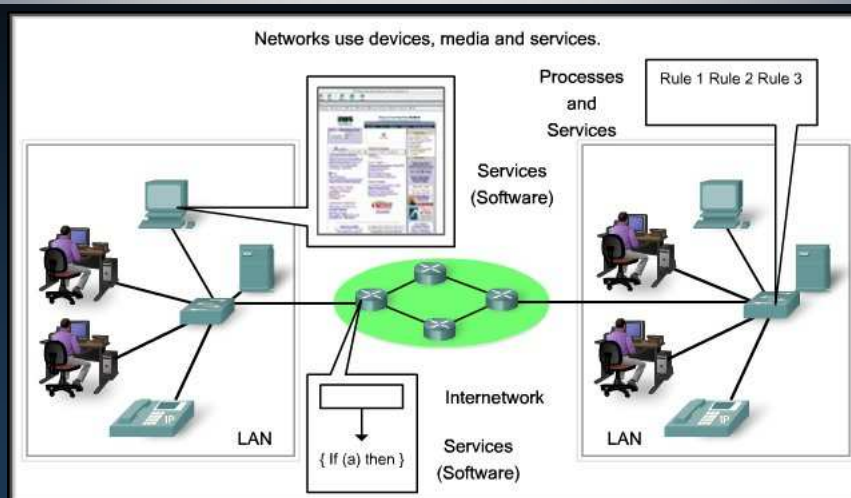
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Communicating the Messages

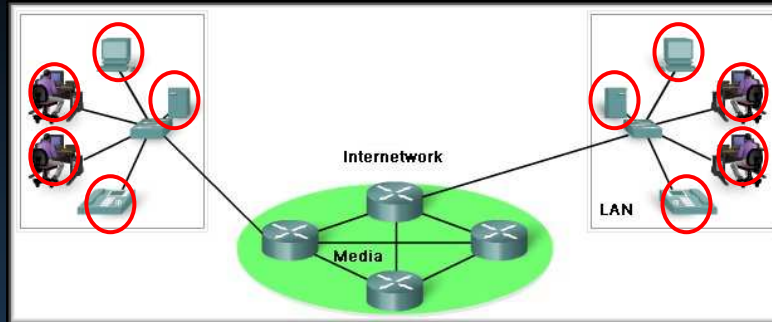


- **Segmentation Disadvantage:** Added level of complexity.
 - The label is a unique sequence number.
 - Handled by protocols that format and address the message.

Components of the Network



End Devices



- Work Stations, Servers, Laptops, Printers, VoIP Phones, Security Cameras, PDAs.....
- Any device that allows us to interface with the network.
- **End devices** are referred to as **hosts** and are either the source or destination of a message.

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End Devices



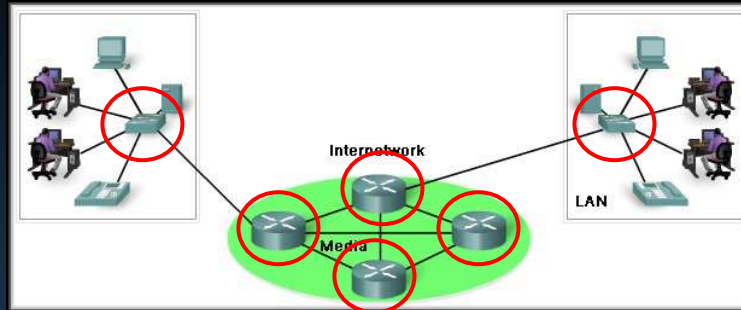
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display the information obtained from the server.

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Intermediary Devices



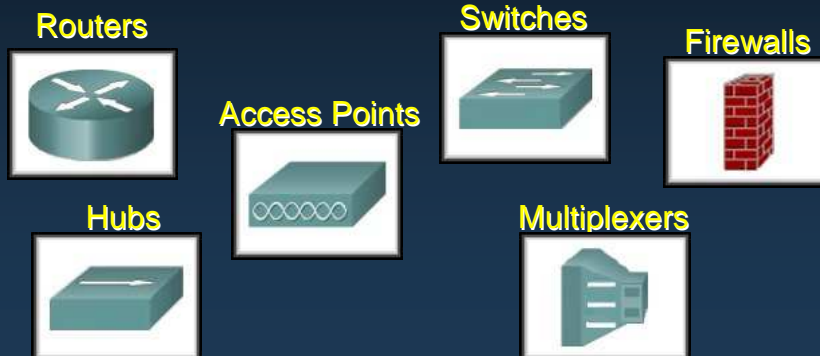
- Routers, Switches, Hubs, Wireless Access Points, Communication Servers, Security Devices.
- Any device that provides **connectivity to the network**, **connectivity to other networks** or **links between network segments**.

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Intermediary Devices

- Manage data as it flows through the network.
- Some use the **destination host address** and **network interconnection information** to find the best path through the network.



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Intermediary Devices

- **Regenerate** and **retransmit** data signals.
- **Maintain information** about what pathways exist through the network and internetwork.
- **Notify other devices** of errors and communication failures.
- **Direct data** along alternate pathways when there is a link failure.
- **Classify and direct messages** according to QoS priorities.
- **Permit or deny** the flow of data, based on security settings.

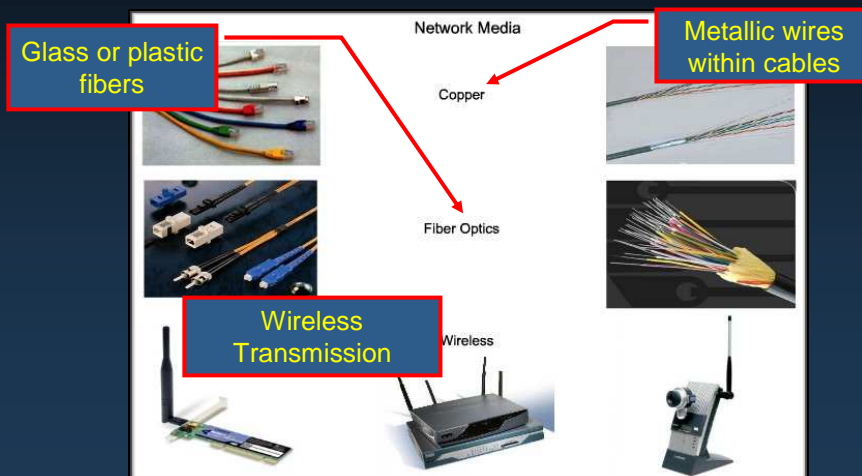


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Media

- The medium **provides the channel** over which the messages travel from source to destination.

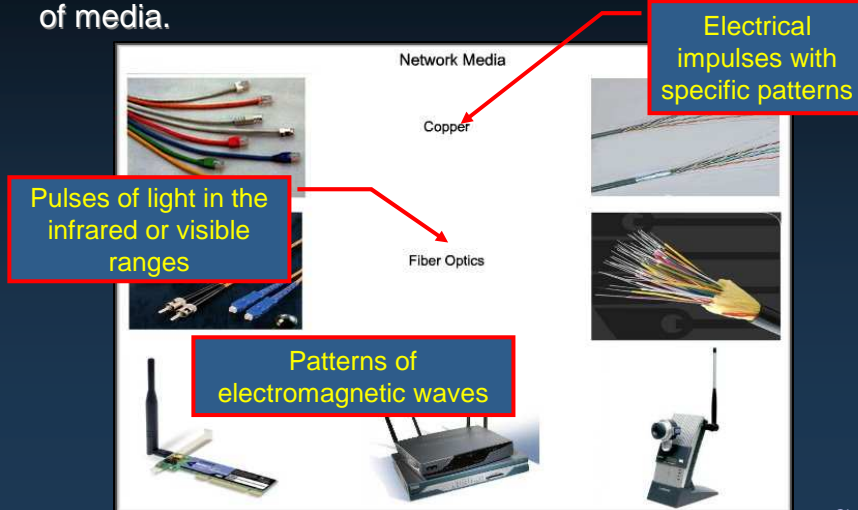


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Media

- The **signal encoding** that must occur is different for each type of media.



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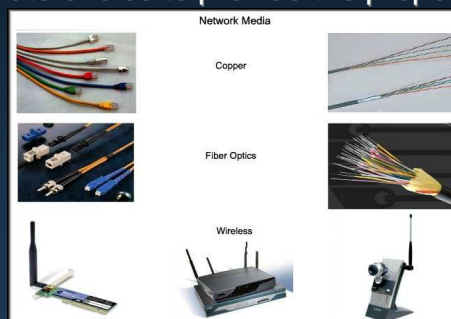
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Media

- Different network media have different features and benefits.*
- Not all network media are appropriate for the same purpose.*

- You must make the appropriate choice to provide the proper channel.

- Distance it can carry the signal
- Environment
- Bandwidth
- Cost of the media
- Installation costs
- Cost of connectors and devices



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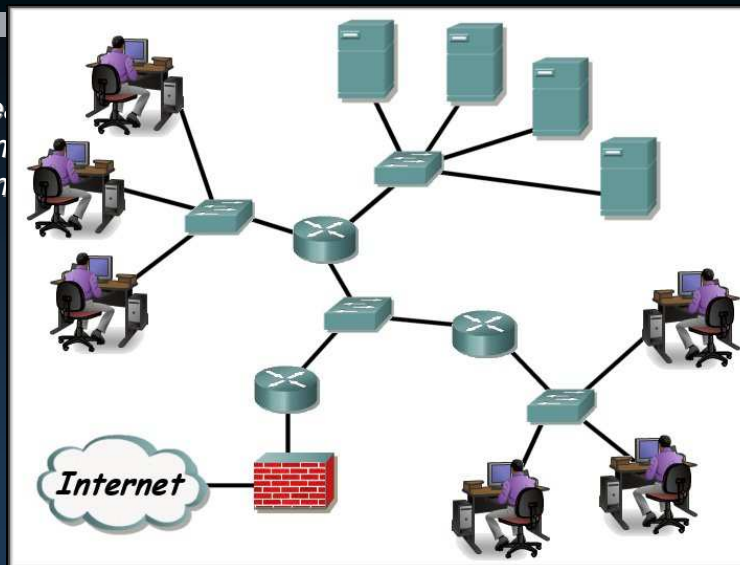
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Communicating Over the Network

LANs, WANs and Internetworks

Local Area Networks

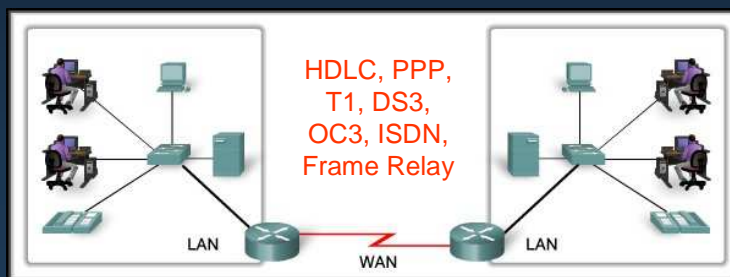
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Wide Area Networks

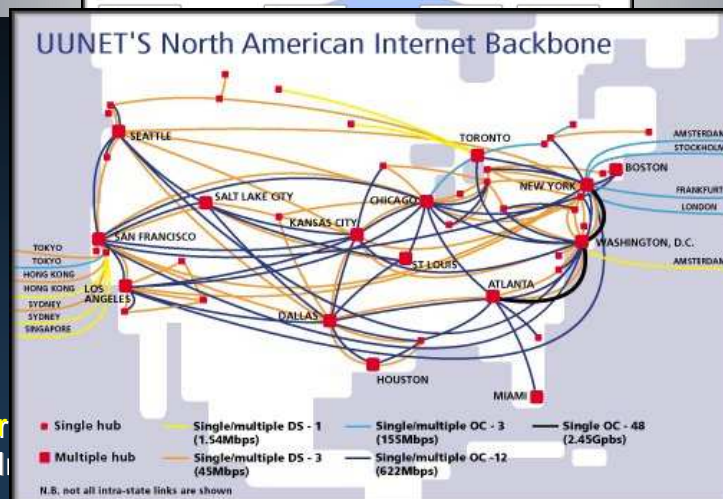
- Networks that connect LANs in geographically separated locations. Usually implemented with leased connections through a **telecommunications service provider (TSP)** network.
- A TSP traditionally transports voice and data on different networks. Now, providers are offering **converged** network services.



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The Internet : A Network of Networks

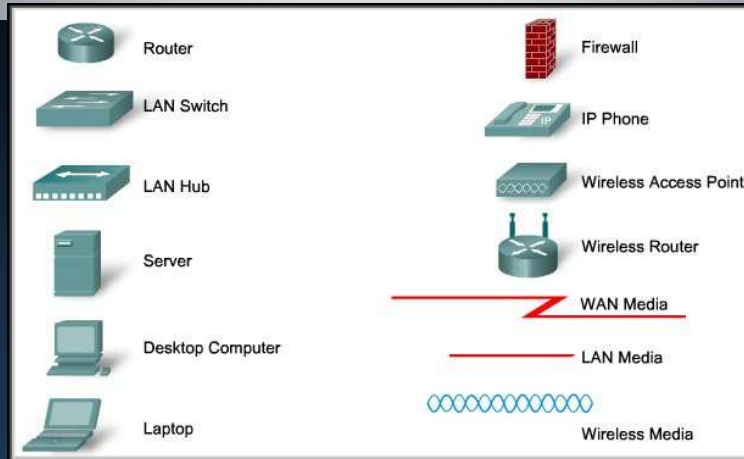


- The Internet, then, is a collection of ISPs co-operating with each other to form one large **converged** internetwork.

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Network Representations



- Specialized terminology is used to describe how these devices and media connect to one another.

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Network Representations

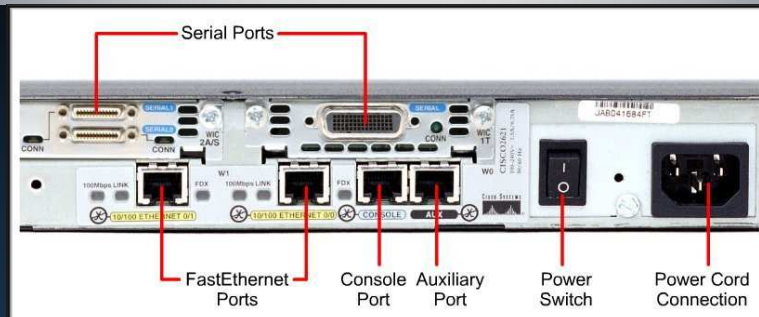
- **Network Interface Card (NIC):**
 - Provides the *physical connection to the network* at the PC or other host device.
- **Physical Port:**
 - A *connector or outlet on a networking device* where the media is connected to a host or other networking device.



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Network Representations



- **Interface:**
 - Specialized ports on an internetworking device that *connect to individual networks*.
 - Because **routers** are used to interconnect networks, the ports on a router are referred to as *network interfaces*.

Communicating Over the Network

Protocols

Rules That Govern Communications

- **Protocols:**
 - Are the rules that govern communications.

The format or structure of the message.

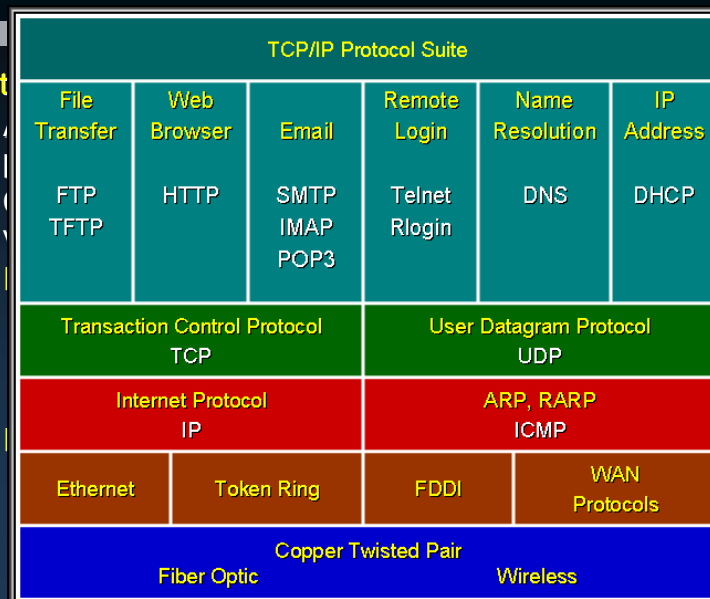
The method by which networking devices share information about pathways with other networks.

How and when error and system messages are passed between devices.

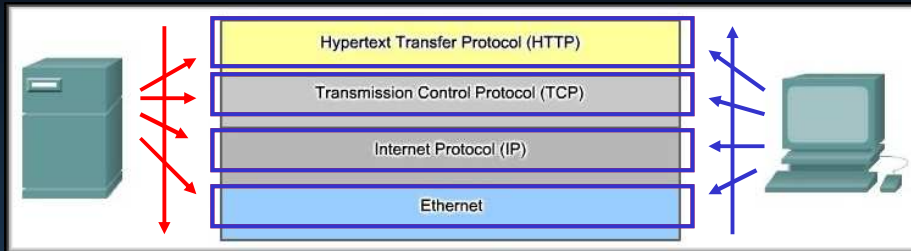
The setup and termination of data transfer sessions.

Protocol Suites

- Prot

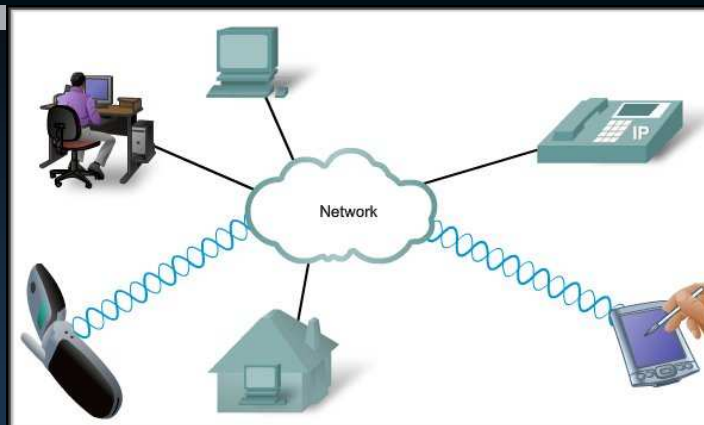


Interaction of Protocols



Each protocol at each layer of the protocol suite work together to make sure messages are received and understood by both devices.

Technology Independent Protocols



- *Protocols are not dependent upon any specific technology.*
 - They describe *what* must be done to communicate but *not how* its to be carried out.

Communicating Over the Network

Using Layered Models

Layered Models

| OSI Model | TCP/IP Protocol Suite | | | | | | TCP/IP Model |
|--------------|--|-------------|-------|-------------------------------|-----------------|------------|----------------|
| Application | File Transfer | Web Browser | Email | Remote Login | Name Resolution | IP Address | Application |
| Presentation | FTP | HTTP | SMTP | Telnet | DNS | DHCP | |
| Session | TFTP | | IMAP | Rlogin | | | |
| Transport | Transaction Control Protocol TCP | | | User Datagram Protocol UDP | | | Transport |
| Network | Internet Protocol IP | | | ARP, RARP ICMP | | | Internet |
| Data Link | Ethernet | Token Ring | FDDI | WAN Protocols | | | Network Access |
| Physical | Copper Twisted Pair Fiber Optic Wireless | | | | | | |

- Layered models separate the functions of specific protocols.

Benefits of a Layered Model

- **Benefits of a Layered Model:**
 - 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.
 - Prevents technology or capability *changes in one layer from affecting other layers* above and below.
 - *Provides a common language* to describe networking functions and capabilities.

Protocol and Reference Models

- **Protocol Model:**
 - Closely matches the structure of a *particular protocol suite*.
 - The set of related protocols in a suite typically represents all the functionality required to interface the human network with the data network.
 - The TCP/IP model is a *protocol model* because it describes the functions that occur at each layer of protocols *only within the TCP/IP suite*.



Protocol and Reference Models

- **Reference Model:**
 - Provides a *common reference* for maintaining consistency within *all types of network protocols* and services.
 - *Not* intended to be an implementation specification.
 - *Primary purpose is to aid in clearer understanding of the functions and process involved.*

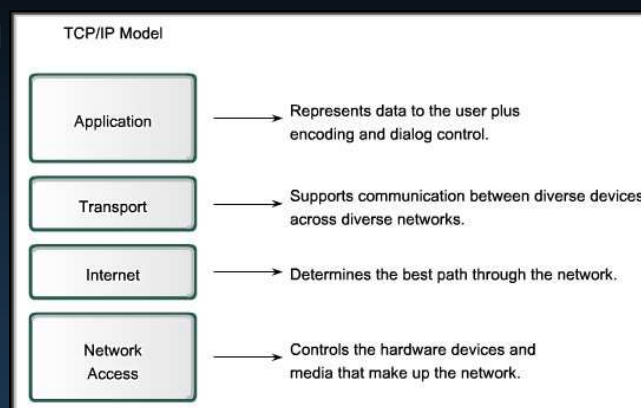


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TCP/IP Model


- **Open Standard**
- **No one company controls it.**
- **Governed by IETF Working Groups**
- Standards proposed using *Request for Comments (RFCs)*.



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Request For Comments RFC



The Internet Engineering Task Force

INTERNET PROTOCOL
DARPA INTERNET PROGRAM
PROTOCOL SPECIFICATION

September 1981

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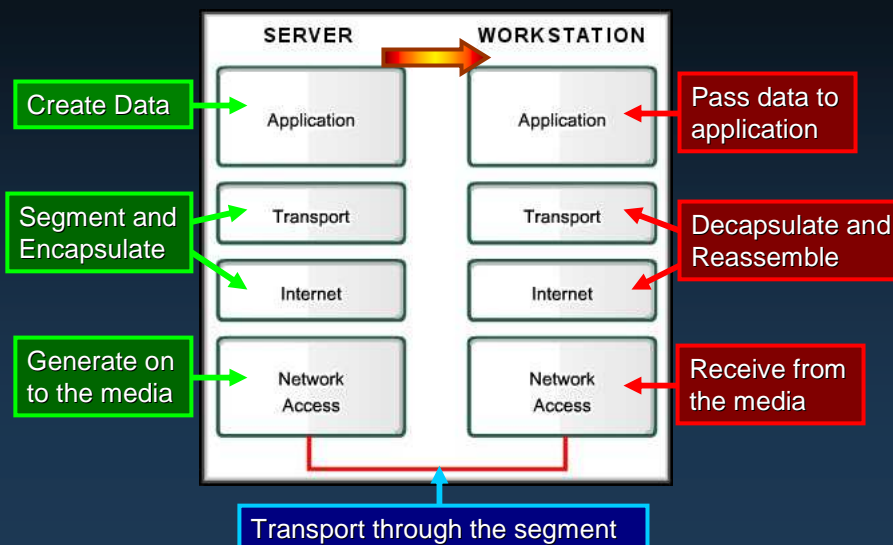
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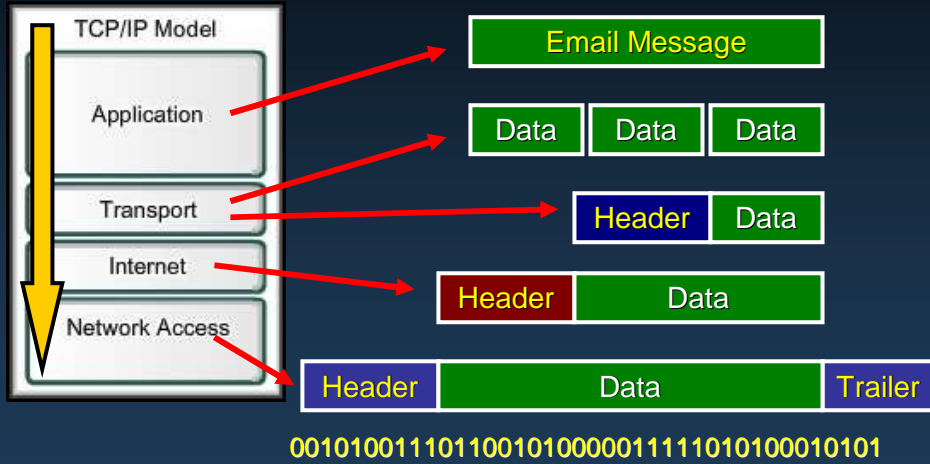
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The Communication Process



Protocol Data Units and Encapsulation

Segmentation and Encapsulation

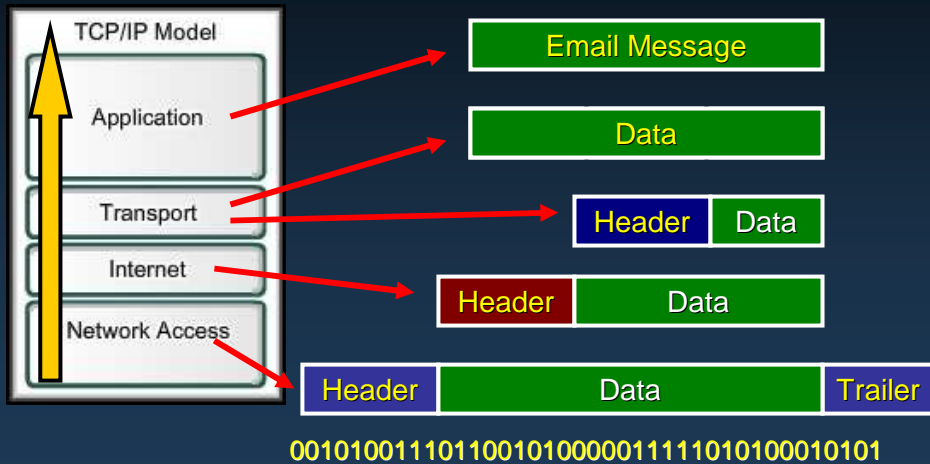


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Protocol Data Units and Encapsulation

Decapsulation and Reassembly

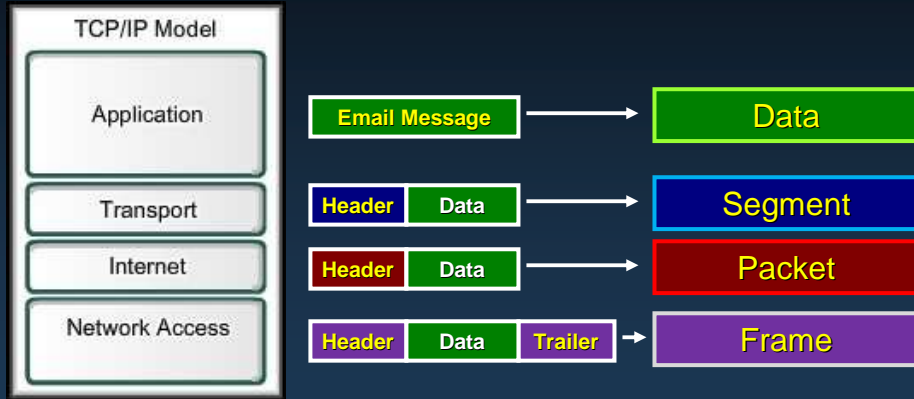


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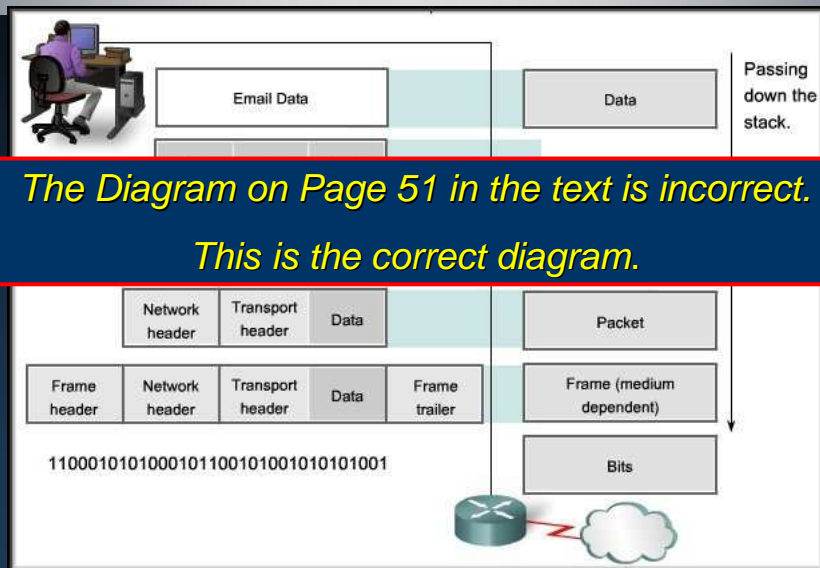
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Protocol Data Units and Encapsulation

Protocol Data Units



Protocol Data Units and Encapsulation



The Diagram on Page 51 in the text is incorrect. This is the correct diagram.

Communicating Over the Network

The OSI Model

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OSI Model



- The **International Organization for Standardization (ISO)** released the **Open Systems Interconnection (OSI)** reference model in 1984.
- www.iso.org for more information

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OSI Model

- **Breaks network communication** into smaller, **more manageable parts**.
 - Makes learning it easier to understand.
 - Prevents changes in one layer from affecting other layers.
- **Standardizes network components** to allow **multiple vendor** development and support.
- Allows **different types** of network hardware and software **to communicate** with each other.
- It is a **descriptive scheme**.

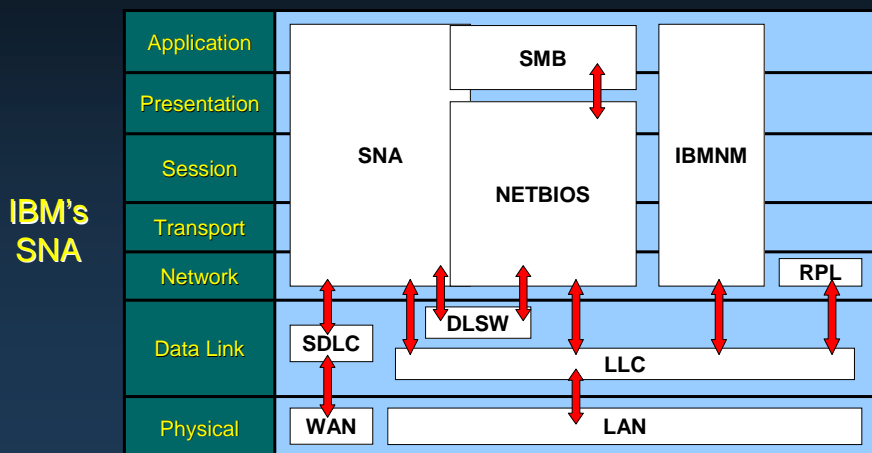


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OSI Model - Example - *FYI*

- **Descriptive Scheme:** Can be used to describe the functionality and interaction of different protocol suites.

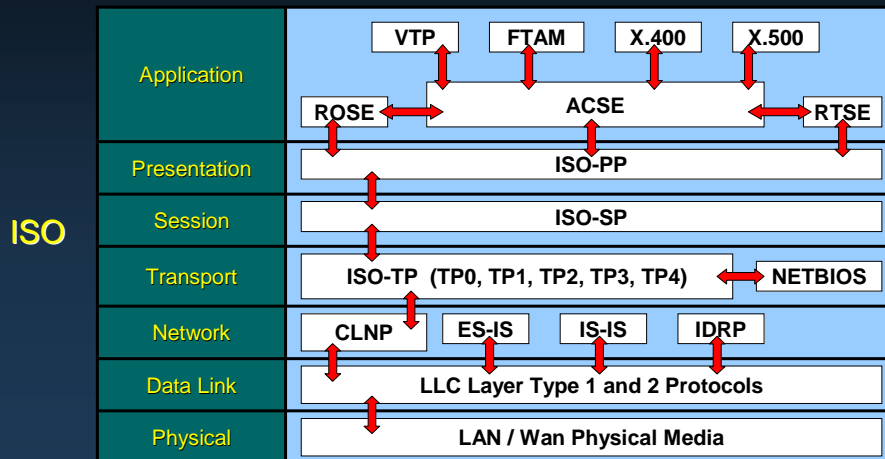


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OSI Model – Example - *FYI*

- **Descriptive Scheme:** Can be used to describe the functionality and interaction of different protocol suites.

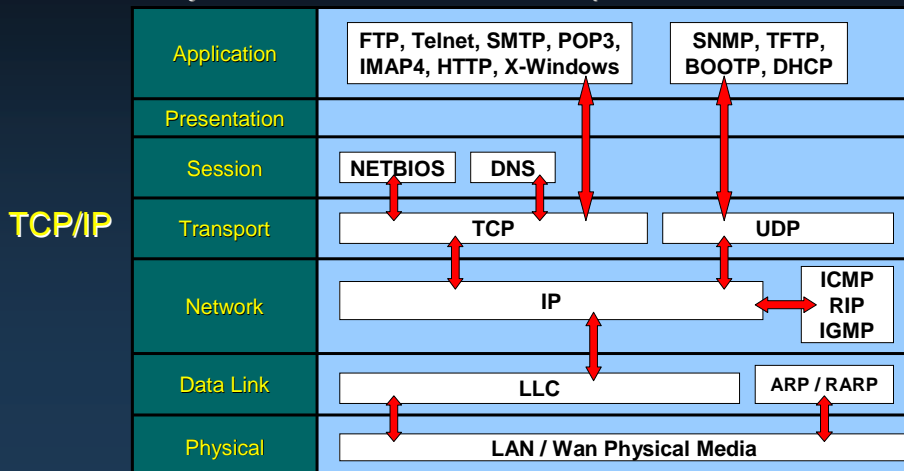


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OSI Model – Example - *FYI*

- **Descriptive Scheme:** Can be used to describe the functionality and interaction of different protocol suites.



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OSI Model

| | Layers | <u>CISCO</u> | <u>MICROSOFT</u> | |
|--|--------|--------------|------------------|---------|
| Usually referenced by layer number | 7 | Application | All | Away |
| | 6 | Presentation | People | Pizza |
| These two layers are not commonly referred to in most instances. | 5 | Session | Seem | Sausage |
| | 4 | Transport | To | Throw |
| | 3 | Network | Need | Not |
| | 2 | Data Link | Data | Do |
| | 1 | Physical | Processing | Please |

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OSI Model

| | Layers | <u>CISCO</u> | <u>MICROSOFT</u> | |
|--|--------|--------------|------------------|---------|
| Primary concern: Communications between applications | 7 | Application | All | Away |
| | 6 | Presentation | People | Pizza |
| | 5 | Session | Seem | Sausage |
| | 4 | Transport | To | Throw |
| Primary concern: Moving raw data cross the network | 3 | Network | Need | Not |
| | 2 | Data Link | Data | Do |
| | 1 | Physical | Processing | Please |

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Communicating Over the Network

Network Addressing

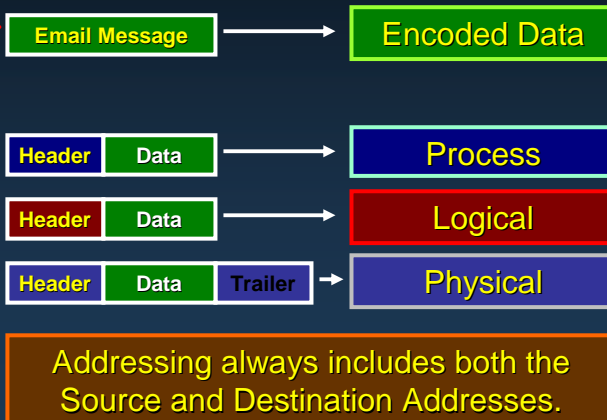
OSI Model

| OSI Model Layer | Addressing |
|-----------------|---|
| Application | Encoded Application Data (Usually referred to as the <u>Upper Layers</u>) |
| Presentation | |
| Session | |
| Transport | Source and Destination: Process Address |
| Network | Source and Destination: Logical Network Address |
| Data Link | Source and Destination: Device Physical Address |
| Physical | Timing and Synchronization Bits |

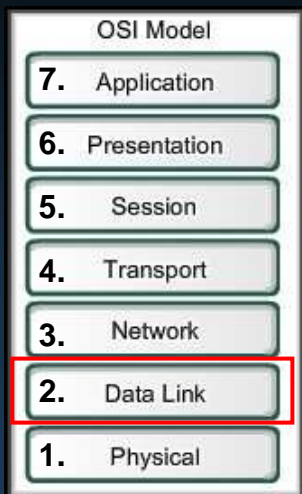
Getting Data to the End Device



Encapsulation Process and Addressing

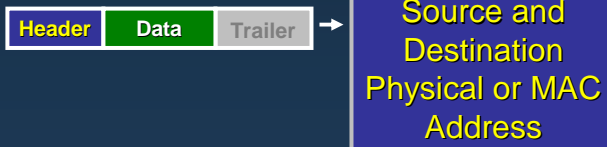


Getting Data to the End Device



Layer 2 Addressing

- Delivery on a *single local network*.
- Unique on the network and represents the device.
- Codes placed on the **NIC** by the manufacturer.
- Referred to as the *physical address* or the *MAC address*.



Getting Data to the End Device

Layer 2 Header



Getting Data Through The Network

Layer 3 Addressing



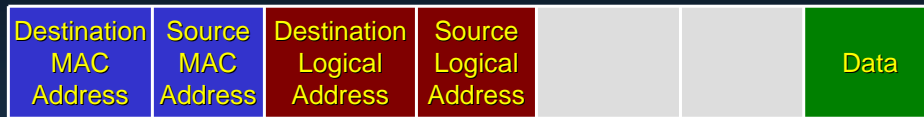
- Move data from one local network to another local network.
- **Addresses must identify both the network and the host on that network.**
- Used by routers to determine the best path to the destination host.



Source and
Destination
Logical Network
Address
(IP, IPX, etc.)

Getting Data Through the Network

Layer 2 Header



Layer 3 Header

Getting Data to the Right Application



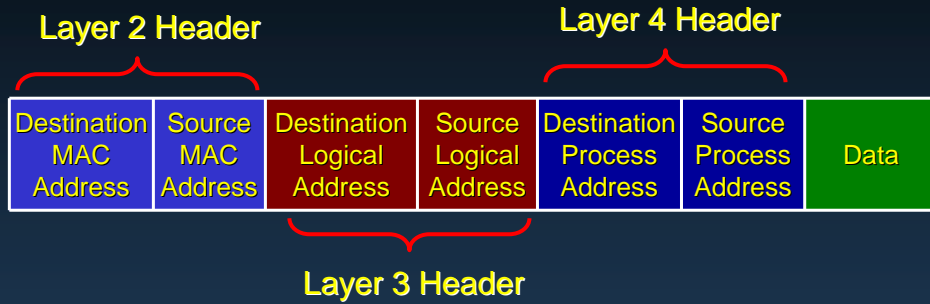
Layer 4 Addressing

- Identifies the *specific process* or service running on the destination host *that will act on the data*.
- *Multiple, simultaneous applications.*

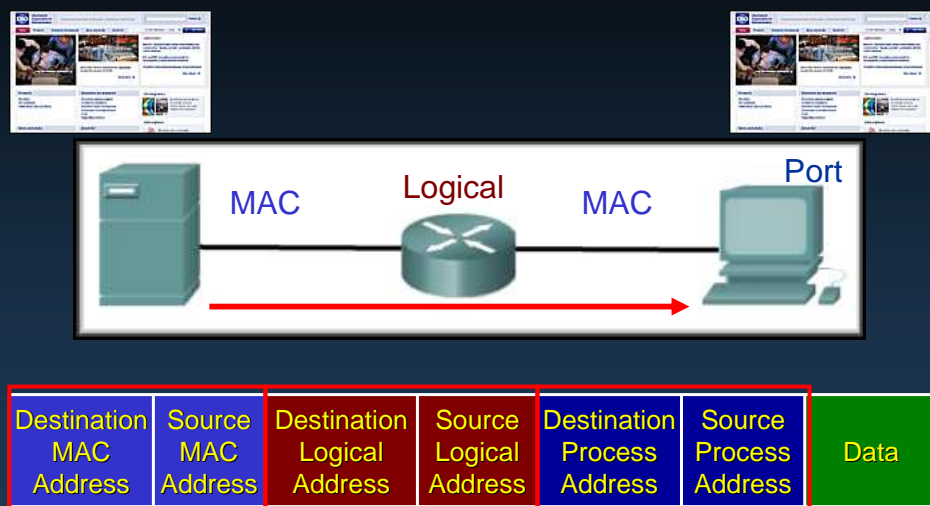


- Under TCP/IP, a *port number* to identify the application.
 - **Port 80:** HTTP (Web Browser)
 - **Port 25:** SMTP (Email)
 - **Port 194:** IRC (Internet Relay Chat)

Getting Data to the Right Application



Putting It All Together



Comparing the OSI and TCP/IP Models

| OSI Model | Layer Function | Protocol Data Unit | Device | TCP/IP Model |
|-----------|----------------|--------------------|--------|----------------|
| 7 | Application | Character | | Application |
| 6 | Presentation | | | |
| 5 | Session | | | |
| 4 | Transport | Segment | | Transport |
| 3 | Network | Packet | Router | Internet |
| 2 | Data Link | Frame | Switch | Network Access |
| 1 | Physical | Bit | Hub | |

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Chapter 2

Brain a little fuzzy?

- You need to learn to crawl before you can walk and walk before you can run.
- We are starting with the theory and concepts and will move on to the actual design and implementation of networks.



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