Chapter 2

Communicating Over The Network

Communicating Over the Network

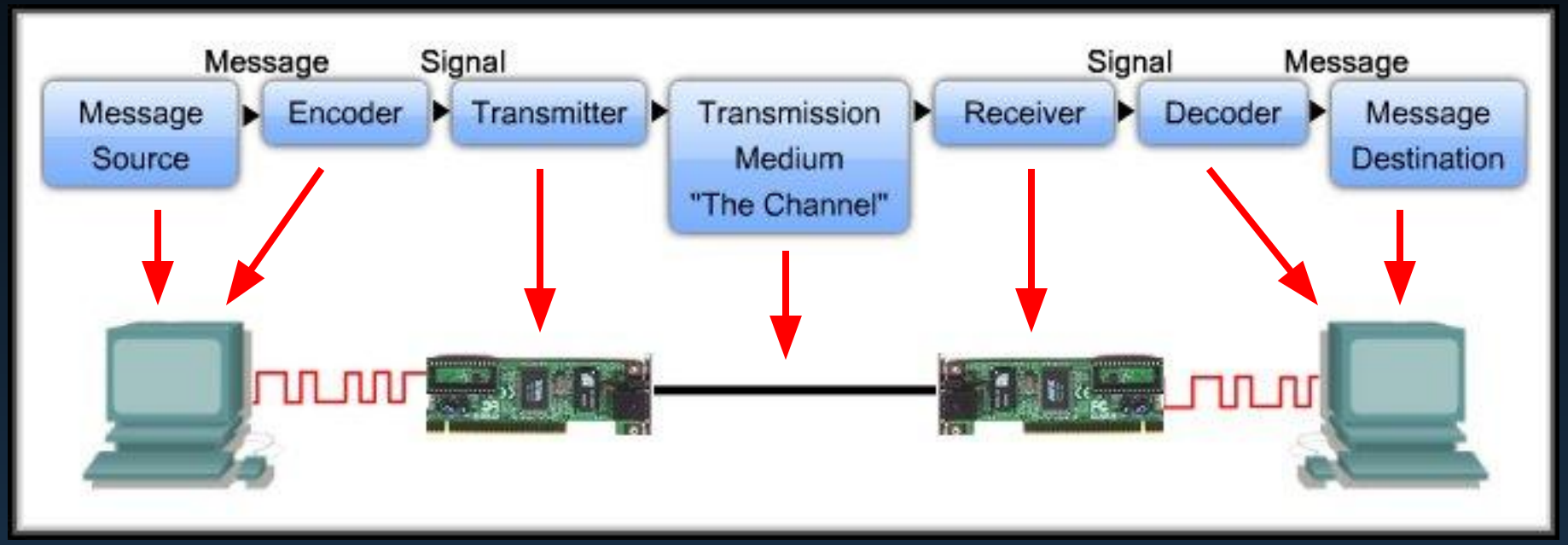
The Platform for Communications

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.

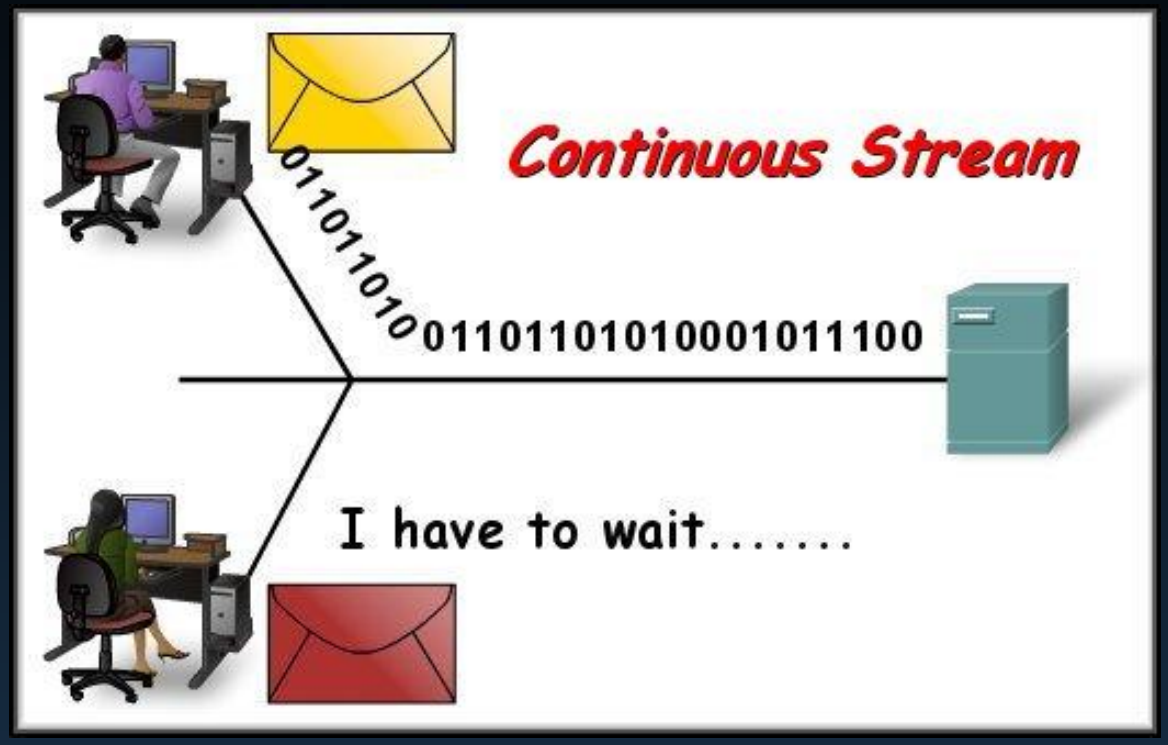
Elements of Communication

- Devices communicate in exactly the same way.



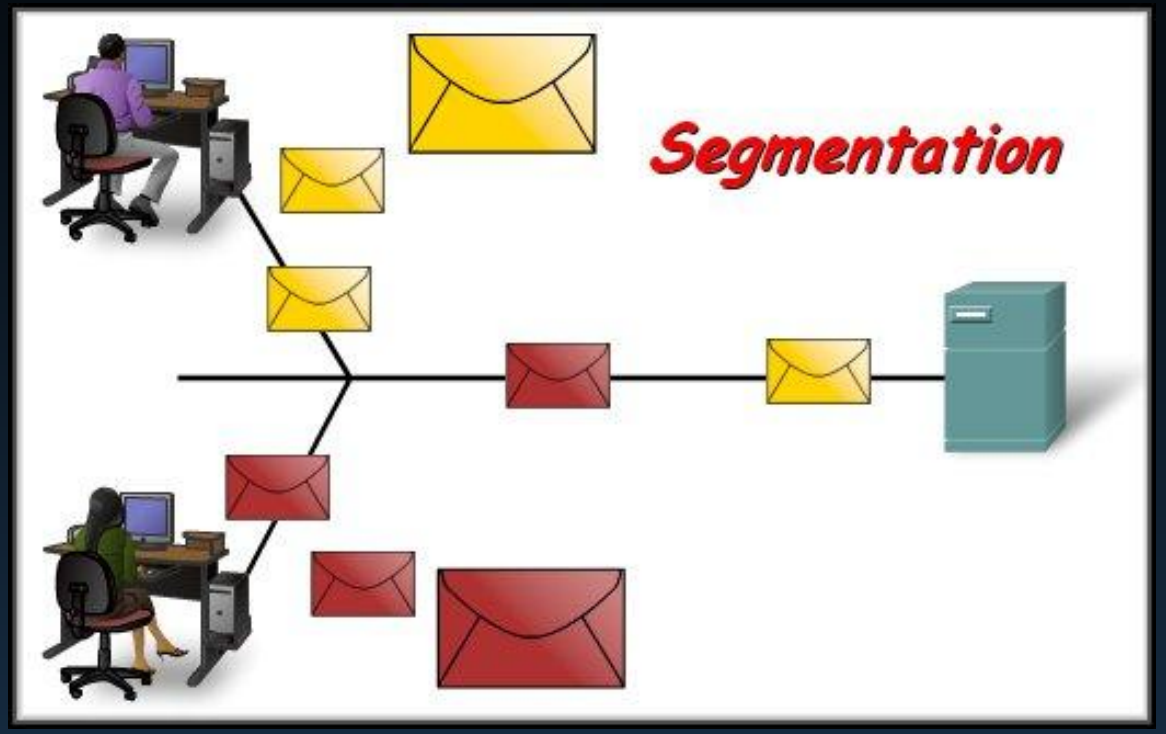
Communicating the Messages

- 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.



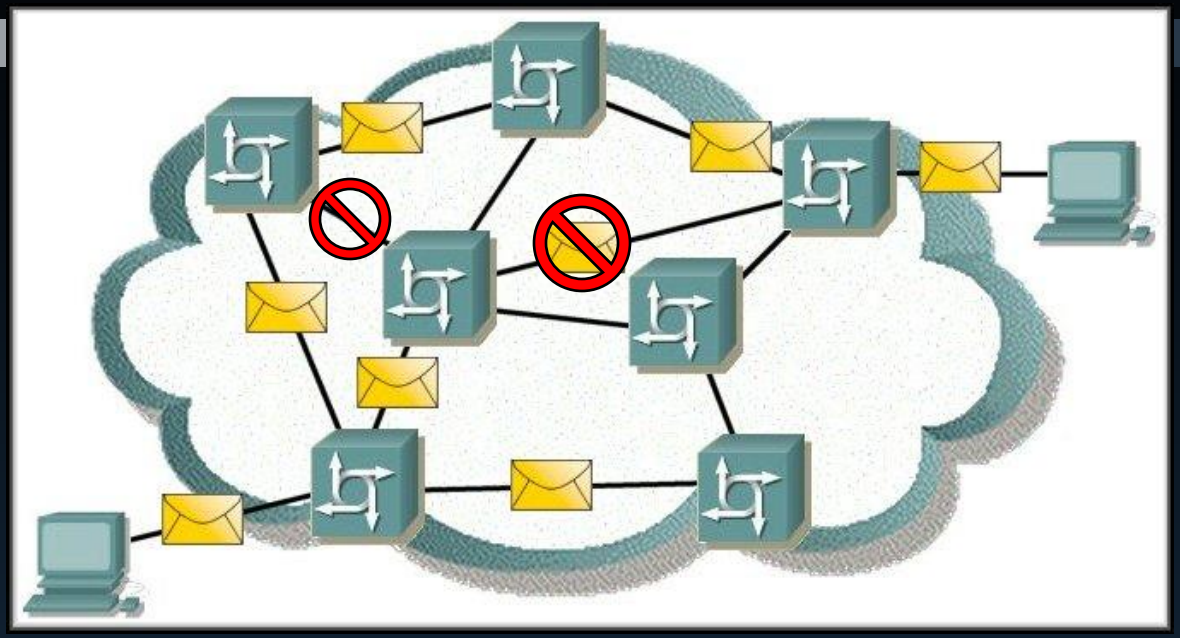
Communicating the Messages

- 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



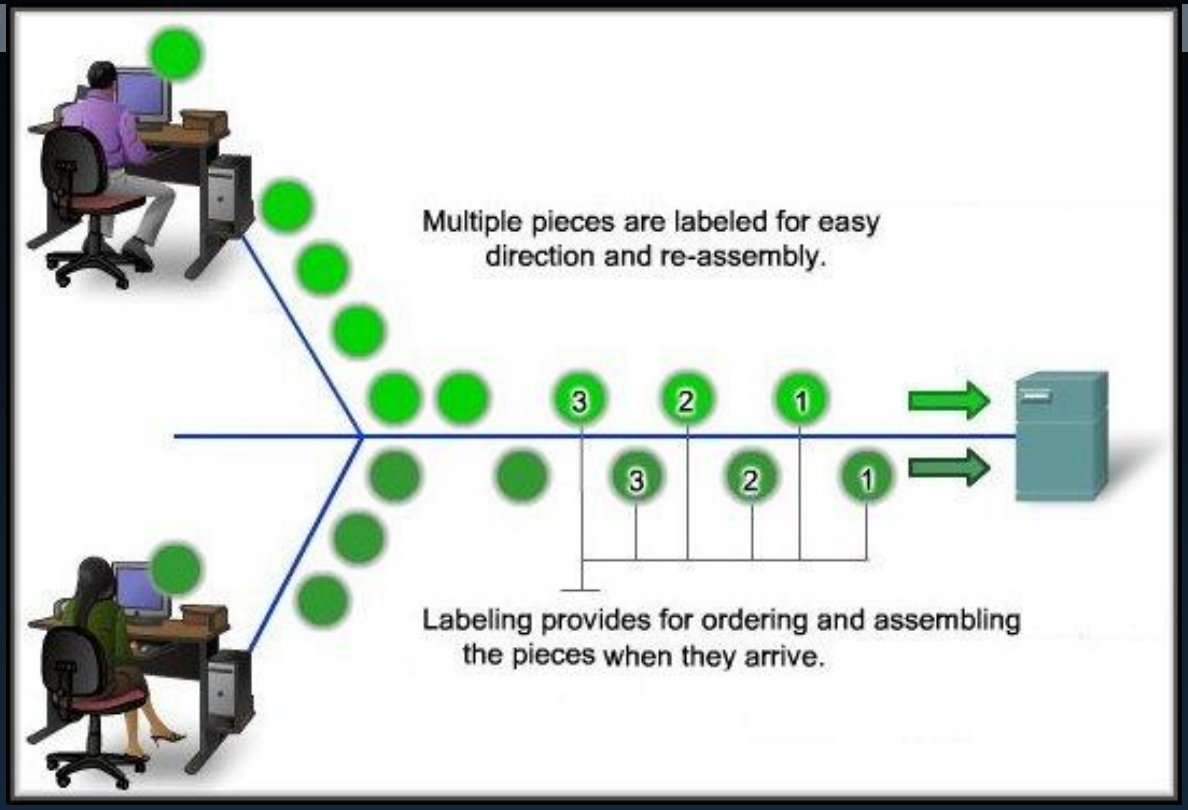
Communicating the Messages

In a packet switched network like the Internet.



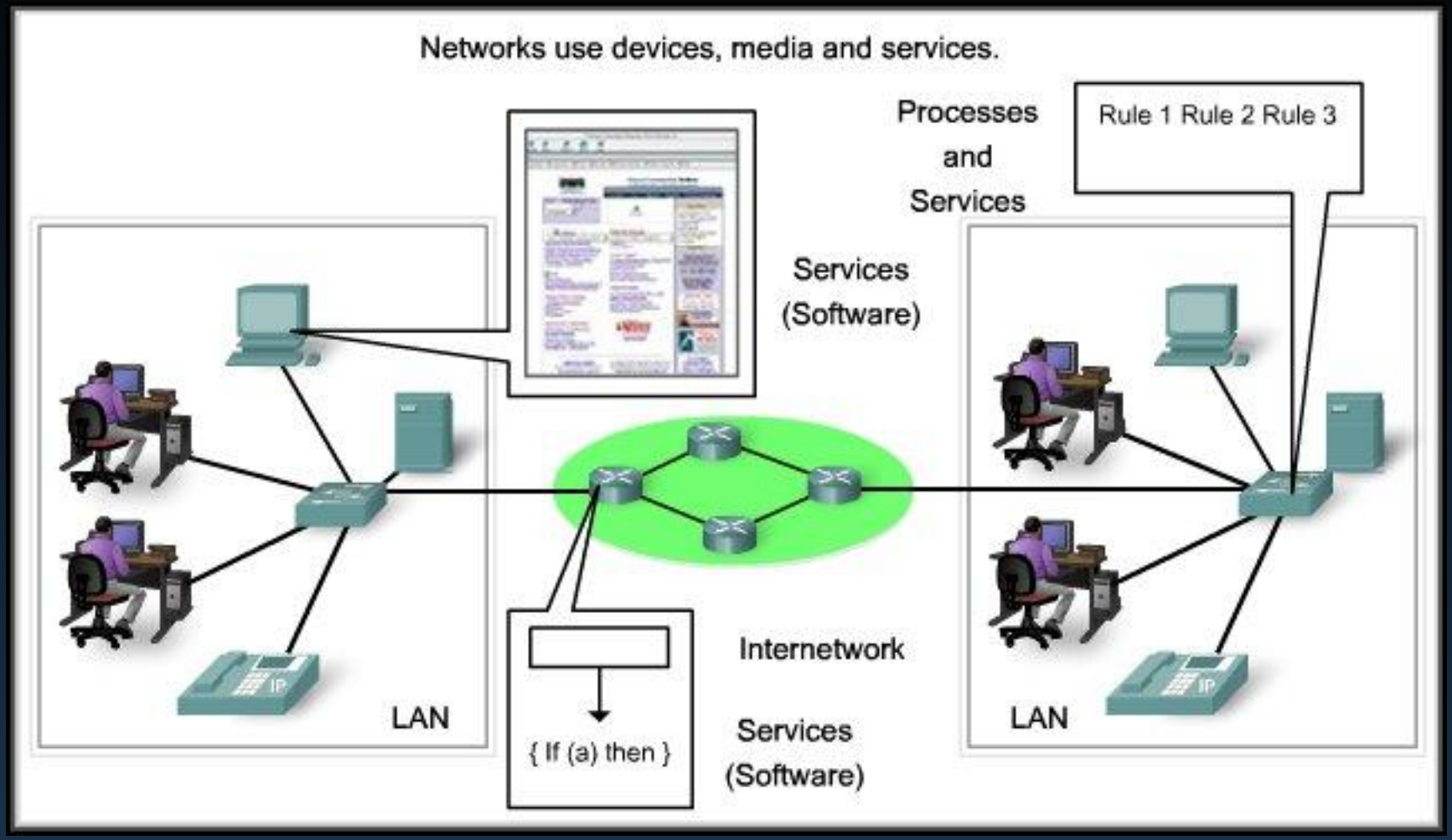
- Segmentation and Reliability:
  - Increases the reliability of network communications.
  - Separate pieces of each message can travel across different paths to destination.
  - Path fails or congested, alternate path can be used.
  - Part of the message fails to make it to the destination, only the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

Communicating the Messages

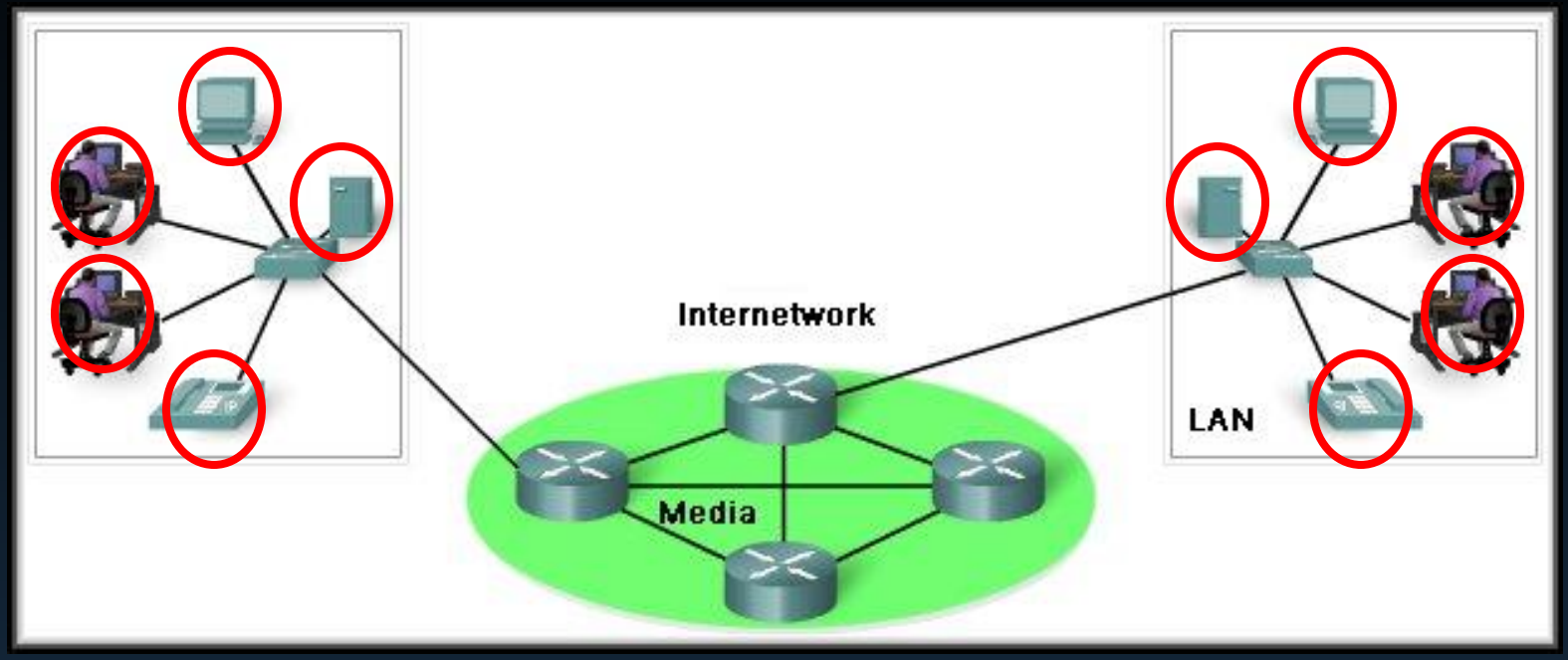


- Segmentation Disadvantage: Added level of complexity.
  - The label is a unique sequence number.
  - Handled by protocols that format and address the message.

Components of the Network



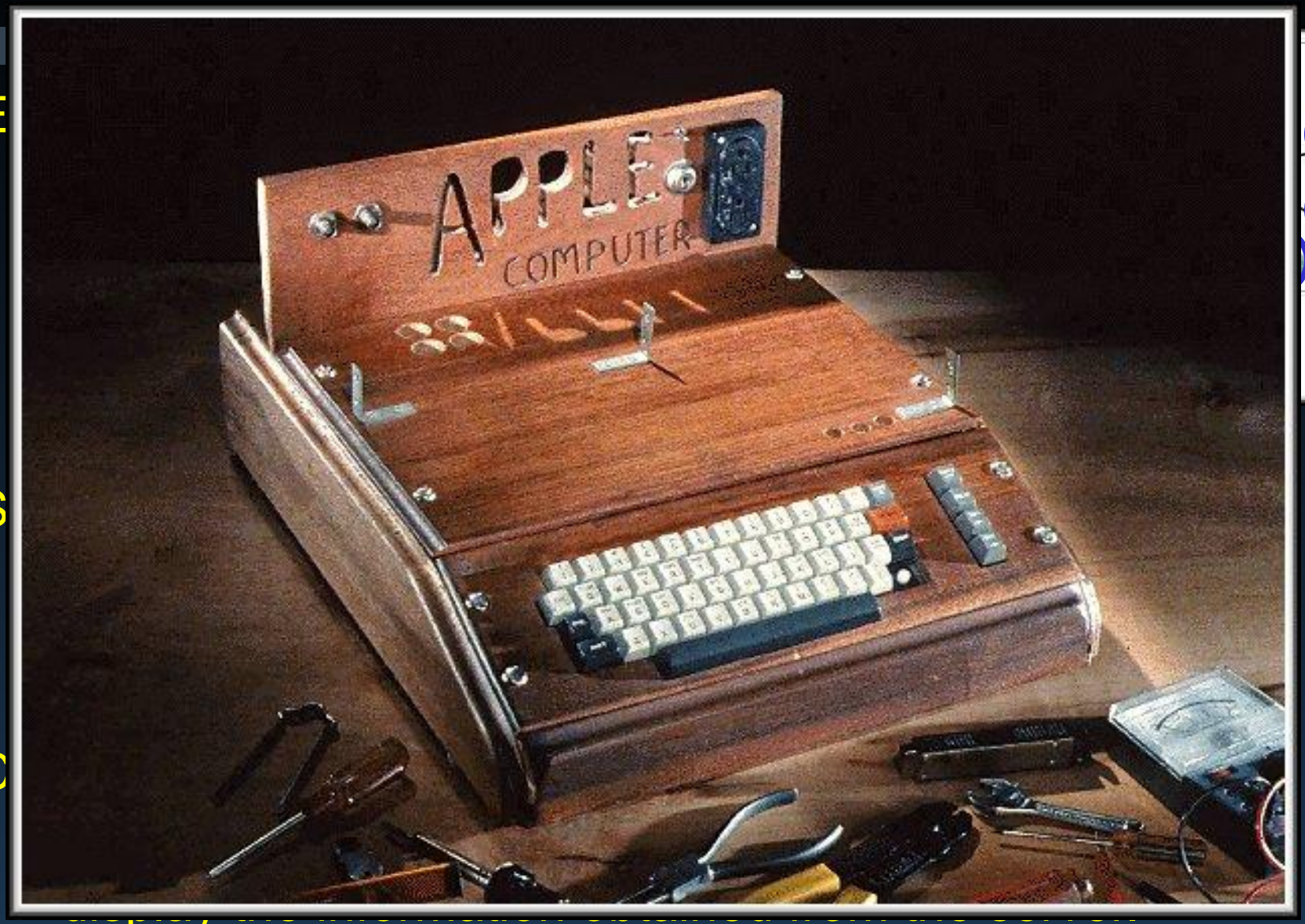
End Devices



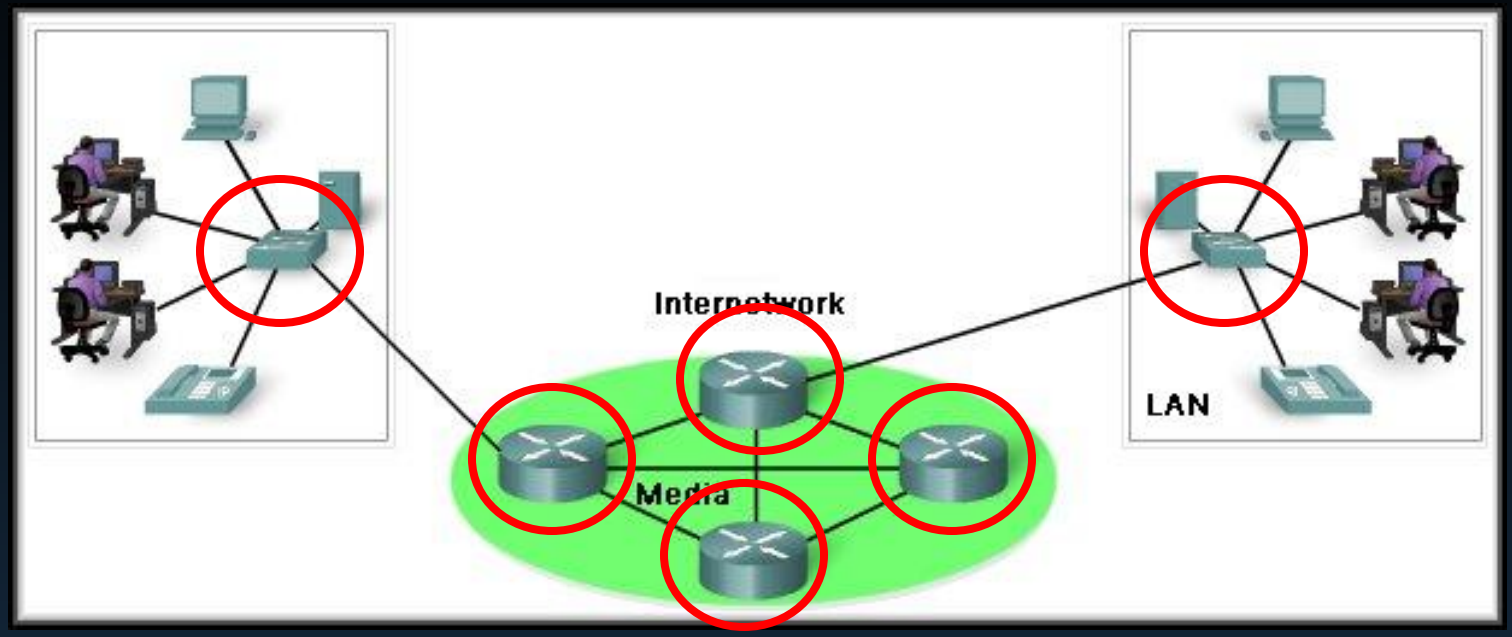
- Work Stations, Servers, Laptops, Printers, VoIP Phones, Security Cameras, PDAs.....
- Any device that allows us to interface with the network.
- End devices are referred to as hosts and are either the source or destination of a message.

End Devices

- E
- S
- C



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.

Intermediary Devices

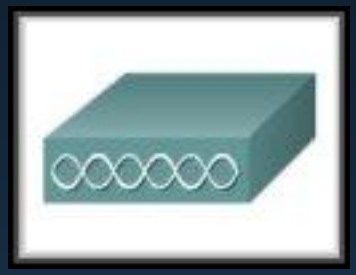
- Manage data as it flows through the network.
- Some use the destination host address and network interconnection information to find the best path through the network.

Routers

Switches

Firewalls

Access Points

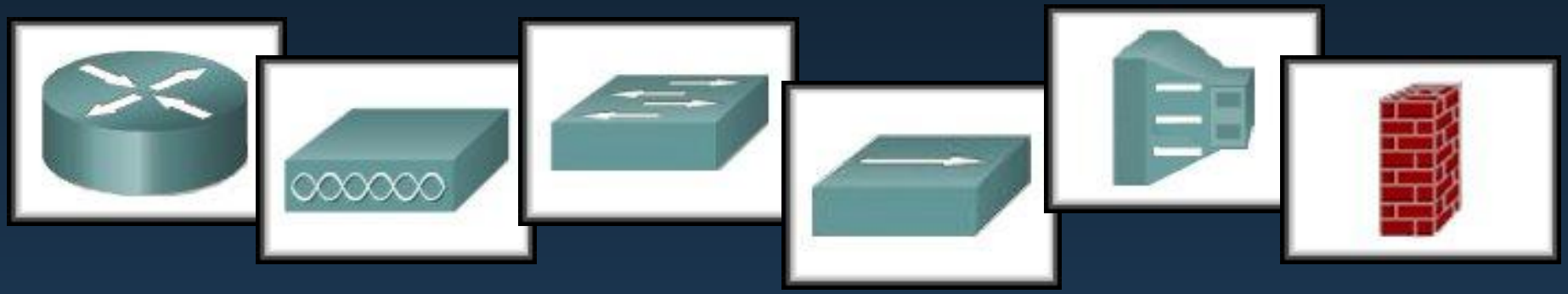


Hubs

Multiplexers

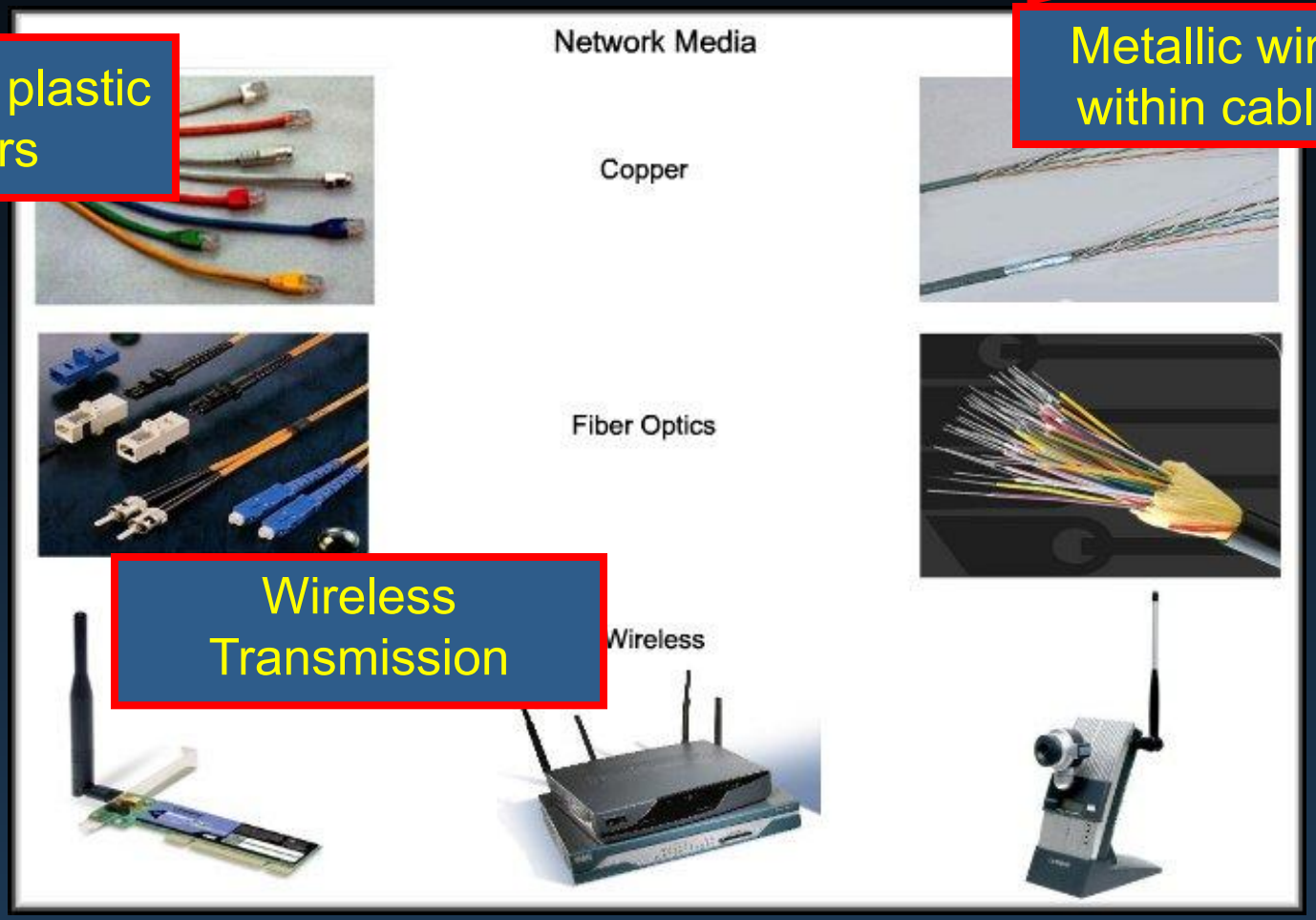
Intermediary Devices

- 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.



Media

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



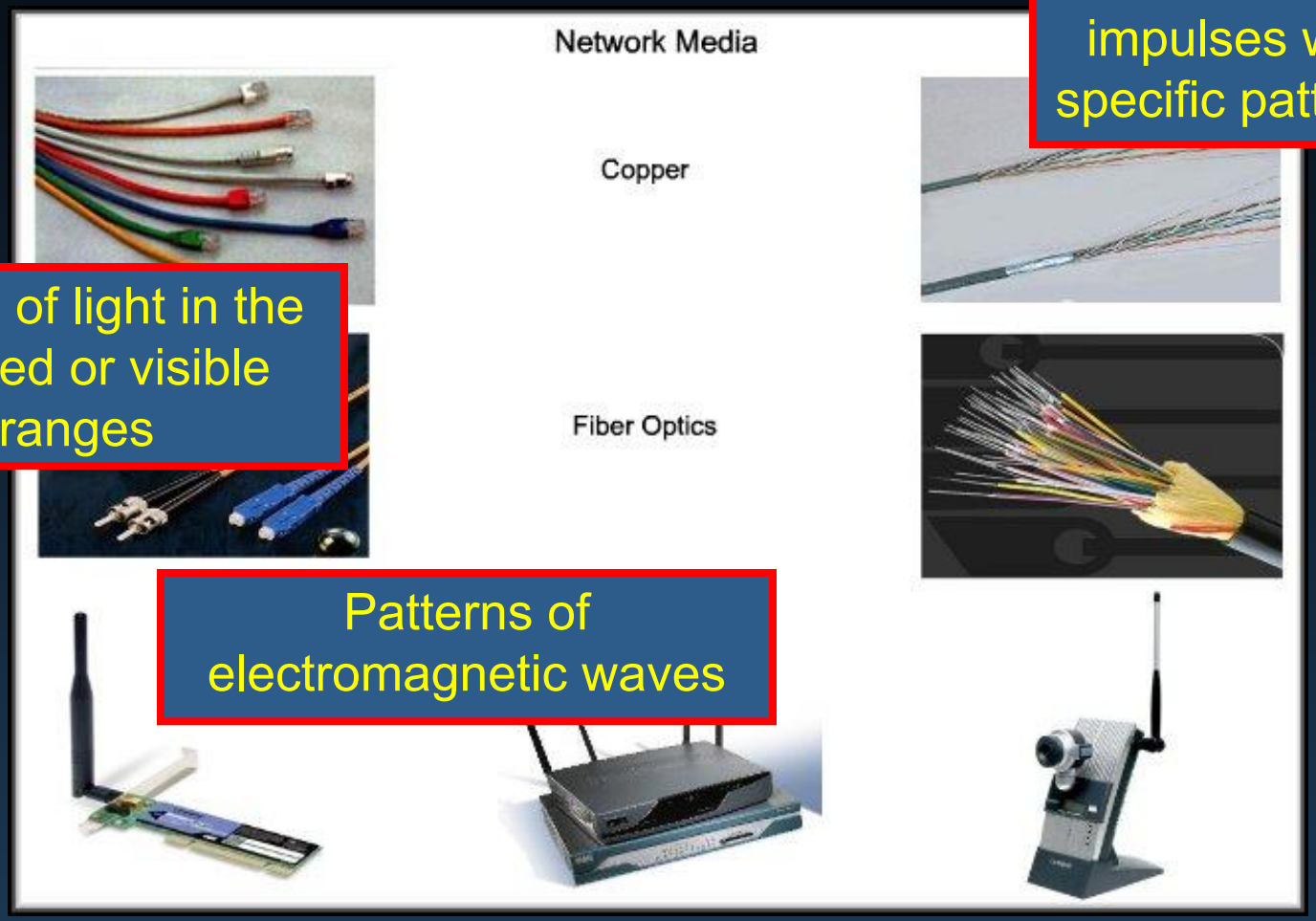
Glass or plastic fibers

Metallic wires within cables

Wireless Transmission

Media

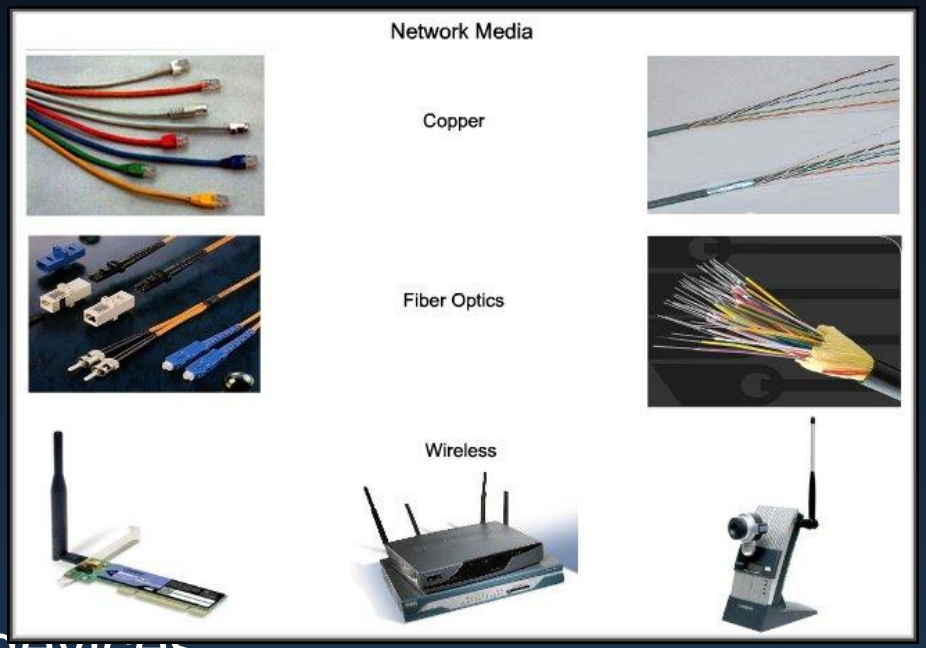
- The signal encoding that must occur is different for each type of media.



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



Communicating Over the Network

LANs, WANs and Internetworks

Local Area Networks

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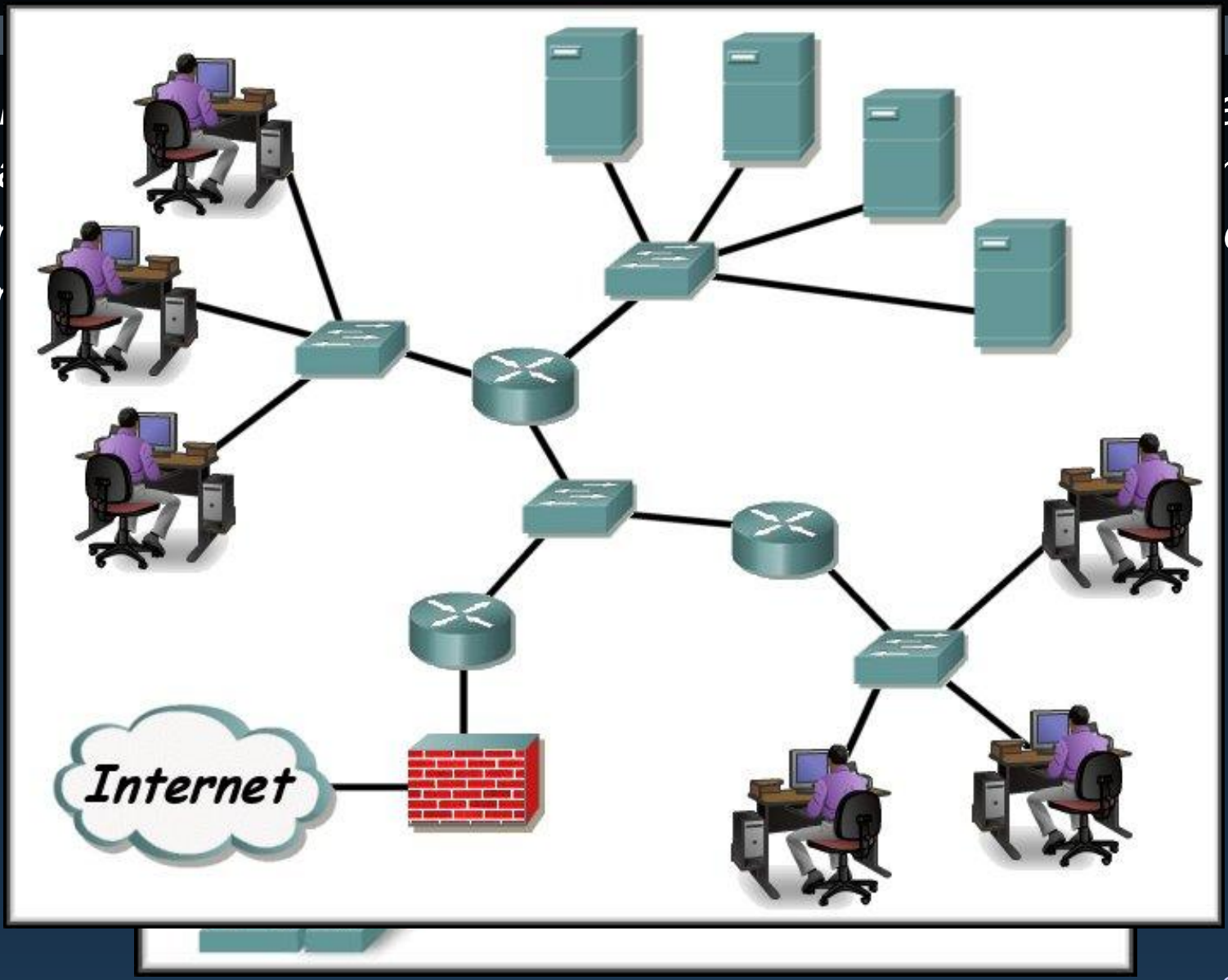
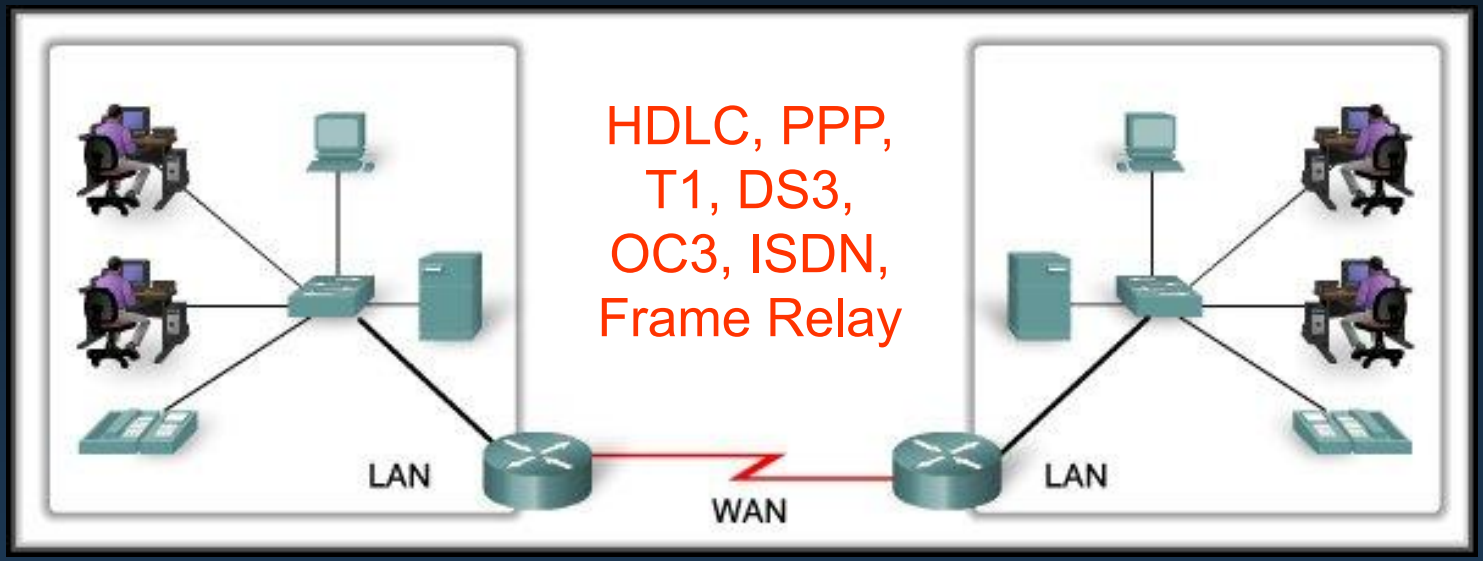
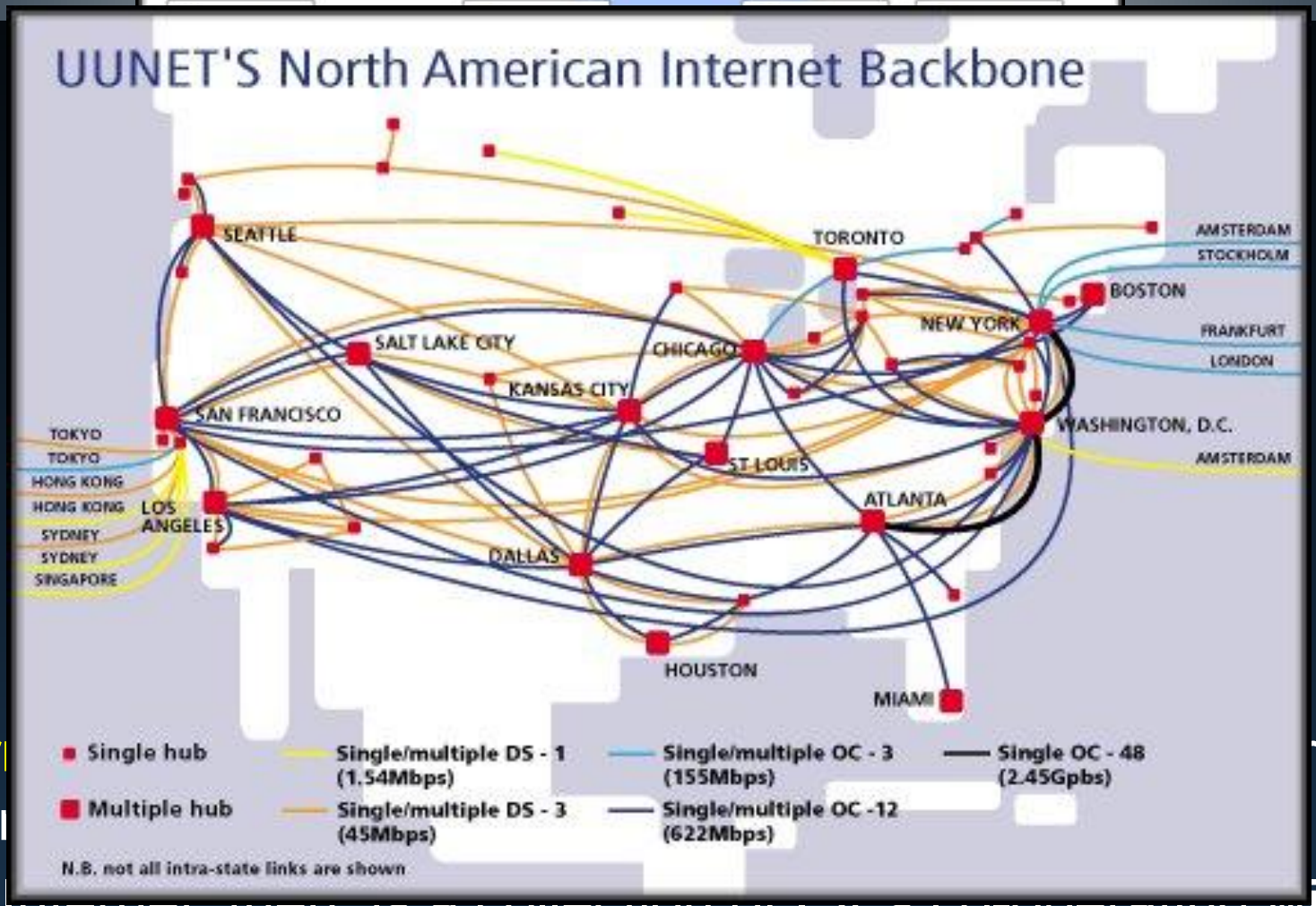


Wide Area Networks

- *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.

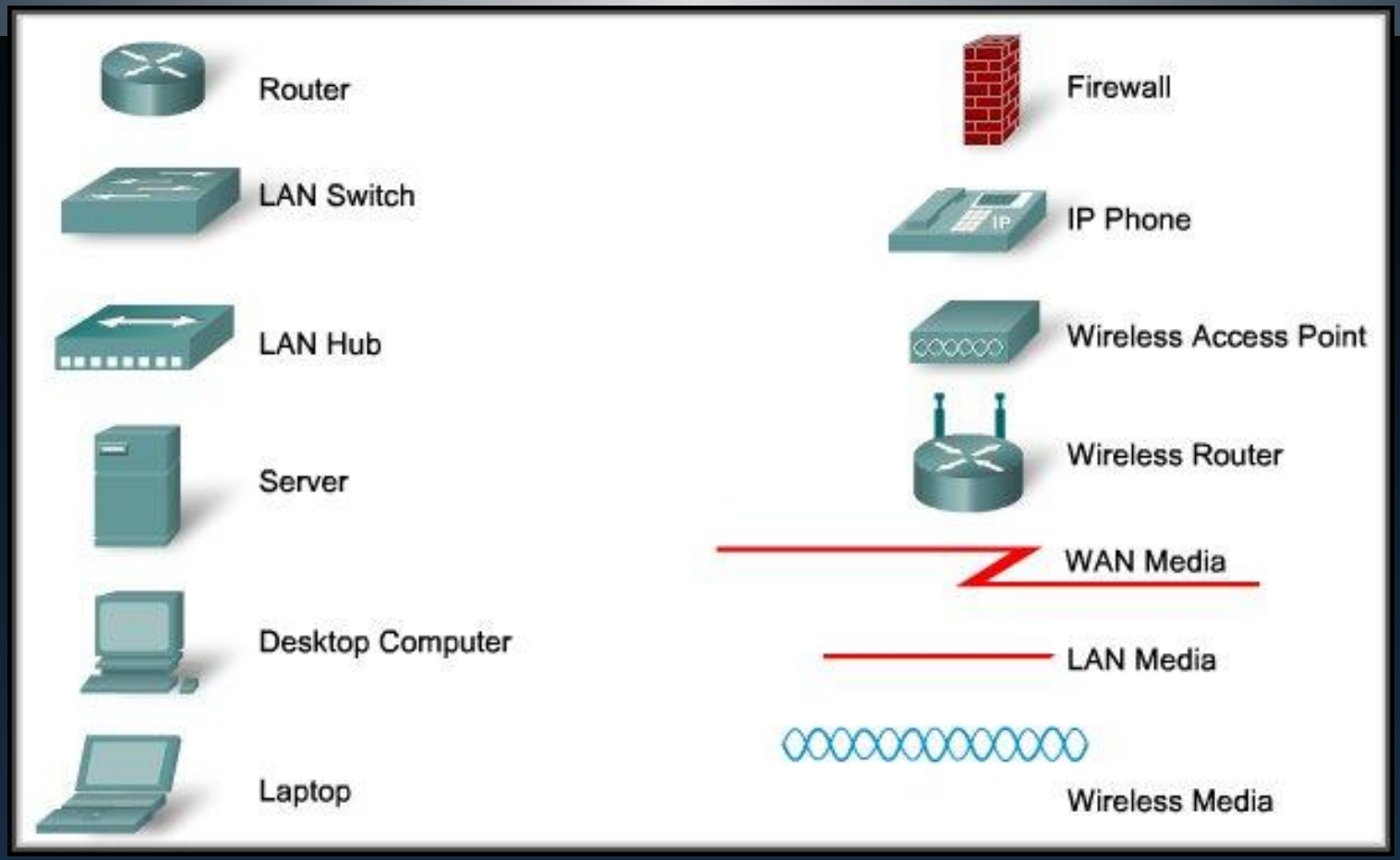


The Internet : A Network of Networks



- Inter … rs to the I…
- The Internet, then, is a collection of ISP's co-operating with each other to form one large converged internetwork.

Network Representations



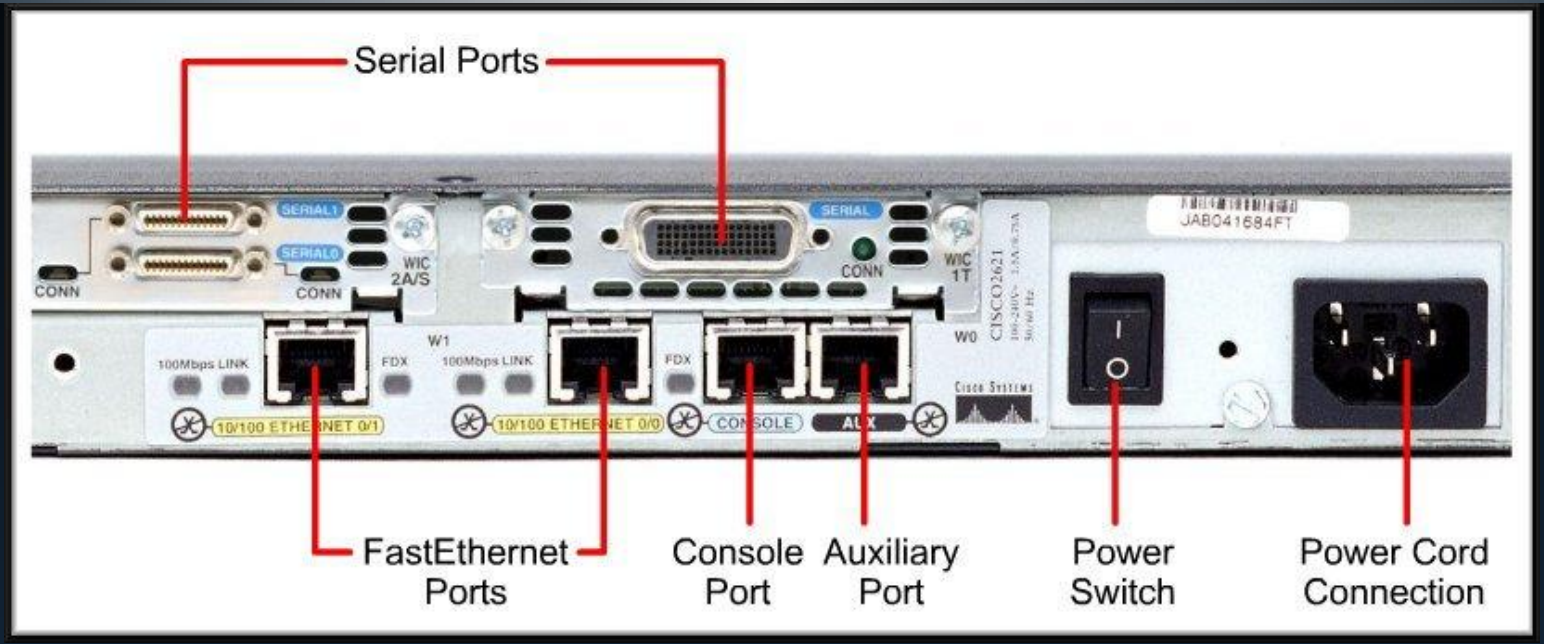
- Specialized terminology is used to describe how these devices and media connect to one another.

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.

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

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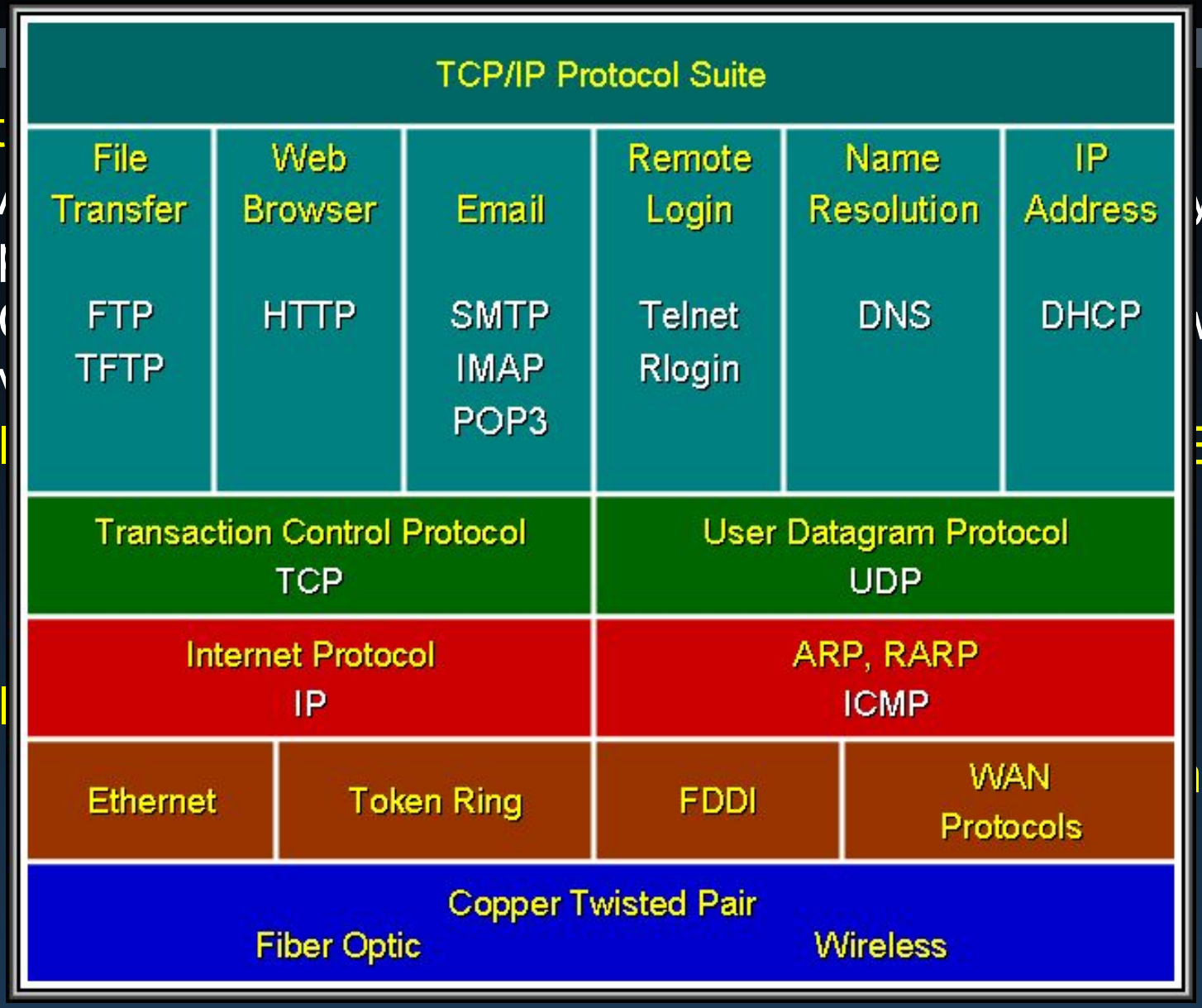
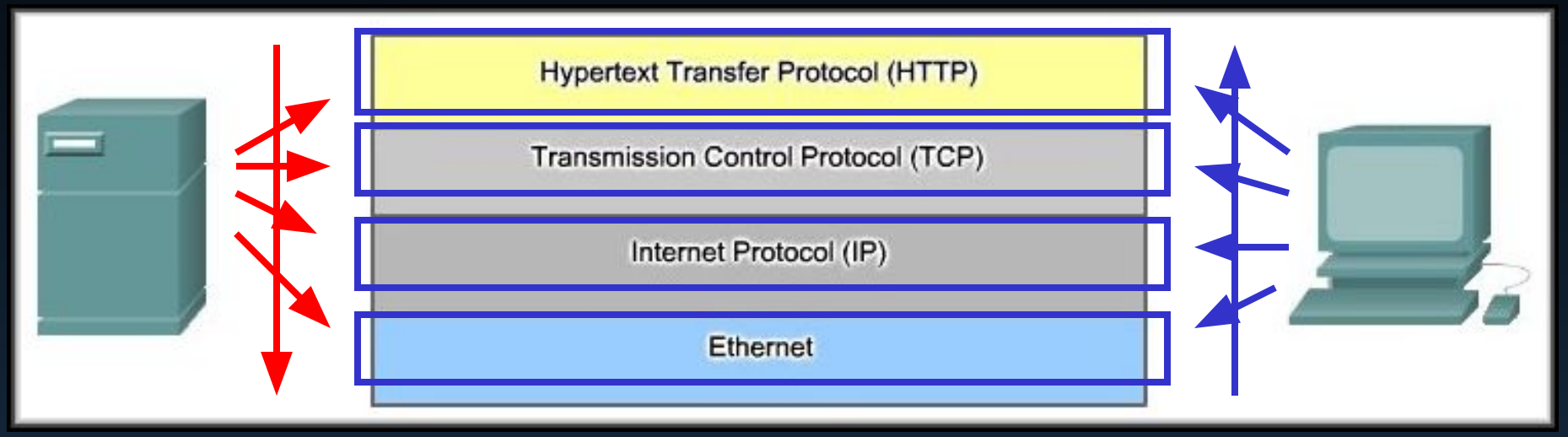
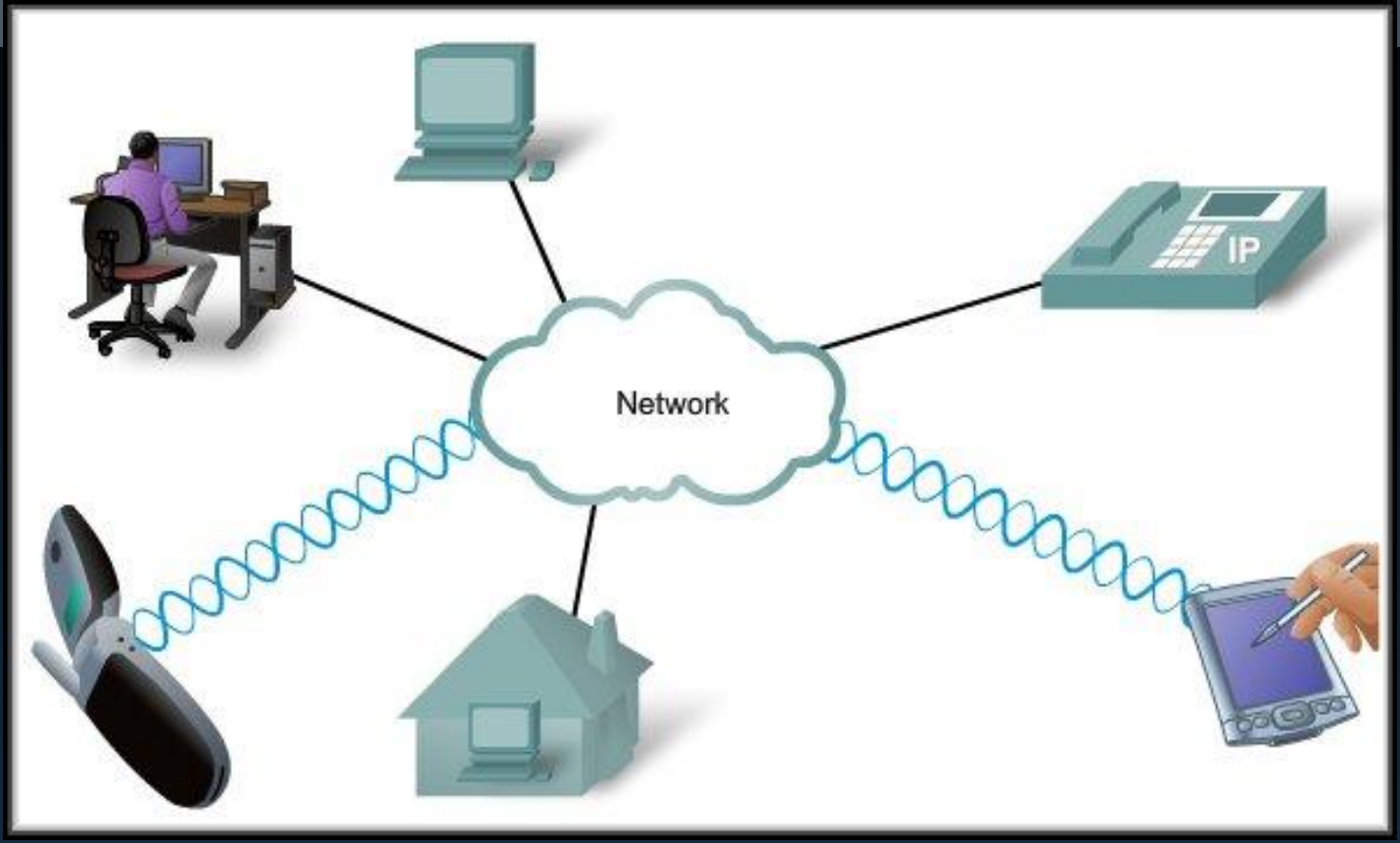


Interaction of Protocols



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

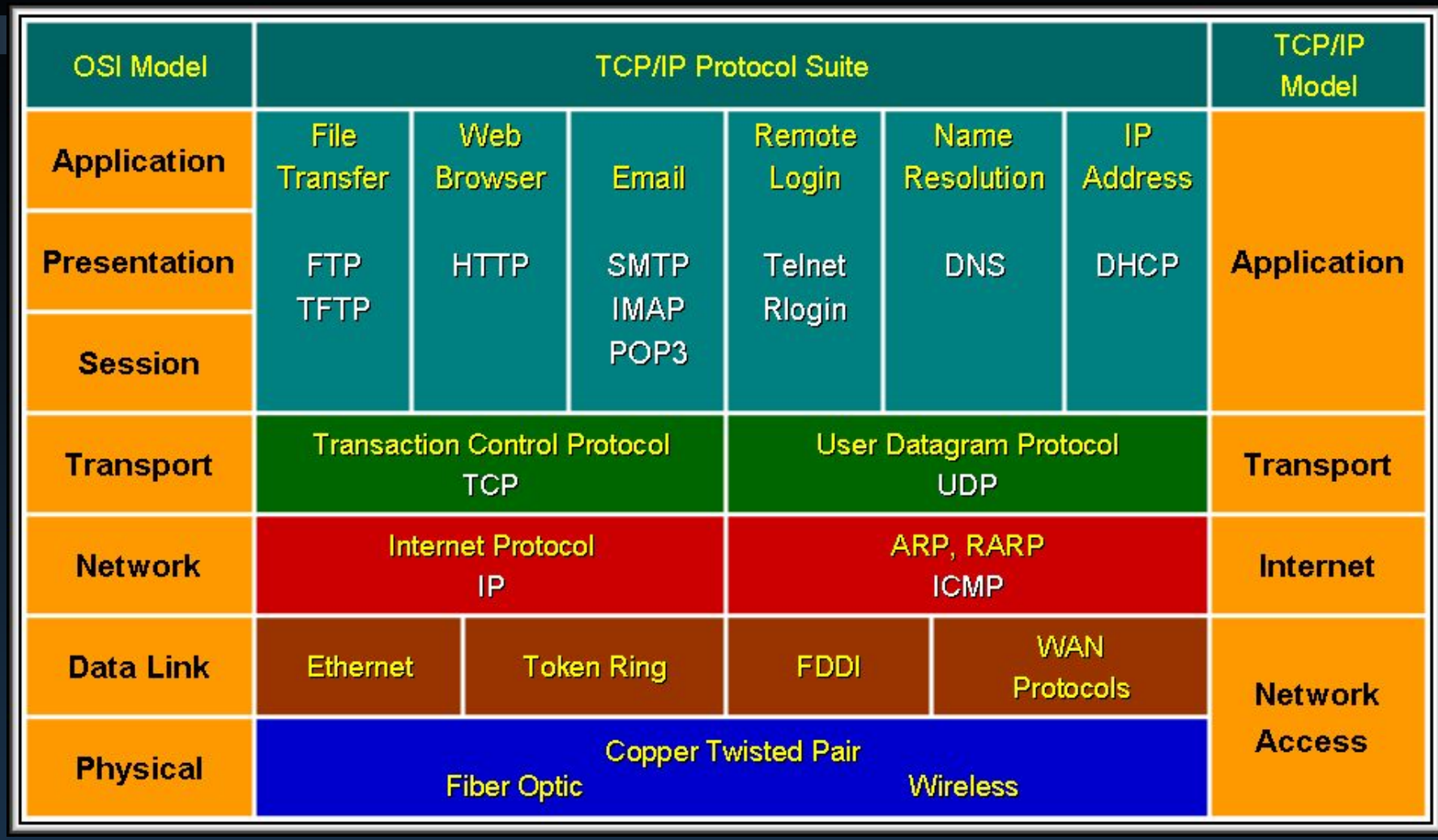
Technology Independent Protocols



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

Using Layered Models

Layered Models



- 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

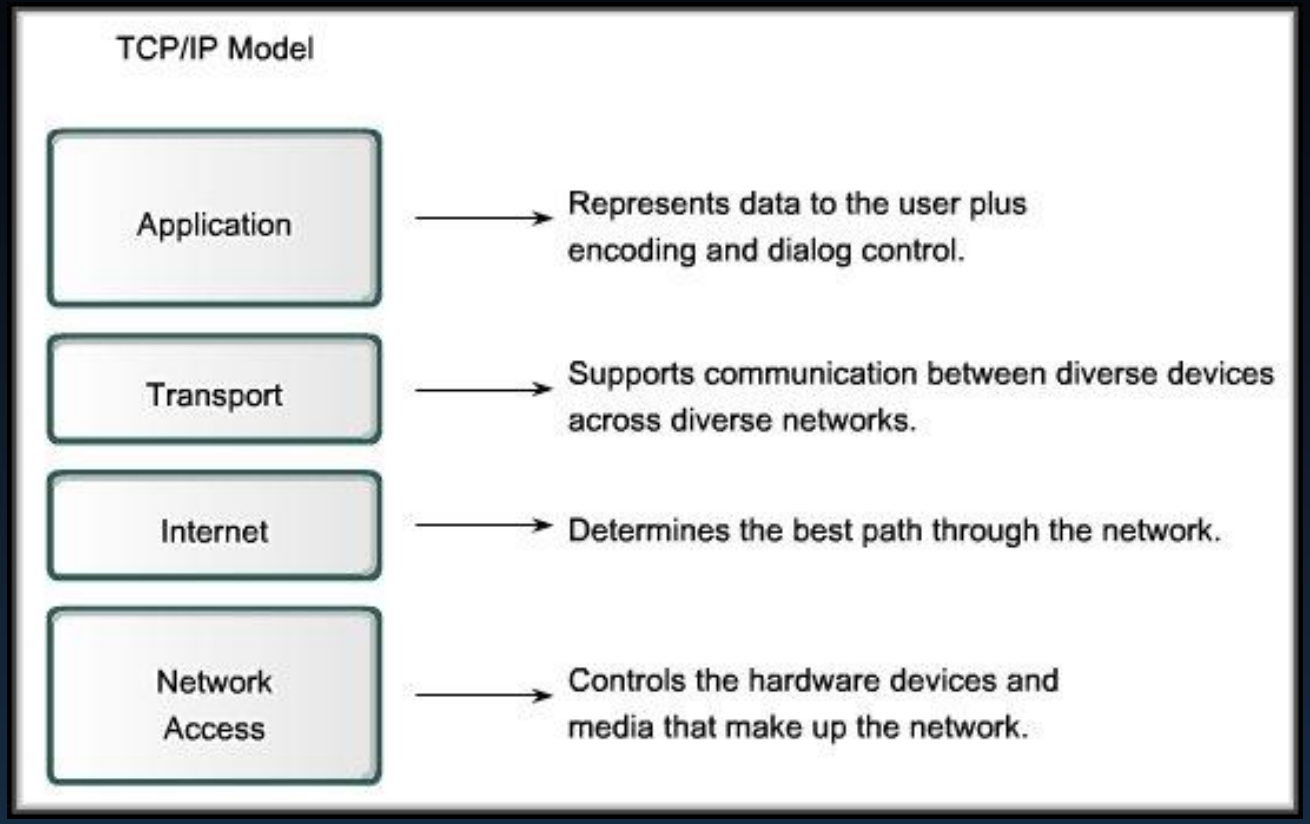
- Protocol Model:
  - Closely matches the structure of a *particular protocol suite*.
  - The set of related protocols in a suite typically represents all the functionality required to interface the human network with the data network.
  - The TCP/IP model is a *protocol model* because it describes the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

TCP/IP Model

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



Request For Comments RFC

The Internet Engineering Task Force

- Overview of the IETF
- The Internet Standards Process
- IETF Working Groups
- WG Chairs Web Page
- Internet-Drafts
- RFC Pages
- Educational Materials
- Mailing Lists
- IETF Web Tools
- IESG Activities/Actions
- Meetings
  - 71st IETF - Philadelphia, PA, USA (March 9-14, 2008)
- Proceedings
- IETF Liaison Activities
- IETF IPR Disclosure Page
- The NomCom
- IETF Secretariat

INTERNET PROTOCOL

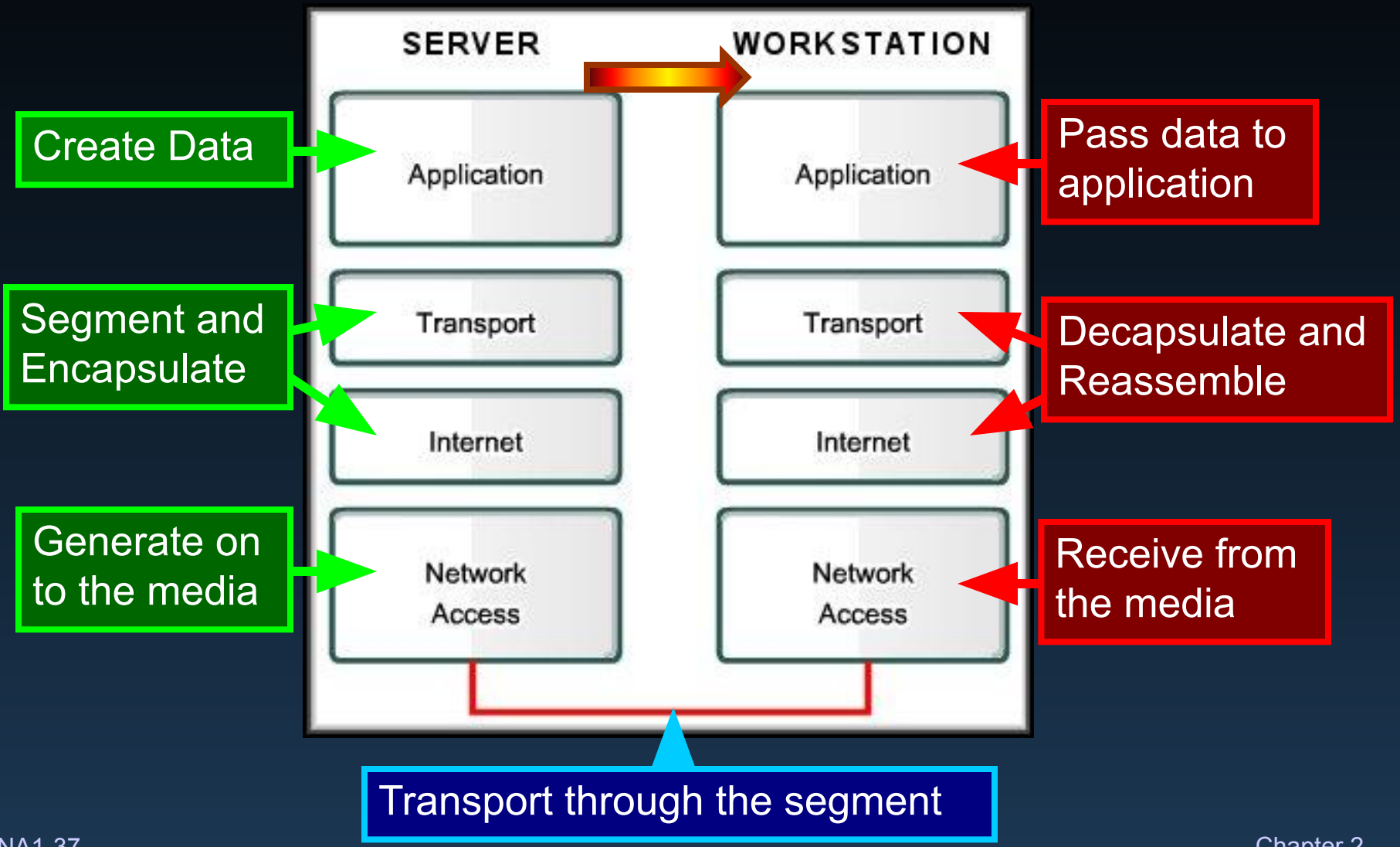
DARPA INTERNET PROGRAM

PROTOCOL SPECIFICATION

September 1981

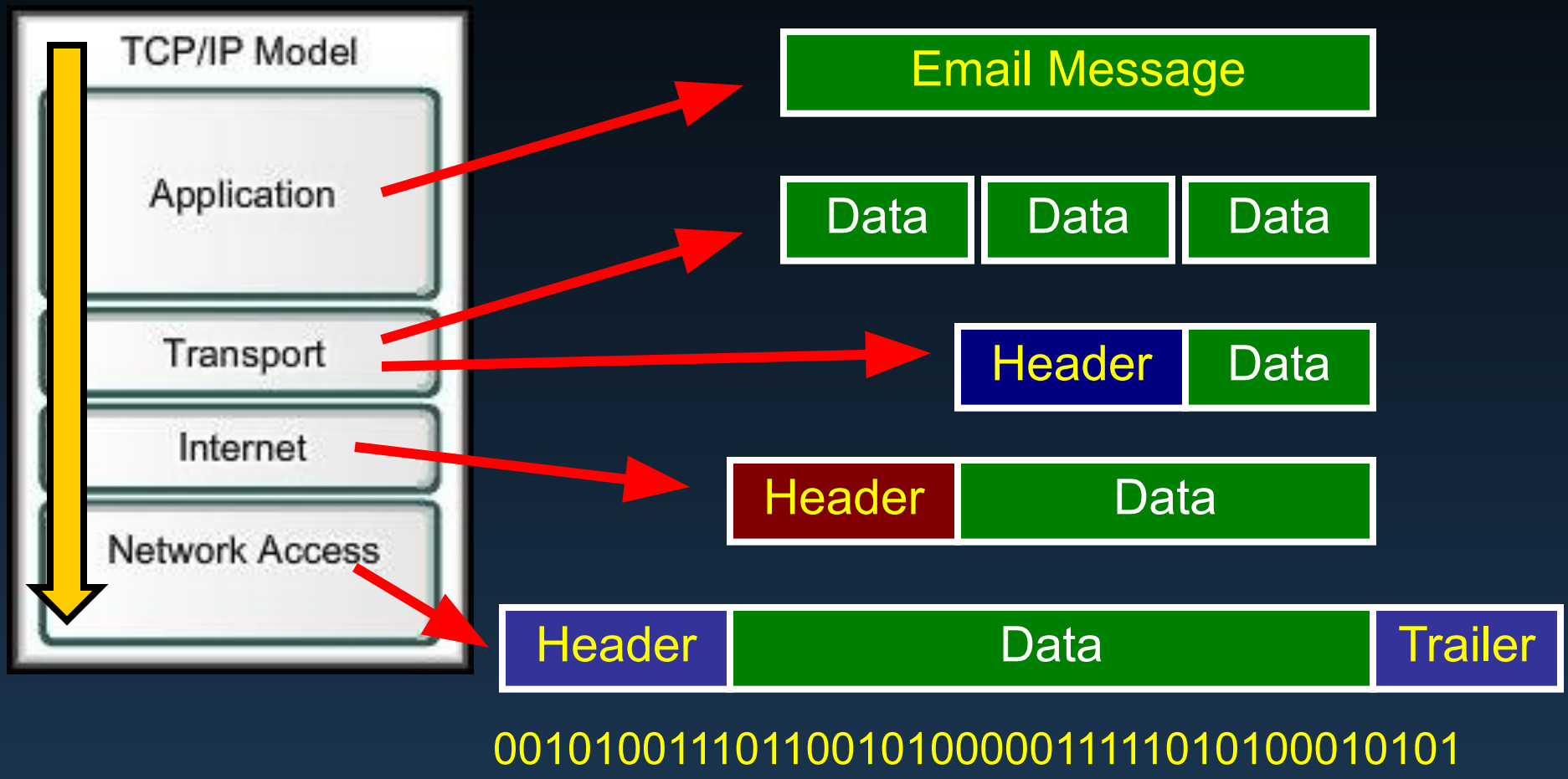
TABLE OF CONTENTS

The Communication Process



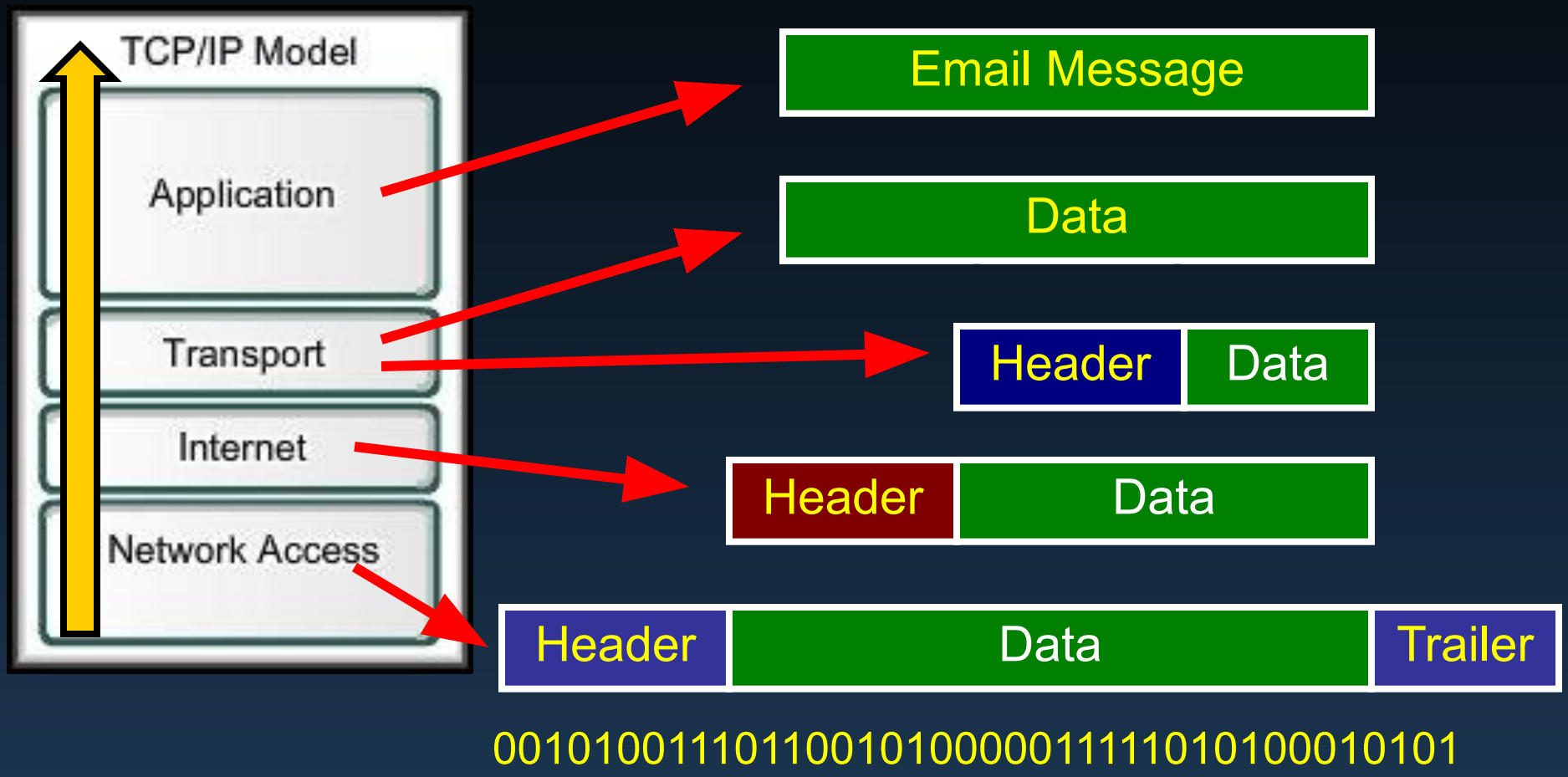
Protocol Data Units and Encapsulation

Segmentation and Encapsulation



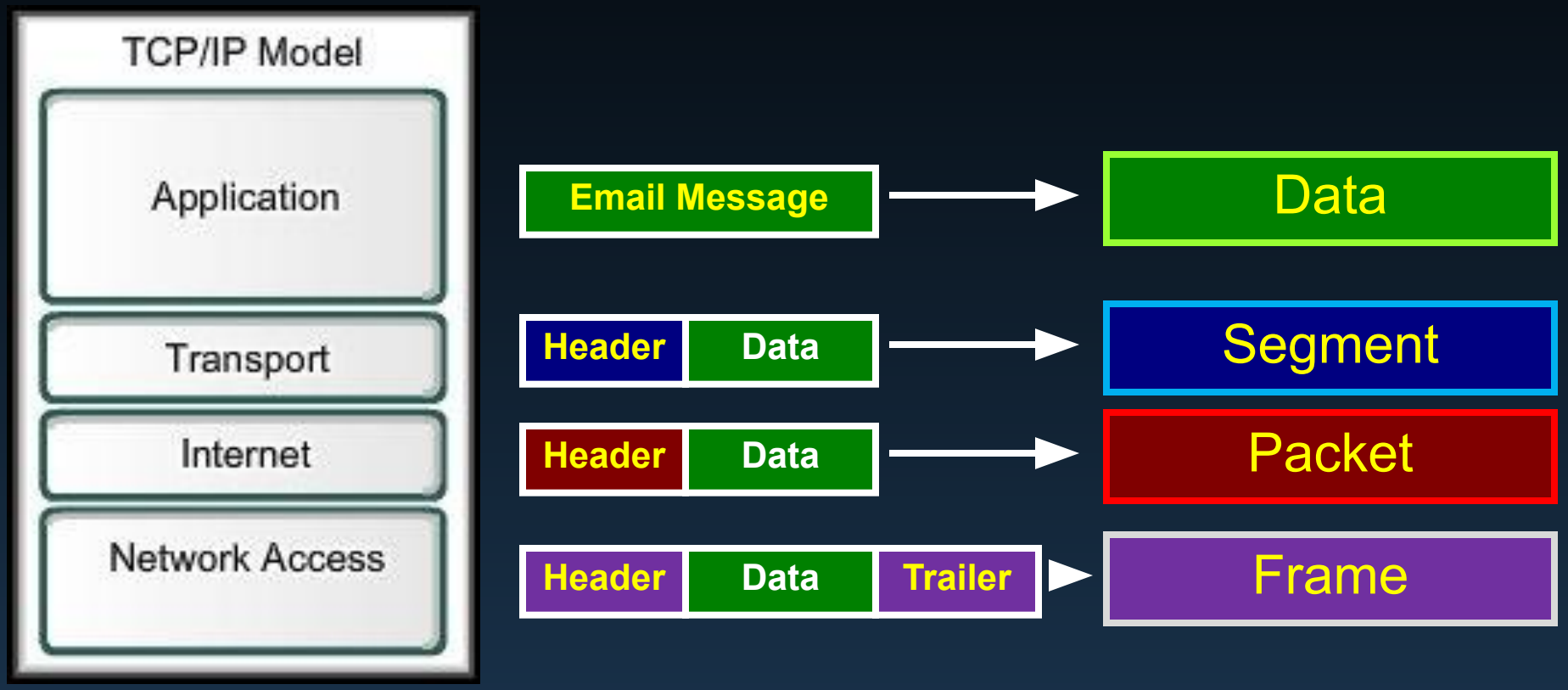
Protocol Data Units and Encapsulation

Decapsulation and Reassembly



Protocol Data Units and Encapsulation

Protocol Data Units



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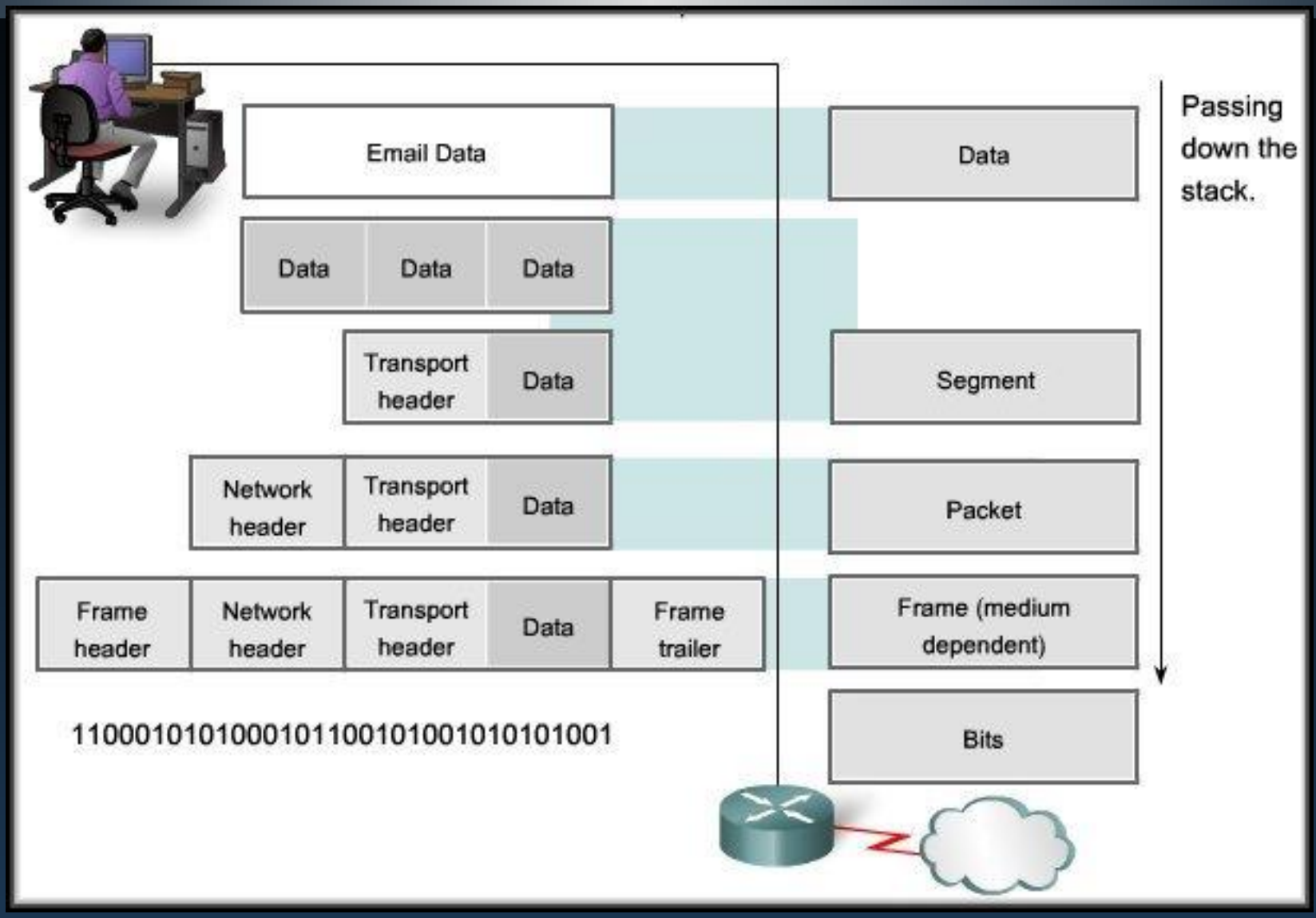
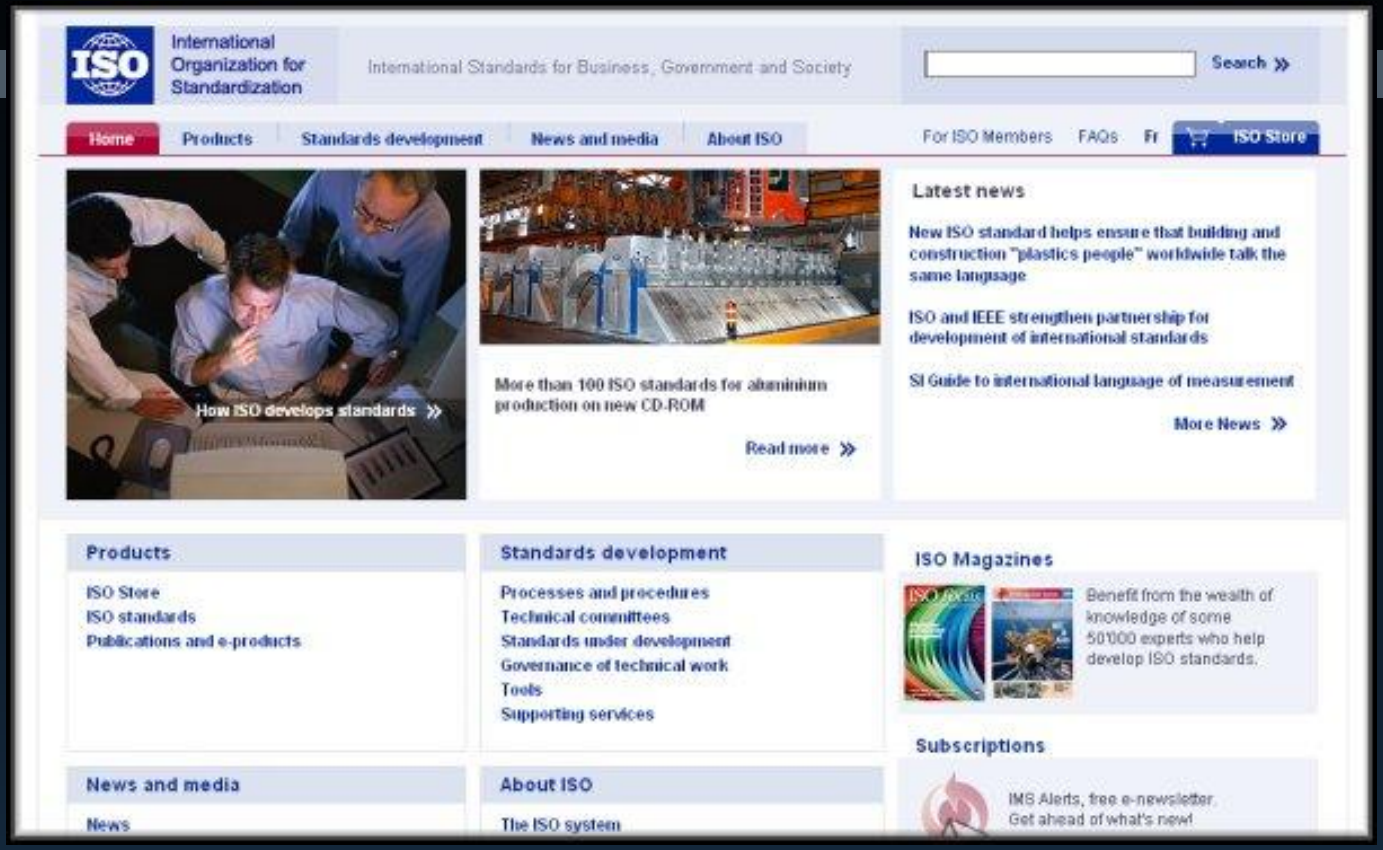


Communicating Over the Network

The OSI Model

OSI Model



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

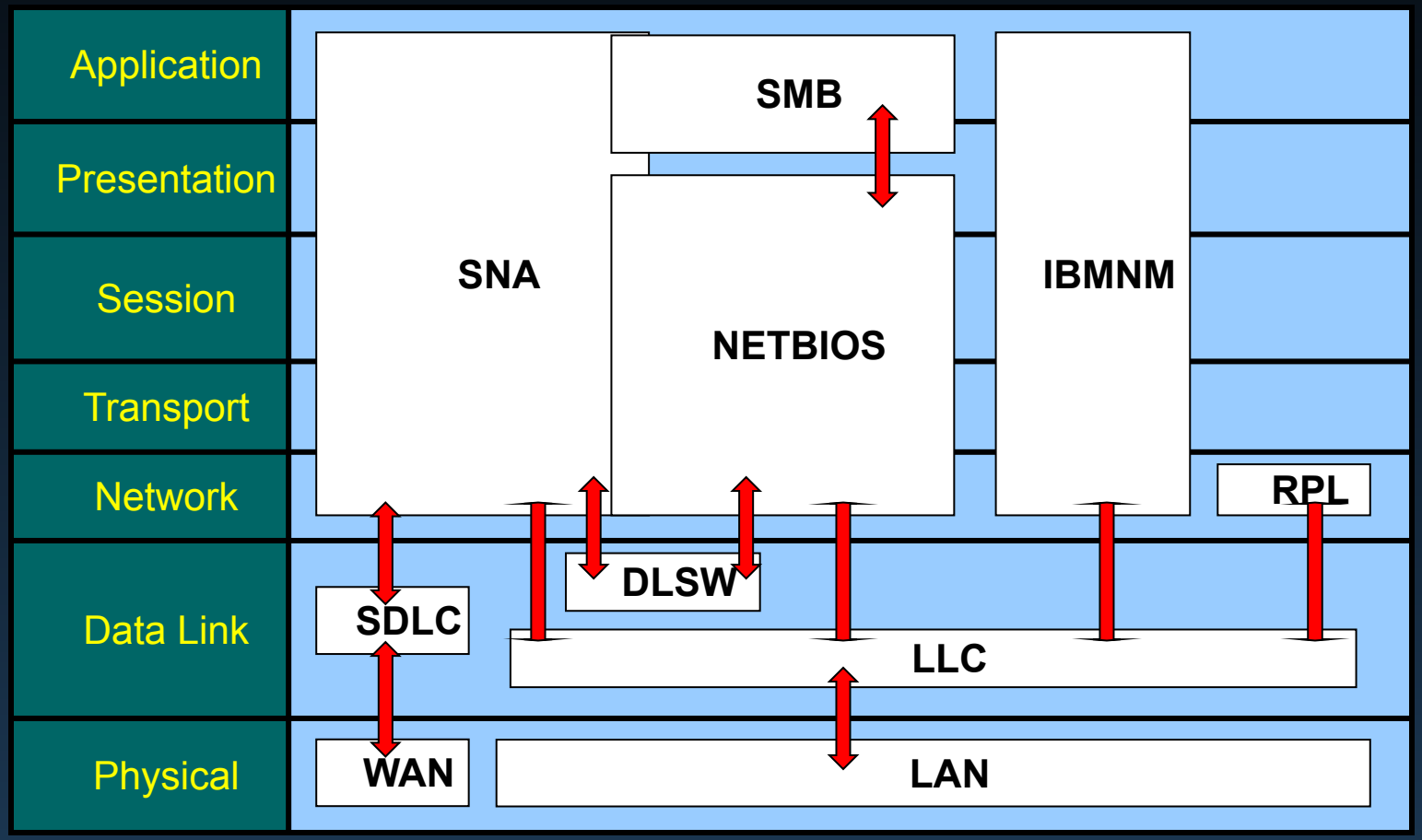
OSI Model

- *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*.

OSI Model - Example - *FYI*

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

IBM's SNA



OSI Model – Example - *FYI*

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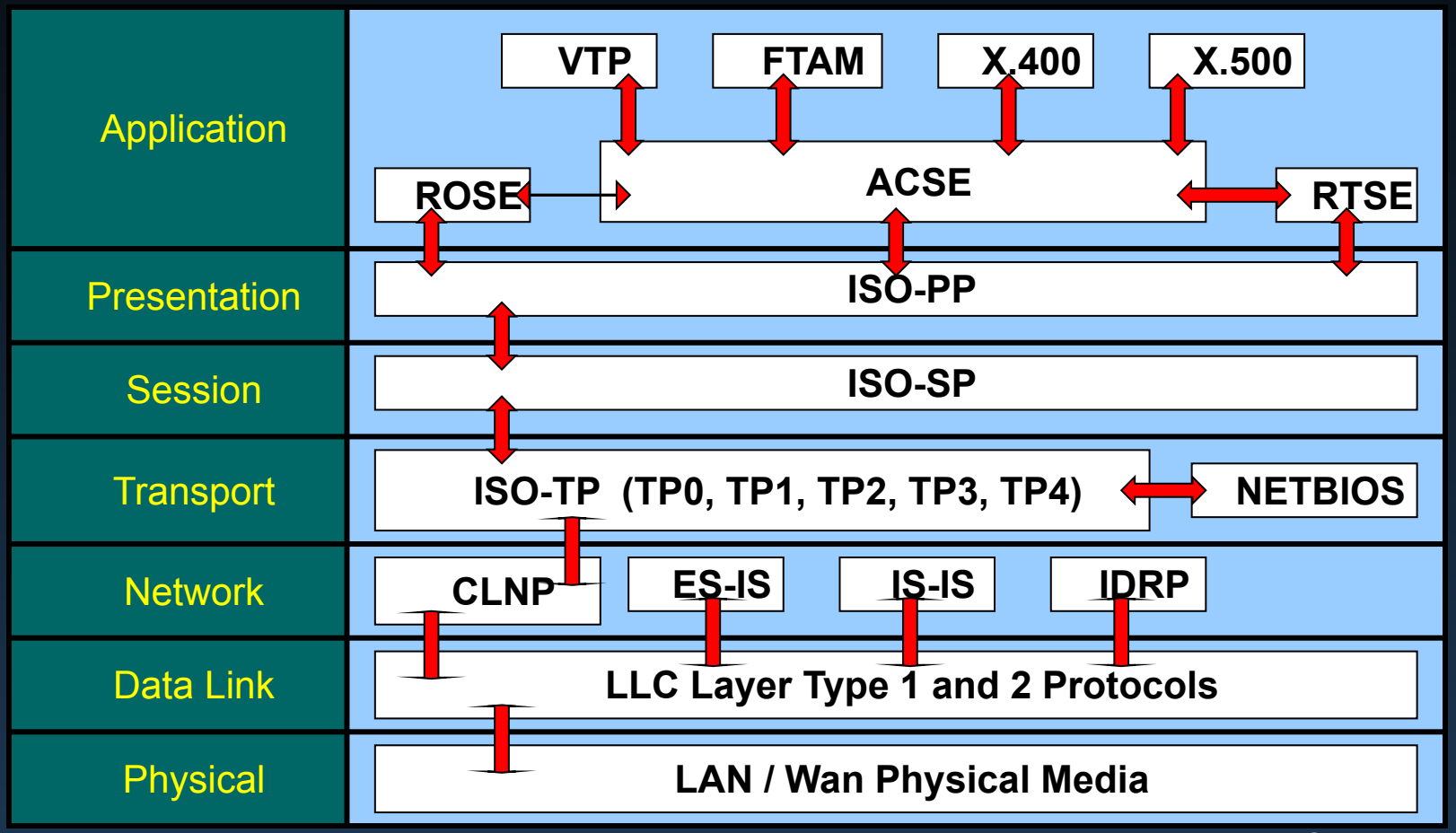
ISO



OSI Model – Example - *FYI*

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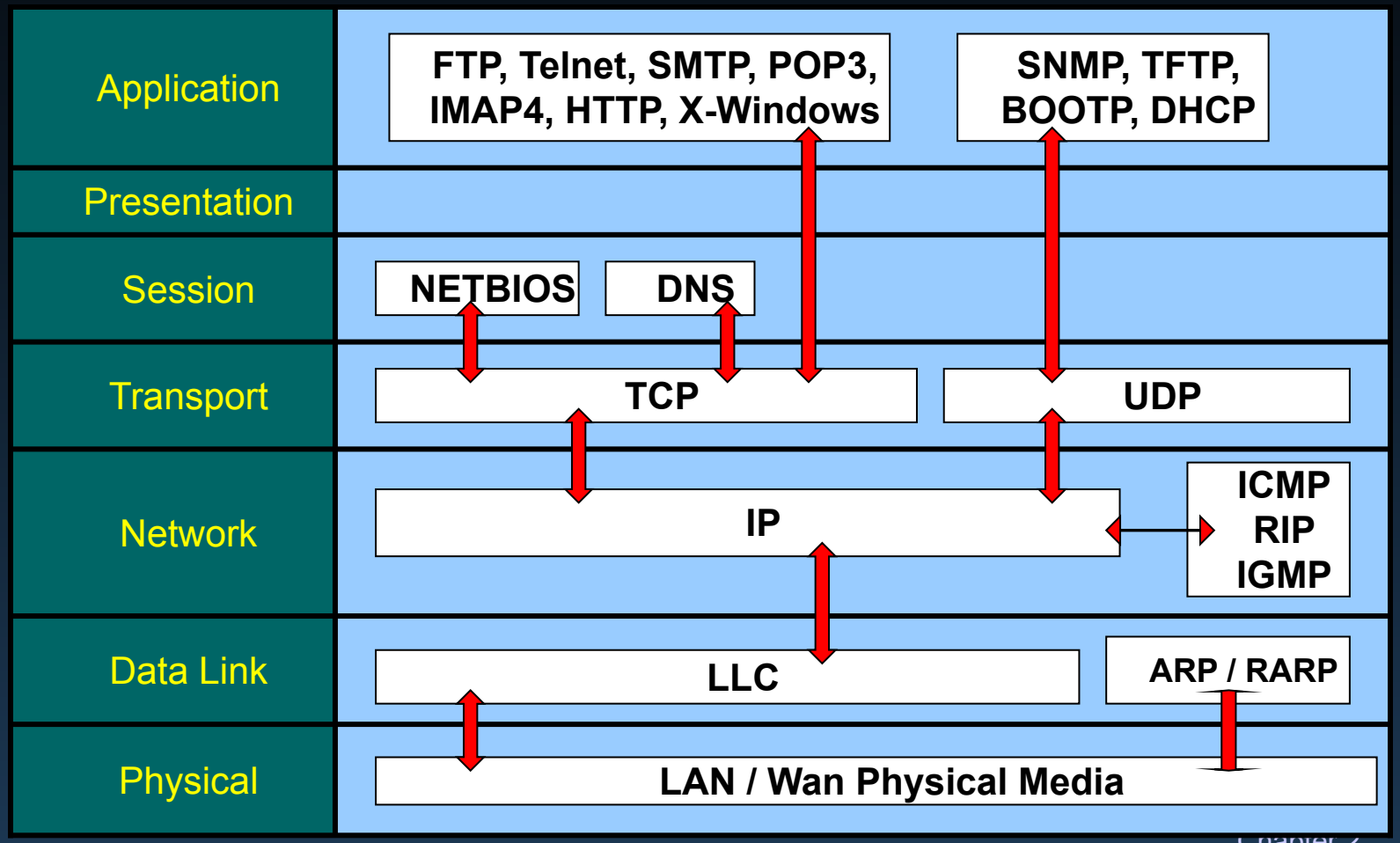
TCP/IP



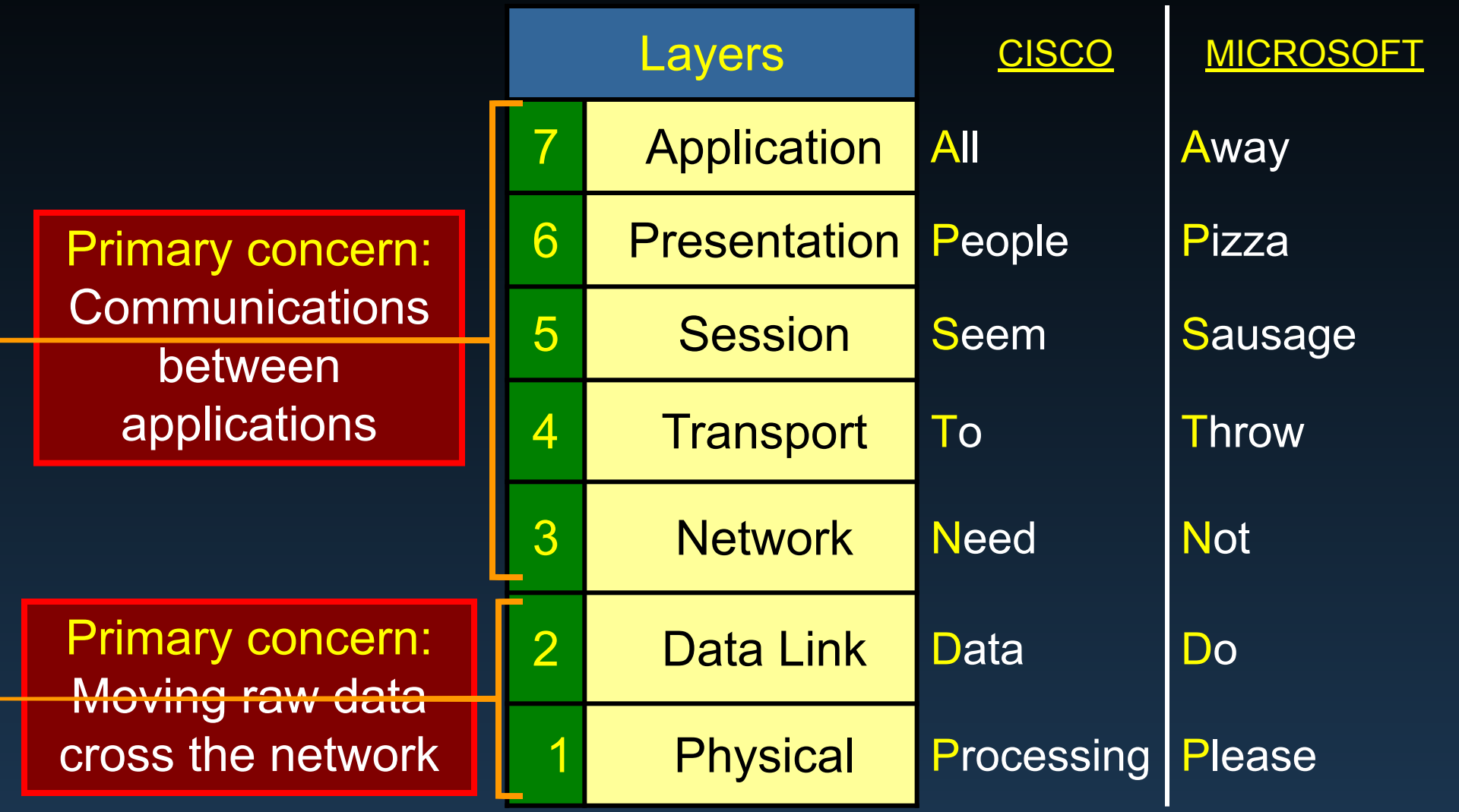
OSI Model

Usually referenced by layer number

These two layers are not commonly referred to in most instances.

Layers		CISCO	MICROSOFT
7	Application	All	Away
6	Presentation	People	Pizza
5	Session	Seem	Sausage
4	Transport	To	Throw
3	Network	Need	Not
2	Data Link	Data	Do
1	Physical	Processing	Please

OSI Model


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

Communicating Over the Network

Network Addressing

OSI Model

OSI Model Layer	Addressing
Application	Encoded Application Data **(Usually referred to as the *Upper Layers*)**
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

Email Message → Encoded Data

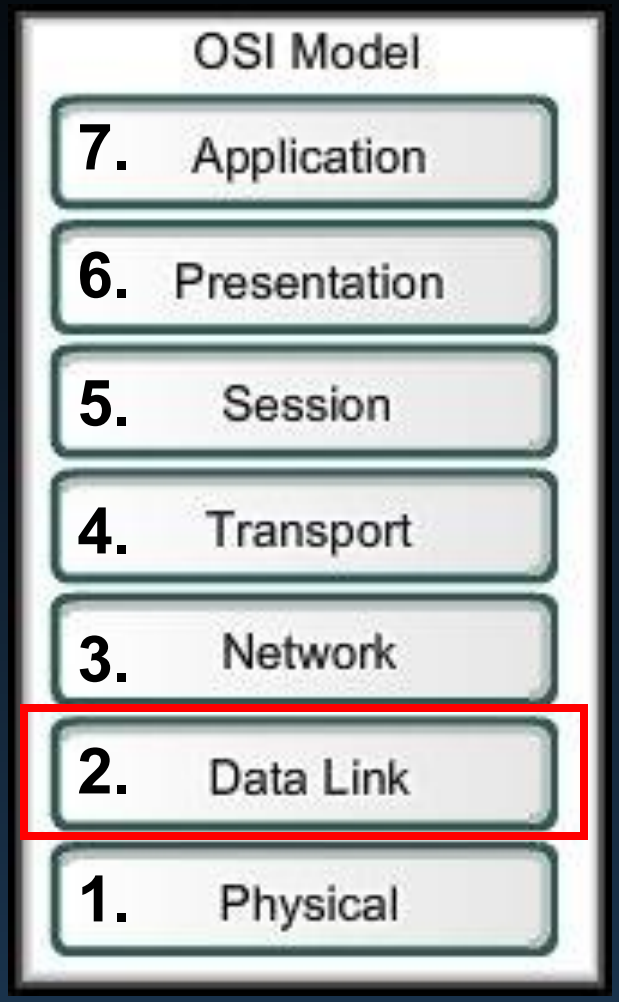
Header | Data → Process

Header | Data → Logical

Header | Data | Trailer → Physical

Addressing always includes both the Source and Destination Addresses.

Getting Data to the End Device

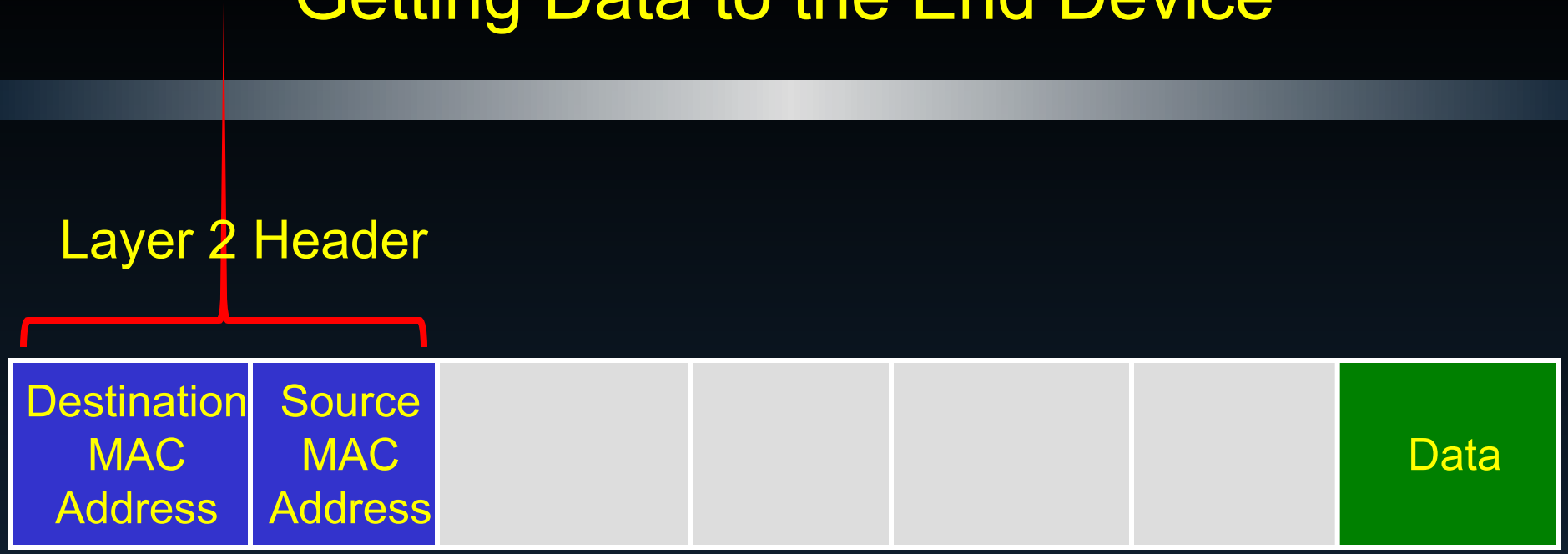


Layer 2 Addressing

- 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*.

Source and Destination Physical or MAC Address

Getting Data to the End Device



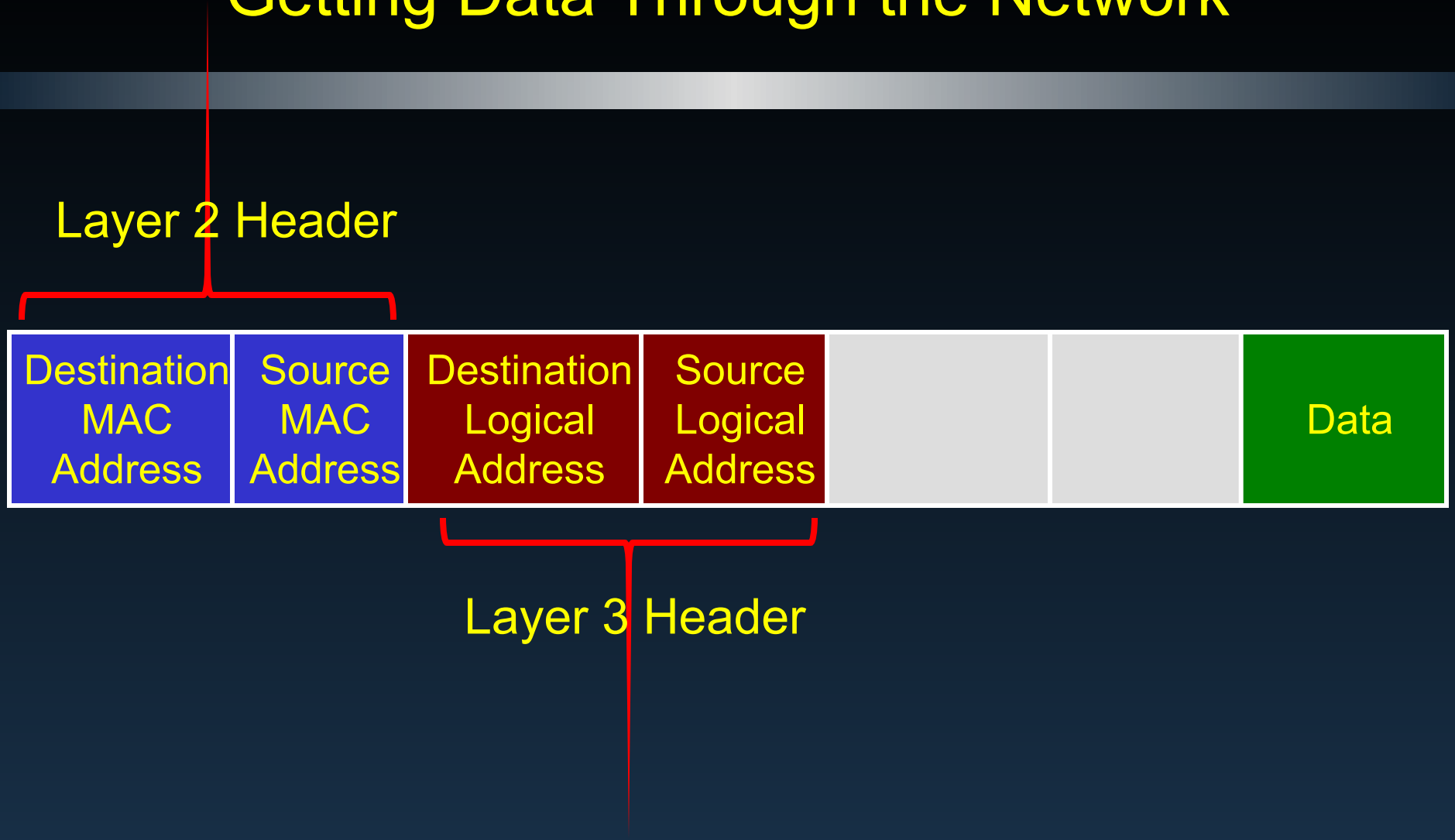
Getting Data Through The Network

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.)

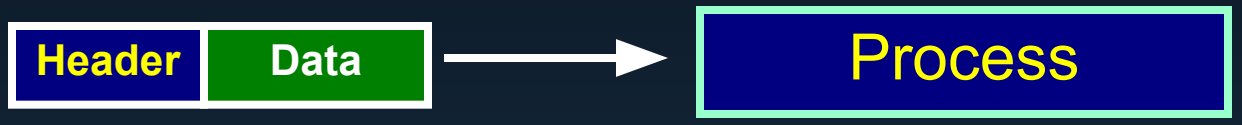
Getting Data Through the Network



Getting Data to the Right Application

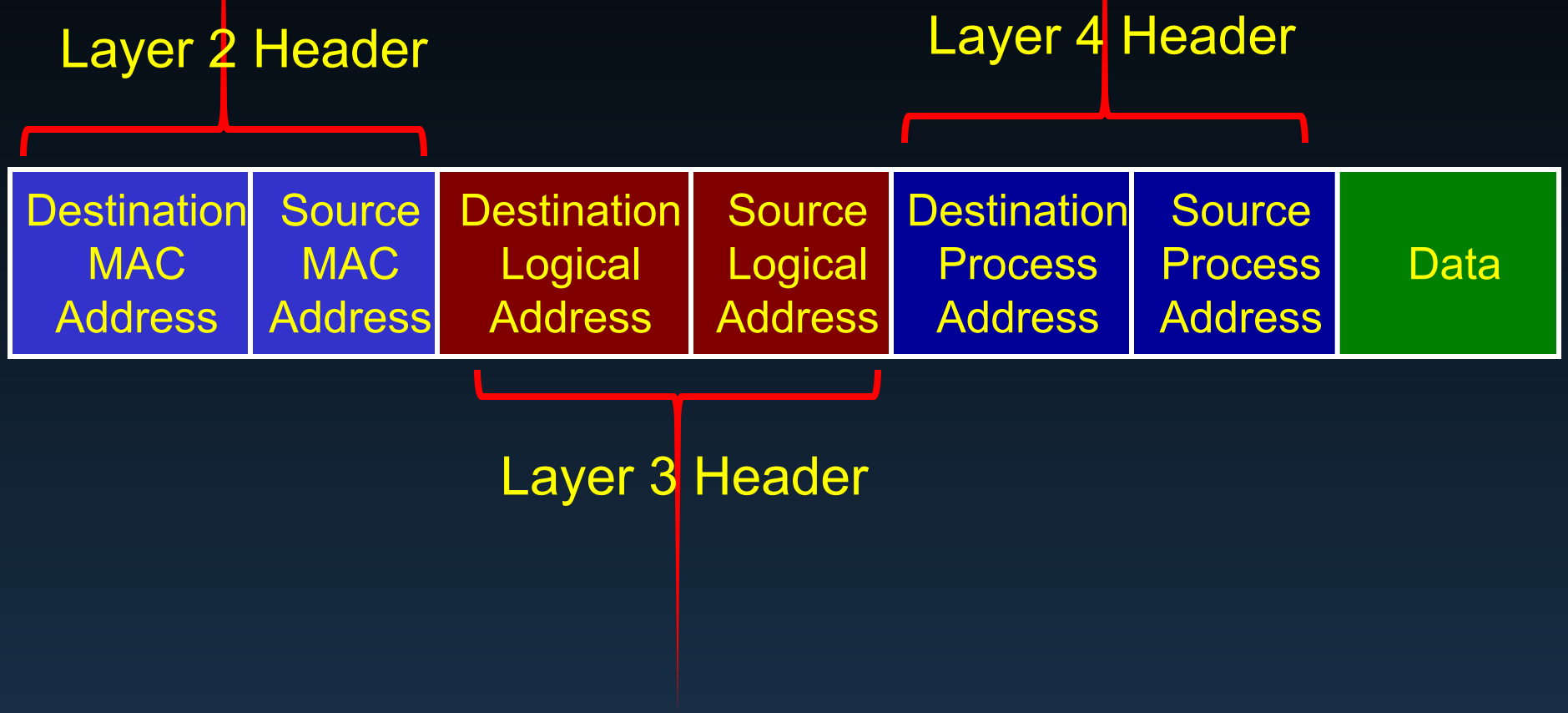
Layer 4 Addressing

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

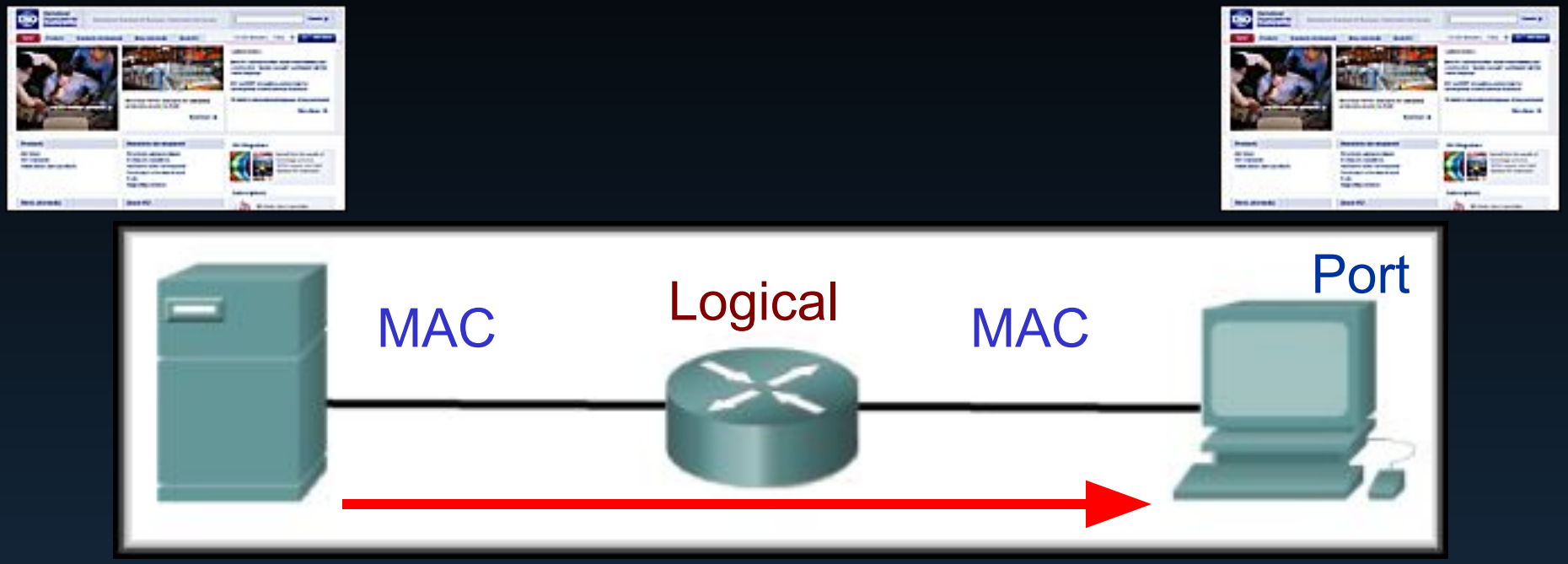


- Under TCP/IP, a *port number* to identify the application.
  - Port 80: HTTP (Web Browser)
  - Port 25: SMTP (Email)
  - Port 194: IRC (Internet Relay Chat)

Getting Data to the Right Application



Putting It All Together



Destination MAC Address	Source MAC Address	Destination Logical Address	Source Logical Address	Destination Process Address	Source Process Address	Data

Comparing the OSI and TCP/IP Models

OSI Model		Layer Function	Protocol Data Unit	Device	TCP/IP Model
7	Application	User Functionality	Character		Application
6	Presentation	Character Representation			
5	Session	Manage Data Exchange			
4	Transport	Services to segment, transfer and reassemble the data	Segment		Transport
3	Network	Network addressing and best path determination	Packet	Router	Internet
2	Data Link	Methods for reliable frame exchange over a common media	Frame	Switch	Network Access
1	Physical	Describe physical characteristics to transmit bits over a common media	Bit	Hub	

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.