Networking Basics

The **Cisco Certified Network Associate** Curriculum

NETWORK FUNDAMENTALS

CISCO SYSTEMS
NETWORKING ACADEMY

Version 3.0
Cisco Regional Networking Academy

Objectives

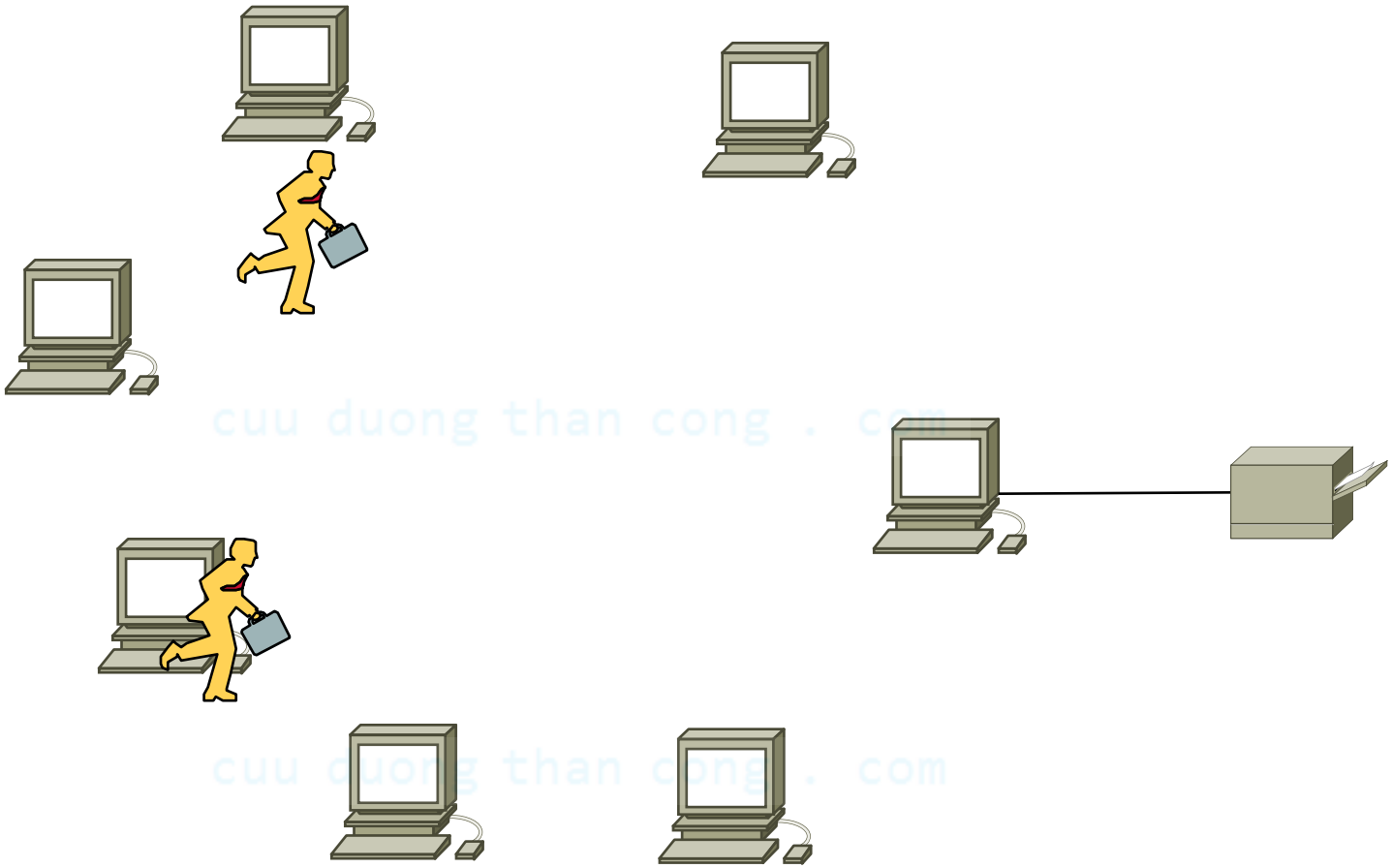
- Explain the importance of bandwidth in networking.
- Identify each of the seven layers of the OSI & TCP/IP model.
- Describe the similarities and differences between the two models.
- Identify devices used in networking.
- Define LAN, WAN, MAN, and SAN.
- Explain VPNs and their advantages.
- Describe the differences between intranets and extranets

Table of Content

1	Networking Terminology
2	Digital Bandwidth
3	Network Models

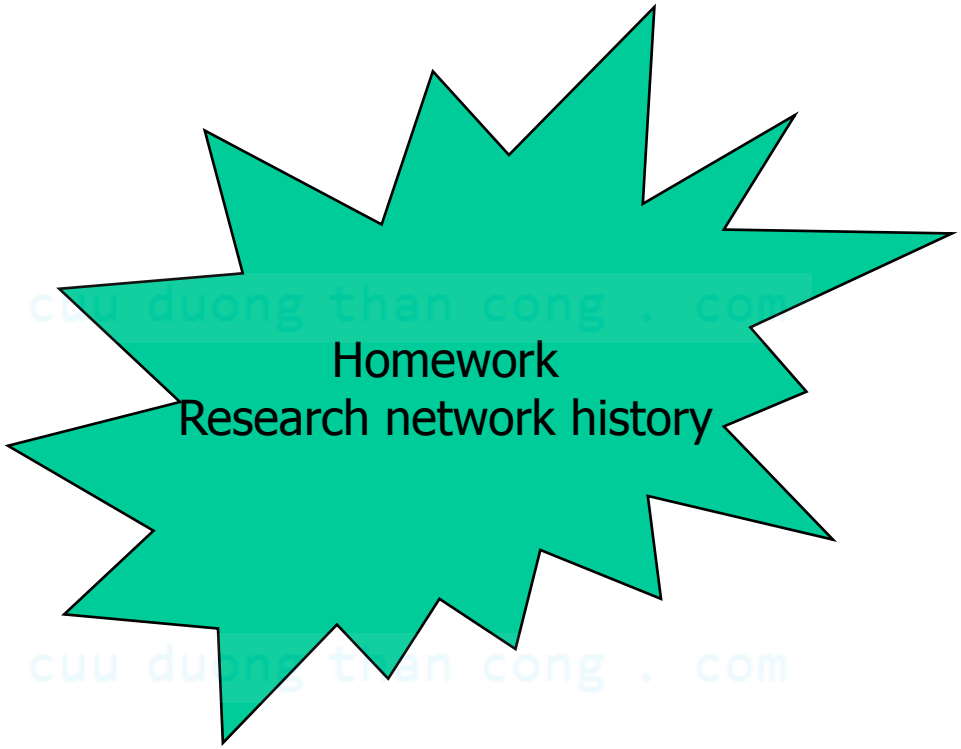
NETWORK TERMINOLOGY

Data Networks

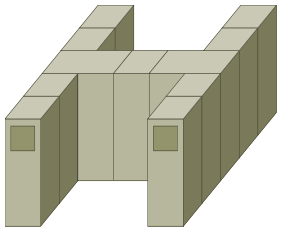


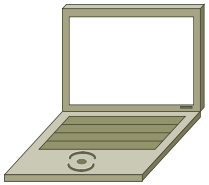
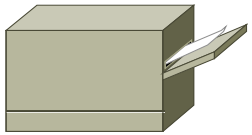
- How to avoid duplication of equipment and resources
- How to communicate efficiently
- How to set up and manage a network

Network history



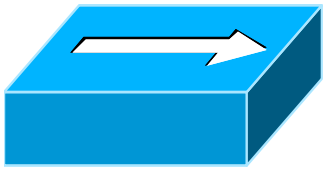
Network Devices

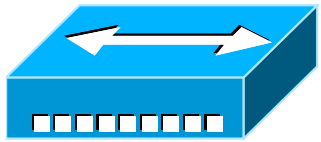


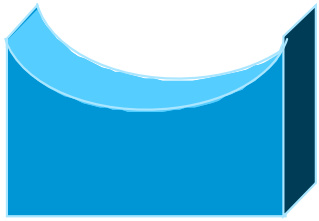
- End-user devices (hosts)
  - Include computers, printers, scanners, etc.
  - Allow users to share, create, and obtain information.
  - Exist without a network, but capabilities are greatly reduced.
  - connected to the network media using a network interface card (NIC)

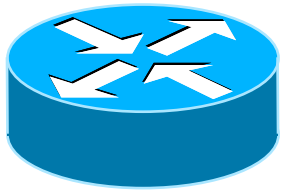
Network Devices (cont)



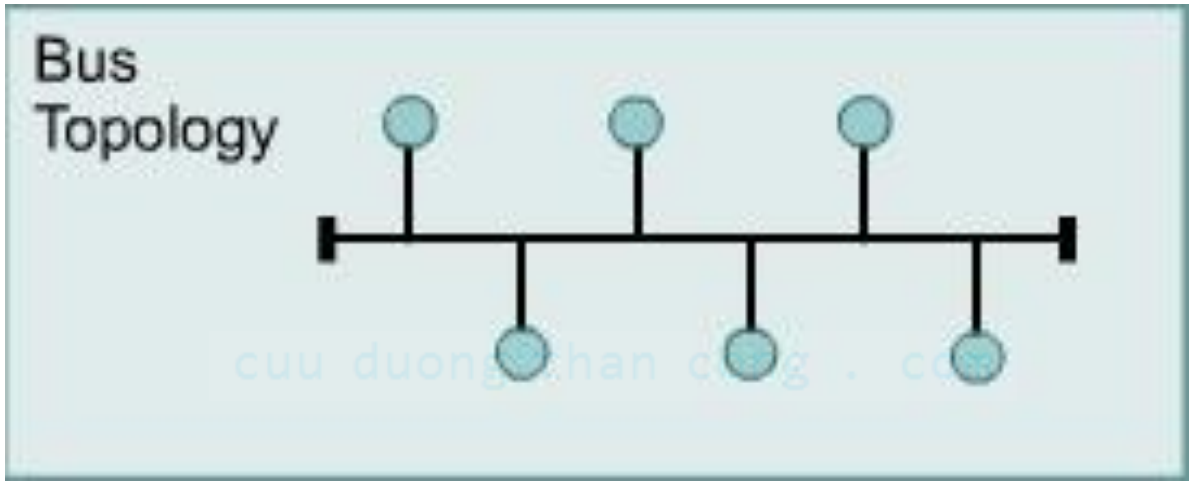


- Network devices
  - Provide transport for the data that needs to be transferred between end-user devices.
  - Provide extension of cable connections, concentration of connections, conversion of data formats, and management of data transfers.
  - E.g. Repeaters, Hubs, Bridges, Switches, Routers



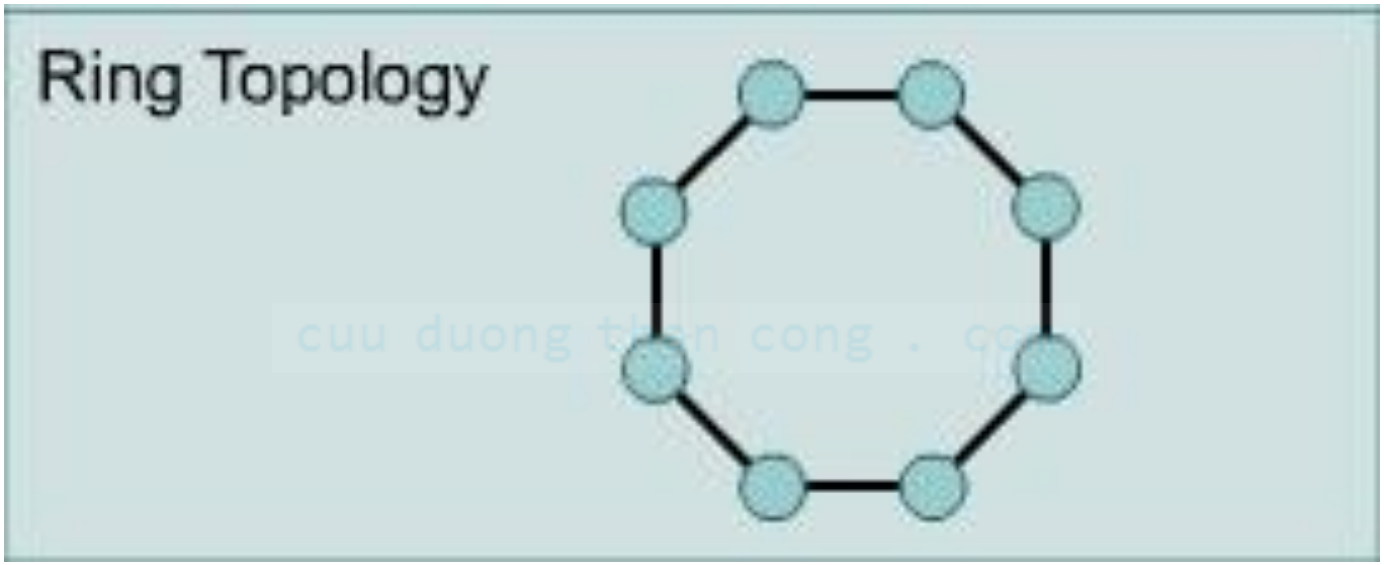


Network Topology: Physical layout



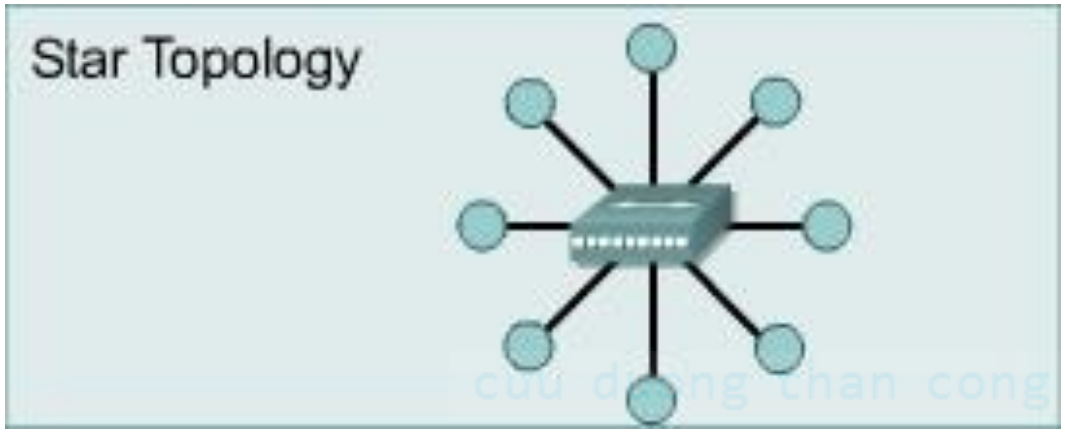
- A bus topology uses a single backbone cable that is terminated at both ends.
- All the hosts connect directly to this backbone.

Network Topology: Physical layout



- A ring topology connects one host to the next and the last host to the first.
- This creates a physical ring of cable

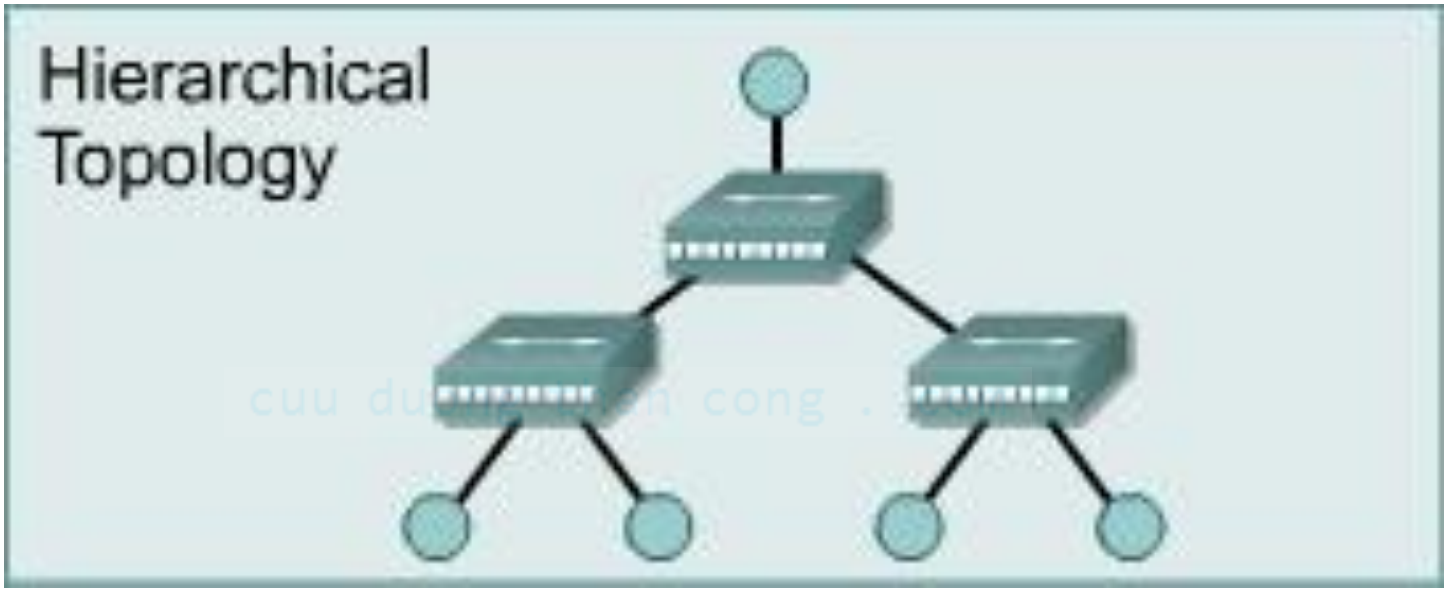
Network Topology: Physical layout



A star topology Connects all cables to a central point of concentration.

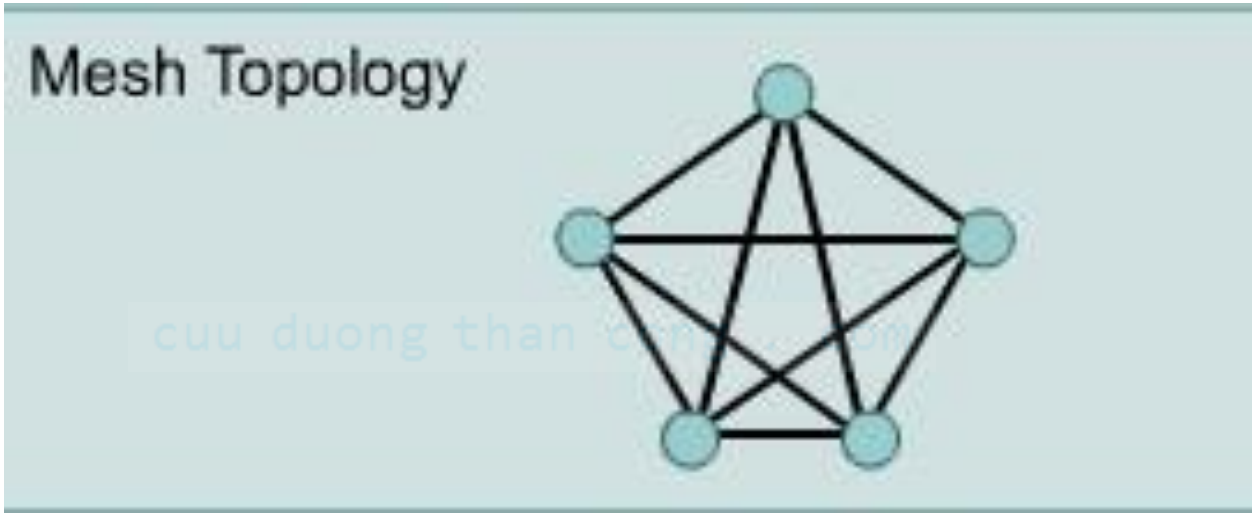
An extended star topology links individual stars together by connecting the hubs or switches.

Network Topology: Physical layout



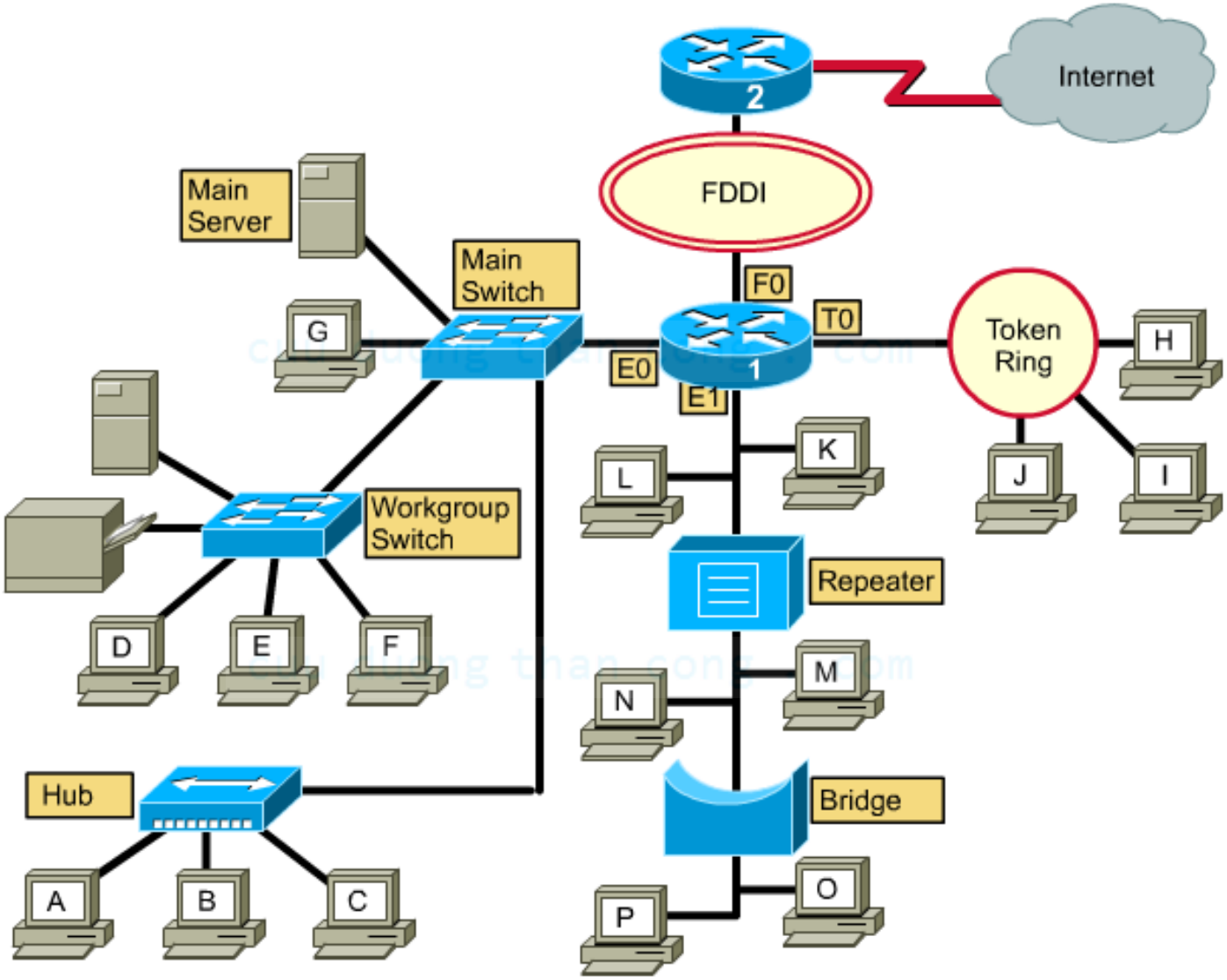
- A hierarchical topology is similar to an extended star
- Instead of linking the hubs and/or switches together the system is linked to a computer that controls the traffic on the topology.

Network Topology: Physical layout



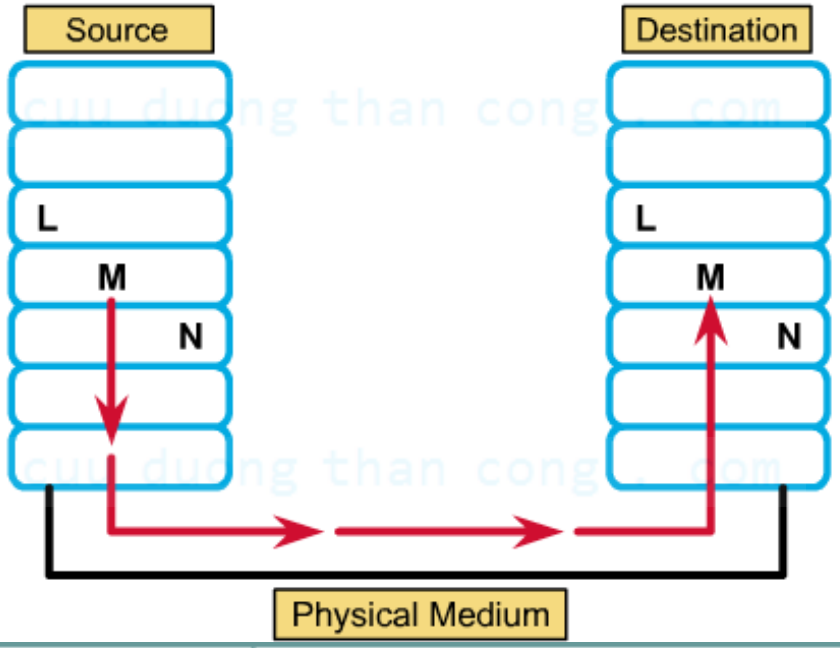
- Each host has its own connections to all other hosts
- Although the Internet has multiple paths to any one location, it does not adopt the full mesh topology.

Network Topology: Logical layout



Network Protocols

- A protocol is a formal description of a set of rules and conventions that govern a particular aspect of how devices on a network communicate.



L, M, N	Layers in our model of computer communications
Msource, Mdestination	Peer layers
→	Peer to peer communications
M layer Protocol	The rules by which Msource communicates with Mdestination

Network Protocols (cont.)

- Protocols control all aspects of data communication, which include the following:
  - How the physical network is built
  - How computers connect to the network
  - How the data is formatted for transmission
  - How that data is sent
  - How to deal with errors

Local-area Networks (LANs)

Local Area Networks and Devices

LANs are designed to:

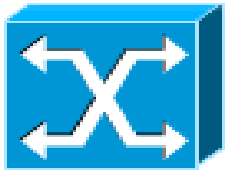
- Operate within a limited geographic area.
- Allow multi-access to high-bandwidth media.
- Control the network privately under local administration.
- Provide full-time connectivity to local services.
- Connect physically adjacent devices.

Using:

Router

Bridge

Ethernet Switch



ATM Switch

Hub

Wide-area Networks (WANs)

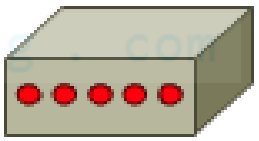
Wide Area Networks and Devices

WANs are designed to:

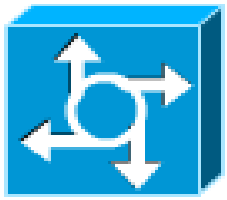
- Operate over large geographical area.
- Allow access over serial interfaces operating at lower speeds.
- Provide full-time and part-time connectivity.
- Connect devices separated over wide, even global areas.

Using:

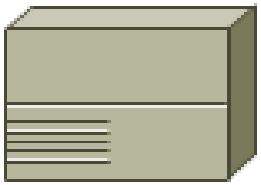
Router



Modem CSU/DSU
TA/NT1

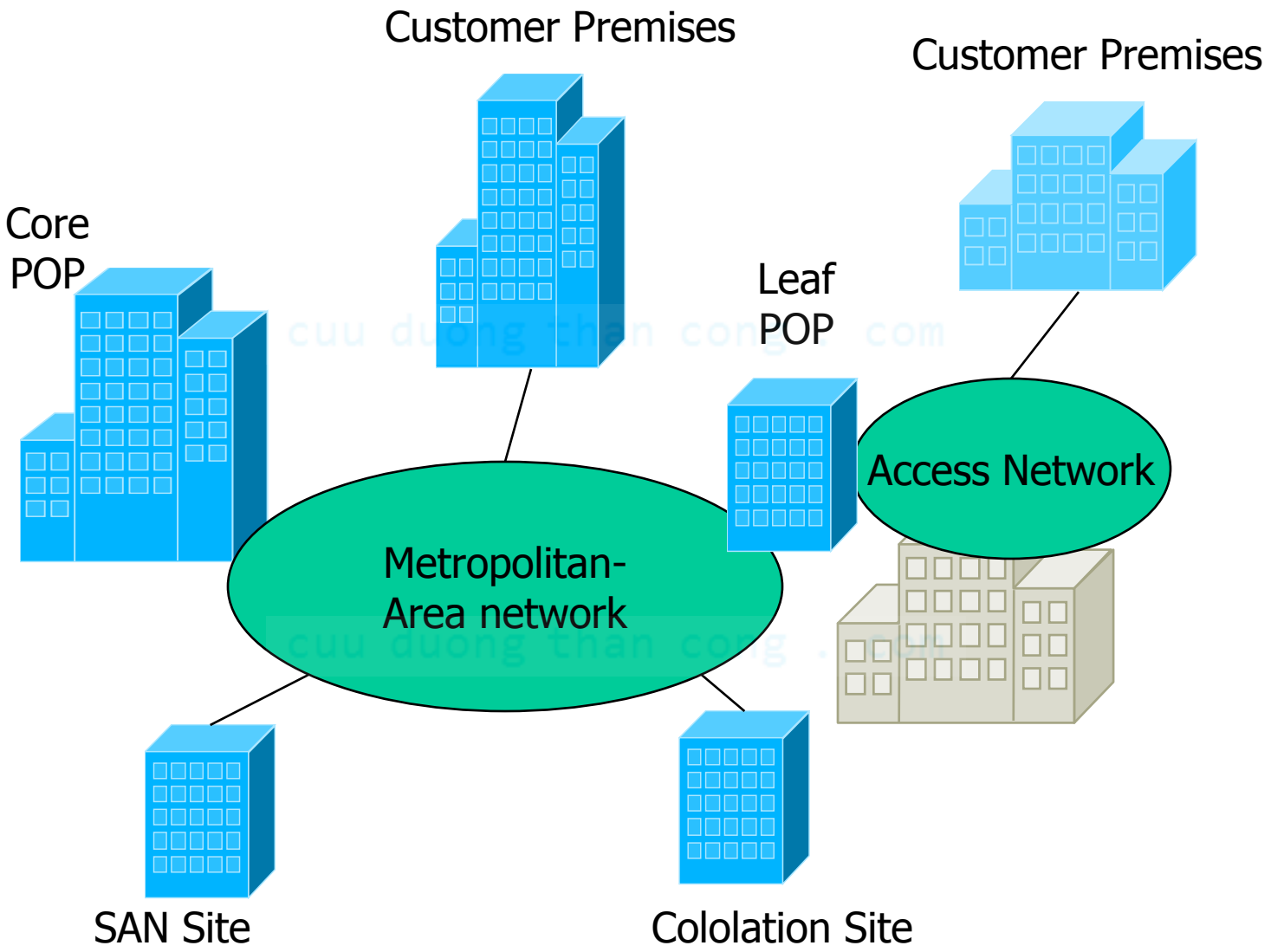


Comm. Server



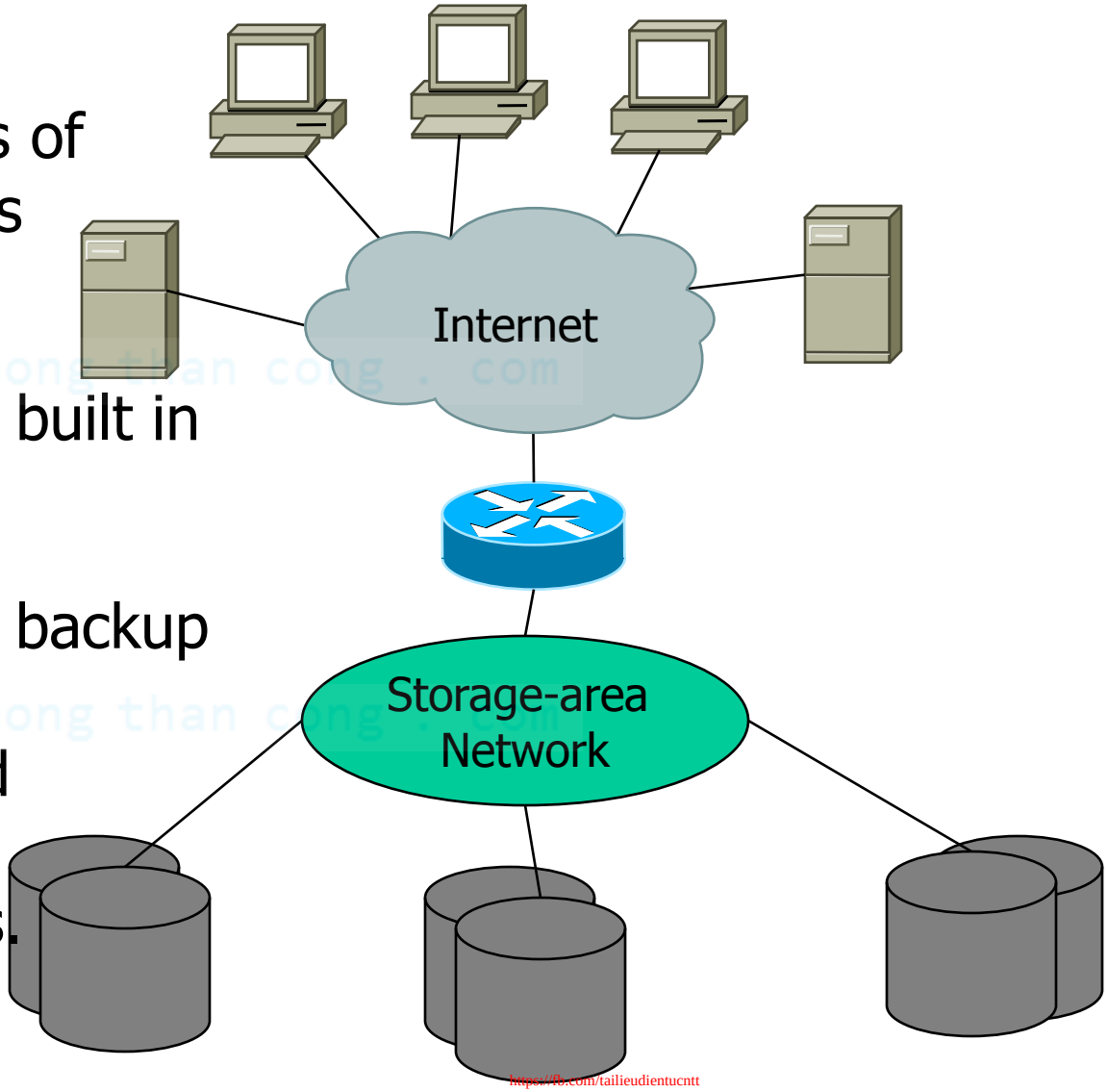
WAN Bandwidth
Switch

Metropolitan-area Networks (MANs)



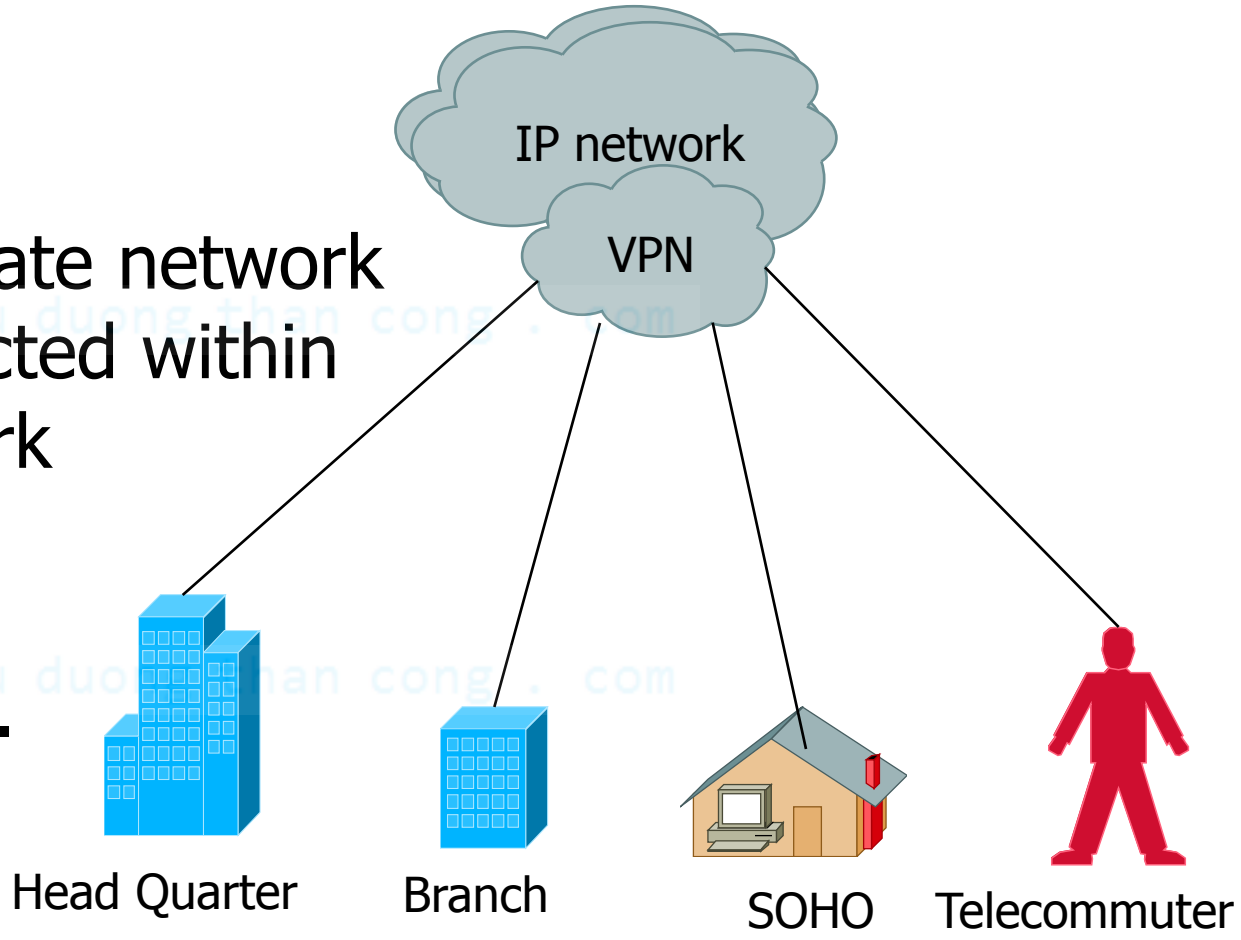
Storage-area Networks (SANs)

- **Performance**
  - Concurrent access of disk or tape arrays
- **Availability**
  - disaster tolerance built in
- **Scalability**
  - easy relocation of backup data, operations, file migration, and data replication between systems.

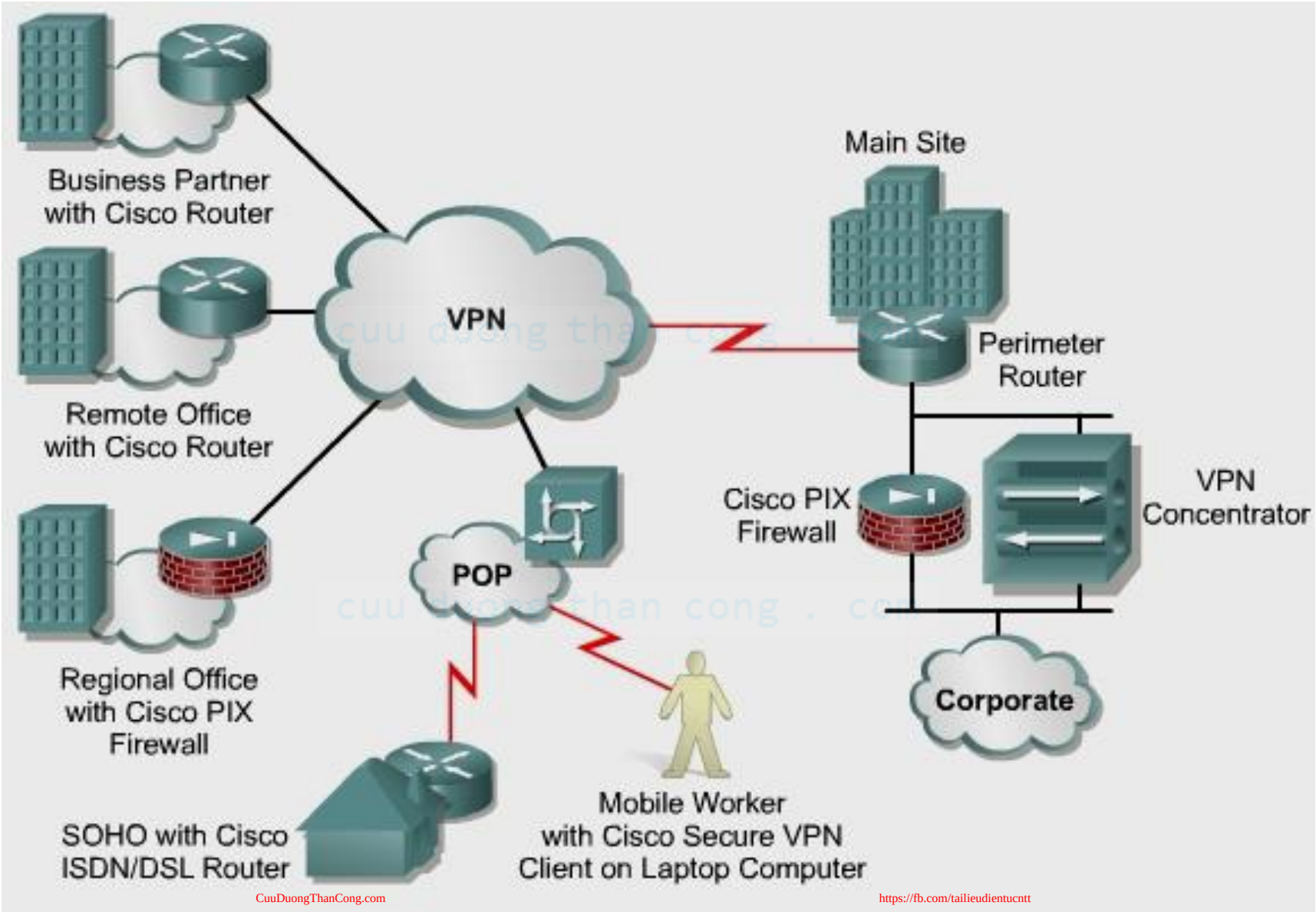


Virtual Private Network (VPN)

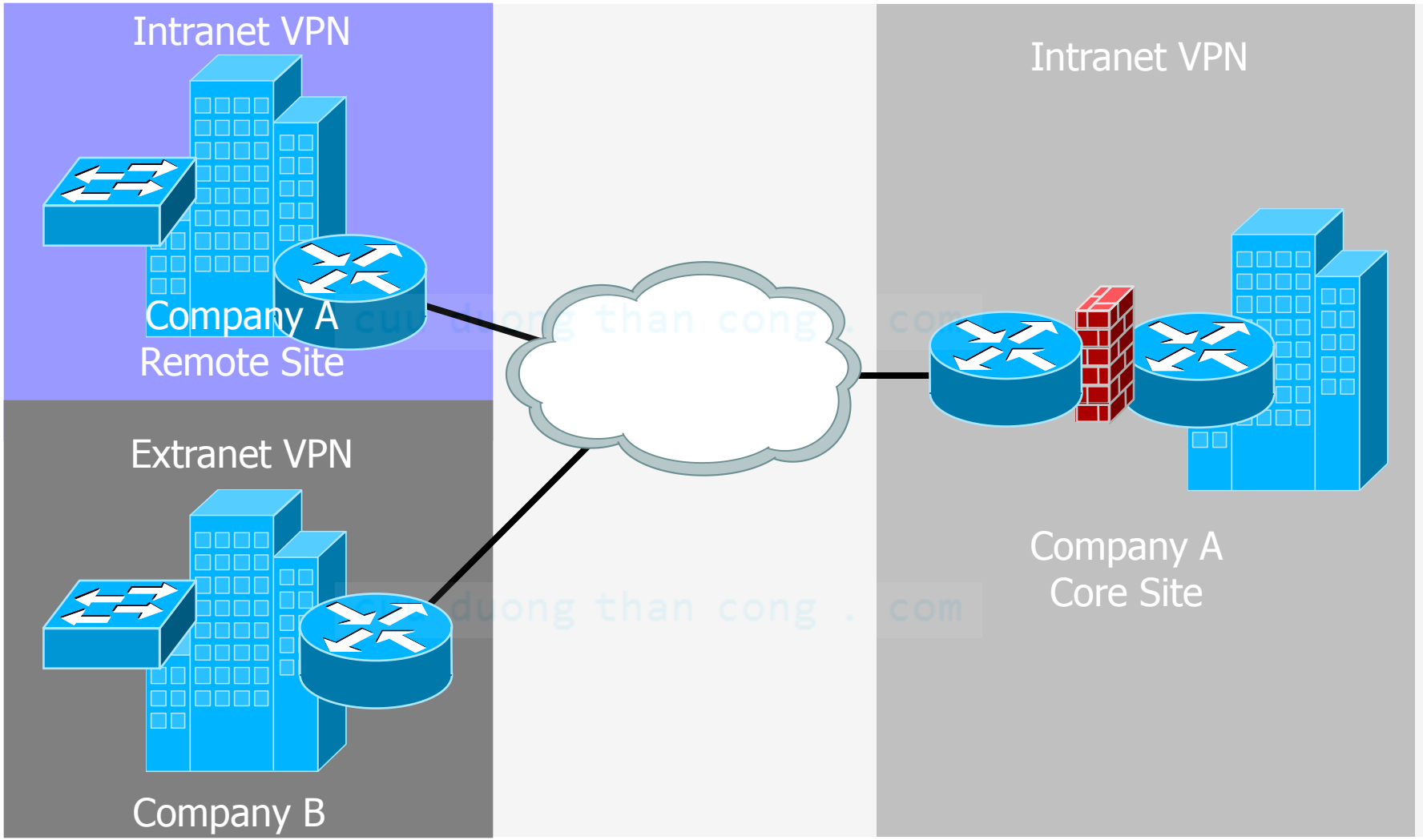
A VPN is a private network that is constructed within a public network Infrastructure such as the global Internet.



Three type of VPNs



Intranets and Extranets



BANDWIDTH

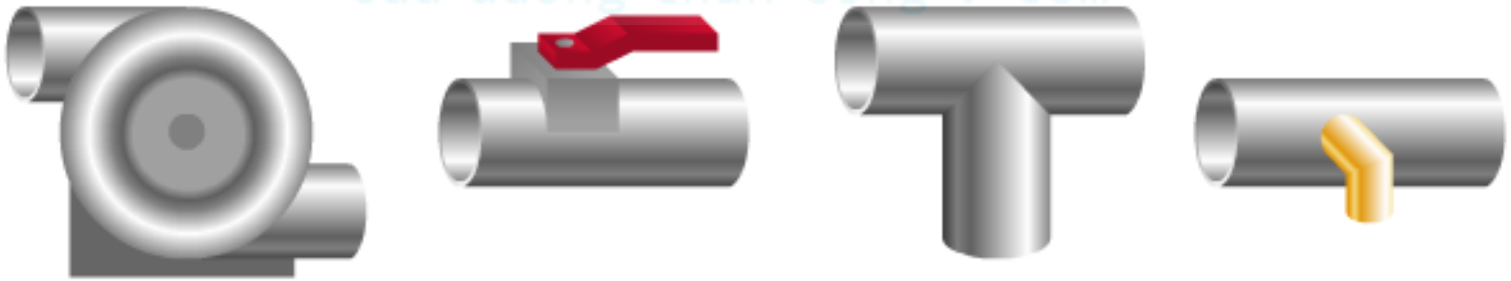
Importance of Bandwidth

- How much information can flow from one place to another in a given amount of time.
- 4 reasons to understanding
  - Bandwidth is finite
  - Bandwidth is not free
  - Bandwidth is a key factor in analyzing network performance, designing new networks, and understanding the Internet.
  - The bandwidth is ever increasing

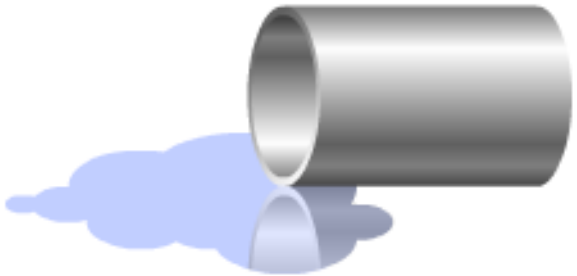
Analogy for Bandwidth: Pipe

Bandwidth is like pipewidth.

Network devices are like pumps, valves, fittings, and taps.



Packets are like water.



Measurements

Unit of Bandwidth	Abbrev.	Equivalence
Bits per second	bps	1 bps = fundamental unit of bandwidth
Kilobits per second	kbps	1 kbps = 1,000 bps = 10^3 bps
Megabits per second	Mbps	1 Mbps = 1,000,000 bps = 10^6 bps
Gigabits per second	Gbps	1 Gbps = 1,000,000,000 bps = 10^9 bps

Limitations: LAN Media

Some Typical Media	Bandwidth	Max. Physical Distance
50-Ohm Coaxial Cable (Ethernet 10BASE2, ThinNet)	10-100 Mbps	185m
50-Ohm Coaxial Cable (Ethernet 10BASE5, ThickNet)	10-100 Mbps	500m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 10BASE-T)	10 Mbps	100m
Category 5 Unshielded Twisted Pair (UTP) (Ethernet 100BASE-TX)(Fast Ethernet)	100 Mbps	100m
Multimode (62.5/125μm) Optical Fiber 100BASE-FX	100 Mbps	2000m
Singlemode (9/125μm core) Optical Fiber 1000BASE-LX	1000 Mbps (1.000 Gbps)	3000m
Wireless	11 Mbps	a few 100meters

Limitations: WAN Services

Type of WAN service	Typical User	Bandwidth
Modem	Individuals	56 Kbps = 0.056 Mbps
ISDN	Telecommuters, Small businesses	128 Kbps = 0.128 Mbps
Frame-Relay	Small institutions (schools); reliable WANs	56 Kbps - 1544Kbps = 0.056 Mbps - 1.544 Mbps
T1	Larger entities	1.544 Mbps
T3	Larger entities	44.736 Mbps
E1	Larger entities	2.048 Mbps
E3	Larger entities	34.368 Mbps

Throughput <= Bandwidth

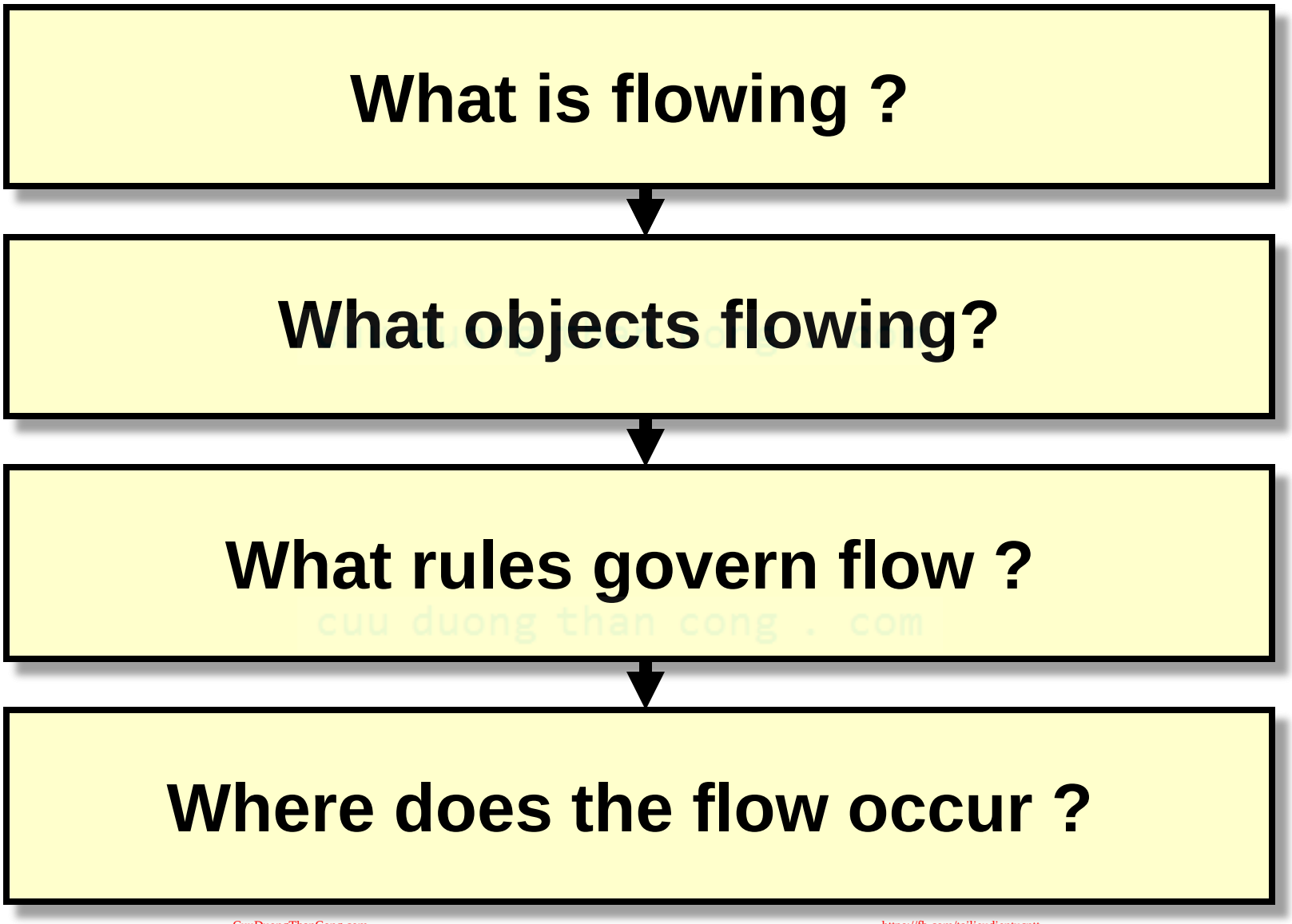
- Throughput refers to actual measured bandwidth, at a specific time of day, using specific Internet routes, and while a specific set of data is transmitted on the network.
- Factors that determine throughput
  - Type of data being transferred
  - Network topology
  - Number of users on the network
  - User computer
  - Server computer
  - Power conditions

Data transfer calculation

Best Download $T = \frac{S}{BW}$	Typical Download $T = \frac{S}{P}$
BW =	Maximum theoretical bandwidth of the "slowest link" between the source host and the destination host. (Measured in bits per second)
P =	Actual throughput at the moment of transter. (Measured in bits per second)
T =	Time for file transfer to occur. (Measured in seconds)
S =	File size in bits.

NETWORKING MODELS

Using Layers To Analyze Problems In A Flow Of Materials



Analyzing Data network in layers

What is flowing ?

Data

What different forms flow ?

Text, Graphic, Video ...

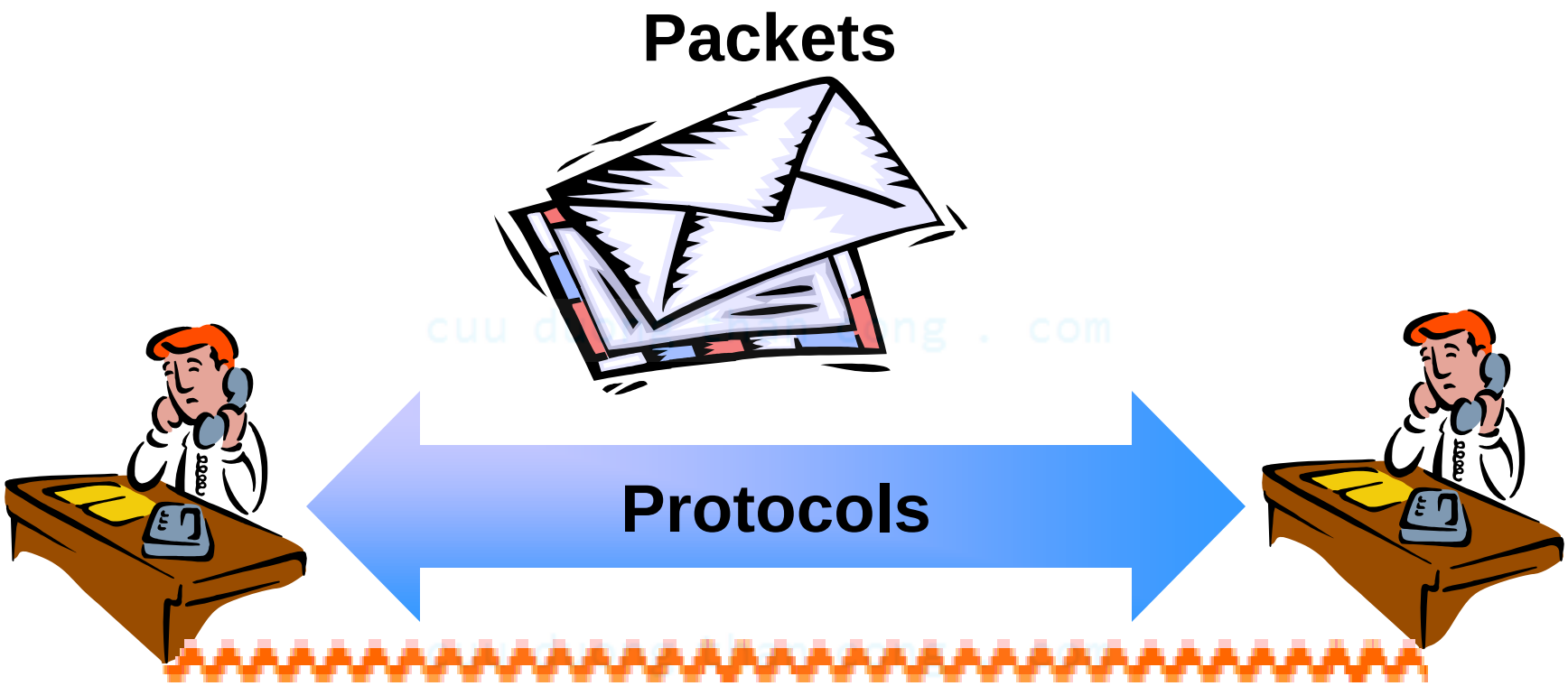
What rules govern flow ?

Standard, Protocol ...

Where does the flow occur ?

Cable, Atmosphere ...

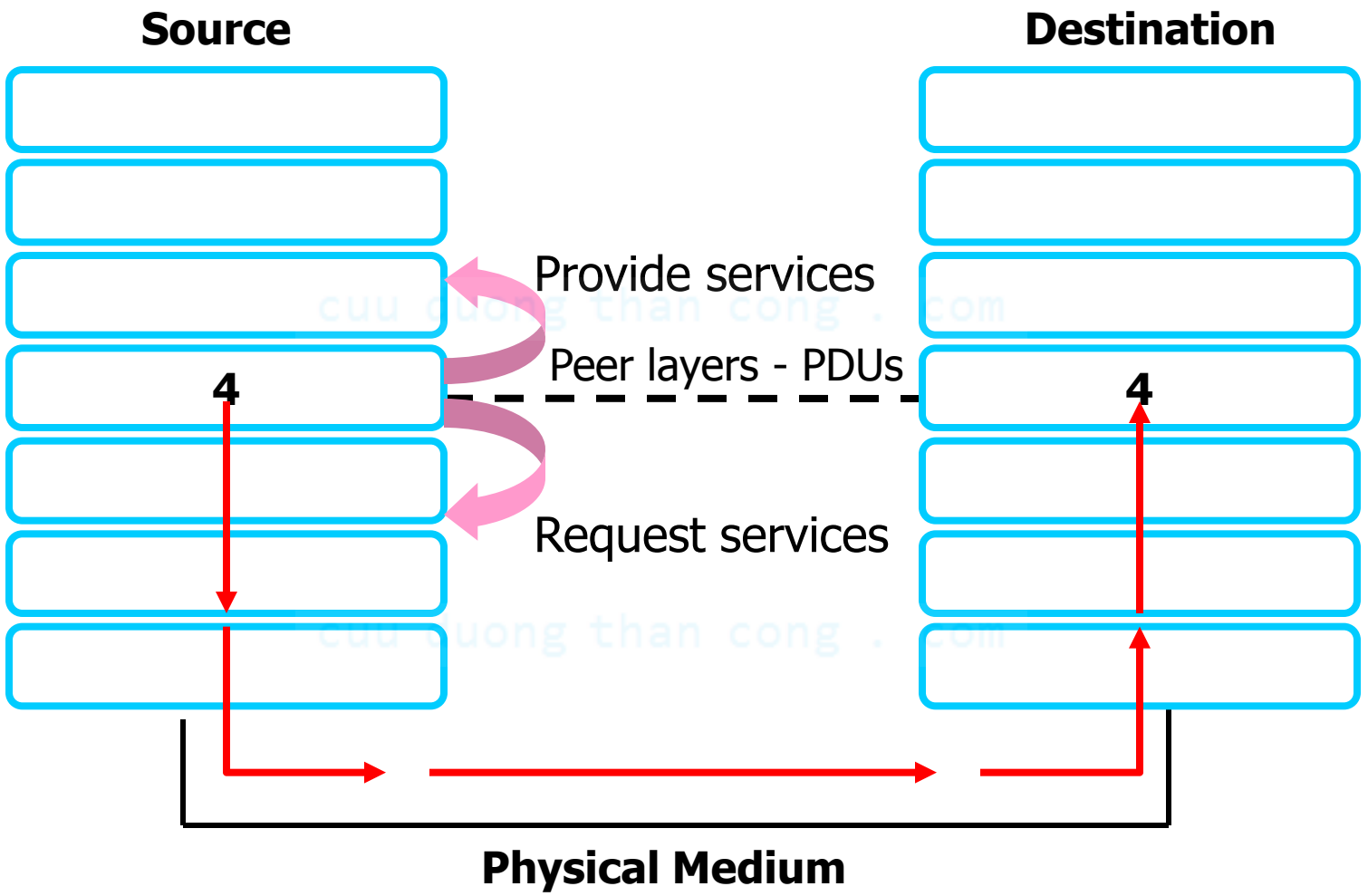
Communication process



Communication characteristics

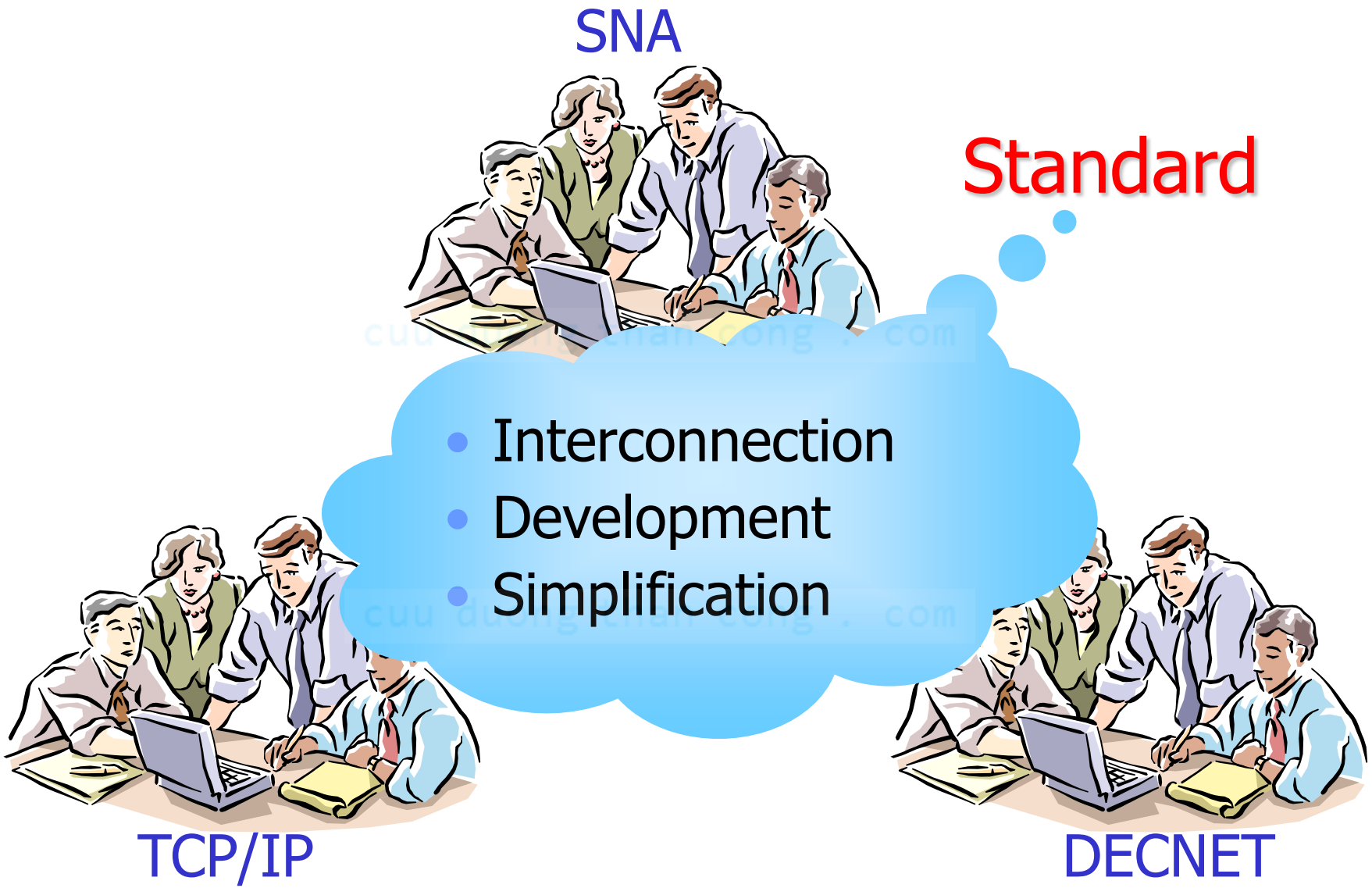
- Addresses
  - Who are the source and the destination of a communication process?
- Media
  - Where is the communication take place?
- Protocols
  - is a set of rules how to make communication on a network more efficient.

Using Layers To Describe Data Communication



OSI REFERENCE MODEL

Evolution of networking standards



OSI reference model development

- Researched and developed by the ISO - *International Organization for Standardizations.*
- 1977: establish a subcommittee to develop a communications architecture.
- 1984: publish ISO-7498, the Open System Interconnection (OSI) reference model.

OSI reference model

- The OSI reference model: A framework that is used to understand how information travels throughout a network.
  - *It provided vendors with a set of standards that ensured greater compatibility and interoperability between the various types of network technologies that were produced by the many companies around the world.*

Proprietary vs. Open

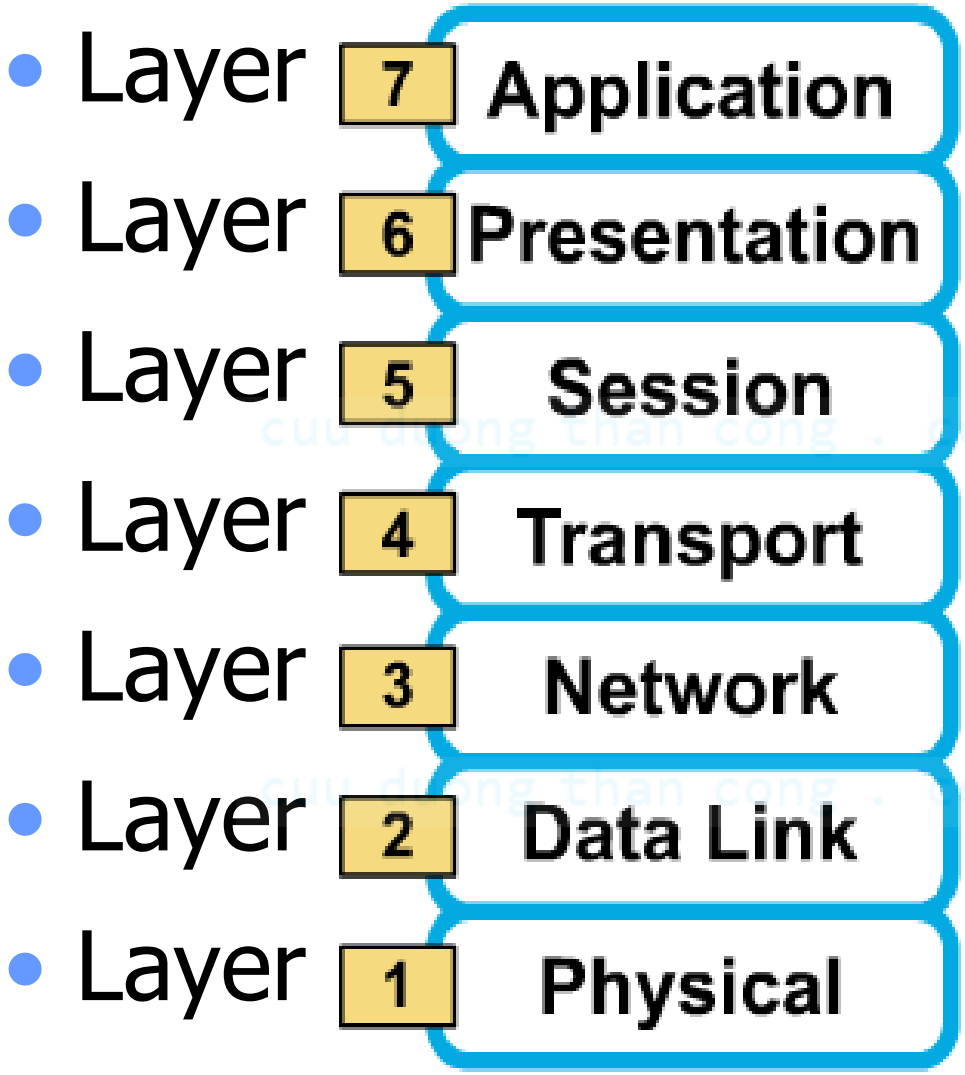
OSI reference model (cont.)

- Dividing the network into seven layers provides the following advantages:
  - **It breaks network communication into smaller, more manageable parts.**
  - **It standardizes network components to allow multiple vendor development and support.**
  - **It allows different types of network hardware and software to communicate with each other.**
  - **It prevents changes in one layer from affecting other layers.**
  - **It divides network communication into smaller parts to make learning it easier to understand.**

Benefits of the OSI model

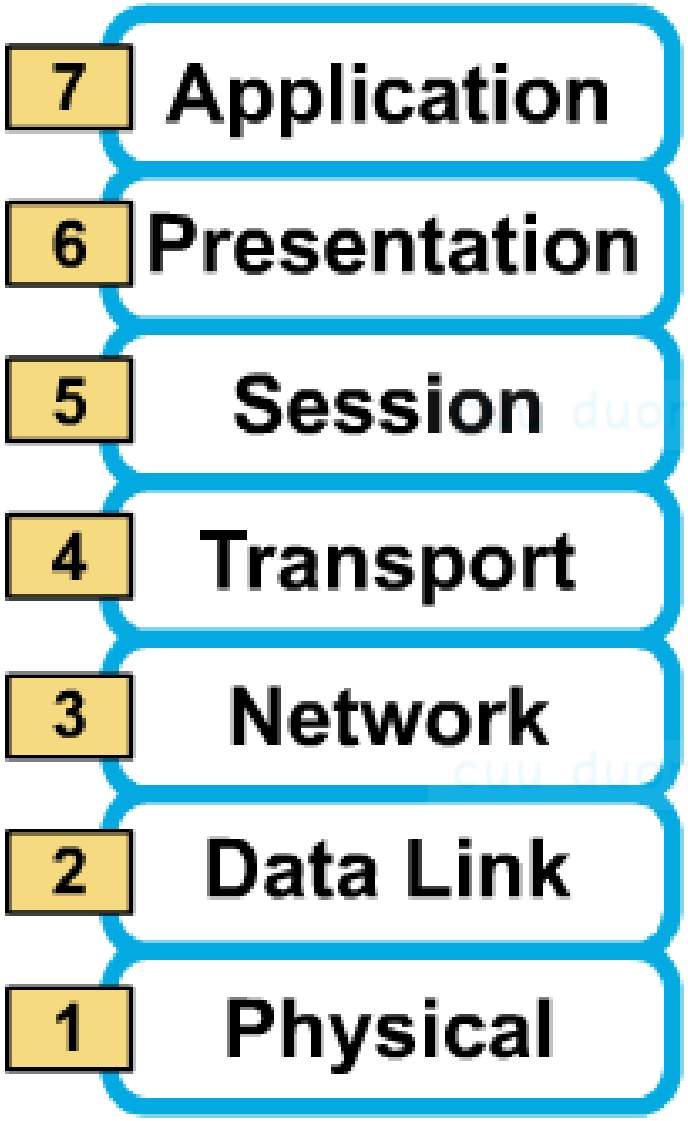
- Reduces complexity
- Standardizes interfaces
- Facilitates modular engineering
- Insures interoperable technology
- Accelerates evolution
- Simplifies teaching & learning

Layers of OSI reference model



- *All People Seem To Need Data Processing*

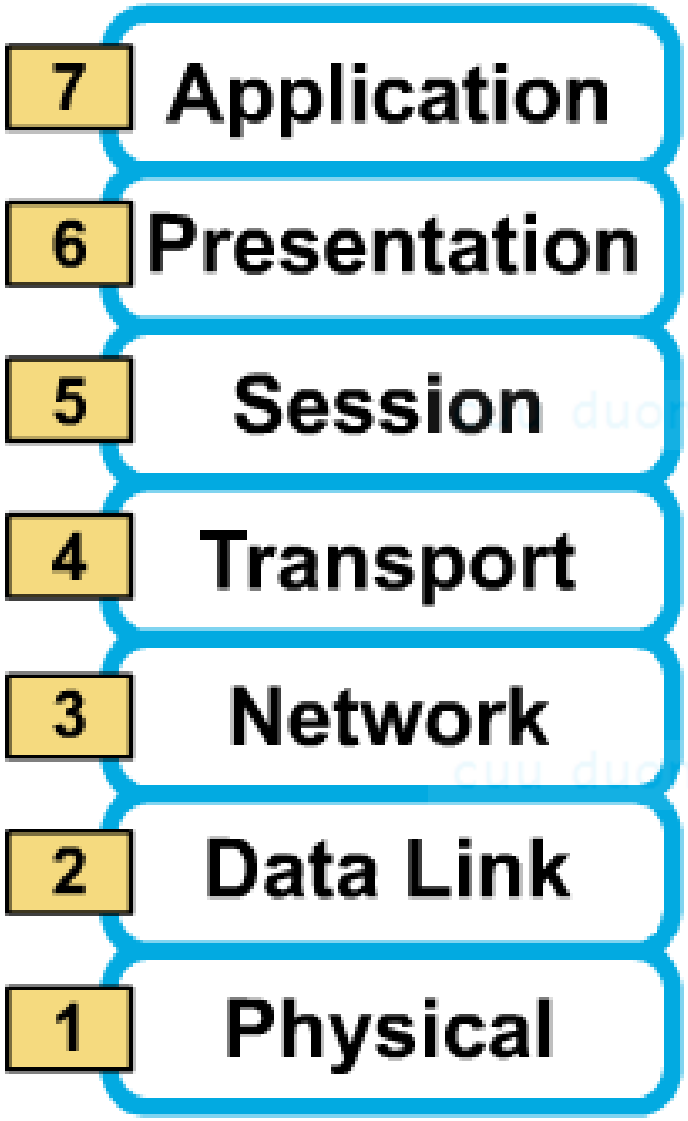
OSI layers: layer 1



Binary Transmission

- Wires, connectors, voltages, data rates

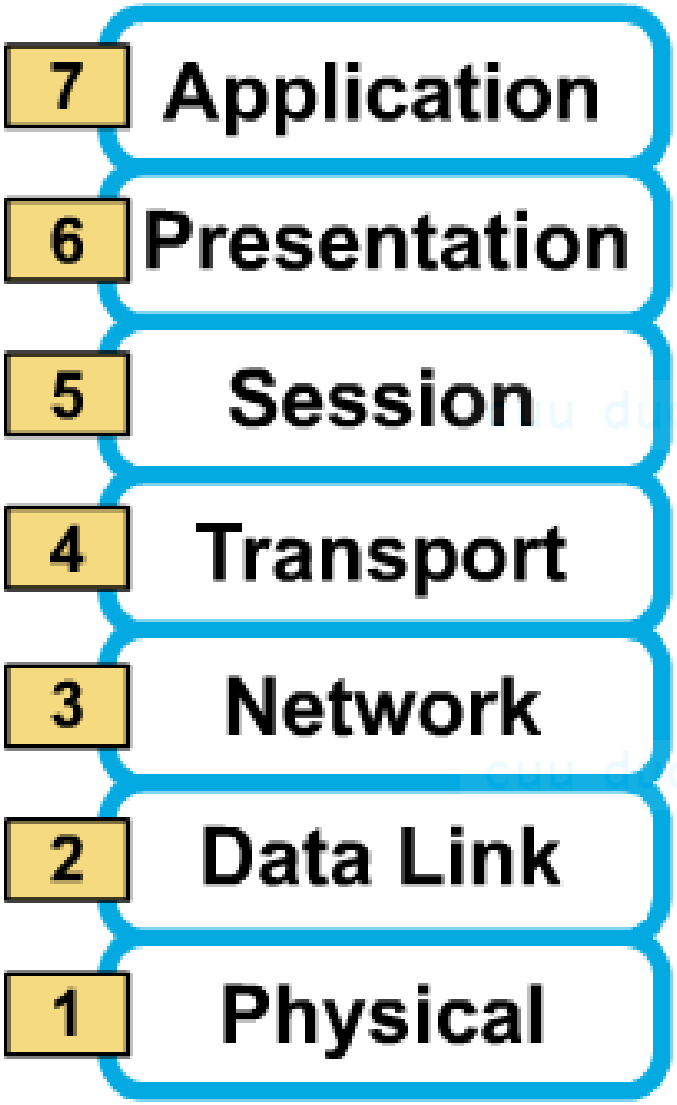
OSI layers: layer 2



Direct Link Control, Access to Media

- Provides reliable transfer of data across media
- Physical addressing, network topology, error notification, flow control

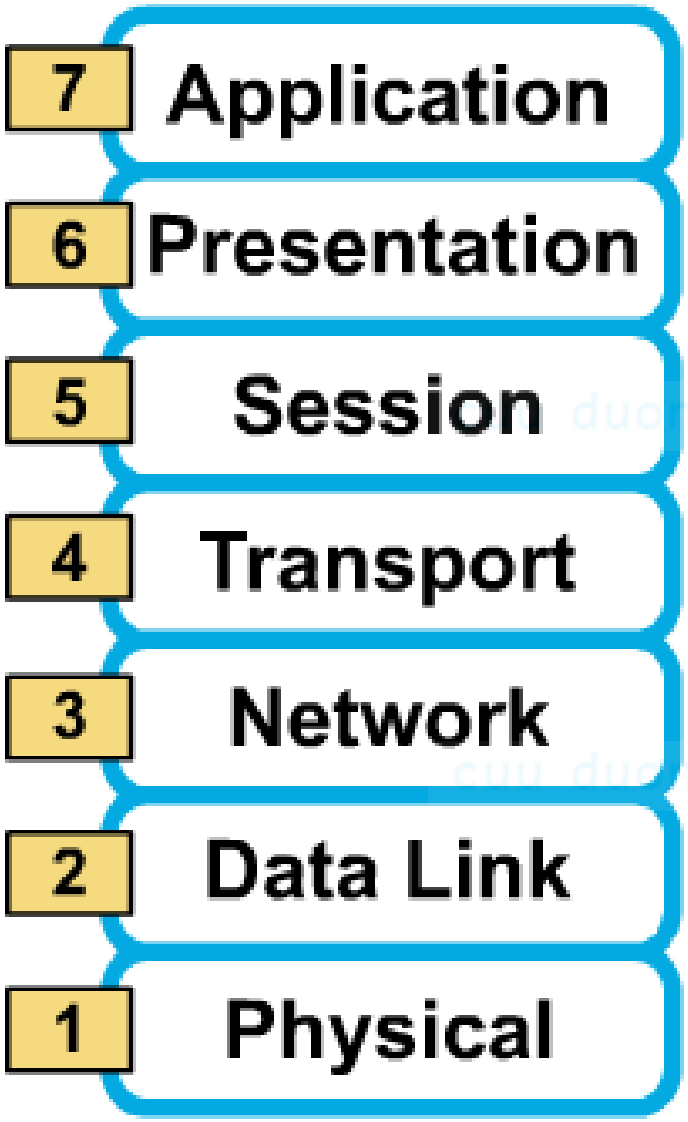
OSI layers: layer 3



Address and Best Path

- Provides connectivity and path selection between two end systems
- Domain of routing

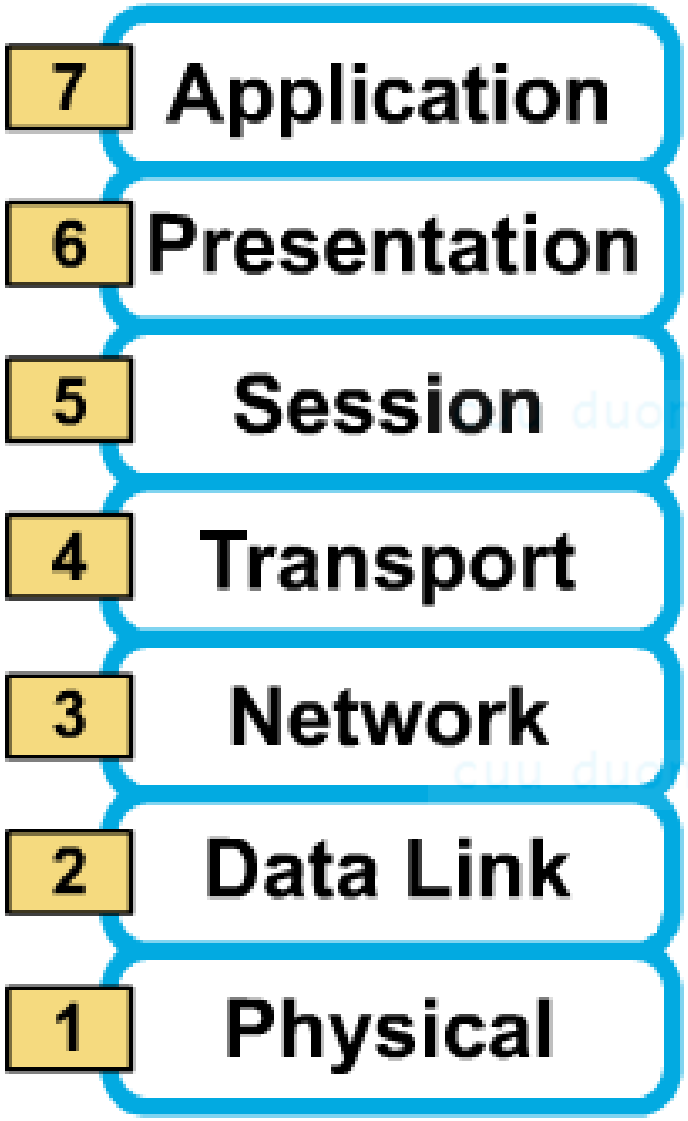
OSI layers: layer 4



End-to-end Connections

- Concerned with transportation issues between hosts
- Data transport reliability
- Establish, maintain, terminate virtual circuits
- Fault detection and recovery information flow control

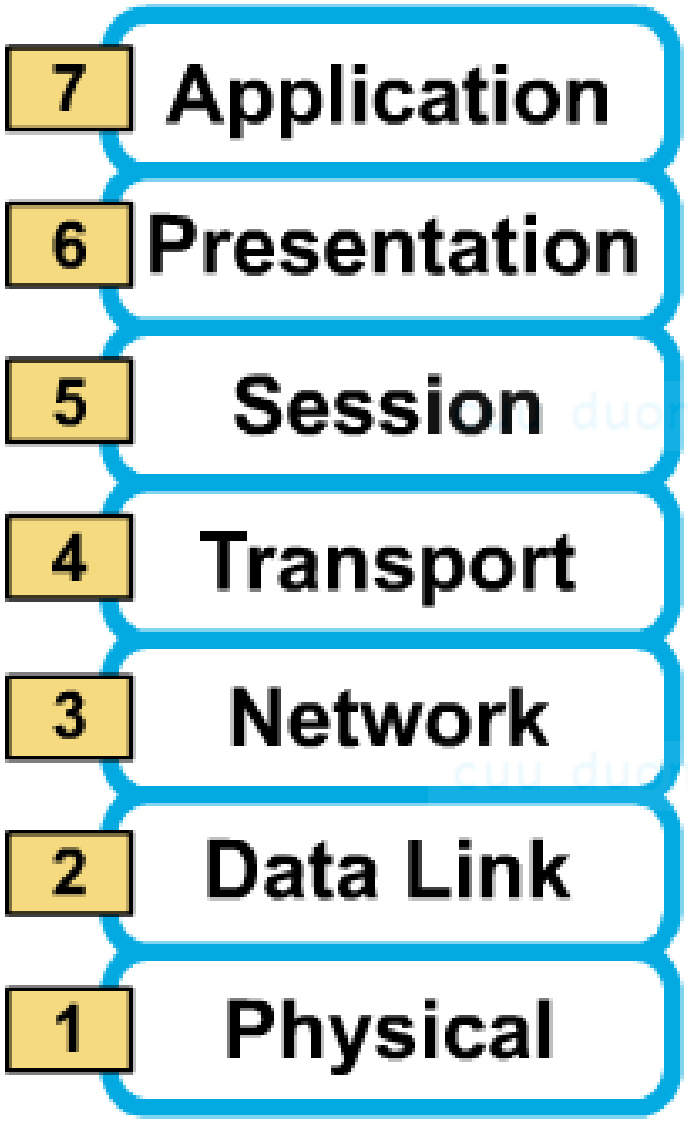
OSI layers: layer 5



Interhost Communication

- Establishes, manages, and terminates sessions between applications

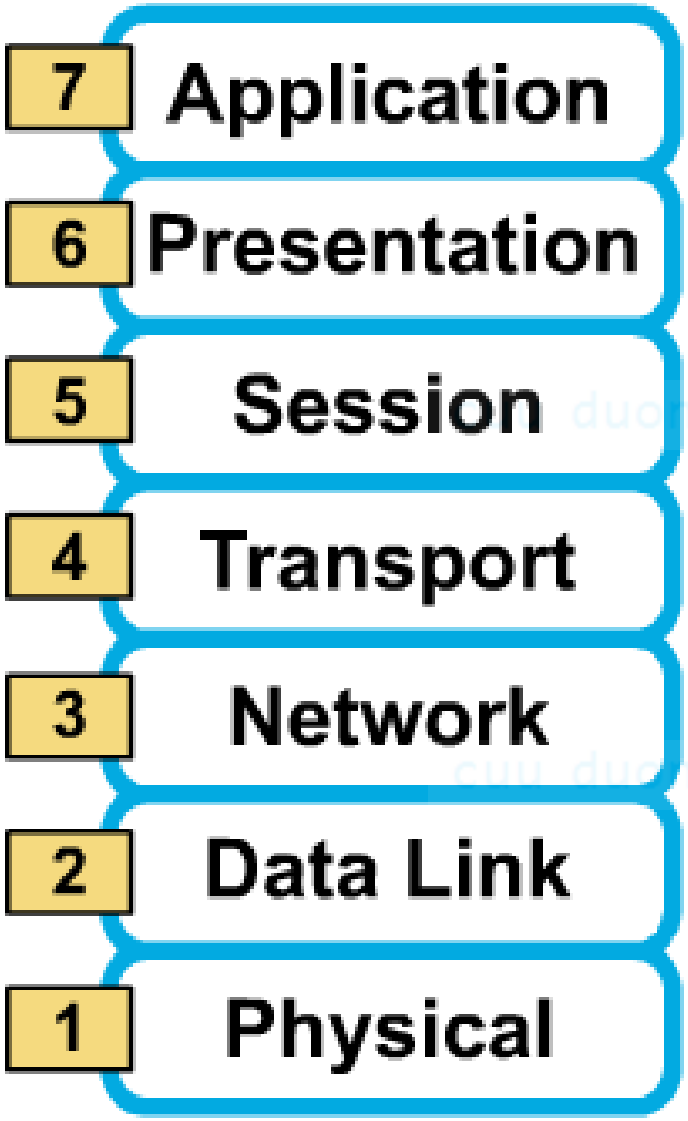
OSI layers: layer 6



Data Representation

- Ensure data is readable by receiving system
- Format of data
- Data structures
- Negotiates data transfer syntax for application layer

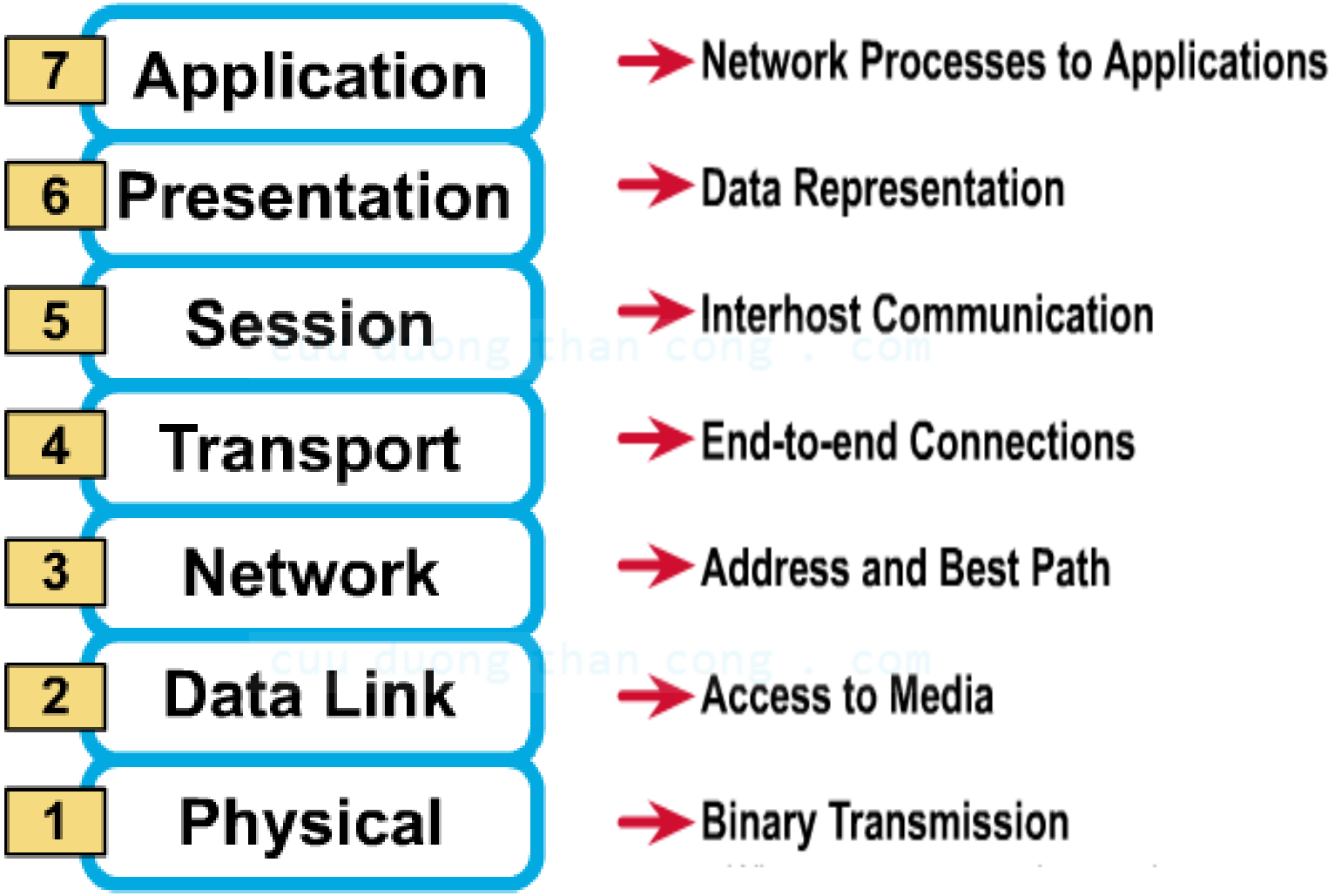
OSI layers: layer 7



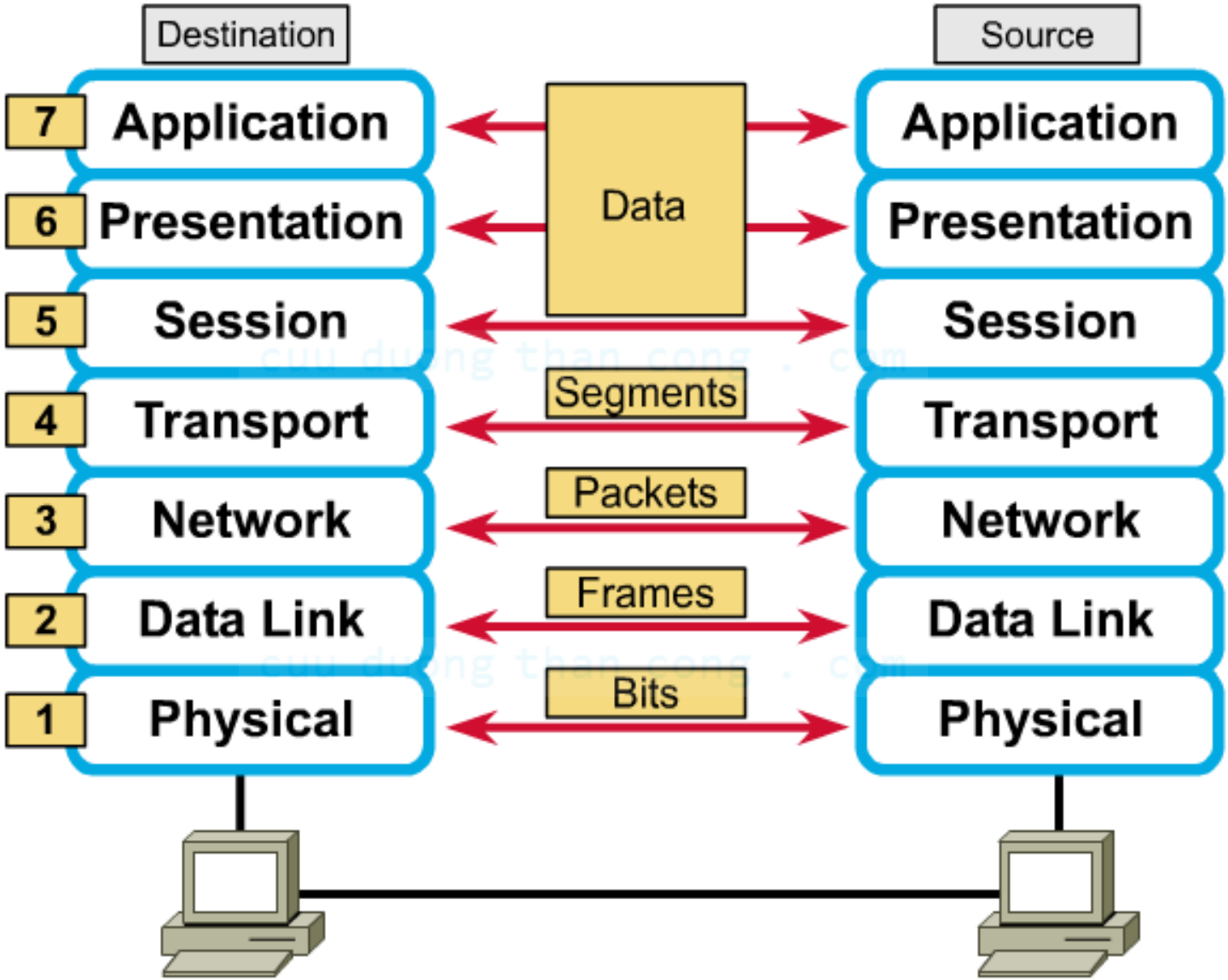
Network Processes to Applications

- Provides network services to application processes (such as electronic mail, file transfer, and terminal emulation)

OSI layers: Summary

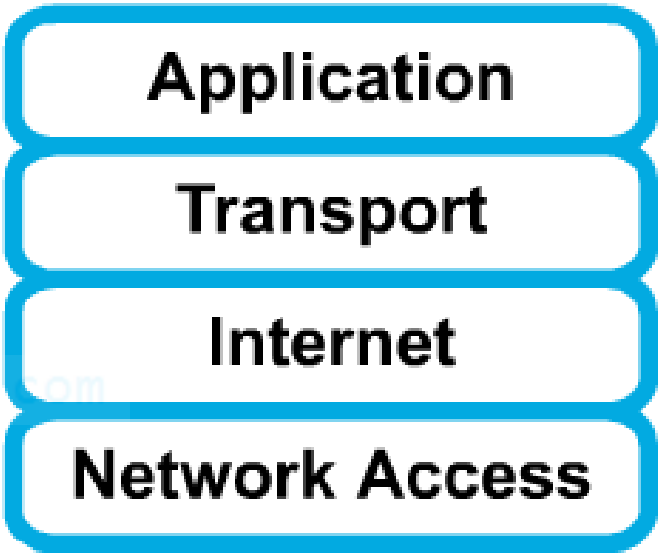


Peer-to-peer communications



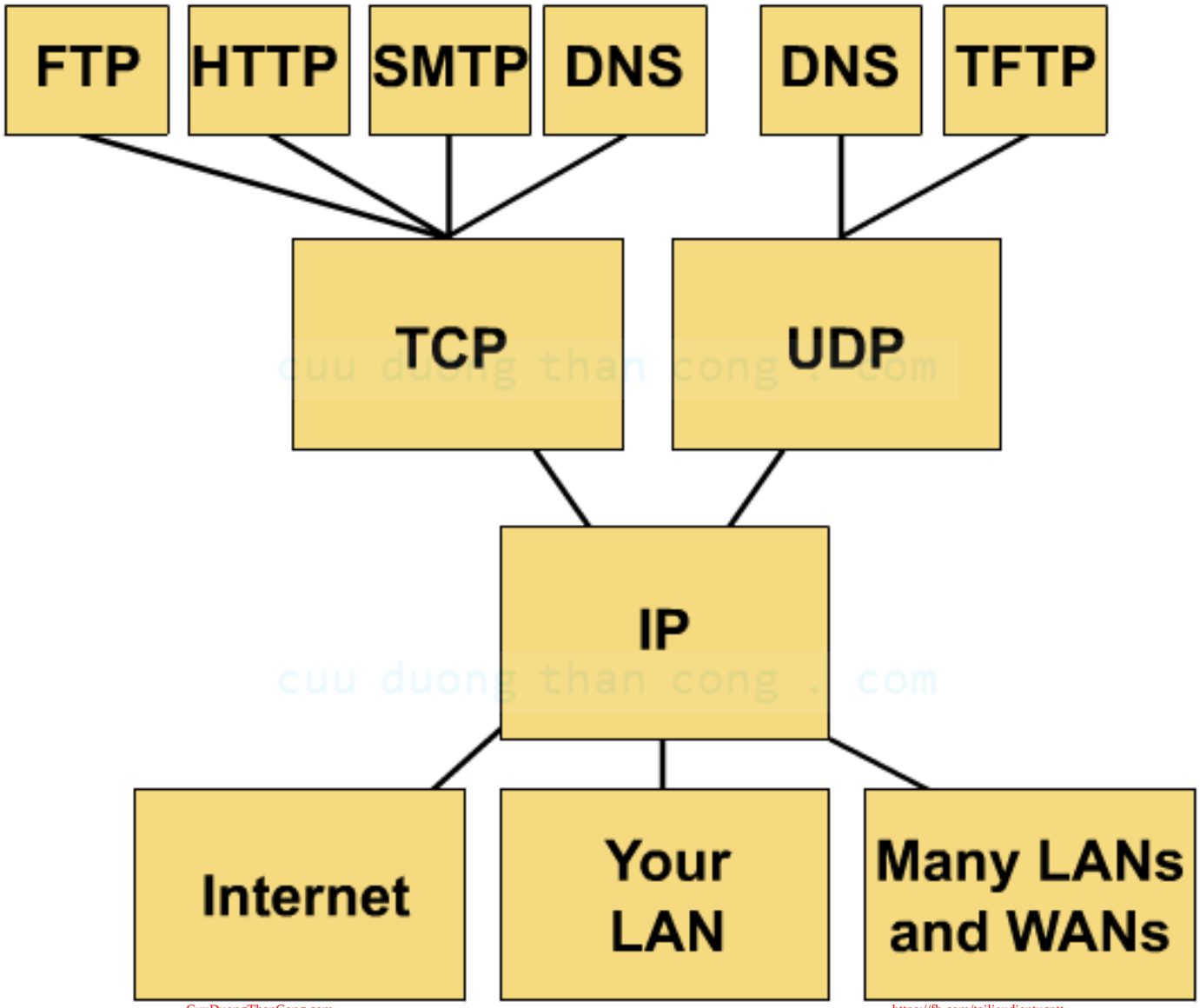
The TCP/IP model

- Layer 4: Application
- Layer 3: Transport
- Layer 2: Internet
- Layer 1: Network access

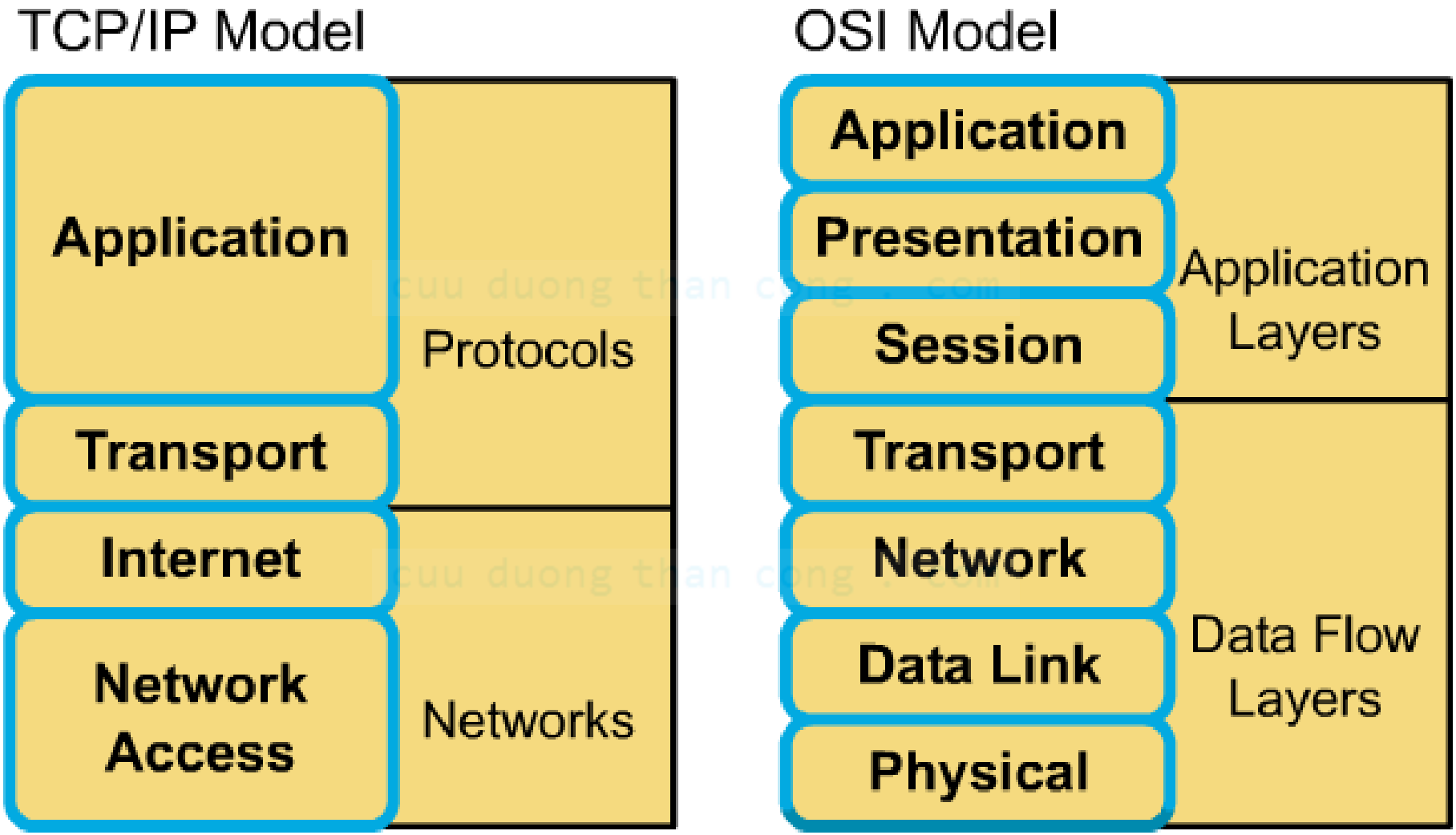


It is important to note that some of the layers in the TCP/IP model have the same name as layers in the OSI model. Do not confuse the layers of the two models.

TCP/IP protocol stack



Comparing TCP/IP with OSI



Comparing TCP/IP with OSI (cont.)

Similarities:

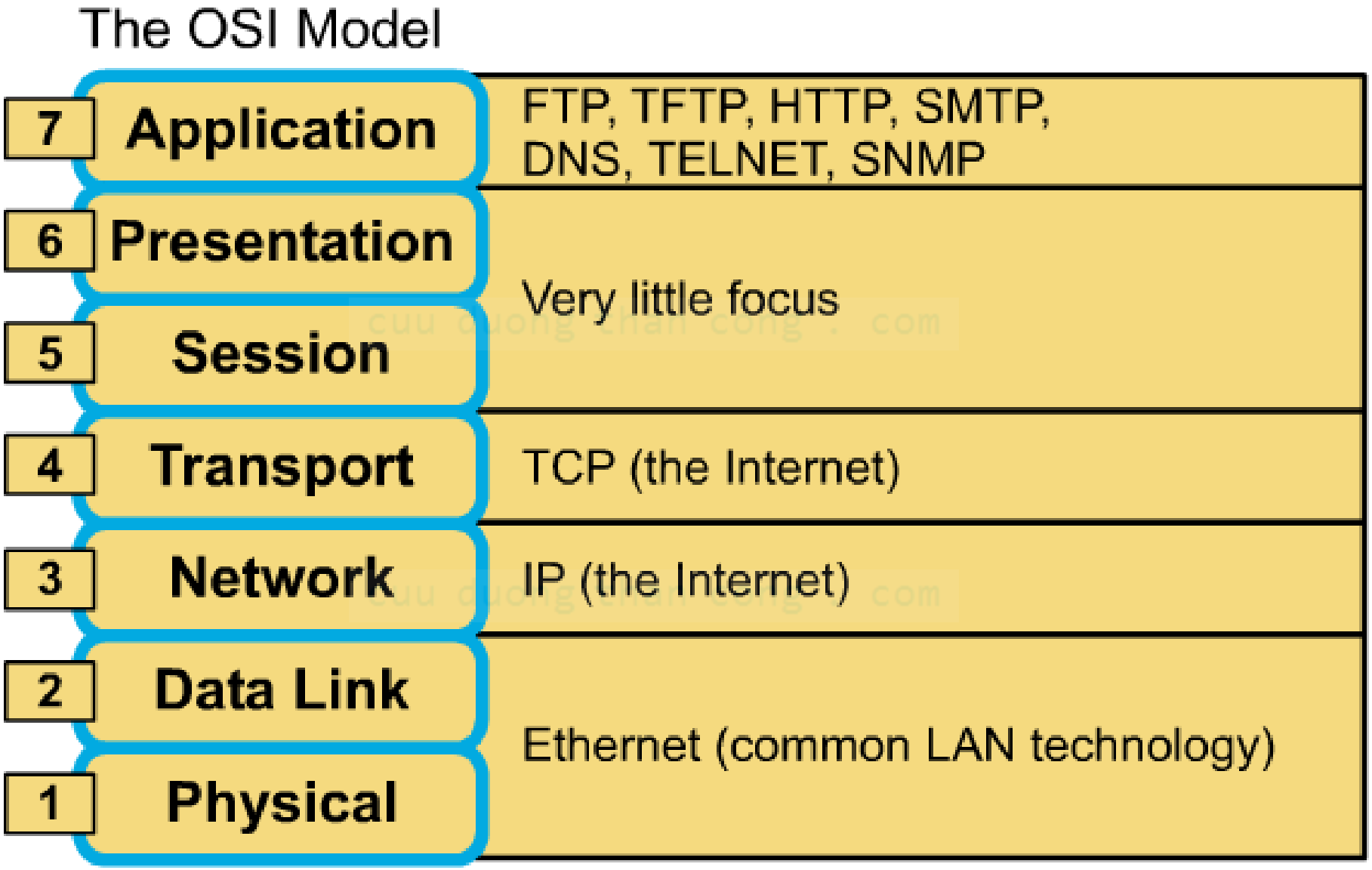
- Both have layers.
- Both have application layers, though they include very different services.
- Both have comparable transport and network layers.
- Both models need to be known by networking professionals.
- Both assume packets are switched.

Comparing TCP/IP with OSI (cont.)

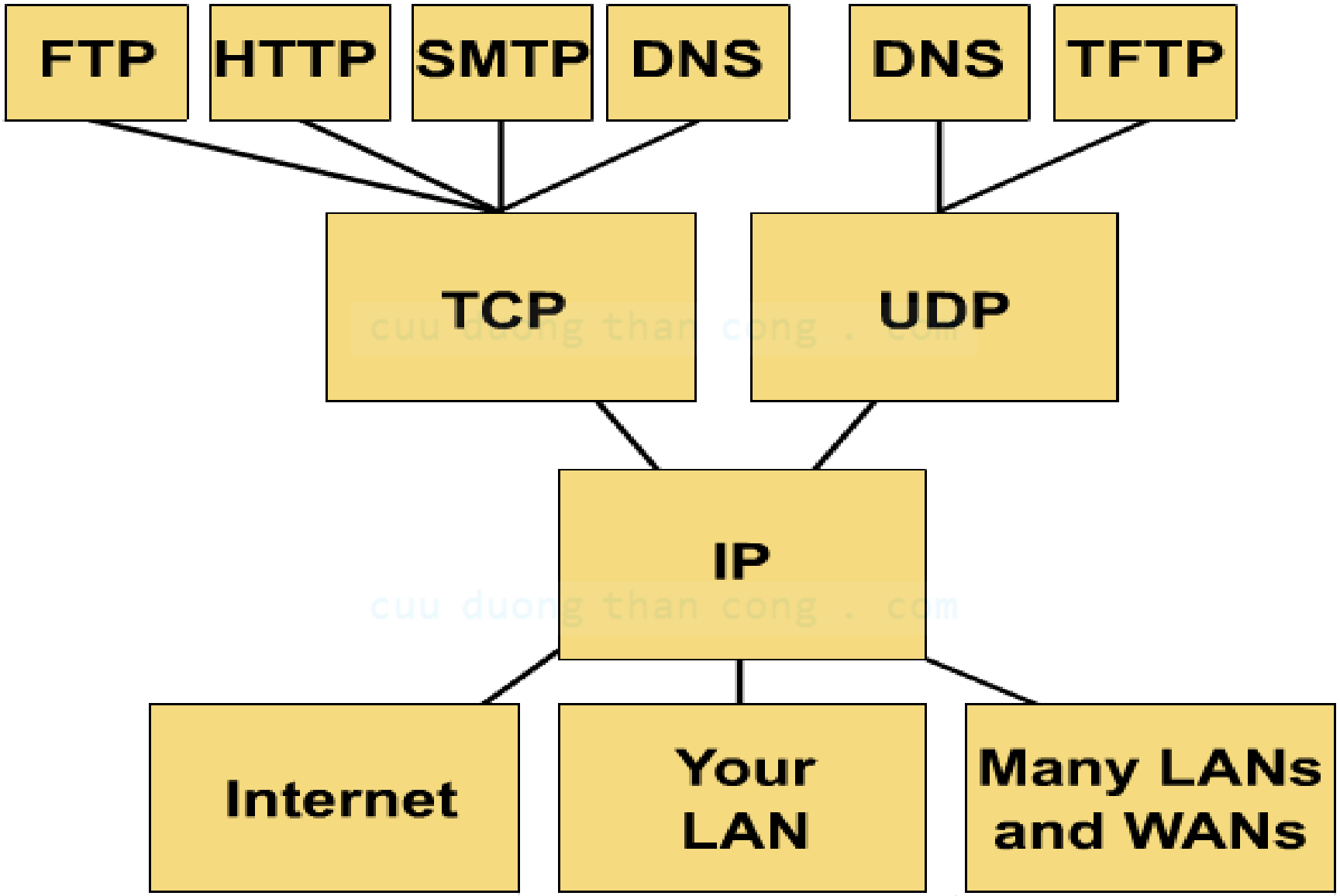
Differences:

- TCP/IP combines the presentation and session layer issues into its application layer.
- TCP/IP combines the OSI data link and physical layers into the network access layer.
- TCP/IP appears simpler because it has fewer layers.

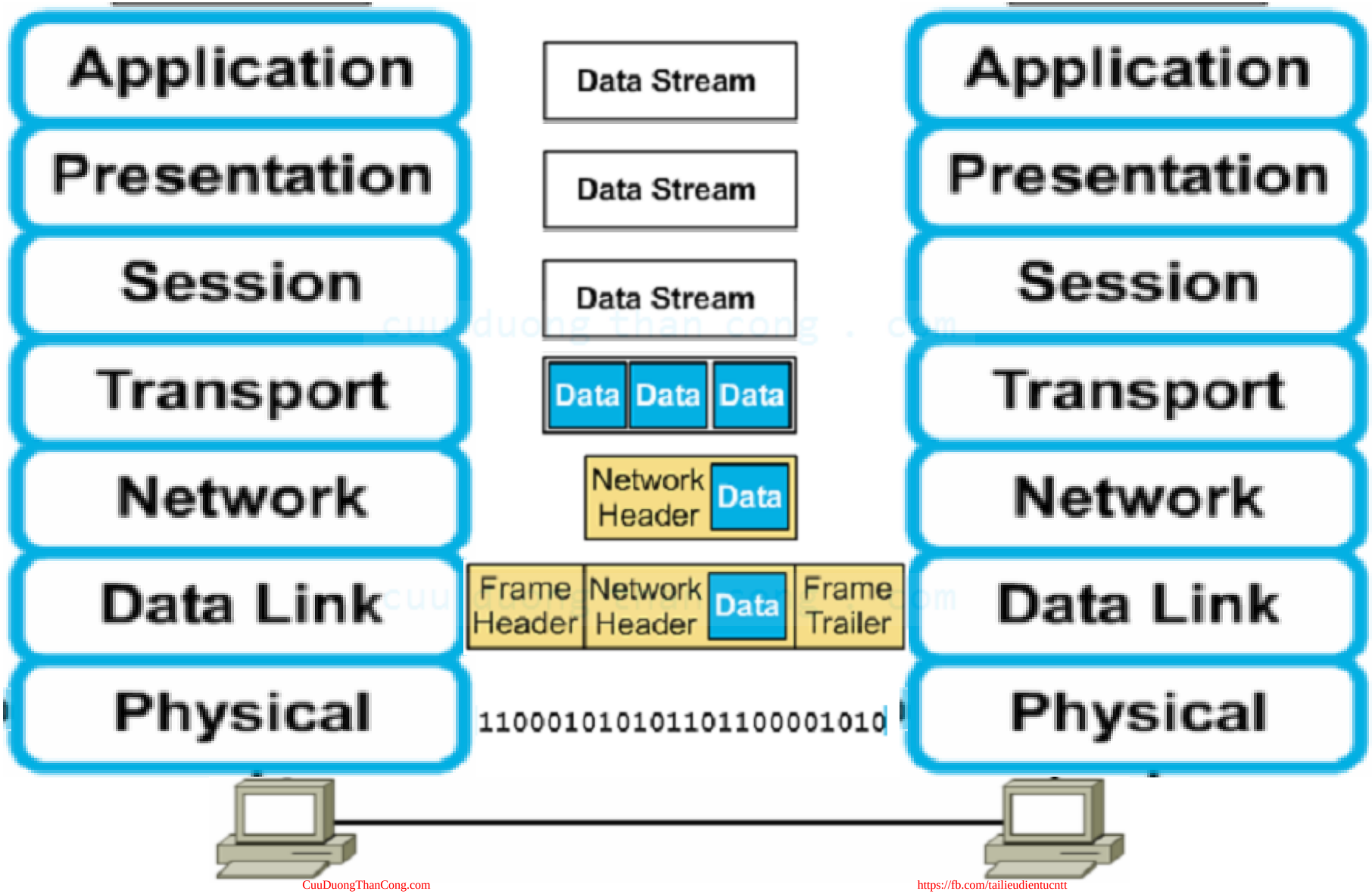
Focus of the CCNA curriculum



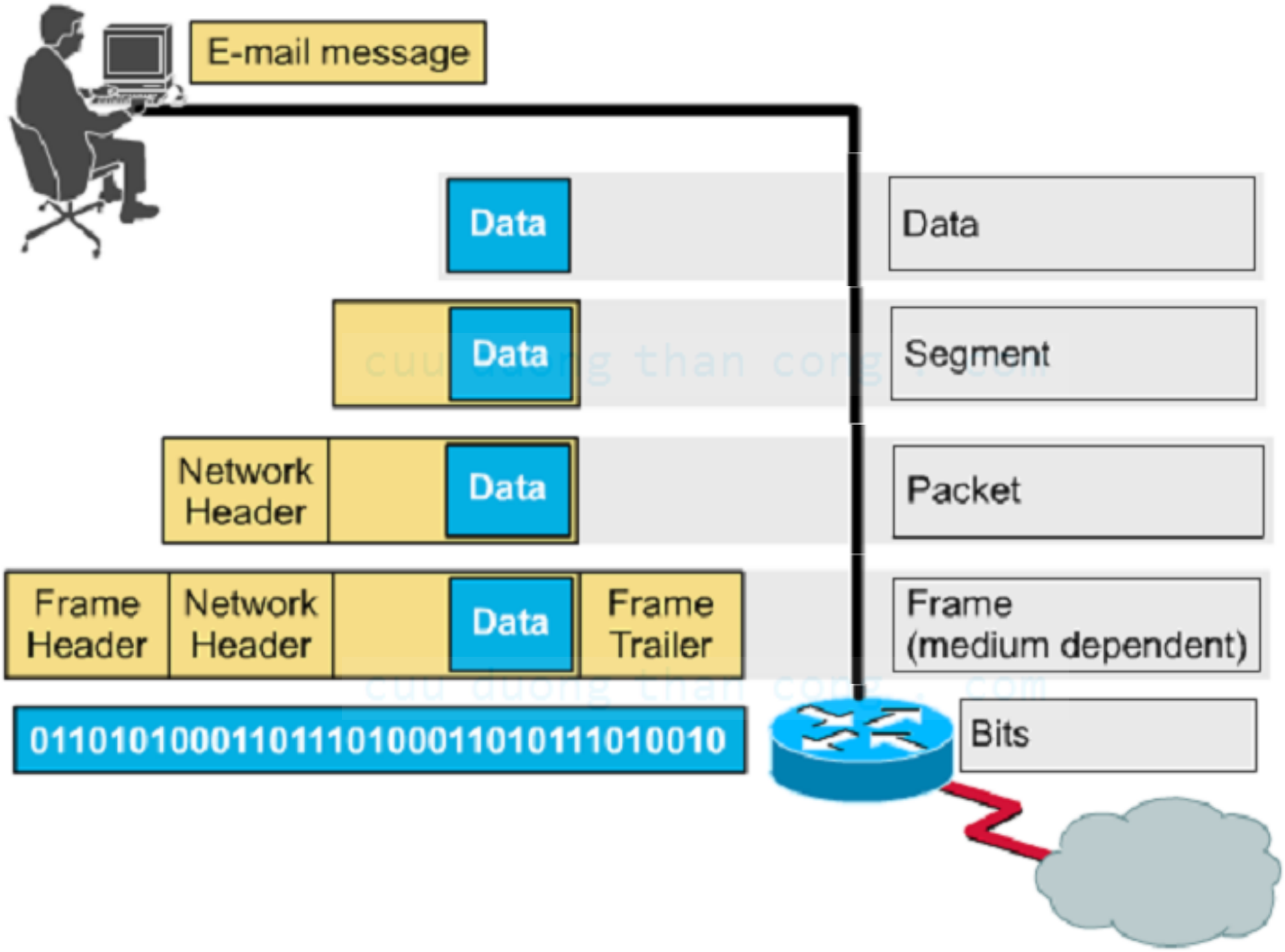
Common TCP/IP Protocols



Detailed Encapsulation Process



Encapsulation example: E-mail



Summary

Cisco Systems
Empowering the Internet Generation℠

- The seven layers of the OSI are application, presentation, session, transport, network, data link, and physical
- The four layers of the TCP/IP are application, transport, internet, and network access
- The TCP/IP application layer is equivalent to the OSI application, presentation, and session layers
- LANs and WANs developed in response to business and government computing needs
- Fundamental networking devices are hubs, bridges, switches, and routers

Q&A

Enjoy the Course