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Lecture 1

The Internet: An Overview

ELEC 3506

ELEC 9506

Communication Networks

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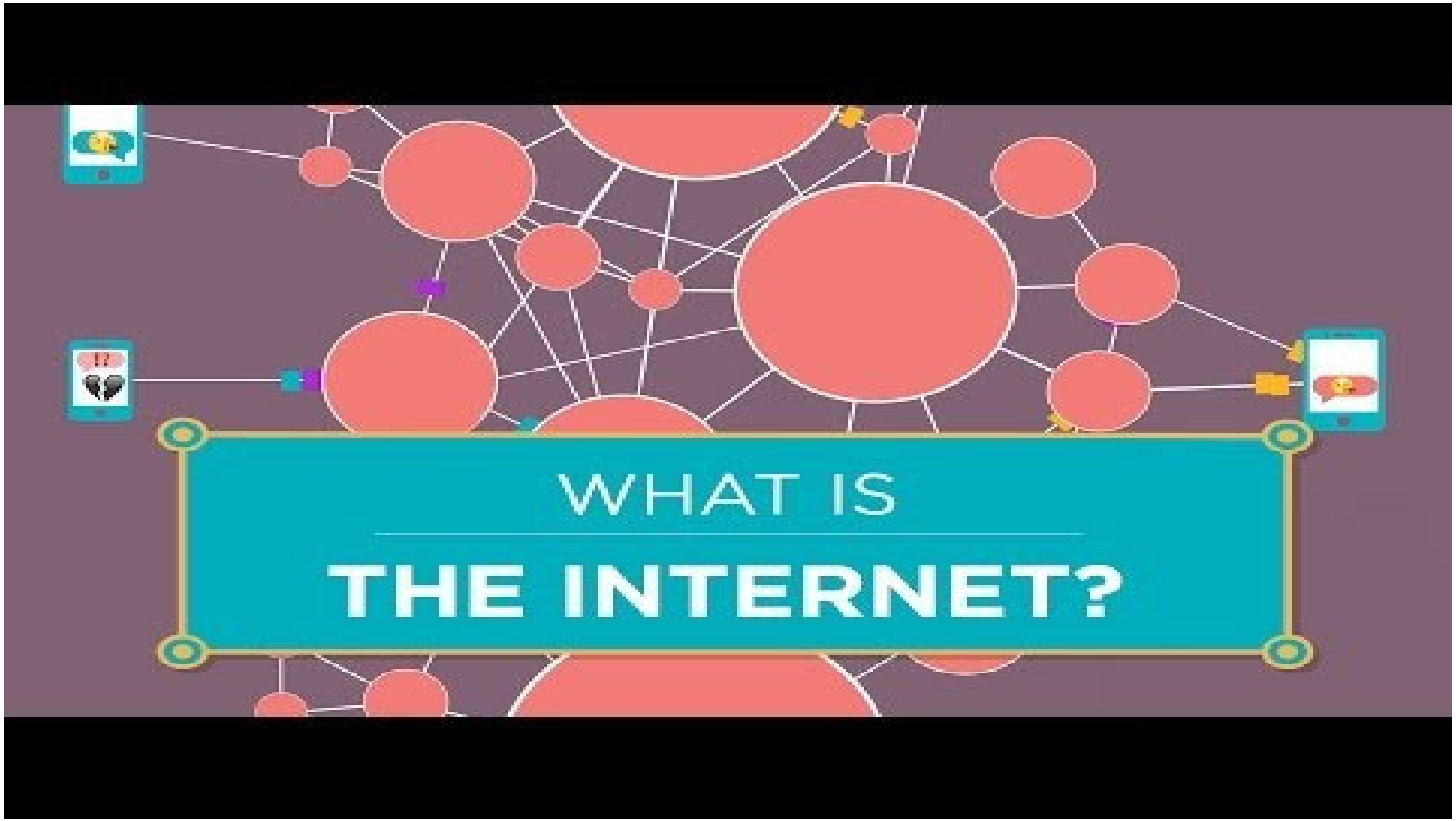
What is Internet?



https://www.youtube.com/watch?v=Dxcc6ycZ73M

The Internet

- A worldwide system of interconnected networks and computers

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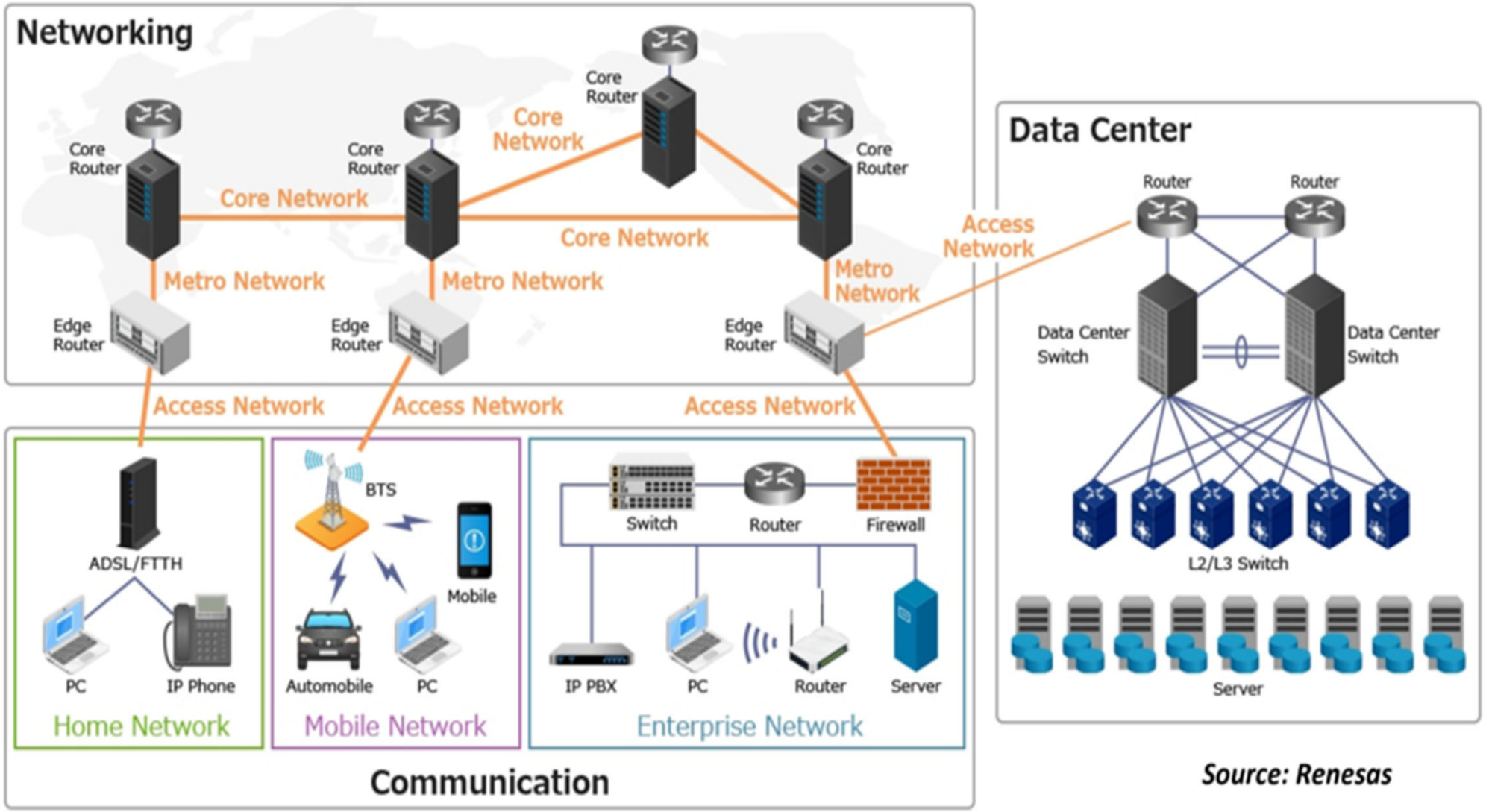
What is it?

So, what is it?

- A large number of interconnected computer/communication networks and nodes
- A set of transmission systems and switching systems which provide this interconnection
- A set of protocols which moves data through these networks and controls operations
  - A protocol is a set of rules (conventions) that govern all aspects of information communication

Internet Infrastructure

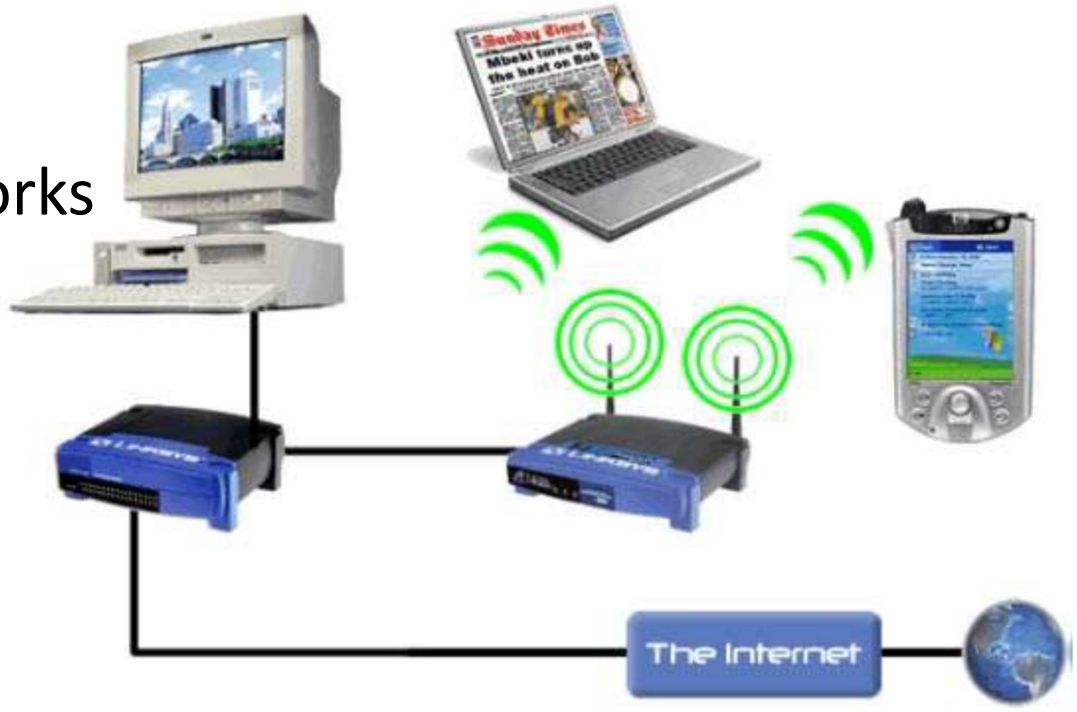


Source: Renesas

What is Network?

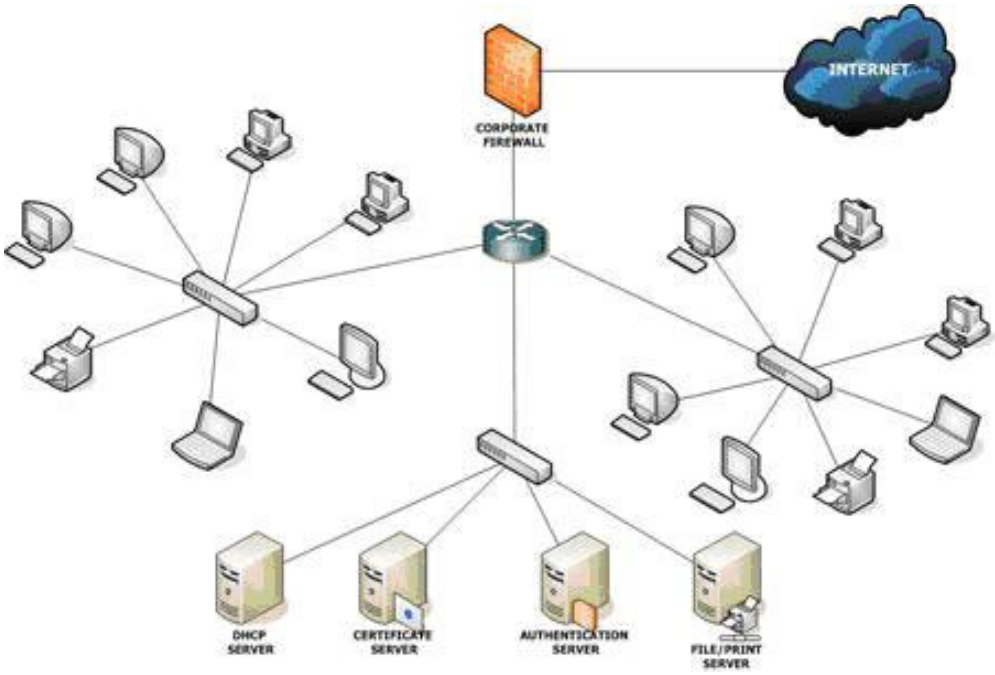
A computer network is an interconnection of a group of computers.

- Local Area Networks
- Metropolitan Area Networks
- Wide Area Networks



LANs

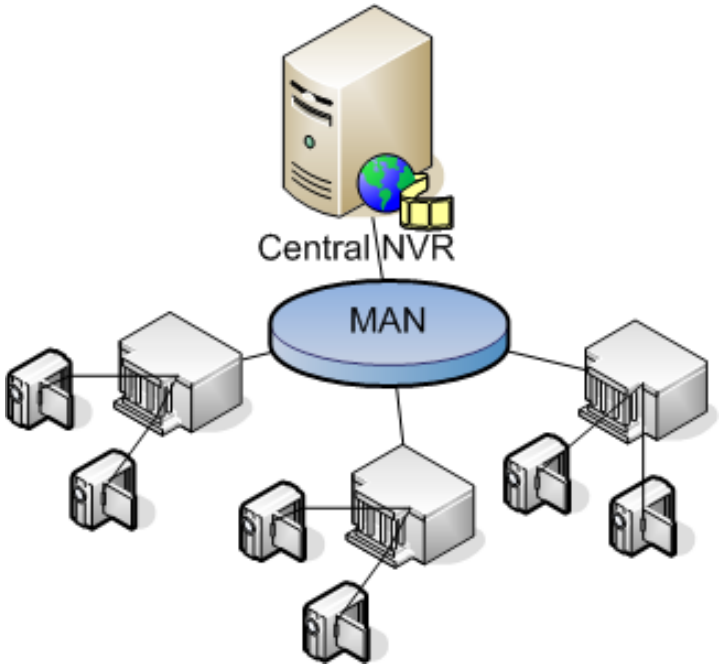
- Allow devices to communicate within a limited geographic area, e.g. Campus, building
- Popular LAN technology:
  - Ethernet
  - Token ring
  - FDDI
  - WLAN
- LAN equipment:
  - bridges, switches, sometimes routers



- Examples: Home network, enterprise network, data centre

MANs

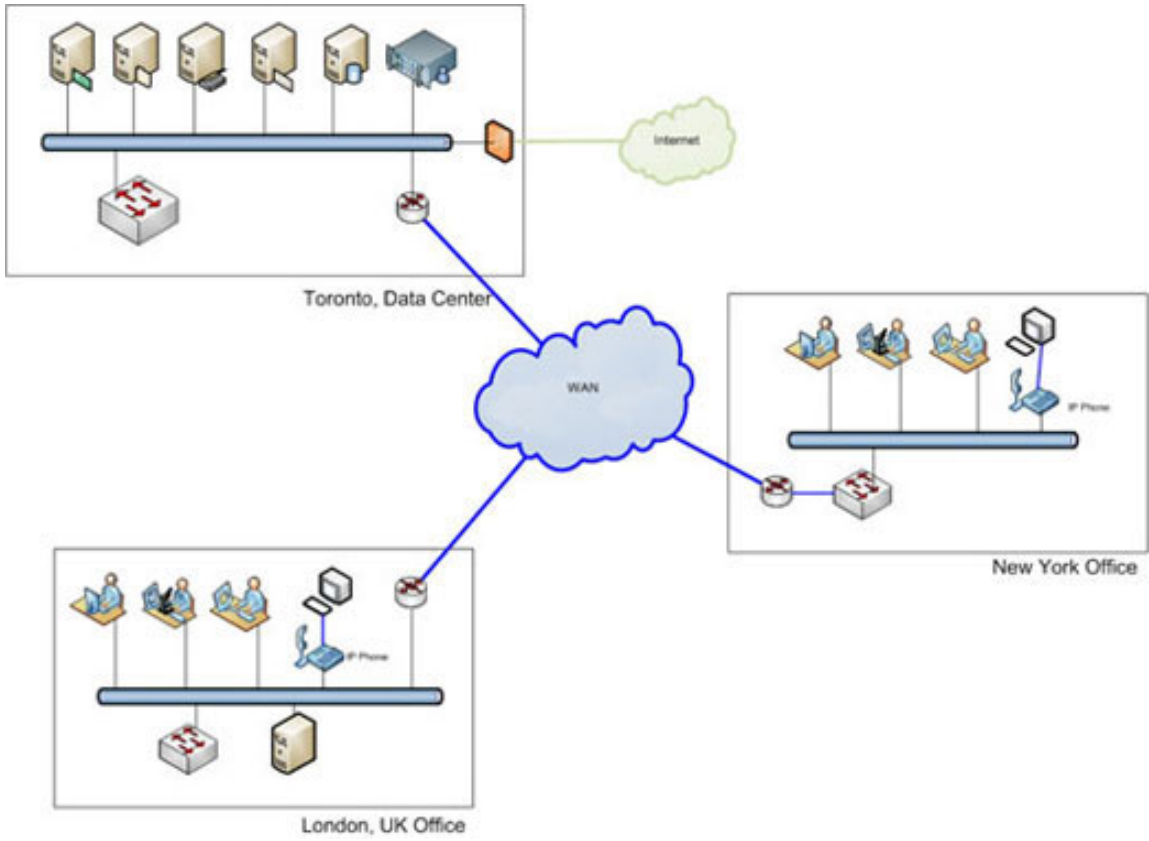
- Designed to extend over an entire city
- Popular technology:
  - Switched Multimegabit Data Service (SMDS)
  - Asynchronous Transfer Mode (ATM)
  - Fiber Distributed Data Interface (FDDI)
  - Other - Wireless MESH and Ad Hoc Networks
- SMDS provides connectionless, high-performance, packet-switched data transport based on the IEEE 802.6 Distributed Queue Dual Bus (DQDB) standard
- Research is undertaken to extend Ethernet to MAN
- Equipment: routers



Typically considered as a core network linking multiple networks

WANs

- Provides long-distance transmission of data, voice, or video over
- Large geographic areas
- Popular technology:
  - X.25
  - Frame Relay
  - Asynchronous Transfer Mode (ATM)
  - Multi Protocol Label Switching (MPLS), etc.
- Equipment: routers

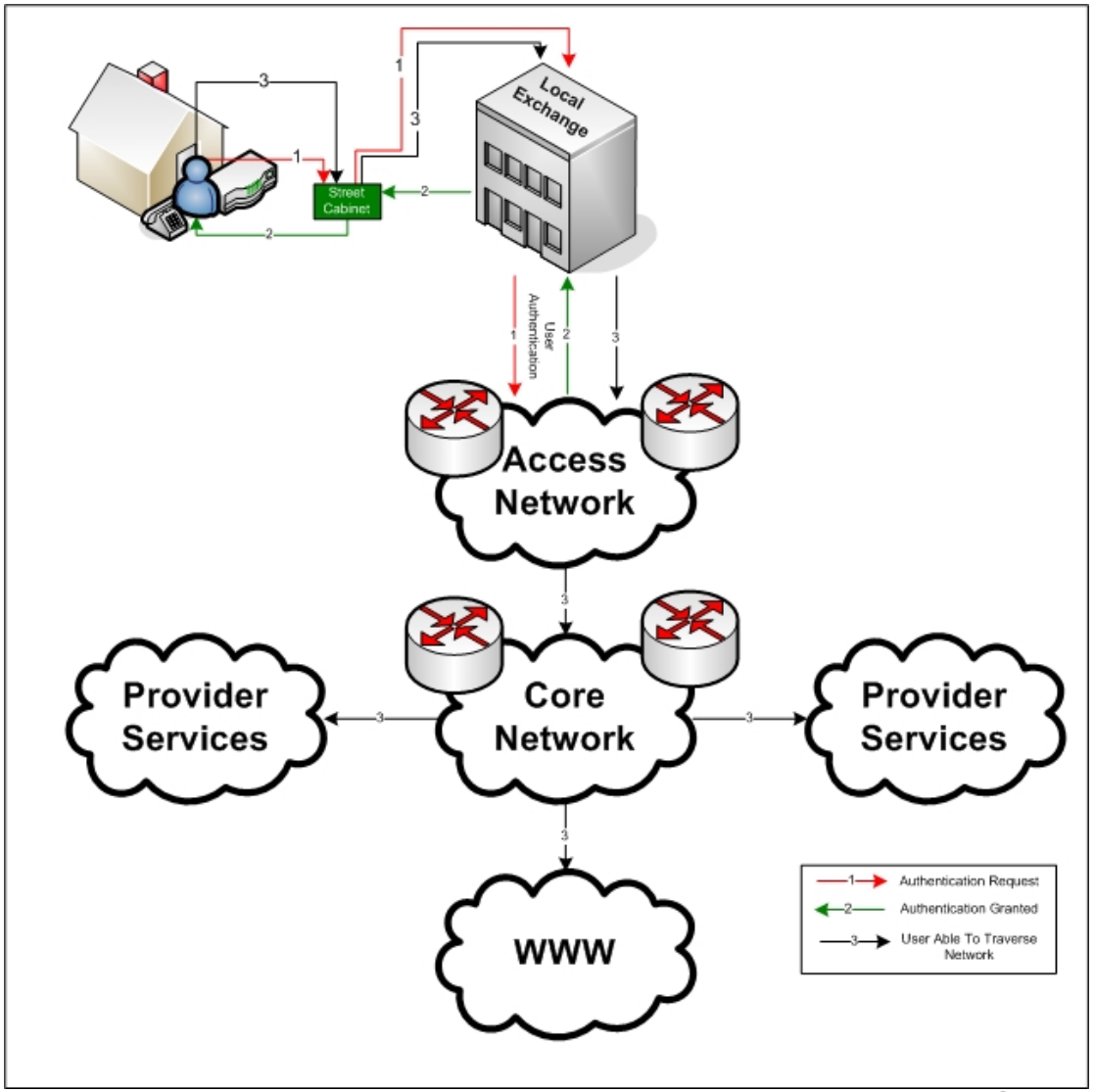


Typically considered as a core network linking multiple networks

Access Network

Connects your private LAN, WLAN, or mobile to the global internet or core network

Examples: Base stations, FTTH, xDSL etc



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The Internet: a Formal Definition

- On October 24, 1995, the Federal Networking Council (FNC) unanimously passed a resolution defining the term Internet.
- FNC agrees that "Internet" refers to the global information system that
  - is logically linked together by a globally unique address space based on the Internet Protocol (IP) or its subsequent extensions/follow-ons;
  - is able to support communications using the Transmission Control Protocol/Internet Protocol (TCP/IP) suite or its subsequent extensions/follow-ons, and/or other IP-compatible protocols; and
  - provides, uses or makes accessible, either publicly or privately, high level services layered on the communications and related infrastructure described herein.
  - Source: "A Brief History of the Internet" http://www.isoc.org/internet/history/brief.shtml

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1970s

- In October 1972, Kahn organized a large, very successful demonstration of the ARPANet at the International Computer Communication Conference (ICCC)
- In the same year, the initial “hot” application, electronic mail, was introduced
- In the 1980s, ARPANet was split into a military component (MILNet) and a civilian component (ARPANet). Many other networks emerge. The Internet starts creeping all over the globe, to Europe, Australia, Canada, South America and beyond

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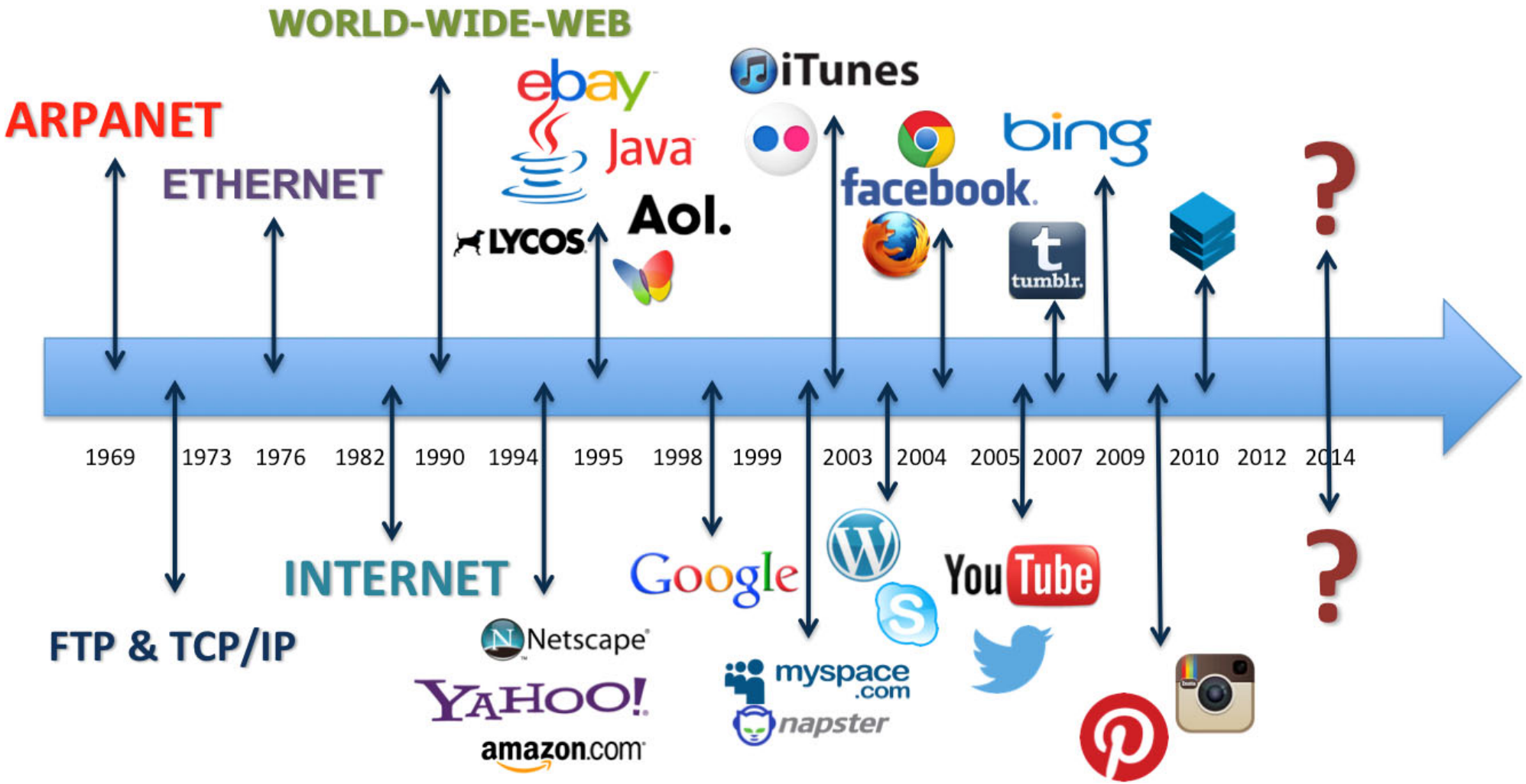
1990s

- Commercial organization started getting on-line
- 1991 WWW – World Wide Web
  - Created by Tim Berners-Lee at CERN (a French acronym for the European Laboratory for particle Physics)
  - As a simple way to publish information and make it available on the Internet
- 1992 WWW publicly available
- Those who first used the system were immediately impressed
- The growth of the Internet like never before
  - URLs appeared in TV advertisement
  - HTML allow users to publish on WWW
  - Work, shop, bank, be entertained on-line
- Internet starts changing our lifestyle

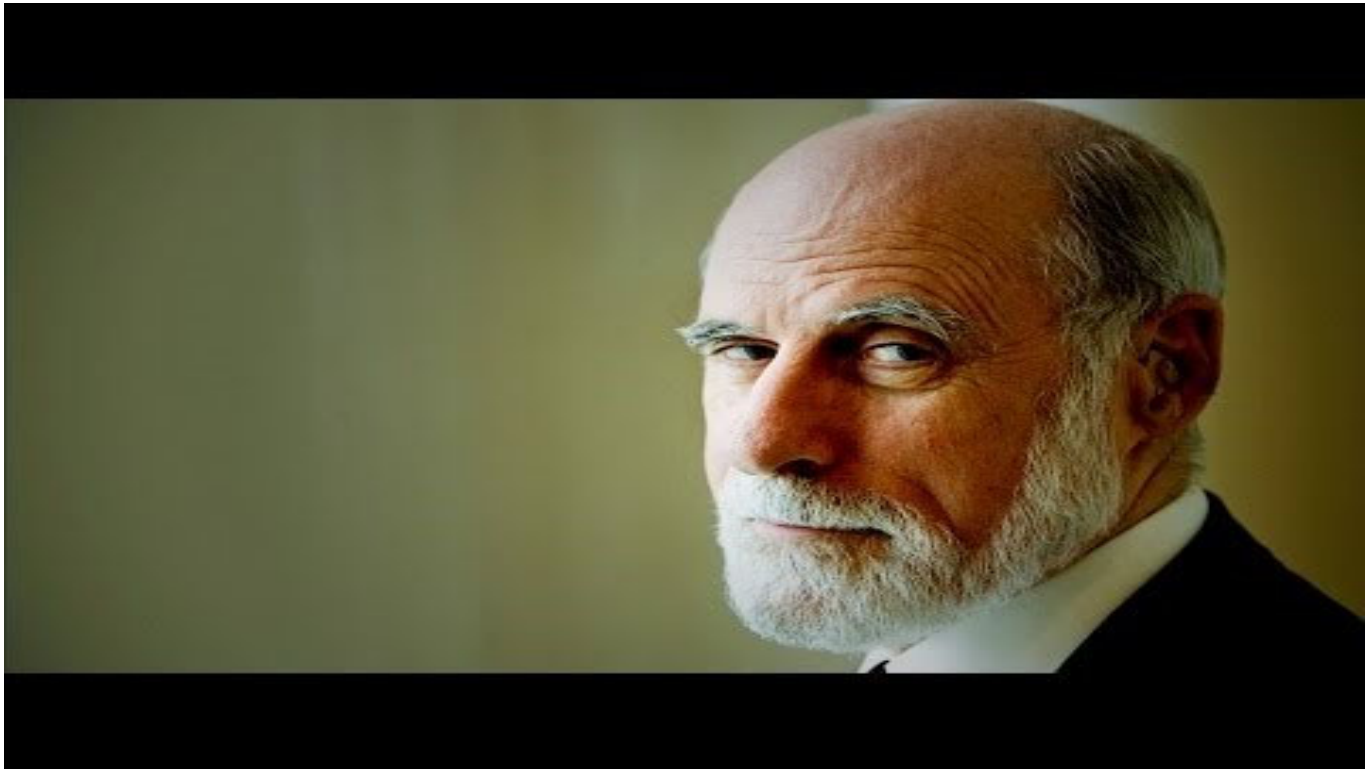
The Internet Timeline

https://www.internethalloffame.org/internet-history/timeline



Meet the Father of Internet

Robert E Kahn is an American computer scientist, who along with Vinton Cerf invented the Transmission Control Protocol and the Internet protocol which are the heart of the Internet.



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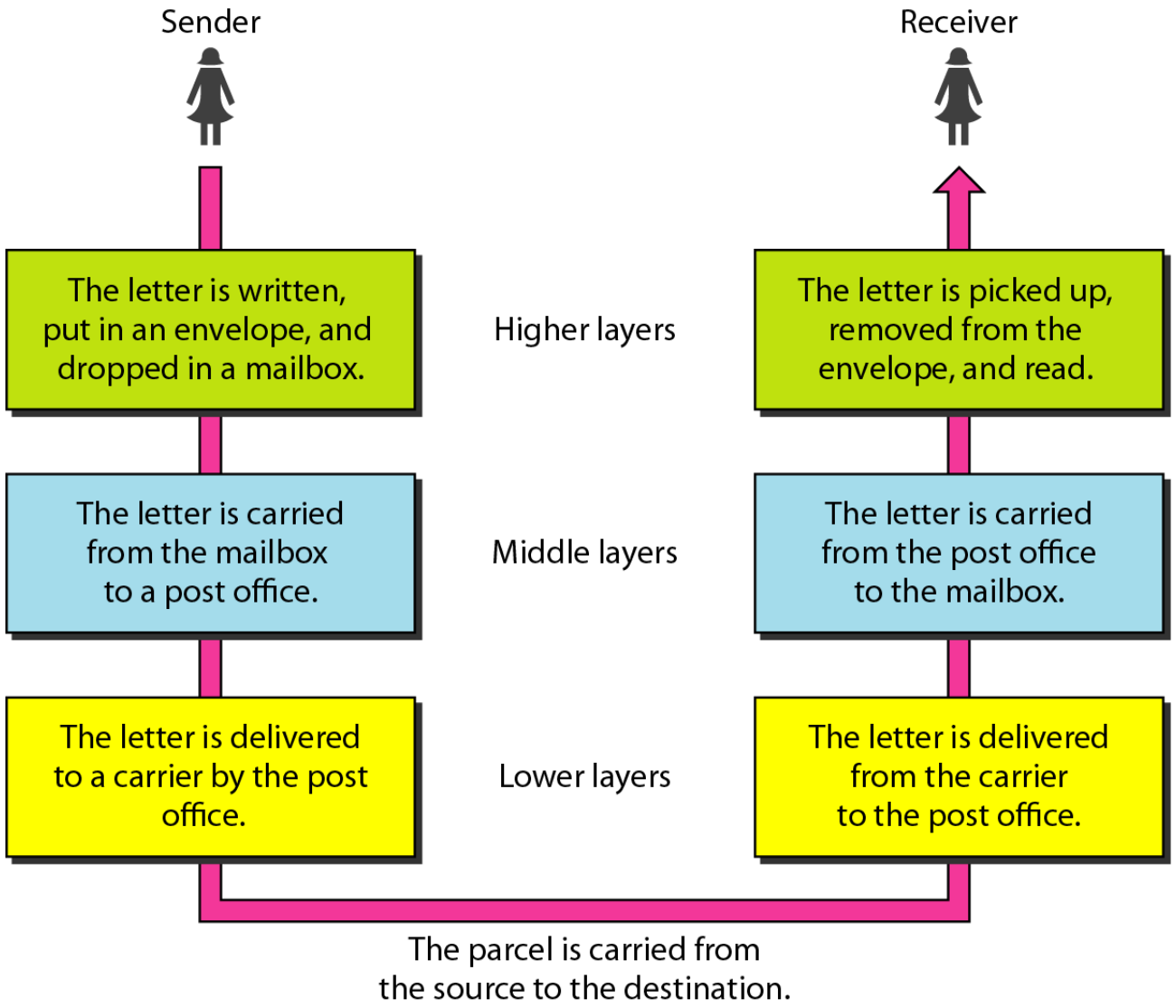
Layering Concept



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Layered Architecture

- The concept of a layered architecture
  - Any given communications task is too complex to be considered as a whole
  - The whole complex task is divided into simpler, smaller functions
  - Several functions are grouped together – layer
  - A set of layers implements the communication tasks
  - Each layer provide services to the layer immediately above it and uses services immediately below it
  - There is a standard interface between each layer
  - The details of internal implementations is hidden from other layers

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ISO-OSI Model

- International Standards Organization's (ISO) Open Systems Interconnection (OSI) model
- ISO is the organization and OSI is the model
- An open system is a model that allows any two different systems to communicate regardless of their underlying architecture
- Benefits:
  - Standardized interfaces among layers facilitates modular engineering
  - A better environment for interoperability is created
  - Reduced complexity
  - Easier to understand
- The Key to understand OSI model
  - It is your slave, not master

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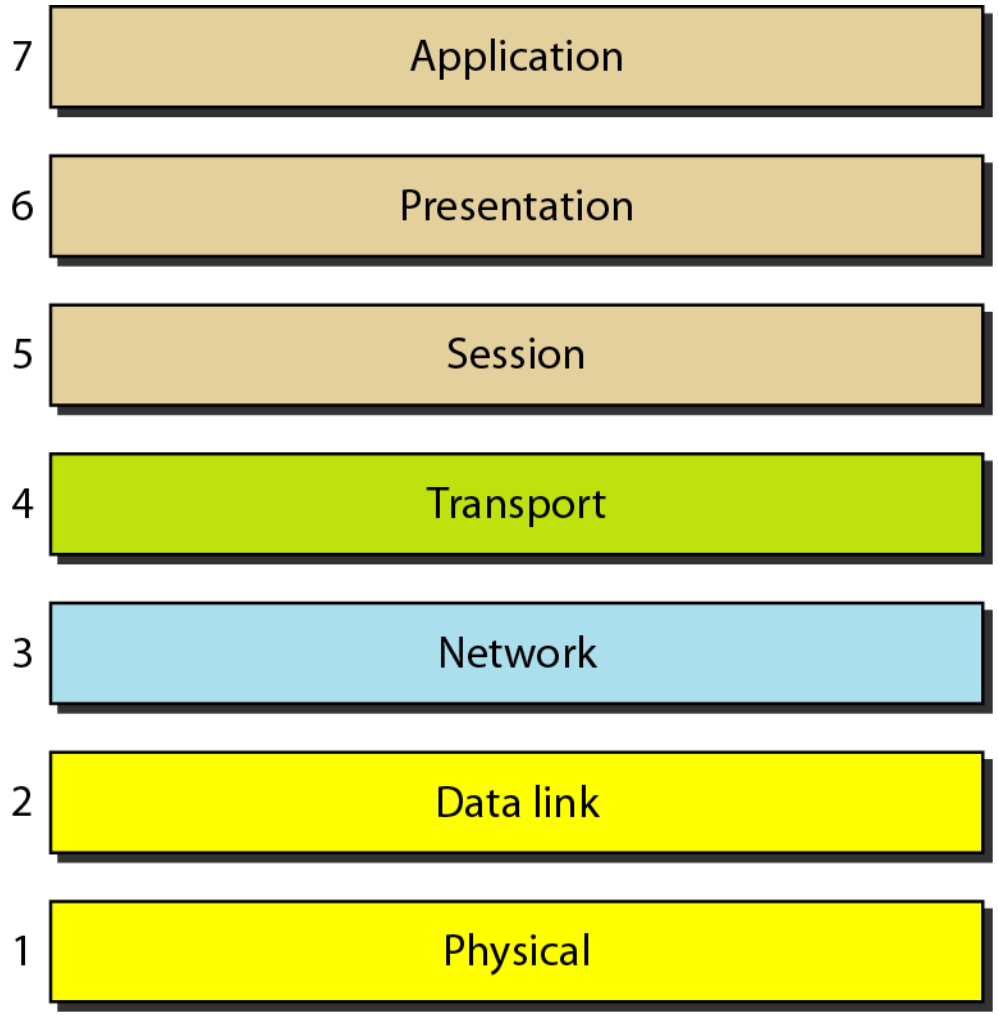
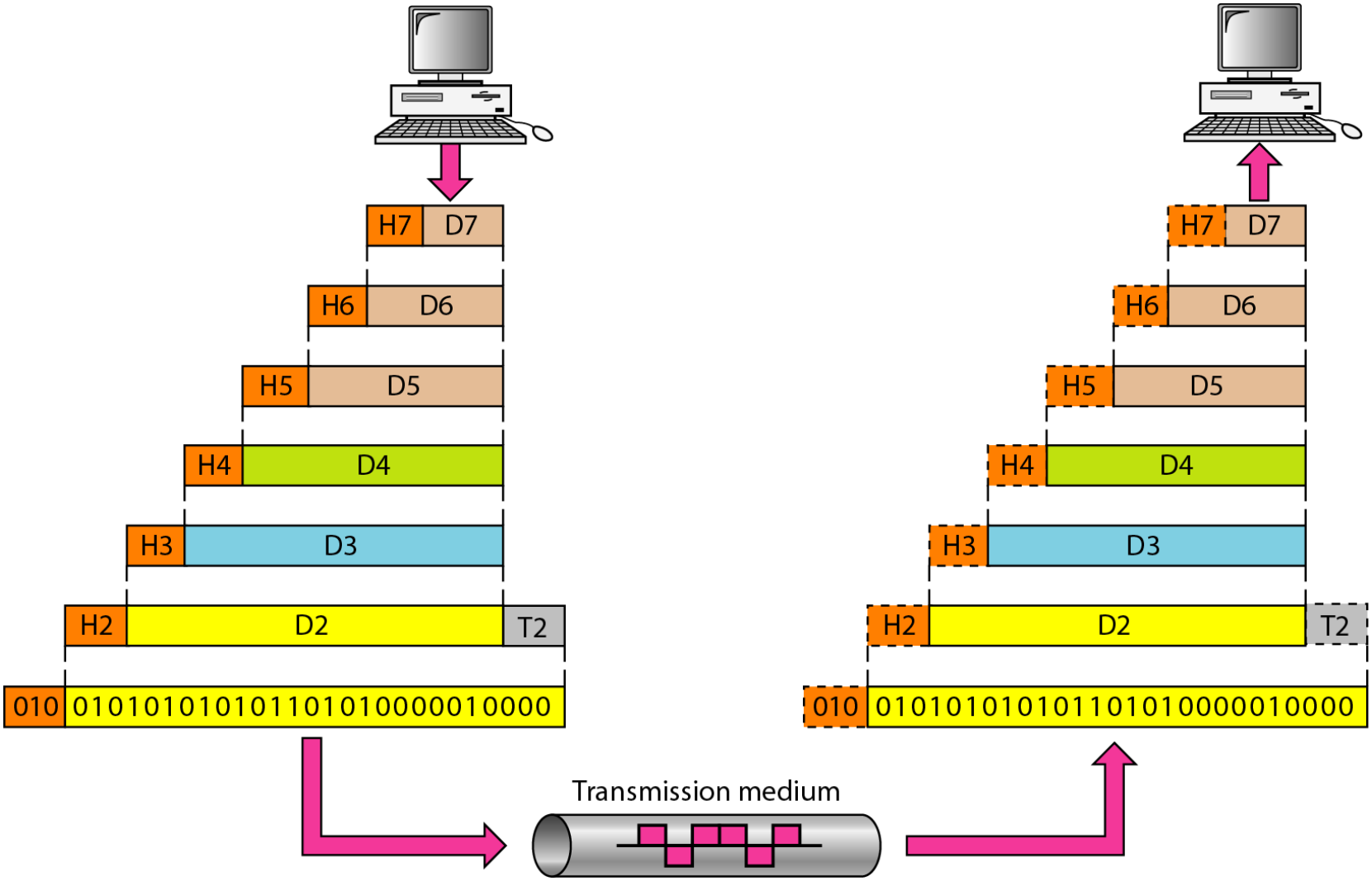
Seven layers of the OSI model



Interaction between Layers



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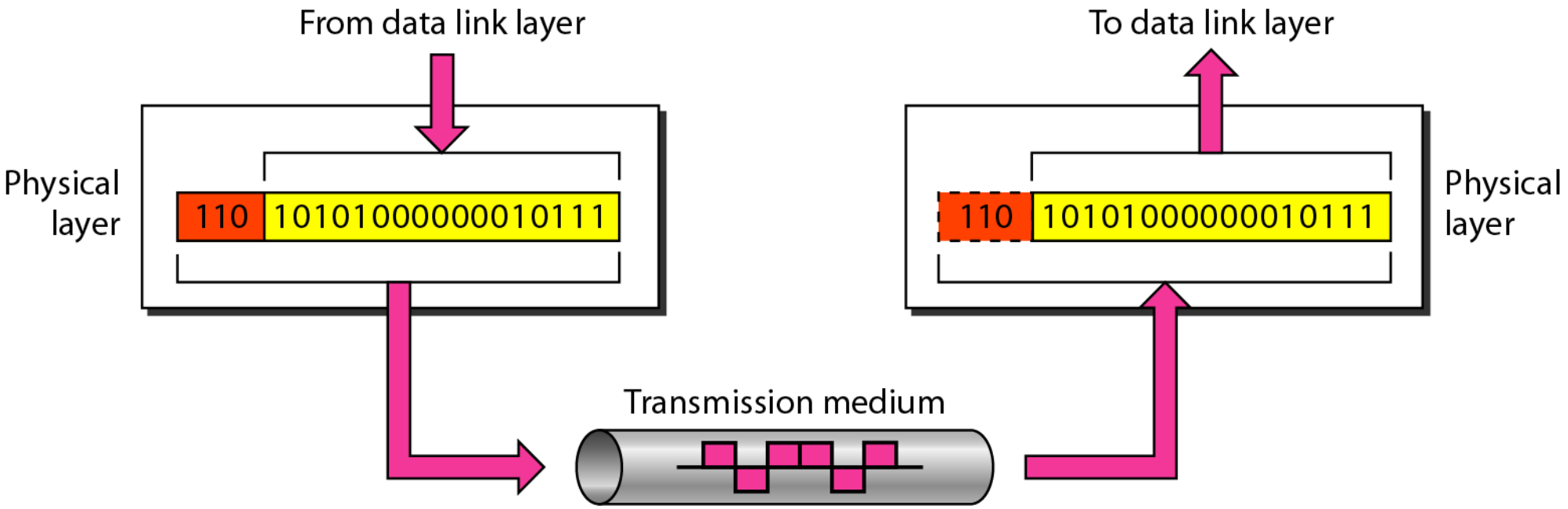
Encapsulation

- Each layer in the sending device adds its own information to the message (or package) it receives from the layer just above it and passes the whole package to the layer just below it.
- This is called data encapsulation.
- At the receiving machine, the message is unwrapped layer by layer, with each process receiving and removing the data meant for it.
- Each interface defines the information and services a layer must provide for the layer above it.

Physical Layer

- Responsible for transmitting individual bits from one node to the next



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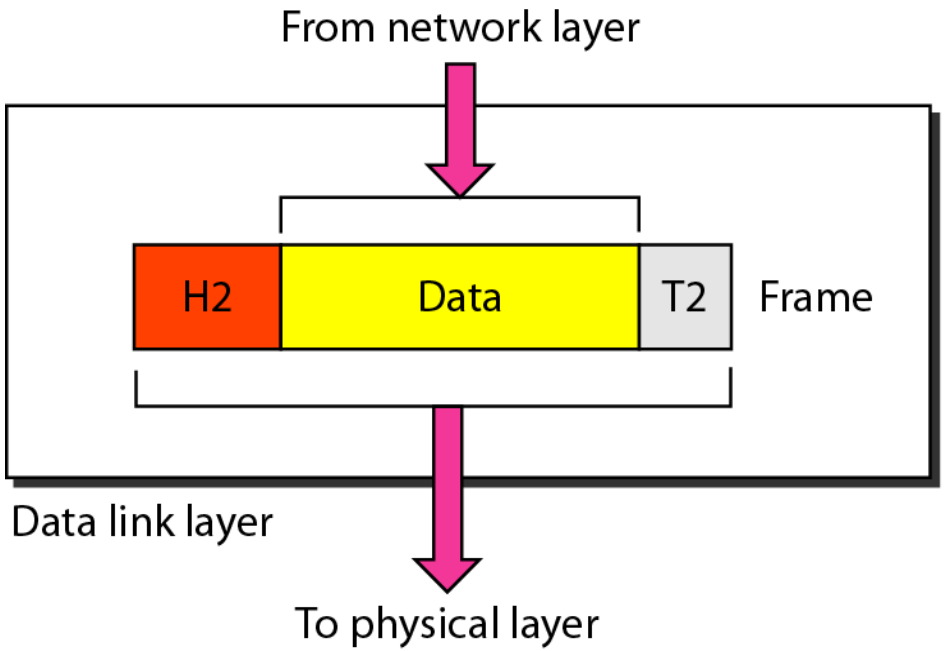
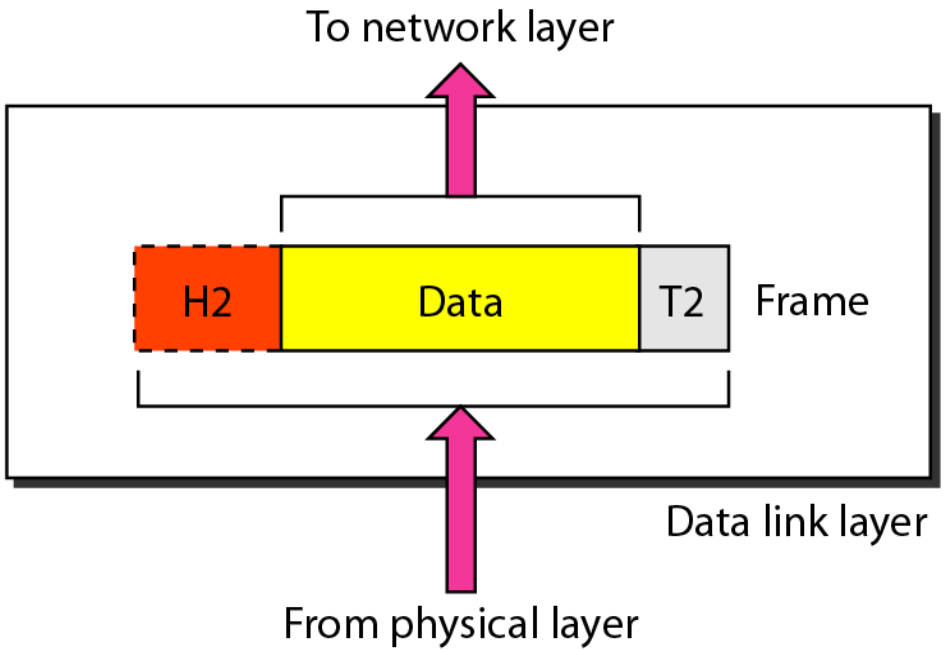
Physical Layer

- Physical characteristics of interfaces and medium
- Representation of bits (type of encoding)
- Synchronization of bits (clocks)
- Line configuration (point-to-point or multi point)
- Physical topology
- Transmission mode (simplex, half-duplex, full duplex)
- Can be wired or wireless

Data Link Layer

- Responsible for transmitting frames from one network layer device to the next (i.e., hop-to-hop delivery)
- Makes physical layer appear error free to the above layers.



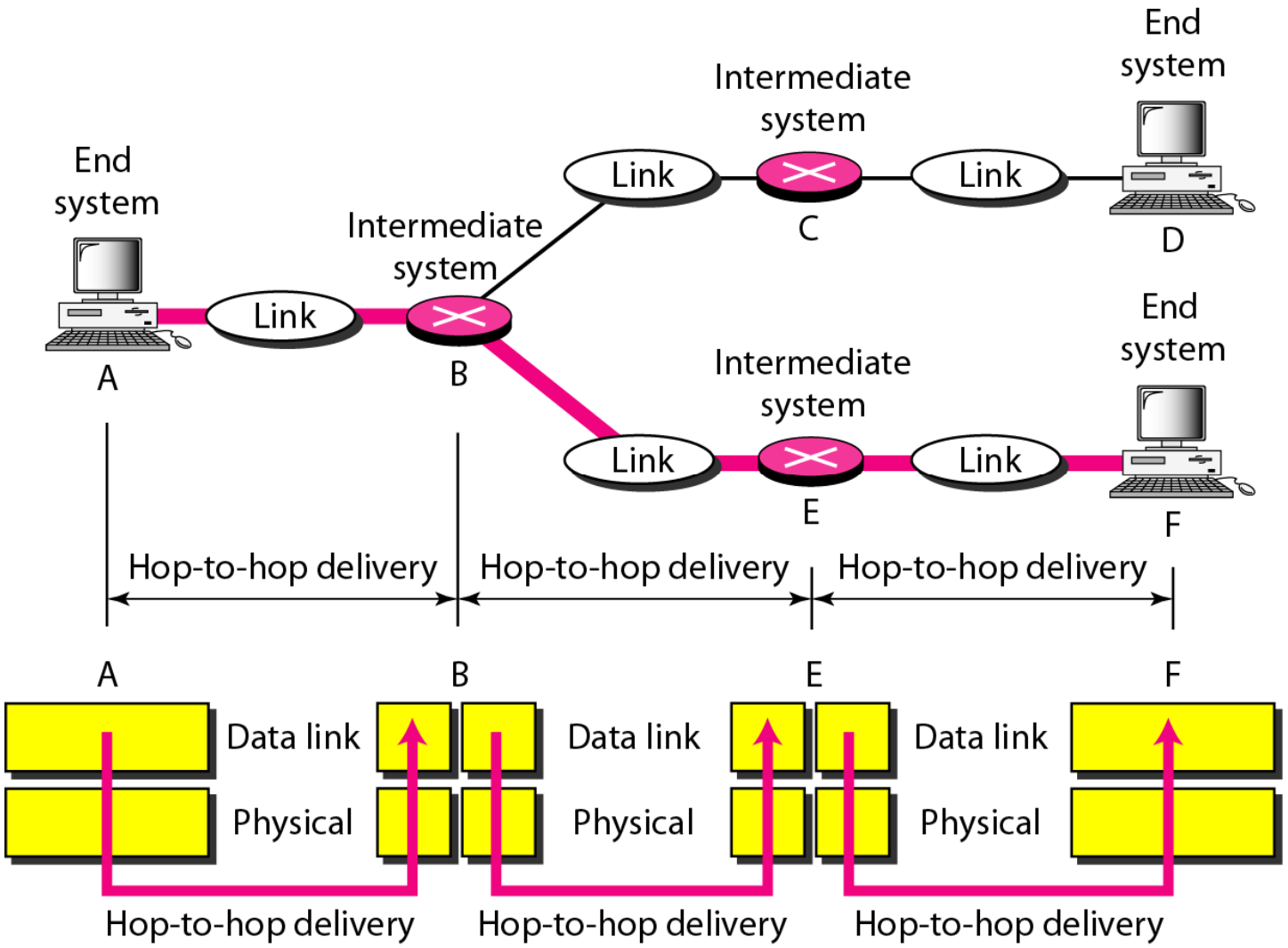


Data Link Layer

Other responsibilities include

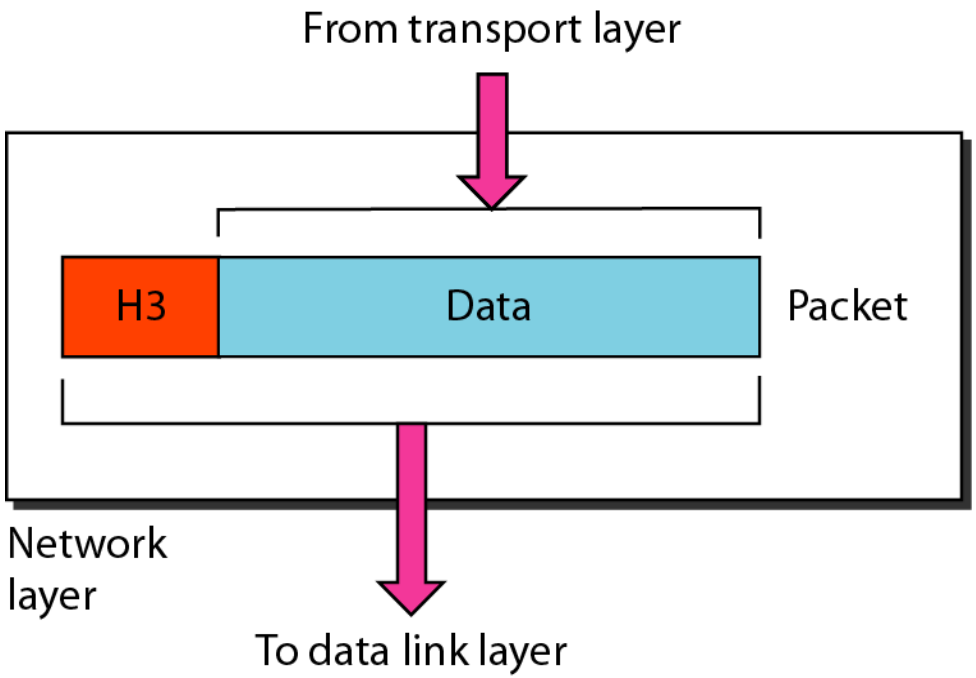
- Framing
- Physical/MAC addressing
- Flow control
- Error control
- Access control

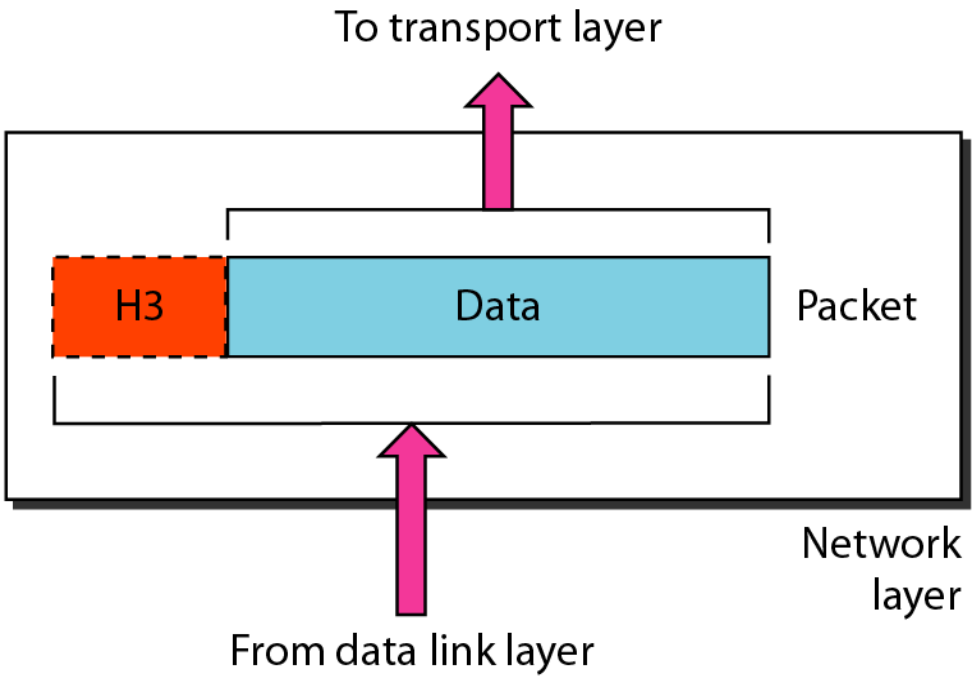
Hop-to-hop delivery



Network Layer

- Responsible for source-to-destination delivery of a packet across multiple networks (i.e., end-to-end)
- Other responsibilities include
  - Logical addressing
  - Routing (between networks)





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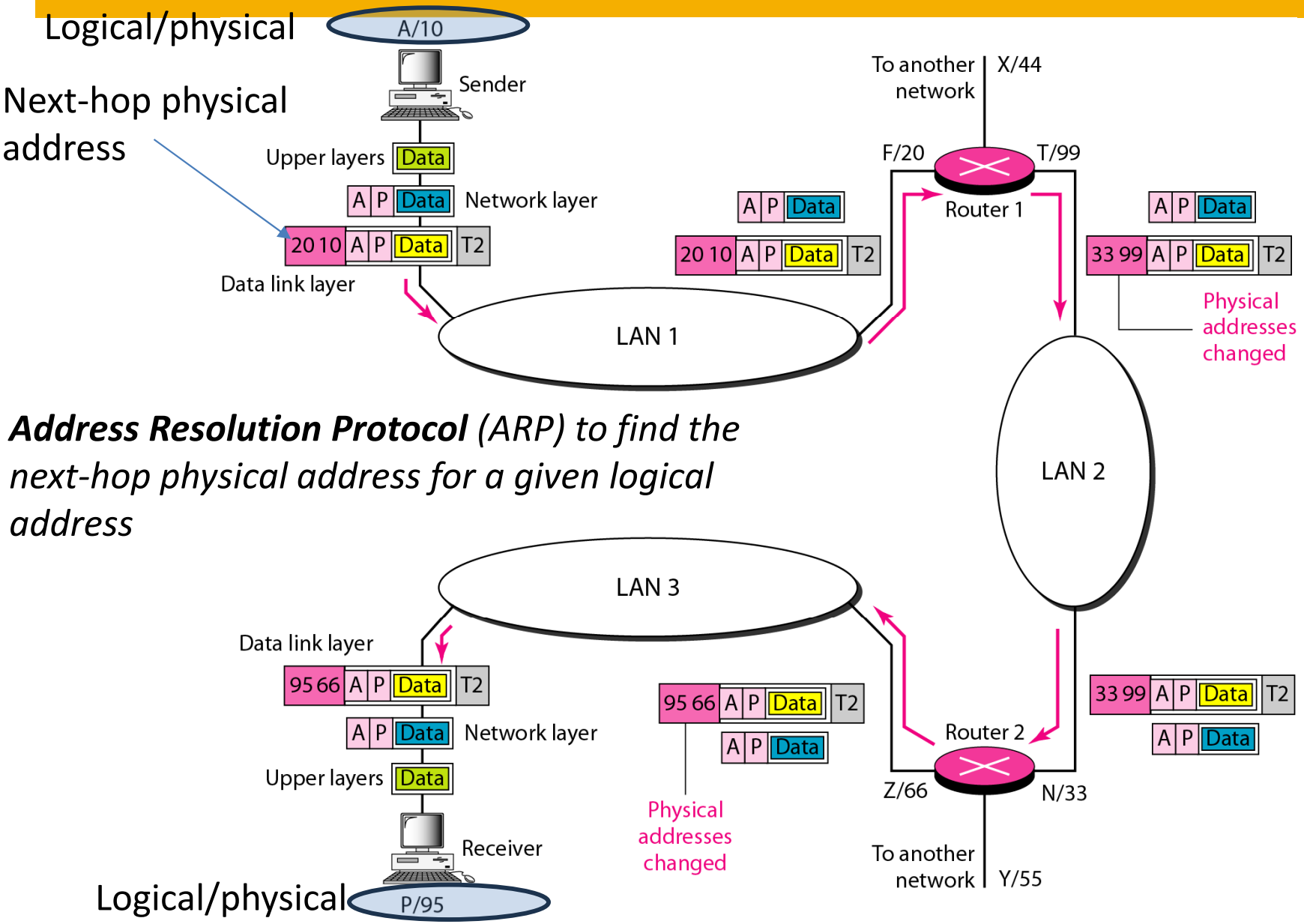
Logical Address

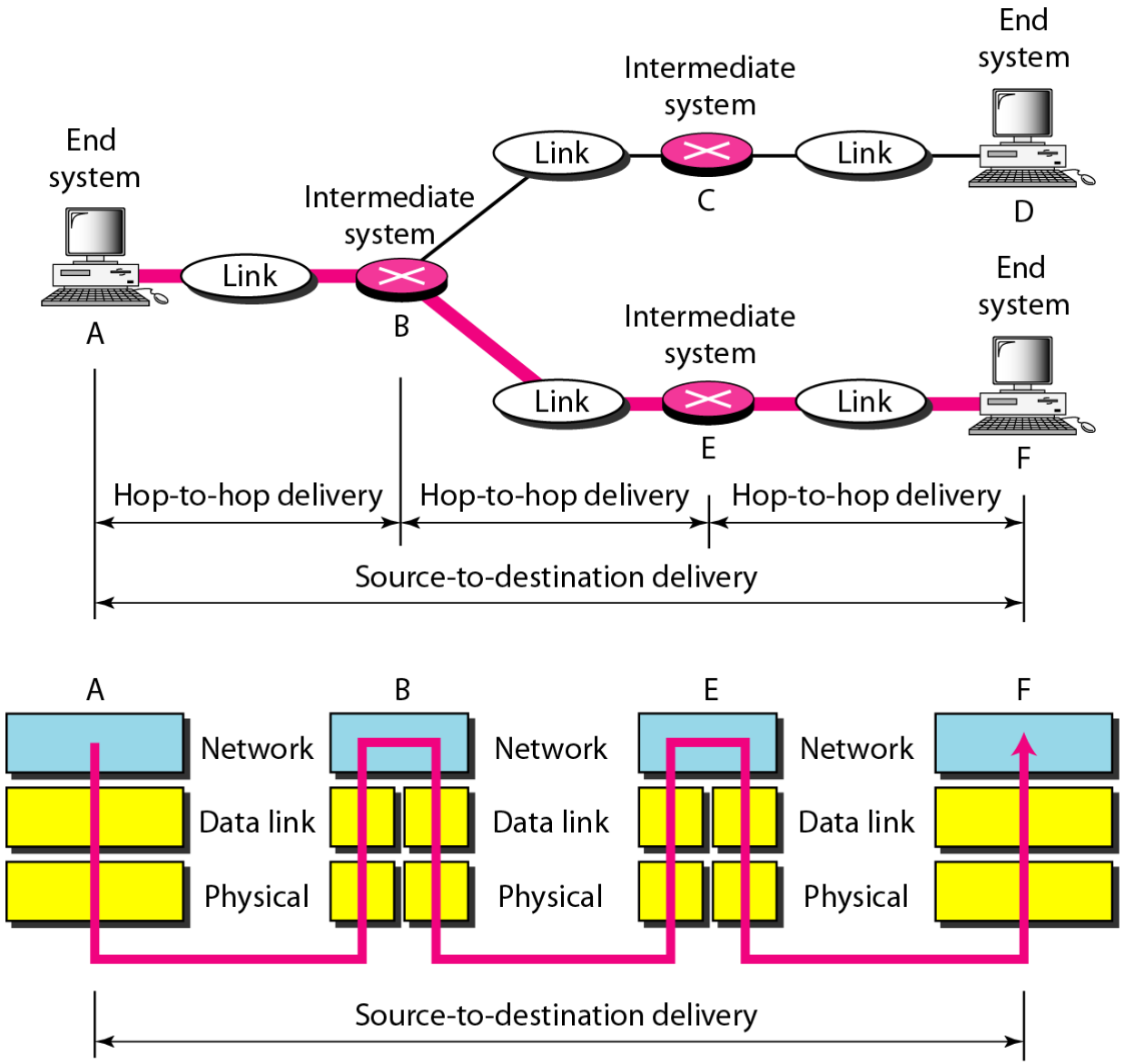
- Necessary for end-to-end universal communications independent of underlying physical networks
- A logical address currently in the Internet is a 32-bit address (e.g., 192.168.10.5)
- No two publicly connected addresses can be the same
- The physical address may change hop-to-hop but the logical addresses usually remains the same

Logical Address



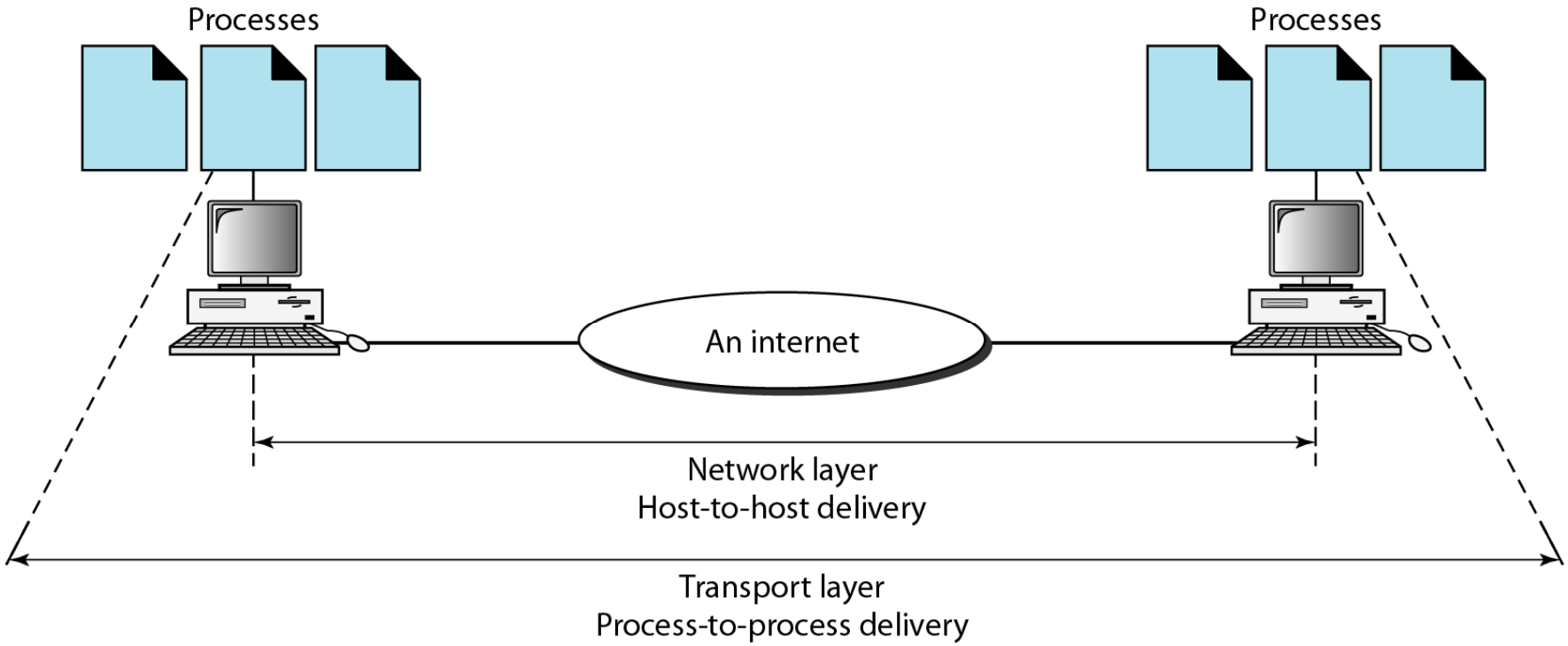
Address Resolution Protocol *(ARP) to find the next-hop physical address for a given logical address*

Source-to-destination delivery



Transport Layer

- Responsible for process-to-process delivery of a message



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Transport Layer

Other responsibilities include

- Service point addressing
- Segmentation and reassembly
- Connection control (Connection oriented or Connection less)
- Flow Control (end-to-end)
- Error Control (process-to-process)

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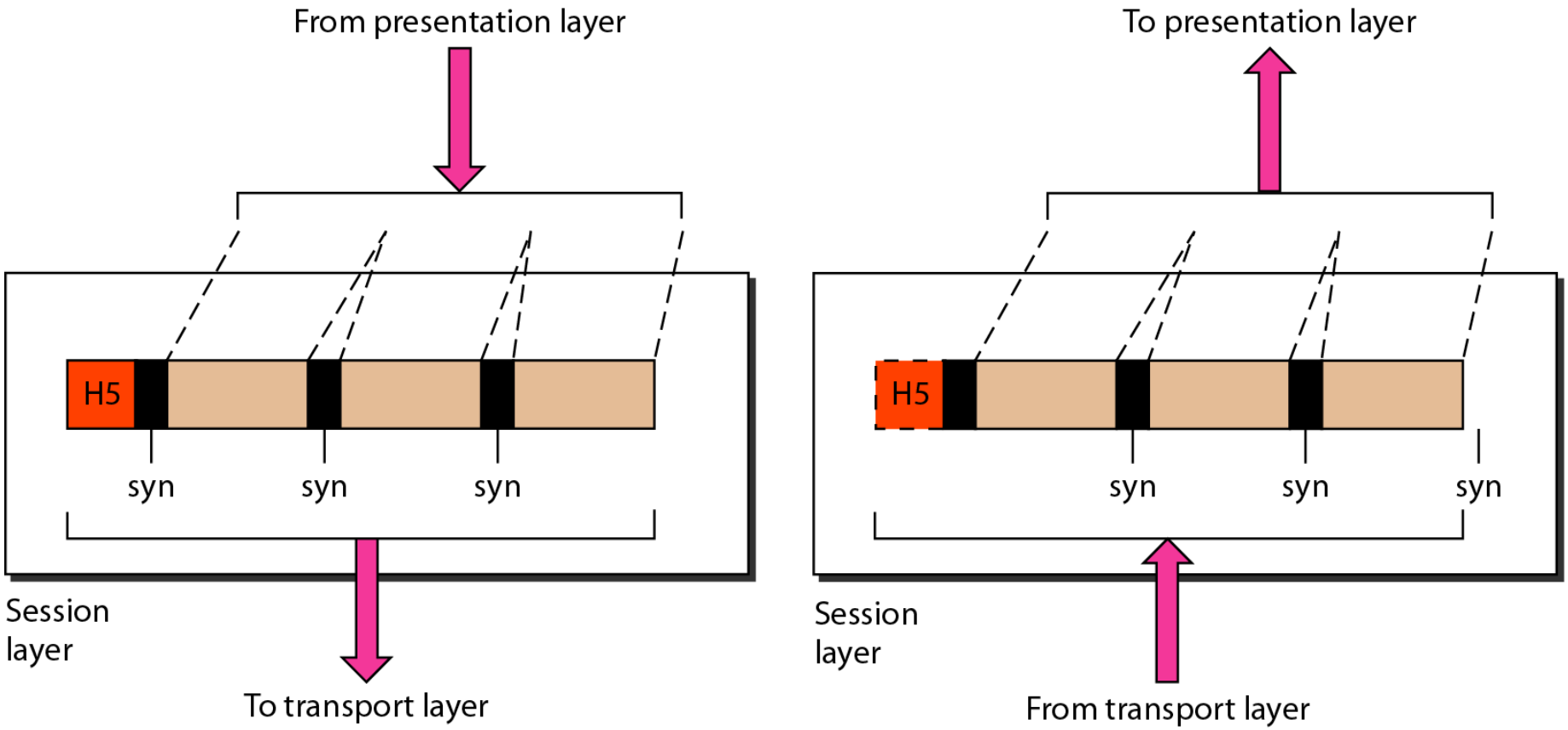
Port Address

- This is the label assigned to a specific process/application
- A port address in TCP/IP is 16 bits in length (e.g., HTTP – 80, FTP – 21, Telnet-23; DNS-53)
- The physical address may change hop-to-hop but the logical addresses and port address usually remain the same

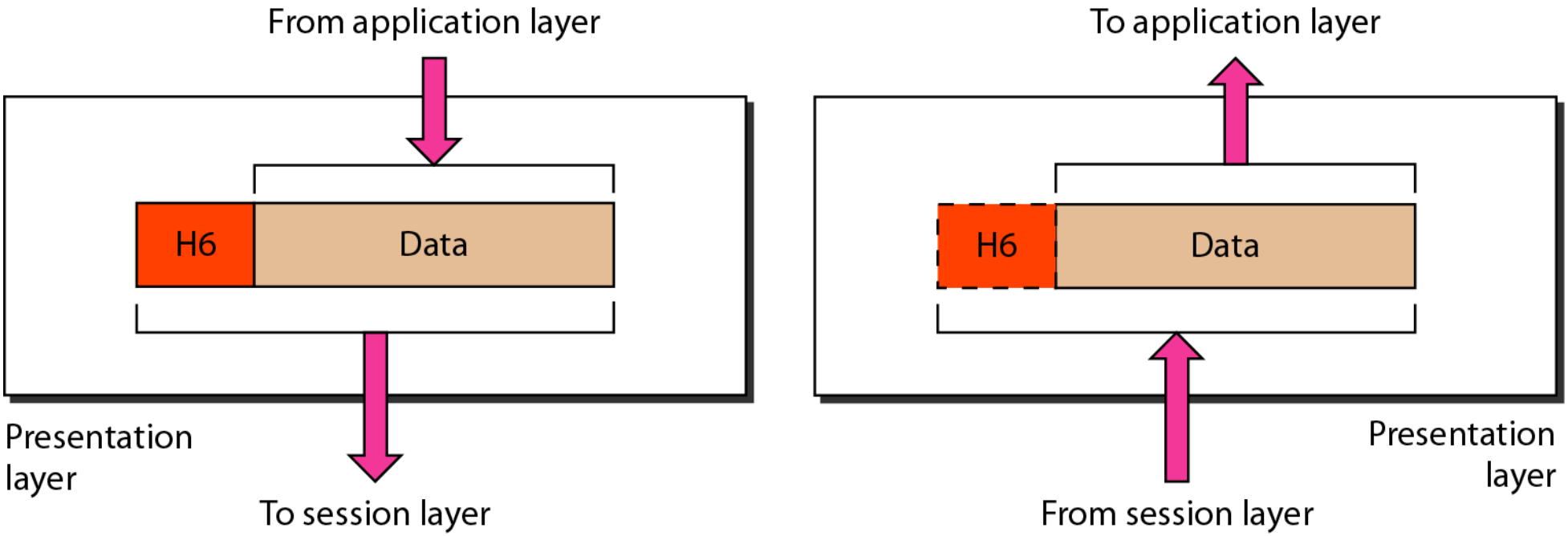
Session Layer

- Responsible for dialog control (half or full duplex) and synchronization.



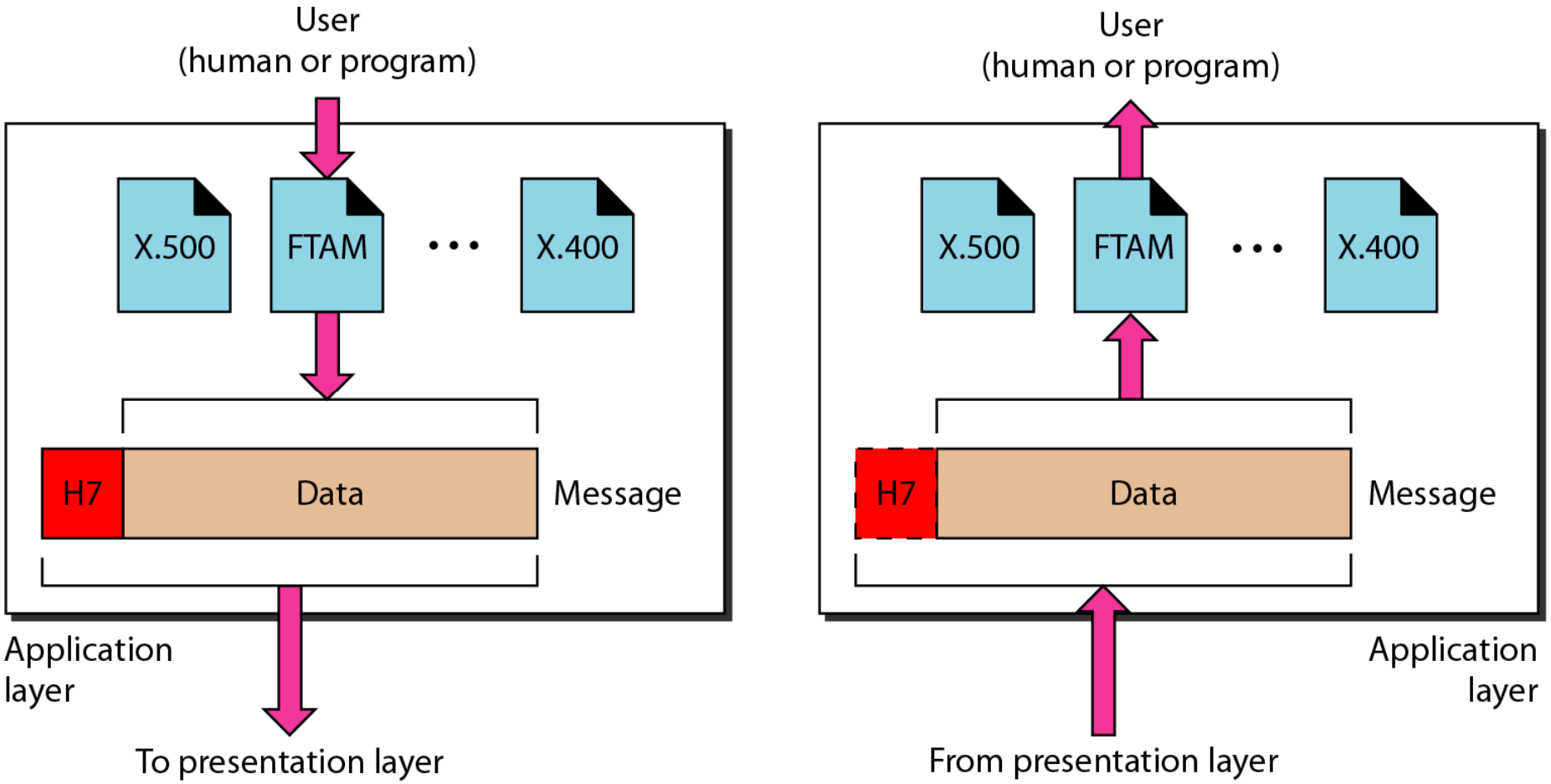
Presentation Layer

- Responsible for translation, compression, and encryption (Syntax and Semantics).



Application Layer

- Responsible for providing services to the user



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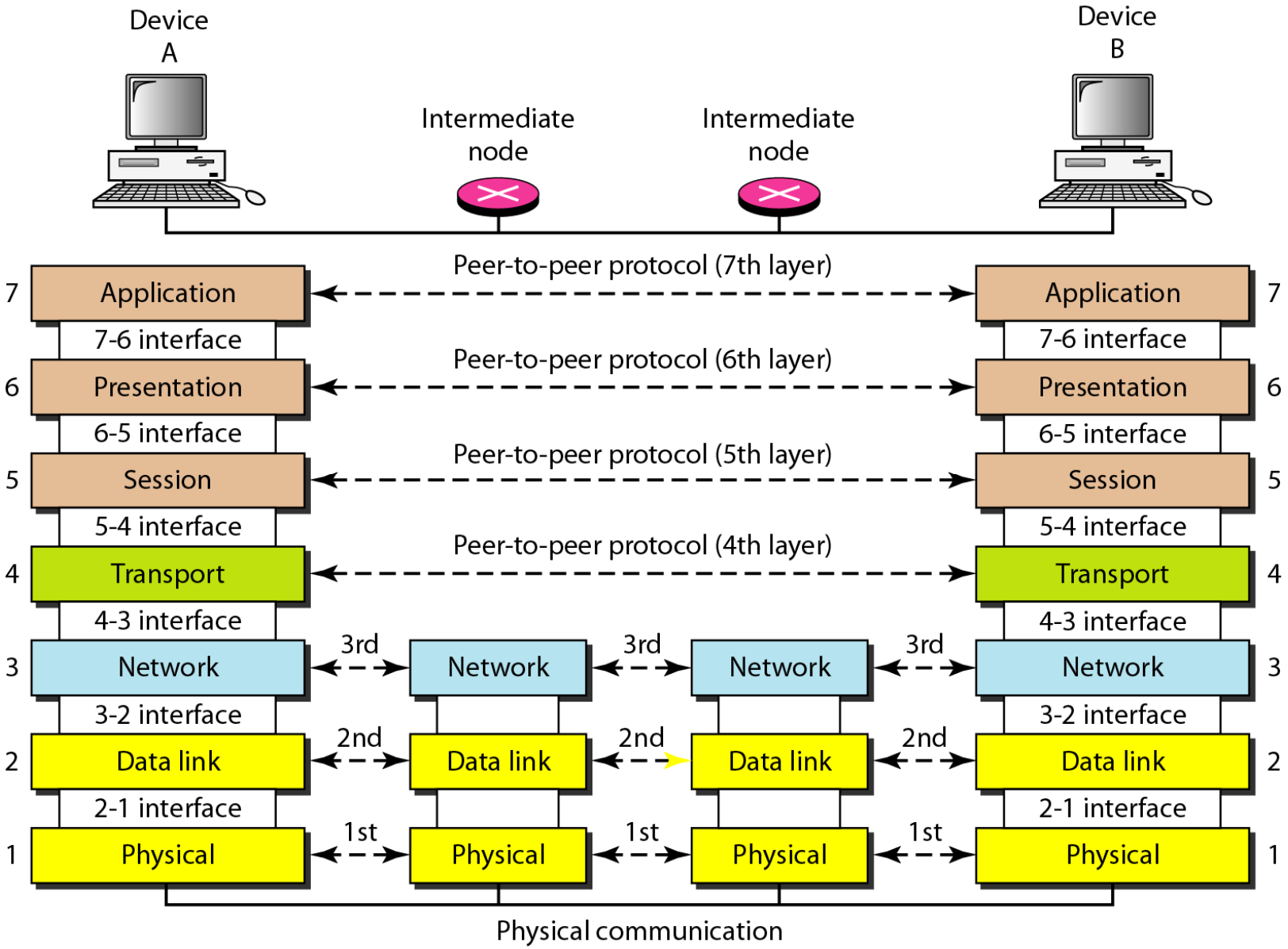
Application Layer

Other services include

- Network virtual terminal (Remote Desktop)
- File transfer, access, and management (FTAM)
- Mail services (X.400)
- Directory services (X.500)

Interaction between Peers



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Summary of OSI Layers

Application	An application that communicates with other computers is implementing OSI application layer concepts. The application layer refers to communication services to applications. Example : Telnet, HTTP, FTP, WWW browsers, etc.
Presentation	Defining data formats; encryption is also defined by OSI as a presentation layer service. Example : JPEG, ASCII, Binary, Encryption, etc.
Session	Defines how to start, control, and end conversations (called sessions). This include the control and management of multiple bidirectional messages so that the application can be notified only if some of a series of messages are completed. Example :NFS, SQL
Transport	Provides end - to - end delivery of entire message. Functions include flow control, error control, sequence control, segmentation and reassembly, etc. Example: TCP, UDP, SPX.
Network	Responsible for end - to - end delivery of packets. Functions include addressing, routing, etc. Example : IP, IPX, etc.
Data Link	Data link layer is concerned with getting data across one particular link or medium correctly. Functions include framing, physical addressing, flow control, error control, access control, etc. Example :Ethernet, Token Ring, FDDI, Frame relay, ATM, etc.
Physical	Defines the physical characteristics of the medium, e.g. connectors, pins, data rate, synchronization, coding and modulation. Example :EIA/TIA - 232, EIA/TIA - 449, V.24, RJ45, etc

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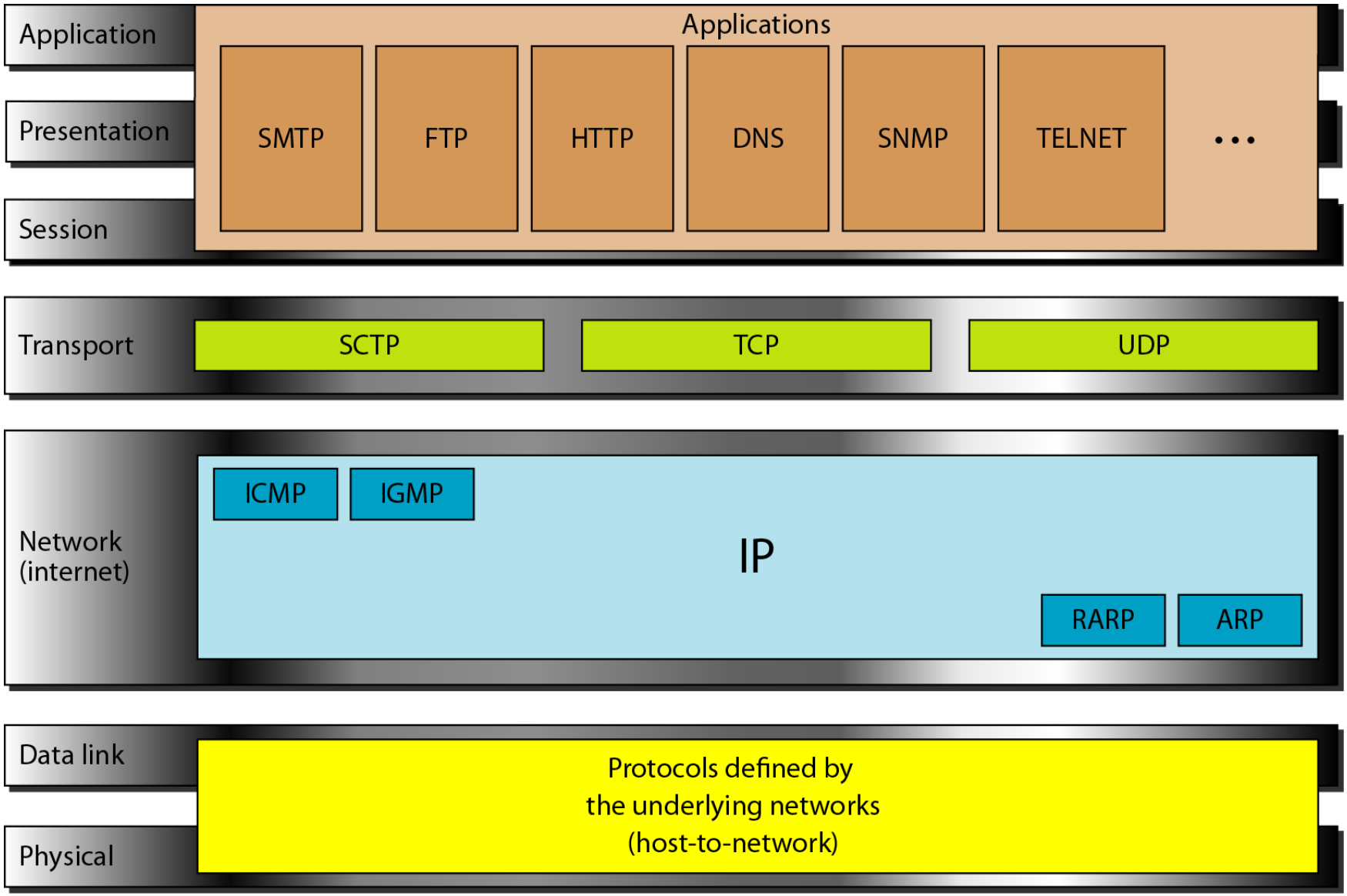
TCP/IP Protocol Suite

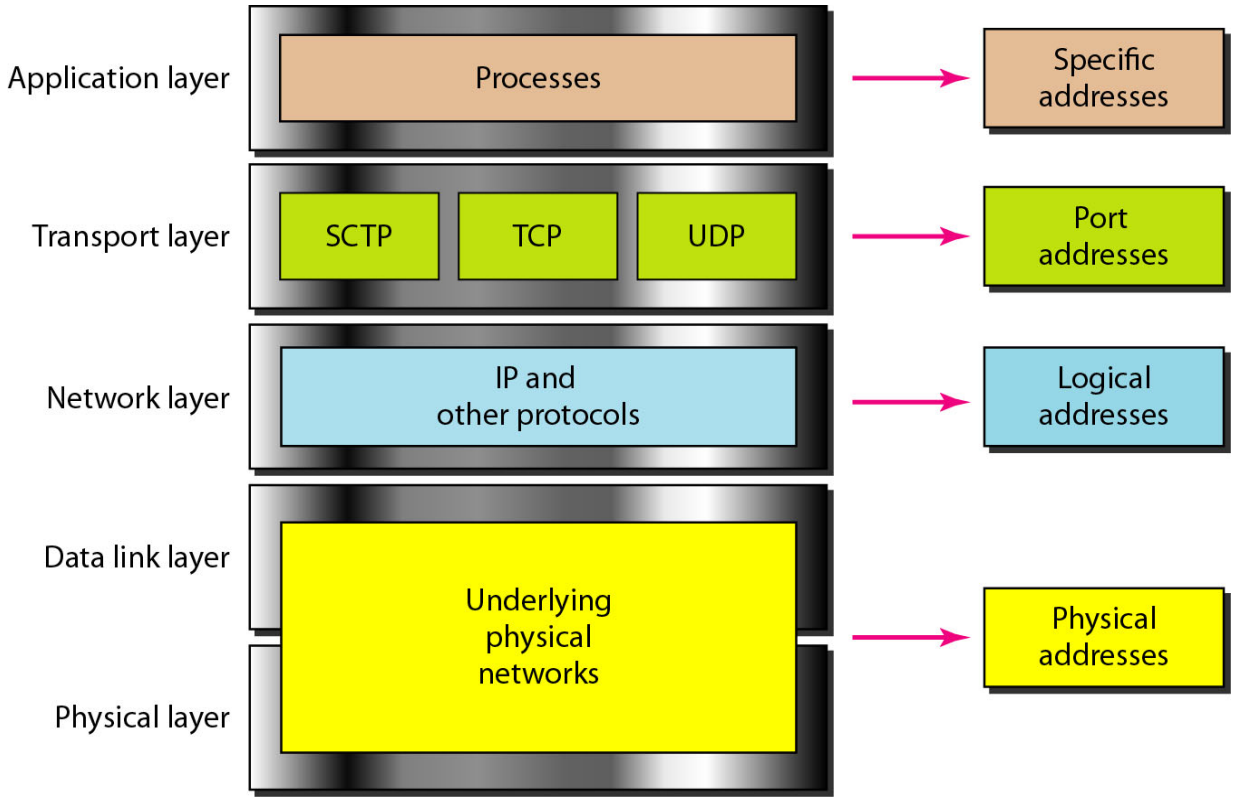
- TCP/IP Protocol Suite was developed prior to the OSI Model
- Layers do not exactly match
- Has five layers:
  - Physical
  - Data link
  - Network
  - Transport
  - Application
- TCP/IP is a hierarchical protocol made up of interactive modules
- However, the modules are not necessarily independent

TCP/IP and OSI model



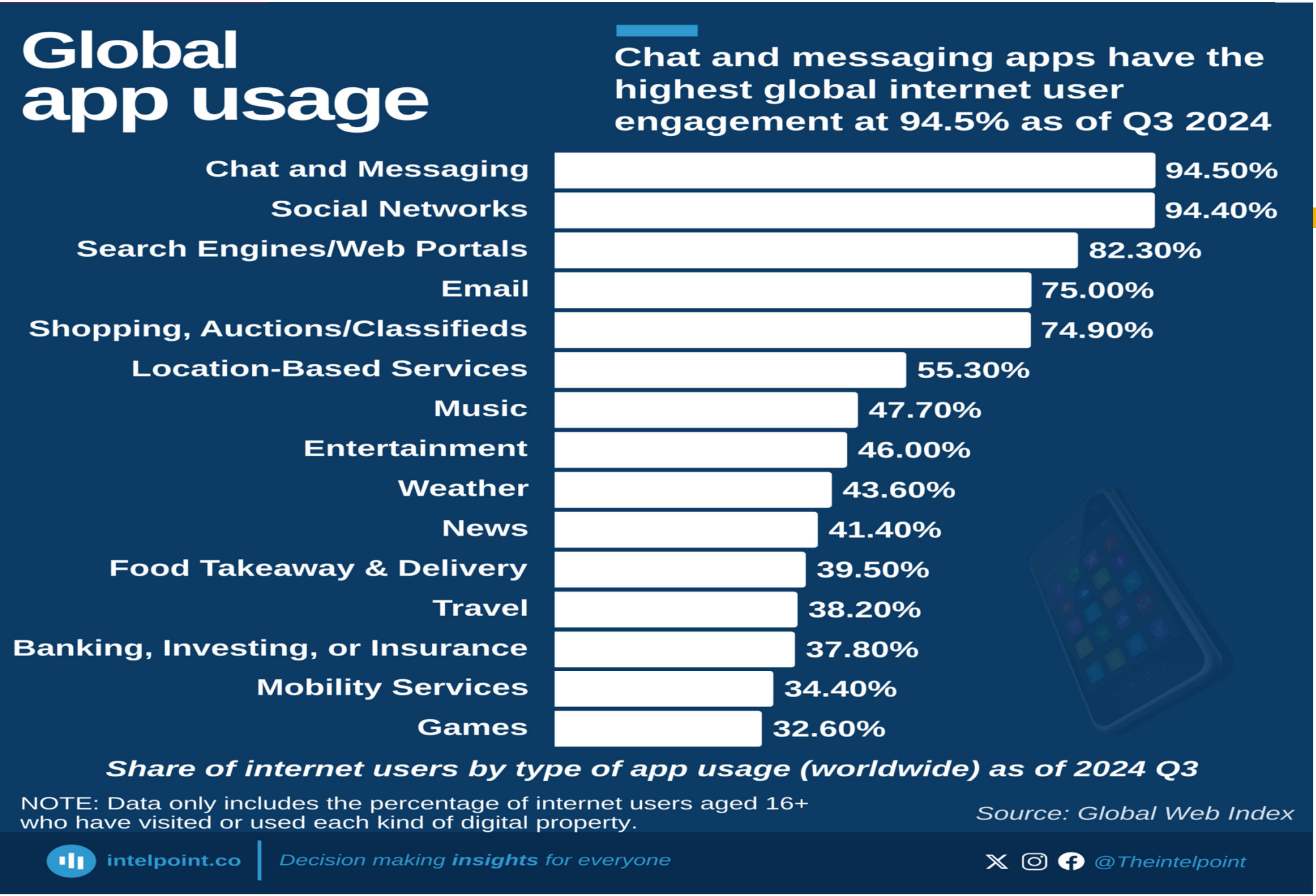
Addressing

- Four levels of addresses are used in an internet employing the TCP/IP protocols: physical, logical, port, and specific.



Key Standards Organizations

- The Internet Engineering Task Force (IETF)
  - Standards body for Internet. IETF standards are called RFC – request for comments. http://www.ietf.org/
- The International Standards Organization (ISO)
  - An organization dedicated to worldwide agreement on international
  - standards in a variety of fields
  - http://www.iso.ch/
- The International Telecommunications Union – Telecommunication Standards Sector (ITU-T)
  - An international standards organization related to the United Nations that develops standards for telecommunications
  - http://www.itu.int/
- The American National Standards Institute (ANSI)
  - U.S. representatives to both ISO and the ITU-T
  - http://www.ansi.org/



https://intelpoint.co/insights/chat-and-messaging-apps-have-the-highest-global-internet-user-engagement-at-94-5-as-of-q3-2024/