INTEGRATED TECHNICAL EDUCATION CLUSTER
AT ALAMEERIA

E-626-A
Data Communication and Industrial Networks (DC-IN)

Lecture #2
Layered Communication protocols & Network Topologies

Instructor:
Dr. Ahmad El-Banna

SPRING 2015

Agenda

- TCP/IP
- UDP
- OSI
- Network Topologies

LAYERED COMMUNICATION PROTOCOLS

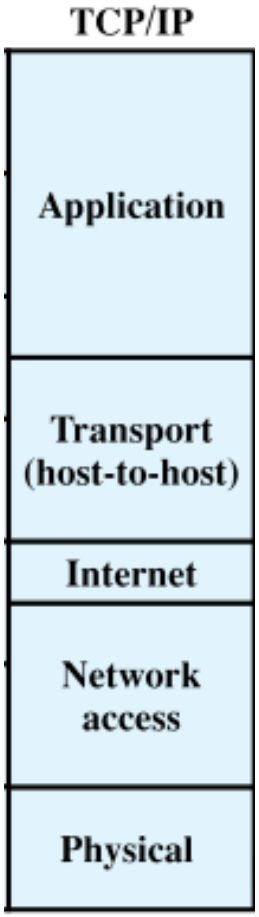
TCP/IP

- The TCP/IP protocol architecture is a result of protocol research and development conducted on the experimental packet-switched network, **ARPANET,** funded by the Defense Advanced Research Projects Agency (DARPA), and is generally referred to as the TCP/IP protocol suite.

- This protocol suite consists of a large **collection of protocols** that have been issued as Internet standards by the Internet Activities Board (IAB).

TCP/IP Layers

- The communication task can be organized into **five** relatively independent layers.
  - Physical layer
  - Network access layer
  - Internet layer
  - Host-to-host, or transport layer
  - Application layer



TCP/IP Layers ..

- The **physical layer** covers the physical interface between a data transmission device (e.g., workstation, computer) and a transmission medium or network.

- The **network access layer** is concerned with the exchange of data between an end system (server, workstation, etc.) and the network to which it is attached.
  - Concerned with issues like:
    - Destination address provision
    - Invoking specific services like priority
    - Access to & routing data across a network

- The function of the **internet layer** is to complete the procedures needed to allow data to traverse *multiple* interconnected networks.
  - The Internet Protocol (IP) is used at this layer to provide the routing function across multiple networks.

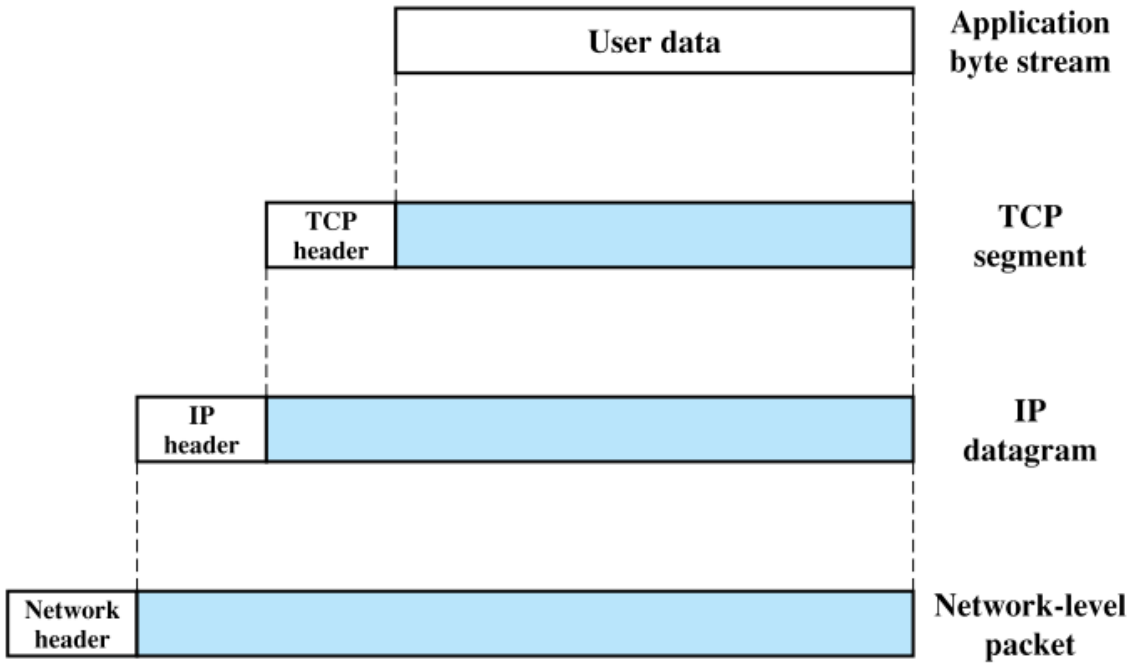
TCP/IP Layers …

- The **Transport layer**:
  - Common layer shared by all applications
  - Concerned with providing reliable delivery of data
  - Essentially independent of nature of the applications

- The **application layer** contains the logic needed to support the various user applications.
  - Separate module is needed for each type of application

Protocol Data Units (PDU) in the TCP/IP architecture

- The combination of data and control information is a protocol data unit (PDU)
- Typically control information is contained in a PDU header.
- Headers may also include:
  - source port, destination port, sequence number, and error-detection code



TCP and UDP

- In addition to TCP, there is one other transport-level protocol that is in common use as **part of the TCP/IP** protocol suite: the User Datagram Protocol (UDP).
- UDP does **not guarantee delivery**, preservation of sequence, or protection against duplication.
- UDP enables a procedure to send messages to other procedures with a **minimum of protocol mechanism**.

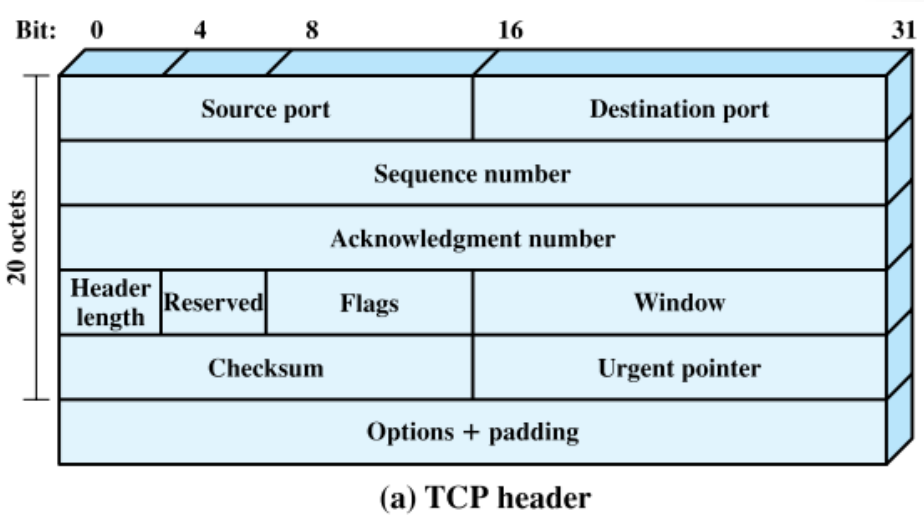


Figure 2.3 TCP and UDP Headers

IP and IPv6

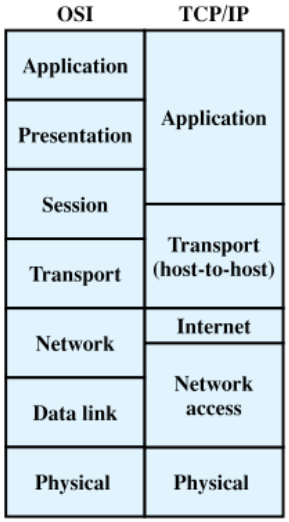
- For decades, the keystone of the TCP/IP protocol architecture has been IP.
- IPv6 provides a number of **functional enhancements** over the previous IP, designed to accommodate the higher speeds of today's networks and the mix of data streams, including graphic and video.

- But the driving force behind the development of the new protocol was the need for **more addresses**.
- The previous IP uses a **32-bit** address to specify a source or destination.
- IPv6 includes **128-bit** source and destination address fields.

OSI Model

- The Open Systems Interconnection (**OSI**) reference model was developed by the International Organization for Standardization (ISO) as:
  - a model for a computer protocol architecture and
  - a framework for developing protocol standards.
- The OSI model consists of seven layers:
  - Application
  - Presentation
  - Session
  - Transport
  - Network
  - Data link
  - Physical

OSI Layers



OSI Model				
Layer		Data unit	Function[3]	Examples
Host layers	7. Application	Data	High-level APIs, including resource sharing, remote file access, directory services and virtual terminals	HTTP, FTP, SMTP
	6. Presentation		Translation of data between a networking service and an application; including character encoding, data compression and encryption/decryption	ASCII, EBCDIC, JPEG
	5. Session		Managing communication sessions, i.e. continuous exchange of information in the form of multiple back-and-forth transmissions between two nodes	RPC, PAP
	4. Transport	Segments	Reliable transmission of data segments between points on a network, including segmentation, acknowledgement and multiplexing	TCP, UDP
Media layers	3. Network	Packet/Datagram	Structuring and managing a multi-node network, including addressing, routing and traffic control	IPv4, IPv6, IPsec, AppleTalk
	2. Data link	Bit/Frame	Reliable transmission of data frames between two nodes connected by a physical layer	PPP, IEEE 802.2, L2TP
	1. Physical	Bit	Transmission and reception of raw bit streams over a physical medium	DSL, USB

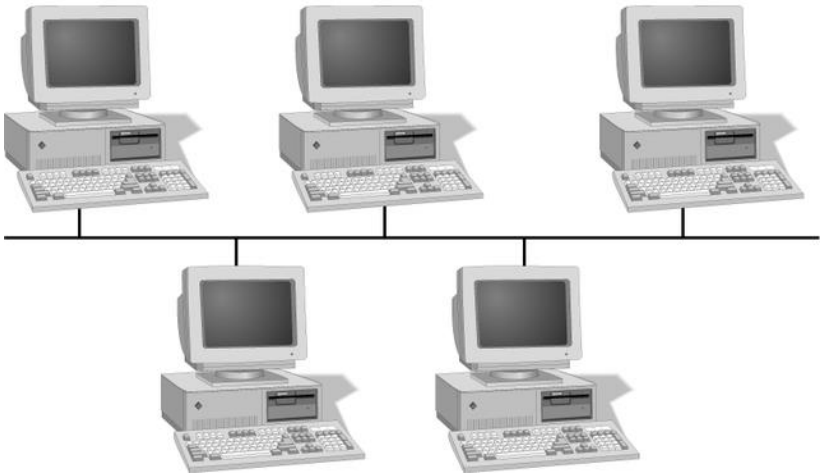
NETWORK TOPOLOGIES

Simple Physical Topologies

- Physical topology: physical layout of nodes on a network.
- Three fundamental shapes:
  - Bus
  - Ring
  - Star
- May create hybrid topologies
- Topology integral to type of network, cabling infrastructure, and transmission media used.

Bus Topology

- A **Bus topology** consists of a single cable—called a **bus**— connecting all nodes on a network without connectivity devices.

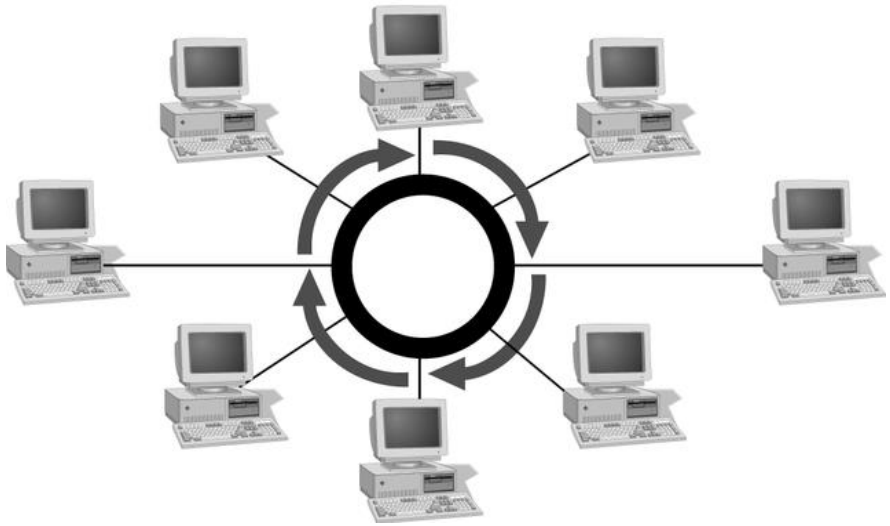


Bus Topology..

- Advantages
  - Works well for small networks
  - Relatively inexpensive to implement
  - Easy to add to it
- Disadvantages
  - Management costs can be high
  - Potential for congestion (crowding) with network traffic

Ring Topology

- Ring topology
  - Each node is connected to the two nearest nodes so the entire network forms a circle
  - One method for passing data on ring networks is **token passing**
    - **token passing** is a channel access method where a signal called a token is passed between nodes that authorizes the node to communicate.



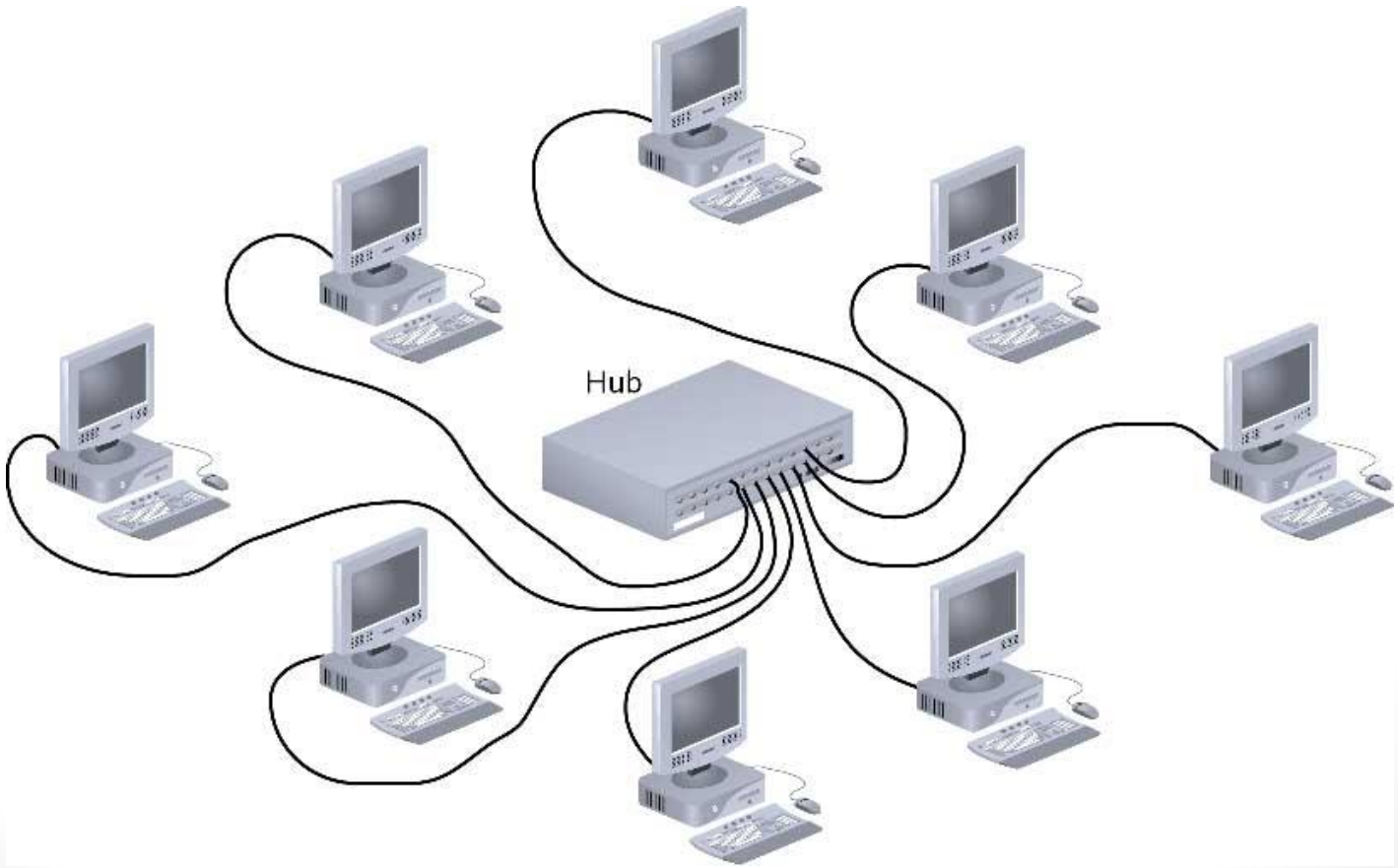
Ring Topology..

- Advantages
  - Easier to manage; easier to locate a defective node or cable problem.
  - Well-suited for transmitting signals over long distances on a LAN
  - Handles high-volume network traffic.
  - Enables reliable communication.

- Disadvantages
  - Expensive.
  - Requires more cable and network equipment at the start.
  - Not used as widely as bus topology
    - Fewer equipment options.
    - Fewer options for expansion to high-speed communication.

Star Topology

- Every node on the network is connected through a central device



Star Topology..

- Any single cable connects only two devices
  - Cabling problems affect two nodes at most
- Requires more cabling than ring or bus networks
  - More fault-tolerant
- Easily moved, isolated, or interconnected with other networks
  - Scalable

Star Topology…

- Advantages
  - Good option for modern networks
  - Low startup costs
  - Easy to manage
  - Offers opportunities for expansion
  - Most popular topology in use; wide variety of equipment available

- Disadvantages
  - Hub is a single point of failure
  - Requires more cable than the bus

- For more details, refer to:
  - Chapter 2, W. Stallings, **Data and Computer Communications**, 8th edition, 2007.
- The lecture is available online at:
- Lecture notes are found at:
  - http://bu.edu.eg/staff/ahmad.elbanna-courses/12133
- For inquires, send to:
  - ahmad.elbanna@feng.bu.edu.eg