

King Fahd University of Petroleum & Minerals Computer Engineering Dept

**COE 342 – Data and Computer
Communications**

Term 031

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Lecture Contents

1. Protocols
 - a. Characteristics
 - b. Functions
2. OSI
 - a. The model
 - b. OSI layers
3. TCP/IP Protocol Suite

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Protocols - Characteristics

- **What is a Protocol:**
 - **Convention between two communicating entities governing exchange of data**
- **Elements of Protocol:**
 - **Syntax: data format, signal levels, etc.**
 - **Semantics: control info coordination and error handling**
 - **Timing: matching speeds and sequencing (synchronization)**

Protocols - Characteristics

- **Characteristics:**
 - **Direct/Indirect:**
 - **Direct: e.g for point-to-point communications, RS-232**
 - **Indirect: e.g devices connected through other nodes (internetwork, internet)**
 - **Monolithic/Structured**
 - **Monolithic: One package (SW and HW) performing all functions pertaining to the comm session**
 - **Structured: modular approach ← The focus of this course**

Protocols - Characteristics

- **Characteristics – cont'd:**
 - **Symmetric/Asymmetric**
 - **Symmetric:** comm between peer entities
 - **Asymmetric:** to keep one side simple
 - E.g. client-server model, polling methods
 - **Standard/Nonstandard**
 - **Standard:** conforming to a single agreed upon standard
 - **Nonstandard:** no conformity
 - **Clients vs. vendors ?**

Protocols - Functions

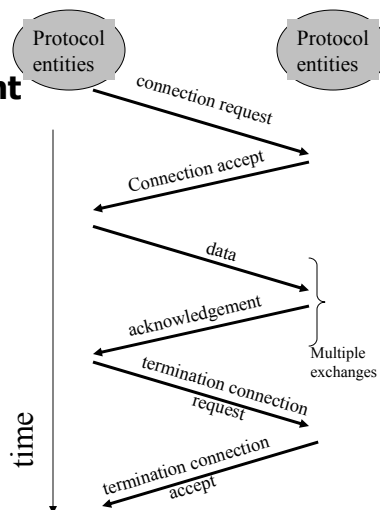
- **Encapsulation**
- **Segmentation and Assembly**
- **Connection Control**
- **Ordered Delivery**
- **Flow Control**
- **Error Control**
- **Addressing**
- **Multiplexing**
- **Transmission Services**

Protocols - Functions

- **Encapsulation:**
 - **PDU: block of data exchanged between two entities**
 - **PDU = user data + overhead (addressing, error control, protocol control)**
 - **User data is referred to as SDU**
- **Segmentation and Reassembly:**
 - **Example: ATM (53 bytes cells) core with Ethernet LAN (frames up to 1526 bytes)**

Protocols - Functions

- **Connection Control:**
 - **Connection establishment**
 - **Data transfer**
 - **Connection termination**



Protocols - Functions

- **Ordered Delivery**
 - **Ordered delivery of PDUs**
 - **Requires buffering, sequence numbers**
- **Flow control:**
 - **Limit amount of flow – e.g stop and wait procedure – receiving entity must acknowledge block before transmitter sends the next one in line**

Protocols - Functions

- **Error Control**
 - **To combat corruption of transmitted data**
 - **Transmitters inserts overhead info to detect corruption**
 - **Receiver checks overhead bits and finds out if block is corrupted or not**
 - **Corrupted – may be correctable or request another copy**
 - **OK – accept block**

Protocols - Functions

- **Addressing:**
 - **Level, Scope, Connection Identifiers, and Mode**

Level:

- Process or application address (e.g. SAP)
- Network level address (e.g. IP)

Scope:

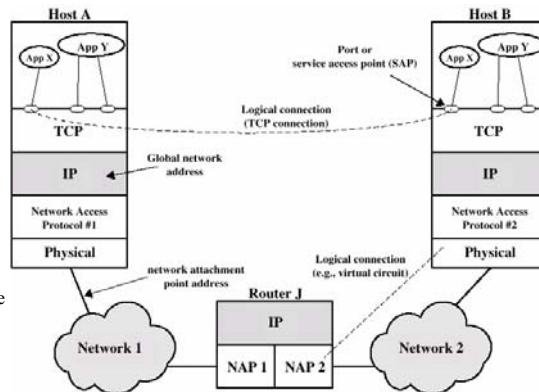
- IP is globally unique and applicable
- Network attachment point address (e.g. MAC frames, X.25)

CI:

- Connection vs. connectionless
- Connection: use connection name (e.g. virtual circuit identifier)
- Connectionless: with each transmission the global address is used

Mode:

- Unicast
- Multicast
- Broadcast



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Protocols - Functions

- **Multiplexing:**
 - **Multiple virtual circuits on one physical link (e.g. X.25 – from one end system to another)**
 - **Mapping connections from one level (layer) to another:**
 - **E.g. Multiple service points carried on one virtual circuit (called upward or inward multiplexing)**
 - **Downward multiplexing: one high level connection is split or served by multiple lower level connections (for reliability and performance issues)**

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The OSI Model

- Software model and abstraction
- Defines set of layers and the services at these layers necessary to perform communication
- Promotes compatibility of network designs
- Logical partitioning:
 - Manageability and scalability

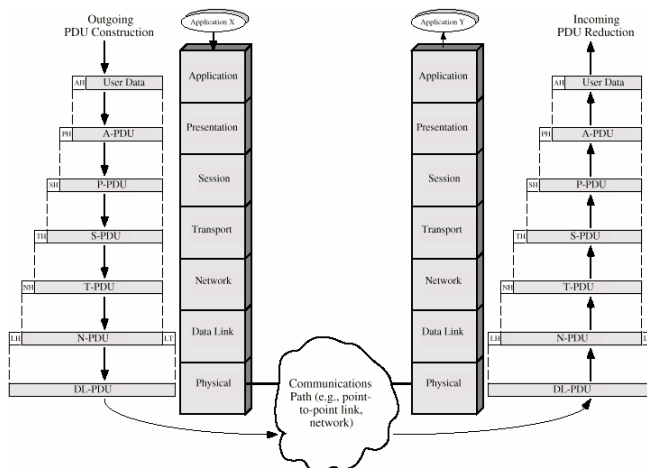
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The OSI Model - Environment

- Layer *i* establishes a PEER relationship with layer *i* on the target node
- This means Layer *i* requires service from layer *i*-1
- And so on
- The use of the PDUs
- No direct communication except for the physical layer – all other communication is indirect or virtual
- Encapsulation of user data
- Each layer may segment SDU to accommodate its own requirement – These are reassembled at the other end



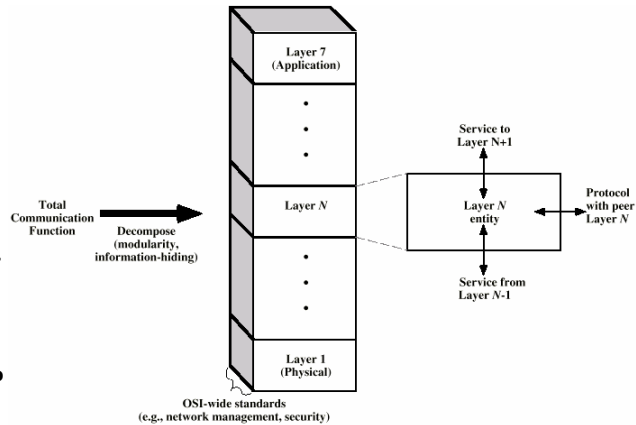
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The OSI Model - Framework

- Very similar to subroutine or function design in software engineering
- Boundaries and functionalities are well designed – development of one layer has little or no effect on other layers
- Protocol specification:
 - Format of PDUs, and the semantic of each field
- Service definition:
 - What are the services provided to upper layer and the lower one
- Addressing:
 - E.g: NSAP is the address of an entity in the transport layer who uses the network service



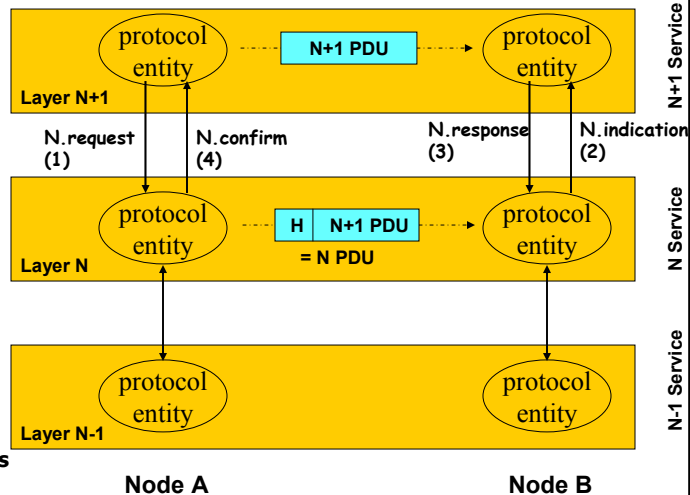
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The OSI Model - Framework

- Service Primitives:
 - Request:
 - Indication:
 - Respond
 - Confirm
- Note:
 - Encapsulation
 - Peer communication is virtual (dashed lines) – except at physical layer
 - Figure shows confirmed services case – For non confirmed services, the initiated receives no confirmation.



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The OSI Model – Physical Layer

- **Specifications:**
 - **Mechanical:** dimensions, connectors, etc.
 - **Electrical:** signal levels, rates of change, etc
 - **Functional:** functions performed by each circuit
 - **Procedural:** steps required to transport bits from one end to the other
- **Provides service to do “transmission of raw bits”**

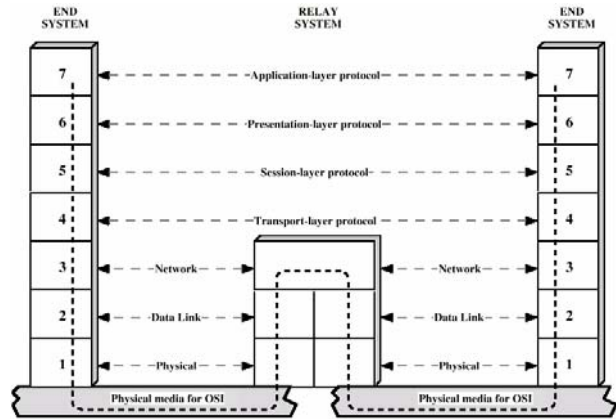
The OSI Model – Data Link Layer

- **Coverts the raw bit stream service provided by the physical layer to a reliable stream:**
 - **Performs error detection and error control**
- **Examples: HDLC, LAPB, LLC, etc**

The OSI Model – Network Layer

- **Service:** transfer of information between two end systems across communication network – End to end delivery of packets

- **Two end systems may be connected by:**
 - **Point-2-point:** no need for network layer
 - **Same network** (see figure)
 - **Different network**



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The OSI Model – Transport Layer

- **Service:** mechanism of exchanging data (or messages) between the two end systems:
 - **For connection oriented networks:**
 - **Error-free delivery**
 - **Ordered delivery**
 - **No loss or duplication**
 - **Attempts to provide a certain quality of service (QoS)** {certain max error rate, delay jitter, etc) through optimizing the the network layer services
- **Example:** TCP (connection oriented), UDP (connectionless)

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The OSI Model – Session Layer

- **Service: mechanism of controlling the dialogue between applications at end systems**
 - Dialogue Discipline
 - Grouping
 - Recovery

The OSI Model – Presentation

- **Service: defines format of data (format, encryption, and compression) to be exchanged between applications**

The OSI Model – Application

- **Service: A means for user applications (email, ftp, etc) to access the services provided by the OSI model**

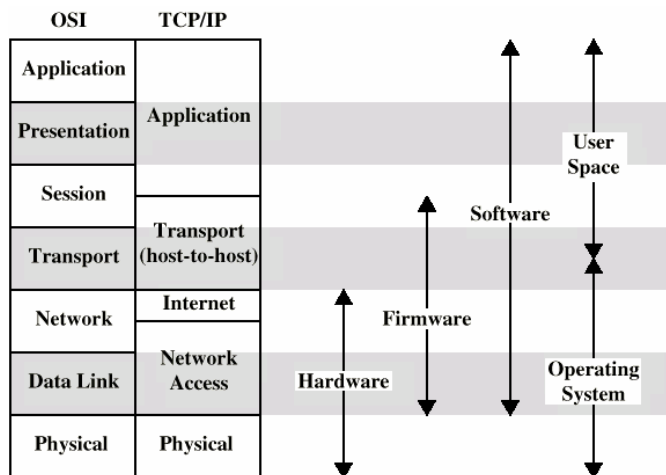
The TCP/IP Model

- **TCP/IP is the result of R&D conducted on experimental packet switched network (ARPANET) and funded by Defense Advanced Research Agency (DARPA)**
- **TCP/IP is NOW the dominant commercial architecture – The foundation of the internet and its applications**

The TCP/IP Model

- **Model has five independent layers:**
 - **Application layer:** comm between processes or applications on separate hosts
 - **Transport layer:** end-2-end transfer service – may include reliability mechanisms
 - **Internet layer:** routing data from source to destination through one or more networks
 - **Network access layer:** logical interface between end systems and the network
 - **Physical layer:** defines mechanism of transmitting raw bits depending on media characteristic

The TCP/IP Model (using the OSI Model as a reference)



Example of TCP/IP Communications

- A process (has port 1) on host A needs to communicate to another process: port 2 at host B
- The application layer on A hands the msg down to TCP with instructions to deliver it to (port2,host B)
- TCP hands msg down to IP with instructions to send it to host B:
 - The IP layer knows how to reach host B (or at least the first hop of the route) – does not care about port info
- IP hands down packets to network access (say Ethernet) with instructions to pass it to next router (first hop on the way to B)

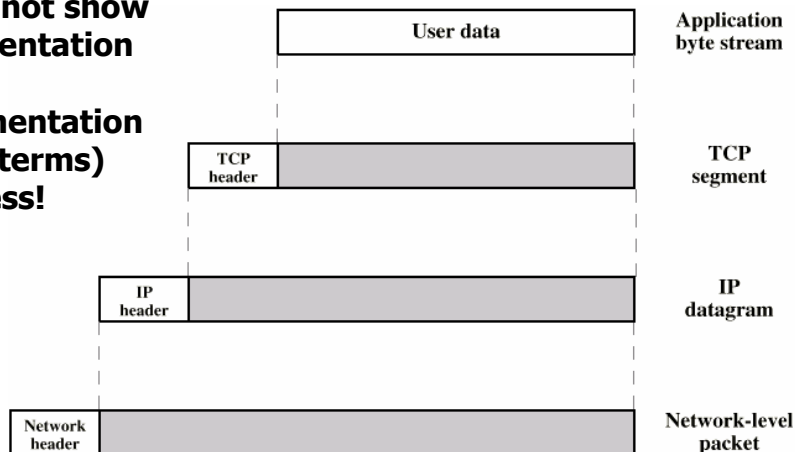
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Example of TCP/IP Communications

- Does not show segmentation (or fragmentation in IP terms) process!



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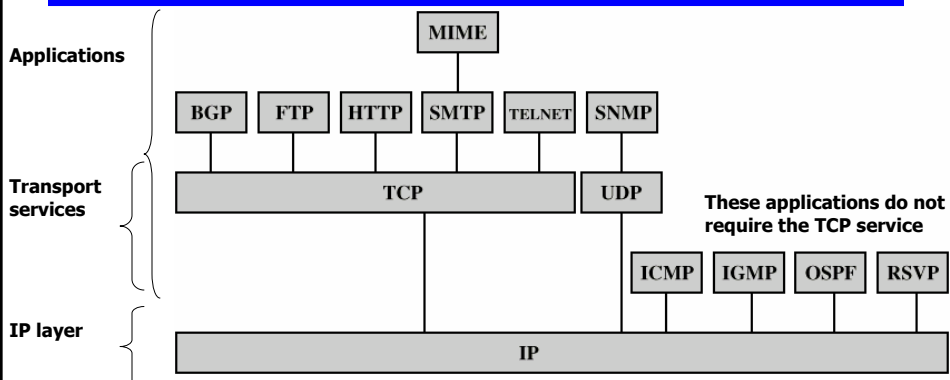
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TCP/IP Control Information (Partial)

- **TCP control info:**
 - Destination port number
 - Sequence number
 - Checksum
- **IP control info:**
 - IP address
- **Network Access control info:**
 - Destination network access address (this is not the IP!!)
 - Facilities request (e.g. priorities)

TCP/IP Control Information (Partial)



BGP = Border Gateway Protocol
 FTP = File Transfer Protocol
 HTTP = Hypertext Transfer Protocol
 ICMP = Internet Control Message Protocol
 IGMP = Internet Group Management Protocol
 IP = Internet Protocol
 MIME = Multi-Purpose Internet Mail Extension
 OSPF = Open Shortest Path First
 RSVP = Resource ReSerVation Protocol
 SMTP = Simple Mail Transfer Protocol
 SNMP = Simple Network Management Protocol
 TCP = Transmission Control Protocol
 UDP = User Datagram Protocol