

# King Fahd University of Petroleum & Minerals Computer Engineering Dept

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COE 341 – Data and Computer  
Communications

Term 112

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## Lecture Contents

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

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## Protocols - Definition

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- **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 - Functions

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- 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)

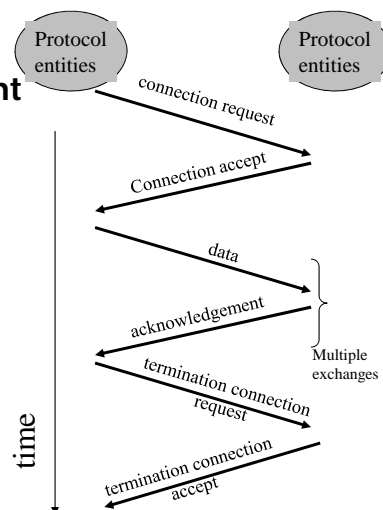
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## Protocols - Functions

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



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## Protocols - Functions

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- **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

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- **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:

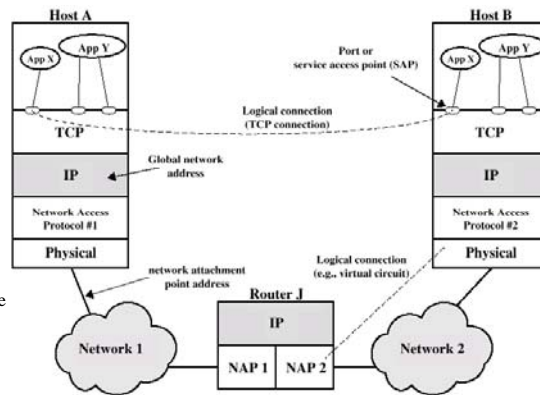
- IP is globally unique and applicable
- Network attachment point address (e.g. MAC frames, X.25)

### 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

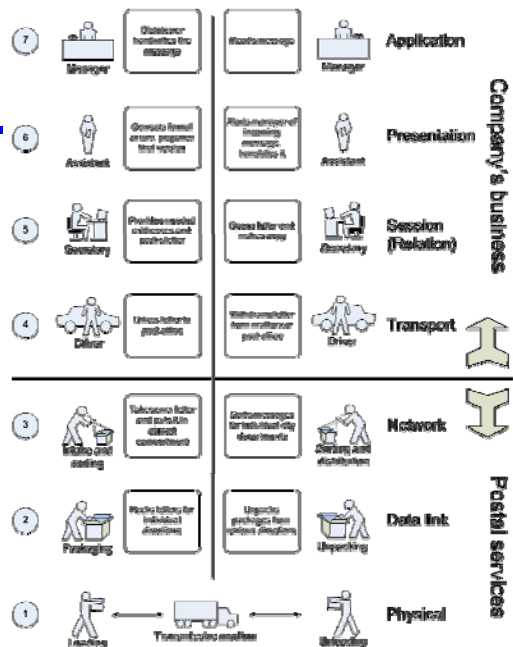
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## The OSI Model – Example:

- Source: [http://en.wikipedia.org/wiki/OSI\\_model](http://en.wikipedia.org/wiki/OSI_model)



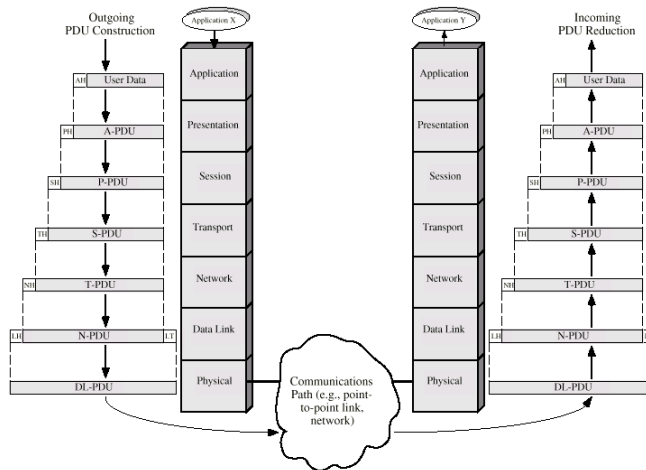
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RM – OSI and letter communication parallel

## 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



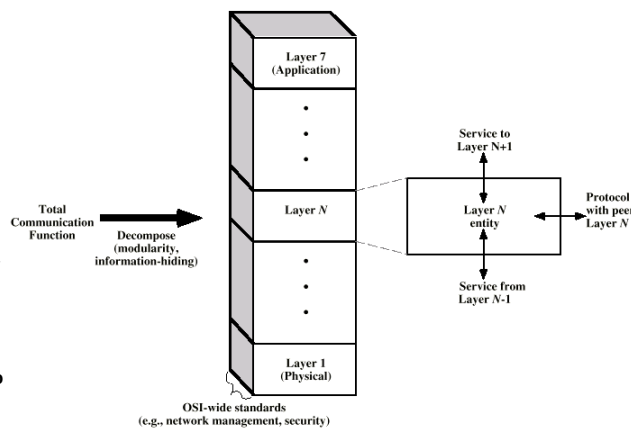
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## The OSI Model - Framework

- 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

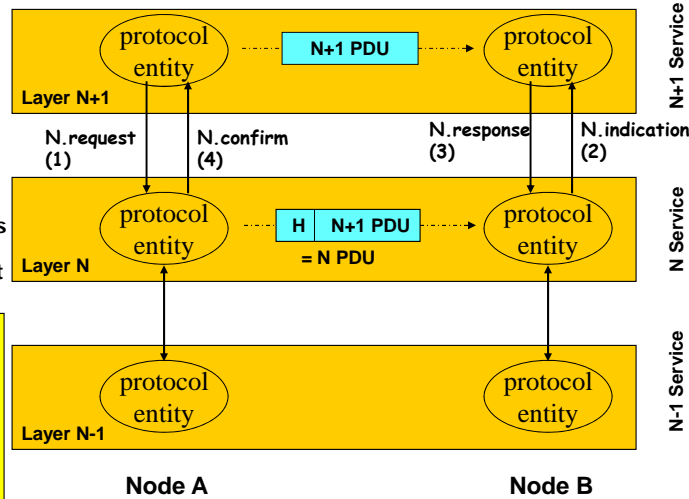
- Service Primitives:

- 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 initiator 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”

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## The OSI Model – Data Link Layer

- **Converts 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**

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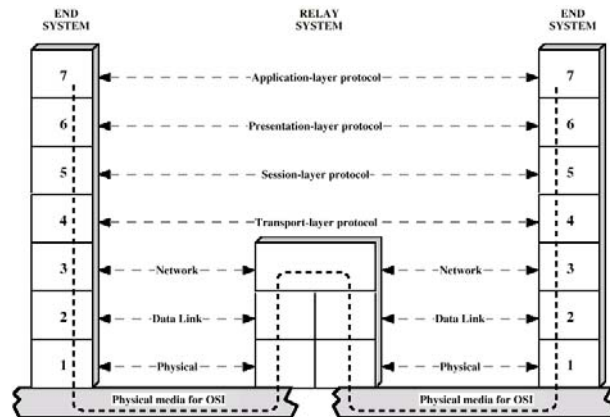
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## The OSI Model – Network Layer

- **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

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- **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

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

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## The OSI Model – Presentation

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

## The OSI Model – Application

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

## The TCP/IP Model

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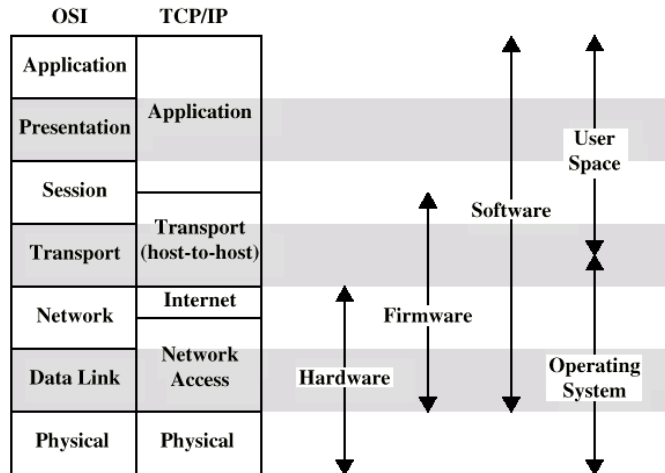
- **TCP/IP is the result of R&D conducted on experimental packet switched network (ARPANET) and funded by Defense Advanced Research Agency (DARPA)**
- **TCP/IP is NOW the dominant commercial architecture – The foundation of the internet and its applications**

## The TCP/IP Model

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- **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)



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## 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)

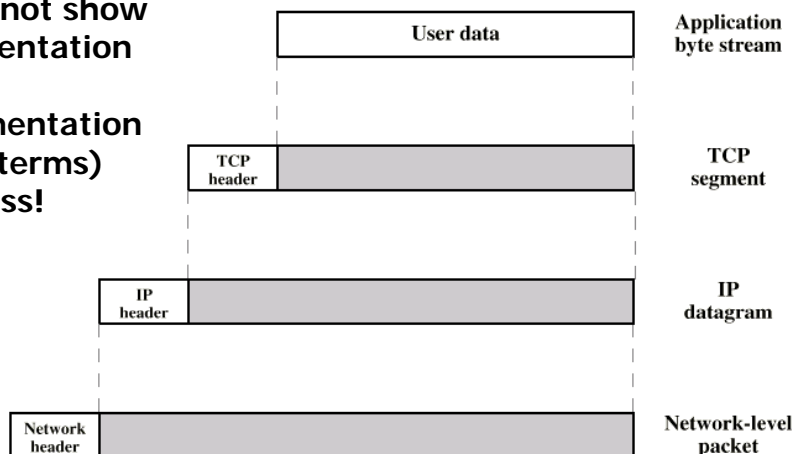
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## Example of TCP/IP Communications

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



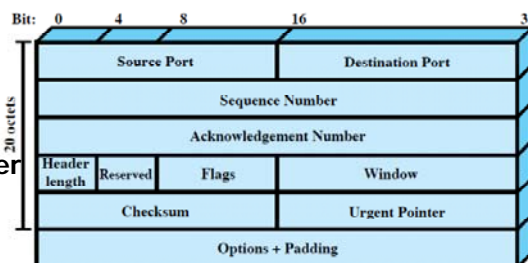
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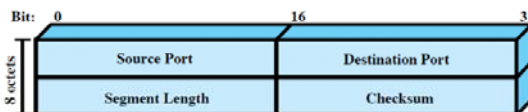
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## TCP Headers

- TCP control info:
  - Destination port number
  - Sequence number
  - Checksum



(a) TCP Header



(b) UDP Header

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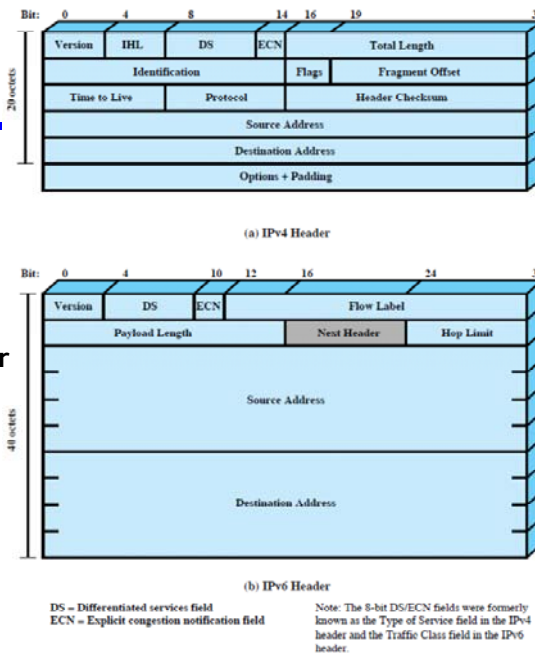
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Figure 2.3 TCP and UDP Headers

# IP Header

- **IP control Info**
  - Version
  - Source Address
  - Destination Address
  - Protocol
- Note the 32-bit address for IPv4 versus the 128-bit address for IPv6.



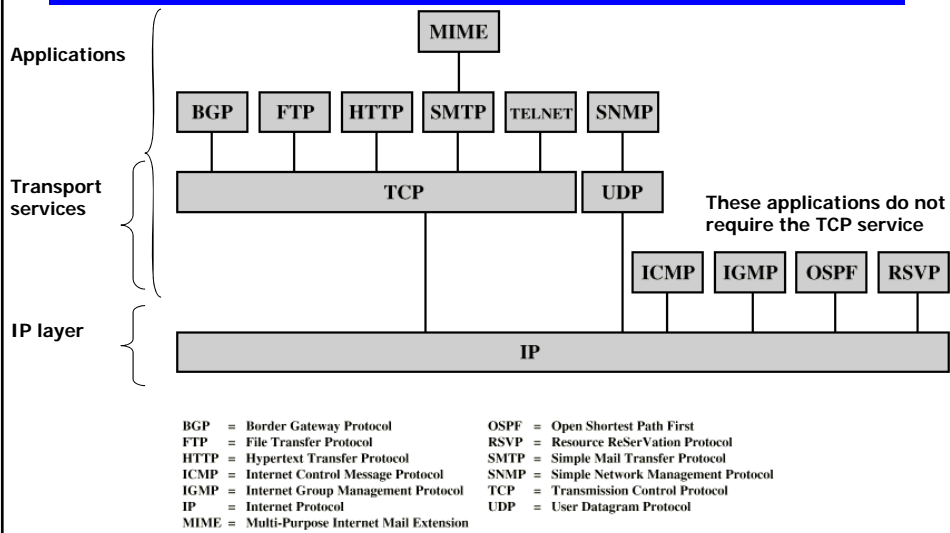
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Figure 2.4 IP Headers

# TCP/IP Protocols



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## Typical Internet Applications

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- **Simple Mail Transfer Protocol (SMTP)**
- **File Transfer Protocol (FTP)**
- **Telnet**

## Multimedia

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- **Media: text, still images, and video**
- **Multimedia: Human-computer interaction involving text, graphics, images, and/or audio/video**
- **Streaming Media: video and audio clips**
- **Quality of Service (QoS) Parameters include:**
  - Throughput, delay, delay variation (jitter), packet loss, etc.
- **Types of Traffic:**
  - **Elastic:** can accept variable range of QoS levels across the internet – e.g. TCP/IP is designed for this
  - **Inelastic** – have very strict QoS levels requirements – e.g. (real-time) voice traffic