King Fahd University of Petroleum & Minerals
Computer Engineering Dept

COE 341 – Data and Computer Communications

Term 071

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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

Protocols - Definition

- 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)

Standards Organizations

- Internet Society (http://www.isoc.org/):
  - Internet Organization and RFC Publication
  - Internet Architecture Board (IAB)
  - Internet Engineering Task Force (IETF)
  - Internet Engineering Steering Group (IESG)
- International Organization for Standardization or ISO:
  - Open System Interface (OSI): communication architecture and reference model

Standards Organizations

- International Telecommunication Union (ITU)
  - United nations organization
  - ITU-T: Telecommunications Standardization Sector
  - Replaced International Telegraph and Telephone Consultative Committee (CCITT)
- ATM Forum:
  - 600 member companies

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

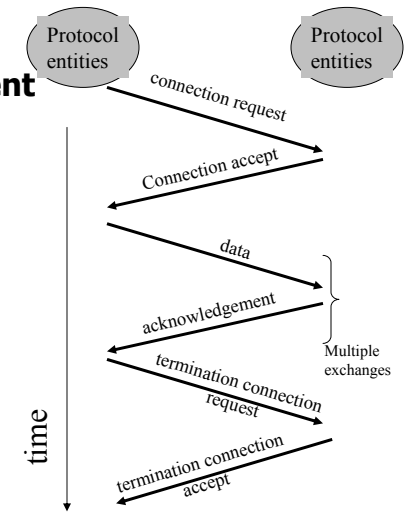
- Encapsulation
- Segmentation and Assembly
- Connection Control
- Ordered Delivery
- Flow Control
- Error Control
- Addressing
- Multiplexing
- Transmission Services

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 outs if block is corrupted or not
    - Corrupted – may be correctable or request another copy
    - OK – accept block

Protocols - Functions

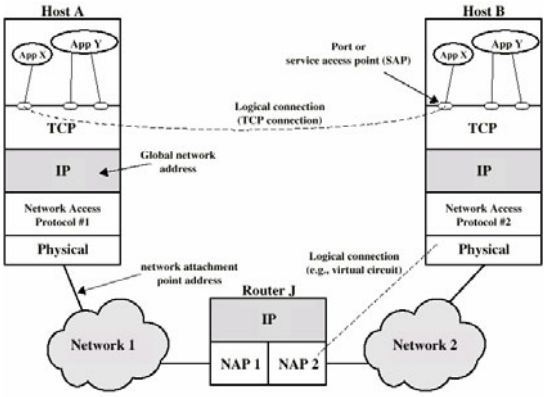
- **Addressing:**
  - **Level, Scope, Connection Identifiers, and Mode**

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



Protocols - Functions

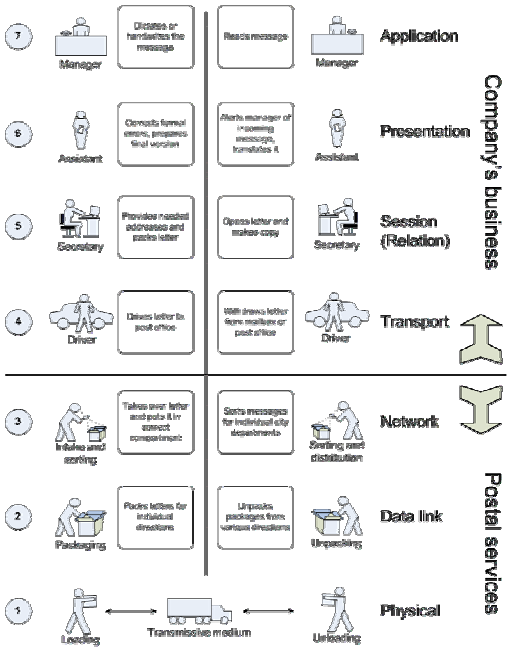
- **Multiplexing:**
  - **Multiple virtual circuits on one physical link (e.g X.25 – from one end system to another)**
  - **Mapping connections from one level (layer) to another:**
    - **E.g. Multiple service points carried on one virtual circuit (called upward or inward multiplexing)**
    - **Downward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

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

The OSI Model – Example:

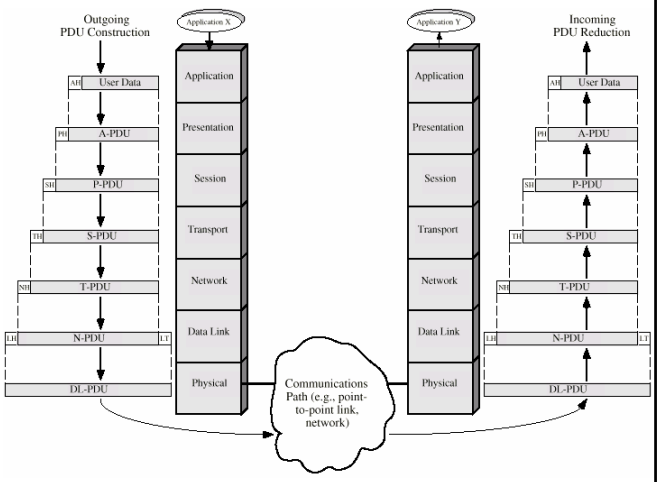
- Source: http://en.wikipedia.org/wiki/OSI_model



RM – OSI and letter communication parallel

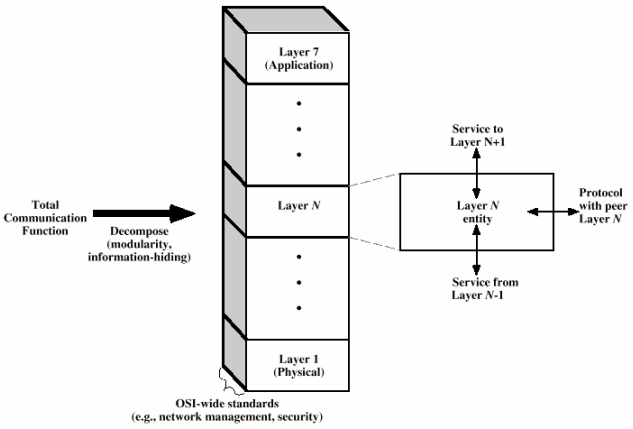
The OSI Model - Environment

- 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



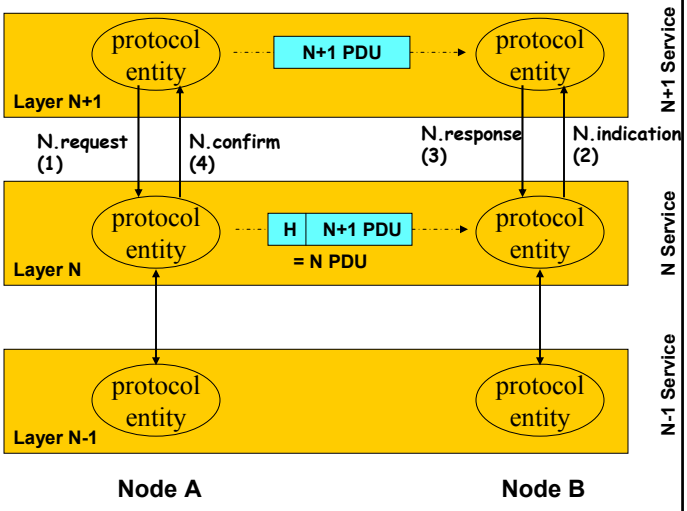
The OSI Model - Framework

- 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



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.



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"

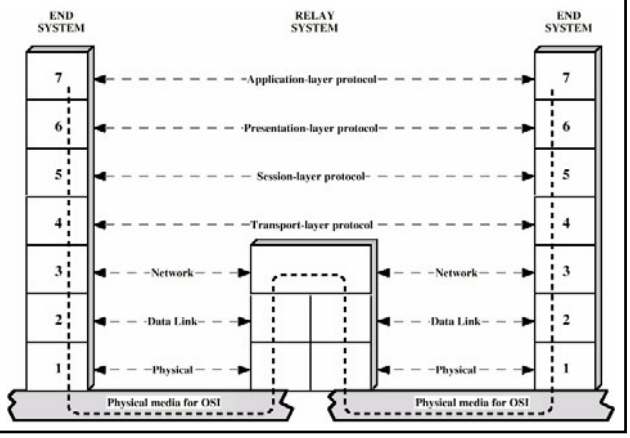
The OSI Model – Data Link Layer

- 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



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)

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**

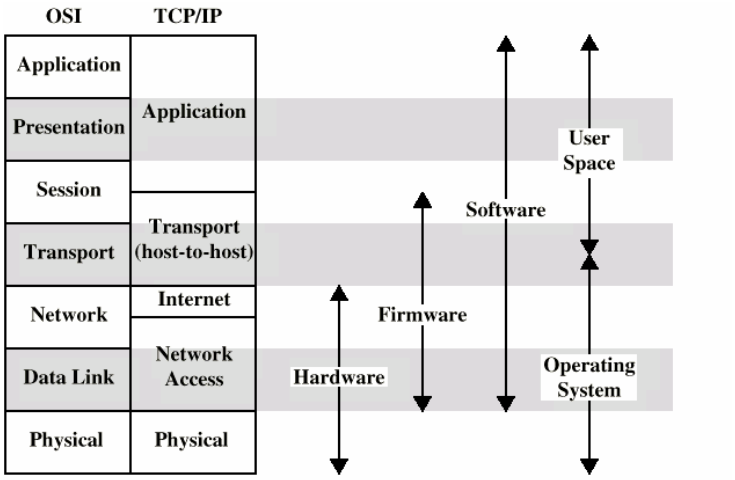
The TCP/IP Model

- 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)

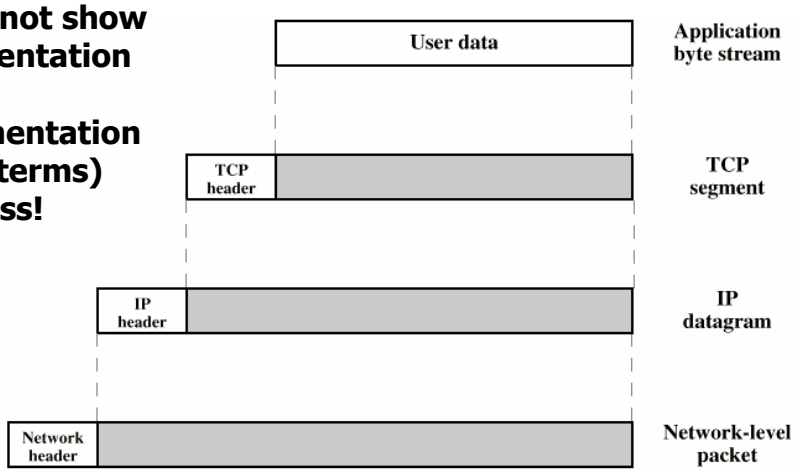


Example of TCP/IP Communications

- 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)

Example of TCP/IP Communications

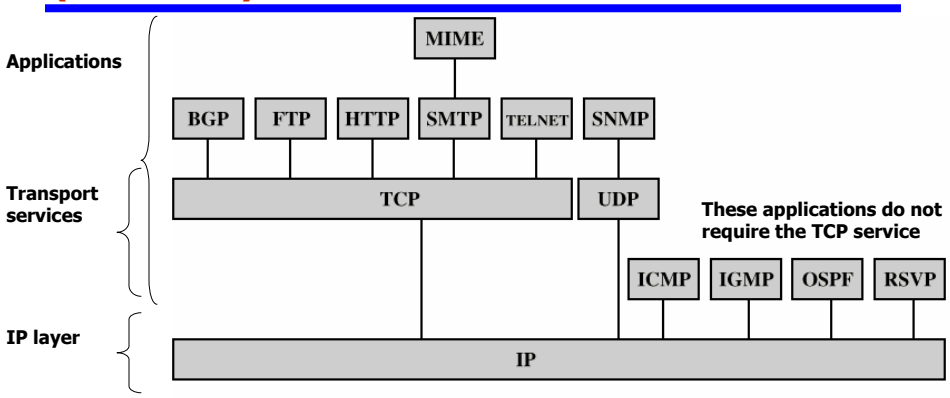
- Does not show segmentation (or fragmentation in IP terms) process!



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