Chapter 2

Protocol Architecture

A Few Questions

- What is a protocol?
- What is a protocol architecture?
- How many layers are needed?
- Major function of network access layer?
- What is TCP/IP?
- What tasks performed by transport layer?
- Does all traffic running on Internet use TCP?
- Differences between TCP & UDP?

Need For Protocol Architecture

- Protocol: a set of technical rules about how information should be transmitted and received using computers.
- Task broken into subtasks
- Implemented separately in layers in stack
- Functions needed in both systems
- Peer layers communicate

Standardized Protocol Architectures

- Required for devices to communicate
- Vendors have more marketable products
- Customers can insist on standards-based equipment
- Two standards:
  - OSI Reference model
    - Never lived up to early promises
  - TCP/IP protocol suite
    - Most widely used

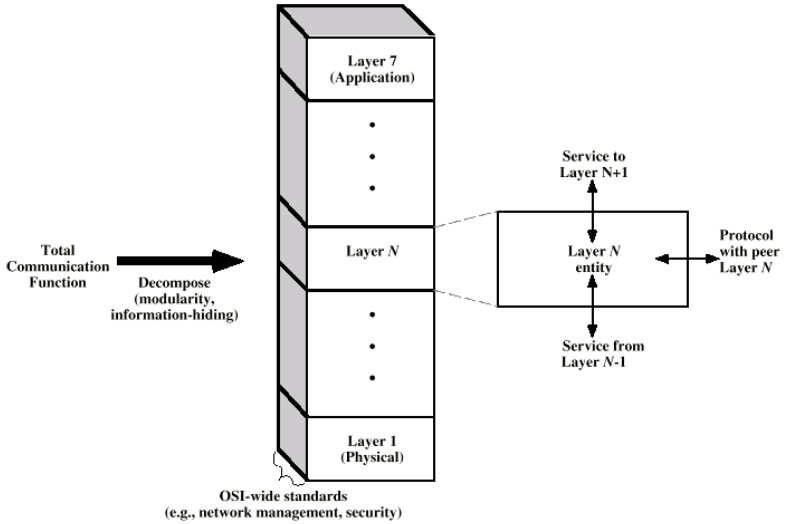
OSI

- Open Systems Interconnection
- Developed by the International Organization for Standardization (ISO)
- Seven layers
- A theoretical system delivered too late!
- TCP/IP is the de facto standard

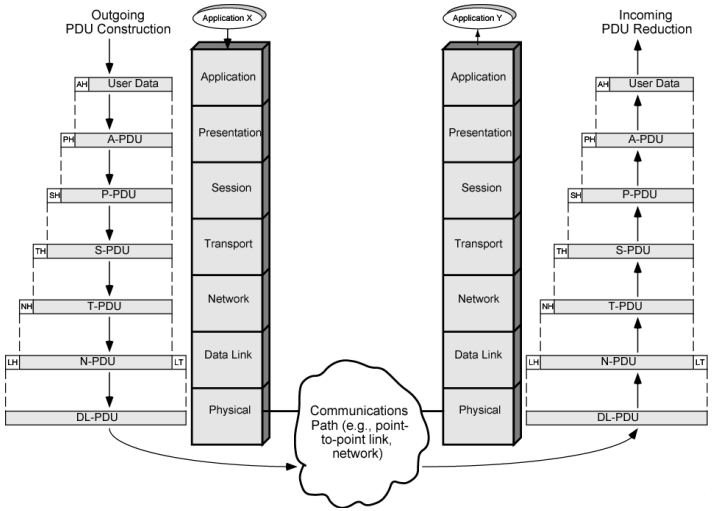
OSI - The Model

- A layer model
- Each layer performs a subset of the required communication functions
- Each layer relies on the next lower layer to perform more primitive functions
- Each layer provides services to the next higher layer
- Changes in one layer should not require changes in other layers

OSI as Framework for Standardization



The OSI Environment



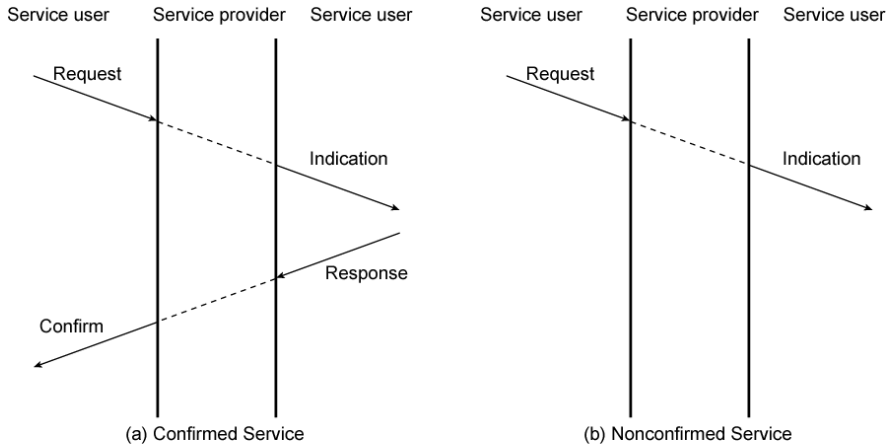
Service Primitives and Parameters

- Services between adjacent layers expressed in terms of primitives and parameters
- Primitives specify function to be performed
- Parameters pass data and control info

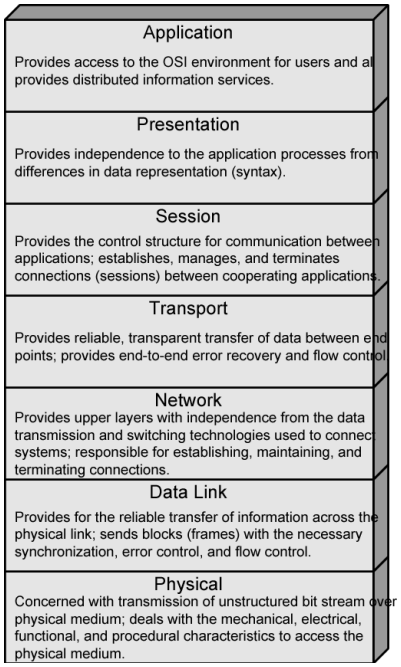
Primitive Types

REQUEST	A primitive issued by a service user to invoke some service and to pass the parameters needed to specify fully the requested service
INDICATION	A primitive issued by a service provider either to: indicate that a procedure has been invoked by the peer service user on the connection and to provide the associated parameters, or notify the service user of a provider-initiated action
RESPONSE	A primitive issued by a service user to acknowledge or complete some procedure previously invoked by an indication to that user
CONFIRM	A primitive issued by a service provider to acknowledge or complete some procedure previously invoked by a request by the service user

Timing Sequence for Service Primitives



OSI Layers



OSI Layers (I)

- Physical
  - Physical interface between devices
    - Mechanical
    - Electrical
    - Functional
    - Procedural
- Data Link
  - Means of activating, maintaining and deactivating a reliable link
  - Error detection and control
  - Higher layers may assume error free transmission

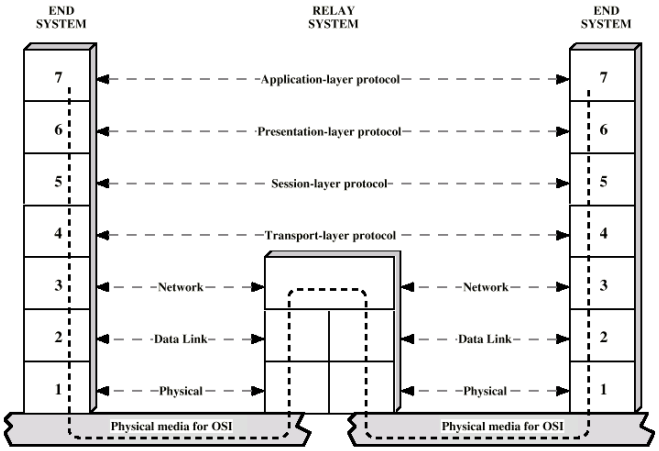
OSI Layers (II)

- Network
  - Transport of information cross communication network
  - Relieve higher layers of the need to know about underlying technology
  - Not needed on direct links
- Transport
  - Exchange of data between end systems
  - Error free
  - In sequence
  - No losses
  - No duplicates
  - Quality of service

OSI Layers (III)

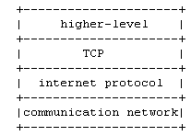
- Session
  - Control of dialogues between applications
  - Dialogue discipline
  - Grouping
  - Recovery
- Presentation
  - Data formats and coding
  - Data compression
  - Encryption
- Application
  - Means for applications to access OSI environment

Use of a Relay



TCP/IP Protocol Architecture

- Developed by the US Defense Advanced Research Project Agency (DARPA) for its packet switched network (ARPANET)
- Used by the global Internet
- No official model but a working one.
  - Application layer
  - Host to host or transport layer
  - Internet layer
  - Network access layer
  - Physical layer



Physical Layer

- Physical interface between data transmission device (e.g. computer) and transmission medium or network
- Characteristics of transmission medium
- Signal levels
- Data rates
- etc.

Network Access Layer

- Exchange of data between end system and network
- Destination address provision
- Invoking services like priority

Internet Layer (IP)

- Systems may be attached to different networks
- Routing functions across multiple networks
- Implemented in end systems and routers

Transport Layer (TCP)

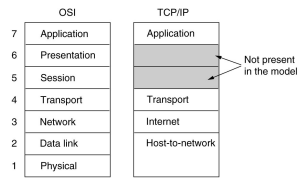
- Reliable delivery of data
- Ordering of delivery

Application Layer

- Support for user applications
- e.g. HTTP, SMPT

OSI vs TCP/IP

- OSI: reference model was devised before the corresponding protocols were invented.
- The OSI model has proven to be exceptionally useful for discussing computer networks.
- The OSI protocols have not become popular.
- TCP/IP: the protocols came first, and the model was just a description of the existing protocols.
- TCP/IP protocols are widely used.



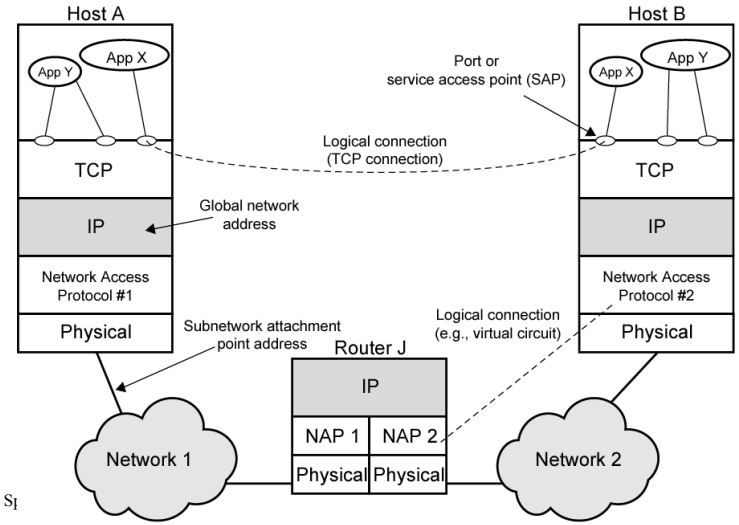
TCP

- Usual transport layer is Transmission Control Protocol
  - Reliable connection
- Connection
  - Temporary logical association between entities in different systems
- TCP PDU
  - Called TCP segment
  - Includes source and destination port
    - Identify respective users (applications)
    - Connection refers to pair of ports
- TCP tracks segments between entities on each connection

UDP

- Alternative to TCP is User Datagram Protocol
- Not guaranteed delivery
- No preservation of sequence
- No protection against duplication
- Minimum overhead
- Adds port addressing to IP

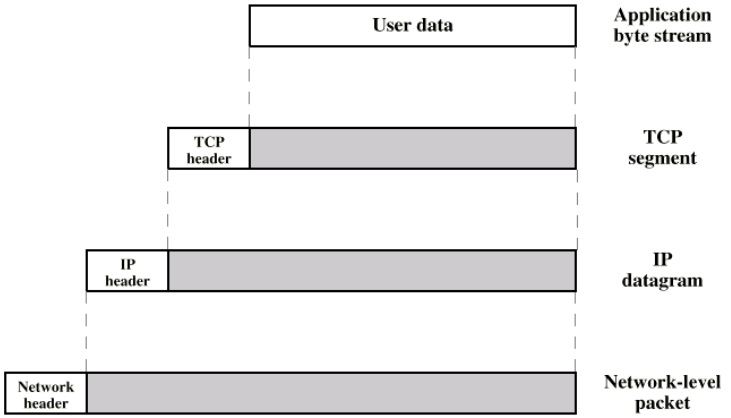
TCP/IP Concepts



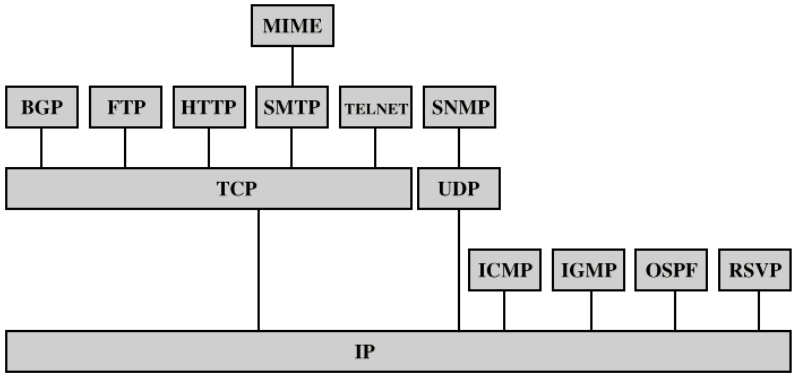
Trace of Simple Operation

- Process associated with port 1 in host A sends message to port 2 in host B
- Process at A hands down message to TCP to send to port 2
- TCP hands down to IP to send to host B
- IP hands down to network layer (e.g. Ethernet) to send to router J
- Generates a set of encapsulated PDUs

PDUs in TCP/IP



Some Protocols in TCP/IP Suite



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