



# Chapter 2

#### **Protocol Architecture**

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#### 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

# 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?

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#### 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

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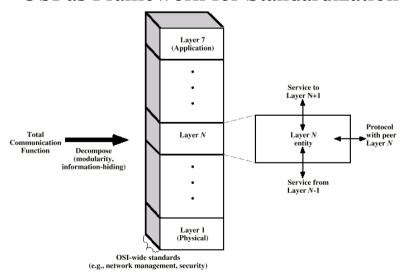
#### **OSI**

- 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

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#### OSI as Framework for Standardization





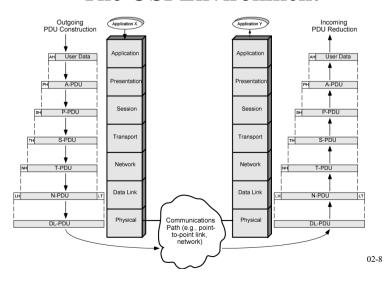
#### OSI - The Model

- 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

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#### The OSI Environment





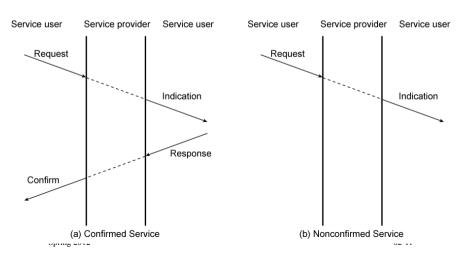
#### Service Primitives and Parameters

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

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# Timing Sequence for Service Primitives





# **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

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# **OSI** Layers

Application
Provides access to the OSI environment for users and al provides distributed information services.
Presentation
rieschiation
Provides independence to the application processes from differences in data representation (syntax).
Session
Provides the control structure for communication between
applications; establishes, manages, and terminates
connections (sessions) between cooperating applications
Transport
Halisport
Provides reliable, transparent transfer of data between e points; provides end-to-end error recovery and flow conti
Network
Provides upper layers with independence from the data transmission and switching technologies used to connec systems; responsible for establishing, maintaining, and terminating connections.
Data Link
Provides for the reliable transfer of information across the physical link; sends blocks (frames) with the necessary synchronization, error control, and flow control.
Physical
Concerned with transmission of unstructured bit stream or physical medium; deals with the mechanical, electrical,

functional, and procedural characteristics to access the

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# 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

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# 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



# 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

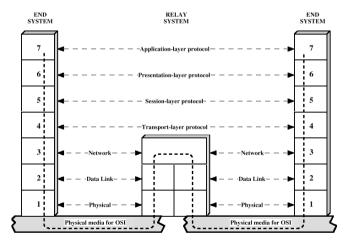
#### • Transport

- Exchange of data between end systems
- Error free
- In sequence
- No losses
- No duplicates
- Quality of service

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# Use of a Relay



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#### 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

higher-level |
TCP |
internet protocol |
| communication network

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### Network Access Layer

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



### 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.

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# Internet Layer (IP)

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

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# Transport Layer (TCP)

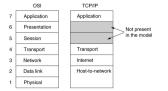
- Reliable delivery of data
- Ordering of delivery

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#### 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.





## **Application Layer**

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

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#### **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

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#### **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

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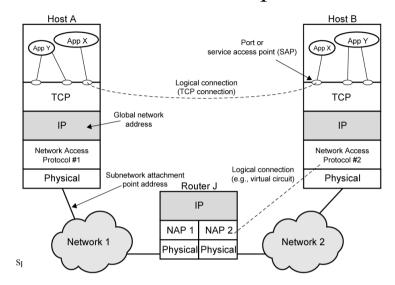


## Trace of Simple Operation

- 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

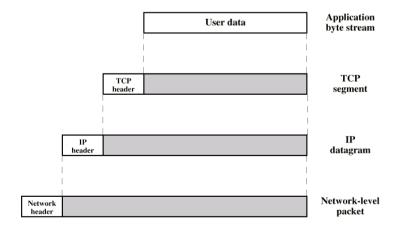


## TCP/IP Concepts





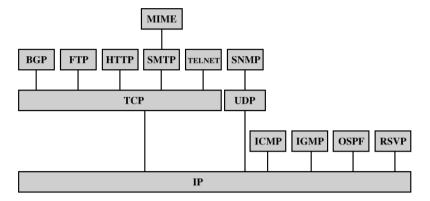
#### PDUs in TCP/IP



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# Some Protocols in TCP/IP Suite



 BGP
 = Border Gateway Protocol
 OSPF = Open Shortest Path First

 FTP = File Transfer Protocol
 RSVP = Resource ReserVation Protocol

 HTTP = Hypertex Transfer Protocol
 SMTP = Simple Mail Transfer Protocol

 ICMP = Internet Control Message Protocol
 SMM = Simple Network Management Protocol

 IGMP = Internet Group Management Protocol
 TCP = Transmission Control Protocol

 IDP = Internet Protocol
 TCP = User Datagram Protocol

MIME = Multi-Purpose Internet Mail Extension