Data and Computer Communications

Chapter 2 – Protocol Architecture, TCP/IP, and Internet-Based Applications

Eighth Edition

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Protocol Architecture, TCP/IP, and Internet-Based Applications

- *To destroy communication completely, there must be no rules in common between transmitter and receiver—neither of alphabet nor of syntax —On Human Communication*, Colin Cherry

Need For Protocol Architecture

- data exchange can involve complex procedures, cf. file transfer example
- better if task broken into subtasks
- implemented separately in layers in stack
  - each layer provides functions needed to perform comms for layers above
  - using functions provided by layers below
- peer layers communicate with a protocol

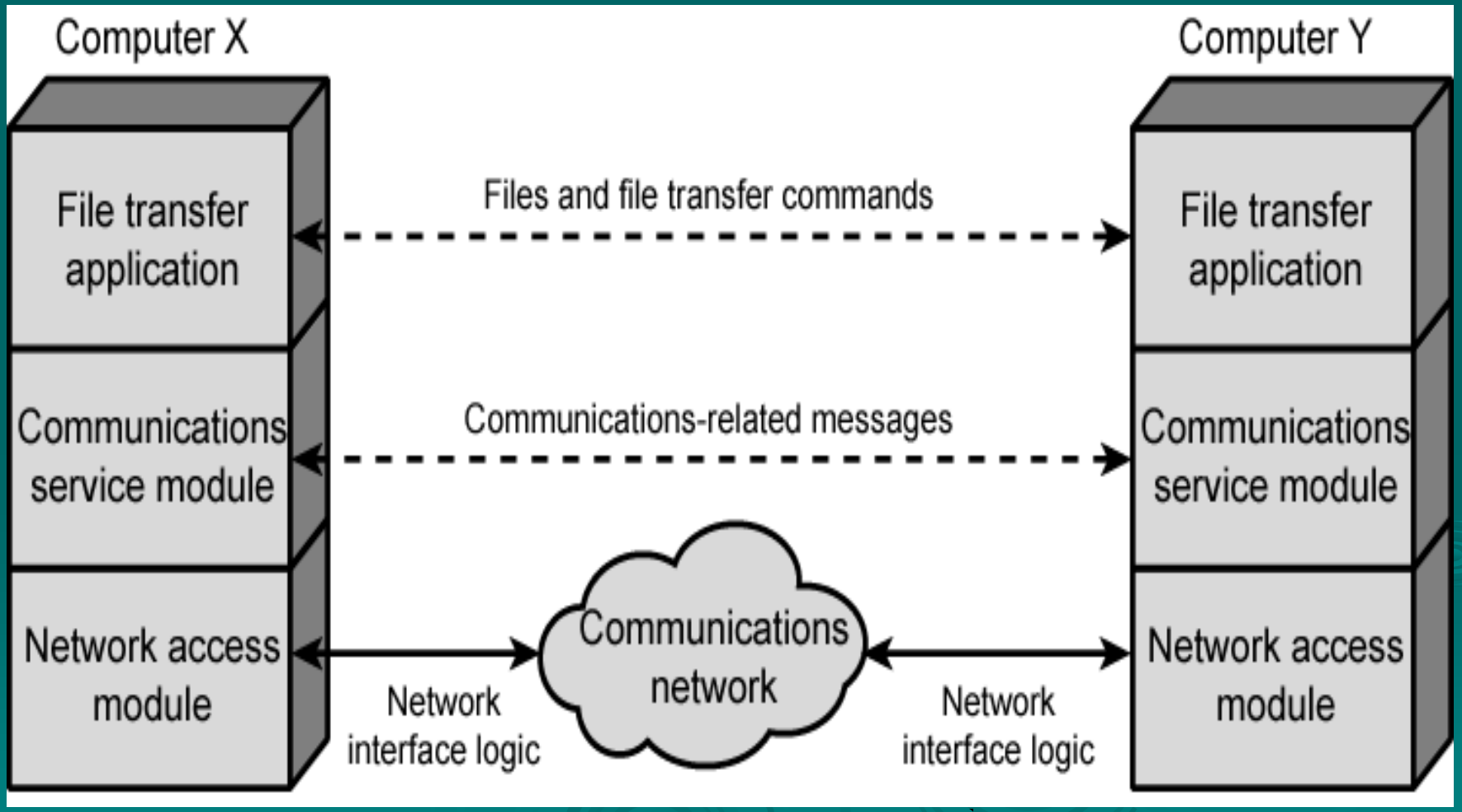
Key Elements of a Protocol

- syntax - data format
- semantics - control info & error handling
- timing - speed matching & sequencing

TCP/IP Protocol Architecture

- developed by US Defense Advanced Research Project Agency (DARPA)
- for ARPANET packet switched network
- used by the global Internet
- protocol suite comprises a large collection of standardized protocols

Simplified Network Architecture



TCP/IP Layers

- no official model but a working one
  - Application layer
  - Host-to-host, or transport layer
  - Internet layer
  - Network access layer
  - Physical layer

Physical Layer

- concerned with physical interface between computer and network
- concerned with issues like:
  - characteristics of transmission medium
  - signal levels
  - data rates
  - other related matters

Network Access Layer

- exchange of data between an end system and attached network
- concerned with issues like :
  - destination address provision
  - invoking specific services like priority
  - access to & routing data across a network link between two attached systems
- allows layers above to ignore link specifics

Internet Layer (IP)

- routing functions across multiple networks
- for systems attached to different networks
- using IP protocol
- implemented in end systems and routers
- routers connect two networks and relays data between them

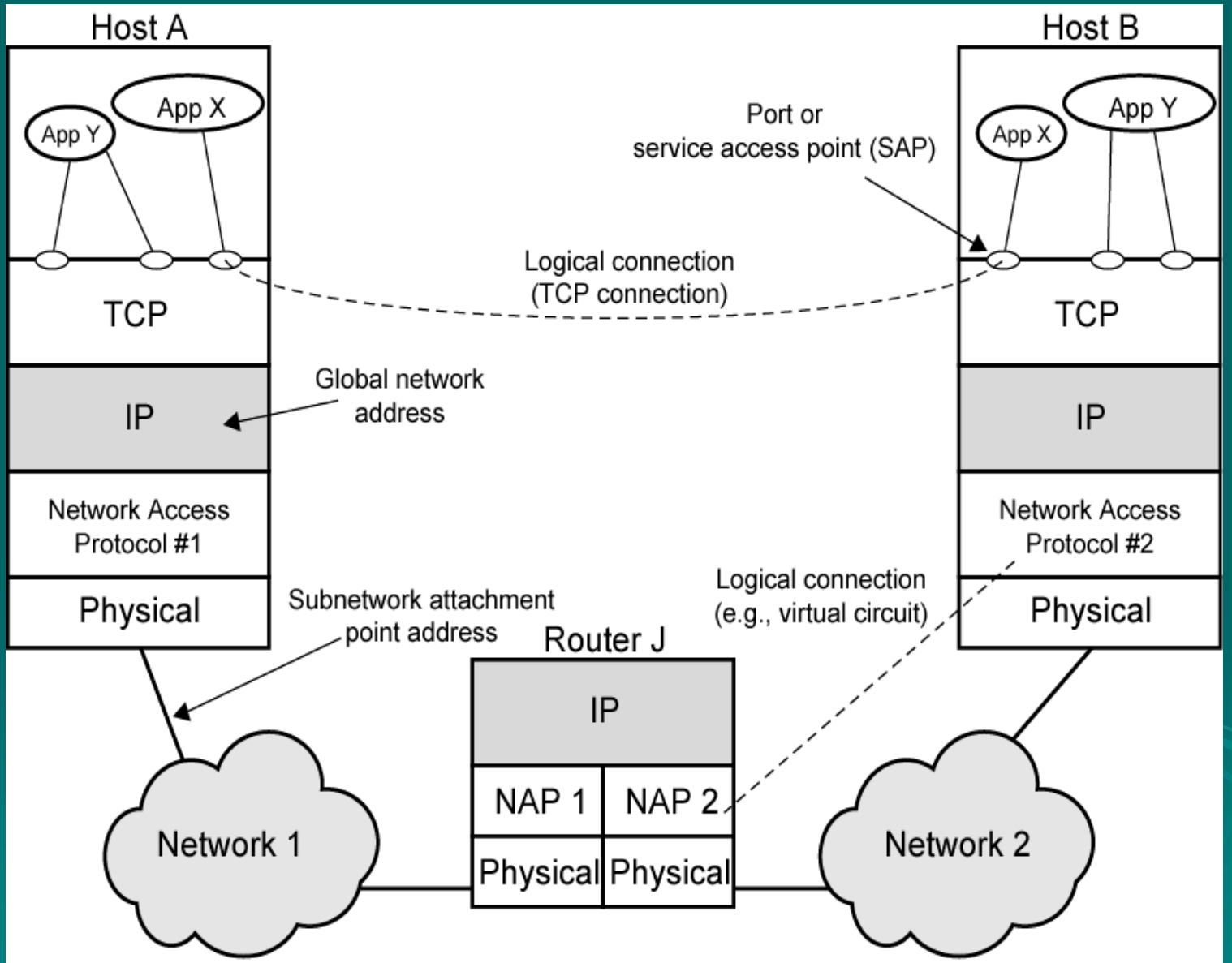
Transport Layer (TCP)

- common layer shared by all applications
- provides reliable delivery of data
- in same order as sent
- commonly uses TCP

Application Layer

- provide support for user applications
- need a separate module for each type of application

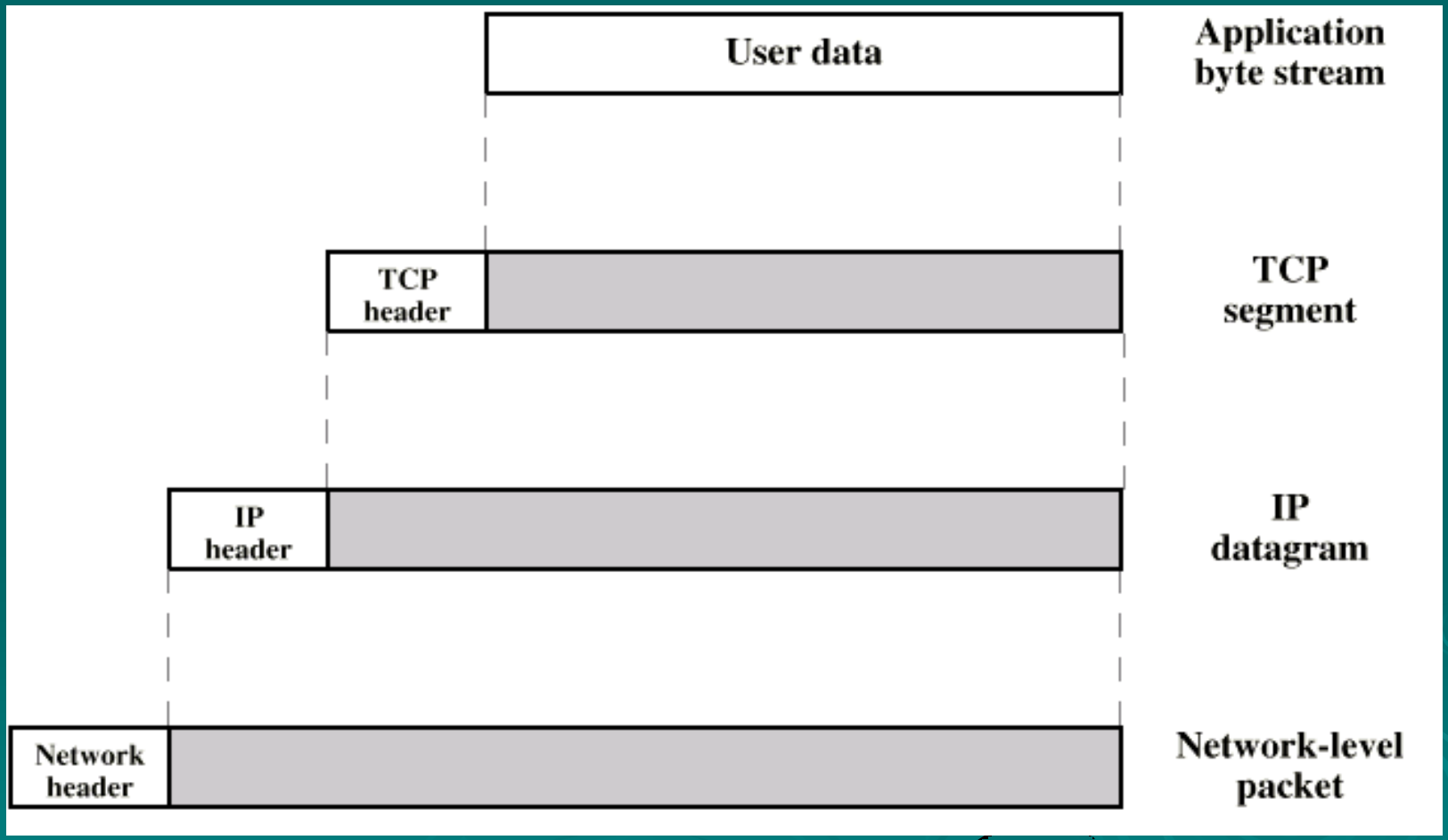
Operation of TCP and IP



Addressing Requirements

- two levels of addressing required
- each host on a subnet needs a unique global network address
  - its IP address
- each application on a (multi-tasking) host needs a unique address within the host
  - known as a port

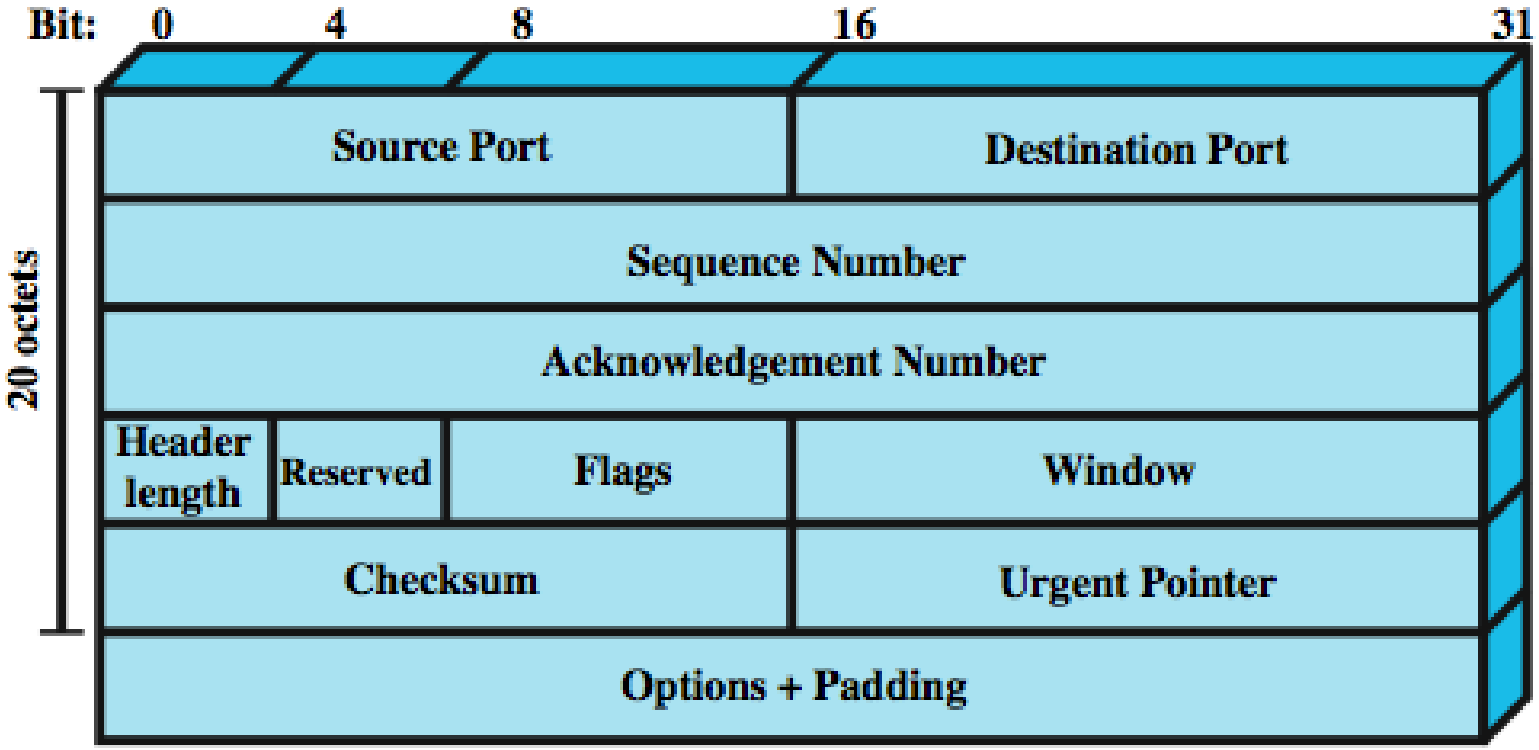
Operation of TCP/IP



Transmission Control Protocol (TCP)

- usual transport layer is (TCP)
- provides a reliable connection for transfer of data between applications
- a TCP segment is the basic protocol unit
- TCP tracks segments between entities for duration of each connection

TCP Header

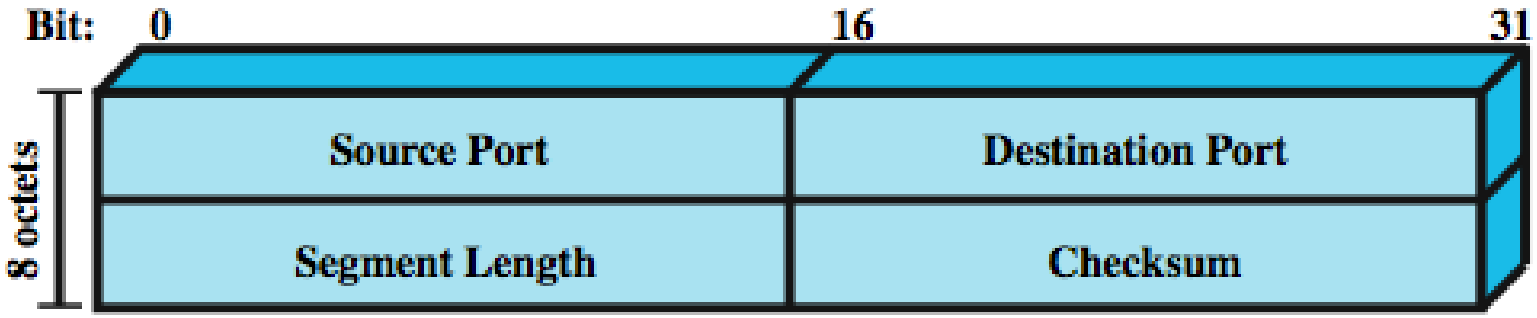


(a) TCP Header

User Datagram Protocol (UDP)

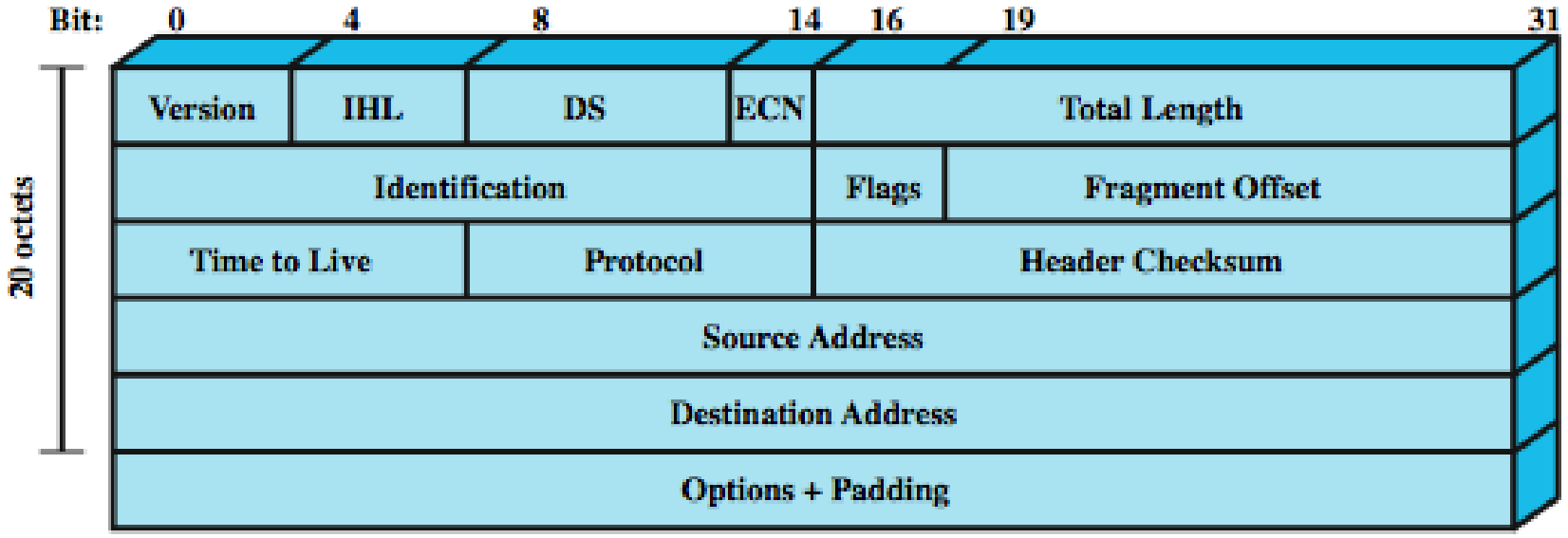
- an alternative to TCP
- no guaranteed delivery
- no preservation of sequence
- no protection against duplication
- minimum overhead
- adds port addressing to IP

UDP Header



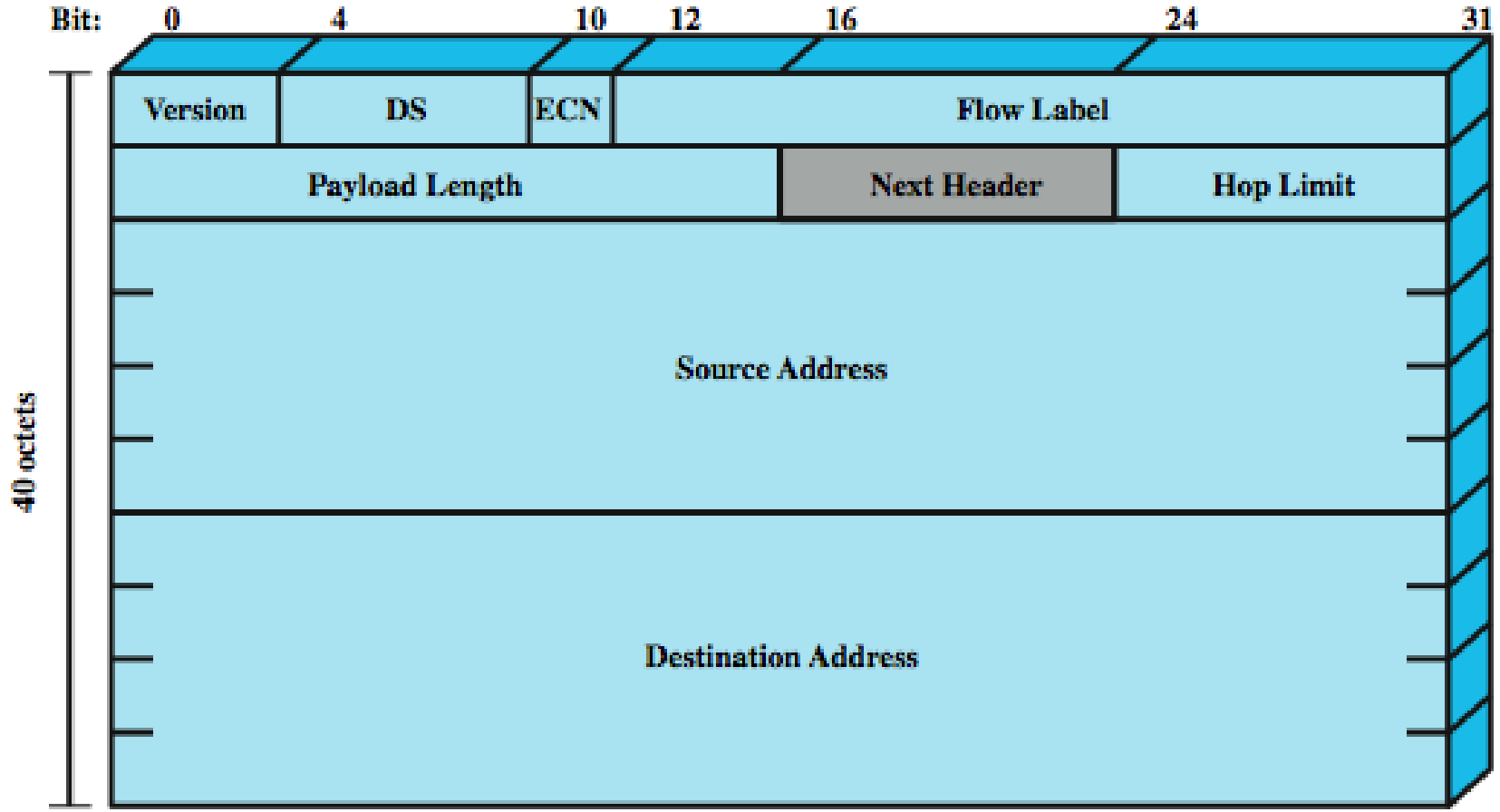
(b) UDP Header

IP Header



(a) IPv4 Header

IPv6 Header

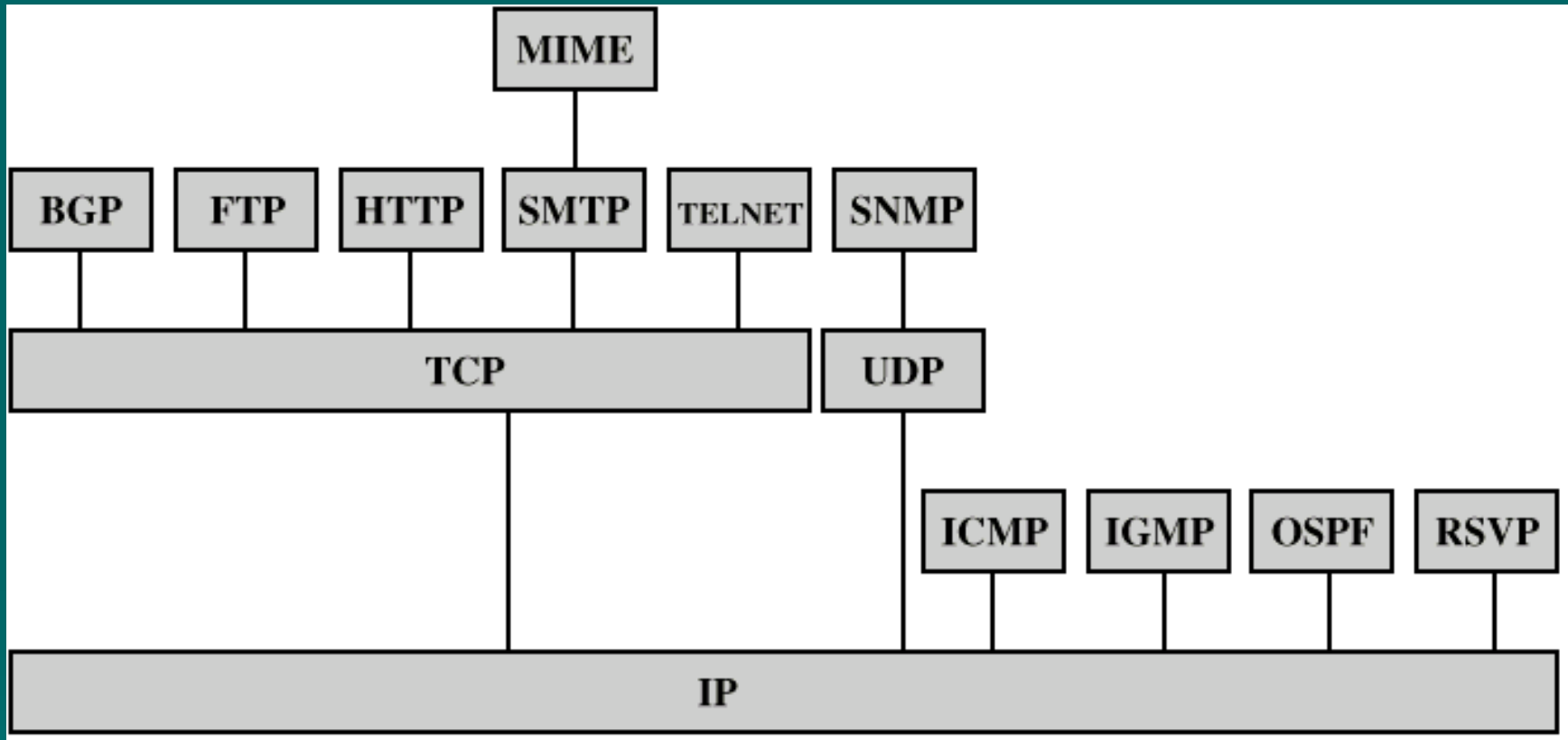


(b) IPv6 Header

TCP/IP Applications

- have a number of standard TCP/IP applications such as
  - Simple Mail Transfer Protocol (SMTP)
  - File Transfer Protocol (FTP)
  - Telnet

Some TCP/IP Protocols



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

OSI

- Open Systems Interconnection
- developed by the International Organization for Standardization (ISO)
- has seven layers
- is a theoretical system delivered too late!
- TCP/IP is the de facto standard

OSI Layers

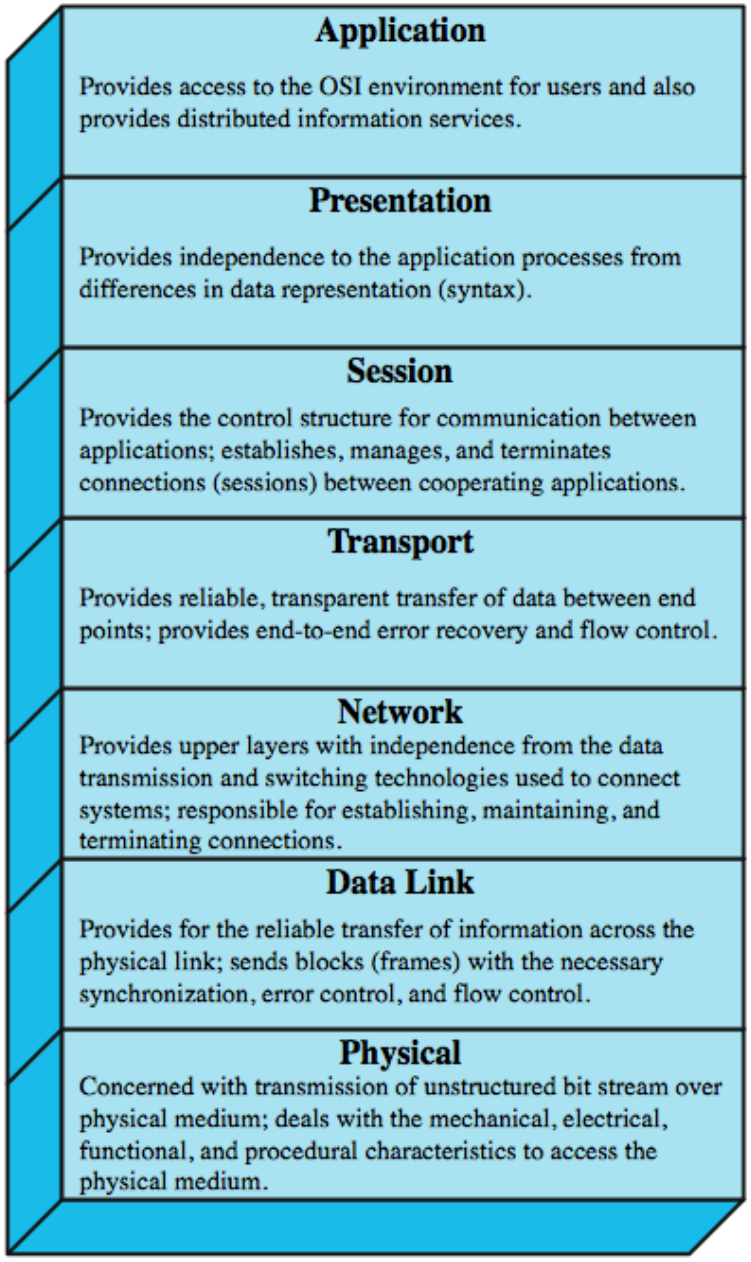
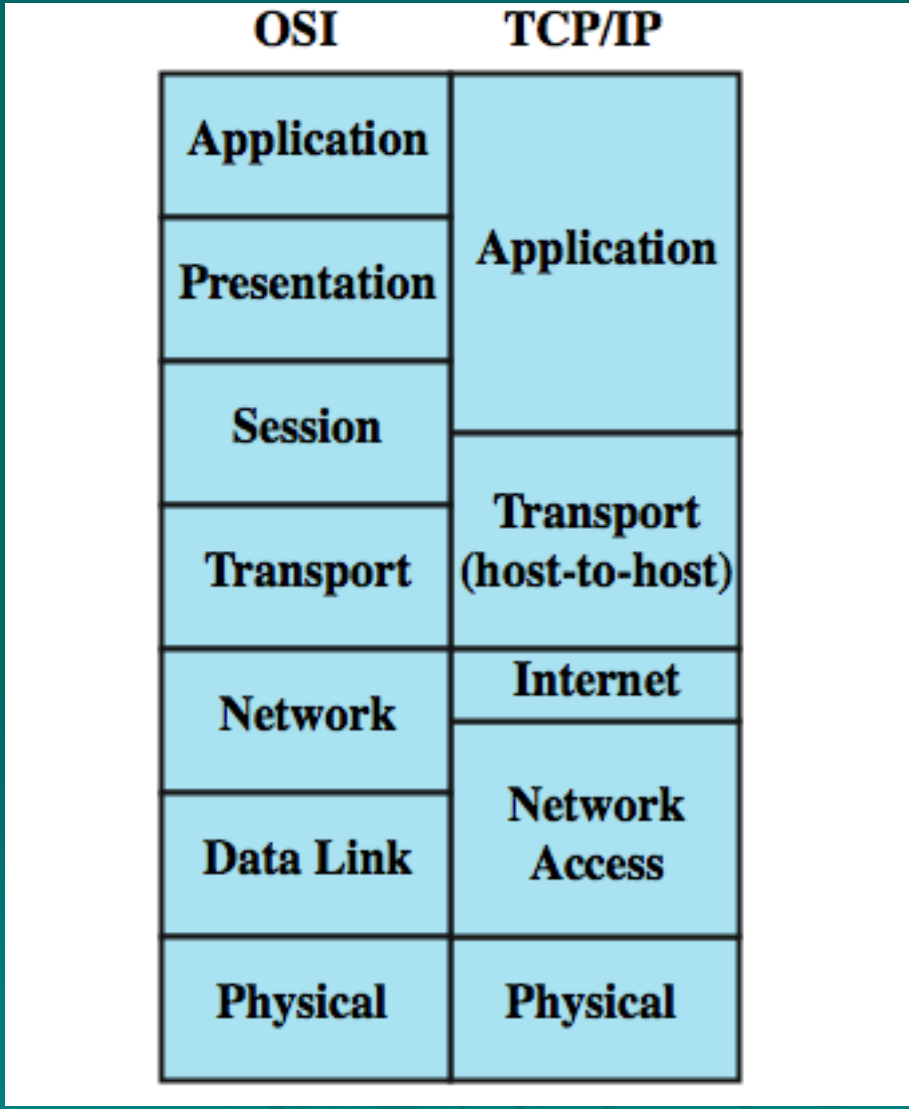
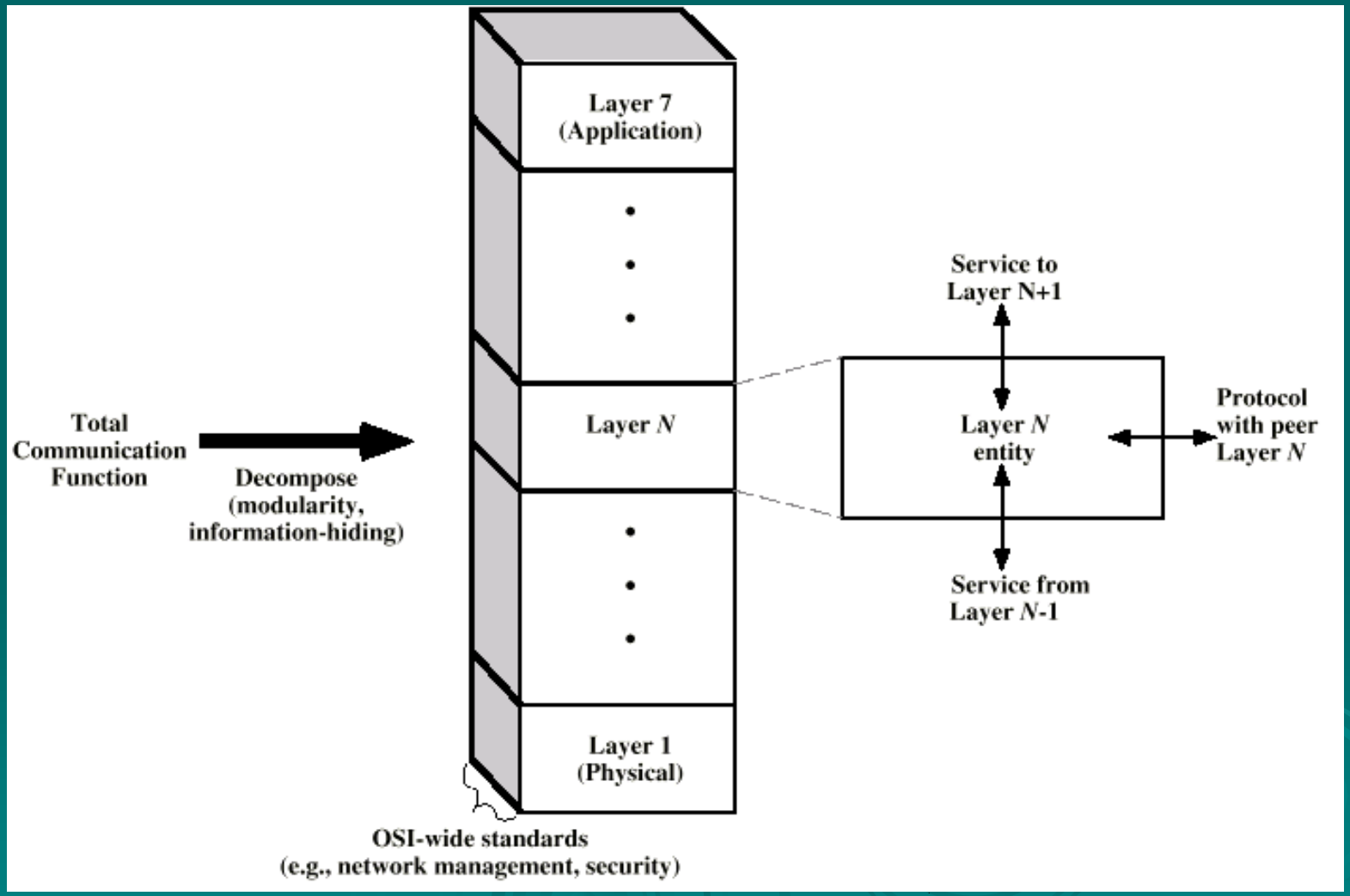


Figure 2.6 The OSI Layers

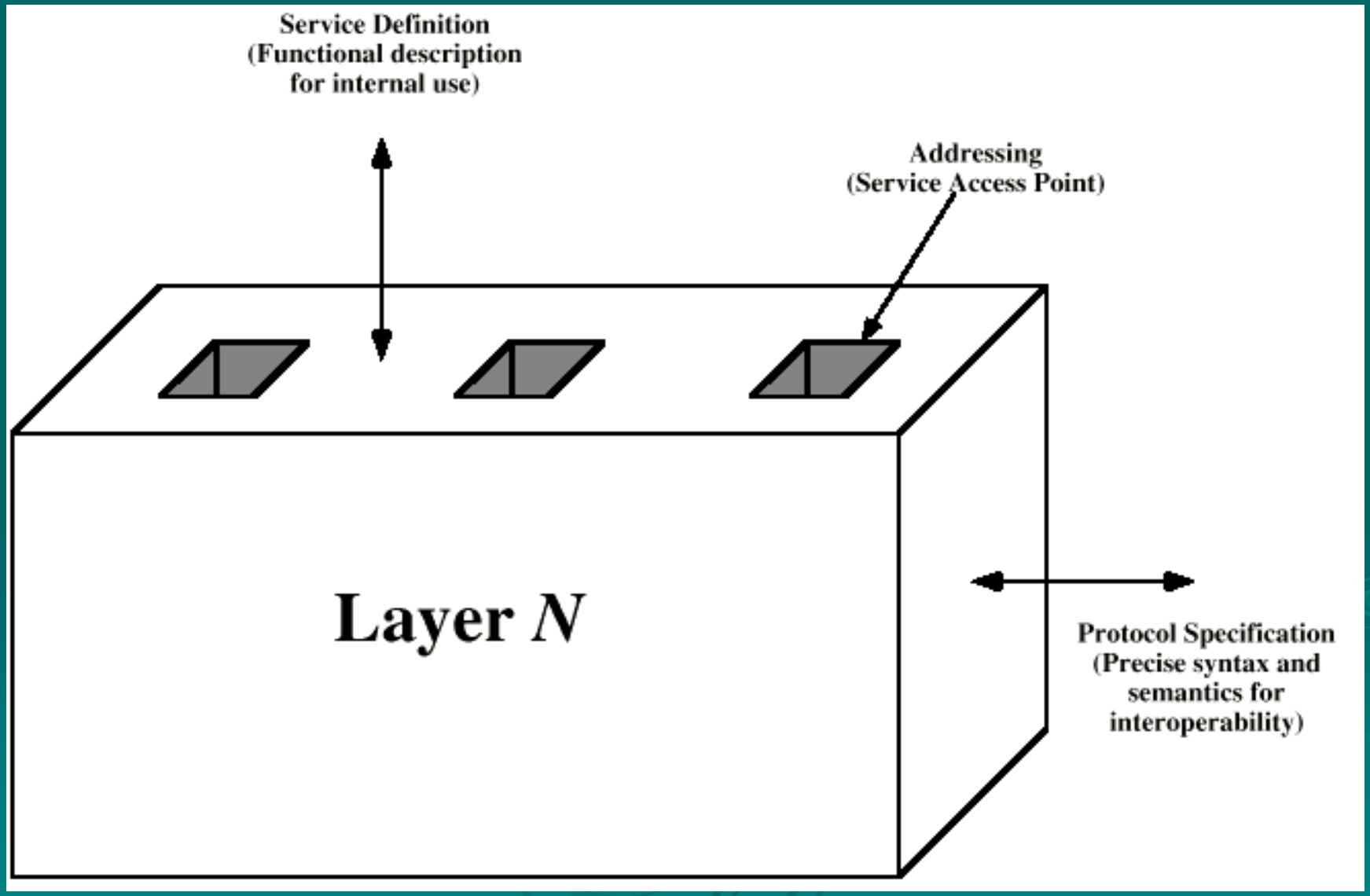
OSI v TCP/IP


OSI
TCP/IP
Application
Presentation
Session
Transport
Network
Data Link
Physical
Application
Transport (host-to-host)
Internet
Network Access
Physical

Standardized Protocol Architectures

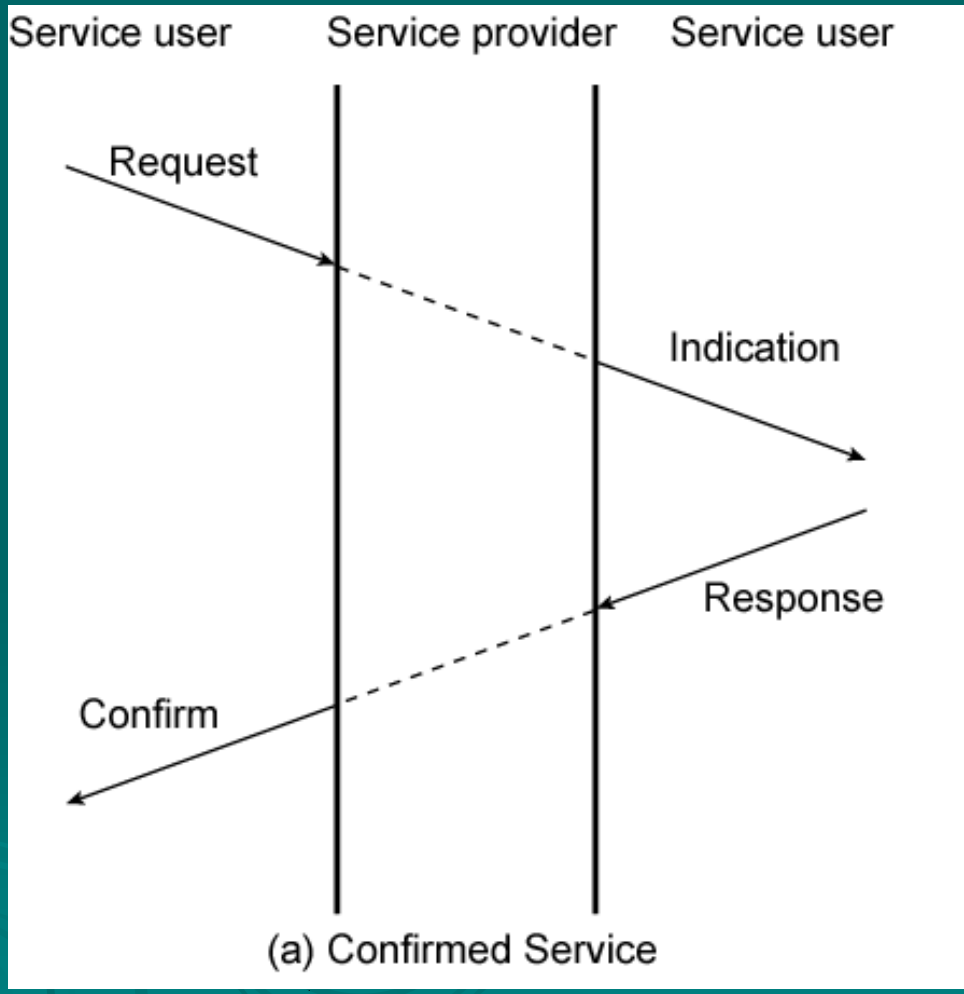


Layer Specific Standards



Service Primitives and Parameters

- define services between adjacent layers using:
- primitives to specify function performed
- parameters to 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

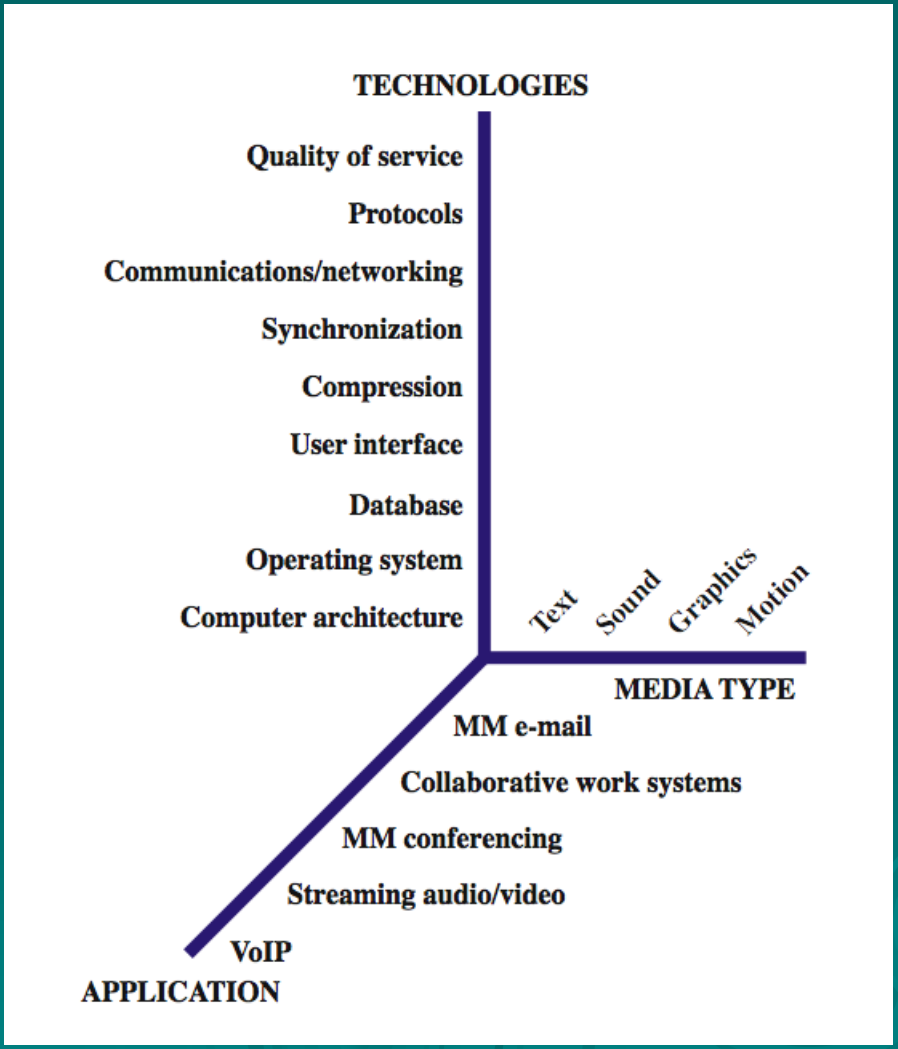
Traditional vs Multimedia Applications

- traditionally Internet dominated by info retrieval applications
  - typically using text and image transfer
  - eg. email, file transfer, web
- see increasing growth in multimedia applications
  - involving massive amounts of data
  - such as streaming audio and video

Elastic and Inelastic Traffic

- elastic traffic
  - can adjust to delay & throughput changes over a wide range
  - eg. traditional "data" style TCP/IP traffic
  - some applications more sensitive though
- inelastic traffic
  - does not adapt to such changes
  - eg. "real-time" voice & video traffic
  - need minimum requirements on net arch

Multimedia Technologies



Summary

- introduced need for protocol architecture
- TCP/IP protocol architecture
- OSI Model & protocol architecture standardization
- traditional vs multimedia application needs