

Data and Computer Communications

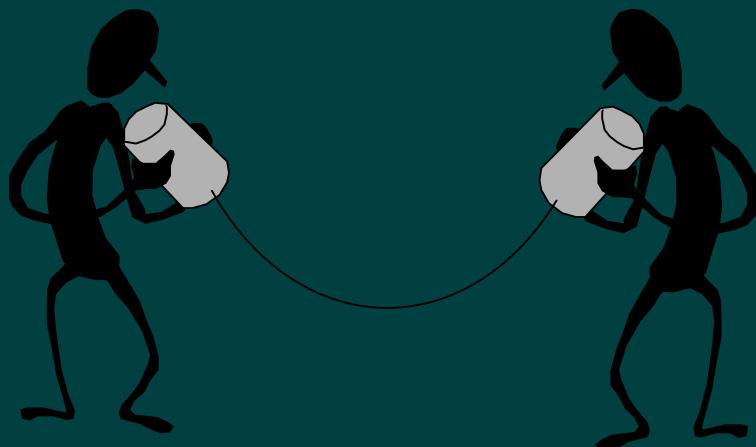
Tenth Edition
by William Stallings

CHAPTER 2

**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



The Need for a Protocol Architecture

1.) The source must either activate the direct communications path or inform the network of the identity of the desired destination system

2.) The source system must ascertain that the destination system is prepared to receive data

To transfer data several tasks must be performed:

3.) The file transfer application on the source system must ascertain that the file management program on the destination system is prepared to accept and store the file for this particular user

4.) A format translation function may need to be performed by one or the other system if the file formats used on the two systems are different

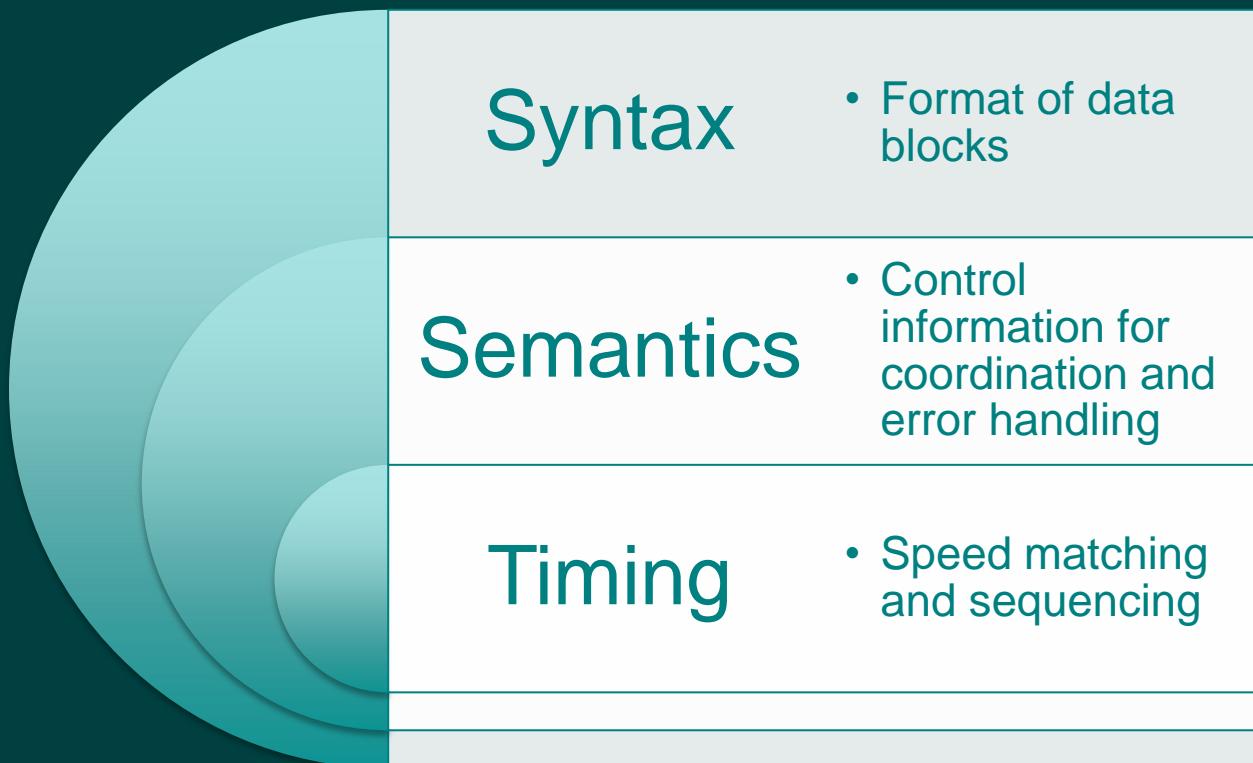
Functions of Protocol Architecture

- Breaks logic into subtask modules which are implemented separately
- Modules are arranged in a vertical stack
 - Each layer in the stack performs a subset of functions
 - Relies on next lower layer for primitive functions
 - Provides services to the next higher layer
 - Changes in one layer should not require changes in other layers

Key Features of a Protocol

A protocol is a set of rules or conventions that allow peer layers to communicate

The key features of a protocol are:



A Simple Protocol Architecture

Agents involved:

- Applications
- Computers
- Networks

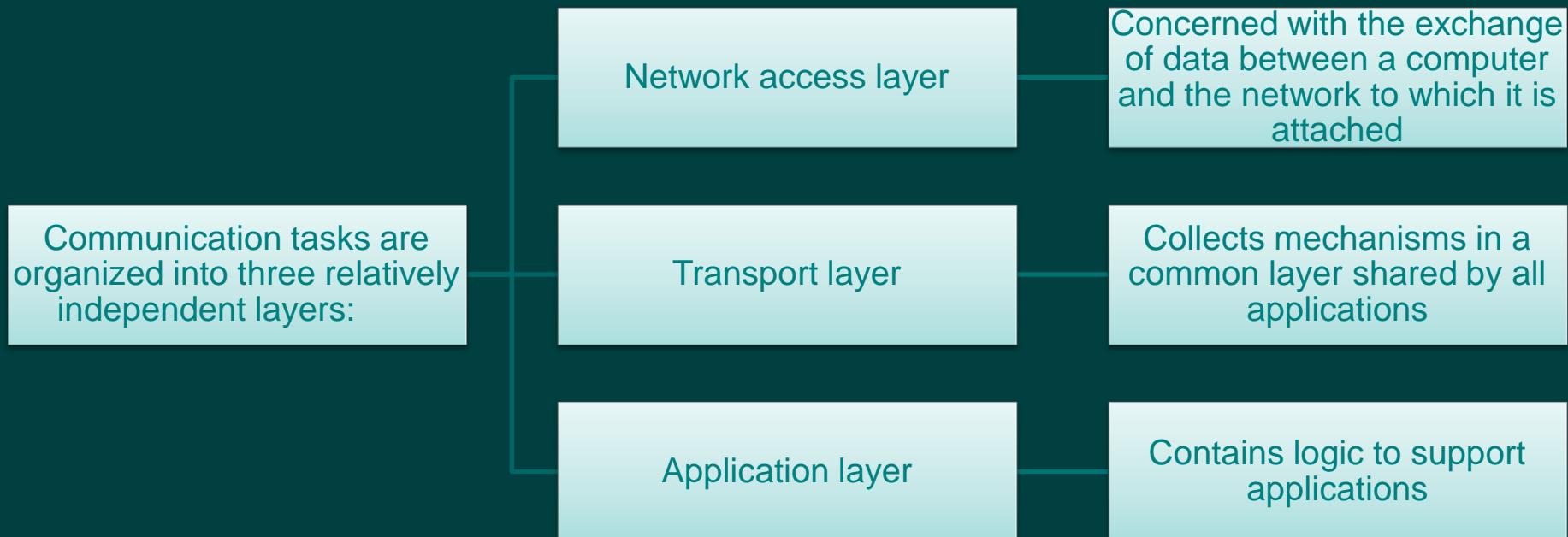


Examples of applications include file transfer and electronic mail

These execute on computers that support multiple simultaneous applications



Communication Layers



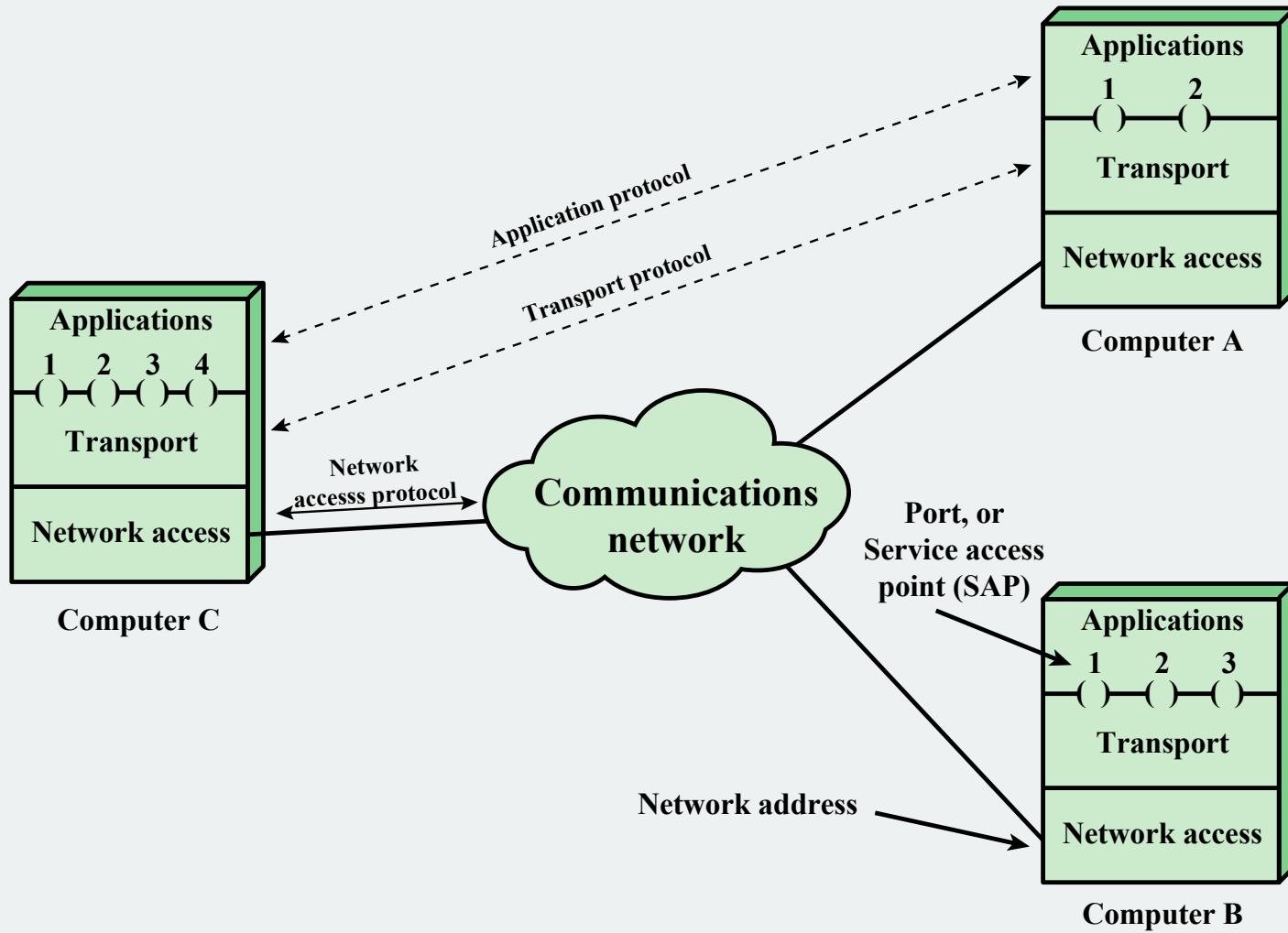
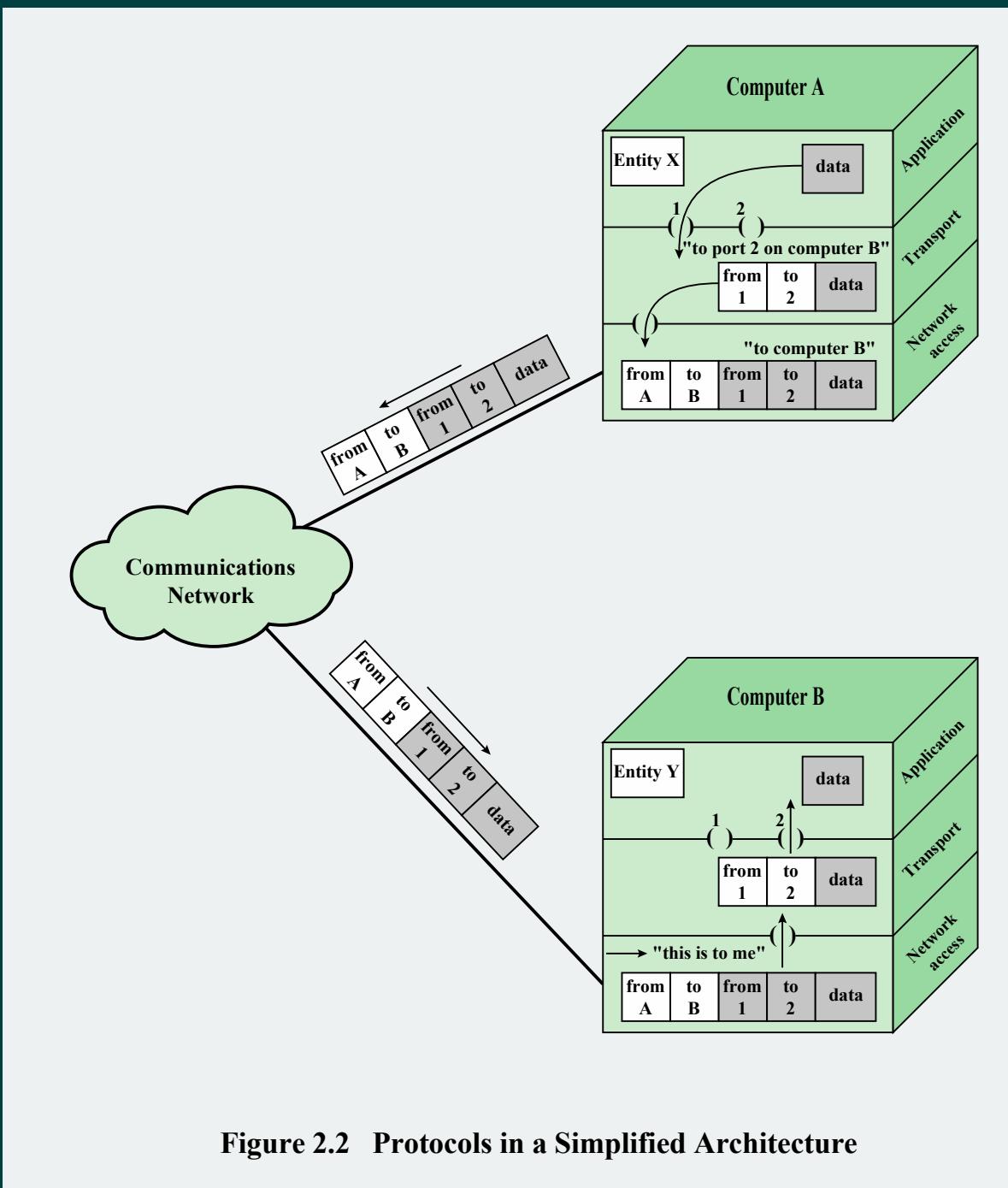


Figure 2.1 Protocol Architectures and Networks



TCP/IP Protocol Architecture

TCP/IP Protocol Architecture

- Result of protocol research and development conducted on ARPANET
- Referred to as TCP/IP protocol suite
- TCP/IP comprises a large collection of protocols that are Internet standards

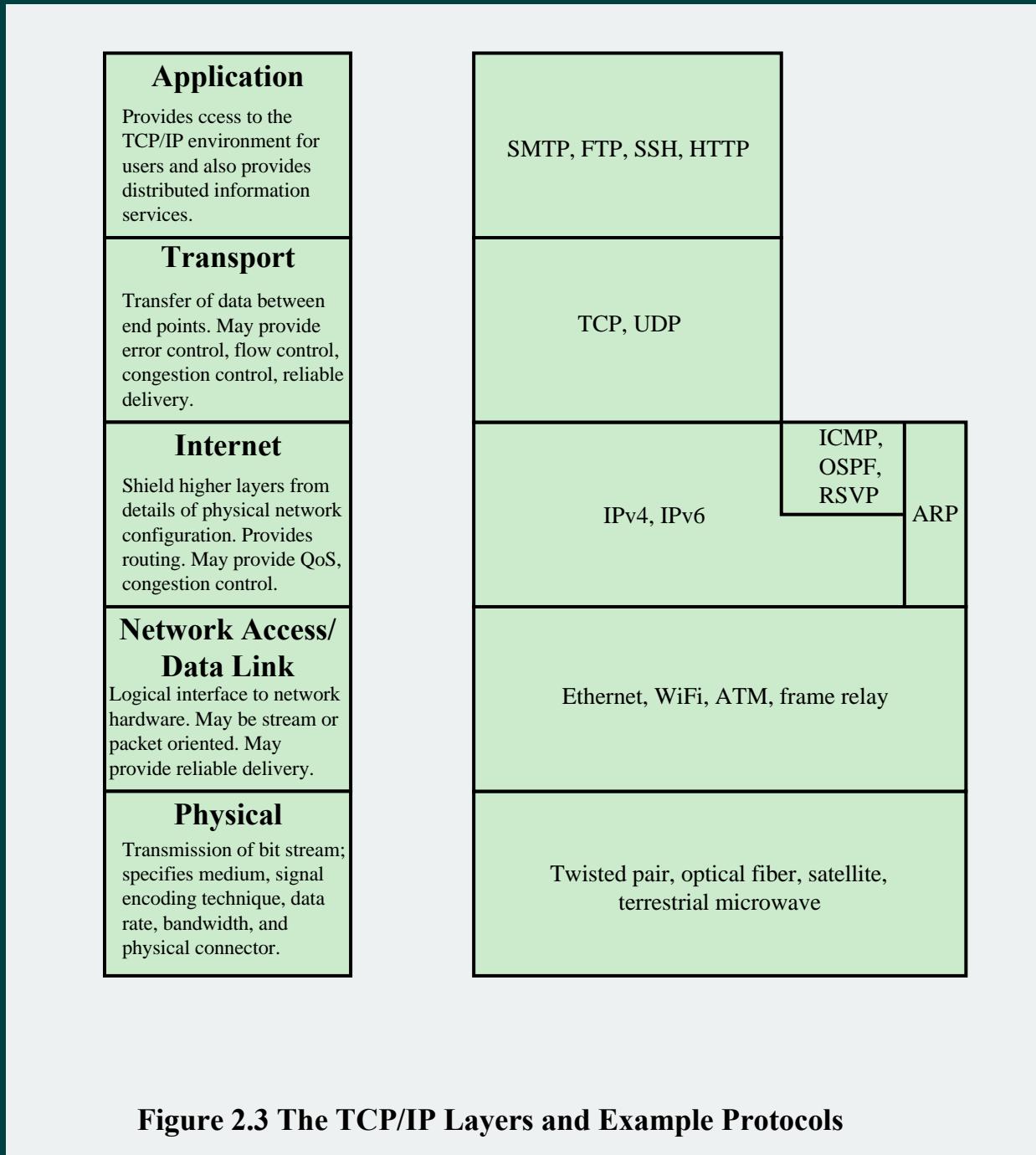


Figure 2.3 The TCP/IP Layers and Example Protocols

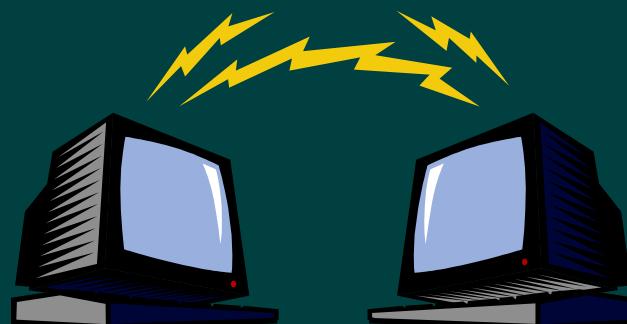
Physical Layer

- Covers the physical interface between computer and network
- Concerned with issues like:
 - Characteristics of transmission medium
 - Nature of the signals
 - Data rates

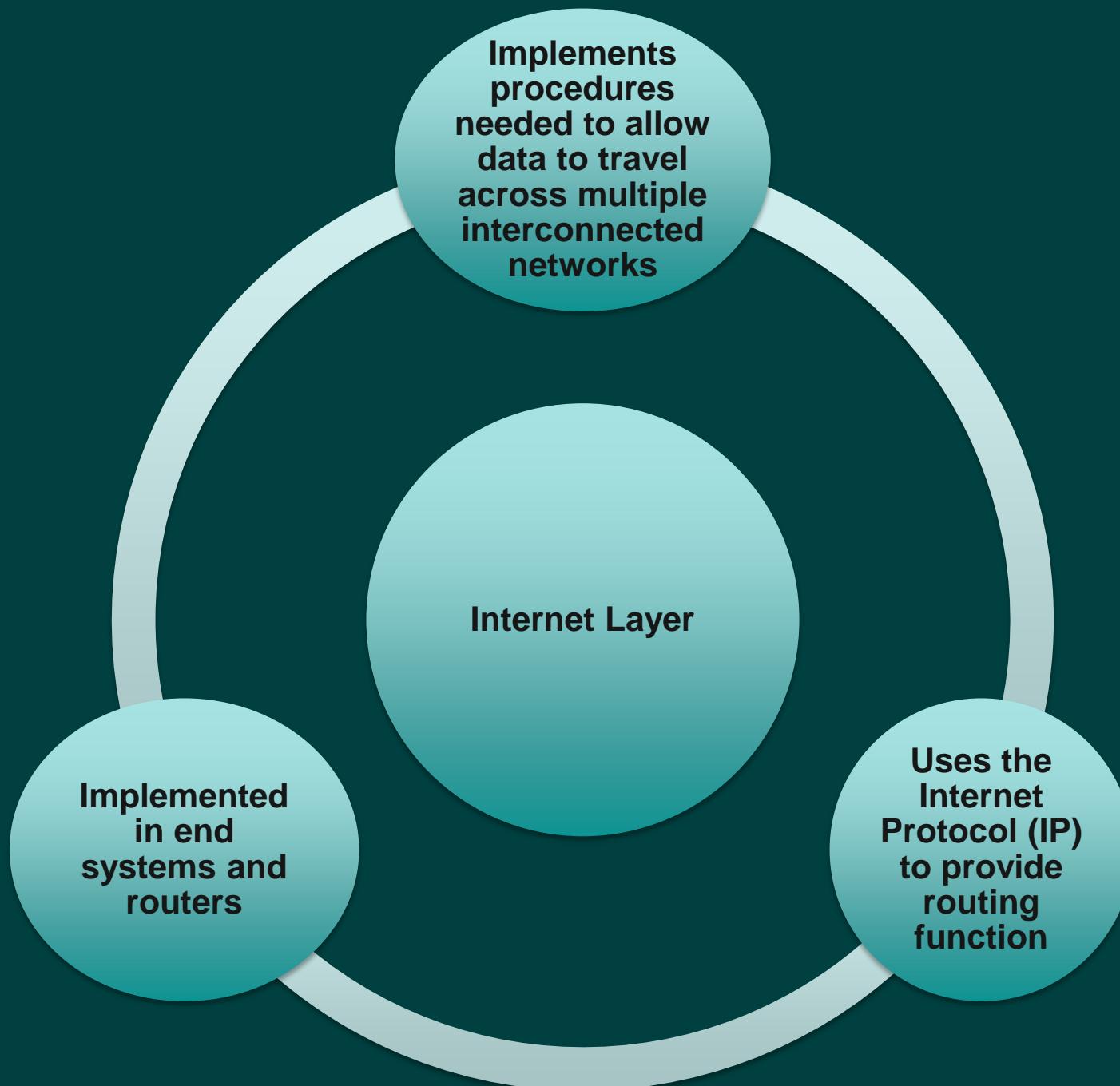


Network Access/Data Link Layer

- Covers the exchange of data between an end system and the network that it is attached to
- Concerned with:
 - Access to and routing data across a network for two end systems attached to the same network



Internet Layer



Host-to-Host (Transport) Layer

- May provide reliable end-to-end service or merely an end-to-end delivery service without reliability mechanisms

Transmission
Control Protocol

TCP

- Most commonly used protocol to provide this functionality



Application Layer

- Contains the logic needed to support the various user applications
- A separate module is needed for each different type of application that is peculiar to that application



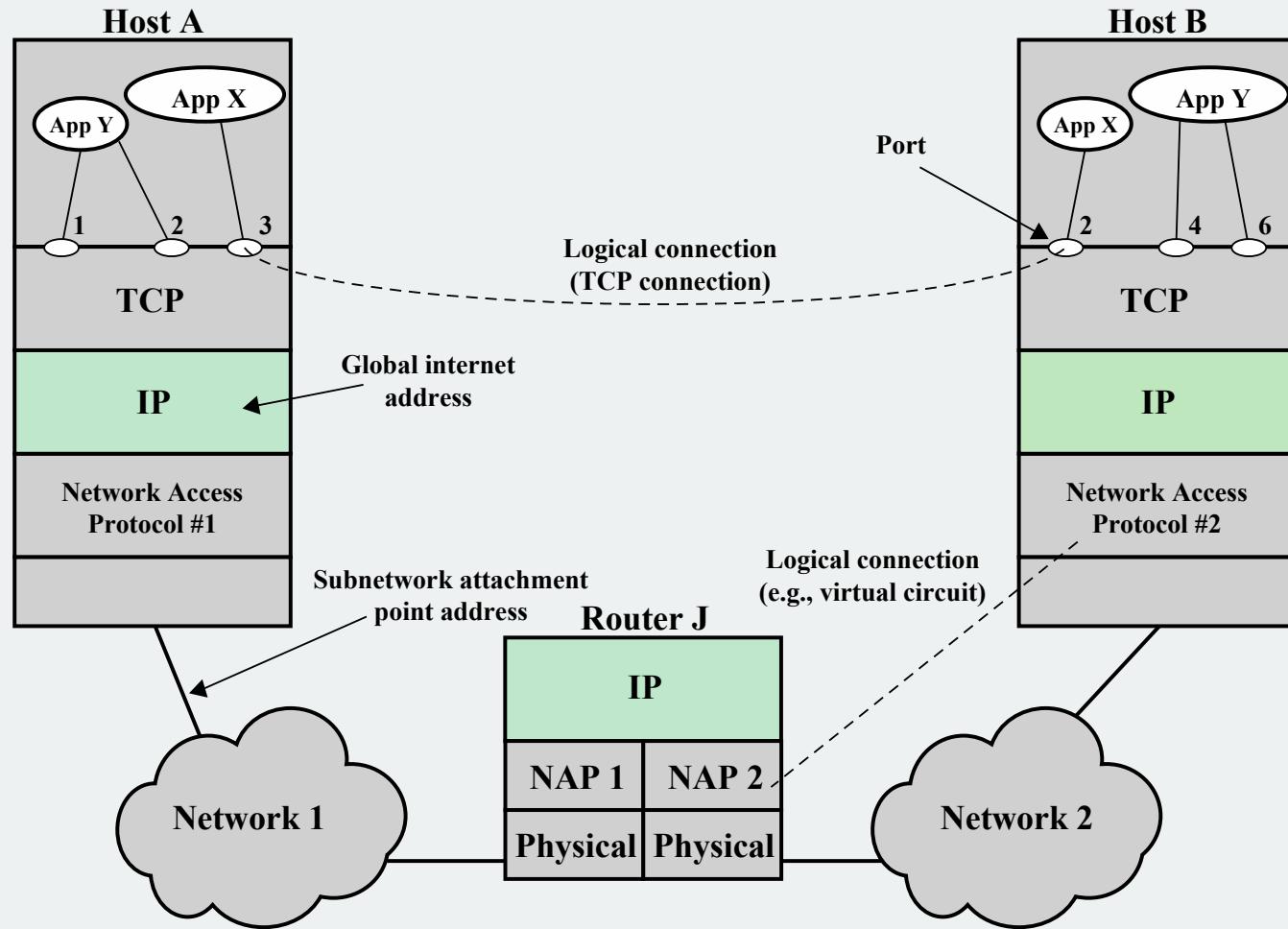


Figure 2.4 TCP/IP Concepts

TCP/IP Address Requirements

Two levels of addressing are needed:

Each host on a subnetwork must have a unique global internet address

Each process with a host must have an address (known as a port) that is unique within the host

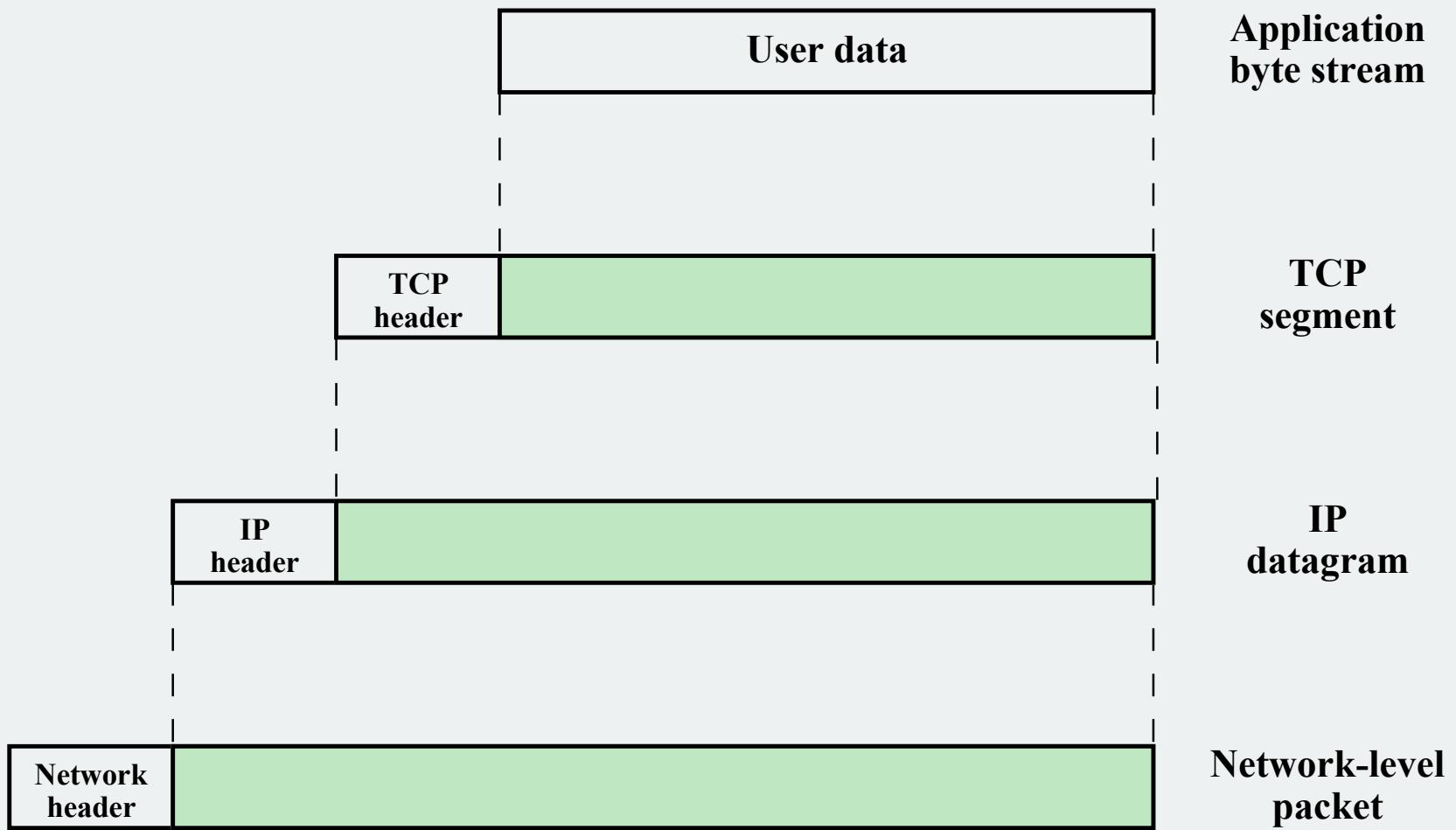
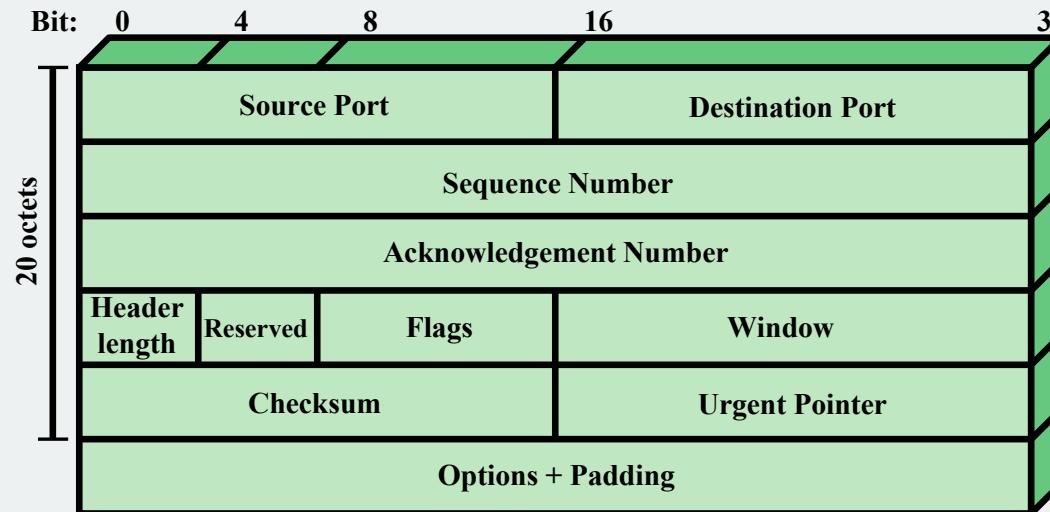


Figure 2.5 Protocol Data Units (PDUs) in the TCP/IP Architecture

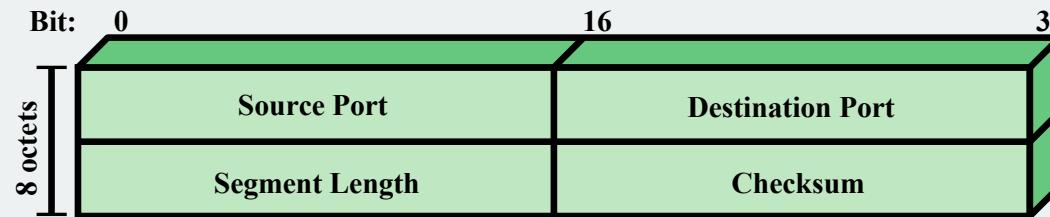
Transmission Control Protocol (TCP)

- TCP is the transport layer protocol for most applications
- 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





(a) TCP Header

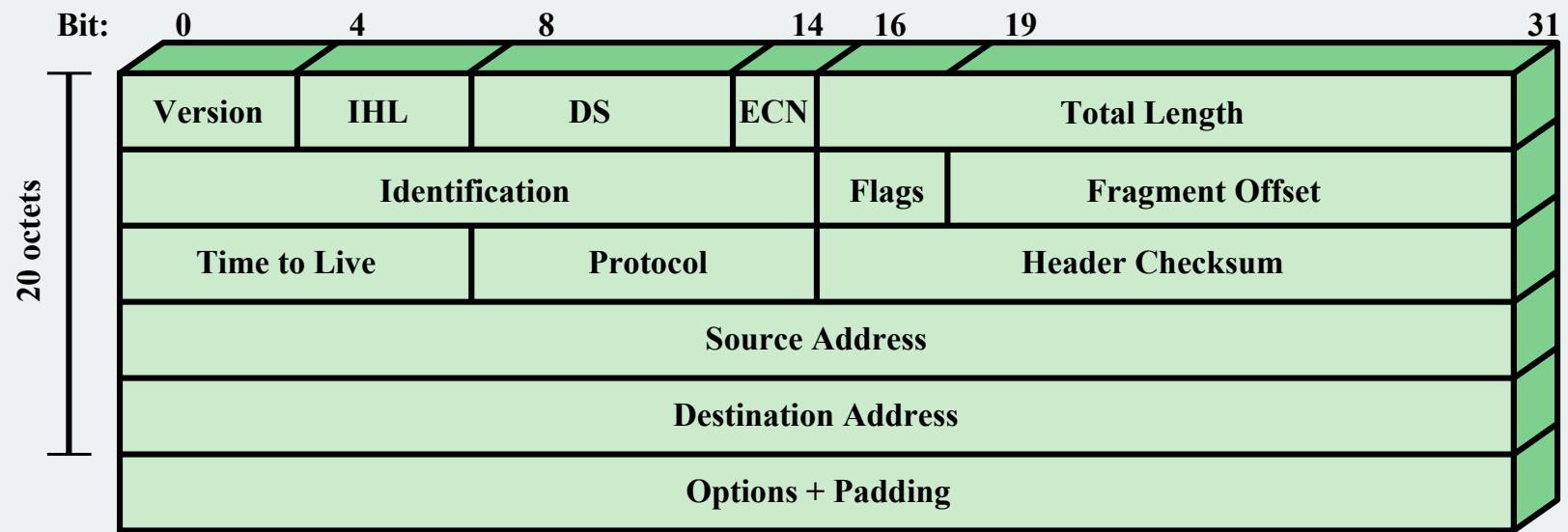


(b) UDP Header

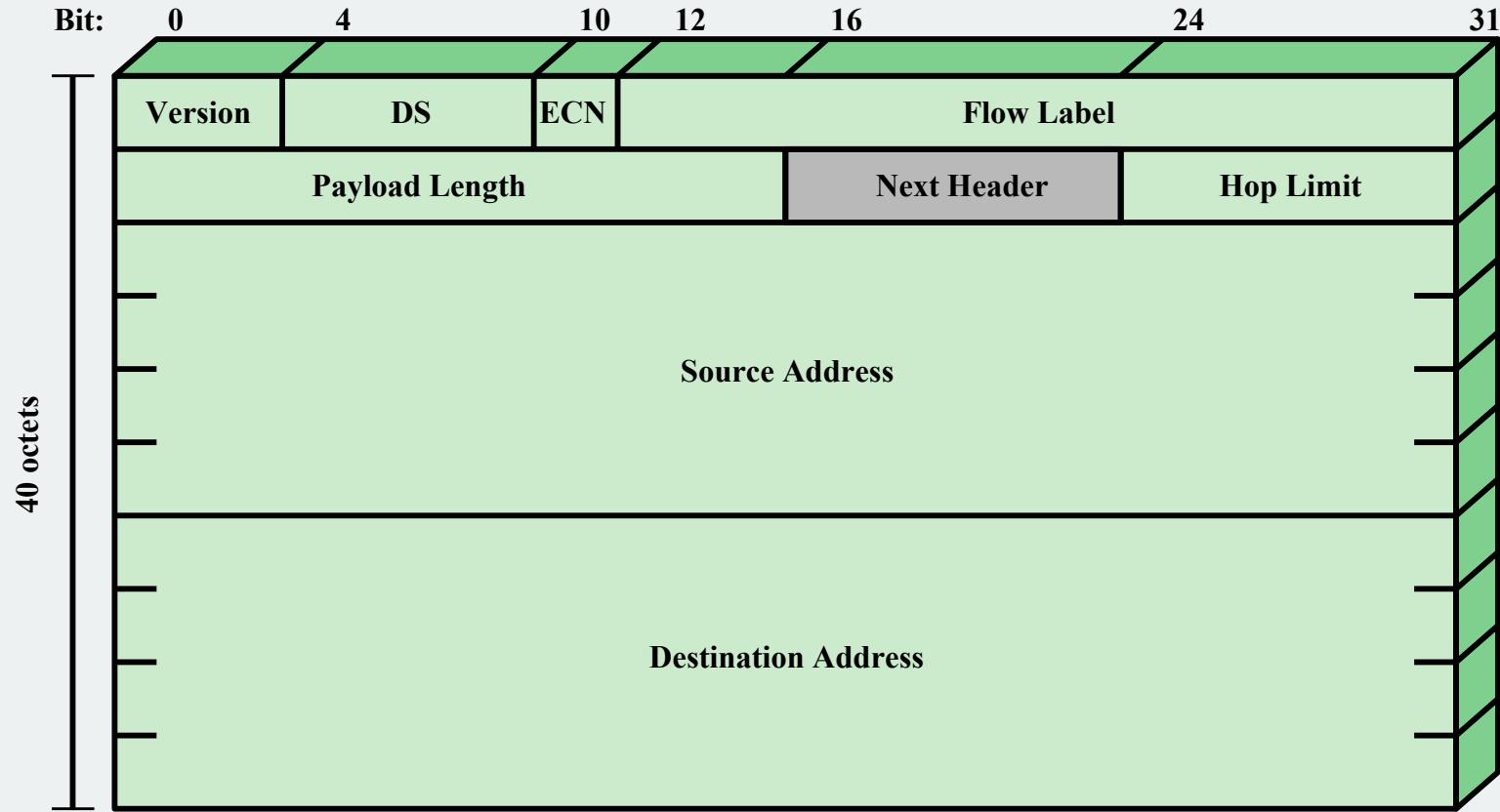
Figure 2.6 TCP and UDP Headers

User Datagram Protocol (UDP)

- Alternative to TCP
- Does not guarantee delivery, preservation of sequence, or protection against duplication
- Enables a procedure to send messages to other procedures with a minimum of protocol mechanism
- Adds port addressing capability to IP
- Used with Simple Network Management Protocol (SNMP)
- Includes a checksum to verify that no error occurs in the data



(a) IPv4 Header



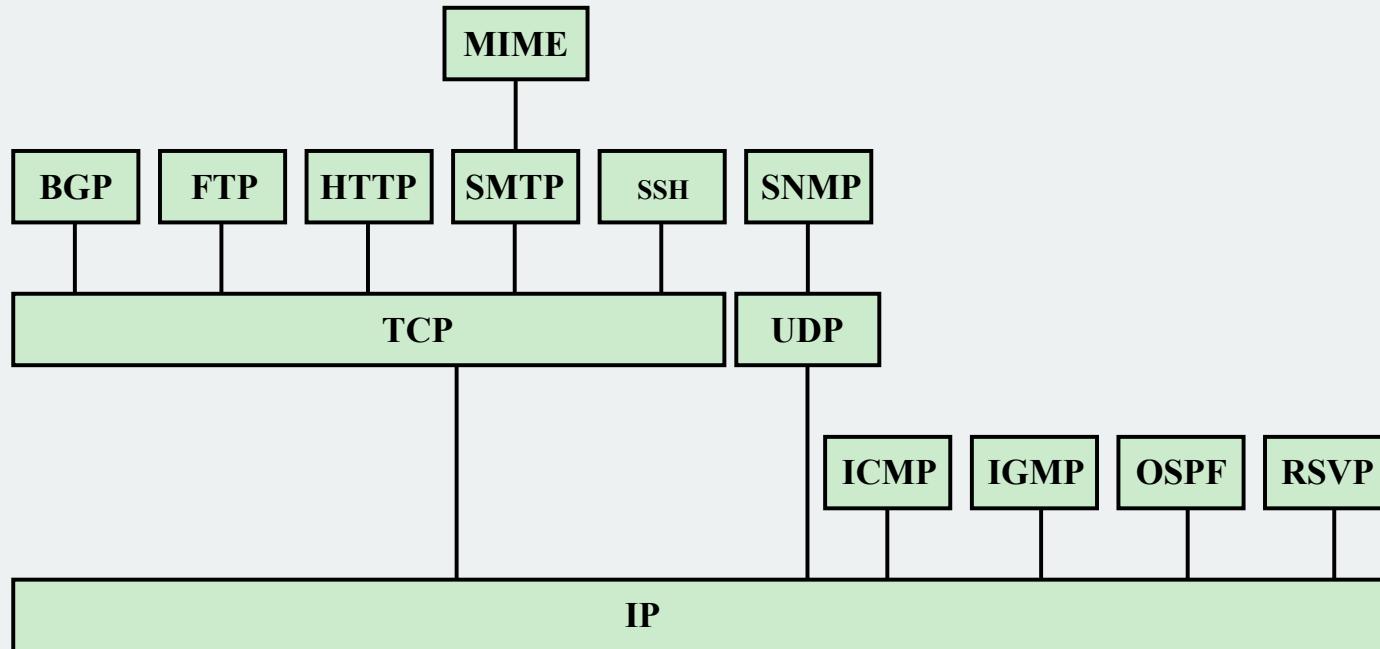
(b) IPv6 Header

DS = Differentiated services field

ECN = Explicit congestion notification field

Note: The 8-bit DS/ECN fields were formerly known as the Type of Service field in the IPv4 header and the Traffic Class field in the IPv6 header.

Figure 2.7 IP Headers



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 = Multipurpose Internet Mail Extension

OSPF = Open Shortest Path First
RSVP = Resource ReSerVation Protocol
SMTP = Simple Mail Transfer Protocol
SNMP = Simple Network Management Protocol
SSH = Secure Shell
TCP = Transmission Control Protocol
UDP = User Datagram Protocol

Figure 2.8 Some Protocols in the TCP/IP Protocol Suite

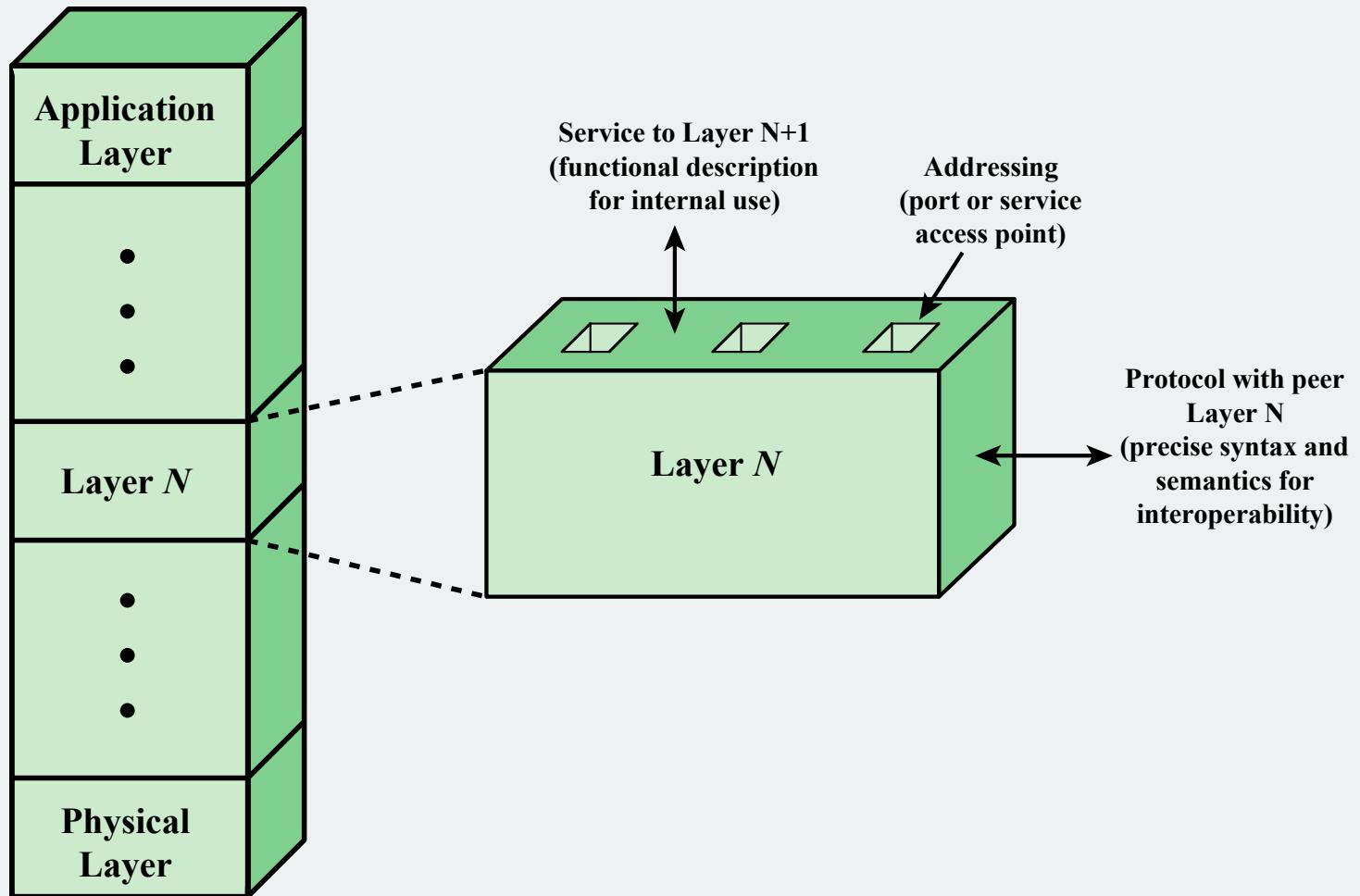


Figure 2.9 A Protocol Architecture as a Framework for Standardization

Traditional Internet-Based Applications

- Three common applications that have been standardized to operate on top of TCP are:

Simple Mail Transfer Protocol (SMTP)

- Provides a mechanism for transferring messages among separate hosts

File Transfer Protocol (FTP)

- Used to send files from one system to another under user command
- Both text and binary files are accommodated

Secure Shell (SSH)

- Provides a secure remote logon capability

Table 2.2

Multimedia Terminology

Media

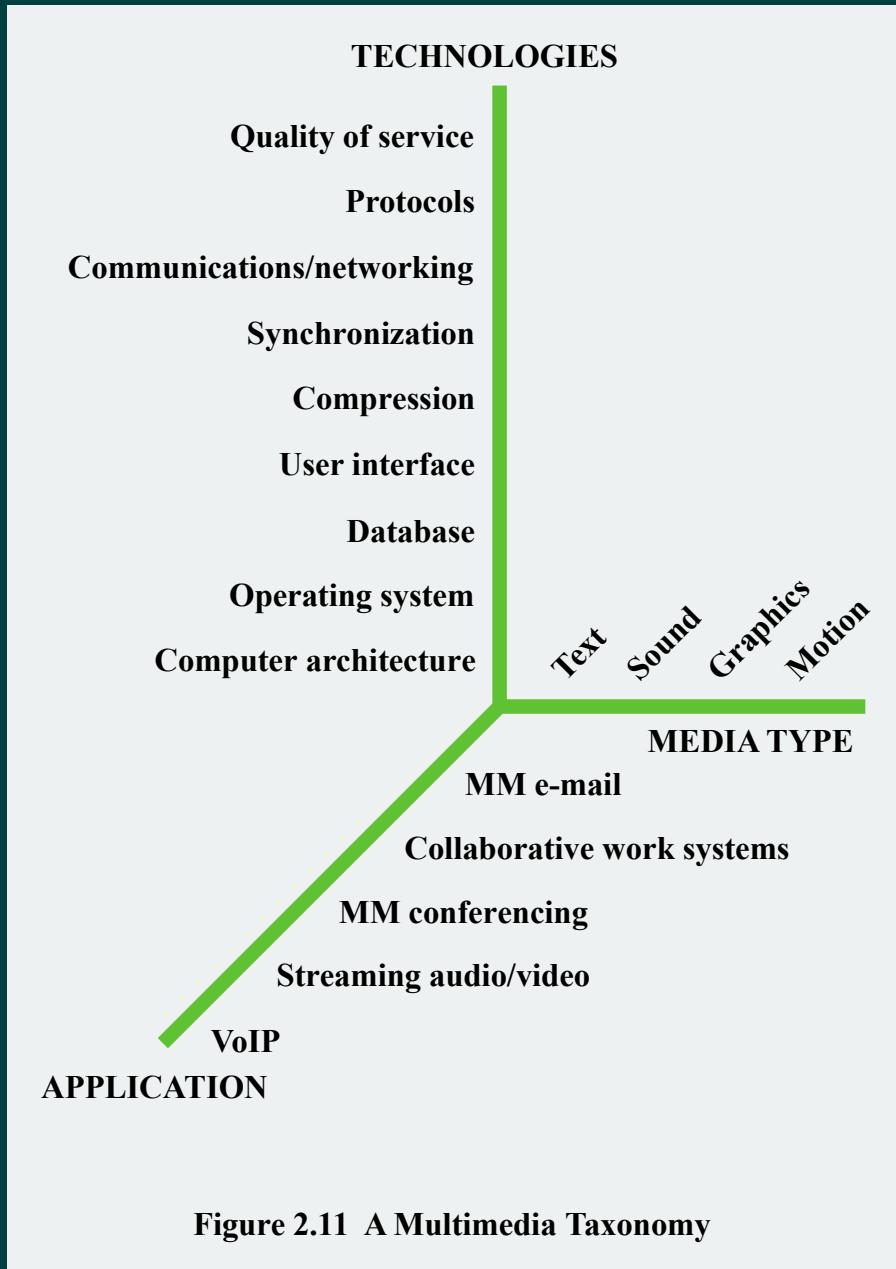
Refers to the form of information and includes text, still images, audio, and video.

Multimedia

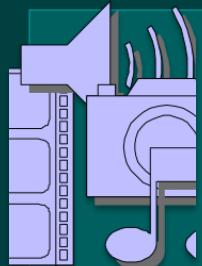
Human-computer interaction involving text, graphics, voice and video. Multimedia also refers to storage devices that are used to store multimedia content.

Streaming media

Refers to multimedia files, such as video clips and audio, that begin playing immediately or within seconds after it is received by a computer from the Internet or Web. Thus, the media content is consumed as it is delivered from the server rather than waiting until an entire file is downloaded.



Media Types



audio generally encompasses sounds that are produced by the human speech mechanism



image supports the communication of individual pictures, charts, or drawings



video service carries sequences of pictures in time



text is information that can be entered via a keyboard and is directly readable and printable

Table 2.3

Domains of Multimedia Systems and Example Applications

Domain	Example Application
Information management	Hypermedia, multimedia-capable databases, content-based retrieval
Entertainment	Computer games, digital video, audio (MP3)
Telecommunication	Videoconferencing, shared workspaces, virtual communities
Information publishing/delivery	Online training, electronic books, streaming media

Multimedia Applications

Information systems

- Information kiosks, electronic books that include audio and video, and multimedia expert systems

Communication systems

- Support collaborative work, such as videoconferencing

Entertainment systems

- Computer and network games and other forms of audiovisual entertainment

Business systems

- Business-oriented multimedia presentations, video brochures, and online shopping

Educational systems

- Electronic books with a multimedia component, simulation and modeling applets, and other teaching support systems

Multimedia Technologies

- Some technologies that are relevant to the support of multimedia applications are:

Compression

JPG for still images

MPG for video

Communications/networking

Refers to the transmission and networking technologies that can support high-volume multimedia traffic

Protocols

RTP

SIP

Quality of service (QoS)

Can deal with priority, delay constraints, delay variability constraints, and other similar requirements



Summary

- The need for a protocol architecture
- Simple protocol architecture
- TCP/IP protocol architecture
 - TCP/IP layers
 - Operation of TCP and IP
 - TCP and UDP
 - IP and IPv6
 - Protocol interfaces
- Standardization within a protocol architecture
 - Standards and protocol layers
- Traditional internet-based applications
- Multimedia
 - Media types
 - Multimedia applications
 - Multimedia technologies