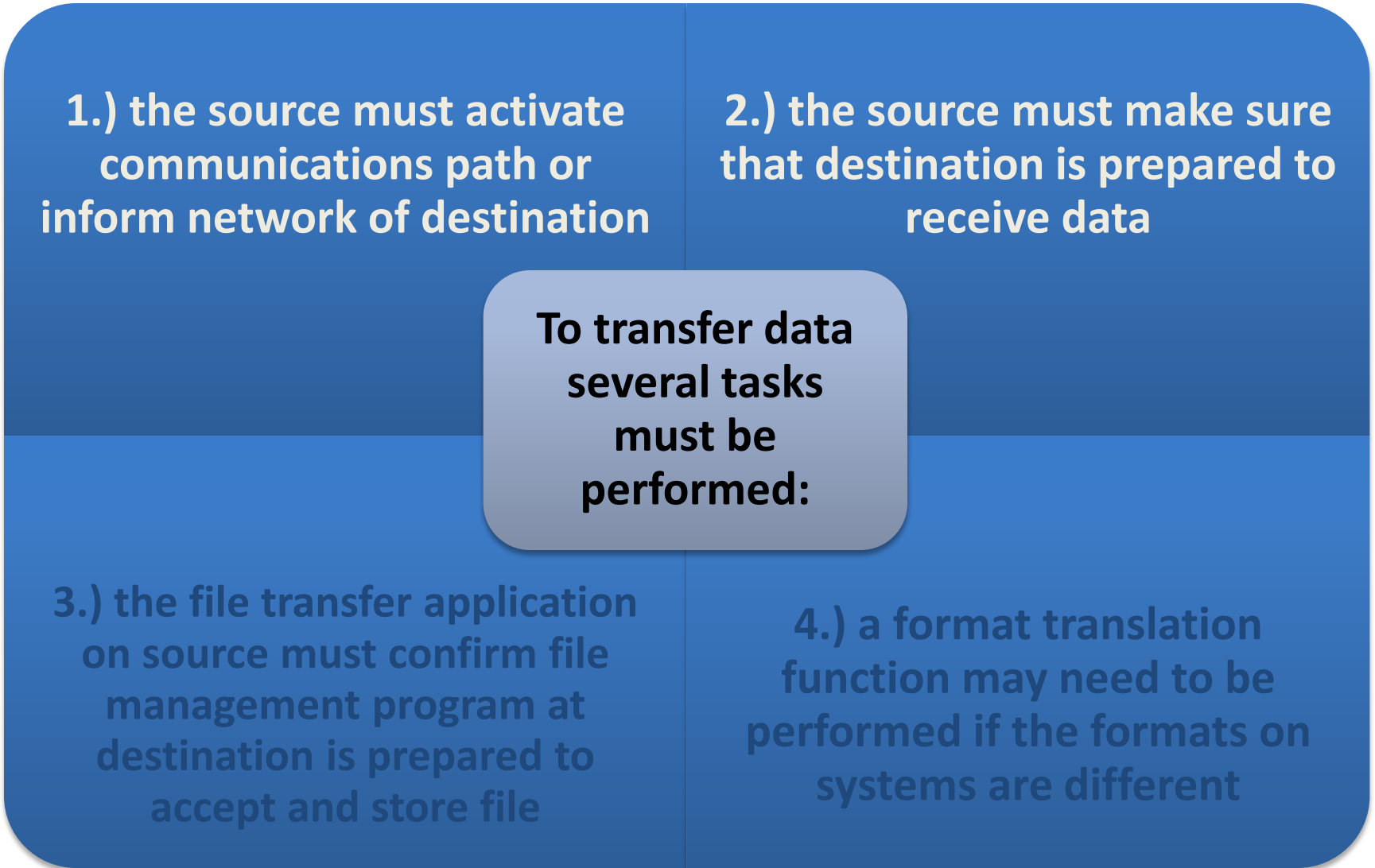
# Protocol Architecture, TCP/IP, and Internet-Based Applications

# The Need For Protocol Architecture



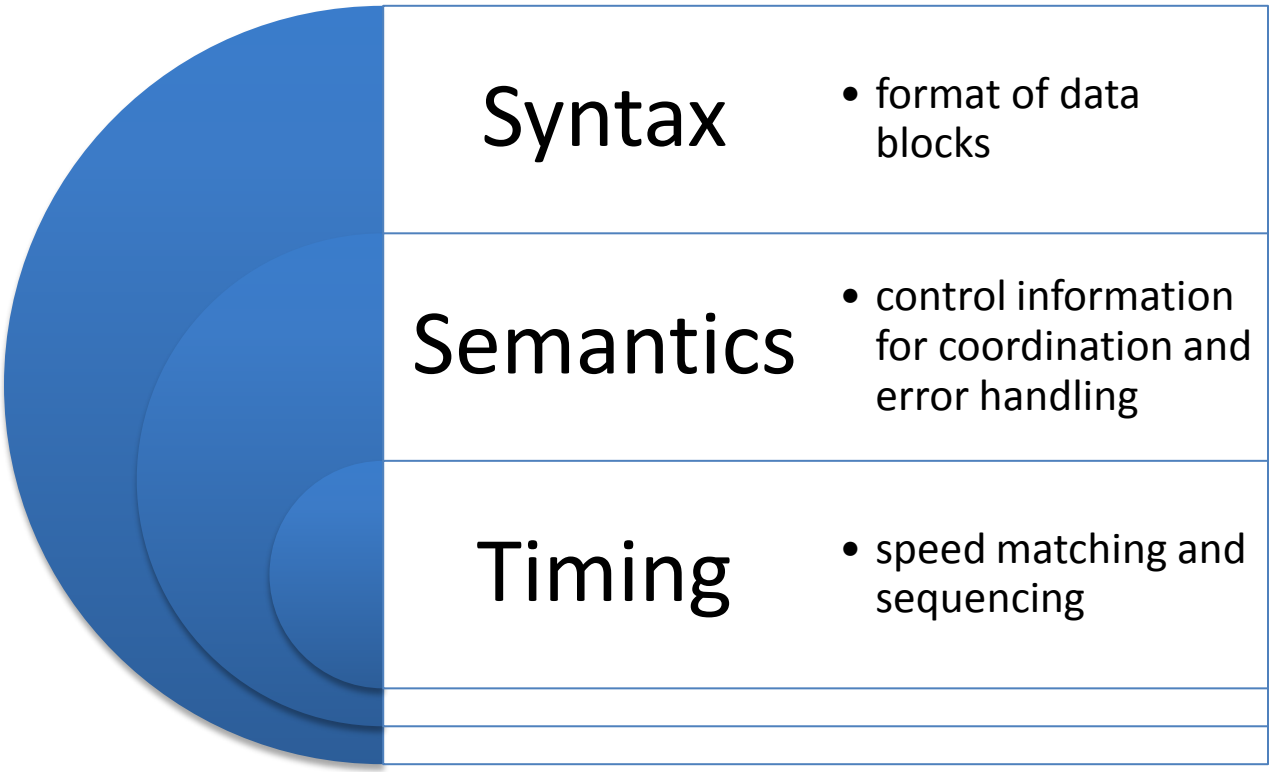
# Functions of Protocol Architecture

- 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
  - 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

agents involved:

- applications
- computers
- networks

examples of applications include file transfer and electronic mail

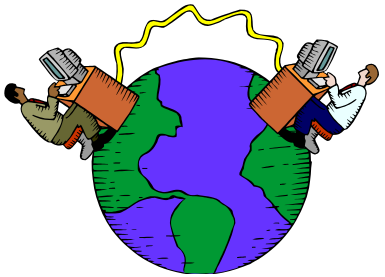
these execute on computers that support multiple simultaneous applications

# Communication Layers

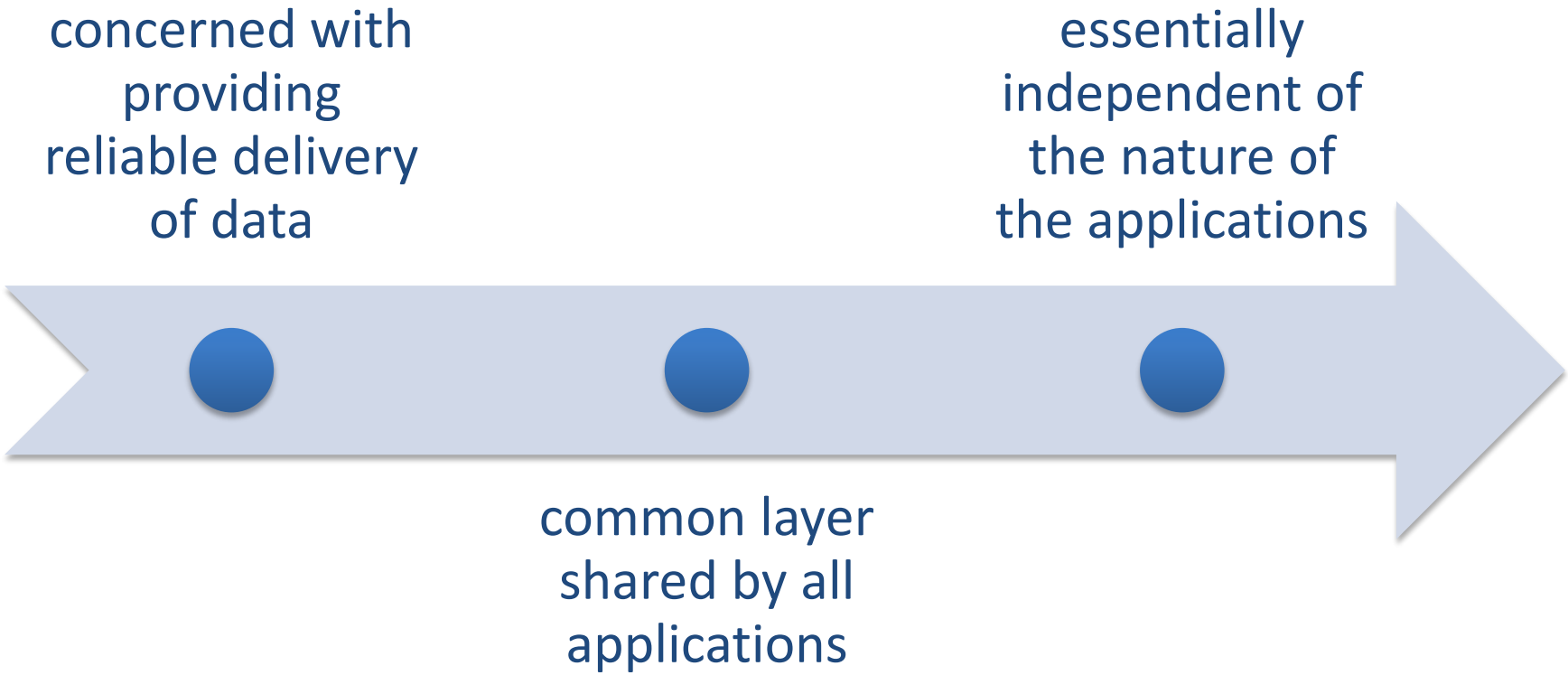
- communication tasks are organized into three relatively independent layers:
  - Network access layer
    - concerned with the exchange of data
  - Transport layer
    - provides reliable data transfer
  - Application layer
    - Contains logic to support applications

# Network Access Layer

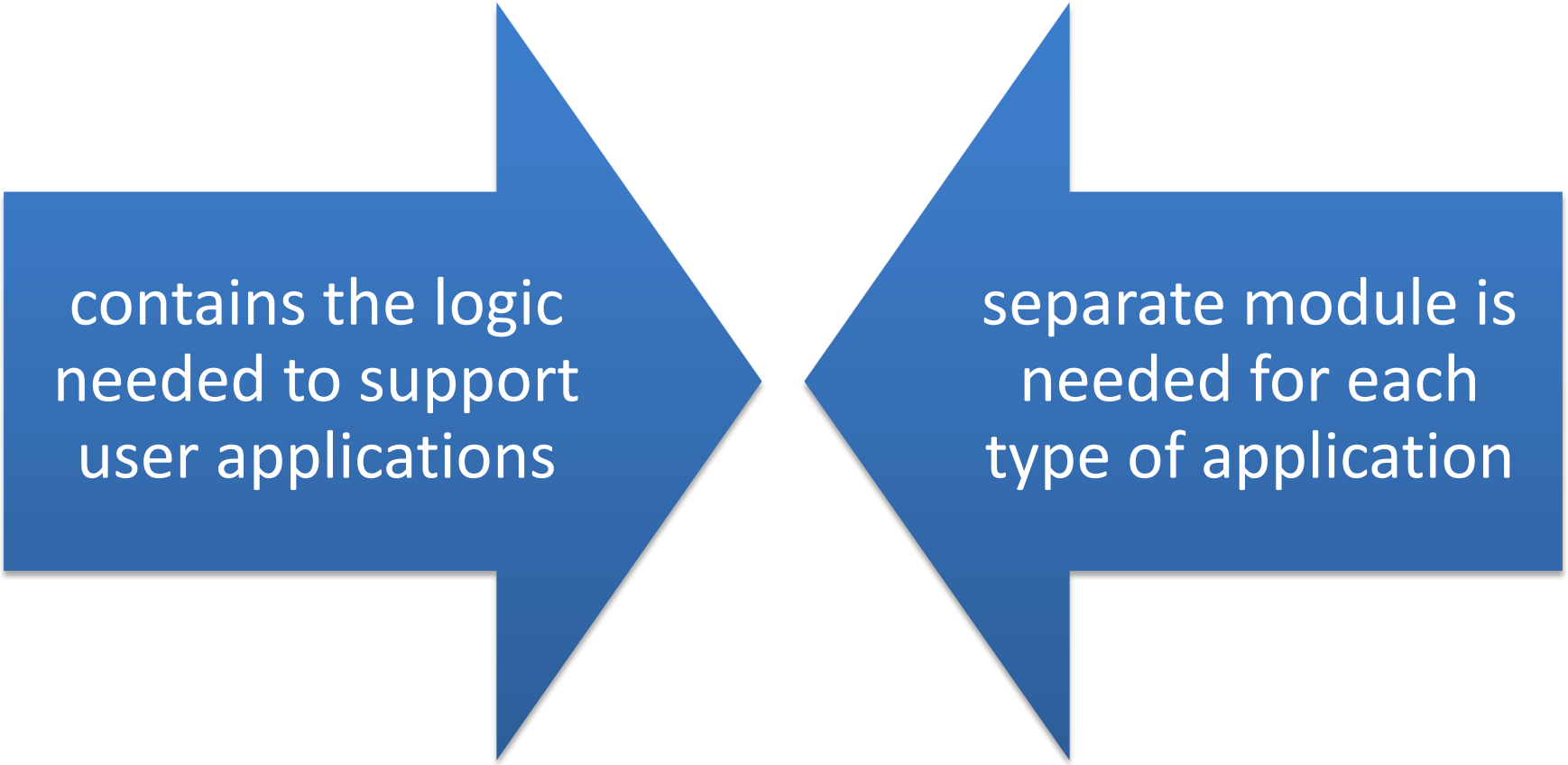
- covers the exchange of data between an end system and the network that it is attached to
- concerned with issues like :
  - destination address provision
  - invoking specific services like priority
  - access to & routing data across a network for two end systems attached to the same network



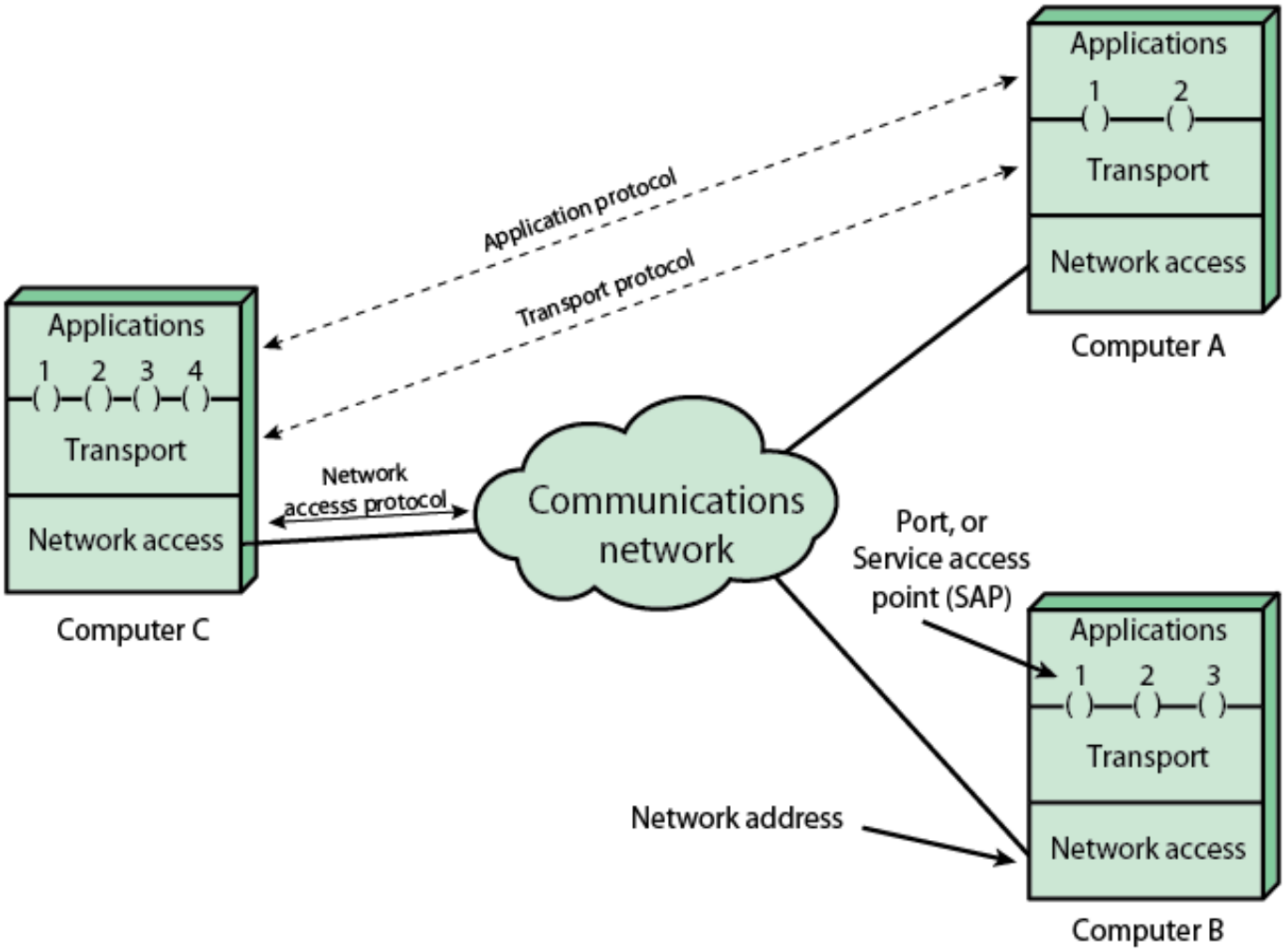
# Transport Layer



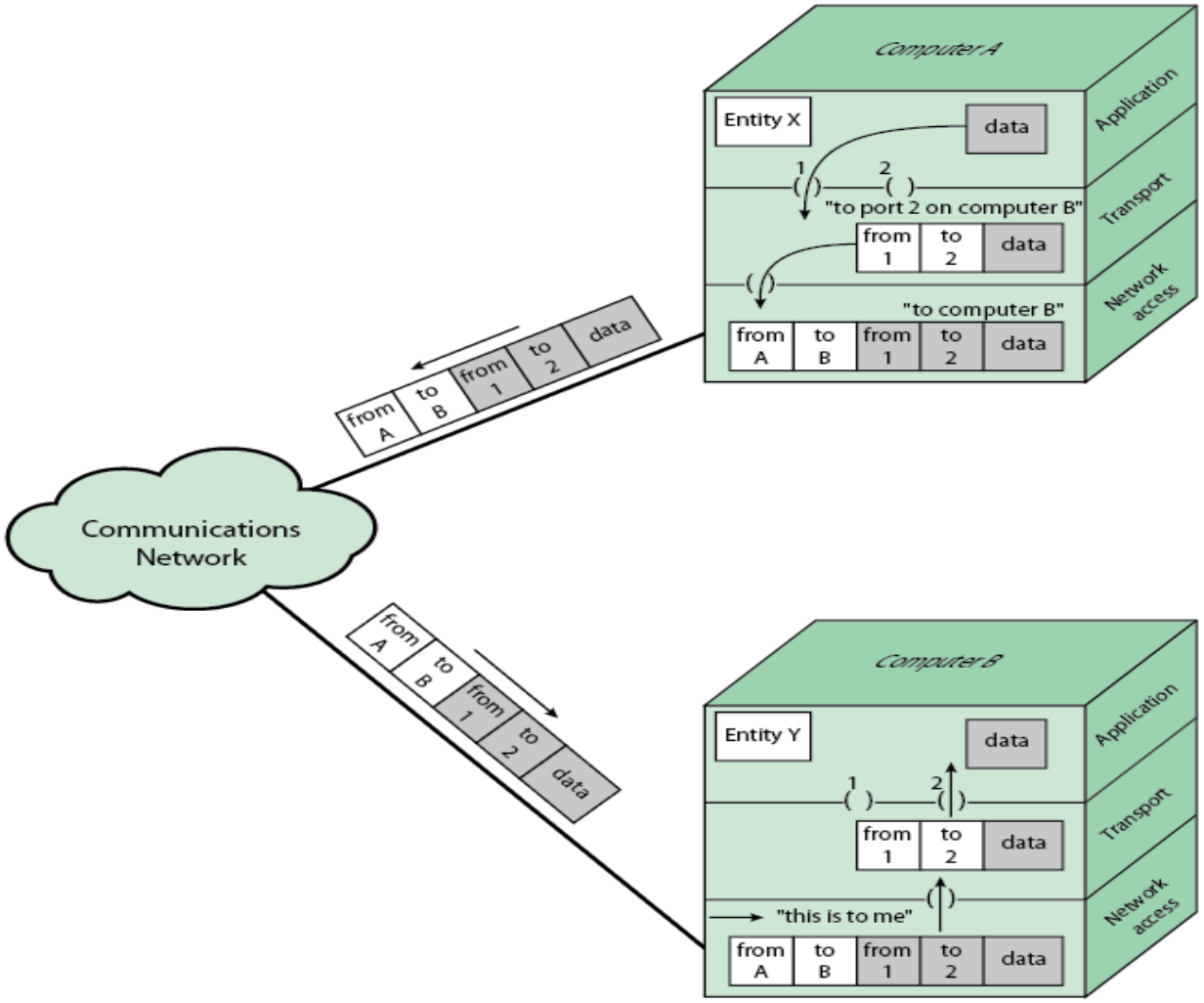
# Application Layer



# Protocol Architecture and Networks

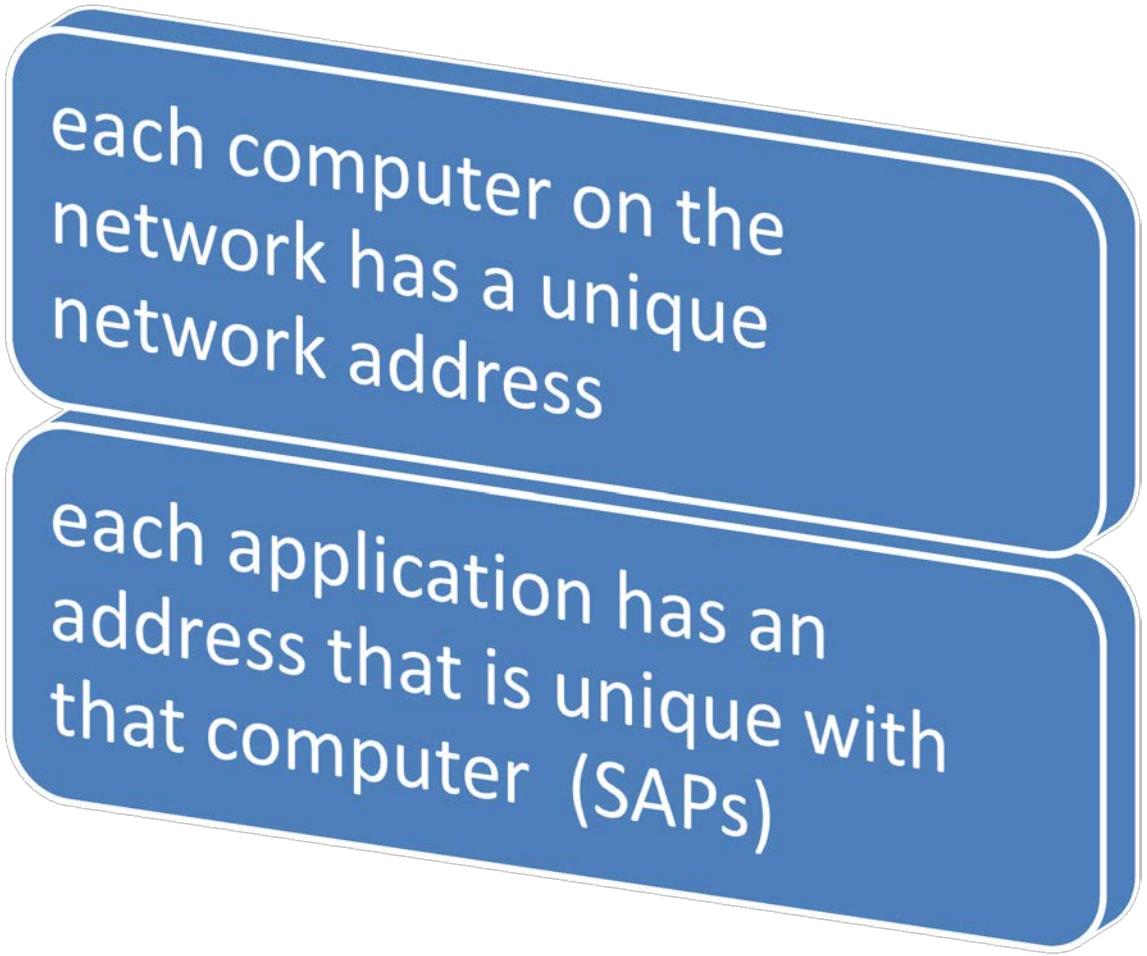


# Protocols in a Simplified Architecture



# Addressing

Two levels of addressing are needed:



# Protocol Data Unit (PDU)

- the combination of data and control information is a protocol data unit (PDU)
- typically control information is contained in a PDU header
  - control information is used by the peer transport protocol at computer B
- headers may include:
  - source port, destination port, sequence number, and error-detection code

# Network Access Protocol

- after receiving segment from transport layer, the network access protocol must request transmission over the network
  - the network access protocol creates a network access PDU (packet) with control information
- header includes:
  - source computer address
  - destination computer address
  - facilities requests

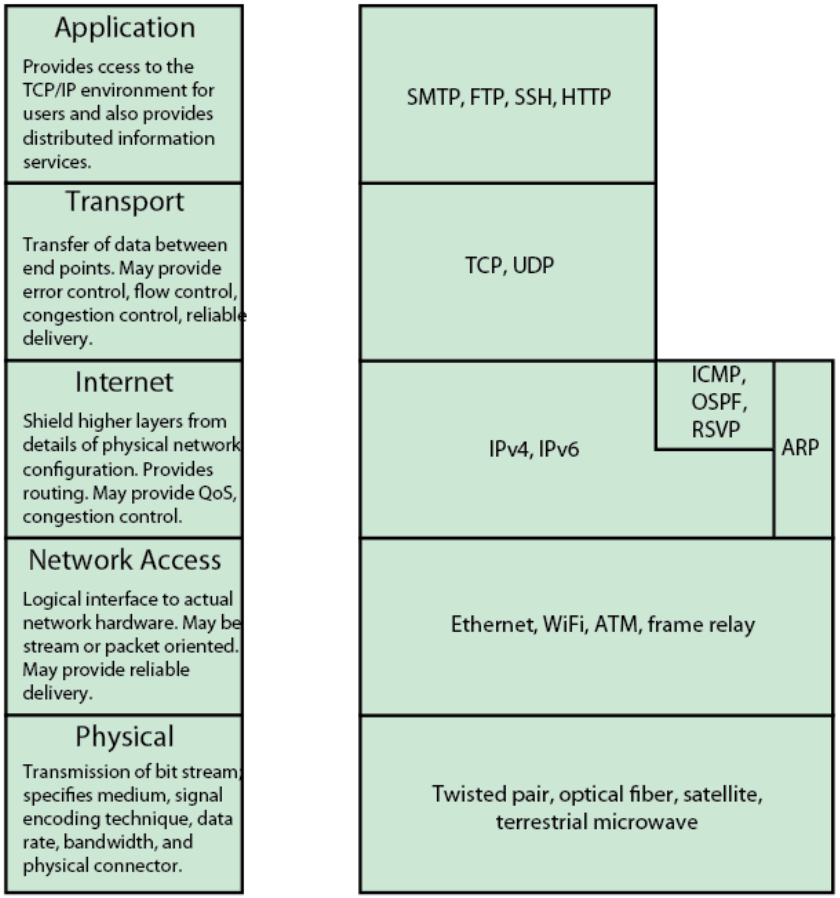
# TCP/IP Protocol Architecture

Result of protocol research and development conducted on ARPANET

Referred to as TCP/IP protocol suite

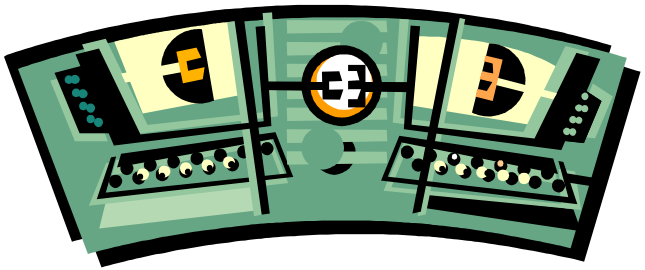
TCP/IP comprises a large collection of protocols that are Internet standards

# 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



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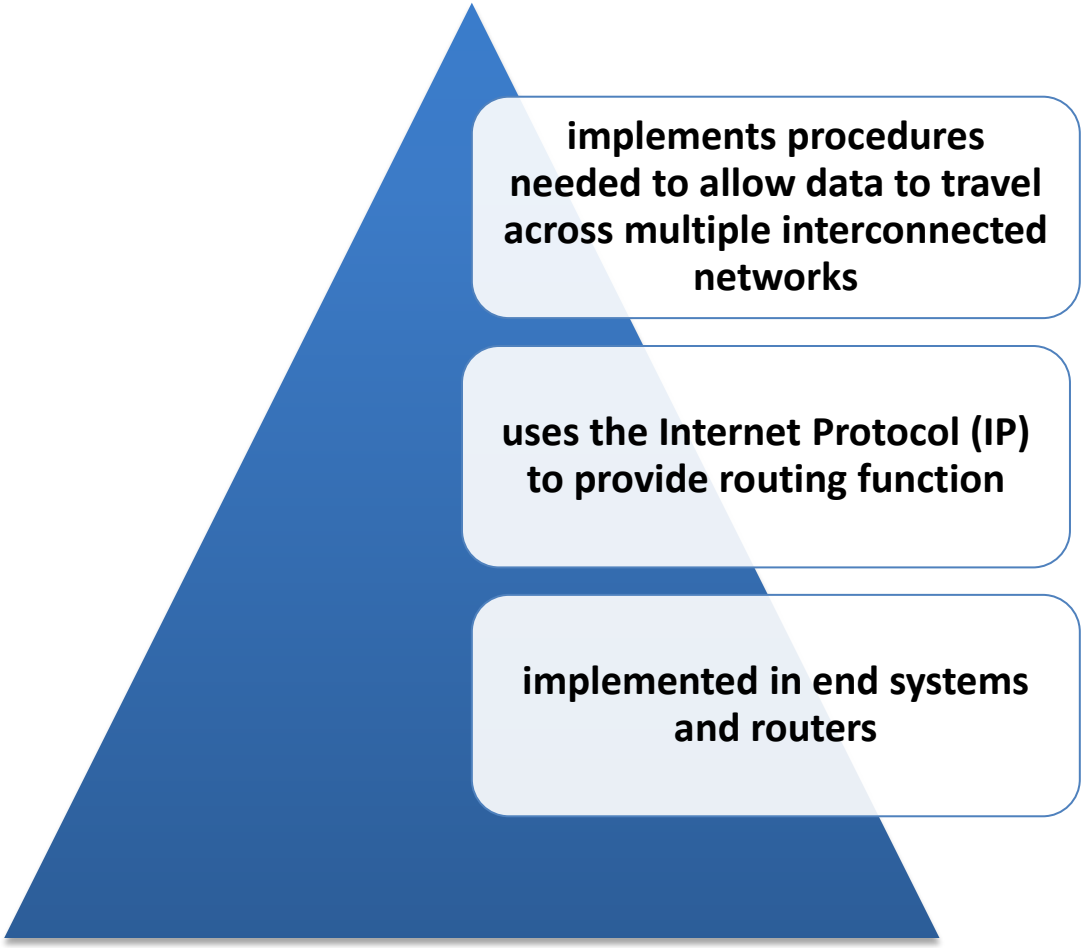
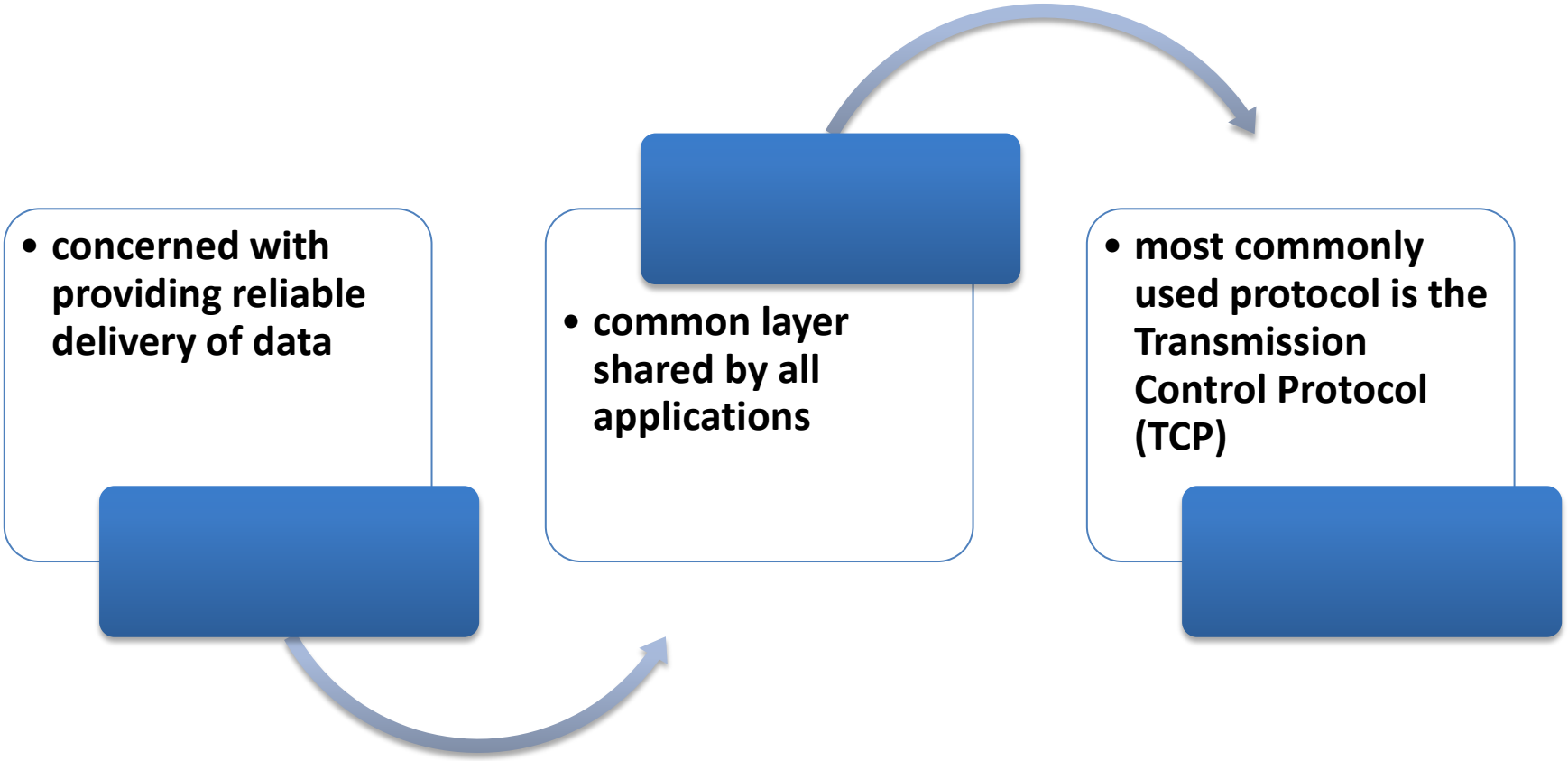
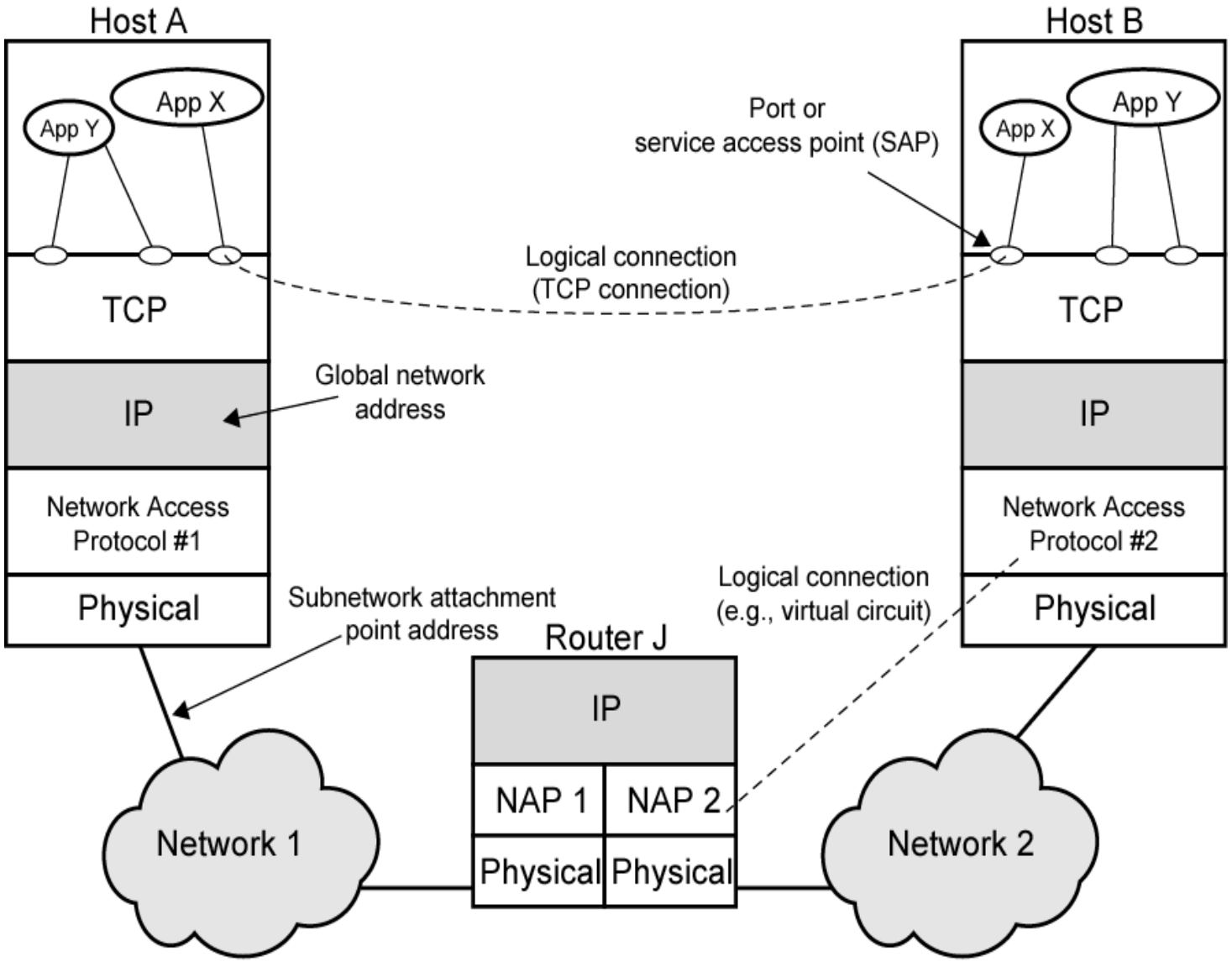
# Internet Layer



# Host-to-Host (Transport) Layer

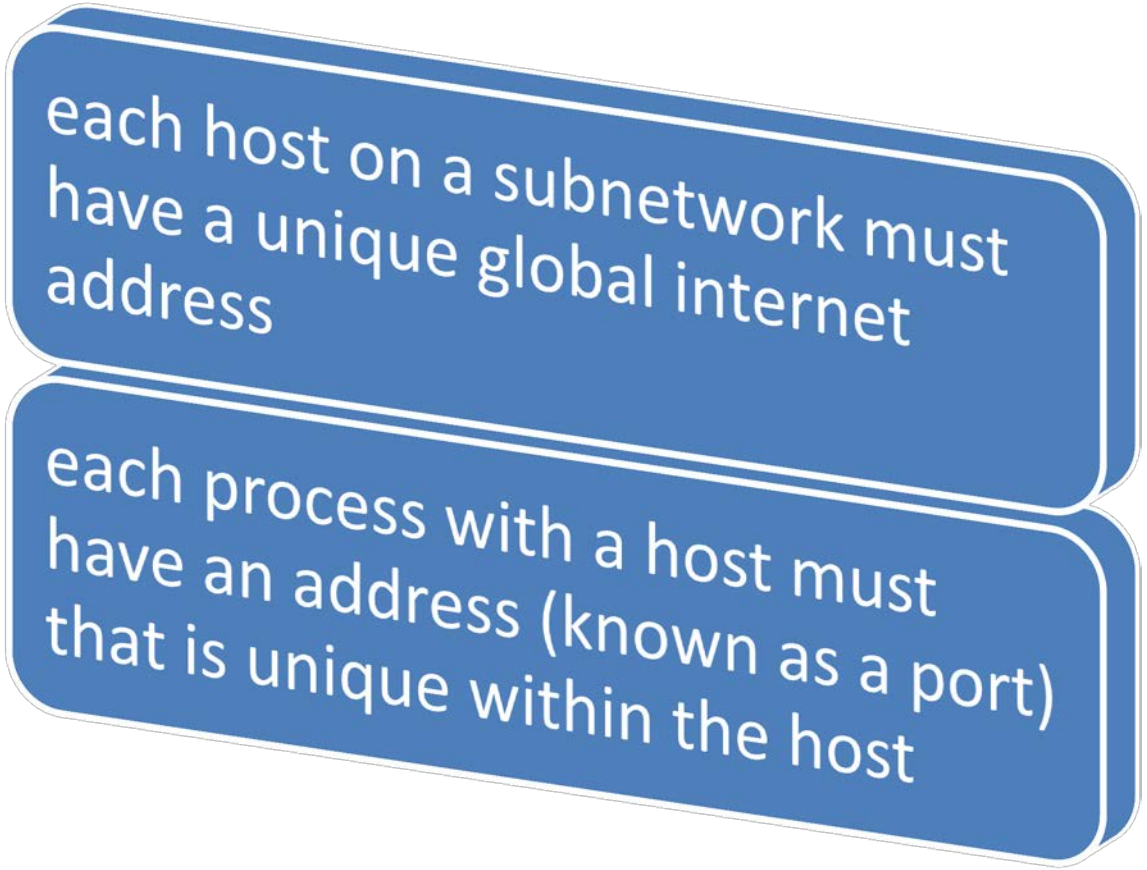


# Operation of TCP/IP



# TCP/IP Address Requirements

Two levels of addressing are needed:



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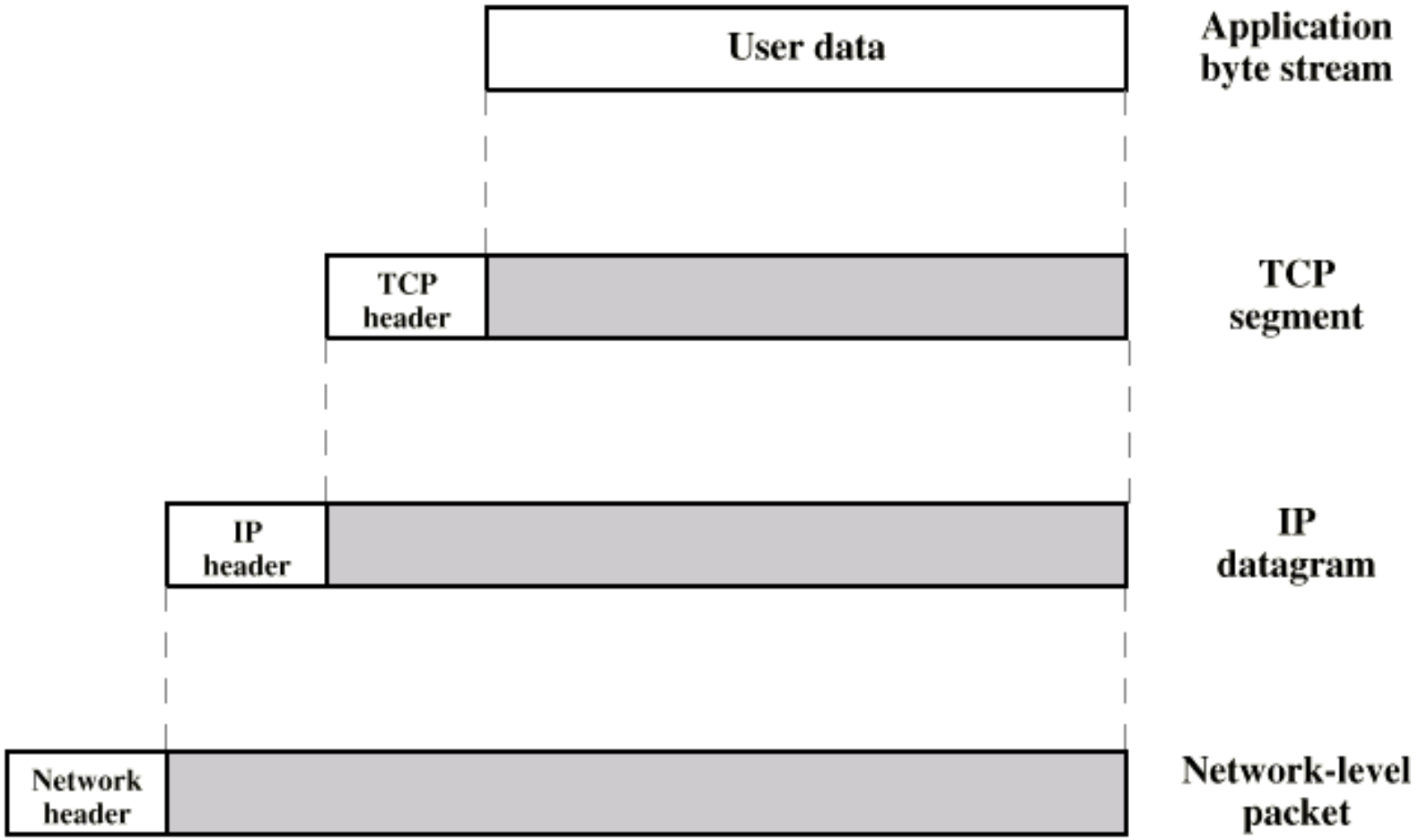
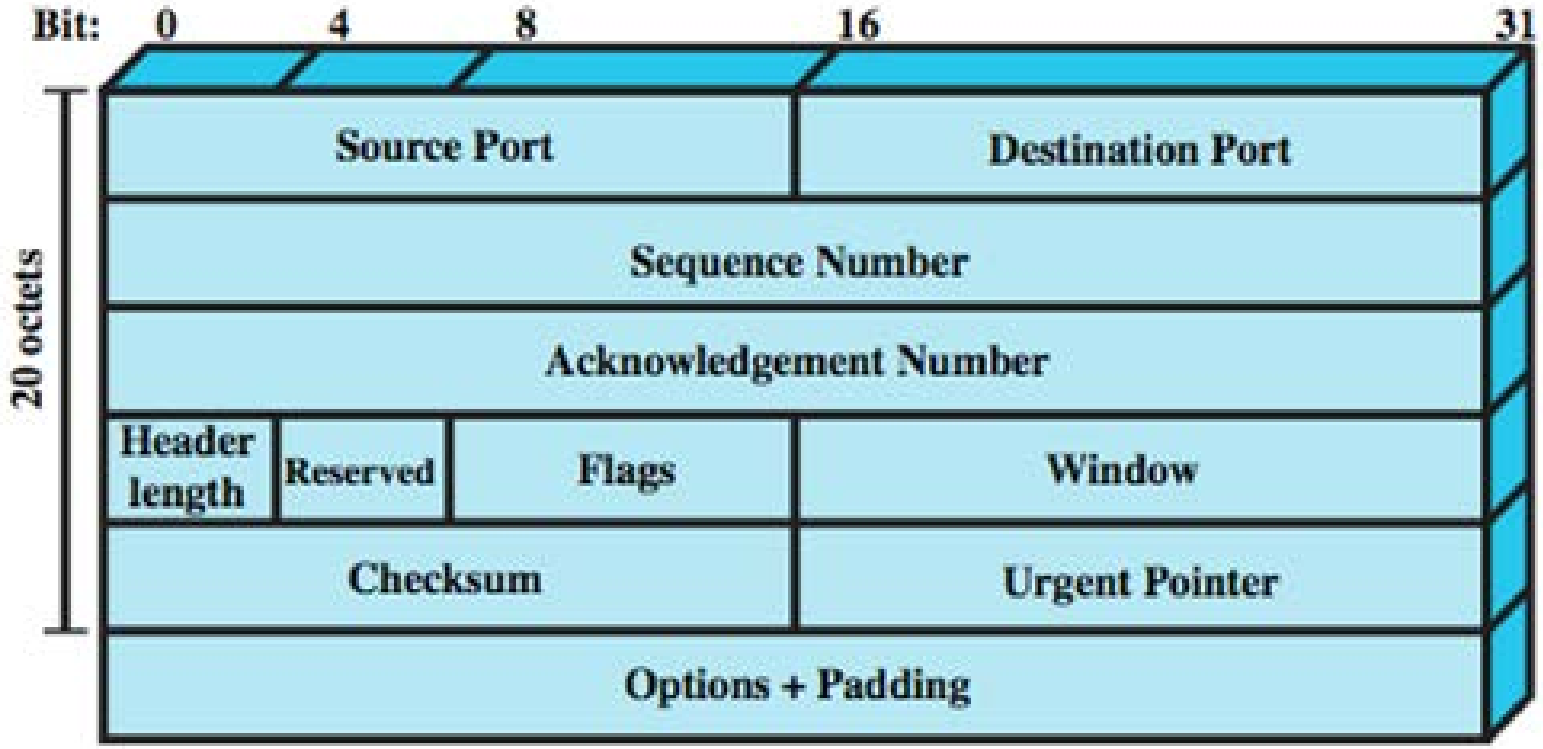


# Transmission Control Protocol (TCP)

- 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

# TCP Header

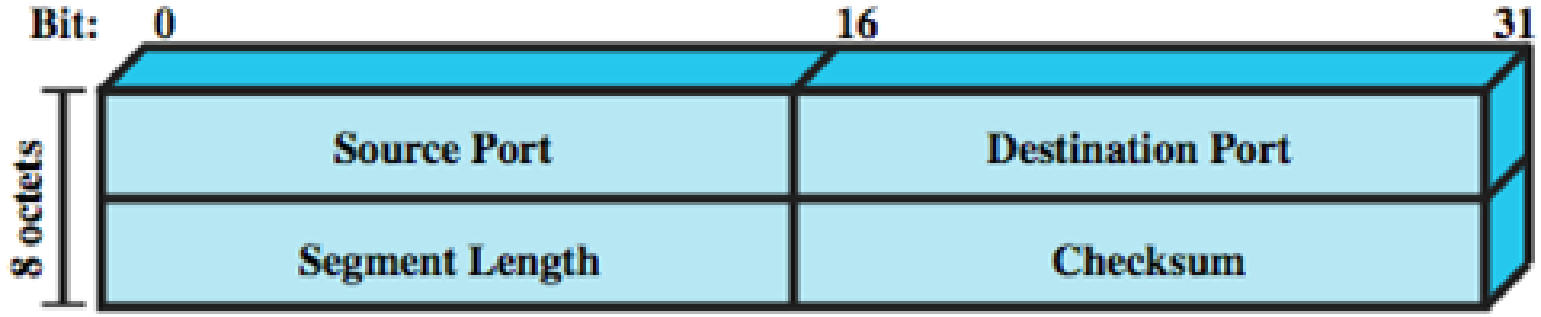



(a) TCP Header

# User Datagram Protocol (UDP)

- alternative to TCP
- does not guarantee delivery, preservation of sequence, or protection against duplication
- adds port addressing capability to IP
- used with Simple Network Management Protocol (SNMP)

# UDP Header

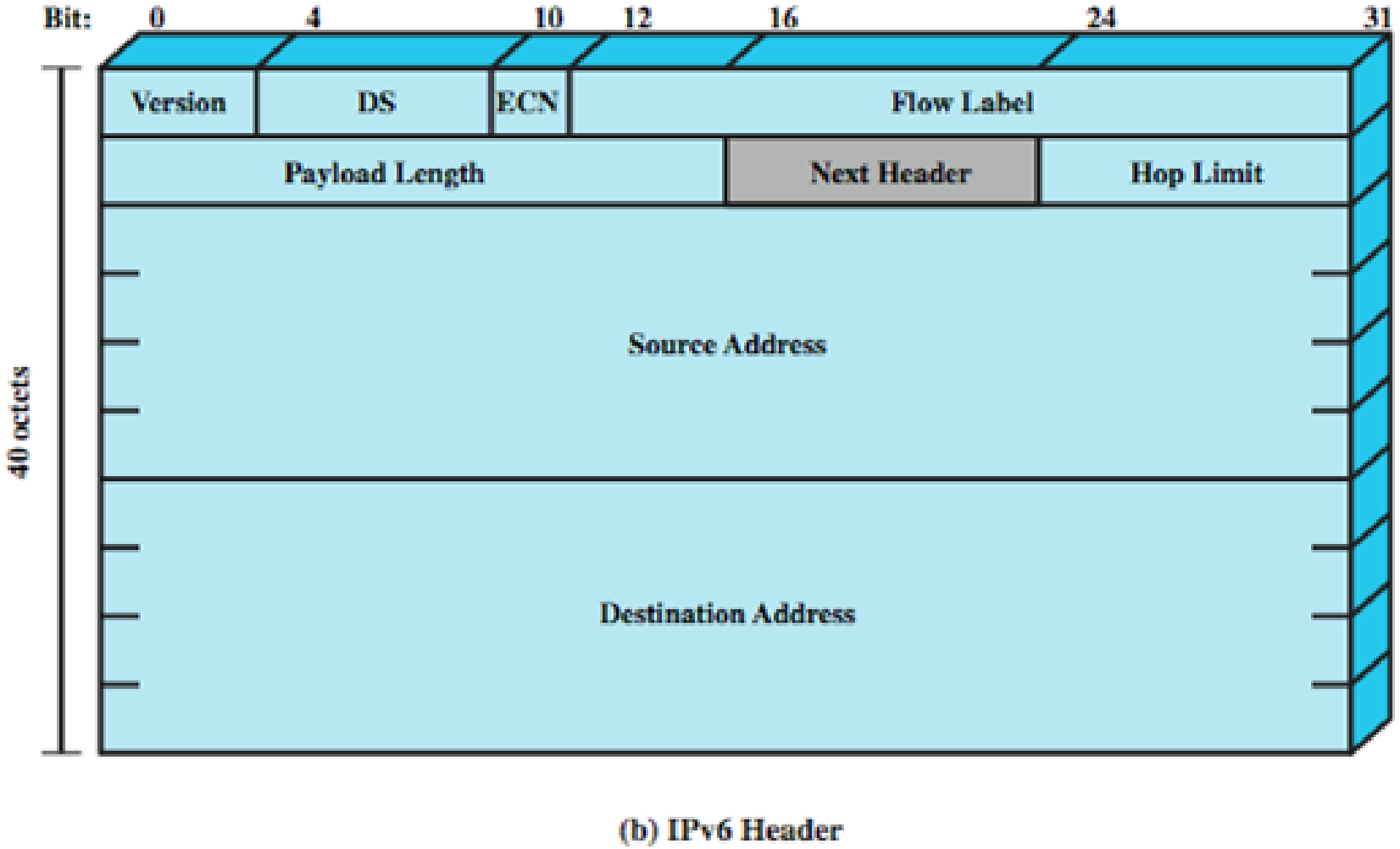



(b) UDP Header

# IPv6

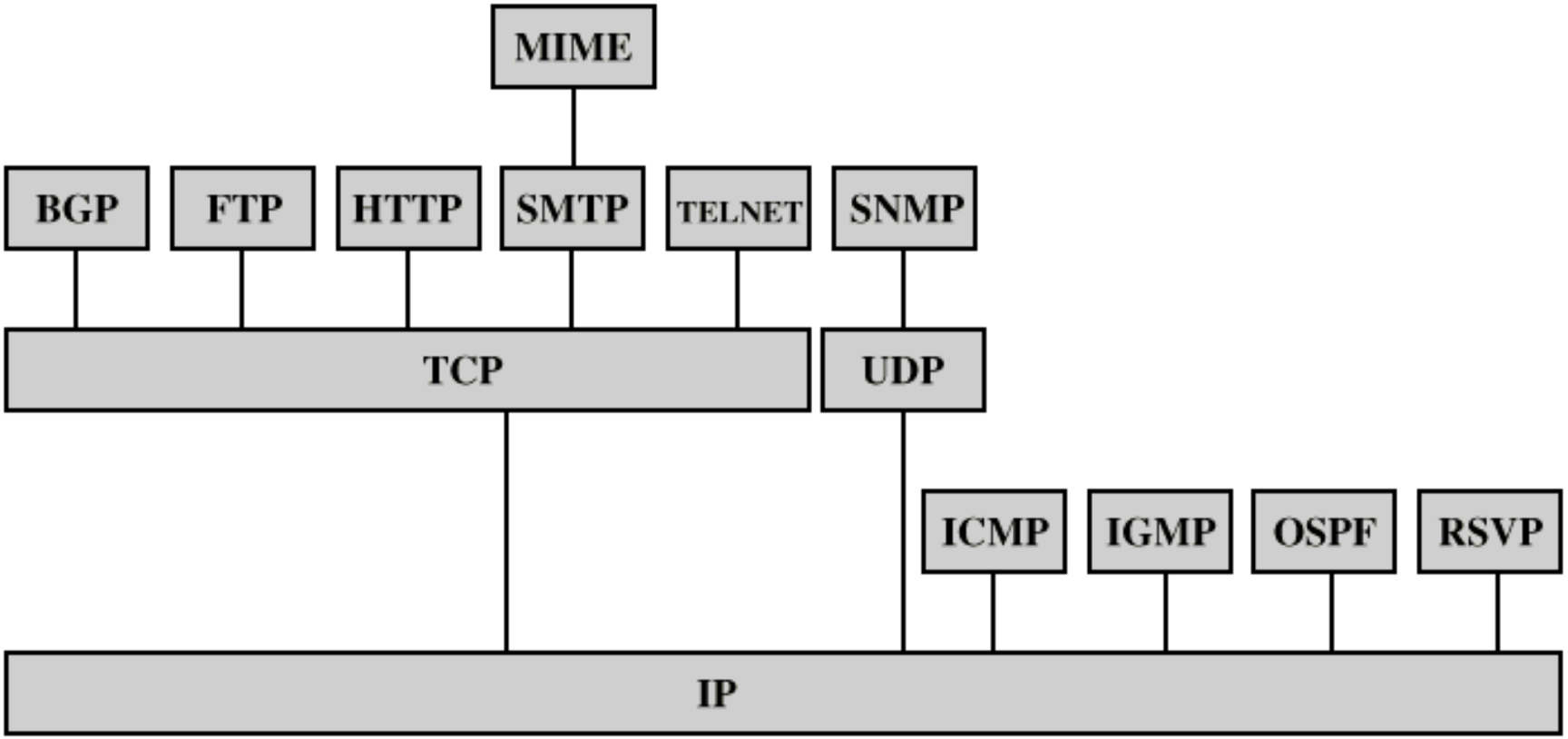
- Provides enhancements over existing IP
- Designed to accommodate higher speeds and the mix of graphic and video data
- Driving force was the need for more addresses due to growth of the Internet
- IPv6 includes 128-bit source and destination address fields

# IPv6 Header



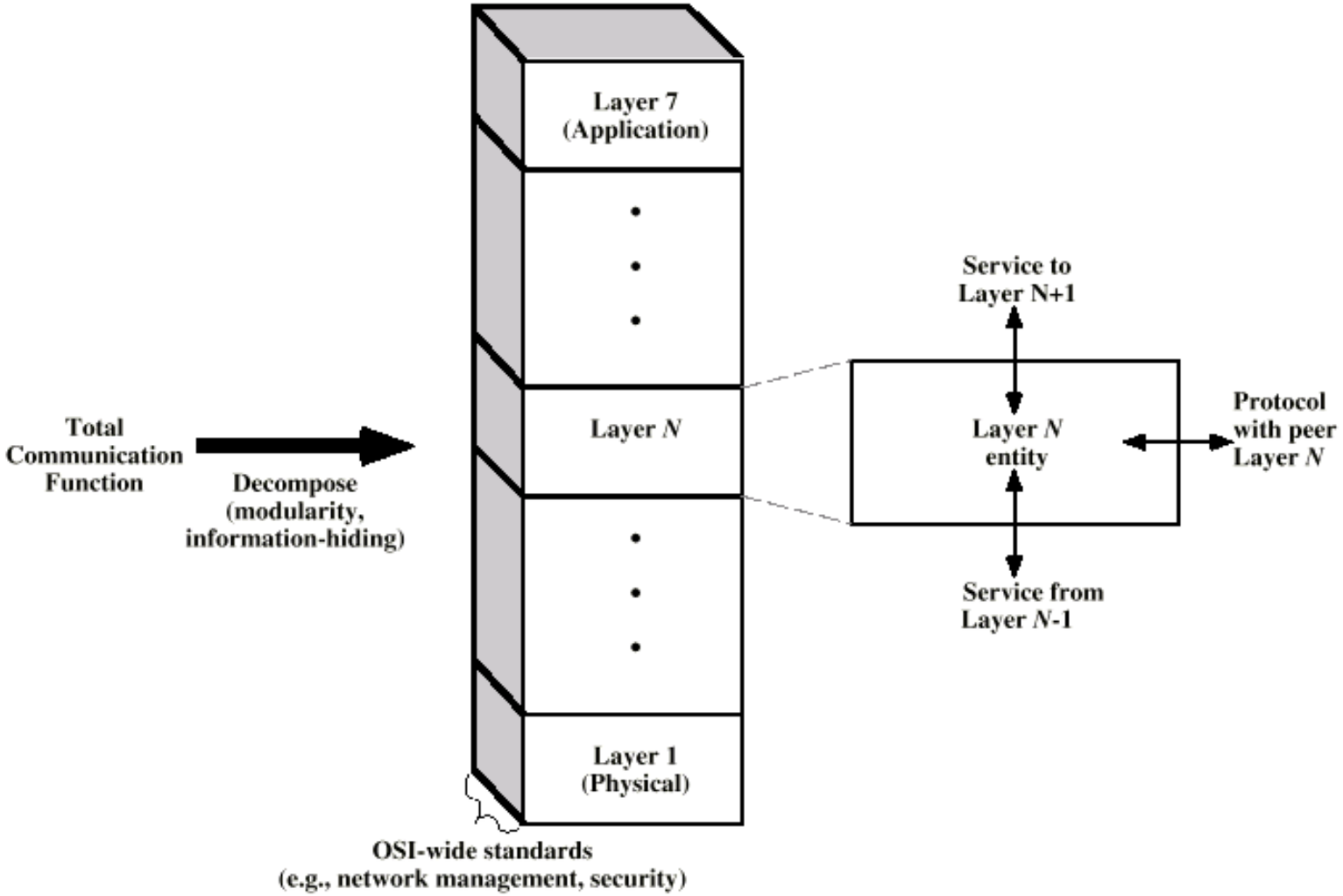

(b) IPv6 Header

# TCP/IP Protocols

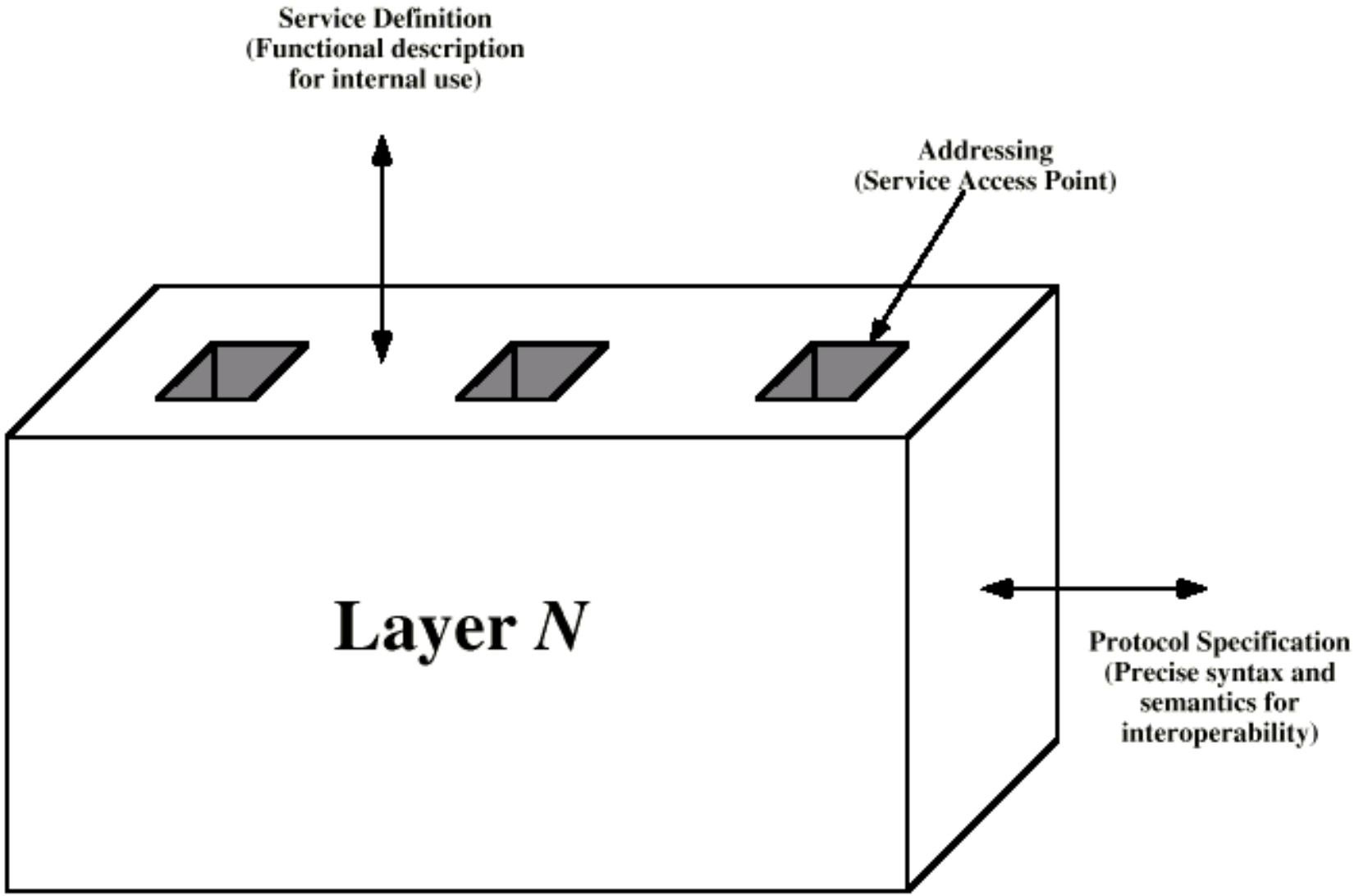



BGP = Border Gateway Protocol
FTP = File Transfer Protocol
HTTP = Hypertext Transfer Protocol
ICMP = Internet Control Message Protocol
IGMP = Internet Group Management Protocol
IP = Internet Protocol
MIME = Multi-Purpose Internet Mail Extension
OSPF = Open Shortest Path First
RSVP = Resource ReSerVation Protocol
SMTP = Simple Mail Transfer Protocol
SNMP = Simple Network Management Protocol
TCP = Transmission Control Protocol
UDP = User Datagram Protocol

# Standardized Protocol Architectures



# Layer Specific Standards



# OSI Standardization

- framework for standardization was motivator
- lower layers are concerned with greater levels of details
- each layer provides services to the next higher layer
- three key elements:

# OSI Layers

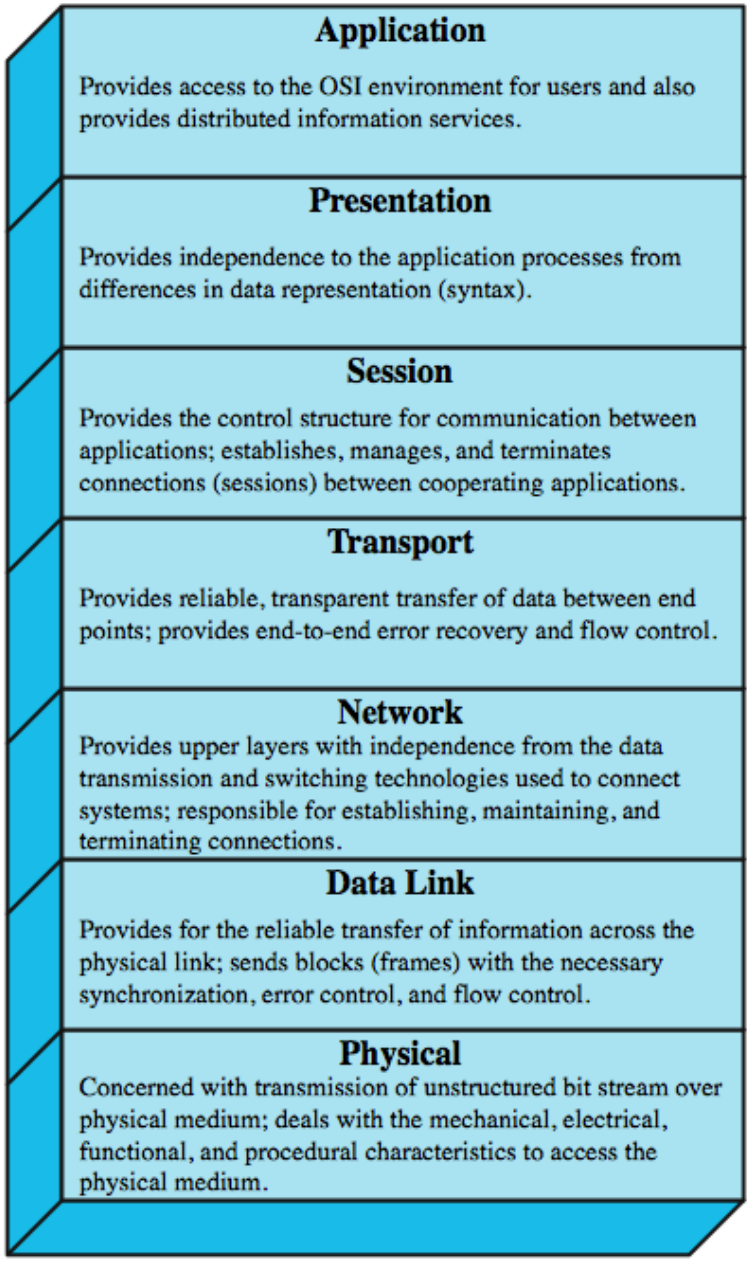
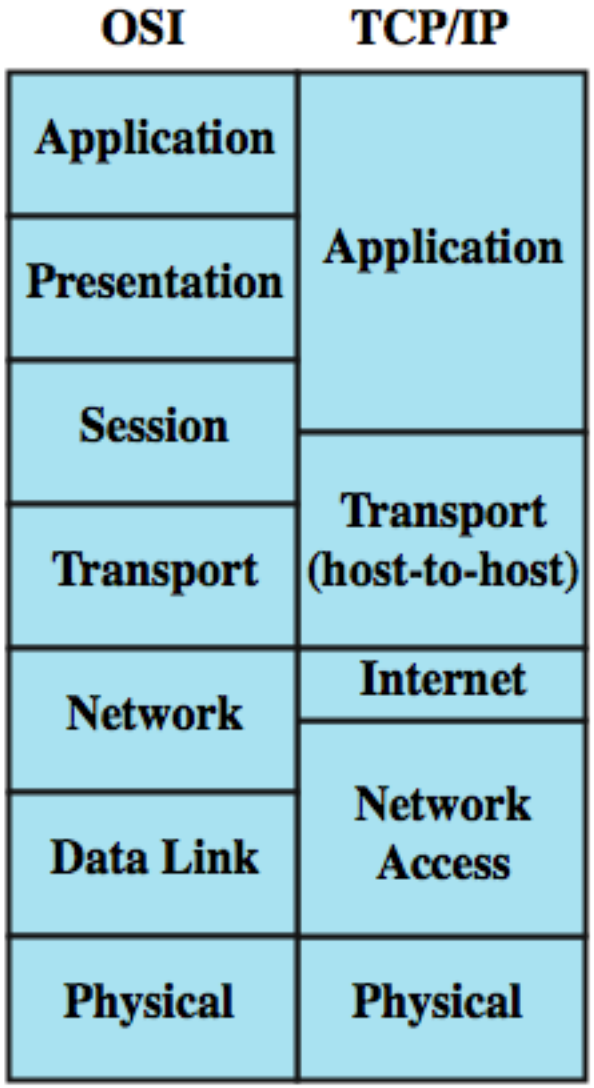


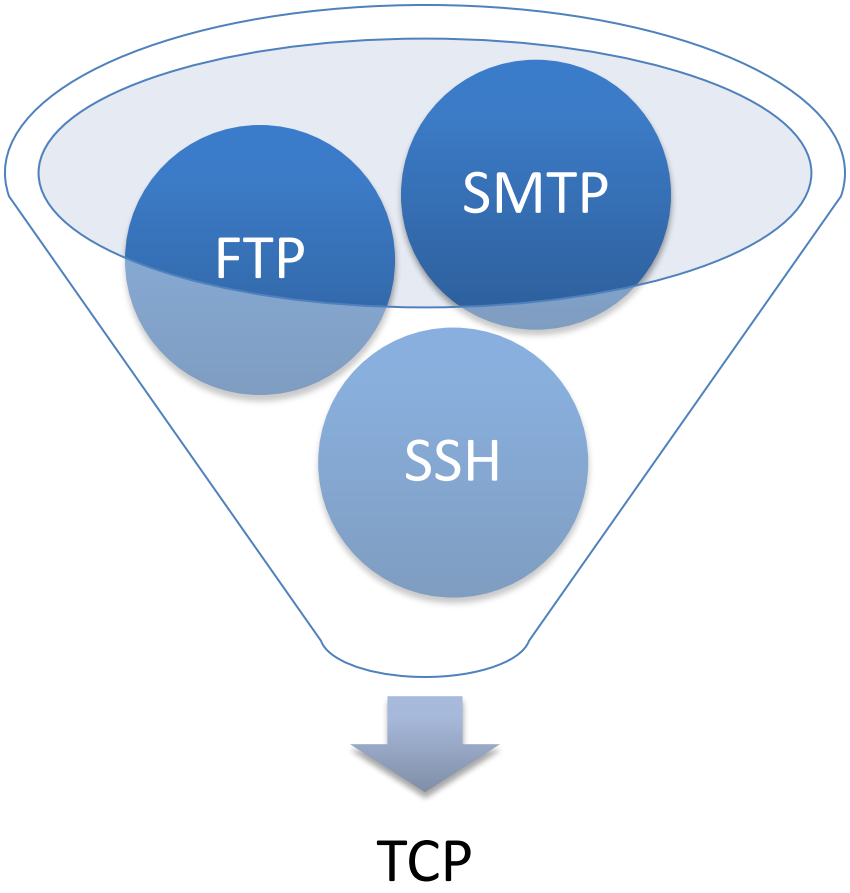

**Figure 2.6 The OSI Layers**

# OSI v TCP/IP


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

# Internet Applications

Applications that operate on top of TCP include:



# Multimedia Terminology

**Media**

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

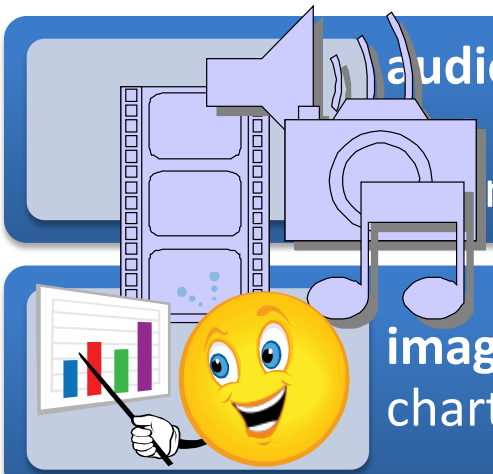
**Multimedia**

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

**Streaming media**

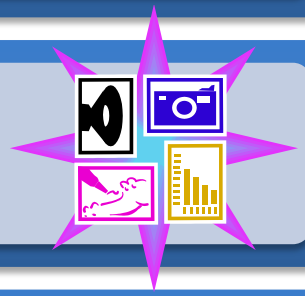
Refers to multimedia files, such as video clips and audio, that begin playing immediately or within seconds after it is received by a computer from the Internet or Web. Thus, the media content is consumed as it is delivered from the server rather than waiting until an entire file is downloaded.

# Multimedia Terminology



**audio** generally encompasses sounds that are produced
human, telephony and related voice
munications technology

**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

# Multimedia Applications

**Multimedia information systems**

- databases, information kiosks, hypertexts, electronic books, and multimedia expert systems

**Multimedia communication systems**

- computer-supported collaborative work, videoconferencing, streaming media, and multimedia teleservices

**Multimedia entertainment systems**

- 3D computer games, multiplayer network games, infotainment, and interactive audiovisual productions

**Multimedia business systems**

- immersive electronic commerce, marketing, multimedia presentations, video brochures, virtual shopping

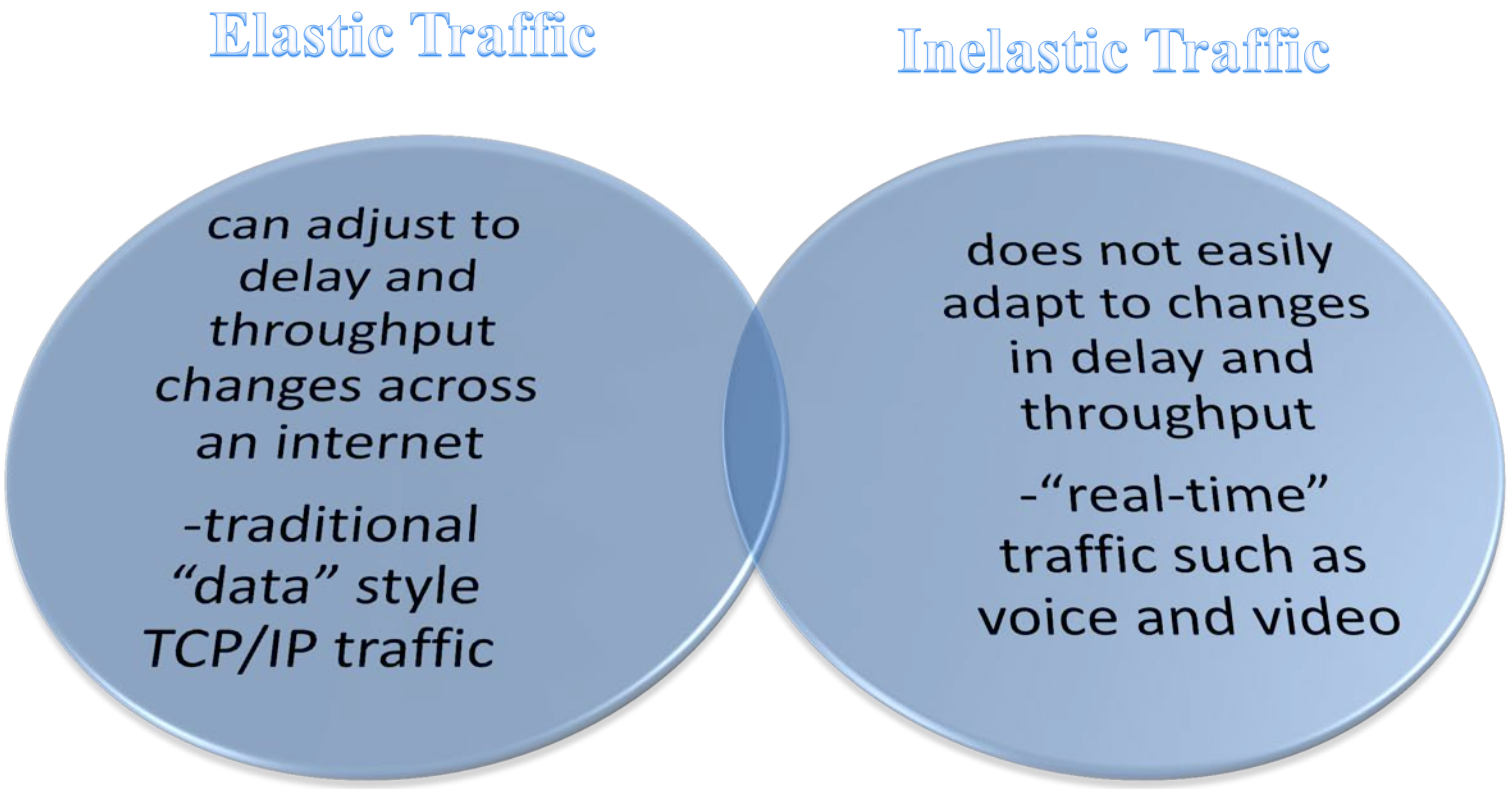
**Multimedia educational systems**

- electronic books, flexible teaching materials, simulation systems, automatic testing, distance learning

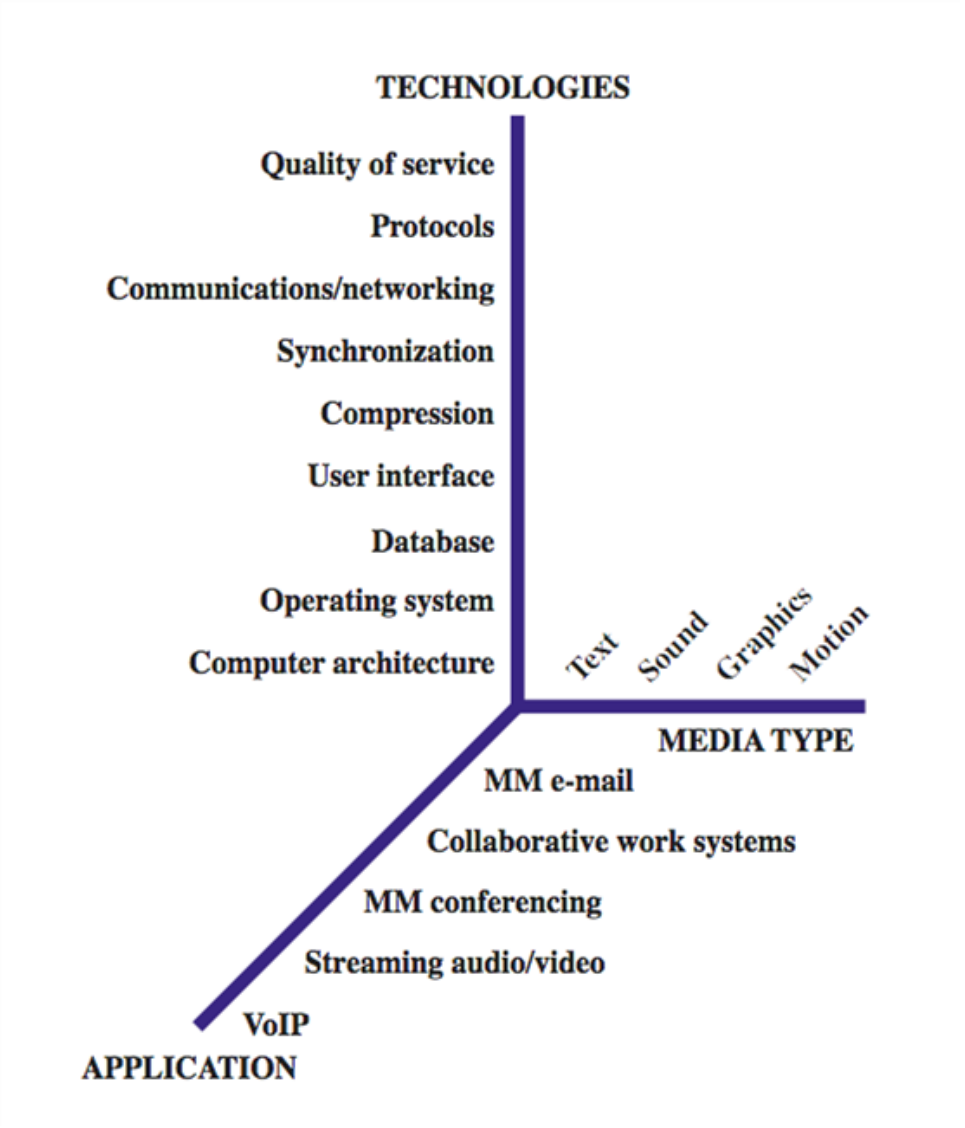
# Domains of Multimedia Systems and Example Applications

| 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 |

# Elastic and Inelastic Traffic



# Multimedia Technologies



# Summary

- needs and key elements for protocol architecture
- TCP/IP protocol architecture
- OSI Model & protocol architecture standardization
- traditional versus multimedia application needs