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

### The Need For Protocol Architecture

- 1.) the source must activate communications path or inform network of destination
- 2.) the source must make sure that destination is prepared to receive data

To transfer data several tasks must be performed:

- 3.) the file transfer application on source must confirm file management program at destination is prepared to accept and store file
- 4.) a format translation function may need to be performed if the formats on systems are different

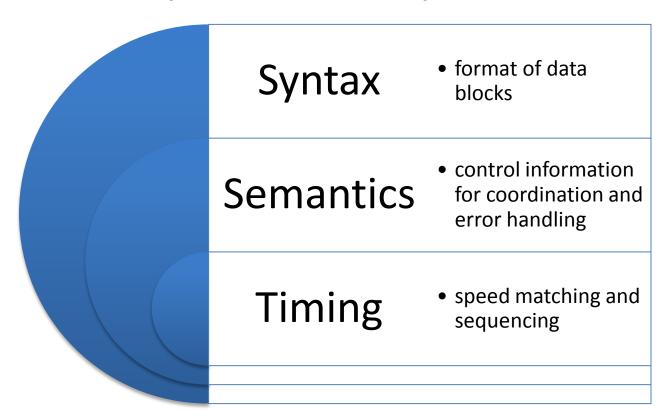
### Functions of Protocol Architecture

- 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
  - 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

concerned with providing reliable delivery of data

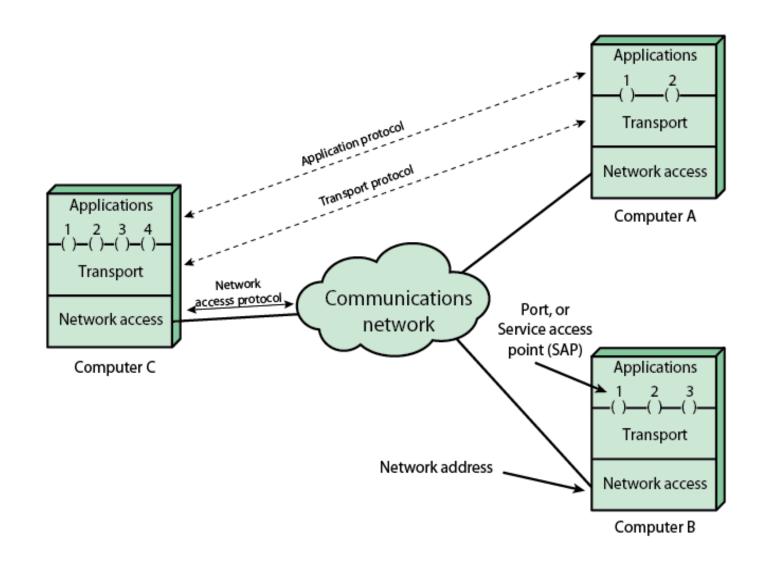
essentially independent of the nature of the applications

common layer shared by all applications

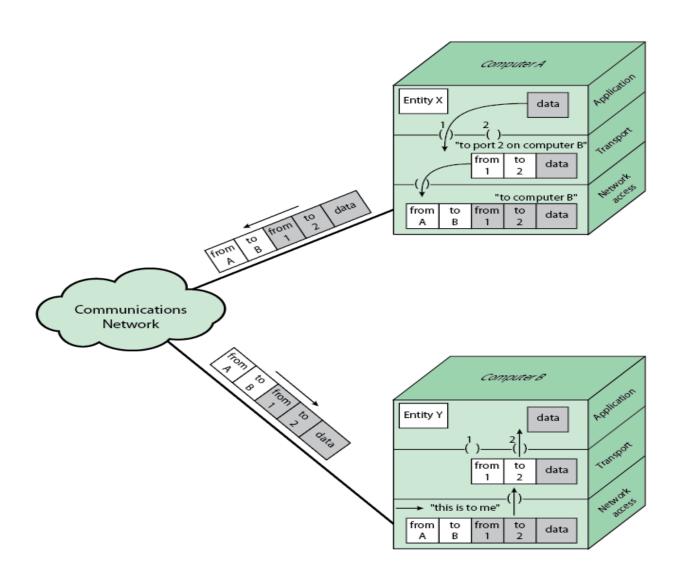
## **Application Layer**

contains the logic needed to support user applications separate module is needed for each type of application

### Protocol Architecture and Networks



### Protocols in a Simplified Architecture



## Addressing

Two levels of addressing are needed:

each computer on the network has a unique network address

each application has an address that is unique with that computer (SAPs)

## 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

### Application

Provides ccess to the TCP/IP environment for users and also provides distributed information services.

#### **Transport**

Transfer of data between end points. May provide error control, flow control, congestion control, reliable delivery.

#### Internet

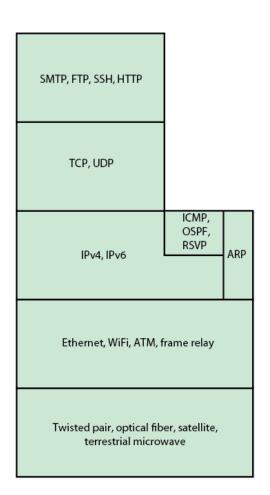
Shield higher layers from details of physical network configuration. Provides routing. May provide QoS, congestion control.

#### **Network Access**

Logical interface to actual network hardware. May be stream or packet oriented. May provide reliable delivery.

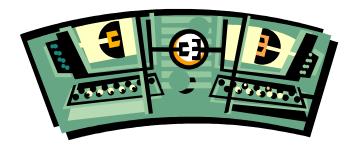
### Physical

Transmission of bit stream, specifies medium, signal encoding technique, data rate, bandwidth, and physical connector.



## 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 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

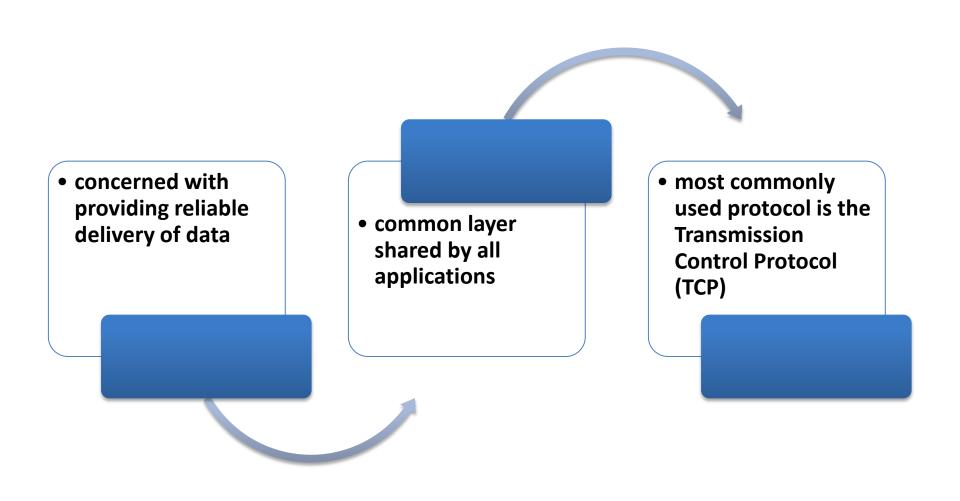
### Internet Layer

implements procedures needed to allow data to travel across multiple interconnected networks

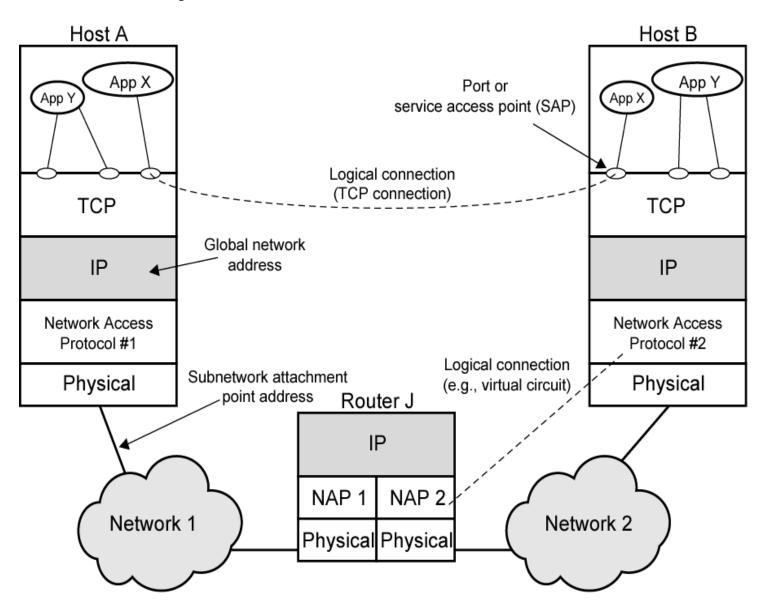
uses the Internet Protocol (IP) to provide routing function

implemented in end systems and routers

## Host-to-Host (Transport) Layer



## Operation of TCP/IP



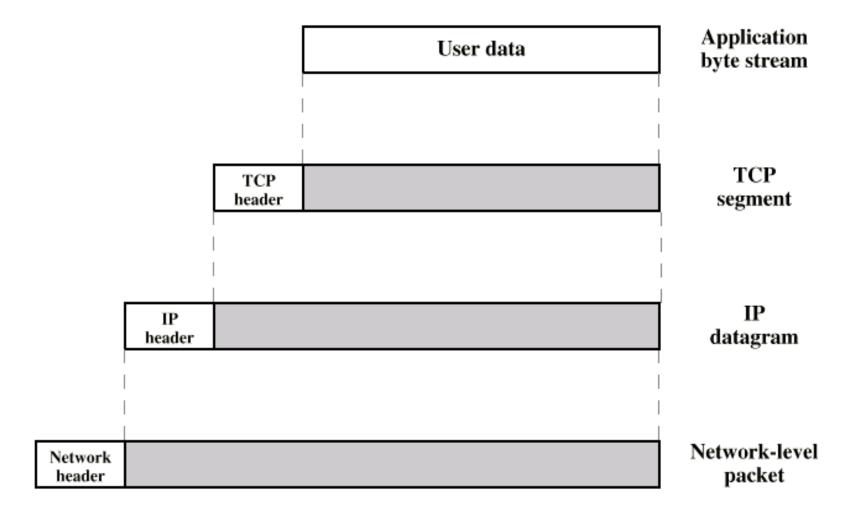
# TCP/IP Address Requirements

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

# Operation of TCP/IP

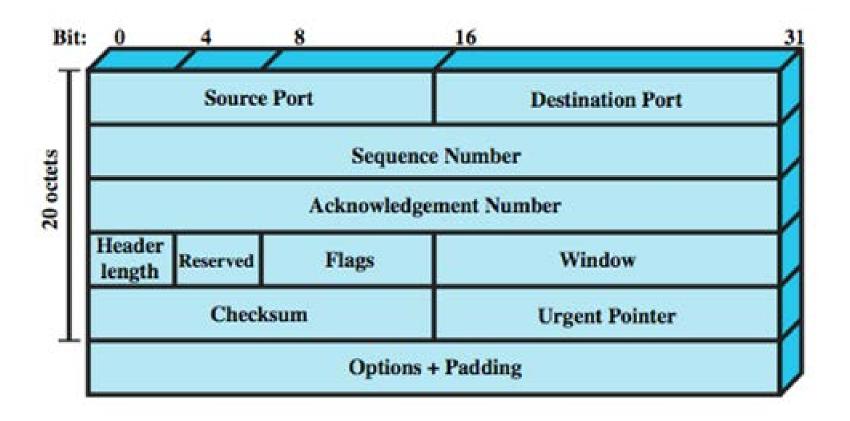


### Transmission Control Protocol (TCP)

- 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

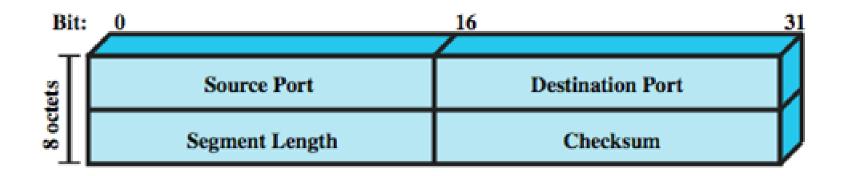


(a) TCP Header

# 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

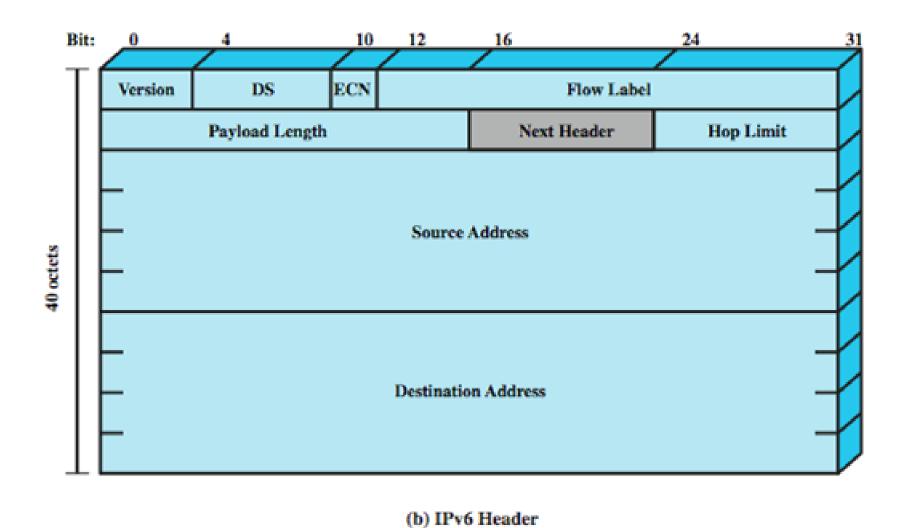


(b) UDP Header

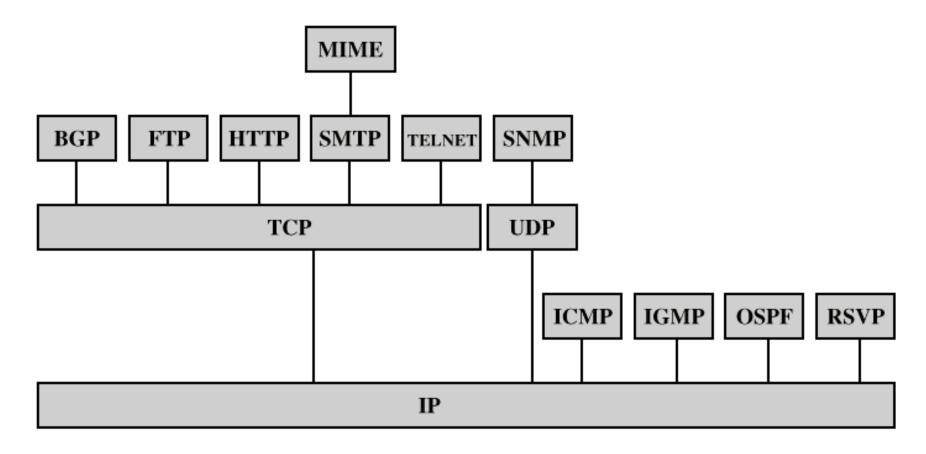
### IPv6

- 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



## 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

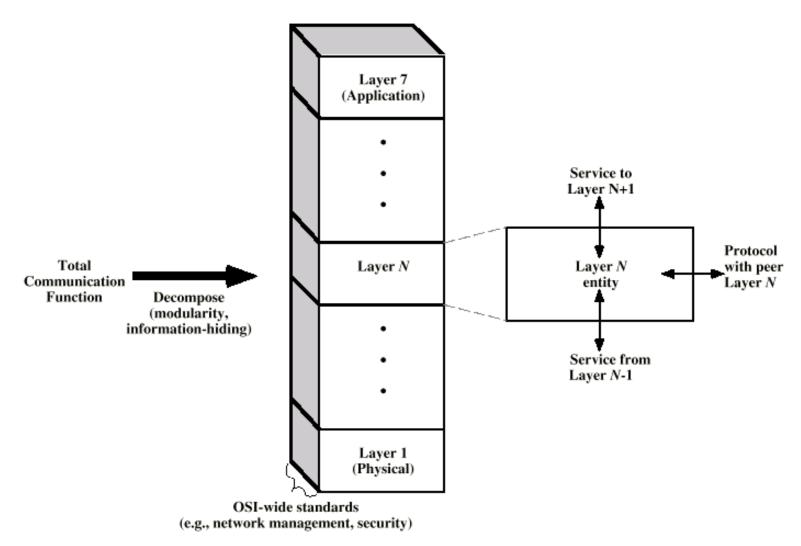
RSVP = Resource ReSerVation Protocol SMTP = Simple Mail Transfer Protocol

SNMP = Simple Network Management Protocol

TCP = Transmission Control Protocol

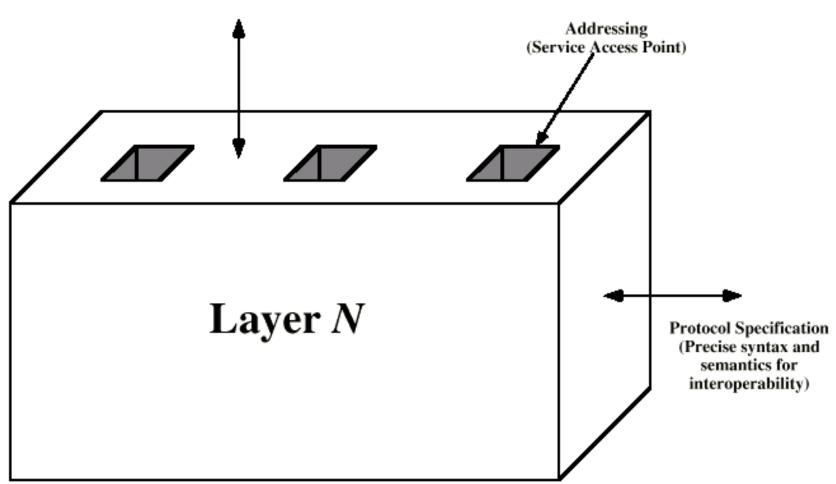
UDP = User Datagram Protocol

# Standardized Protocol Architectures



# Layer Specific Standards

Service Definition (Functional description for internal use)



### **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**

### Application

Provides access to the OSI environment for users and also provides distributed information services.

### **Presentation**

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**

Provides reliable, transparent transfer of data between end points; provides end-to-end error recovery and flow control.

#### Network

Provides upper layers with independence from the data transmission and switching technologies used to connect 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 over physical medium; deals with the mechanical, electrical, functional, and procedural characteristics to access the physical medium.

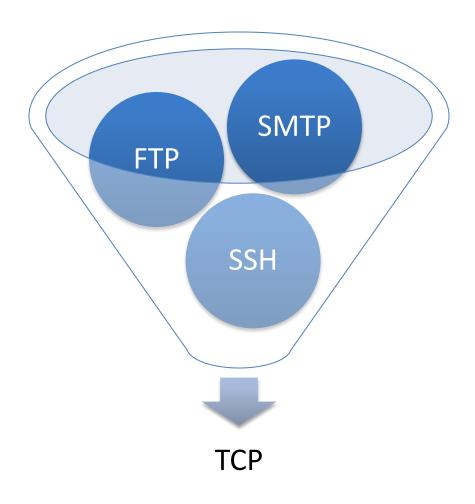
Figure 2.6 The OSI Layers

# OSI v TCP/IP

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



**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 entertainment systems

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

### Multimedia communication systems

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

### 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

<b>Example Application</b>
Hypermedia, multimedia-capable databases, content-based retrieval
Computer games, digital video, audio (MP3)
Videoconferencing, shared workspaces, virtual communities
Online training, electronic books, streaming media

### Elastic and Inelastic Traffic

### Elastic Traffic

can adjust to delay and throughput changes across an internet

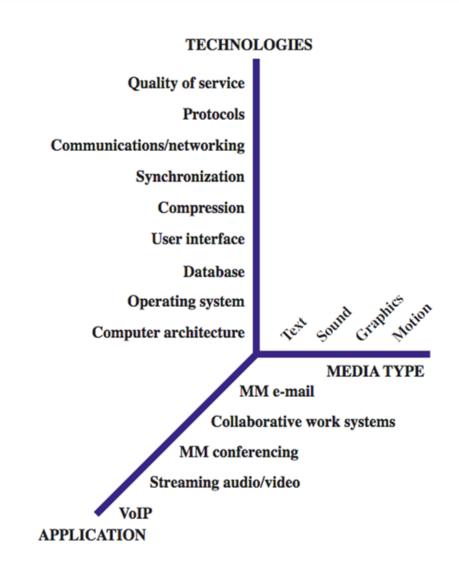
-traditional "data" style TCP/IP traffic

### Inelastic Traffic

does not easily adapt to changes in delay and throughput

-"real-time" traffic such as voice and video

## Multimedia Technologies



### Summary

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