Computer Networks

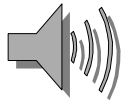# Introduction to Computer Networks and Data Communications

Dr Yvan Petillot

A bit of history…

1980: Networks are an academic curiosity

1988: All networks wires are copper based

1988: Networks used by universities and large businesses

1996: Networks used by millions of people

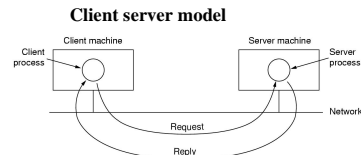2002: High bandwidth connections and information highways are common place

2050: ?

Data Communications and Computer Networks
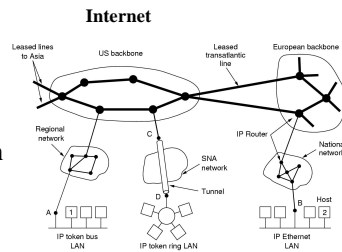
Who uses networks and why?

Client server model

· Companies
  - Resource sharing
  - High reliability
  - Saving money

· Individuals
  - Access to remote information
  - Person to person communication
  - Interactive entertainment
  - Online shopping

Internet

Data Communications and Computer Networks
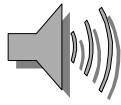
What A Network Does

Provides communication that is
  · Reliable
  · Fair
  · Efficient
  · From one application to another
Automatically detects and corrects
  · Data corruption
  · Data loss
  · Duplication
  · Out-of-order delivery
Automatically finds optimal path from source to destination

The Language of Computer Networks

WAN: Wide area network - a large network that encompasses parts of states, multiple states, countries, and the world

LAN: Local Area Network. Small, privately owned, localised network.

Data communications - the transfer of digital or analog data using digital or analog signals

Voice network - a network that transmits telephone signals

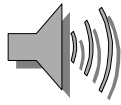Data network - a network that transmits computer data

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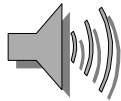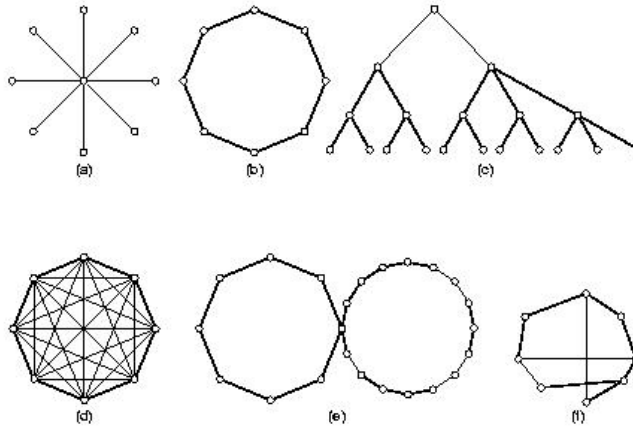**Data Communications and Computer Networks**

Type of networks

- Broadcast (small localised)
  - One communication channel shared by all users
  - All messages received by all users
  - Users decode message target and discard useless messages
  - Some messages are addressed to all users / groups of users (multicast)

- Point to point (large, de-localised)
  - many connections between pairs of computers

Data Communications and Computer Networks

Network topologies

Data Communications and Computer Networks

The Big Picture of Network hardware
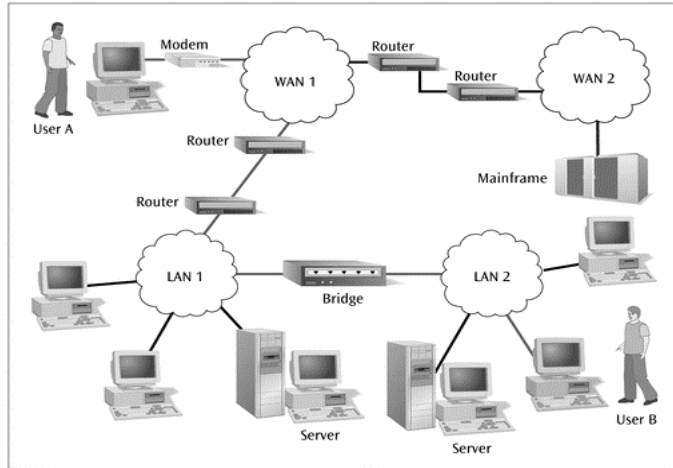
Networks are composed of many devices, including:

- workstations
- servers
- bridges
- routers
- hubs and switches
- nodes

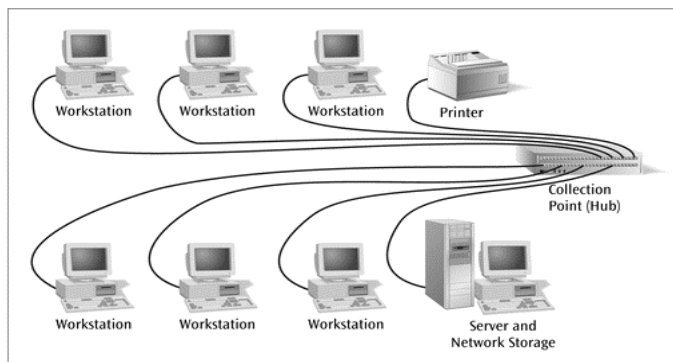## Data Communications and Computer Networks

Examples

Figure 1-1
An overall view of the interconnection between local area networks and wide area networks

Data Communications and Computer Networks

Examples

Figure 1-3
A microcomputer lab, showing the cabling that exits from the back of a computer and runs to a collection point of the LAN in the back of the room
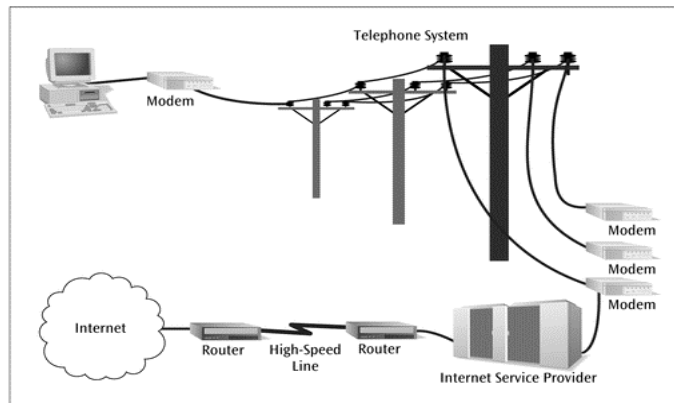
Data Communications and Computer Networks

Examples

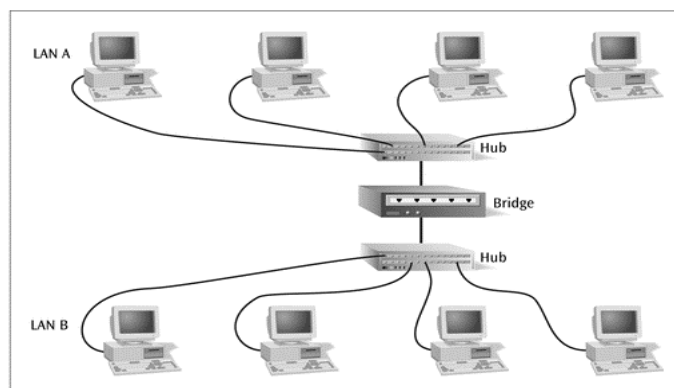**Figure 1-4**
A microcomputer sending data over a telephone line to an Internet service provider and into the Internet

Telephone System

Modem
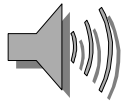
Modem
Modem
Modem

Internet

Router High-Speed Router
Line

Internet Service Provider

Data Communications and Computer Networks

Examples

Figure 1-5
Two local area networks connected by a bridge

LAN A

Hub

Bridge

Hub

LAN B

Data Communications and Computer Networks

Examples

Figure 1-6
*Local area network to a
wide area network
connection*

Hub   Router

LAN

Telephone
System

Router

Wide
Area
Network
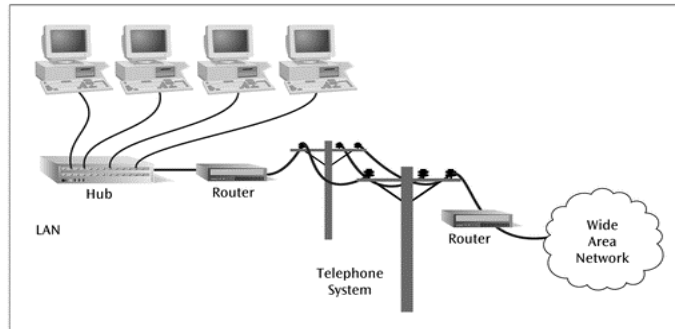
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Examples

Figure 1-8
*Example of a television
company using a satel-
lite system to broadcast
television services into
homes and businesses*

Satellite

Home

Television
Company

Satellite
Dish

Business

Homes
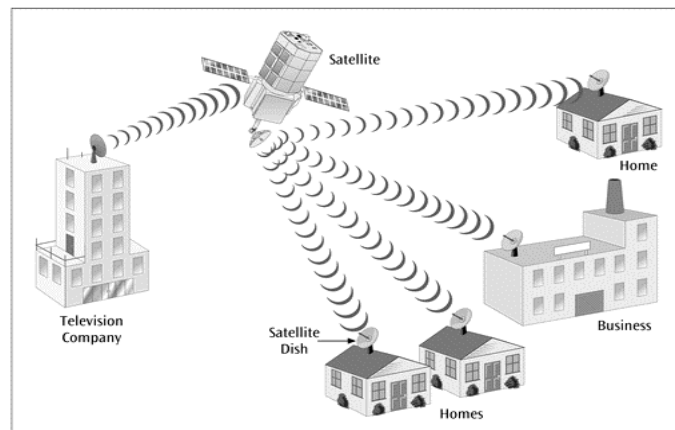
Data Communications and Computer Networks

Examples

Figure 1-9
An example of a laptop computer connected to a wireless telephone system to transmit and receive data

Land-based Telephone Line

PC Card

Telephone Company

Wireless Transmission Tower

Wireless Telephone

Laptop
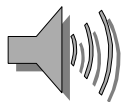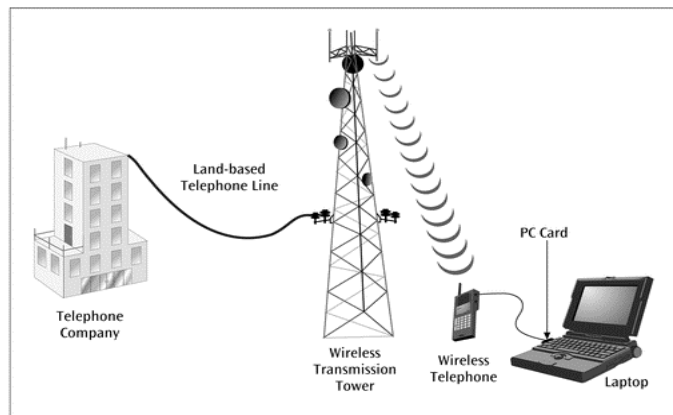
Data Communications and Computer Networks

A network is a combination of:

· hardware

· data communications

· protocols

· routing

· software

· services (applications)

How is it all organised and managed ?

Network Architecture Models

• A reference model that describes the layers of hardware and software necessary to transmit data between two points
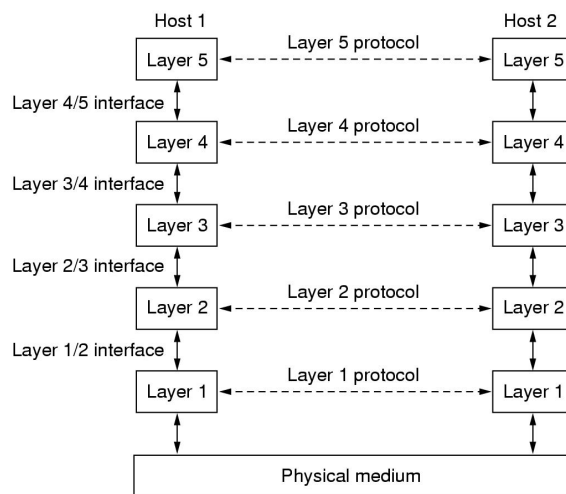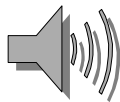
• Reference models are necessary to increase the likelihood that different components from different manufacturers will converse

• There are two models that are required learning: The OSI Model, and the Internet Model (TCP/IP model).

Layer

5   M ←----- Layer 5 protocol -----→ M

4   [H4 | M] ←----- Layer 4 protocol -----→ [H4 | M]

3   [H3 | H4 | M1]   [H3 | M2] ←-- Layer 3 protocol --→ [H3 | H4 | M1]   [H3 | M2]

2   [H2 | H3 | H4 | M1 | T2]   [H2 | H3 | M2 | T2] ←-- Layer 2 protocol --→ [H2 | H3 | H4 | M1 | T2]   [H2 | H3 | M2 | T2]

1

Source machine   Destination machine
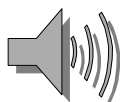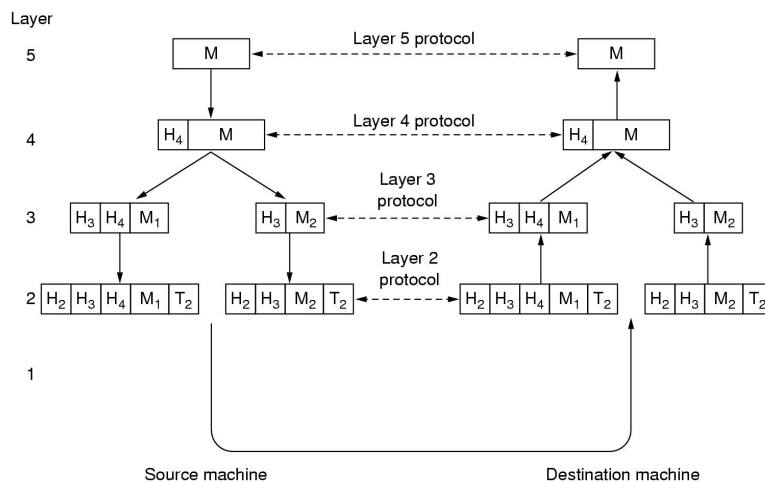
The Open Systems Interconnections (OSI) ISO seven layers Model:

Figure 1-11
The seven layers of the OSI model

| Application |
| Presentation |
| Session |
| Transport |
| Network |
| Data link |
| Physical |

Data Communications and Computer Networks

Layer		Application protocol			Name of unit exchanged
7	Application	◄ - - - - - - - - - - ►		Application	APDU
Interface		Presentation protocol			
6	Presentation	◄ - - - - - - - - - - ►		Presentation	PPDU
Interface		Session protocol			
5	Session	◄ - - - - - - - - - - ►		Session	SPDU
4	Transport	Transport protocol ◄ - - - - - - - - - - ►		Transport	TPDU

Communication subnet boundary

Internal subnet protocol

3	Network		Network	◄ ►	Network		Network	Packet
2	Data link		Data link	◄ ►	Data link		Data link	Frame
1	Physical		Physical	◄ ►	Physical		Physical	Bit
	Host A		Router		Router		Host B	

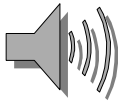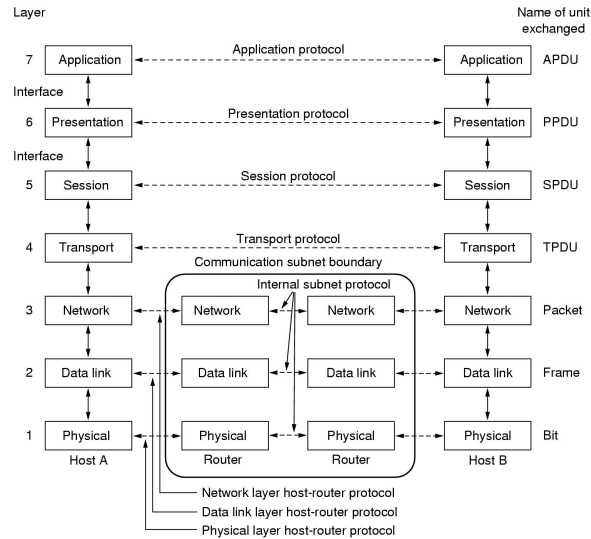Network layer host-router protocol
Data link layer host-router protocol
Physical layer host-router protocol
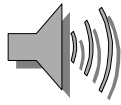

Data Communications and Computer Networks

Network architecture models

Physical layer :

handles the transmission of bits over a communications channel. Includes voltage levels, connectors, media choice, modulation techniques.

Data link layer:

responsible for taking the data and transforming it into a *frame* with header, control and address information, and error detection code.

Data Communications and Computer Networks

Network layer:

> responsible for creating maintaining and ending network connections. Transfers a data packet from node to node within the network.

Transport layer:

> provides an end-to-end, error-free network connection. Makes sure the data arrives at the destination exactly as it left the source.

Session layer:

> responsible for establishing sessions between users.

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Presentation layer:

> performs a series of miscellaneous functions necessary for presenting the data package properly to the sender or receiver
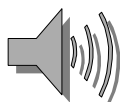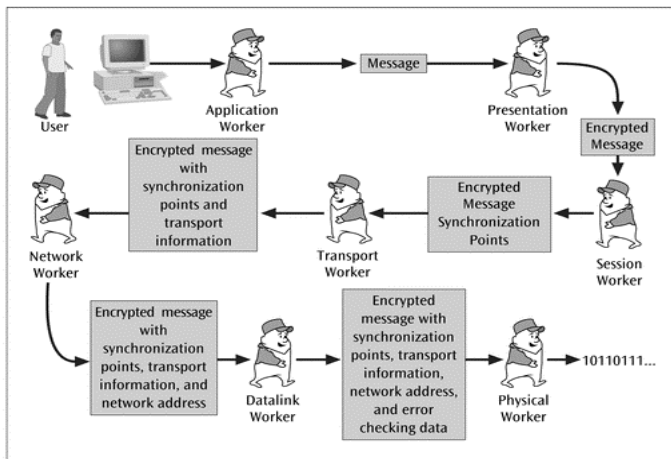
Application layer:

> where the application using the network resides. Common network applications include remote login, file transfer, e-mail, and web page browsing.
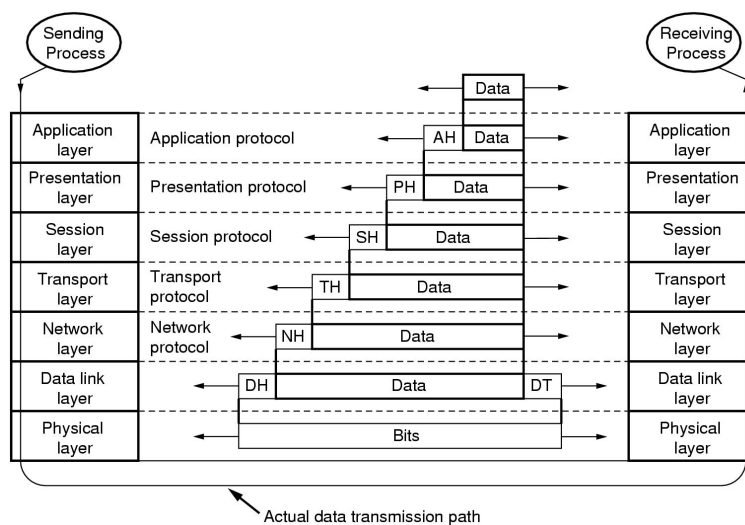
Data Communications and Computer Networks
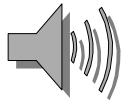
Network architecture models

Figure 1-10
The network workers performing their job duties at each layer in the model

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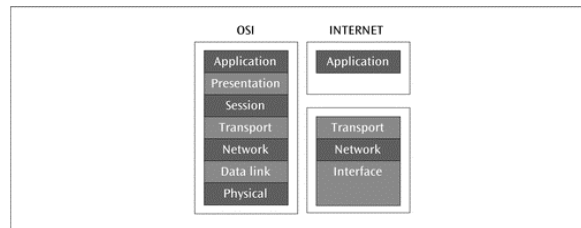
Network architecture models

The Internet Model (TCP/IP)

Figure 1-13
The layers of the Internet model compared to the layers of the OSI model

OSI	INTERNET
Application	Application
Presentation	
Session	
Transport	Transport
Network	Network
Data link	Interface
Physical	

Interface layer:

equivalent to the OSI's physical and data link layers

Network layer:

roughly equivalent to the OSI's network layer

Transport layer:

performs same function as OSI transport layer

Application layer:

equivalent to the OSI's presentation and application layers

Logical and physical connections

A logical connection is one that exists only in the software, while a physical connection is one that exists in the hardware.
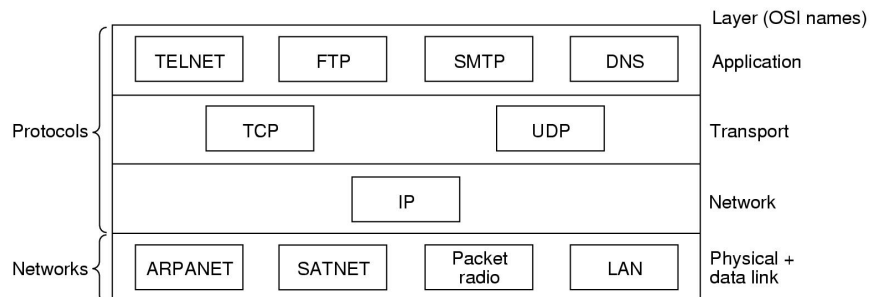
Note that in a network architecture model, only the lowest layer contains a physical connection, while all higher layers contain logical connections.

TCP/IP model

Protocols				Layer (OSI names)
TELNET	FTP	SMTP	DNS	Application
TCP		UDP		Transport
IP				Network
ARPANET	SATNET	Packet radio	LAN	Physical + data link

Networks

Our hybrid model

5	Application layer
4	Transport layer
3	Network layer
2	Data link layer
1	physical layer

CONNECTION-ORIENTED /
CONNECTIONLESS SERVICES:

Connection oriented service -
> Like the phone system. The system establishes a connection, uses it, and closes it. Acts like a tube. Data comes out the other end in the same order as it goes in.
> > **Connection Setup**
> > **Data Transfer**
> > **Connection Termination**

Connectionless service -
> Like the post office. Each message has the entire address on it. Each message may follow a different route to its destination. Ordering not maintained.

> > **Data Transfer**