Networking and the Internet

- **4.1 Network Fundamentals**
- 4.2 The Internet
- 4.3 The World Wide Web
- 4.4 Internet Protocols
- 4.5 Security

Network

- A network is a set of computers which are linked together.
  - The link can be with/without wire.

More precisely

- A network is a group of *nodes* connected in a way that allows information to be exchanged between them.
- A **node** is any device connected to the network, such as a computer, printer, etc.

Network Applications

- File Storage/Sharing/Backup
- Printing
- E-mail (Internal & Internet)
- World Wide Web access (HTTP)
- File transfer (FTP)
- Network Video (NVP)
- Chat (IRC, WhatsApp)
- Intranet

Network classifications

On the basis of ownership of software:

- Open network: communication software is freely available / public domain (e.g. the Internet).
- Closed or proprietary network: communication software is licensed or owned

Network classifications

- Personal Area Network (PAN)
  - Normally used for short range communications, e.g. between a wireless headset and a smartphone, or between a wireless mouse and PC.

- Local area network (LAN)
  - Normally consists of a collection of computers in the same general location, e.g. a single building or building complex such as a factory, hospital or university

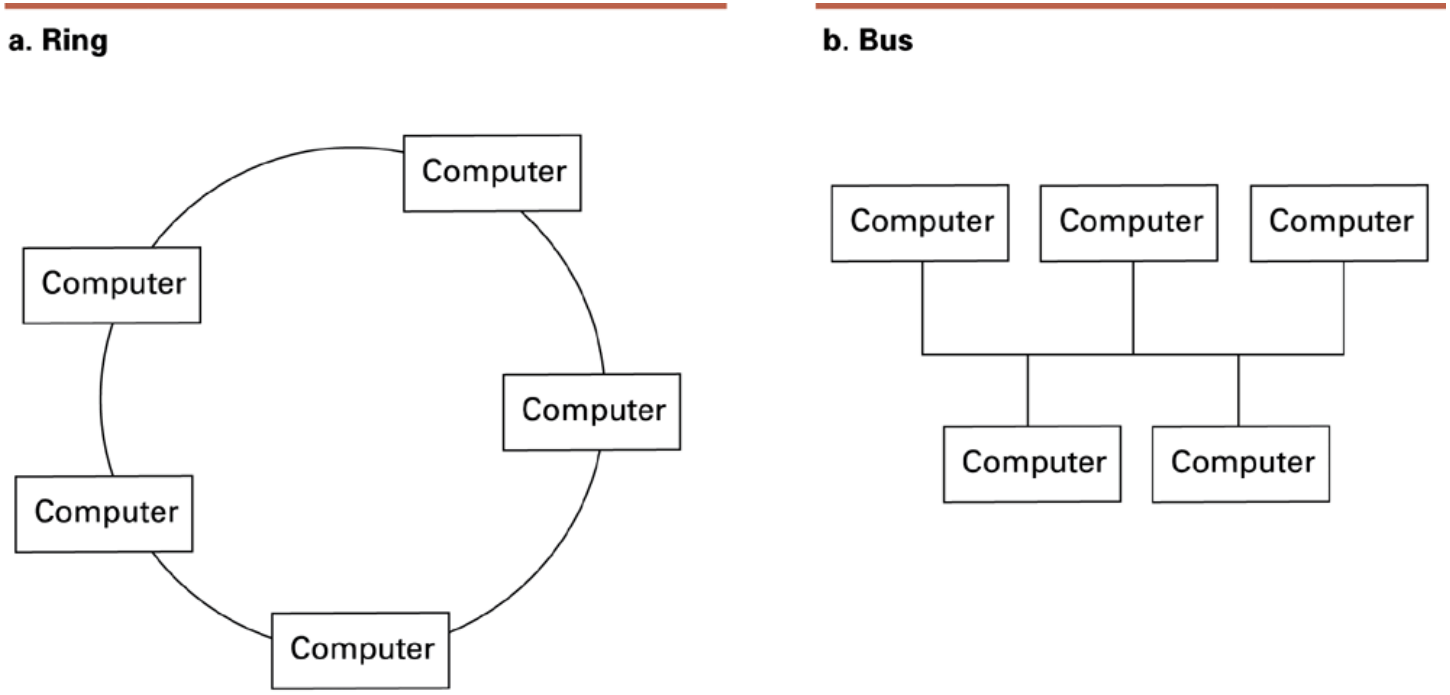
- Wide area network (WAN)
  - Links computers (or LANs) over greater distances: in neighbouring cities or on opposite sides of the world. Biggest WAN is the Internet

Network topology

It is the pattern in which the machines are connected.

- Ring
- Bus
- Star
- Irregular

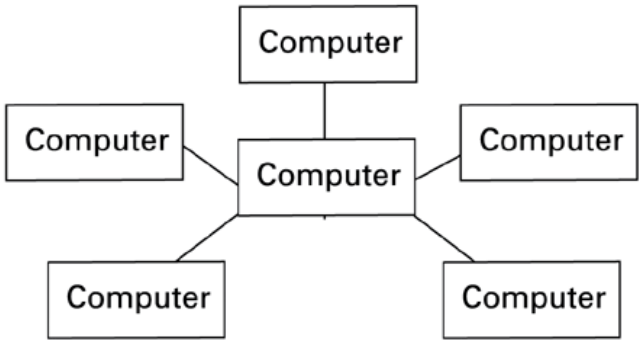
Figure 4.1 Network topologies



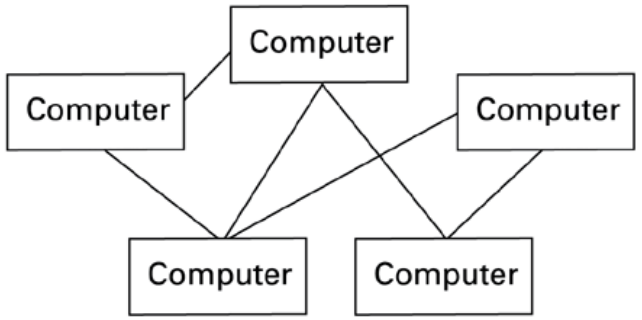
- Ring topology
  - machines are connected in one closed loop
- Bus topology
  - machines are all connected to a common communication line called a bus
- Star topology
  - one machine serves as a central focal point to which all the others are connected

Figure 4.1 Network topologies (cont'd)

c. Star



d. Irregular

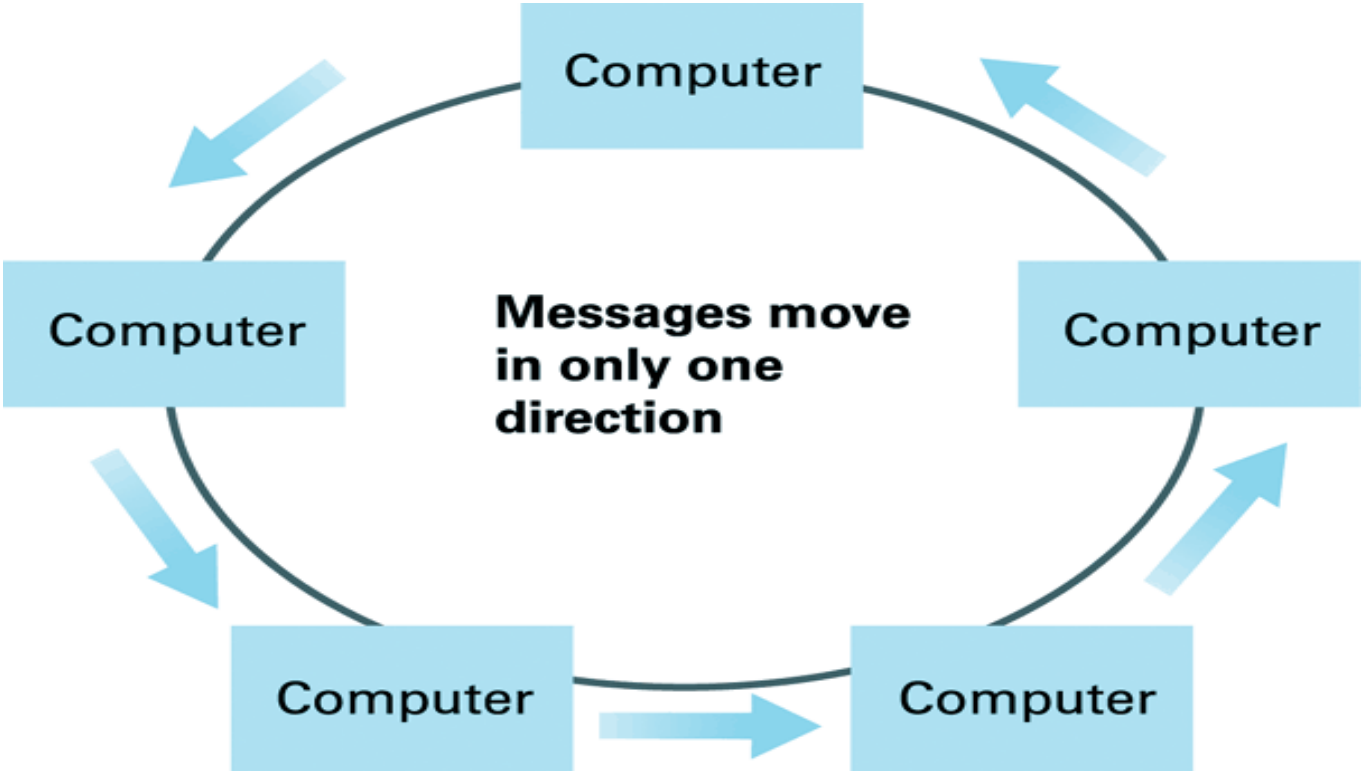


- A bus network may be constructed by linking computers to a central hub, which acts like a short bus: the hub passes on any signal it receives to all connected machines.
- Thus, the network looks like a star network but operates like a bus network.
- The difference is that in the star network, the central device is a computer that receives and processes messages from other machines.
- In the bus network, the hub provides a common communication path for the machines.

Protocols

- Protocols are rules governing interprocess communication.
- Network protocols establish rules for the conduct of network activities,
  - e.g. transmission of messages between networked machines
  - without rules all machines could transmit at the same time or fail to relay messages when needed

Figure 4.2: Communication over a ring network



Communication over a ring network

The **token ring** protocol was one approach to solving the problems of governing communication over a ring network:

•All machines transmit messages in only one common direction: all messages move round the ring in the same direction by being forwarded from computer to computer

•When a message reaches its destination, the destination machine keeps a copy of it and forwards a copy on. When the copy reaches the originating machine, that machine knows the message has been delivered and removes the message from the ring.

•But if machines constantly transmit their own messages without forwarding other machines'messages this scheme will not work. The solution to this involves a unique bit pattern called a **token.**

The **token ring** protocol

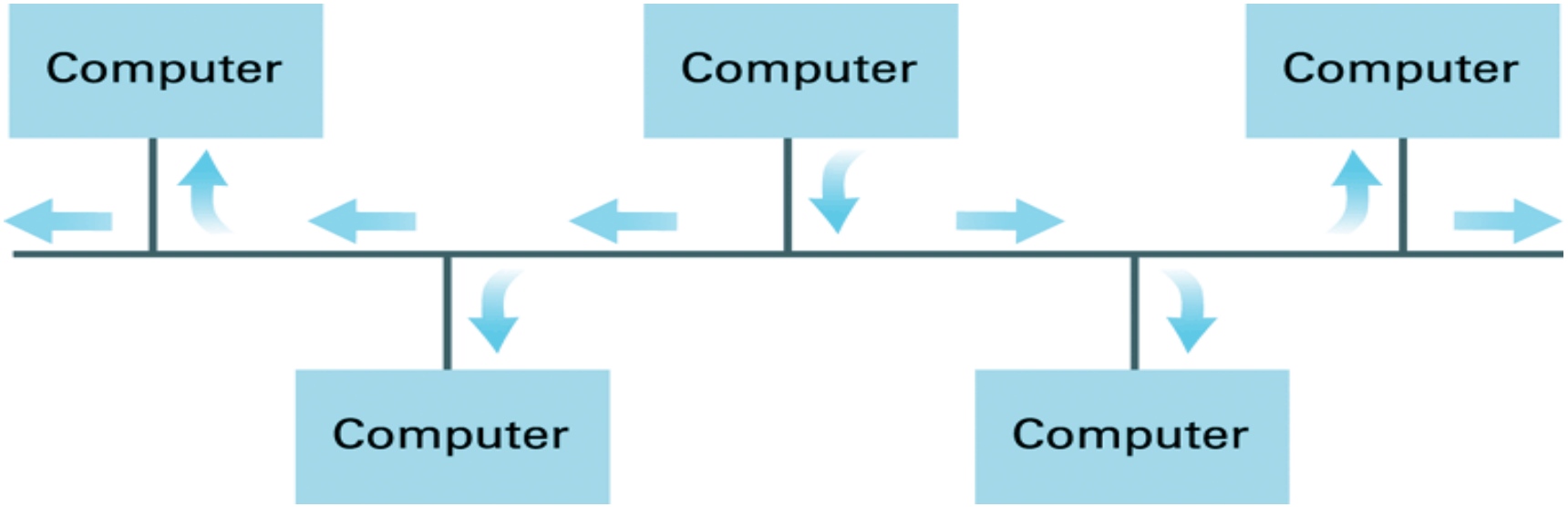
The token is passed around the ring.

A machine may transmit its own message only if it holds the token; a machine without the token can only forward messages.

If a machine receiving the token has messages of its own to transmit, then it transmits one message while holding the token. When this message has gone around the ring back to the machine, then the machine forwards the token to the next machine

In this way each machine in the ring has equal opportunity to send its messages as the token is passed on.

Figure 4.3: Communication over a bus network



Another protocol for coordinating message transmission is used in bus topology networks that is based on the Ethernet protocol collection: the CSMA/CD protocol.

Ethernet

- A technology used for local area networks (LANs) with a bus topology that defines how devices in a network communicate physically and electrically.
- It provides wired connectivity between devices within a network (e.g., computers, routers, and switches).

The **Carrier Sense, Multiple Access with Collision Detection (CSMA/CD)** protocol controls the right to transmit messages in an Ethernet system:

- Each message must be broadcast to all machines on the bus
- Each machine monitors all messages, but keeps only those addressed to itself
- A machine waits until the bus is silent before sending a message, then begins to broadcast it while still monitoring the bus
- If another machine also starts transmitting both machines detect the clash, they pause for a short, random time period, then try to transmit again

Connecting networks

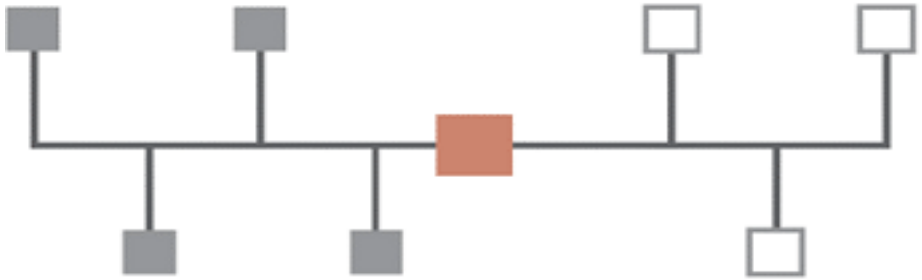
- May need to connect existing networks to form an extended communication system.
- Different methods/devices are needed according to the types of networks being connected
  - repeater
  - bridge
  - switch
  - router

Connecting networks

- **Segment**: Any portion of a network separated, by a repeater, switch/hub, bridge or router, from other parts of the network

- **Repeater**: a device that connects two buses into one longer bus. It amplifies or regenerates signals to extend the distance of a network
- Does not understand or manage data traffic - purely a signal booster.

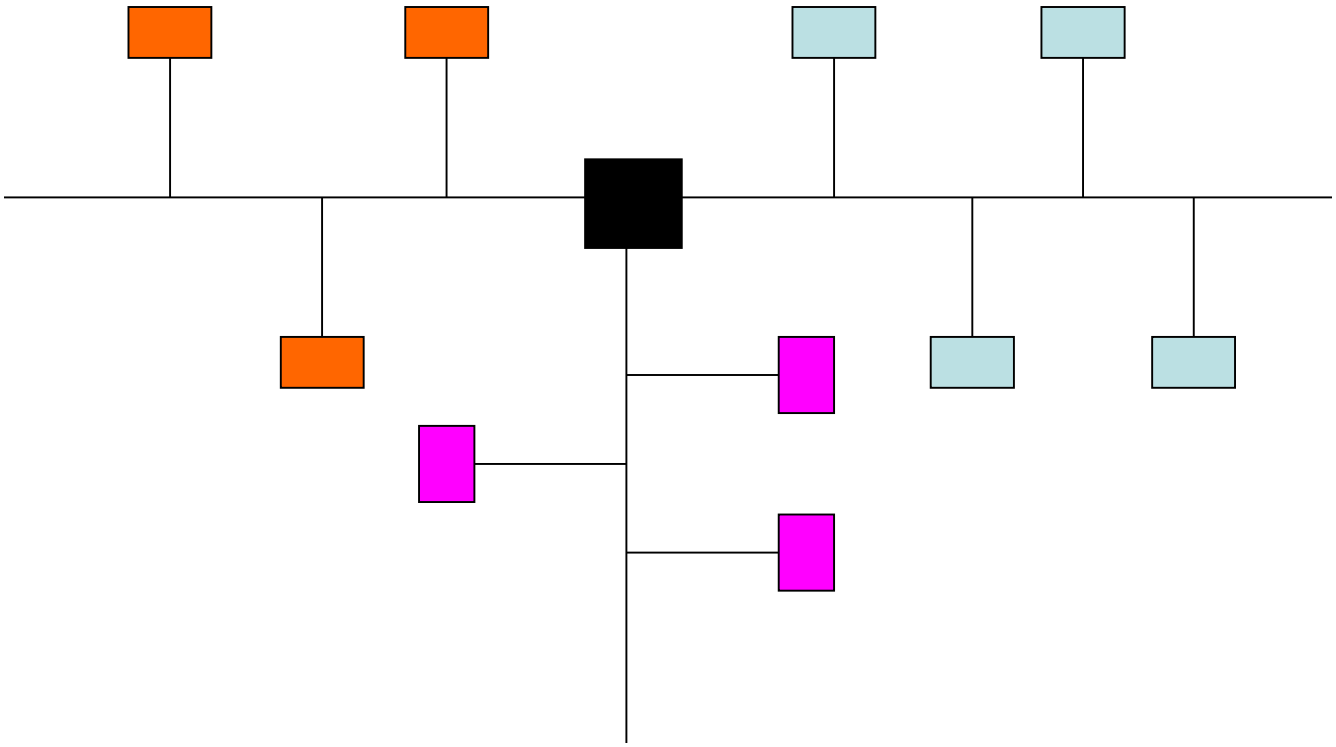
Connecting networks



A repeater or bridge connecting two buses

- A **bridge** only passes a message across the connection if the destination address lies on the other side of the connection. Connects and filters traffic between two or more network segments.
- So two machines on the same side of the bridge communicate without interfering with messages on the other side of the bridge.

A switch connecting multiple buses



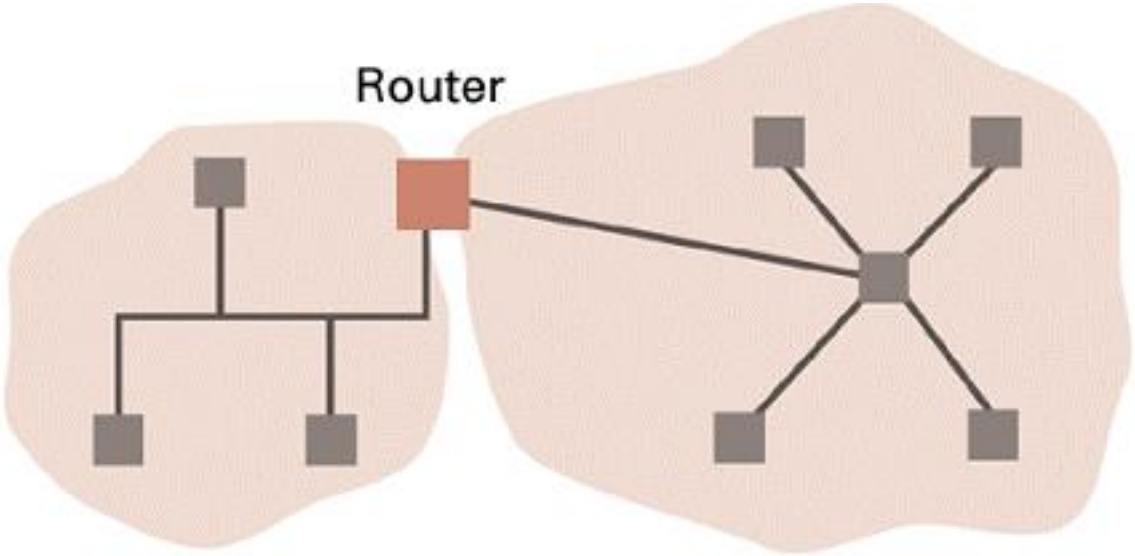
Connecting networks

- A **switch** is essentially a bridge with multiple connections, connecting two or more buses. It connects devices like computers, printers, and servers.
- Messages are relayed through the switch as appropriate to the destination address (as with a bridge) and this minimises the message traffic in each segment.
- Repeaters, bridges and switches connect networks having compatible characteristics but sometimes we need to connect incompatible networks.

Connecting incompatible networks

- The different networks must be connected to build a network of networks, known as the Internet.
- On the internet, the original networks continue to function as independent networks.
- A **router** handles the connection between 2 networks.

connecting two incompatible networks

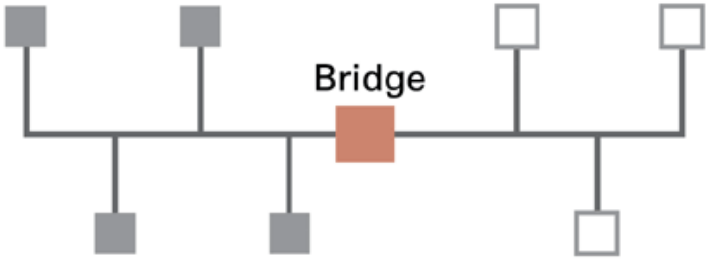


A router connecting a bus network to a star network to form an Internet consisting of two networks

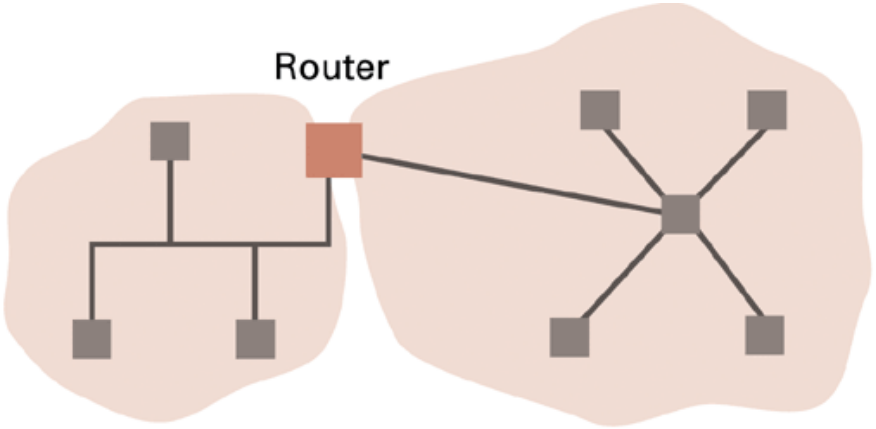
Connecting two networks with a router

- A router is a device belonging to both networks.
- The router forwards messages in one network into the other network.
- The router must convert between the systems used in the two networks, e.g.
  - the network protocols used
    - the router receives a message using one protocol and transmits it using another
  - the addressing systems used for messages
    - a new internet-wide addressing system is established

The distinction between a bridge and a router



a. A bridge connecting two bus networks to form one large network



b. A router connecting a bus network to a star network to form an Internet consisting of two networks

Protocols

- Protocols are rules governing interprocess communication.
- E.g. whether the communication is client/server or peer to peer.
- Encoding of information in a message.
- Packaging and addressing for transmission.
- Transmission and reception.

Inter-process communication

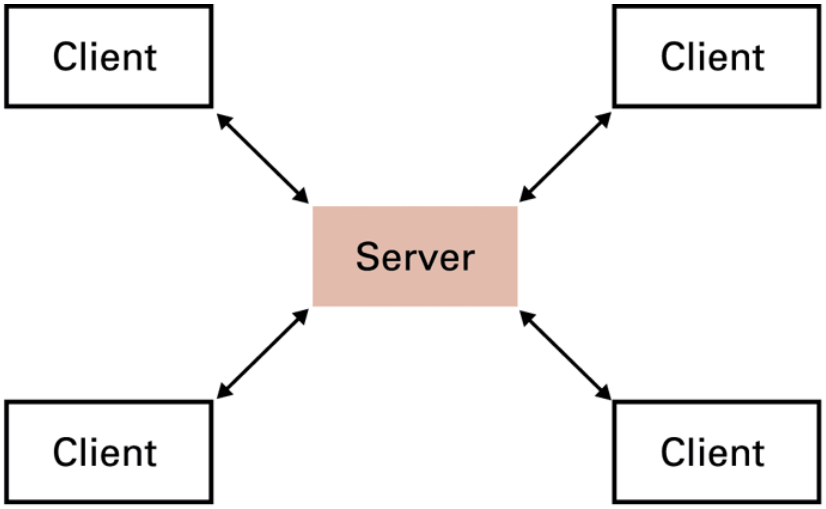
- Client-server model
  - The client sends requests to the server
  - One server, many clients
  - Server must execute continuously
  - Client initiates communication
- Examples
  - print server in a network
  - file server
  - database server

The client/server model

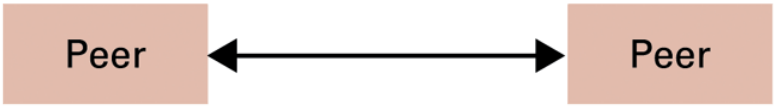
Inter-process communication

- Peer-to-peer model (P2P)
  - Every device is both a client and a server, capable of requesting and sharing resources.
  - Peer processes can be short-lived
- Examples
    - File sharing on the Internet
      - not using a central server (distribution centre)
    - Instant messaging

Figure 4.6 The client/server model compared to the peer-to-peer-model



a. Server must be prepared to serve multiple clients at any time.



b. Peers communicate as equals on a one-to-one basis.

Distributed Systems

Consist of software units that run as processes across different computers, enabling interaction via networks.

Cluster Computing: Multiple independent computers work together to provide high-performance computation or services.

Grid Computing: Loosely coupled distributed systems working together on large tasks.

Cloud Computing: Allows clients to rent shared computing resources over the network, providing scalability and flexibility. E.g. Google Apps