Networks

Networking of computers has become ubiquitous (cf. WWW).

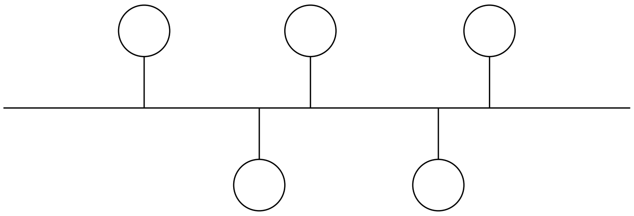
Two major types of networks depending on geographical distances.

1. *Local Area Networks* (LAN's). Connect 100's of computers within a maximum distance of a few kilometers. Often limited to a single building. LAN's can be connected together via bridges (also called switched networks).
2. *Wide Area Networks* (or WAN's or long haul networks). Connect 1000's of computers all over the world.

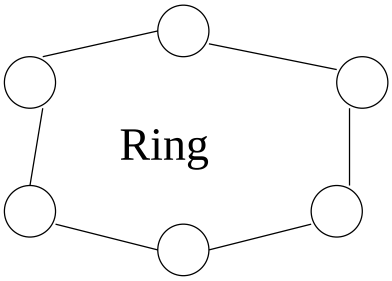
Network Architectural Issues

- How are "nodes" connected?
- What is a message? How are messages routed from node to node?
- What is the "quality of service" of the network?

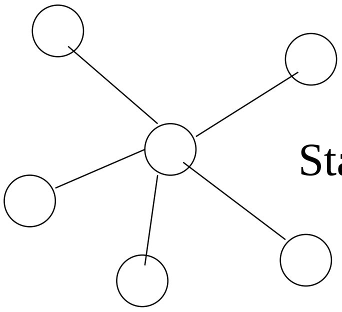
Network topologies



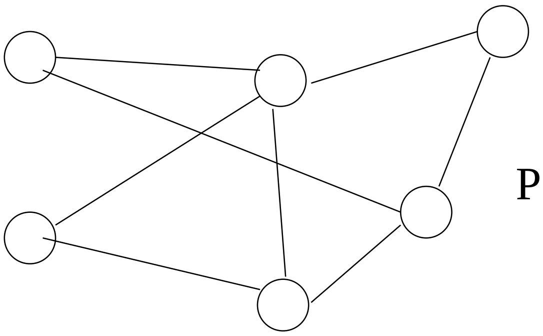
Bus (e.g., Ethernet)



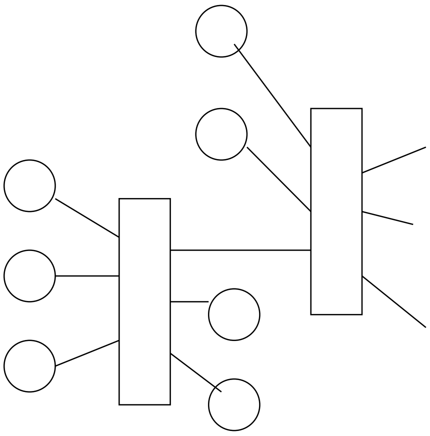
Ring



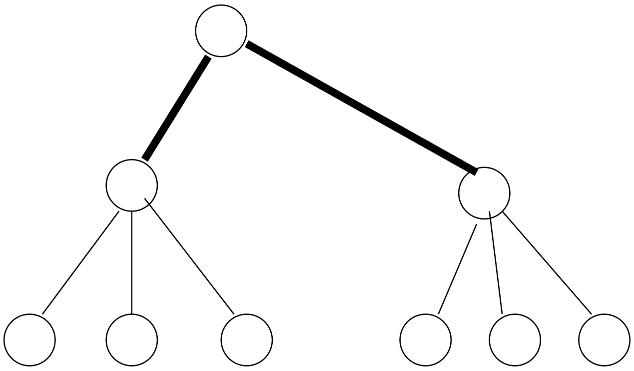
Star



Point to point



Switch-based



(Fat) Tree

Typical network bandwidths

Ethernet: Originally 10 Mbit/sec. Now Fast Ethernet 100 Mbit/sec. In the near future Gigabit Ethernet

Internet (successor of Arpanet): Point to point with special processors (Interface Message Processor IMP) used for protocol handling, routing etc. Currently copper co-axial cables yield bandwidths of the order of 100 Mbits/sec. Fiber optics yield 1 Gbit/sec.

ATM (Asynchronous transfer mode): can yield from 150 Mbit/sec to 2.5 Gbit/sec. Has been used in WAN's and could be used in LAN's. For the latter there is a number of emerging technologies that are for point-to-point or star topologies (e.g., Myrinet)

Message format

- Header (request type, address of where it has to go)
- Payload (Data or address; from a few bytes to KB's)
- Checksum (for checking that the message is correct)

Long messages can be split into *packets*.

Sending/receiving messages requires a (complex) software protocol with several layers (TCP/IP, ISO standard etc.; cf CSE/EE 461)

LAN's

Generally the interconnection is a bus (Ethernet) or a ring. Nowadays, though, ATM switches are becoming more and more popular (and affordable).

Ethernet = broadcast medium. (10 Mbits/sec to 100 Mbits/sec)

Collision/detection with backoff

WAN's

Point to point topology

Store-and-forward routing (virtual circuits or packet switching)

In virtual circuits, the network functions like the telephone network. A path from source to destination is set before message transmission.

In packet switching, long messages are split into packets that do not necessarily follow the same route from source to destination. Packets can be dropped, delivered out of order or duplicated. This implies lots of software! But can provide better performance because network congestion can be avoided.