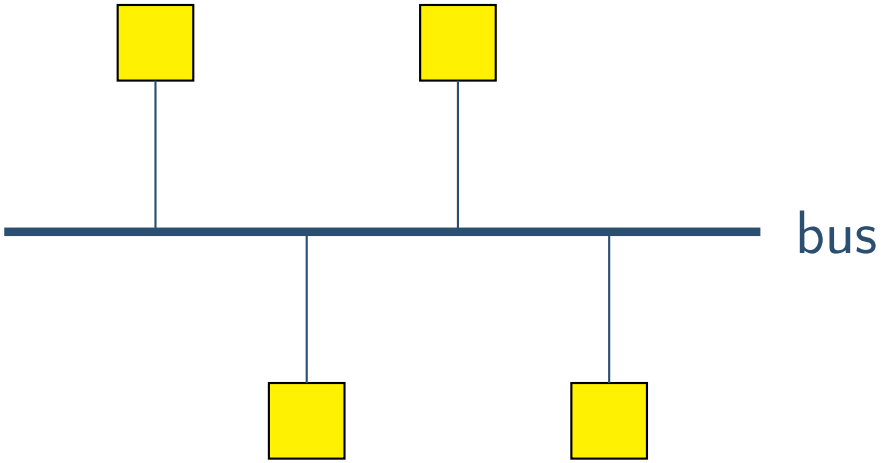
Networks

Networks

Network: several computers who can communicate.

Bus topology:



Main example: Ethernet (1980–today: coaxial cable, twisted pair, 10Mb–1000Gb).

Hardware has globally unique MAC addresses (IDs).

Networks

Classic Ethernet:

- Specify address when sending.
- All processors can check if something is there.
- Wait random amount before trying again.
- Wait longer amount if failure again, etc.
  but send for long enough that all can detect the collision.
- Protocol says how to do this.

Compare: conversation at dinner table.

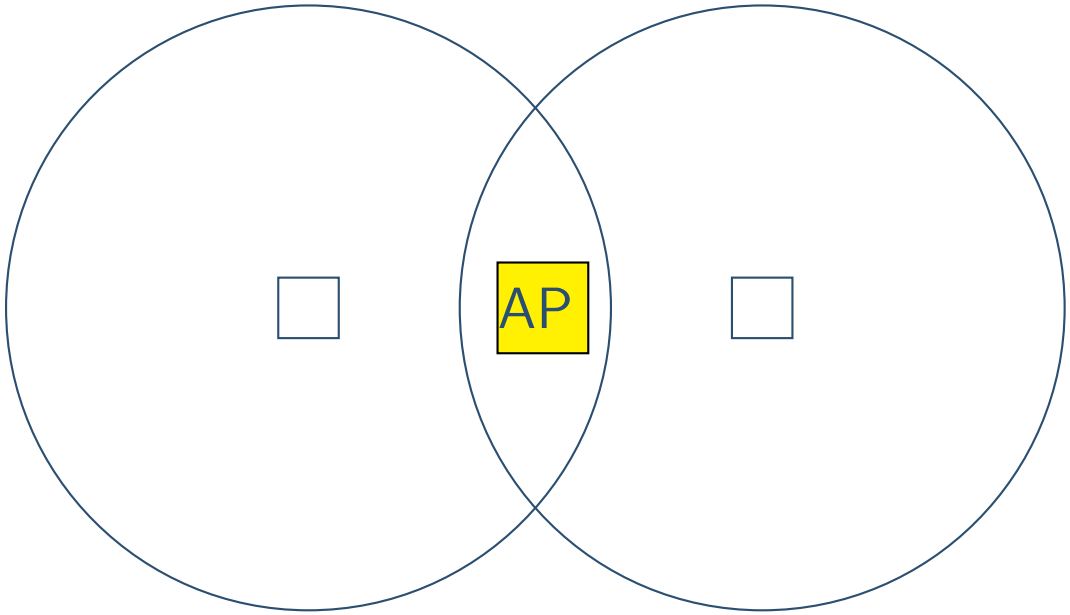
Networks

Other topologies:

- ring
- star
  - — popular in wireless networks
  - — center is access point (AP)
  - — center is a switch for Ethernet

Wireless networks

Hidden terminal problem:



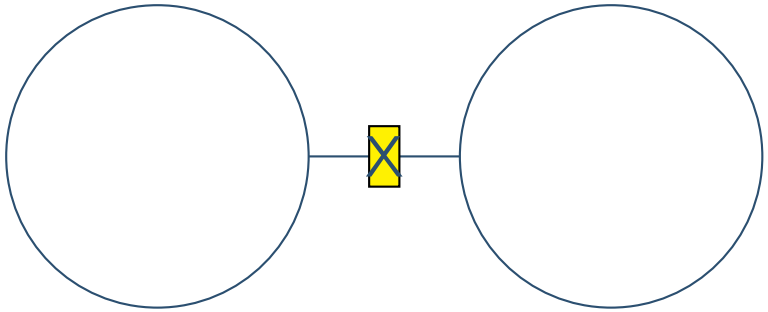
Can't tell if another sends at same time.

Collision avoidance. Wait for longer quiet periods. Wait for ACK for sending (AP will only send ACK to one). Wait for ACK for reception (else, conclude collision).

Ethernet: collision detection. Nodes can hear and speak at the same time.

Connecting networks

Connecting networks:



X:

- repeater — sends further, required by physical limitations
- bridge — only sends further if sent to address on other side
- switch — like bridge, but connecting more than 2

Connecting networks

Connecting dissimilar networks into internet (small i)
— point were connected is gateway

- Connect with routers - often have firewall packet filters, checking source, destination, port
- Home wireless — AP and router in 1 box = gateway
  - Have network in home
  - Router connects to Internet
- Router forwards messages towards proper destination
- Forwarding table — used to figure out from address where to send next

Networks

Peer-to-peer model (P2P) vs. Client server model

P2P: same roles/software at each end. Examples: file sharing.

Client-Server: different roles and software at each end. Example: web server, printer.

Internet

Internet — an internet

- Links together LANs, MANs, WANs, WLANs, globally
- Started in late 1960's.
- Note: the Internet is the actual network, WWW is one concrete use of it (started in the 1990's).

Example: wireless connection (or cell phone).

- Wireless device connects to AP (access point)
- AP connected to access ISP
  — Internet service provider: TDC, AOL, SDU, etc.
- often connect via cable or telephone

Internet

IP addresses:

- IPv4: 32 bits: 10.110.4.199
- IPv6: 128 bits: 2001:0DB8:AC10:FE01 — hexadecimal (only first half shown)

Domain name server (DNS) — Internet directory
212.97.129.250 vs. www.sdu.dk

domain — region of Internet operated by 1 entity (university, company, etc.). Domain names assigned by registrars.
Top-level domains — .edu, .com, .dk
Example: logon9.imada.sdu.dk — imada is a subdomain

No more IPv4 addresses left (Jan 2011). IPv6 still in early deployment. NAT translation (using port numbers) and private networks addresses (192.168.X.X, 10.X.X.X) has helped. DHCP.

Protocols

Layered models
— abstraction to handle complexity

Communication protocols at layer N
— see virtual machine connection at layer $N-1$.
— invoke facilities at layer $N-1$ to transmit layer N data units.

Note: most networks (including the Internet and other TCP/IP networks) are packet switched: message chopped up into several packages, which may take individual routes, and which are assembled at the destination. Better use of bandwith, more robust. Higher latency.

Protocols

4 layer Internet Model — TCP/IP (vs. OSI 7 layer model).

- Application — ssh, sftp, HTTP, SMTP. Generates message, gives destination address.
- Transport — Converts messages to packets, orders packets
  - TCP — transmission control protocol
    — establishes a connection before sending
    — messages and acknowledgements
    — example: e-mail
  - UDP — user datagram protocol
    — no connection established — example: VoIP
- Network – Assigns intermediate address to each packet.
  - IP — internet protocol
    - converts packets to datagrams
    - assigns intermediate addresses
- Link – Transfers packets.

Protocols

Internet Model — TCP/IP

Messages sent through a path in Internet.
Going from one machine to the next — hop

In intermediate stops for a message, only lower layers involved.

Determining which application protocol should get incoming message — port number — 80 is HTTP

Hands-on Internet

Start a command promt.

(Win 8: Win-X, choose command prompt, Win 7: Search for "command" in start button, Ubuntu (Unity): search for "terminal" in Ubuntu-button (top, left), Mac OS X: search (top, right) for "terminal").

Try the following commands:

- Show network interface info: ipconfig /all; ifconfig; /sbin/ifconfig
- Show active connections: netstat
- Contact host: ping google.com
- Show route to host: traceroute google.com; tracert google.com

(Some must be stopped by "^C")

Application: email

Some protocols involved:

- SMTP — sending e-mail between machines
- MIME — make data compatible with SMTP
- accessing e-mail
  - POP3 — mail transferred to your own computer
  - IMAP — mail stays on mail server
    — can access mail from other computers

Application: WWW

hypertext — text documents containing hyperlinks.
hypermedia — more than text (audio and/or video)

Hypertext Transfer Protocol (HTTP)
— to get Web pages displayed by your browser
HTTPS — using SSL or TLS — Transport Layer Security

URL = Uniform Resource Locator — address
Example: http://imada.sdu.dk/~joan/intro/13slides5.pdf
protocol://host with document/directory path/file (document)

HTML — Hypertext Markup Language — can include JPEG, etc.
XML — more general than text
— standardized style organizing and making searching easy
— for recipes, one markup language — for music another

www

Different systems for server-side or client-side functionality.

PHP, ASP, JSP for server side functionality
(database operation, for example)

JavaScript, Applets, Flash — to run programs on client side

Security problem — running programs from elsewhere