Deadlock

Another problem:

- Process 1 and Process 2 each need same 2 resources (printer and disk).
- Process 1 gets 1 resource.
- Process 2 gets the other.
- Neither process can continue. — Deadlock

Deadlock

Deadlock can occur if:

1. There is competition for non-shareable resources
2. Resources requested on partial basis
   — after getting some, may request more
3. Can't take resources back

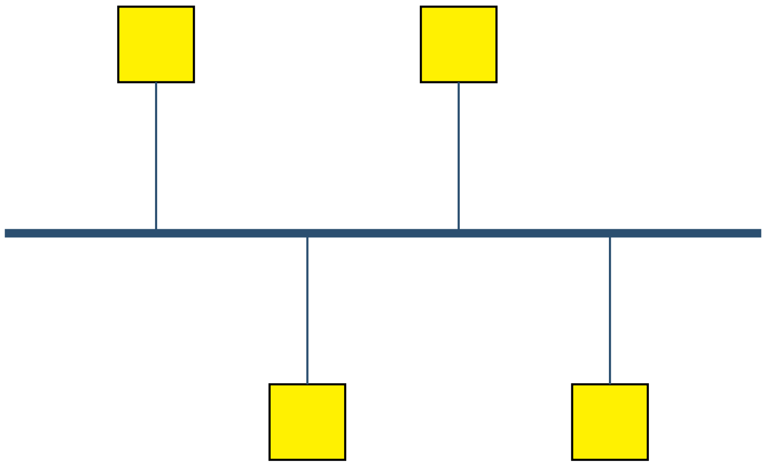
Possible solutions:

- Deadlock detection and correction — remove condition 3
- Spooling
  - device driver saves data (for printer)
  - sends data later
    — process continues as if printing completed

Networks

LAN — local area network
— mostly Ethernet or wireless — 1 building
WAN — wide area network — ex. Internet

Configurations — topology



bus   older Ethernet

Networks

Many variants of Ethernet.
Original:

- 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.

Networks

Other topologies:

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

Wireless:

- WiFi (Wireless Fidelity) — one wireless standard
- WPA2 — security standard

Networks

In a ring topology with N processors, how many rounds does it take for one processor to send a message to another in the worst case? Same question for a star topology.

A. ring – 1; star – 1;

B. ring – 2; star – 2;

C. ring – $\lfloor N/2 \rfloor$; star – 2;

D. ring – $\lfloor N/2 \rfloor$; star – $\lfloor N/2 \rfloor$;

E. ring – N; star – $\lfloor N/2 \rfloor$;

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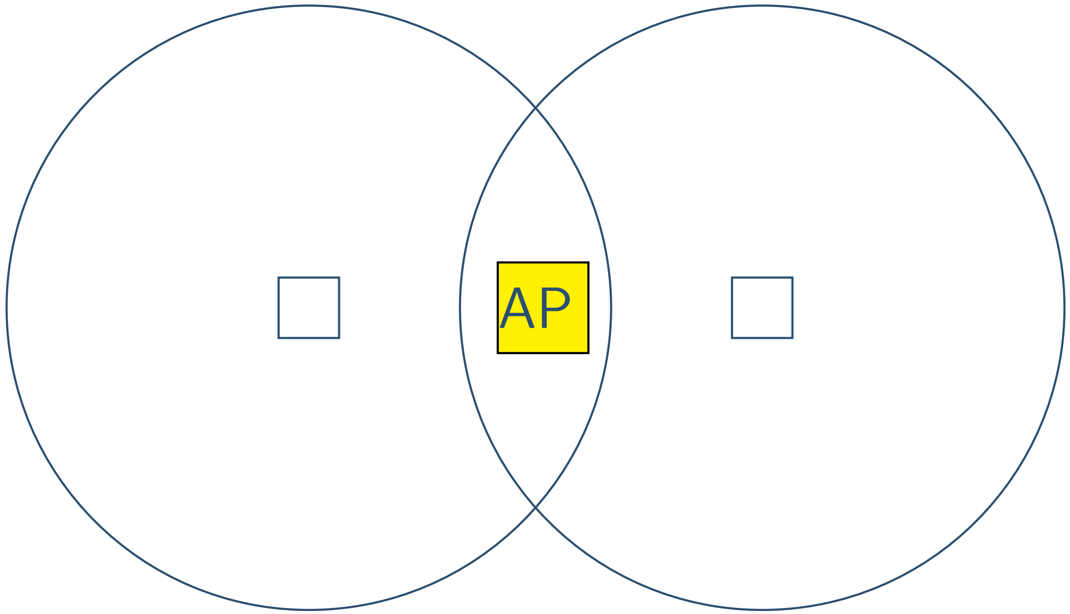
Networks

In a ring topology with N processors, how many rounds does it take for one processor to send a message to another in the worst case? Same question for a star topology.

C. ring – $\lfloor N/2 \rfloor$; star – 2;

Wireless networks

Hidden terminal problem:



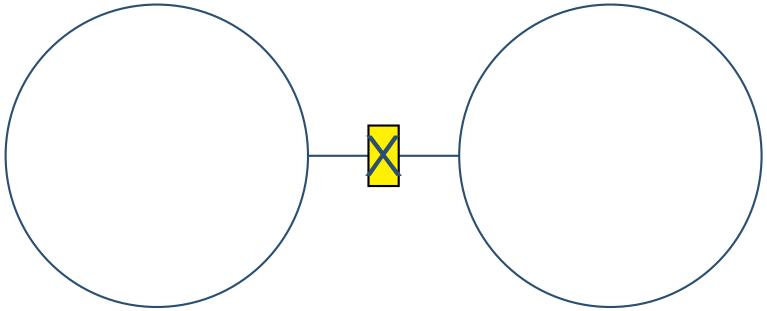
Can't tell if another sends at same time.

Protocol could say: Need OK from AP before sending
collision avoidance

Ethernet — collision detection

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
— depends on what you are doing

Client/server model

Interprocess communication example:
Parts of OS share time and communicate
— scheduler needs help from memory manager to start a process

Server could be on same machine or same network
(distributed system).

Distributed computing

distributed system

file server		cloud computing
Web server	cluster computing	pools of shared computers,
print server	Grid computing	rent computing power, space
mail server		Dropbox

Peer–to–peer (P2P)

Example: 2 processes communicating over the network

Example: file sharing

- due to legality? — copyright can be enforced, even without server
- due to efficiency — with one server (star), have bottleneck

Internet

Internet — an internet

- links together LANs, MANs, WANs, WLANs, globally
- not new — saw in mid 1970s, sent e-mail in early 80s
- Internet was before WWW

Example: wireless connection — similar to cell phone technology

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

Internet

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

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

Domain name server (DNS) — Internet directory

IP addresses

IP addresses: IPv4: 32 bits: 10.110.4.199

Which number base are IPv4 addresses written in?
How large can a number between dots be?

A. decimal, less than 256 between dots

B. hexadecimal, less than 256 between dots

C. decimal, less than 512 between dots

D. hexadecimal, less than 512 between dots

E. decimal, less than 1024 between dots

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IP addresses

IP addresses: IPv4: 32 bits: 10.110.4.199

Which number base are IPv4 addresses written in?
How large can a number between dots be?

A. decimal, less than 256 between dots

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

Protocols

Layered models
— abstraction to handle complexity

Philosopher in Thailand	⟷	Philosopher in Denmark
Translator in Thailand	⟷ English ideas ⟷	Translator in Denmark
Computer sending e-mail	⟷	Computer receiving e-mail

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.

Protocols

ISO Open System Interconnection Model (OSI)

vs.

Internet Model — TCP/IP

Protocols

Internet Model — TCP/IP

- Application — ssh, sftp, HTTP, SMTP
- 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
- IP — internet protocol
  - converts packets to datagrams
  - assigns intermediate addresses

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

Browsers

World Wide Web (WWW) — for making information available.
Which browser do you use most?

A. Firefox

B. Internet Explorer

C. Chrome

D. Opera

E. Safari

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No correct answer.

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