CSS 503A Lecture # 14 2014-05-15

Administrivia

OSSF

- file data
  - contiguous allocation of blocks
  - linked list allocation of blocks
  - allocation table (FAT)
  - direct & indirect index structure
    - slightly slower for larger files

- journaling file systems

- free space management
  - bit vector
  - linked list

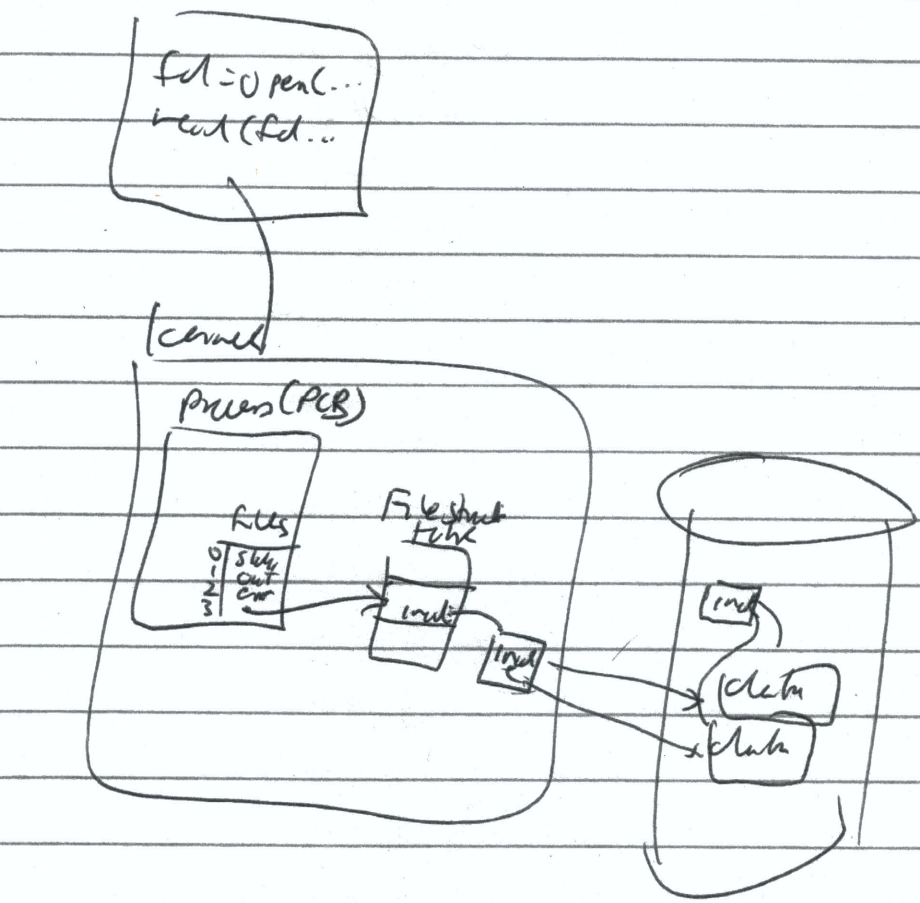
- RAID
  - RAID0 — Striping
  - RAID1 — mirroring
  - RAID4 } Reed Solomon error correction
  - RAID5 }
  - RAID6 }

- Hamming error correction (7, 4)
  - single bit error correction
  - double bit error detection

Virtual Filesystem

-- file ops implemented in kernel via function pointers
  - C-style O-O

Unix Filesystem



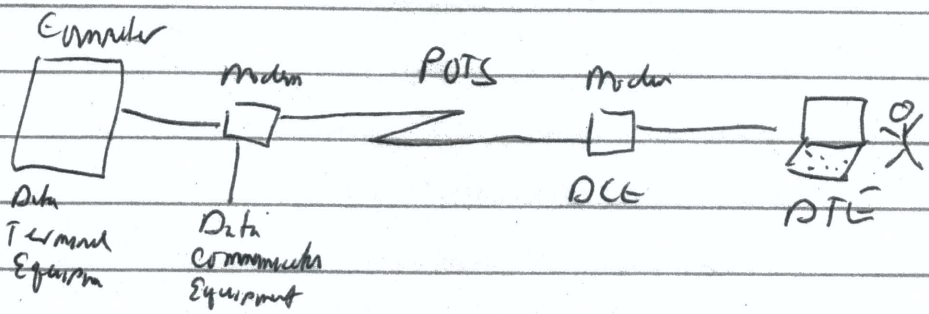
* In-memory inode is same structure as on-disk inode

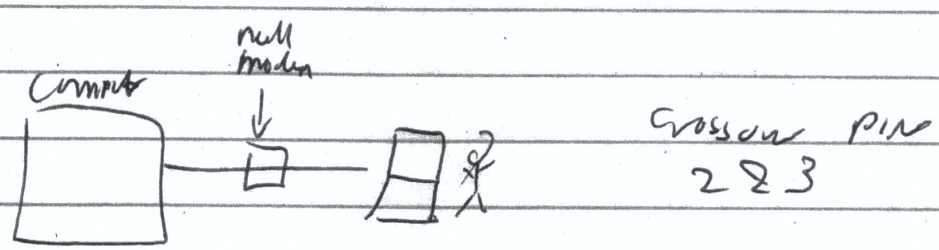
- shutting guess (again) ....

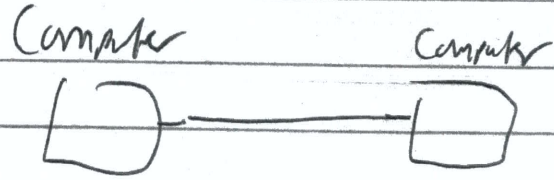
Distributed Systems

- c.e. networking

RS232 - used to be ubiquitous
- Pretty much superceded by USB
(much more complex protocol)
- Simple (?)
  - bits per second
  - parity
  - flow control







- dialup network
- store & forward
- UUCP
  - bang paths
- applications on top of UUCP
  - email
  - usenet news (BBS)

/dev/tty
- ioctl to set parameters

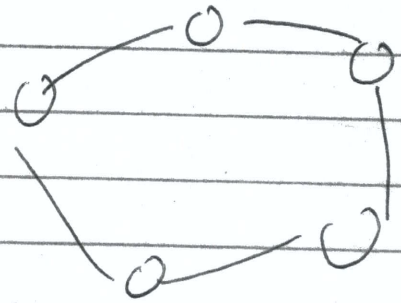
But, for every solution, there is a problem
- line noise
- cutting through cable
- hunters shooting out fiber optic cable

The network is not reliable
See: ~~reading~~ "Fallacies of Distributed Computing"

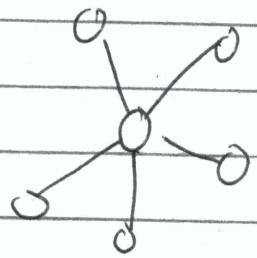
Fallacies of Distributed Computing

1) The network is reliable
2) Latency is Zero
3) Bandwidth is infinite
4) the network is secure (IOT: I'm looking at you)
5) Topology doesn't change
6) there is a single administrator
7) transport cost is Zero
8) the network is homogeneous

Network Topologies

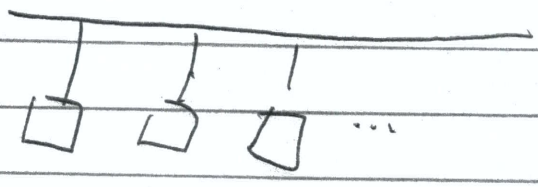


Token Ring



star

multi-way communication
- common bus
- ethernet



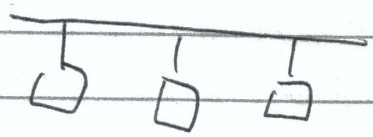
ethernet:

- each computer "broadcasts" messages
  - messages w data structure, "packets"
    - includes Id (address) of sender & destination "MAC" address
  - other computers ignore messages not for them
  - if two computers try to broadcast at same time, they back off & retry later
  - exponential back-offs
    - successive retries increase delay (exponentially)
- works well if utilization is below bandwidth capacity
  - kinda like hashing
- Security? What security?
  - the network is trusted
  - only send encrypted data
    - can still track for "metadata"

LAN: local-area network

Data Link Layer

- trunk: Ethernet



CSMA/CD
- Carrier sense multiple access / collision Detection

* listen / transmit / detect collisions
  - exponential backoff on collision

MAC (media access controller) address
- unique address for NIC (network interface card)

Packet (frame)

Max frame = 1518 bytes
(does not count preamble/interframe gap)

** 8 byte/octet/g

Non-local (wide area) network

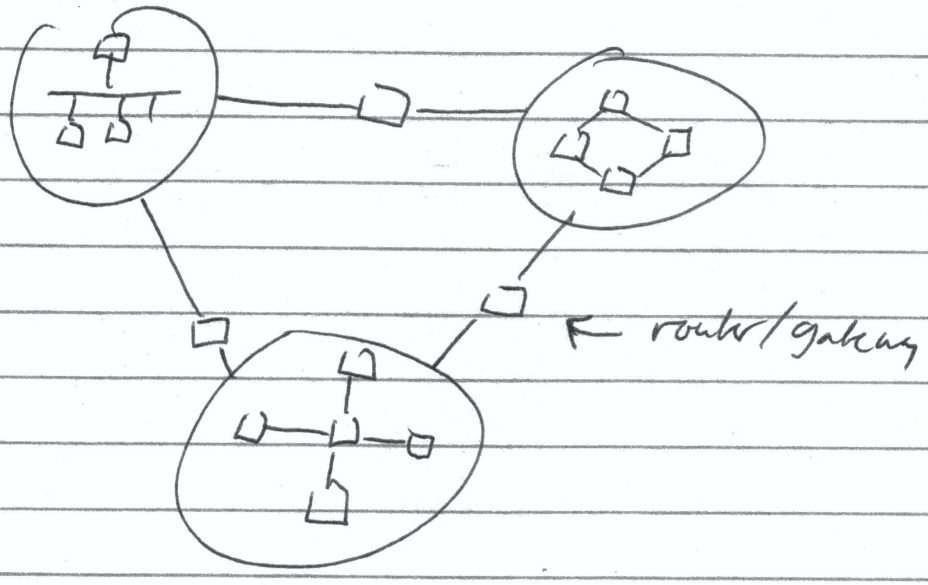
- local area network (LAN) : single campus (nodes are docked)
  - 100 MB - 10 GB
    - higher speeds
  - all nodes visible
    - "broadcast" messaging
  - nodes: computers or peripherals
    - by hub-connected router

- Wide-area Network (WAN)
  - geographically-separated sites
  - point-to-point (P2P) "long haul lines"
    - Google fiber periodically shot by hunters
  - lower bandwidth than LAN
    - up to GB with fiber

telephony predates internet
- T1 : 24 channels
  - phone lines
  - 1.544 MB
- T3 : 45 MB
  - telephony standards

Network of Networks

"an internet" vs "the Internet"



⇒ Complex protocols

Routing

- fixed vs dynamic
- session-based (virtual)
- connection-oriented vs connectionless

OSI - Open System Interconnection

- 7 layers of protocol:

host	7	application	(data)	ssh / telnet / ftp / http
	6	presentation		encryption UTF-8
	5	session		
	4	transport	(segment (TCP) / datagram (UDP))	TCP / UDP
media	3	network	(packet)	IP
	2	data link	(frame)	ethernet
	1	physical	(bit)	ethernet

- while the academics in Europe were trying to get it "right", Americans were busy inventing TCP/IP & UDP/IP

TCP/IP

- 2-layer protocol
- developed by people who wanted to get "stuff" done
- standards docs: RFC
  "Request for Comment"

OSI (cont.)

1) Physical
   - electromechanical
   - Wires: twisted pair vs Coax vs fiber

2) Data Link
   - framing
   - physical error detection/recovery

3) Network
   - Connections
   - routing
   - Load balancing
   - Routers: operate at layer 3

4) Transport
   - message transfer (end-to-end)
   - Packetizing
     - ordering/error recovery
   - flow control
   - physical address

OSI (cont.)

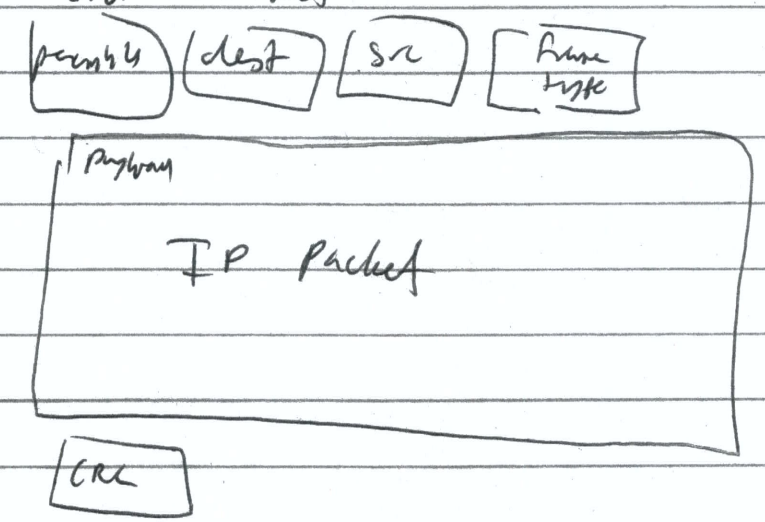
5) Session
- Process - Process communication protocol
(e.g. remote login, mail/file transfer)

6) Presentation
- data format conversion
- UTF-8 / encryption

7) Application
- end-to-end interaction

Network Layer

IP Address



IP packet: ethernet payload
(to Ethernet protocol,
IP packet is just
a bunch of bytes)

IPv4 Datagram

	Byte (octet)	Bits	
word 0	0	0-3	Version # (4)
		4-7	IHL (Internet Header Length) = # 32-bit words in header
	1	8-13	DSCP (Differentiated Service Code Point)
			(formerly: ToS - Type of Service)
		14-15	ECN (Explicit Congestion Notification)
	2,3	16-31	Total Length
			- min packet = 20 bytes (min header)
			+ 0 data bytes
word 1	4,5	0-15	Identification
	6	16-18	Flags
	6,7	19-31	Fragment Offset
word 2	8	0-7	* TTL (Time to Live): max # hops
	9	8-15	* Protocol (e.g. TCP/UDP)
	10,11	16-31	* Header checksum
word 3	12-15	0-31	Source IP Address
word 4	16-19	0-31	Dest IP Address
(words 5-14			Zero or more options)

+ Data