

# Input/Output System

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Virendra Singh

Associate Professor

Computer Architecture and Dependable Systems Lab

Department of Electrical Engineering

Indian Institute of Technology Bombay

<http://www.ee.iitb.ac.in/~viren/>

E-mail: [viren@ee.iitb.ac.in](mailto:viren@ee.iitb.ac.in)

*CP-226: Computer Architecture*

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**CADSL**

# Input/Output

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- Disks
- Networks
- Buses
- Interfaces



# Input/Output

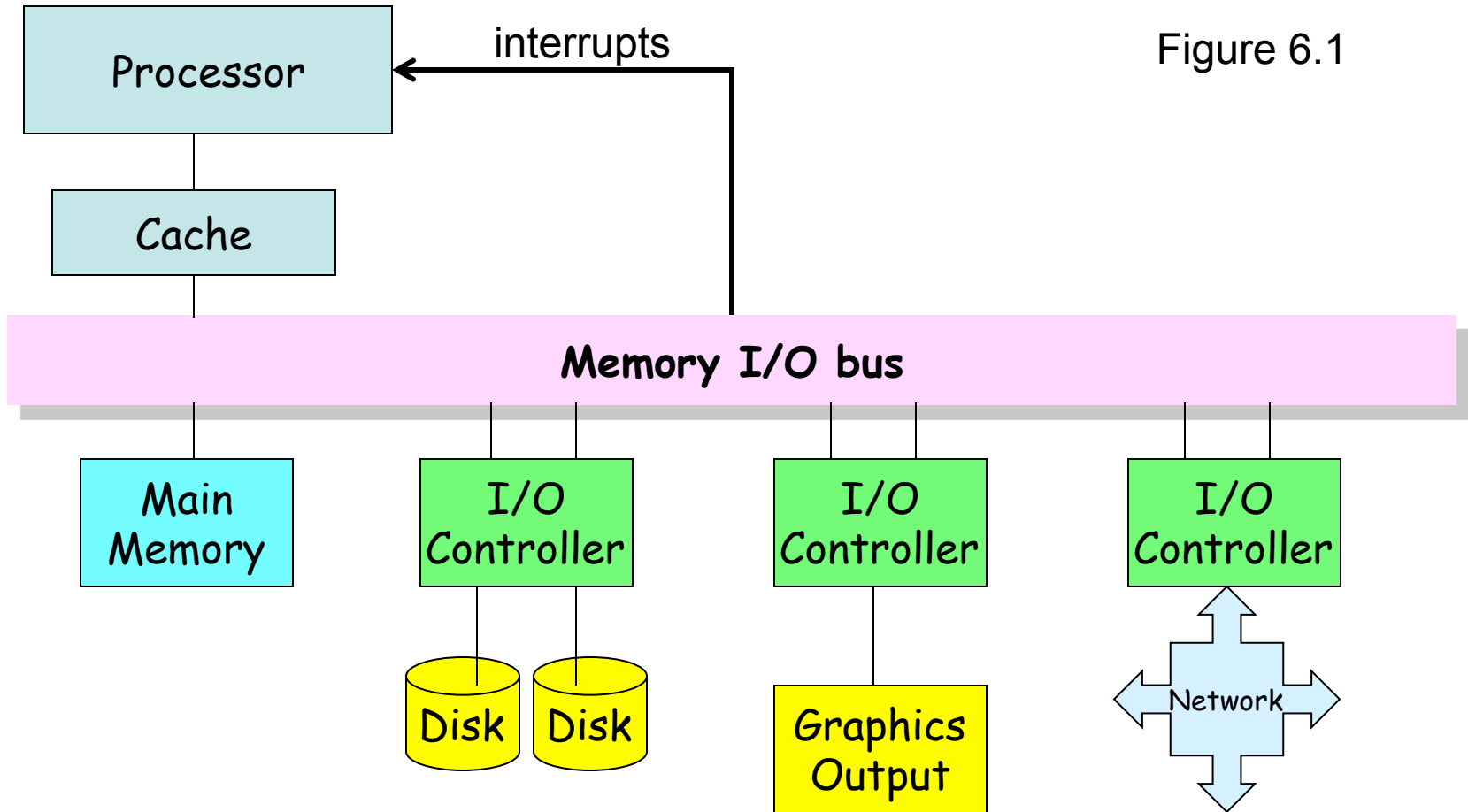
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- I/O necessary
  - To/from users (display, keyboard, mouse)
  - To/from non-volatile media (disk, tape)
  - To/from other computers (networks)
- Key questions
  - How fast?
  - Getting faster?



# Typical Collection of I/O Devices

Figure 6.1



# Examples

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Device	I or O?	Partner	Data Rate KB/s
Mouse	I	Human	0.01
Display	O	Human	60,000
Modem	I/O	Machine	2-8
LAN	I/O	Machine	10000
Tape	Storage	Machine	2000
Disk	Storage	Machine	2000-100,000



# I/O Performance

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- What is performance?
- Supercomputers read/write 1GB of data
  - Want high bandwidth to vast data (bytes/sec)
- Transaction processing does many independent small I/Os
  - Want high I/O rates (I/Os per sec)
  - May want fast response times
- File systems
  - Want fast response time first
  - Lots of locality



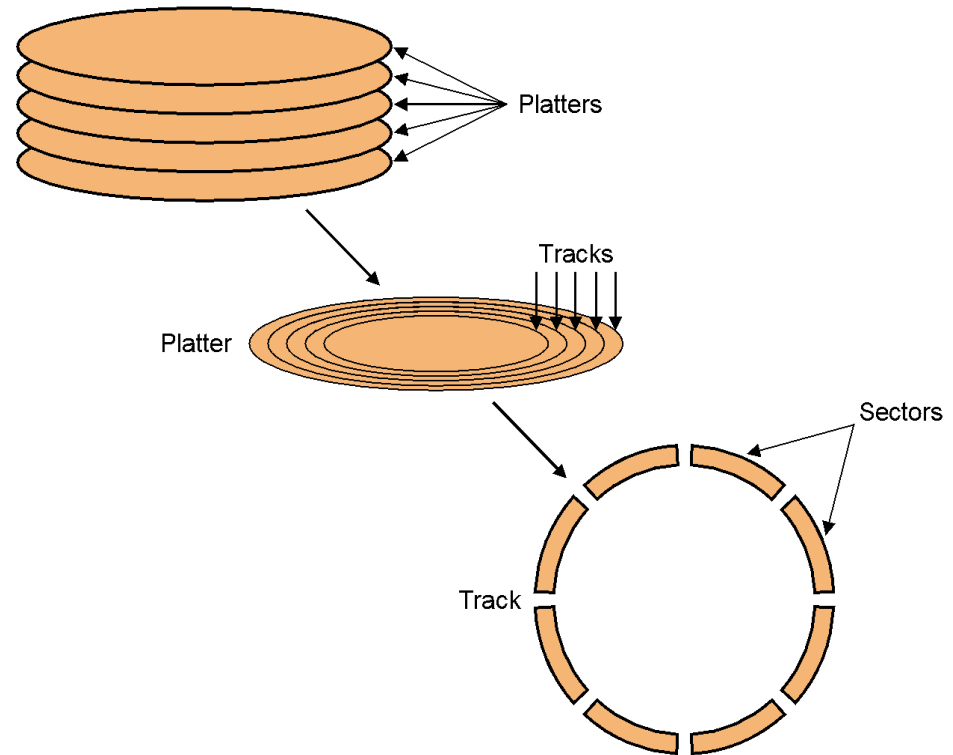
# Faulures

Operator	S/W	H/W	System	Year
42%	25%	18%	Datacentre (Tandem)	1985
18%	44%	39%	Datacentre (VAX)	1985
50%	14%	19%	PSTN	1996
60%	25%	15%	Internet Services	2002



# Magnetic Disks

- Stack of platters
- Two surfaces per platter
- Tracks
- Heads move together
- Sectors
- Disk access
  - Queueing + seek
  - Rotation + transfer





# Disk Trends

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- Disk trends
  - \$/MB down (well below \$1/GB)
  - Disk diameter: 14" => 3.5" => 1.8" => 1"
  - Seek time down
  - Rotation speed increasing at high end
    - 5400rpm => 7200rpm => 10Krpm => 15Krpm
    - Slower when energy-constrained (laptop, iPod)
  - Transfer rates up
  - Capacity per platter way up (100%/year)
  - Hence, op/s/MB way down
    - High op/s demand forces excess capacity



# Flash Storage

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- Flash memory
  - A type of EEPROM
- possible substitute of disk
  - Nonvolatile
  - 100-1000 times faster than disks
  - Small, power efficient & shock resistant
- Popular in mobile devices



# Flash Storage

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- Disadvantage: wear out
  - Not so popular for desktop and servers
- Solution: wear leveling
  - one block with a specially extended life of 100,000+ cycles (regular: ~1000 cycles)
  - erasures and re-writes are distributed evenly across the medium



# Thank You

