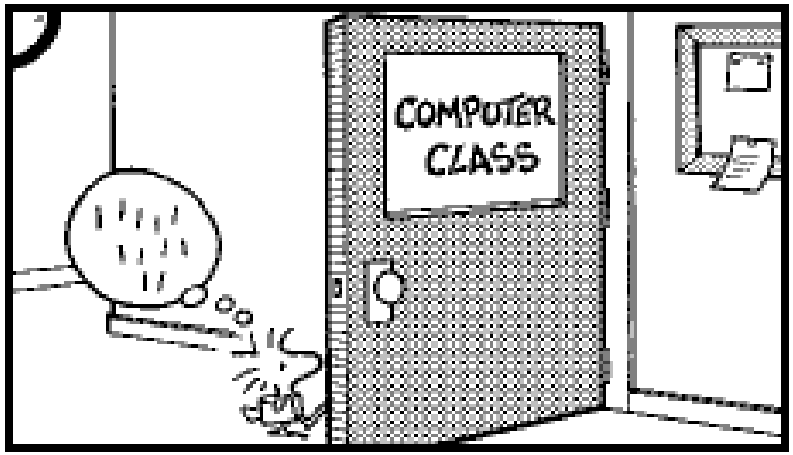
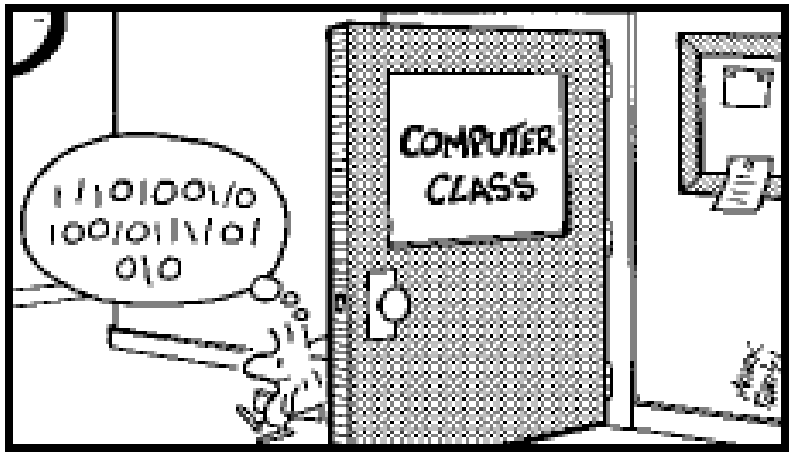
CHAPTER 1

Data Storage (& Representation)





1.1 Bits and Their Storage

- Information represented as patterns of *bits* (binary digits)
- **A bit is either 0 or 1 (*true* or *false*)**
- **Meaning of bit(-stream)s varies**
  - **numeric values, characters, images, sounds…**
- **Requires a device that can be in one of two states (& remain in that state as long as needed)**
  - ***Flip-flop* circuits**

1.1 The Boolean Operations AND, OR, and XOR

The AND operation

0	0	1	1
AND 0	AND 1	AND 0	AND 1
0	0	0	1

The OR operation

0	0	1	1
OR 0	OR 1	OR 0	OR 1
0	1	1	1

The XOR operation

0	0	1	1
XOR 0	XOR 1	XOR 0	XOR 1
0	1	1	0

- Note: AND and OR exist in **natural language**!

Example:
Boolean Operations and natural language

1. Khalid has gone to cafe.
2. **AND** Umer has gone to School.
3. **THEN** their mother can do house chores.

Result:

- Both has to go to school for their mother to do chores of the house.
- Check with OR operation.

1.1 AND and OR Gates

- **‘0’ and ‘1’ Digits are representing “Voltage levels” ?**

AND

Inputs	Output
0 0	0
0 1	0
1 0	0
1 1	1

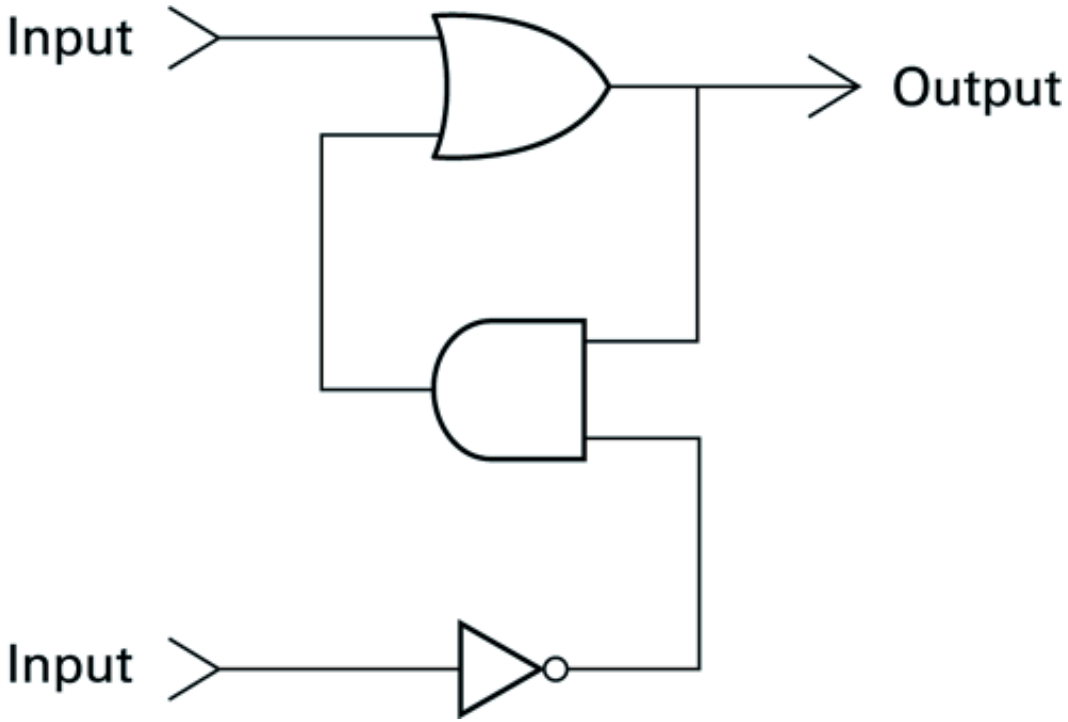
OR

Inputs	Output
0 0	0
0 1	1
1 0	1
1 1	1

Flip Flop circuit:

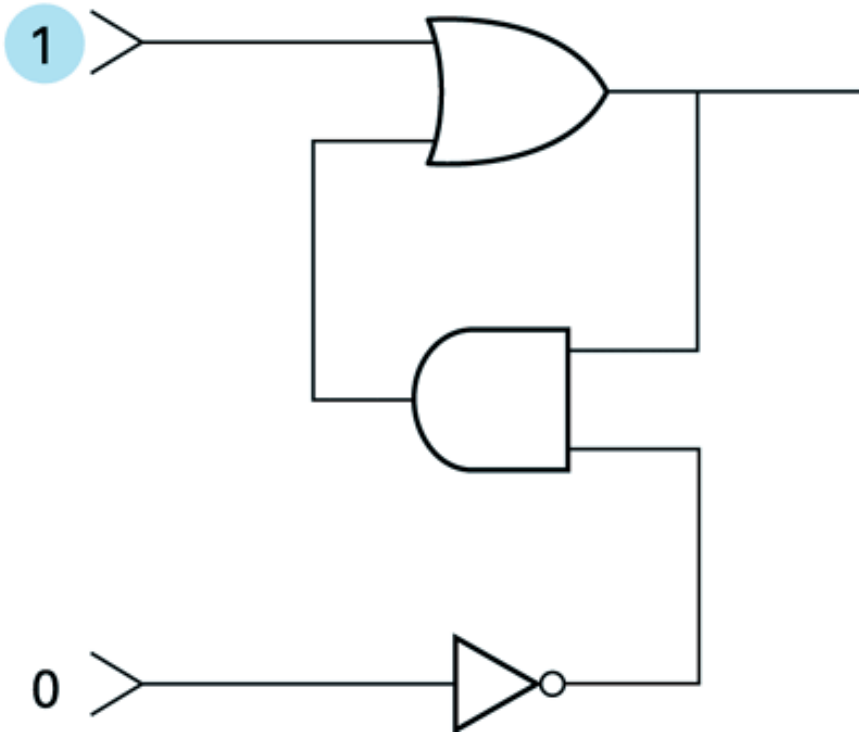
- A flip flop circuit that produces an output value of ‘0’ or ‘1’ that remains constant until a temporary pulse from another circuit causes it to shift to the other value.

1.1 A Simple Flip-flop Circuit

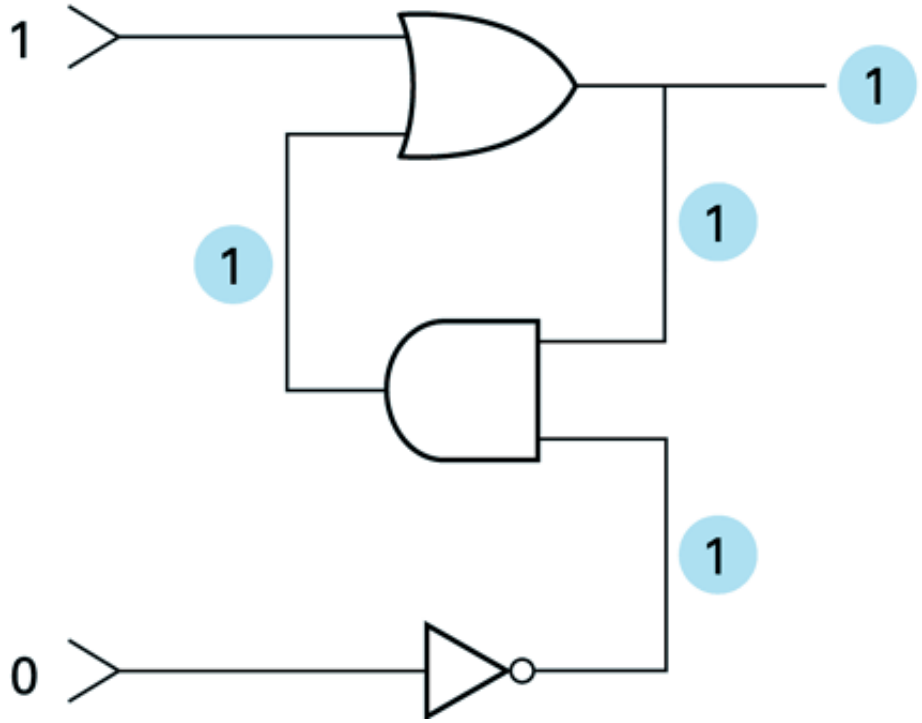


- As long as both inputs remain 0: output does not change
- Temporarily placing **1** on upper input => output = **1**
- Temporarily placing **1** on lower input => output = **0**
- So: output flip-flops between 2 values under external control

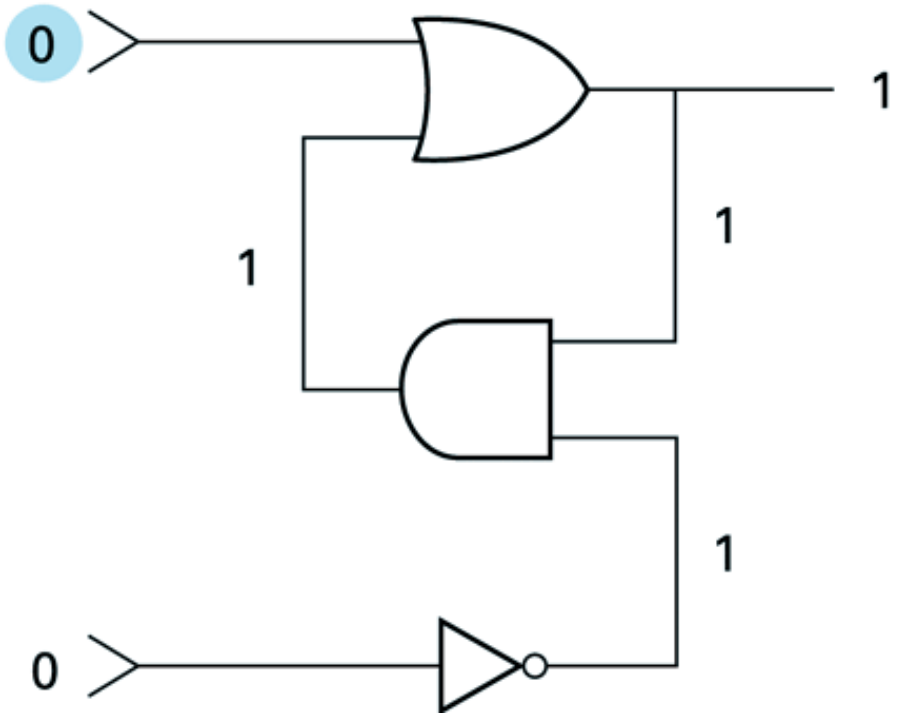
1.1 Setting the Output of a Flip-flop to 1



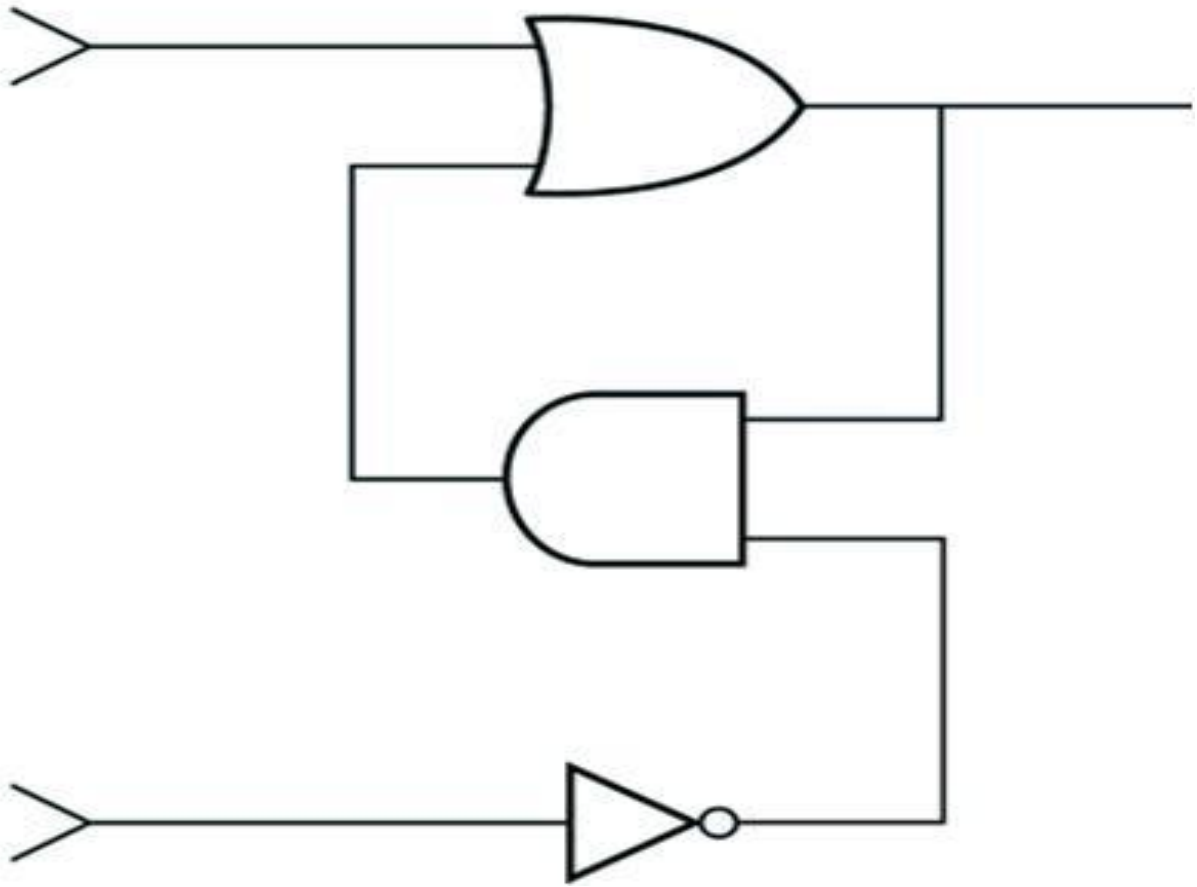
1.1 Setting the Output of a Flip-flop to 1 (cont'd)



1.1 Setting the Output of a Flip-flop to 1 (cont'd)



Temporarily placing ‘1’ on the lower end of the flip flop:

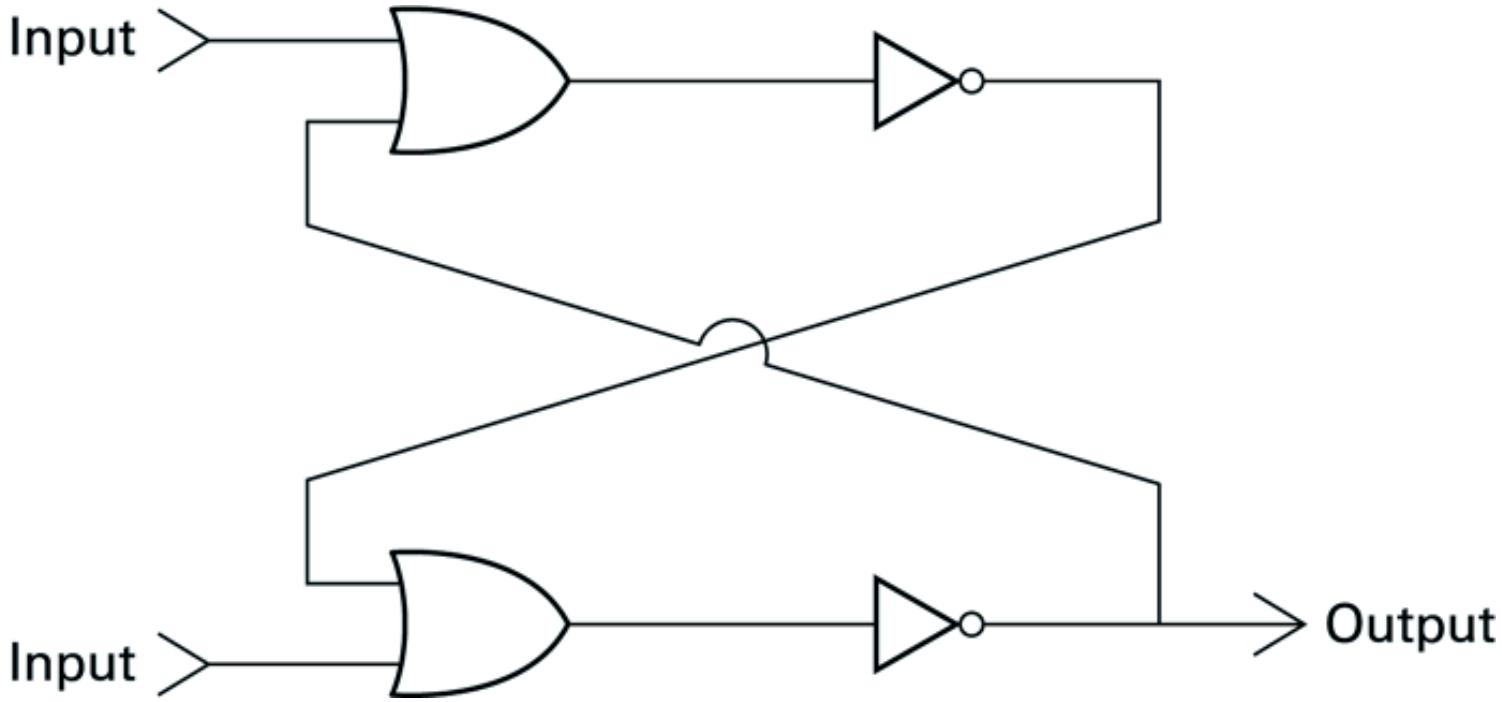


Another way of constructing Flip-Flop

Dead Line: 08-11-2015

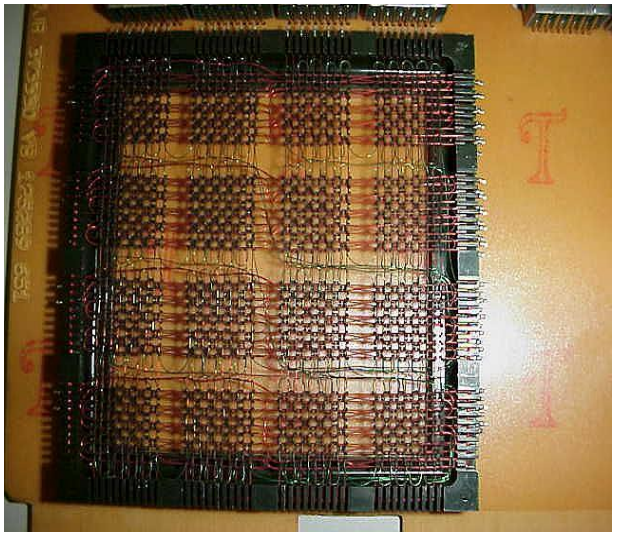
Assignment: Write outputs & sequence of steps on the basis of following inputs?

- **upper input = 1 and lower input = 0**
- **upper input = 0 and lower input = 0**



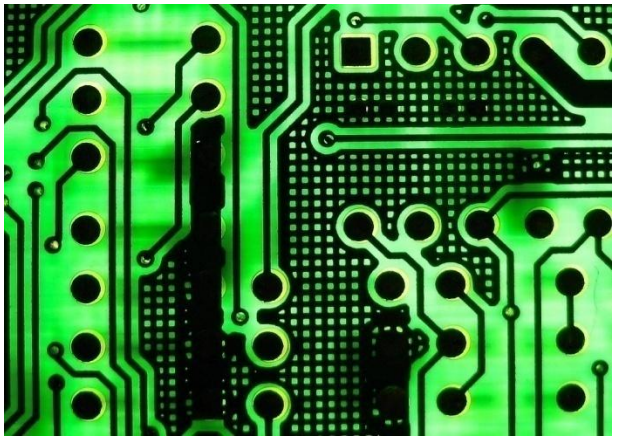
Other Storage Techniques

- **Cores**
- Core will be Magnetized in one of the two directions
- Retain Data after Machine is switched off
- Obsolete



Core Memory from an IBM 2821

- **Capacitors**->Millions-> Chip
  - Charge or Discharge Plates
  - Charges on capacitors dissipate
  - Refresh Circuit



Circuit Board with capacitors

- **Dynamic Memory**

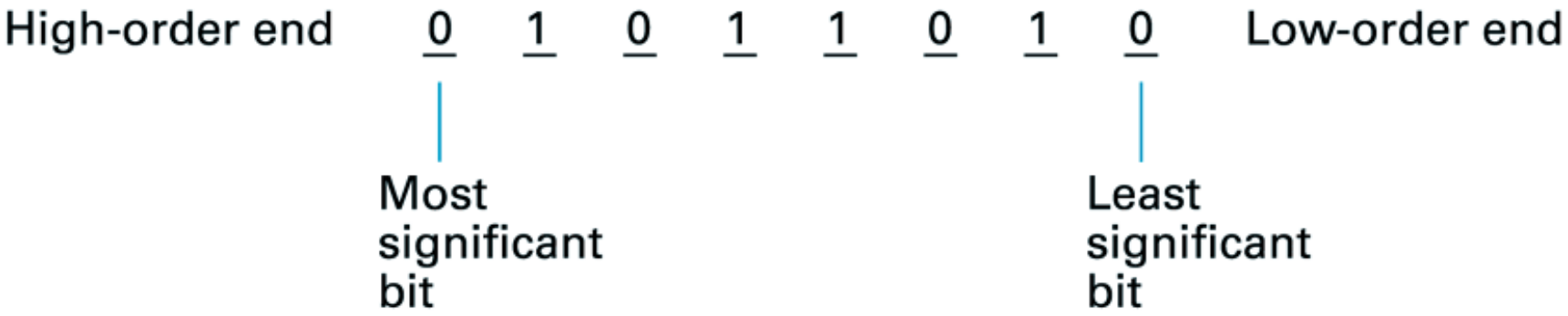
1.1 The Hexadecimal Coding System

- Bit-streams often very long
- For simplicity of notation:
  - Hexadecimal system
- Reduces 4 bits to 1 symbol
- Especially important in assembly language programming

Bit pattern	Hexadecimal representation
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

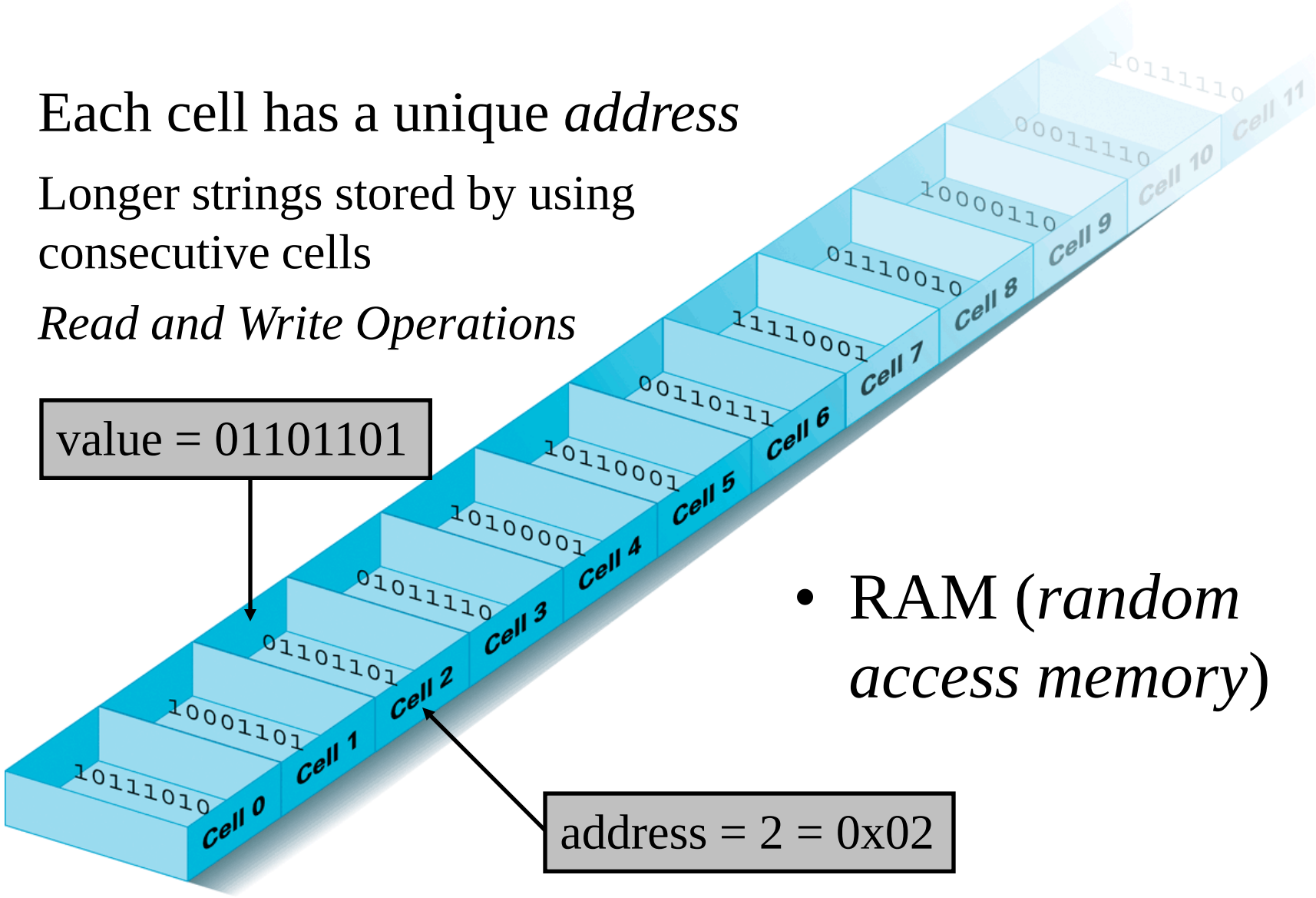
1.2 Main Memory

- Large collection of circuits, each capable of storing a single bit
- Arranged in small cells, typically of 8 bits each (a.k.a.: *byte*)



1.2 Arrangement of Memory Cells

- Each cell has a unique *address*
- Longer strings stored by using consecutive cells
- *Read and Write Operations*

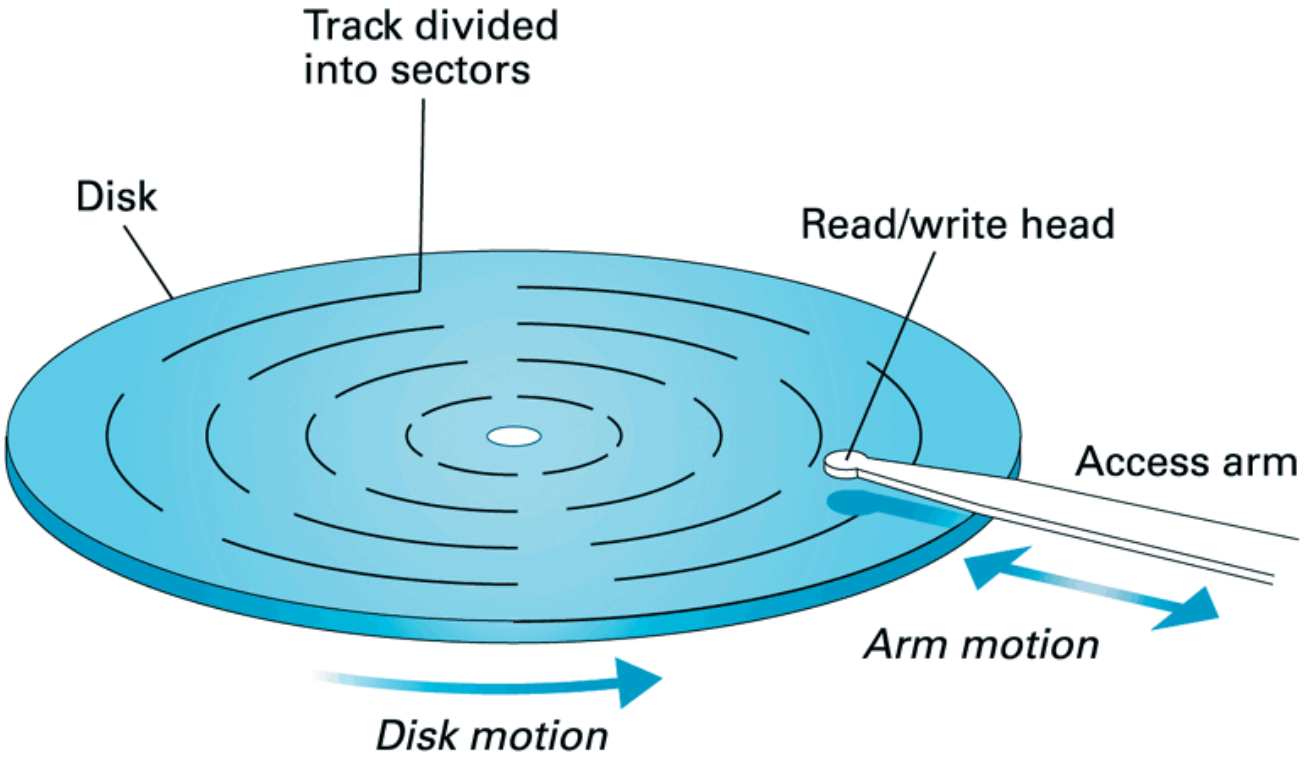


- RAM (*random access memory*)

1.3 Mass Storage

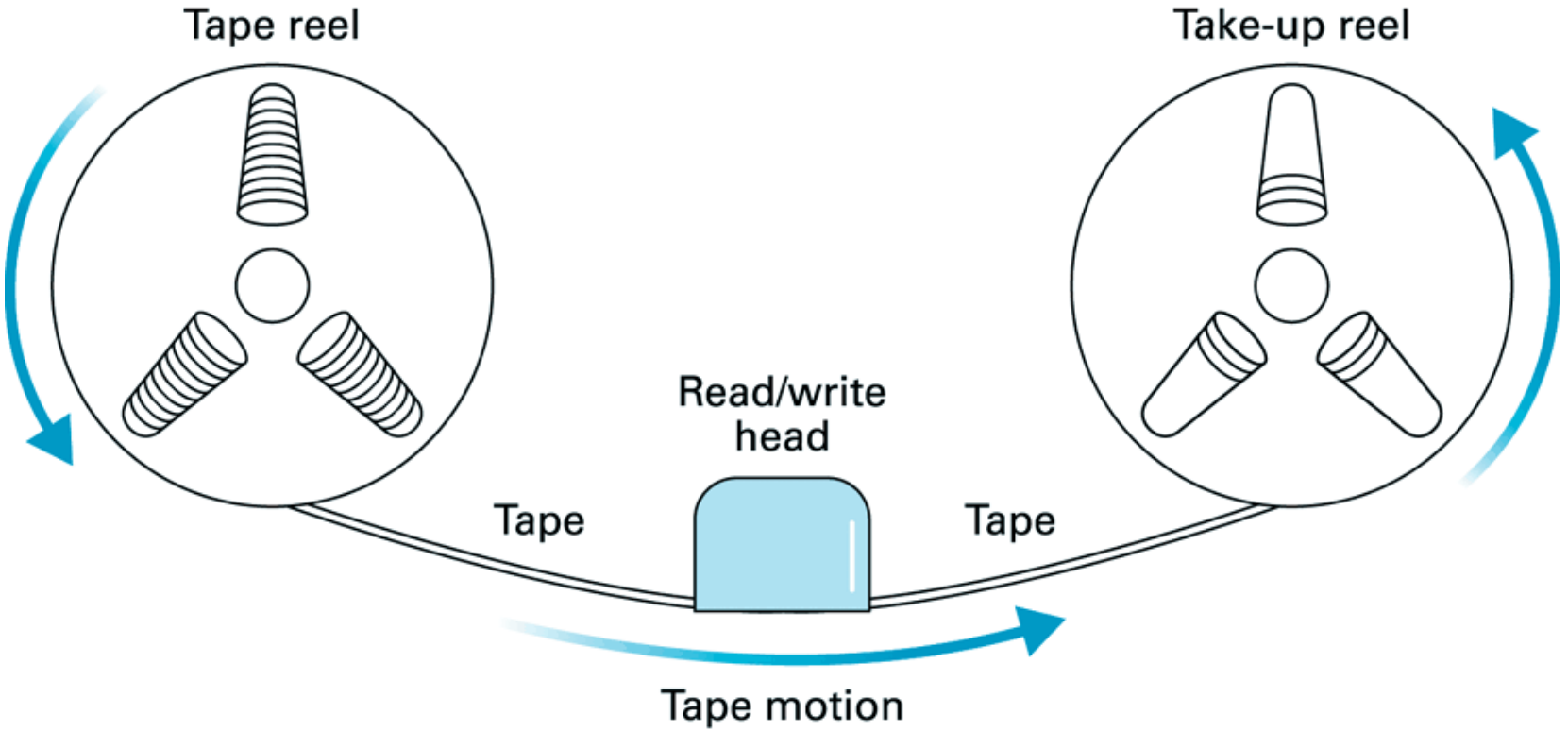
- Main memory is *volatile* and limited in size
- Additional memory devices for mass storage:
  - a.o.: magnetic disks, optical disks, magnetic tapes
  - Online and Offline Devices
- Advantages over main memory:
  - less volatile, large capacity, capability of removal, generally much cheaper
- Disadvantages over main memory
  - mechanical motion for data access/retrieval (Response time slow!)
  - in general: lesser degree of random access

1.3 A Magnetic Disk Storage System



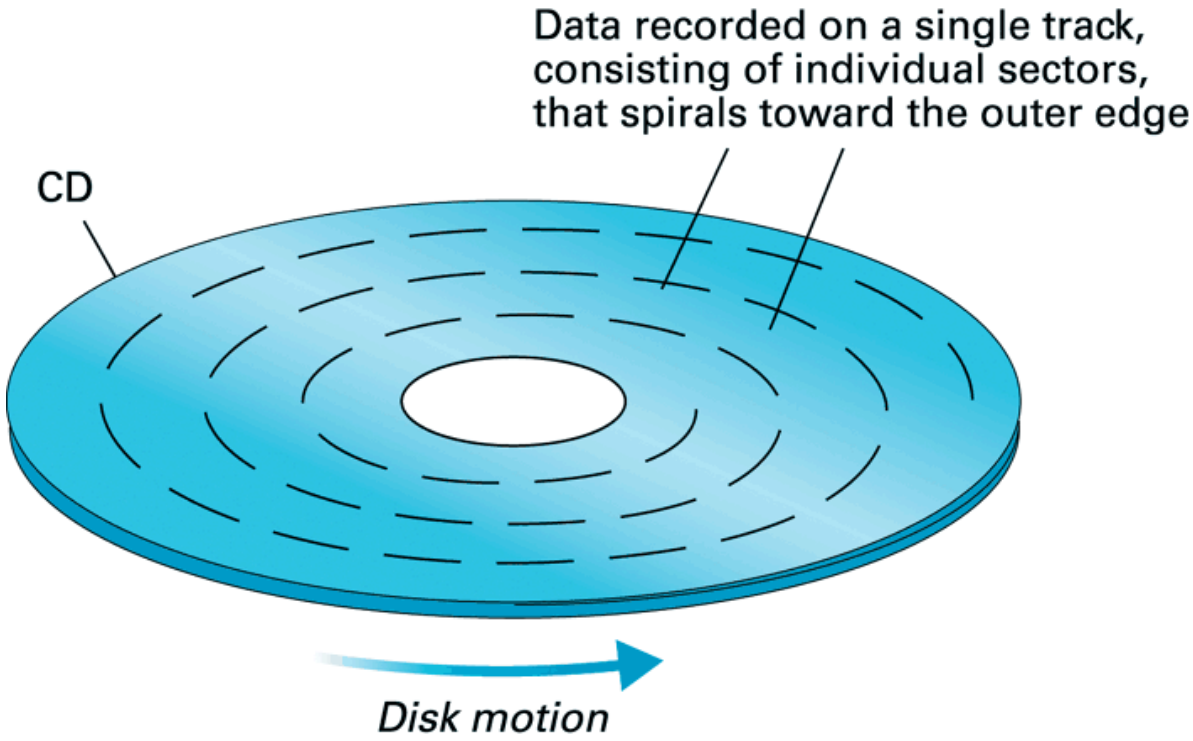
- Each track contains same number of sectors
  - Sector Size -> 512 or 1024 KB
- Location of tracks and sectors not permanent (*formatting*)
- Examples: hard disks, floppy disks, Zip disks, ...
- **Evaluating disk's performance:** seek, latency and access times
  - transfer rate

1.3 Old, but still commonly used: Magnetic Tape



- Offers little or no random access (slow!)
- Good choice for off-line data storage (archives)

1.3 CD/DVD Storage Format



- Data stored by creating variations in the reflective surface
- Data retrieved by means of a laser beam
- Data stored uniformly (so CD rotation speed varies)
- Random access much slower than for magnetic disks

Media type
High-density optical disc

Capacity
25 GB (single-layer)
50 GB (dual-layer)
100/128 GB (BDXL)
Block size 64 kb

Usage
Data storage
High-definition video (1080p)
High-definition audio
Stereoscopic 3D
PlayStation 3 games

The name Blu-ray Disc refers to the blue laser used to read the disc, which allows information to be stored at a greater density than is possible with the longer-wavelength red laser used for DVDs. The major application of Blu-ray Discs is as a medium for video material such as feature films.

File Storage and Retrieval

- Storage in mass storage medium->Files
- A block of data conforming to the physical characteristics of storing device is called **Physical records.**
- A file usually has natural divisions determined by the information represented. It describes **Logical records.**
- Problem: scattered data
- Solution: **Buffer**
- **Degree of random access of the data**