Bits and Data Storage

Basic Hardware Units of a Computer
Bits and Bit Patterns

- **Bit**: Binary Digit (0 or 1)
- Bit Patterns are used to represent information.
  - Numbers
  - Text characters
  - Images
  - Sound
  - And others

Boolean Operations

- **Boolean Operation**: An operation that manipulates one or more true/false values
- Specific operations
  - AND
  - OR
  - XOR (exclusive or)
  - NOT
The Boolean operations AND, OR, and XOR (exclusive or)

The AND operation

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The OR operation

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The XOR operation

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Gates

- **Gate**: A device that computes a Boolean operation
  - Often implemented as (small) electronic circuits
  - Provide the building blocks from which computers are constructed
  - VLSI (Very Large Scale Integration)
A pictorial representation of AND, OR, XOR, and NOT gates as well as their input and output values

Flip-flops

- **Flip-flop**: A circuit built from gates that can store one bit.
  - One input line is used to set its stored value to 1
  - One input line is used to set its stored value to 0
  - While both input lines are 0, the most recently stored value is preserved
A simple flip-flop circuit

Setting the output of a flip-flop to 1

a. 1 is placed on the upper input.
Setting the output of a flip-flop to 1 (continued)

b. This causes the output of the OR gate to be 1 and, in turn, the output of the AND gate to be 1.

Setting the output of a flip-flop to 1 (continued)
e. The 1 from the AND gate keeps the OR gate from changing after the upper input returns to 0.
Another way of constructing a flip-flop

** Usually abstracted out as a box that stores a bit **

Main Memory Cells

- **Cell**: A unit of main memory (typically 8 bits which is one **byte**)
  - **Most significant bit**: the bit at the left (high-order) end of the conceptual row of bits in a memory cell
  - **Least significant bit**: the bit at the right (low-order) end of the conceptual row of bits in a memory cell
The organization of a byte-size memory cell

Main Memory Addresses

- **Address:** A “name” that uniquely identifies one cell in the computer’s main memory
  - The names are actually numbers.
  - These numbers are assigned consecutively starting at zero.
  - Numbering the cells in this manner associates an order with the memory cells.
Memory Terminology

• **Random Access Memory (RAM):** Memory in which individual cells can be easily accessed in any order

• **Dynamic Memory (DRAM):** RAM composed of volatile memory (usually when referring to RAM we mean DRAM)

• **Read Only Memory (ROM):** RAM that cannot store new values; limited to pre-stored data

Measuring Memory Capacity

• **Kilobyte:** $2^{10}$ bytes = 1024 bytes
  – Example: 3 KB = 3 times 1024 bytes

• **Megabyte:** $2^{20}$ bytes = 1,048,576 bytes
  – Example: 3 MB = 3 times 1,048,576 bytes

• **Gigabyte:** $2^{30}$ bytes = 1,073,741,824 bytes
  – Example: 3 GB = 3 times 1,073,741,824 bytes
Mass Storage

• On-line versus off-line
• Typically larger than main memory
• Typically less volatile than main memory
• Typically slower than main memory

Mass Storage Systems

• Magnetic Systems
  – Disk
  – Tape
• Optical Systems
  – CD
  – DVD
• Flash Drives
A magnetic disk storage system

CD storage

Data recorded on a single track, consisting of individual sectors, that spirals toward the outer edge
Files

- **File:** A unit of data stored in mass storage system
  - Fields and keyfields
- Physical record versus Logical record
- **Buffer:** A memory area used for the temporary storage of data (usually as a step in transferring the data)