

COA

Chapter 05: | Internal Memory – Organization

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| AGENDA

- Explain **how a memory stores** binary data
- Discuss the basic **organization** of a memory

| Memory

- **Memory** is the **portion of a computer** or other system that **stores binary data**.
 - speed and
 - accuracy

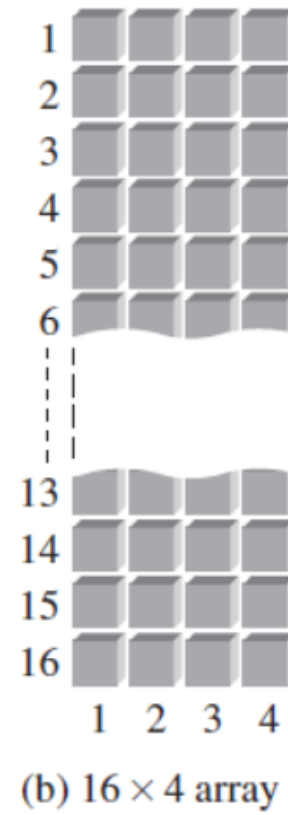
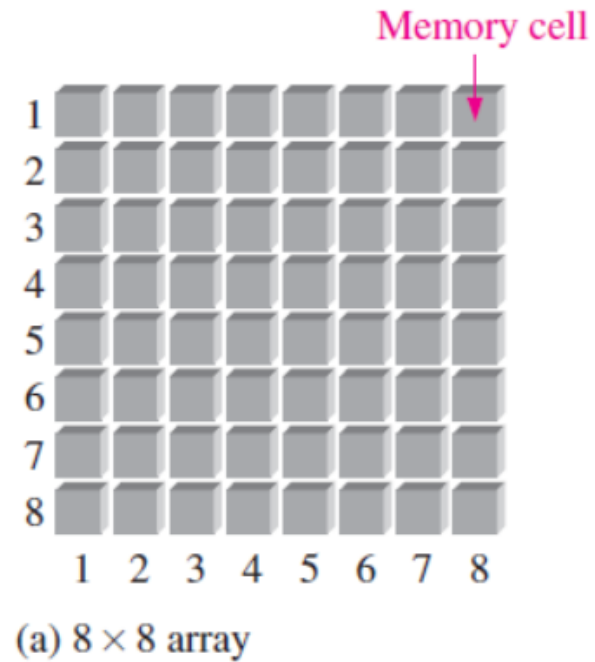
| Units of Binary Data

- Memories store data in **units** that have from **one to eight bits**.
 - Bit.
 - Byte: 8-bit units.
 - Nibble: 4-bit units.
 - Word: Grouped of Bytes

| Memory Word

- The term **word** can have two meanings in computer terminology.
 - In **memories**, a group of bits or bytes that acts as a **single entity** that can be **stored in one memory location**.
 - In **assembly language**, a word is specifically defined as two bytes
 - **DW** (Define Word) **directive** means to define data in 16-bit units
 - Independent **microprocessor** or the size of its **data bus**

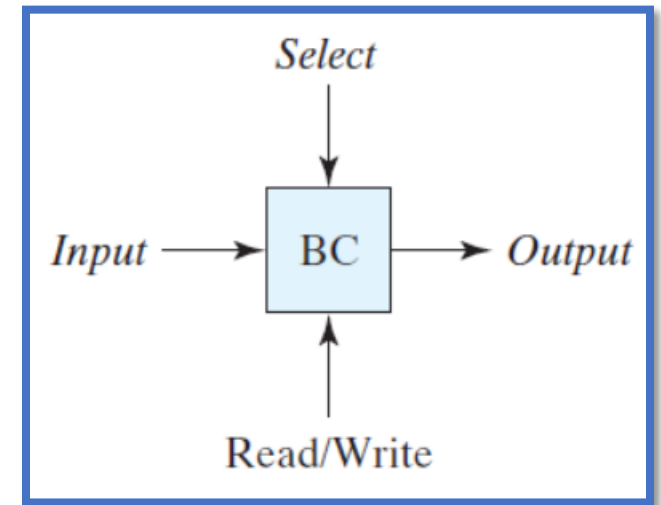
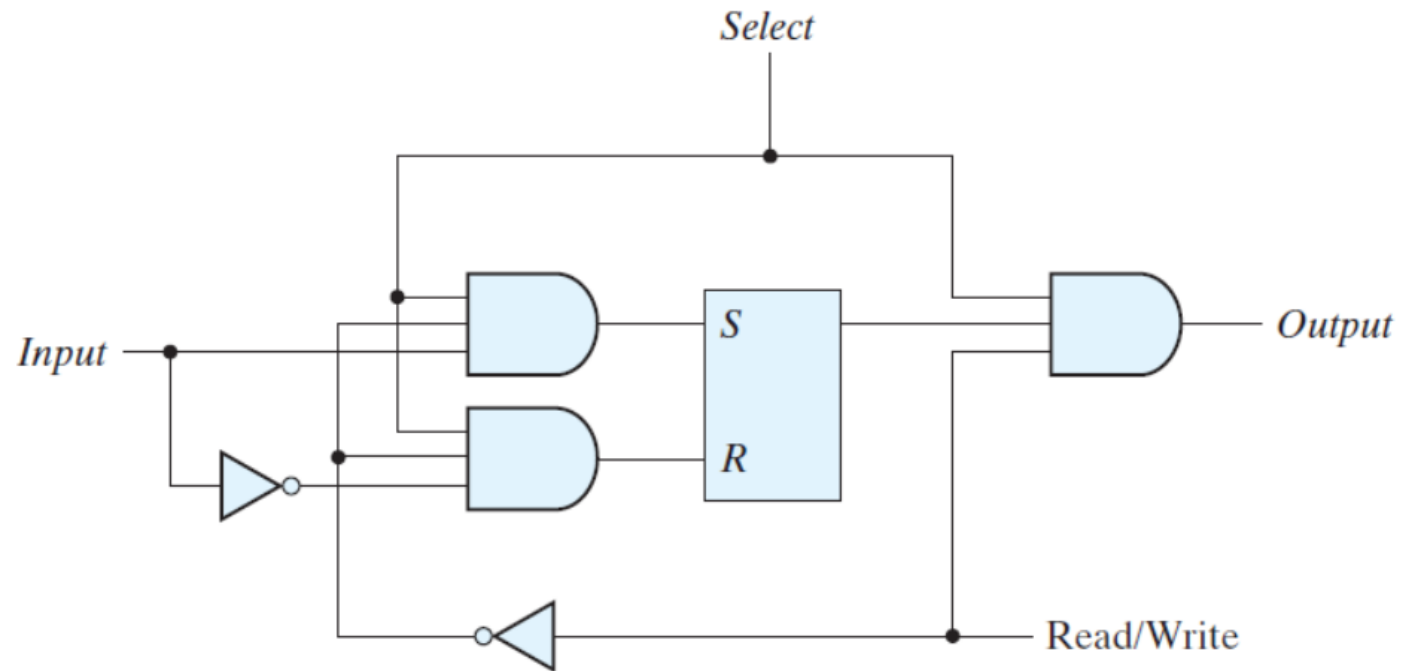
| Basic Memory Array



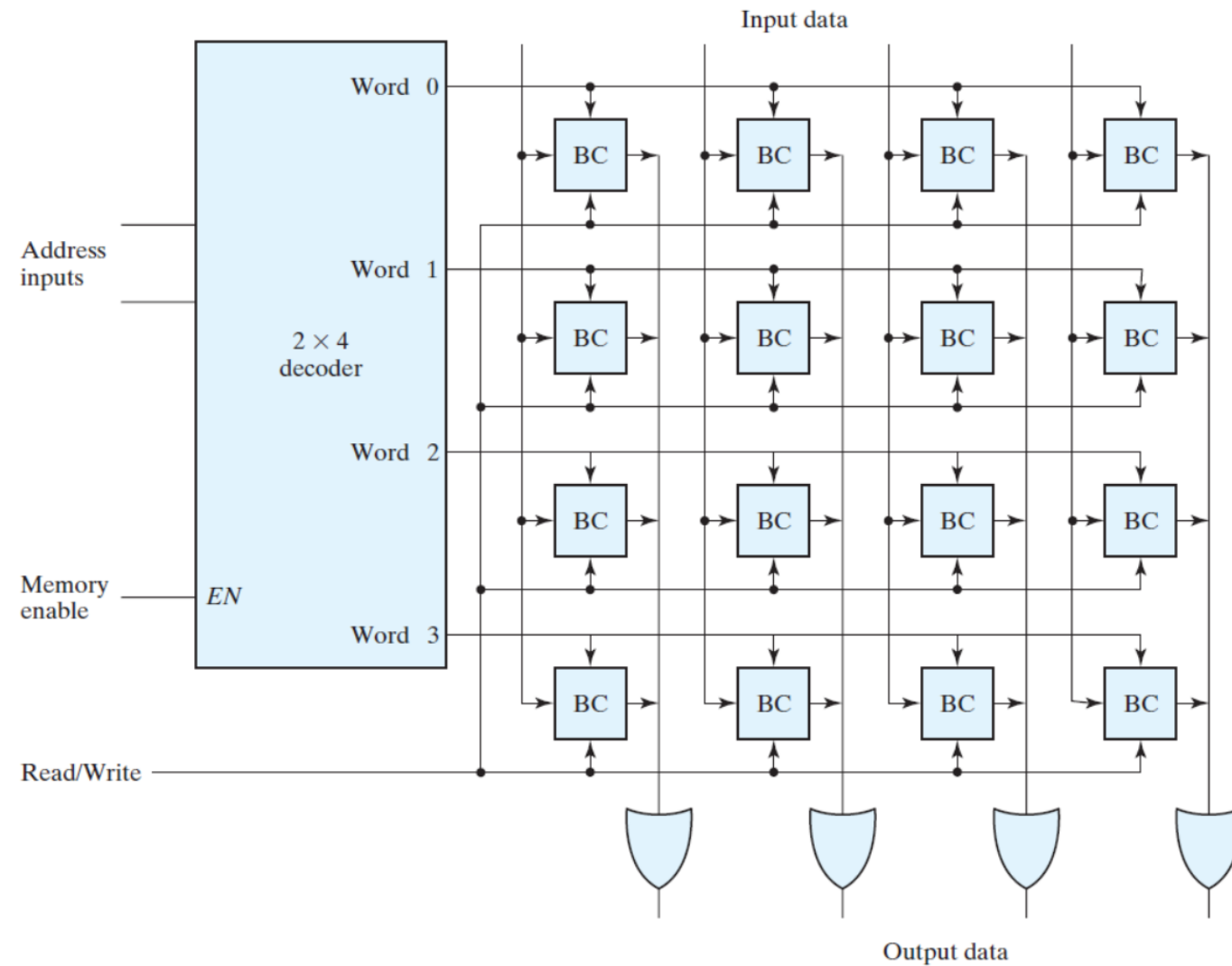
| Memory Cell

- **Cell** is the **basic building block** of a memory unit
 - Modeled by an **SR latch** with associated gates to form a D latch
 - Actually, the cell is an electronic circuit with **four to six transistors**
 - A binary storage cell **must be very small** in order to be able to **pack as many cells as** possible in the small area available in the integrated circuit chip

| Memory Cell

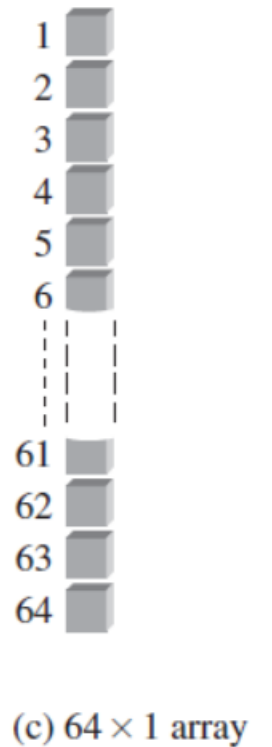
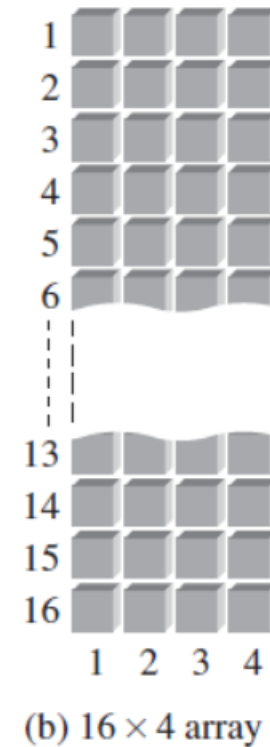
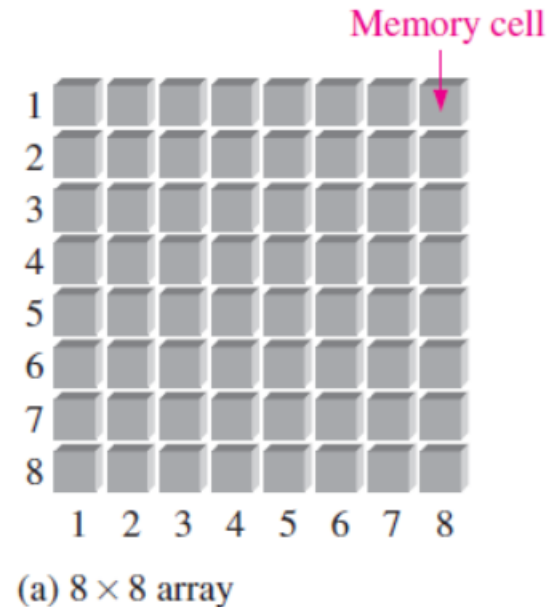


| 4 × 4 RAM



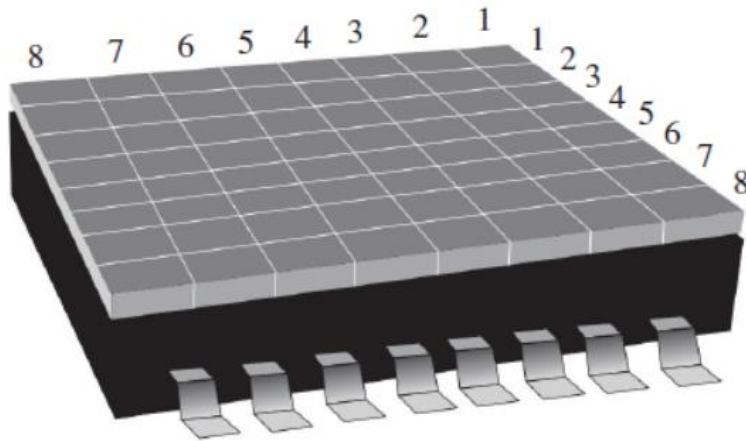
| Basic Memory Array

- The **64-cell array** can be organized in several ways **based on units of data**
- A memory is identified by the **number of words** it can store **times the word size**
 - $16k \times 8$ memory = 2^{14} byte

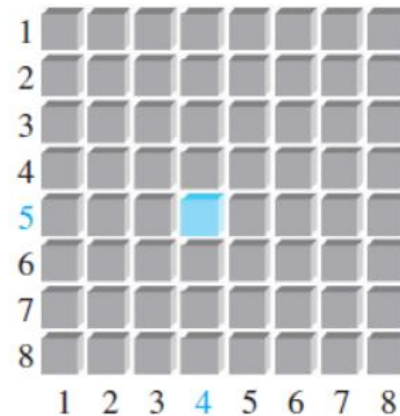


| Memory Address and Capacity

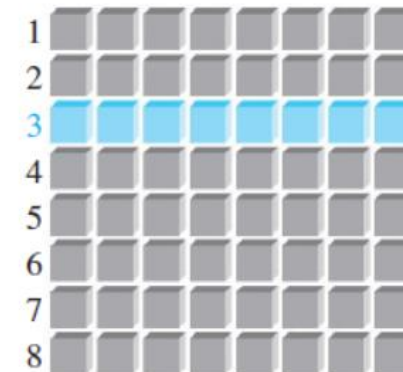
- The **location** of a unit of data in a memory array is called its **address**
- **Personal computers** have random-access memories organized in bytes.



(a) Physical structure of 64-bit memory.



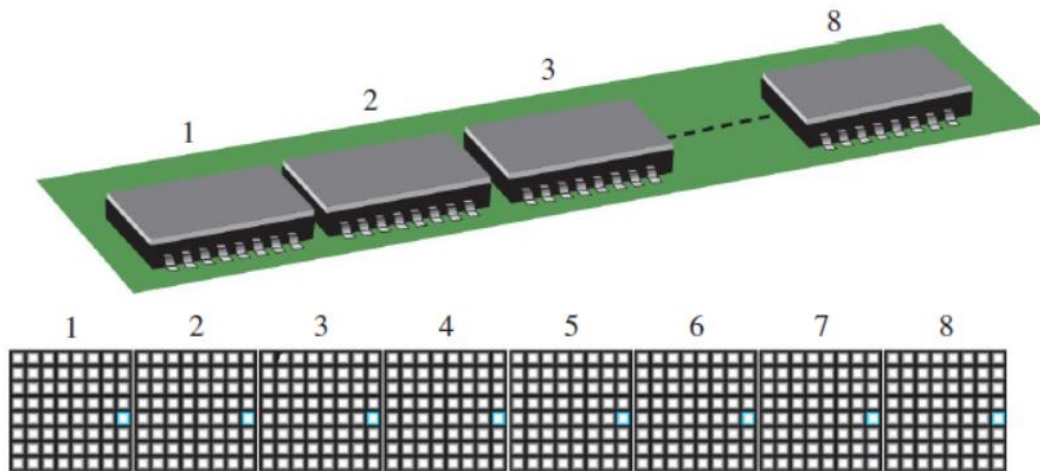
(b) The address of the blue bit is row 5, column 4.



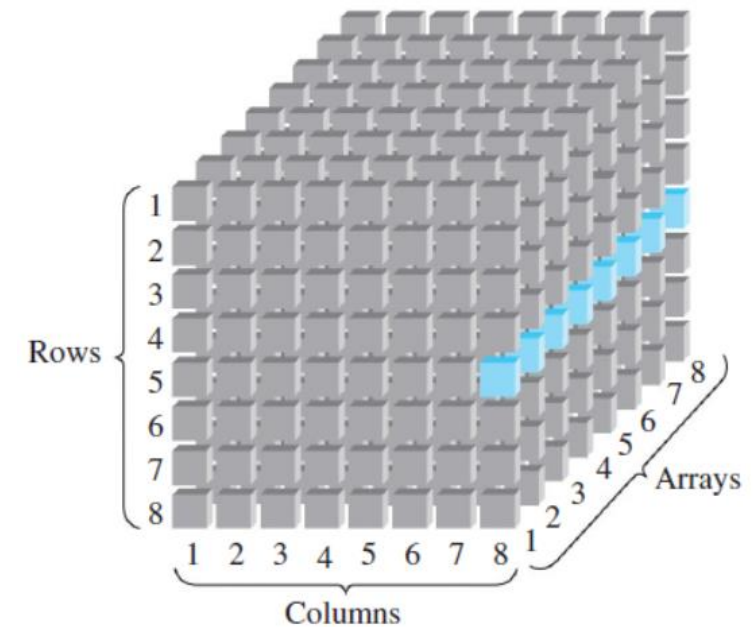
(c) The address of the blue byte is row 3.

| Memory address in an expanded array

- The **expansion** of the 8×8 (64-bit) array to a **64-byte** memory.
- The **address** of a byte in the array is specified by the **row** and **column**



(a) The 8×8 bit array expanded to a 64×8 bit array. This array forms a memory module.

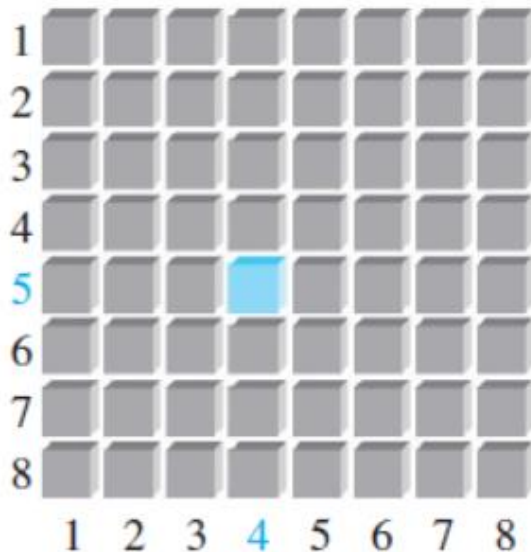


(b) The address of the blue byte is row 5, column 8.

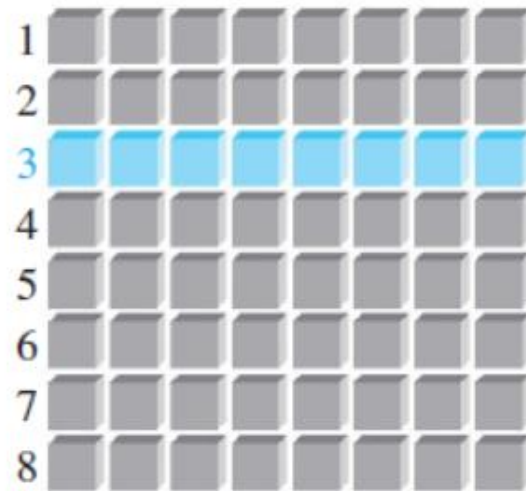
| Memory Capacity

- The **capacity** of a memory is the **total number of data units** that can be stored.

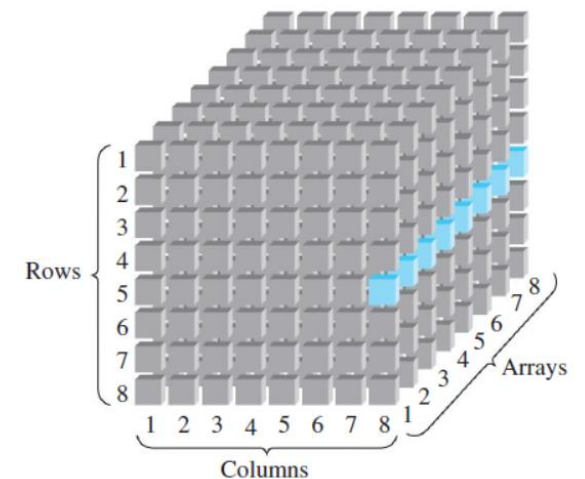
The capacity is 64 bits



The capacity is 8 bytes



The capacity is 64 bytes



(b) The address of the blue byte is row 5, column 8.

| Memory Banks and Ranks

- A **bank** is a section of memory within a single memory array (chip).
 - A memory chip may have one or more banks.
 - Storing frequently used information.
 - Easier and faster access
- A **rank** is a **group of chips that make up a memory module** that stores data in units such as words or bytes

| Memory Banks and Ranks

