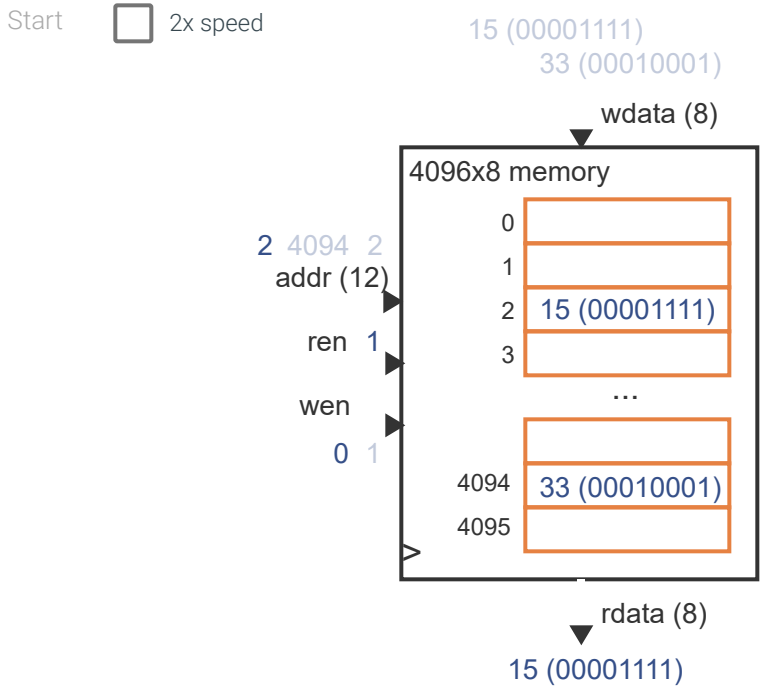
7.13 SRAM and DRAM

Memory basics

An NxM ***memory*** is a digital component that retains bit values, consisting of N words of M bits each. Each word has a uniq
4096x8 memory has 4096 8-bit words (for a total of 32,768 bits), with word addresses from 0 to 4095. Nearly every compu
requires memory.

PARTICIPATION ACTIVITY 7.13.1: Memory basics.



Such memory is often called ***random access memory*** (or ***RAM***) because any "random" word can be quickly accessed, in co sequentially-accessed memory technologies like tape that had to first be spun or moved to access a particular word.

Most RAM is ***volatile memory***, meaning bit values are lost if electrical power is removed.

Note: For a processor, "word" may refer to 4 bytes. But for a memory, word means one address location, however wide.

PARTICIPATION ACTIVITY 7.13.2: Memory basics.

Consider the memory above. Question actions follow the previous question's actions. All words initially contain 0. Answer in decimal, not binary.

1) On rising clock 1, addr is 9, wen is 1, and wdata is 44.
On rising clock 2, addr is 5, wen is 1, and wdata is 77.
What value is in word 9?

Check Show answer

2) On rising clock 3, addr is 15, wen is 0, and wdata is 305.
What value is now in word 15?

Check Show answer

3) addr is 5, ren is 1.
What soon appears on rdata?

Check Show answer

4) How many bits does word 3 contain?

Check Show answer

5) How many total bits does the memory store?

Check Show answer

6) Based on the general memory design described above, is simultaneously setting both ren and wen with 1 reasonable? Type yes or no.

Check Show answer

SRAM and DRAM

Memory comes in two common forms:

- A ***static RAM*** (or ***SRAM***) typically uses 6 transistors to store each bit value, by passing the bit into a loop within those
- A ***dynamic RAM*** (or ***DRAM***) typically uses 1 transistor and 1 capacitor to store each bit value, by charging the capacit

SRAM is faster than DRAM, but DRAM is denser and cheaper. SRAM is thus typically used by processors for small fast on-c DRAM is used for the larger main memory off-chip. Also, processors and SRAM are made using different chip design proce DRAM, so putting DRAM on-chip with a processor is rare.

PARTICIPATION ACTIVITY 7.13.3: SRAM vs. DRAM.

Start 2x speed

SRAM	DRAM	Ex:
~10x faster		S: 5 ns D: 50 ns
	~5x denser	S: 1 MB D: 5 MB
	~100x cheaper	S: $100 D: $1
Cache On-chip memory	Off-chip memory	S (1 MB) D (1 GB)

PARTICIPATION ACTIVITY 7.13.4: SRAM vs. DRAM.

1) Which is faster?
   - SRAM
   - DRAM

2) For a fixed size, which can store more bits?
   - SRAM
   - DRAM

3) Consider a processor that accesses a memory once per instruction. Suppose each instruction's time is 0.5 ns to access SRAM and 0.5 ns to run the instruction, so a 1 billion instruction program takes 1 second to execute. How many seconds would the program take using DRAM instead?

- ○ 1.2 sec
- ○ 5.5 sec

4) Consider a processor that requires 1 GB of DRAM, where the DRAM costs $50. About how much would the memory cost if all the DRAM was instead SRAM?

- ○ $500
- ○ $5000

Memory size

A memory's size may be specified in various ways.

- *4096x32*: Indicates the number of words, and the bits per word.
- *131,072 bits*: Indicates the total number of bits.
- *16,384 bytes*: Indicates the total number of bytes (a byte is 8 bits).
- *16 KBytes (or 16 KB)*: Approximate number of bytes. The K is the metric kilo, for 1,000. Note: This method is common because 16 Kbytes means 16,000 bytes rather than the actual 16,384 bytes.
- *128 Kbits (or 128 Kb)*: Indicates the total number of bits. Again, this method is common *but inaccurate*.

Memory sizes are commonly measured in MB (megabytes, or 1 million bytes)), GB (gigabytes, or 1 billion bytes), or TB (tera trillion bytes). Ex: A 16 GB memory. The uppercase B means bytes (like GB), while lowercase b means bits (like Gb).

Memory sizes are powers of 2, so metric prefixes like kilo, mega, and giga, which are powers of 10, are inaccurate. Alternat known as ***IEC prefixes***, exist like kibi (2^{10} or 1024), mebi (2^{20} or 1,048,576), gibi (2^{30} or 1,073,741,824), and tebi (2^{40} or 1,09 In kibi, the ki refers to the metric prefix kilo, and the bi to "binary". A kibi is abbreviated Ki, as in 1 KiB for 1 kibibyte. Likewise prefixes.

When metric prefixes are used, those prefixes are known to actually refer to the nearest power of 2, so a kilobyte is known t bytes (a kibibyte) and not 1000 bytes.

PARTICIPATION ACTIVITY 7.13.5: Memory sizes.

1) A 512x8 memory has how many *words*?

Check Show answer

2) A 64x4 memory has how many *bits*?

Check Show answer

3) In 1 KB, does the B mean bytes or bits?

Check Show answer

4) For memory, 1K actually refers to what value? Just type a number.

Check Show answer

5) What IEC prefix refers to the power of 2 nearest to 1 million?

Check Show answer

6) How many bits are in a 1 KB memory? Just type a number.

Check Show answer

7) How many bits are in a 2 Kb memory? Just type a number.

Check Show answer

Exploring further:

- SRAM (Wikipedia)
- DRAM (Wikipedia)
- SRAM vs. DRAM (diffen.com)
- IEC prefixes

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