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UTAustinX: UT.6.01x Embedded Systems - Shape the World

KarenWest (/dashboard) ▼

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Help

The common bus in Figure 2.8 defines the von Neumann architecture. Computers are not intelligent. Rather, you are the true genius. Computers are electronic idiots. They can store a lot of data, but they will only do exactly what we tell them to do. Fortunately, however, they can execute our programs quite quickly, and they don't get bored doing the same tasks over and over again. **Software** is an ordered sequence of very specific instructions that are stored in memory, defining exactly what and when certain tasks are to be performed. It is a set of instructions, stored in memory, that are executed in a complicated but well-defined manner. The **processor** executes the software by retrieving and interpreting these instructions one at a time. A **microprocessor** is a small processor, where small refers to size (i.e., it fits in your hand) and not computational ability. For example, Intel Xeon E7, AMD Fusion, and Sun SPARC are microprocessors. An ARM®Cortex™-M microcontroller includes a processor together with the bus and some peripherals.

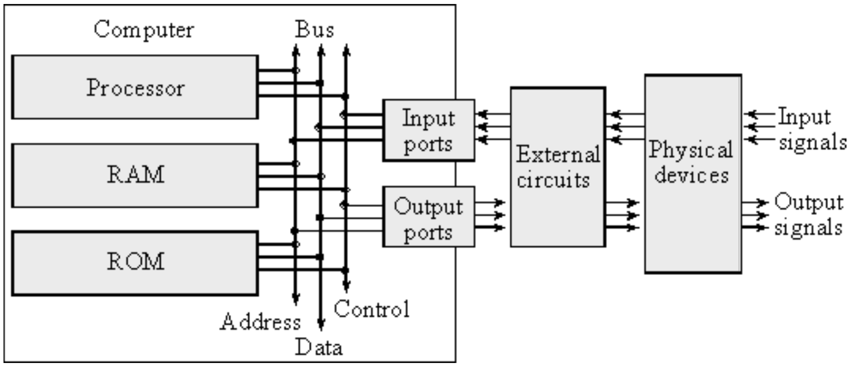

Figure 2.8. The basic components of a von Neumann computer include processor, memory and I/O.

A **microcomputer** is a small computer, where again small refers to size (i.e., you can carry it) and not computational ability. For example, a desktop PC is a microcomputer. Small in this context describes its size not its computing power. Consequently, there can be great confusion over the term microcomputer, because it can refer to a very wide range of devices from a PIC12C508, which is an 8-pin chip with 512 words of ROM and 25 bytes RAM, to the most powerful I7-based personal computer.

A **port** is a physical connection between the computer and its outside world. Ports allow information to enter and exit the system. Information enters via the input ports and exits via the output ports. Other names used to describe ports are I/O ports, I/O devices, interfaces, or sometimes just devices. A **bus** is a collection of wires used to pass information between modules.

A very small microcomputer, called a **microcontroller**, contains all the components of a computer (processor, memory, I/O) on a single chip. As shown in Figure 2.9, the Atmel ATtiny, the Texas Instruments MSP430, and the Texas Instruments TM4C123 are examples of microcontrollers. Because a microcomputer is a small computer, this term can be confusing because it is used to describe a wide range of systems from a 6-pin ATtiny4 running at 1 MHz with 512 bytes of program memory to a personal computer with state-of-the-art 64-bit multi-core processor running at multi-GHz speeds having terabytes of storage.

The computer can store information in **RAM** by writing to it, or it can retrieve previously stored data by reading from it. RAMs are **volatile**; meaning if power is interrupted and restored the information in the RAM is lost. Most microcontrollers have **static RAM** (SRAM) using six metal-oxide-semiconductor field-effect transistors (MOS or MOSFET) to create each memory bit. Four transistors are used to create two cross-coupled inverters that store the binary information, and the other two are used to read and write the bit.

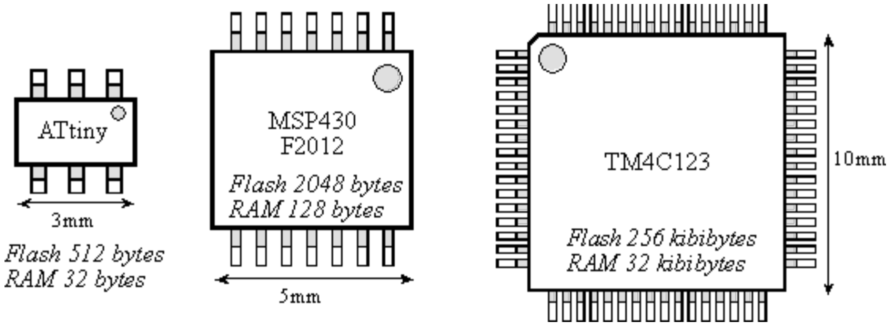

Figure 2.9. A microcontroller is a complete computer on a single chip.

Information is programmed into **ROM** using techniques more complicated than writing to RAM. From a programming viewpoint, retrieving data from a ROM is identical to retrieving data from RAM. ROMs are nonvolatile; meaning if power is interrupted and restored the information in the ROM is retained. Some ROMs are programmed at the factory and can never be changed. A Programmable ROM (PROM) can be erased and reprogrammed by the user, but the erase/program sequence is typically 10000 times slower than the time to write data into a RAM. Some PROMs are erased with ultraviolet light and programmed with voltages, while electrically erasable PROM (EEPROM) are both erased and programmed with voltages. We cannot program ones into the ROM. We first erase the ROM, which puts ones into the entire memory, and then we program the zeros as needed. **Flash ROM** is a popular type of EEPROM. Each flash bit requires only two MOSFET transistors. The input (gate) of one transistor is electrically isolated, so if we trap charge on this input, it will remain there for years. The other transistor is used to read the bit by sensing whether or not the other transistor has trapped charge. In regular EEPROM, you can erase and program individual bytes. Flash ROM must be erased in large blocks. On many of Stellaris family of microcontrollers, we can erase the entire ROM or just a 1024-byte block. Because flash is smaller than regular EEPROM, most microcontrollers have a large flash into which we store the software. For all the systems in this class, we will store instructions and constants in flash ROM and place variables and temporary data in static RAM.

CHECKPOINT 2.31

What are the differences between a microcomputer, a microprocessor, and a microcontroller?

Hide Answer

A microprocessor is a small processor. A microcomputer is a small computer that includes a processor, memory and I/O devices. A microcontroller is a single chip computer.

CHECKPOINT 2.32

Which has a higher information density on the chip in bits per mm^2: static RAM or flash ROM? Assume all MOSFETs are approximately the same size in mm^2.

Hide Answer

Flash ROM is higher density because it requires few transistors compared to RAM.

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