

GLOSSARY OF COMPUTER ARCHITECTURE TERMS

- **arithmetic and logical unit** (or **ALU**) – the part of the *CPU* that performs integer arithmetic and logical operations
- **ASCII** – American Standard Code for Information Interchange; a widely-used scheme for encoding alphanumeric and punctuation symbols as 7-bit, unsigned integers
- **assembler** – program that translates from a symbolic version of *instructions* into a binary version. The symbolic language that the assembler translates is called **assembly language**.
- **asynchronous** – not clocked; often controlled by handshaking
- **base- β representation** – if β is an integer such that $\beta > 1$, then the base- β representation of a number x is the sum

$$x = \sum_k d_k \beta^k.$$

The **digits** d_k are such that

$$0 \leq d_k < \beta.$$

For example, in the base-10 representation of the integer 32,767, the digits are $d_4 = 3$, $d_3 = 2$, $d_2 = 7$, $d_1 = 6$, and $d_0 = 7$. The integer β is called the **base** (or **radix**) of the number representation.

- **bit** – binary digit (1 or 0)
- **buffer** – an area of memory, or a specialized memory, used to hold data temporarily during I/O operations. The purpose of a buffer is to permit I/O devices to operate at different data rates, or on blocks of data of different sizes, than the *CPU* or peripheral processors.
- **bus** – a set of parallel conductors that carry information from one functional unit of a computer to another. The **width** of a bus is the number of parallel conductors, which is equal to the number of bits that the bus can transmit simultaneously.
- **byte** – a string of 8 bits
- **cache** – fast memory that holds recently accessed *instructions* or data for the purpose of speeding up subsequent accesses to the same instructions or data. The term cache is usually used to refer to the processor cache, but can also refer to **Level 1 (L1) cache** is located on the same integrated circuit as the processor. **Level 2 (L2) cache** is usually located on a separate printed circuit card and is connected to the processor by a high-bandwidth bus. In order to exploit the fact that data words or instructions that the processor currently needs usually are near the most recently requested data or instructions, a cache usually transfers information in multiword blocks called **cache lines**.
- **cathode ray tube** (or **CRT**) – a quaintly archaic (though still current) term for a computer monitor on which an image is created by scanning a phosphor-coated surface with an electron beam. (Before electrons were known to be particles, they were called “cathode rays”.)
- **chip** – colloquial name for a die or an integrated circuit
- **CISC** (Complex Instruction Set Computer) – refers to an *instruction set architecture* in which the operands of instructions may be in memory (as well as in *registers*), in which many addressing modes are available, and in which some instructions may perform highly specialized tasks. As a rule, implementing a CISC architecture in hardware requires the use of microcode. CISC instructions may require 10 or more clock periods to execute.
- **clock** – a periodic electrical signal generated by a special-purpose circuit (the clock driver) on the same die as a microprocessor. The main processor clock signal controls all of the synchronous logic circuits in the *CPU*. Usually buses are clocked at different frequencies than the CPU.

- **command** – one of a set of predefined key words that are recognized by a computer program. A command may accept one or more arguments. A user may issue a command to the operating system by typing the name of the command and its arguments (if any), as in DOS or Unix, or by selecting an item from a menu in a graphical user interface.
- **compiler** – program that translates from a higher level language to assembly language.
- **conductor** – any object made out of a metal that has very low electrical resistivity. A 3-inch-thick copper bus bar, a .35-micrometer-wide strip of aluminum on a die, and the pins in a cable connector are all conductors. In computer technology, “conductor” usually refers to a wire, a track on a printed-circuit board, or a metal connection in an integrated circuit.
- **control line** – conductor on which control signals are transmitted
- **CPU** – see processor
- **data line** – conductor on which data signals are transmitted
- **defect** – microscopic flaw on a wafer
- **die** – rectangular component that results from dicing a semiconductor wafer
- **directory** – a named set of files, possibly including other directories, that is known to the operating system
- **DOS** – Disk Operating System, used to refer to any of several operating systems that make it possible to use disk I/O. In the 1960’s IBM referred to its disk operating system for the System/360 family of computers as DOS. “DOS” also is used to refer to **MS-DOS**, Microsoft Disk Operating System. MS-DOS supports, on systems using the Intel 8088 processor, the same commands as a now-extinct microcomputer disk operating system called CP/M that was written for the 8080 and the Zilog Z80. MS-DOS supports only one user, runs only one program at a time, and is limited to working within one megabyte of memory. Only 640 kilobytes of memory is usable for running programs under MS-DOS. Add-ons to DOS, such as Microsoft Windows, take advantage of an extended memory system to allow access to more than 1 megabyte of memory.
- **DRAM** – (dynamic random access memory) integrated circuit commonly used to construct the main memory of a computer. Each bit stored in a DRAM is stored as a charge on a capacitor.
- **elapsed time** – the time that passes from the moment when a program starts to run to the moment when it finishes
- **emulator** – a computer program that emulates an instruction set architecture which is not the same as that of the processor on which the emulator runs. For example, an emulator can permit a PowerPC processor to run programs that were compiled for the Motorola 680x0 architecture.
- **file** – a named collection of data that is known to the operating system
- **file system** – the structure in which files are named, stored and organized into directories
- **floating-point (representation of a) number** – representation of a number in the form (fraction) times (base raised to some integral power), where base is 10 for humans and is usually 2 for computers. For example, 3.2767×10^4 is a base-10 floating-point representation of the number that can be represented as a base-10 integer as 32,767. If the base is not 10, then the point that indicates where the negative powers of the base begin is called the **radix point**. Only in base 10 does one have a decimal point!
- **floating-point unit** (or **FPU**) – the electronic circuits that perform floating-point arithmetic operations. In most modern microprocessors an FPU is included on the same die as the *CPU*.
- **frame** – (1) A block of data that is transmitted as a unit over a network. (2) A screenful of data ready to be projected on a CRT.
- **frame buffer** – specialized memory that holds at least one screenful of data

- **gate** – a circuit that realizes one of the logical functions AND, OR, NAND, NOR, XOR, or XNOR.
- **graphical user interface** (or **GUI**) – a program that permits a user to control a computer by pointing at, moving, and mouse-clicking on graphical symbols (called **icons**) or on the textual or graphical content of a document
- **handshake** – a prescribed sequence of digital electrical signals exchanged by two devices in preparation for data transfer
- **hard disk** – a storage device that consists of one or more rotating platters, on which information is stored magnetically
- **Hewlett-Packard** – a U.S. manufacturer of electronic instrumentation, laser printers and computers.
- **higher-level language** – a symbolic language, used for programming a computer, that permits a problem to be stated in a form that is closer to the user’s problem specification than it is to the computer’s instruction set architecture. The first higher-level language to be used widely was **FORTRAN** (from FORmula TRANslation), which was developed by an IBM group led by John Backus between 1954 and 1957. Currently the higher-level languages **C** and **C++** are very widely used. **C**, which was developed at AT&T Bell Laboratories by Brian Kernighan and Dennis Ritchie, is the language in which the Unix operating system is written.
- **input** – transfer of data into memory
- **instruction** – (1) the binary code that causes a computer’s hardware to perform a specific task. Also called a **hardware instruction**. (2) a line of an assembly-language program that the assembler translates into a hardware instruction. In assembly language an instruction is coded in a rigid format, such as

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operation operand1,operand2,operand3
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where the operands are *registers*, memory locations or numerical constants. An assembly-language program consists of a sequence of directives, declarations and instructions. Compare instruction with command.
- **instruction set architecture** – the model (or mental picture) of a computer system that is defined by the instructions that are available to the assembler programmer. Computers that share the same instruction set architecture need not have the same clock frequency, peripheral devices, or operating system.
- **integrated circuit** – a microelectronic device that consists of many transistors and other components, all fabricated on the same small rectangle of semiconductor
- **Intel** – A U.S. microelectronics manufacturing company founded in 1968 by Gordon Moore and Robert Noyce. Noyce is generally credited with the first application of photolithography to the manufacture of integrated circuits. The first microprocessor, the **4004**, was created at Intel in 1971. Other members of the Intel microprocessor family that are directly descended from the 4004 include the **8008**, **8080**, **8086**, **8088**, **80x86** (where x = 1, 2, 3, 4), and the **Pentium** (for which x = 5). The 8088 was the microprocessor used in the original IBM PC. All of the members of the Intel 80x86 family are CISC processors.
- **kernel** – The part of Unix (or other operating systems) that handles resource allocation, low-level hardware interfaces, and security
- **latency** – the amount of time that passes from the moment a hardware data request is issued until the data has arrived at its destination. The term “latency” is applied to memory, hard disks, and networks.
- **memory** – the location of running programs and of the data that they use
- **MFLOPS** – Millions of Floating-point (arithmetic) Operations per Second
- **microkernel** – an approach to operating-system design in which the basic kernel functions of resource allocation, device handling and security are implemented with small program modules that can easily be reconfigured

- **microprocessor** – a processor on a single integrated circuit. Important *CISC* microprocessors include the Intel 4004, 8008, 8080, 8086, 8088, 80x86, and Pentium, the Motorola 6800, and the Motorola 680x0 family. Important examples of *RISC* microprocessors include the Motorola/IBM/Apple PowerPC, the MIPS R2000, R3000, R4000, and R10000, the SPARC family, the DEC Alpha AXP family, and the Hewlett-Packard PA-RISC family.
- **MIPS** – (1) Millions of Instructions Per Second. (2) A subsidiary of Silicon Graphics, Inc., that designs and manufactures the **MIPS R x 000** family of *RISC* microprocessors, where $x = 2, 3, 4, 5, 8$ or 10 . SPIM simulates the R2000–R3000 architecture.
- **Motorola** – a U.S. manufacturer of electronic products. Motorola’s first microprocessor, the **6800**, was introduced in 1974. In 1979 Motorola introduced the **680x0** family of microprocessors. Initially x was 0; for later members of the family, $x = 1, 2, 3, 4$ or 6 . All are (or were) CISC processors and have (or had) 32-bit data and general-purpose *registers*. The Motorola 68020, introduced in 1984, was the first microprocessor with a 32-bit data bus that was widely available and that was upwardly compatible with an earlier 16-bit family (the 68000 and 68010).
- **operating system** – program that manages the resources of a computer for the benefit of the programs that run on that machine. An operating system (**OS**) provides basic input/output services and permits users to “run” other programs. Some computers can support more than one OS; others require a specific OS.
- **output** – transfer of data from memory to a peripheral device for printing, viewing, storage, etc.
- **performance** – a number that is inversely proportional to the execution time of a specific program on a specific computer; intended to measure the usefulness of the computer for the task accomplished by the program
- **platter** – a rigid metal disk that is the part of a hard drive; data is stored as patterns of magnetization in an iron oxide film deposited on the surface of the platter
- **printed circuit board** (or **printed circuit card**) – a thin board, consisting of one or more layers of insulating material on which metal tracks (the printed circuit) have been deposited.
- **process** – an instance of a *program* in execution
- **processor** – A processor adds, subtracts, multiplies and divides numbers, tests inequalities, etc. The central processing unit (**CPU**) is the executive part of the computer, following the instructions of programs to the letter. In some computers one or more **peripheral processors** control routine tasks such as I/O in order to reduce the load on the CPU. A processor is usually classified as 4-, 8-, 16- or 32-bit, depending on the width of its data bus.
- **program** – an executable file
- **register** – a single word in the *register file*. Usually any register can be read or written in one “tick” of the processor clock.
- **register file** – a small, very fast random-access memory located on the same die as the processor
- **RISC** (Reduced Instruction Set Computer) – a class of computer architectures featuring a small number of primitive instructions, a constant hardware instruction length (in bits), and no memory accesses except by “load” and “store” instructions. The objective of a RISC architecture is to reduce the number of clock periods per (integer) instruction to 1 for most executions, in order to maximize *performance*.
- **sector** – smallest organized unit of data on a hard disk. A sector often contains 512 bytes.
- **semiconductor** – a solid (and usually crystalline) material, the electrical conductivity of which can be altered drastically by doping the material with small amounts of impurities. Semiconductors that are important for microelectronics include silicon (Si), germanium (Ge) and gallium arsenide (GaAs).

- **simulator** – a computer program that executes the instruction set of a processor of a different architecture, with the goal of understanding the other processor’s behavior. SPIM simulates the MIPS R2000–R3000 architecture; XMPSIM simulates the CRAY X-MP architecture.
- **stack** – an abstract data structure from which nodes are deleted in last-in, first-out (**LIFO**) order (as for a stack of plates); specifically, a LIFO data structure maintained by an *operating system* to manage a *process*, or maintained by the process itself.
- **state** – information that is held in non-permanent computer memory, or, more generally, non-permanent information about a system
- **synchronous** – controlled by a clock signal
- **system time** – time spent by the operating system on behalf of a user’s program
- **track** – an annular region on one surface of a *platter* in a hard drive. Each track contains several sectors.
- **Unix (R)** – an operating system (originally developed at AT&T Bell Laboratories) that can support many users and give the illusion of carrying out all users’ tasks at once. In Unix, both I/O devices and commands can be treated as files in some respects, with the result that small, simple tools can easily be put together to perform big jobs.
- **user time** – time spent by the processor executing a user’s program
- **von Neumann architecture** – a stored-program architecture in which there is a single processor that operates sequentially on data that is stored in the same physical memory and in the same format as the instructions
- **wafer** – a thin slice of semiconductor material from which integrated circuits are fabricated
- **word** – a data structure, consisting of a fixed number of *bytes*, that is recognized by the processor’s hardware. A word can be interpreted as an unsigned integer, a signed integer, a character string, (part of) a floating-point number, or an instruction. If the word is interpreted as an unsigned integer, the **most significant byte** is the one whose bits multiply the highest powers of 2 in the base-2 representation. The **least significant byte** is the one whose bits multiply the lowest powers of 2 in the base-2 representation. A word may be addressed by the address of its most significant byte (**big-endian** byte order) or its least significant byte (**little-endian** byte order).