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Computer system architecture goals and boundaries

Computer architecture is the theory behind the design of a computer. In the same way as a building architect sets the principles and goals of a building project as the basis for the draftsman's plans, so too, a computer architect sets out the computer architecture as a basis for the actual design specifications.

There are several usages of the term, which can be used to refer to:

* The design of a computer's CPU architecture, instruction set, addressing modes, and techniques such as SIMD and MIMD parallelism.
* More general wider-scale hardware architectures, such as cluster computing and Non-Uniform Memory Access (NUMA) architectures.
* The less formal usage refers to a description of the requirements (especially speeds and interconnection requirements) or design implementation for the various parts of a computer. (Such as memory, motherboard, electronic peripherals, or most commonly the CPU.)

Computer architecture and Design goals

The most common goals in computer architecture revolve around the tradeoffs between cost and performance (i.e. speed), although other considerations, such as size, weight, reliability, feature set, expandability and power consumption, may be factors as well.

**Cost**

Generally cost is held constant, determined by either system or commercial requirements, and speed and storage capacity are adjusted to meet the cost target. Ideally, finding the best possible technological implementations at the lowest cost possible without compromising on any system requirement.

**Performance**

Computer designers describe the performance of their machines in terms of clock speed (usually in MHz or GHz). This refers to the cycles per second of the main clock of the CPU. However, this metric is somewhat misleading, as a machine with a higher clock rate may not necessarily have higher performance. Modern CPUs can execute multiple instructions per clock cycle, which dramatically speeds-up a program. Other factors that aid speed, such as the mix of functional units, bus speeds, available memory, and the type and order of instructions in the programs being run.

The general scheme of optimization is to find the costs of the different parts of the computer. In a balanced computer system, the data rate will be constant for all parts of the system, and cost will be allocated proportionally to assure this. The exact form of the computer system will depend on the constraints and goals it was optimized for.

**Virtual memory**

Another common problem involves virtual memory. Historically, random access memory has been thousands of times more expensive than rotating mechanical storage, i.e. hard drives in a modern computer.

For businesses, and many general computing tasks, it is a good compromise to never let the computer run out of memory, an event which would halt the program, and greatly inconvenience the user.

Instead of halting the program, many computer systems save less-frequently used blocks of memory to the rotating mechanical storage. In essence, the mechanical storage becomes main memory. However, mechanical storage is thousands of times slower than electronic memory.

Computer architecture System boundaries

A computer system’s boundary demarcates a limit to the system’s internal components and processes. Internal to its boundary, the system has some degree of integrity, meaning the parts are working together and this integrity gives the system a degree of autonomy. Boundaries can be established early in the software life cycle.

The Computer system boundary is a conceptual line that divides the system from ‘everything else’ outside of it. It is useful to think of a computer system’s (external) environment as being made up of those things that are not part of the system, but can either affect the system or be affected by it.

Example 4

A hospital in a domain where software is put to a variety of uses. A hospital might, for example, join together a series of patient-monitoring computer systems with the database management system that manages medical records, creating a larger system with a different scope. A forward-looking hospital might wish to go further and add weather-forecasting software. This extension would allow planners to deal with the variations in flow of patients that arise according to the season. Beds may be allocated and other resources, such as drugs, bought in preparation.

Assuming that a computer system of interest has a purpose, the following definitions will be used on this course:

* The entities/components inside the computer system are all those necessary for it to fulfill its purpose and that can be controlled by the system owners or managers
* The entities in the environment are all those things that affect the system but cannot be controlled by the system owners or managers
* Anything not in the system and not in the environment has no effect on the system’s behaviour.