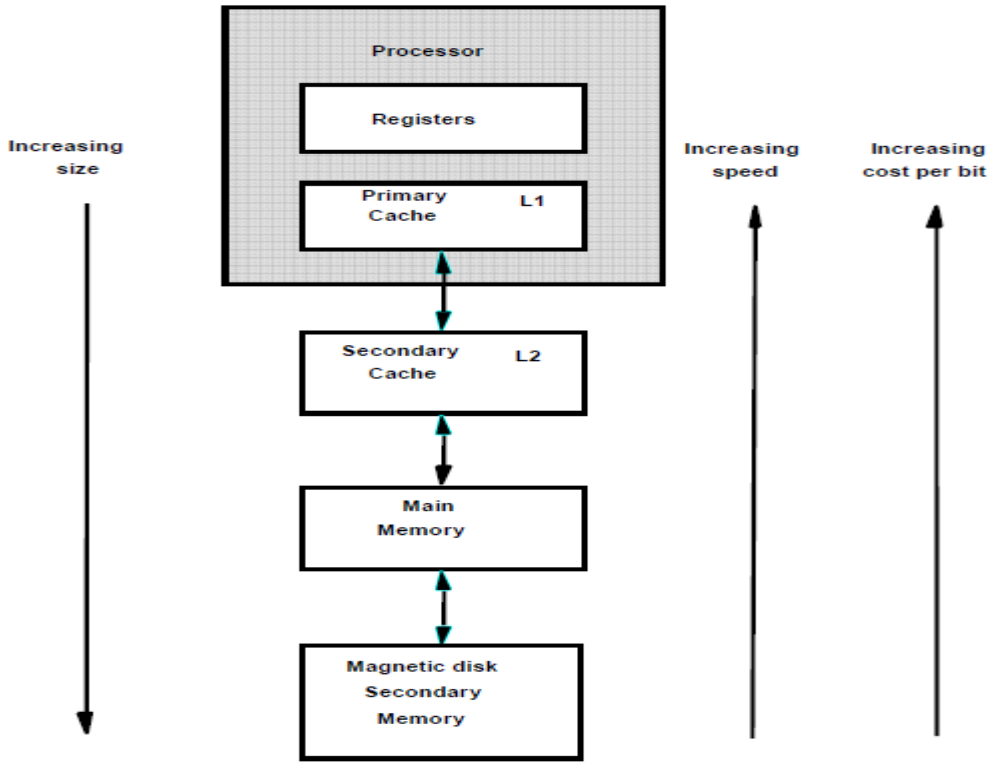
ROMs – Speed, Size and Cost

An ideal memory would be fast, large, and inexpensive. a very fast memory can be implemented if SRAM chips are used. But these chips are expensive because their basic cells have six transistors, which preclude packing a very large number of cells onto a single chip. Thus, for cost reasons, it is impractical to build a large memory using SRAM chips. The alternative is to use Dynamic RAM chips, which have much simpler basic cells and thus are much less expensive. But such memories are significantly slower.

Although dynamic memory units in the range of hundreds of megabytes can be implemented at a reasonable cost, the affordable size is still small compared to the demands of large programs with voluminous data. A solution is provided by using secondary storage, mainly magnetic disks, to implement large memory spaces. Very large disks are available at a reasonable price, and they are used extensively in computer systems. However, they are much slower than the semiconductor memory units. So A huge amount of cost-effective storage can be provided by magnetic disks. A large, yet affordable, main memory can be built with dynamic RAM technology. This leaves SRAMs to be used in smaller units where speed is of the essence, such as in cache memories.



Memory hierarchy

All of these different types of memory units are employed effectively in a computer. The entire computer memory can be viewed as the hierarchy depicted in Figure 4.13. The fastest access is to data held in processor registers. Therefore, if we consider the registers to be part of the memory hierarchy, then the processor registers are at the top in terms of the speed of access. Of course, the registers provide only a minuscule portion of the required memory.

At the next level of the hierarchy is a relatively small amount of memory that can be implemented directly on the processor chip. This memory, called a processor cache, holds copies of instructions and data stored in a much larger memory that is provided externally. There are often two levels of caches. A primary cache is always located on the processor chip. This cache is small because it competes for space on the processor chip, which must implement many other functions.

The primary cache is referred to as level (L1) cache. A larger, secondary cache is placed between the primary cache and the rest of the memory. It is referred to as level 2 (L2) cache. It is usually implemented using SRAM chips. It is possible to have both Ll and L2 caches on the processor chip.
The next level in the hierarchy is called the main memory. This rather large memory is implemented using dynamic memory components, typically in the form of SIMMs, DIMMs, or RIMMs. The main memory is much larger but significantly slower than the cache memory. In a typical computer, the access time for the main memory is about ten times longer than the access time for the L 1 cache.

Disk devices provide a huge amount of inexpensive storage. They are very slow compared to the semiconductor devices used to implement the main memory. A hard disk drive (HDD; also hard drive, hard disk, magnetic disk or disk drive) is a device for storing and retrieving digital information, primarily computer data. It consists of one or more rigid (hence "hard") rapidly rotating discs (often referred to as platters), coated with magnetic material and with magnetic heads arranged to write data to the surfaces and read it from them. During program execution, the speed of memory access is of utmost importance. The key to managing the operation of the hierarchical memory system in Figure 4.13 is to bring the instructions and data that will be used in the near future as close to the processor as possible. This can be done by using the hardware mechanisms.