

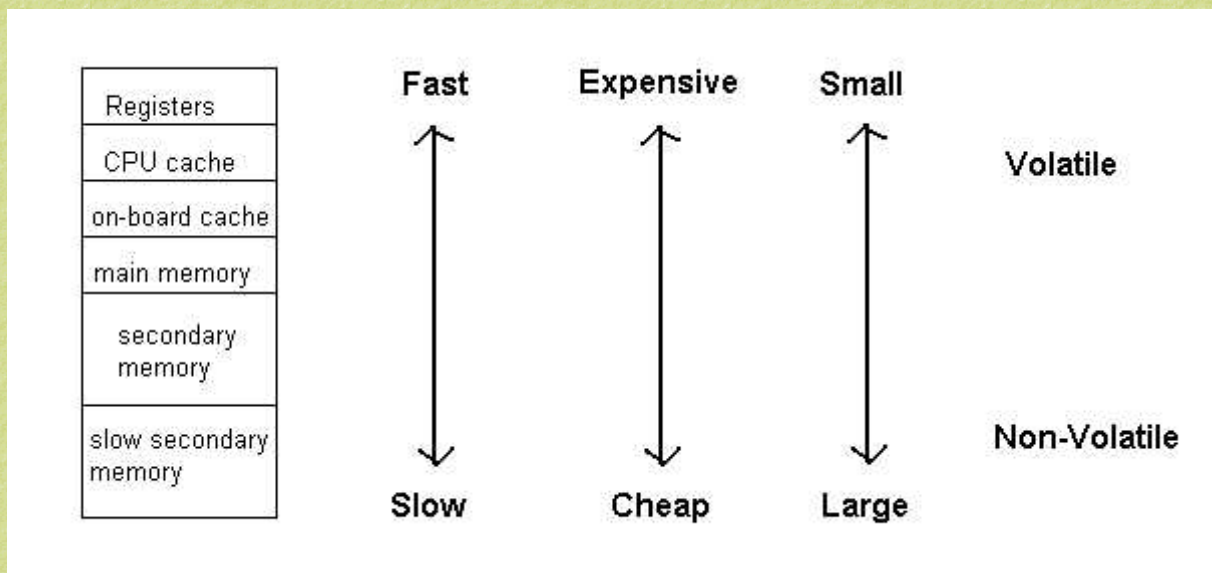
Memory Management



Medium-term scheduler (used in time-sharing systems)

- manages processes waiting for resources
 - examples: waiting to be placed in main memory, waiting for i/o, or waiting to be placed in the ready list of the short tem scheduler.
- integrated with memory management routines (especially processes waiting for main memory)

Storage Hierarchy (Memory Hierarchy)



- **cpu cache** - memory located on the processor chip (VOLATILE)
- **on-board cache** - located on circuit board; fastest external memory available (VOLATILE)
- **main memory** - i.e., Simms, software managed (VOLATILE)
- **secondary memory** - i.e., hard drive (NON-VOLATILE)
- **slow secondary memory** - e.g., tapes, diskettes (NON-VOLATILE)

Volatile Storage

- **volatile** - contents lost if power is interrupted
- **non-volatile** - can withstand power failures and system crashes

Cache Memory

- source: FutureShop.ca web site
- A cache is a very fast block of memory that speeds up the performance of another device. Frequently used data are stored in the cache. The computer looks in the cache first to see if what it needs is there.
- Level 1 Cache is located directly inside the CPU itself, and stores frequently used data or commands. Although relatively small, Level 1 Cache has the most direct effect on overall performance.
- Level 2 Cache is located on the motherboard. It stores frequently used data from the computer's main memory (RAM). In Intel Pentium chips, Advanced Transfer Cache is an improved version of the Level 2 Cache, in which the cache memory operates at the same speed as the processor, which is as much as four times the speed of a standard Level 2 Cache

Pentium III Example (2001):

- **primary or Level 1 (L1) cache** - located in the Pentium III processor chip
 - 32Kb, with 16Kb for instructions and 16Kb for data
- **integrated Level 2 (L2) cache (OR NEXT CHOICE)** - extra memory located in the Pentium III processor chip
 - accessed by a 256-bit data bus - 8-way set associative
- **discrete L2 cache called the *Advanced Transfer Cache*** - EITHER THIS OR PREVIOUS CHOICE
 - connected to processor with a dedicated 64-bit cache bus
 - faster than cache-on-motherboard implementations
- **main memory** - SDRAMs
- **secondary memory** - hard drive
- **slow secondary memory** - tapes, diskettes

Current information

- components in a memory hierarchy
- Pentium example from 2001.

Cache memory

The Pentium III processor has two caches, called the primary or Level 1 ((L1) cache and the secondary or level 2 (L2) cache.

L1 Cache: Pentium 3 Cache is where the processor stores frequently accessed instructions or data for faster performance. The Pentium III processor incorporates a 32K Level 1 cache. This cache consists of 16K for instructions and 16K for data. This cache provides the highest information access speeds available. It is **non-blocking**, which means that _____.

L2 Cache: Working along with the L1 cache, the Pentium III processor has either a 512K unified, non-blocking, Level 2(L2) cache or an integrated 256K Advanced Transfer Cache. The integrated 256K L2 cache is located on-die and runs at the core frequency of the processor. The L2 cache is an area of high-speed memory that improves performance by reducing the average memory access time (source: Intel).

Main Memory

Prices on RAM (random access memory) vary depending on types and manufacturer. Current popular variety is Synchronized Dynamic Random Access Memory (SDRAM). SDRAM comes in increments of 64 MB, 128 MB, 256 MB and 512 MB. For an idea on prices check:

- <http://www.futureshop.ca>

Example prices from Future Shop, January 22, 2003

Price: \$89.99 (plus tax, ignored)

AZEN 256MB, 168 PIN, PC133 MHz, SDRAM DIMM

of bytes = 256MB

of dollars = \$89.99

\$/MB = $\$89.99 / 256 = \$0.3515/\text{MB}$

Access time = 8ns (usual quoted access time)

Assume that MHz is truly million Hertz

Access time = $1 / 133 \text{ M accesses/second} = 1 / 133000000 = 0.000000007518 = 8\text{ns}$

$= 1 / (133 * 1024 * 1024) = 7.17\text{ns}$

Disk Drives

There are many hard drives on the market from 6 Gb to 80 Gb. IDE is the most common type of tape drive. SCSI is more expensive, but it provides better performance and costs more. Prices vary widely depending on many factors. For an idea on prices check:

- <http://www.futureshop.ca>

Example prices from Future Shop, January 22, 2003

Sale Price: \$159.99 plus tax (ignored)

Western Digital Hard Drive 80GB 7200RPM - Their claim: "Western Digital's WD Caviar 7200 RPM EIDE hard drives are the performance champions for advanced desktop personal computers."

of bytes = 80GB = $80 * 1024\text{MB} = 81920 \text{ MB}$

of dollars = \$159.99

\$/MB = $\$159.99 / 8192 = \$0.0020/\text{MB}$

Average access time: 8.9 ms.

CD-ROM

Example prices from Future Shop, January 22, 2003

Regular Price: \$49.99 plus tax (ignored)

Cicero 100 Pack 80 min CDR. Capacity per Disc is 700 megabyte, 80 Minutes.

of bytes = $100 * 700\text{MB} = 70,000 \text{ MB}$

of dollars = \$49.99

\$/MB = $\$49.99 / 70000 = \$0.000714/\text{MB}$

Access time: 110 ms Quote from BZBOYS.COM: "LG Goldstar 8320BI 32X/10X/40X IDE CD-RW DRIVE 8320BI \$56.99 US Mfr Model Number:8320BI 32x10x40x, Data Transfer Rate, 10x Rewritable/CD-RW, 32x Record/CD-R, 40x Max Read/CD-ROM, 110ms Average Access Time, 8MB Buffer with ExacLink for Buffer Underrun Error Protection, MPC III Compliant, Windows XP/2000/ME/98/95/3.1/NT Compatible, Convenient E-IDE/ATAPI/Plug and Play Interface"

Tape Drives

The most common types of tape backup are DAT and DLT. The tapes can store 10 to 80 GB of data. The cost ranges from \$1500 to \$100,000 for the tape drive. The cost of a tape ranges from \$10 to \$200 for the media. Again there is a large amount of variability in pricing. Generally, the type of tape backup unit is determined by the task which it will perform.

No recent pricing available. Please suggest some to hamilton@cs.uregina.ca if you know of an online site.

Zip Disks

Example prices from Future Shop, January 22, 2003

Regular Price: \$49.99 plus tax (ignored)

Iomega 250MB 2 Pack Zip Disks (PC) - I don't know what "2 pack" means

of bytes = 250 MB

of dollars = \$49.99

\$/MB = $\$49.99/250 = \$0.2000/\text{MB}$

Access speed: 50 ms. Quote from

"It features a random access time of less than 50 ms, up to 900 KB/sec sustained transfer rate, up to 1.0 MB/sec burst transfer rate, and a typical throughput of up to 55 MB/min. In addition, it has an average start/stop time of 5-8 seconds. The long format time is just 8-10 seconds, while the short format time is only 10 seconds for 250MB media."



[Table of Contents](#)

