Database Management Systems

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Memory Hierarchy

Structure

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Cache

Cache

- This is the lowest level in the memory hierarchy
- Lowest is used in terms of the hierarchy the last component
- Cache is part of the processor's chip
- Capable of holding data/machine instructions
- Data in cache hold **copy of** certain **memory locations**
- Unit of transfer between cache and main memory is in terms of number of bytes
- For details go through section 11.2.1 of Database systems the complete book

Main Memory

Main Memory

- The main memory is the central storage unit in the computer system.
- Relatively large in size (compared cache) and stores programs and data
- Principle technology used for the main memory is the semiconductor integrated circuits
- Integrated RAM chips are available in two possible operating modes
  - Static RAM
  - Dynamic RAM
- For hardware details of the above two read chapter 12.2 Main Memory of the book *Computer systems architecture*, 3^{rd} edition, M. Morirs Mano `https://faculty.psau.edu.sa/filedownload/doc-10-pdf-d171a71acbe44cd5cd2f78a40570a069-original.pdf`

Virtual Memory

About Virtual Memory

- In any computer program, variables of the program, files read and other associated data occupies what is known as *virtual memory address space*
- Most of the content is actually stored on the disk
- The disk is divided *logically* into blocks
- Typical disk block (block) size would be in the range 4 KB to 56 KB
- Virtual memory is moved between disk and main memory in units of blocks
- This unit is referred to as *pages* in main memory
- The machine hard ward and the operating system (OS) allows pages of virtual memory to be brought into any part of the main memory.
- Go through section 11.2.3 of the text book *Database systems the complete book*

Secondary, tertiary Storage

Reading

Read sections 11.2.4 Secondary Storage and 11.2.5 Tertiary Storage

Mechanics of Disks

Mechanics & Details

- Refer to figure 11.4 of the text book
- Two principal moving pieces of disk drive are *disk assembly* and *head assembly*
- Disk assembly consists of one or more circular *platters* that rotate around a central spindle
- Upper and lower surfaces of platters are covered with a thin layer of magnetic material
- A 0 is represented by orienting the magnetism of a small area in one direction
- A 1 is represented by orienting the magnetism in the opposite direction

Mechanics of Disks

Tracks

- Refer to figure 11.5 of the text book
- The locations where bits are stored are organized into *tracks*
- Tracks are *concentric circles* on a single platter
- Tracks occupy most of the surface of on a single platter
- As we move towards the center of the platter, the tracks becomes shorter
- Tracks consists of many points each of which represents a single bit of the direction of magnetism

Mechanics of Disks

Sectors

- Refer to figure 11.5 of the text book
- Tracks are organized into sectors
- Sectors are nothing but segments of circles separated by gaps
- Gaps are not magnetized in either direction
- Sector is an *indivisible* unit in terms of reading or writing on to disk
- If part of sector is corrupted, the entire sector is corrupted
- From this sense, sectors are indivisible in terms of errors
- Gaps often represent about 10% of total track
- Gaps are used for identifying the beginning of sectors.
- Blocks consists of one or more sectors

Mechanics of Disks

Disk Heads

- Refer to figure 11.4
- The above figure shows the head assembly
- This holds the disk heads
- There is one head for each surface
- Heads ride extremely close to the surface but never touch the surface
- Heads read magnetism passing under it
- Heads can also alter magnetism to write information on the disk
- Each head is attached to an arm
- The arms for all surfaces *move in* or *move out* together
- The entire disk head assembly is rigid

Disk controller

Disk controller

Read section 11.3.2 from the book

Disk storage characteristics

Main components

Rotation speed]: Specifies how many times the disk rotates per minutes. Typical configuration is measured in terms of RPM. Example 5400 RPM, 7200 RPM etc. In 5400 RPM, the disk rotates one rotation every 11 milliseconds

Number of platters per unit A typical disk contains five platters and ten surfaces

Number of tracks per surface A surface may have as many as 10,000 tracks

Number of bytes per track Common disk drives have 10^5 bytes or more per track

Examples problems

Read example problems 11.3 and 11.4 from the book which computes disk capacity given the above four parameters.

Access characteristics

Latency of disk

The time taken between the moment at which the command to read a disk block is issued and the time that the contents of the block appear in the main memory is called the *latency of the disk*

Access characteristics

Latency of disk components

disk controller : Time taken by the processor and disk controller to process the request

Seek Time Time to position the head of the assembly at the proper cylinder.

- Heads require minimum time to start
- Heads require to move to the specified track
- Heads require minimum time to stop

These three put together is the seek time.

Rotational Latency Time for the disk to rotate so that the first of the sectors containing the block reaches the head.

Transfer Time During which the sectors of the block and any gaps between them rotate past the head.

Example Problem

Read example problem 11.5 which computes the time taken to transfer 4096 bytes of data from a hard disk of specified parameters.