COSC1112/1114: Operating Systems Principles

Tutorial 08 (week 09)

1. **None of the disk-scheduling disciplines, except FCFS, is truly fair (starvation may occur).**
    a) **Explain why this assertion is true.**
    b) **Describe a way to modify algorithms such as SCAN to ensure fairness.**
    c) **Explain why fairness is an important goal in a time-sharing system.**
    d) **Give three or more examples of circumstances in which it is important that the operating system be *unfair* in serving I/O requests.**

Answer:

a) New requests for the track over which the head currently resides can theoretically arrive as quickly as these requests are being serviced.
b) All requests older than some predetermined age could be "forced" to the top of the queue, and an associated bit for each could be set to indicate that no new request could be moved ahead of these requests. For SSTF, the rest of the queue would have to be reorganized with respect to the last of these "old" requests.
c) To prevent unusually long response times.
d) Paging and swapping should take priority over user requests. It may be desirable for other kernel-initiated I/O, such as the writing of file system metadata, to take precedence over user I/O. If the kernel supports real-time process priorities

2. **Explain why SSDs often use a FCFS disk scheduling algorithm.**

Answer:

Because SSDs do not have moving parts and therefore performance is insensitive to issues such as seek time and rotational latency. Therefore, a simple FCFS policy will suffice.

3. **Describe some advantages and disadvantages of using SSDs as a caching tier and as a disk drive replacement compared to a system with just magnetic disks.**

Answer:

SSDs have the advantage of being faster than magnetic disks as there are no moving parts and therefore do not have seek time or rotational latency.

4. **Discuss the reasons why the operating system might require accurate information on how blocks are stored on a disk. How could the operating system improve file system performance with this knowledge?**

Answer:

While allocating blocks for a file, the operating system could allocate blocks that are geometrically close by on the disk if it had more information regarding the physical location of the blocks on the disk. In particular, it could allocate a block of data and then allocate the second block of data in the same cylinder but on a different surface at a rotationally optimal place so that the access to the next block could be made with minimal cost.

5. **Consider a RAID Level 5 organization comprising five disks, with the parity for sets of four blocks on four disks stored on the fifth disk. How many blocks are accessed in order to perform the following?**
   a) **A write of one block of data**
   b) **A write of seven continuous blocks of data**

Answer:

a) A write of one block of data requires the following: read of the parity block, read of the old data stored in the target block, computation of the new parity based on the differences between the new and old contents of the target block, and write of the parity block and the target block.

b) Assume that the seven contiguous blocks begin at a four-block boundary. A write of seven contiguous blocks of data could be performed by writing the seven contiguous blocks, writing the parity block of the first four blocks, computing the parity for the next set of four blocks and writing the corresponding parity block onto disk.

6. **Compare the throughput achieved by a RAID Level 5 organization with that achieved by a RAID Level 1 organization for the following:**
   a) **Read operations on single blocks (i.e., multiple non-contiguous)**
   b) **Read operations on multiple contiguous blocks**

Answer:

a) The amount of throughput depends on the number of disks in the RAID system. A RAID Level 5 comprising of a parity block for every set of four blocks spread over five disks can support four to five operations simultaneously. A RAID Level 1 comprising of two disks can support two simultaneous operations. Of course, there is greater flexibility in RAID Level 1 as to which copy of a block could be accessed and that could provide performance benefits by taking into account position of disk head.

b) RAID Level 5 organization achieves greater bandwidth for accesses to multiple contiguous blocks since the adjacent blocks could be simultaneously accessed. Such bandwidth improvements are not possible in RAID Level 1.