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CS 4/53201 **Exam #2** **Operating Systems**

Wednesday 7 November 2001

1. **One common networking topology is the ring.**

   a. **What are the advantages of the ring topology? (4 points)**

      Less expensive than fully-connected, as only n-1 links are required.

   b. **What are the disadvantages of the ring topology? (4 points)**

      In a one-directional ring, a message might require as many as n-1 hops to reach its final destination. Failure of a node prevents all traffic that would have otherwise passed through that node from reaching its destination.

      In a bi-directional ring, less hops are required, and failure of a single node may lengthen the time required to send a message, but does not prevent a message from reaching its destination.

2. **In the 7-layer networking protocol, what are the responsibilities of the transport layer? (10 points)**

   The transport layer is responsible for reliably transmitting messages to a remote host. It breaks messages into packets on the sending side, reassembles those packets into messages on the receiving side, and handles out-of-sequence and missing packets.

3. **For each of the following CPU scheduling algorithms, (i) when does the algorithm run (be specific — think in terms of transitions in the 5-state process model), and (ii) what criteria is used to pick the next thread to run?**

   a. **FCFS (10 points)**

      FCFS runs whenever the process previously on the CPU terminates or blocks, and it picks the process at the head of the queue (which would be the first process in the queue to have entered the queue).

   b. **Shortest Remaining Time (SRT) (10 points)**

      SRT runs whenever a process enters the ready queue (either a new process, or one that was previously blocked), or whenever a running process blocks or terminates. If a process other than the currently running process has a smaller expected CPU burst than what is left of the current process' expected CPU burst, that other process is chosen to run immediately. *(Note that an important distinction between SRT and SJF is that SRT does not consider the time that the current process has already run in this CPU burst, only the time remaining.)*

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4. **Between FCFS, Shortest Job First (SJF), and Priority Scheduling, which of these CPU scheduling algorithms is the most fair with respect to scheduling processes with long CPU bursts, in the sense that it gives those long processes some CPU time? Explain your answer. (10 points)**

   FCFS treats long processes the same as short ones, meaning whichever arrives first runs first, so although a long process may have to wait to run, eventually it will run and once it starts it gets to run until it finishes. SJF strongly favors short processes, and may cause a long process to starve while short processes continuously get priority over the long process. Priority scheduling can allow low-priority processes to starve, so if long processes get low priority, they could starve, although the priority scheduling algorithm can overcome this effect with aging.

   Overall, FCFS is probably best for long processes in giving them CPU time, while Priority Scheduling with aging also good, and SJF a distant third.

5. **In preventing deadlock, how can the hold and wait condition be avoided? How effective is this technique? (10 points)**

   To avoid it, the OS would have to ensure that when a process waits to acquire a resource, it is not holding any other resources. It could do this be forcing the process to request all resources at the beginning of the program execution, or by forcing the process to release existing resources and request both those resources as well as the new resource simultaneously. *(Note that forcing the other process to give up requested resources is avoiding the "no preemption" condition, not the "hold and wait" condition.)*

   This technique is not effective since it is difficult to know in advance what resources will be needed, and wastefully ties up unneeded resources, and it allows starvation.

6. **The Banker's algorithm can be used to avoid deadlock for multiple resource instances, yet it isn't used in practice. Why not? (7 points)**

   For several reasons: (1) the maximum resource requirement for each process must be stated in advance, (2) there must be a fixed number of processes and resources, (3) processes must be independent, and (4) there is a huge overhead to run this algorithm every time a resource is requested.

7. **What is external fragmentation, and which memory management techniques have this problem? (10 points)**

   External fragmentation occurs when small pieces of free memory build up between allocated partitions in memory, where most of those small pieces of memory are too small to be allocated to a process, and all together result in a significant amount of wasted memory space.

   External partitioning occurs when variable-size partitions or segmentation is used; it does not occur when fixed-size partitions or paging is used.

8. **When segmentation is used, how is a process prevented from accessing memory locations outside its segments? Be specific. (15 points)**

The offset in the virtual address is compared to the limit for the segment, and if the offset is greater than the limit, then an address error exception is generated. If this were not done, then the offset would be added to the base address of the segment in physical memory, generating an address greater than the addresses allowed for that segment.

It is not possible for a process to access a memory address less than the addresses allowed for the segment, as it would need a negative virtual address to do so, and the addresses generated by the compiler and assembler are always positive / unsigned values.

9. What advantages do paging (not including demand paging) have over segmentation? (10 points)

Memory allocation is simple, since one frame is as good as any other — no need for First Fit, Best Fit with different frame sizes, etc. No external fragmentation so less memory space is wasted (although there can be a small amount of internal fragmentation in the last page). No need for a limit register since all pages are the same size.