OA Solutions

CSC139-FA24

Question:

A system has 16MB of physical memory and uses 4KB pages. A process requires 40MB of virtual memory. If the system uses an inverted page table with a single entry per physical frame, how many entries does the inverted page table need, and why?

Ideal Answer: The inverted page table requires one entry per physical frame. With 16MB of physical memory and 4KB pages, the number of physical frames is $16\ \mathrm{MB} \div 4\ \mathrm{KB} = 2^{24} \div 2^{12} = 2^{12} = 4096$. Therefore, the inverted page table needs **4096 entries**.

A computer has a TLB with 64 entries and a page size of 8KB. If a program accesses a 1MB array sequentially, how many TLB misses will occur if the TLB is initially empty and all pages are accessed exactly once?

The array is 1MB (2^{20} bytes), and the page size is 8KB (2^{13} bytes). To calculate the number of pages:

$$\text{Number of pages} = \frac{2^{20}}{2^{13}} = 2^{20-13} = 2^7 = 128 \text{ pages.}$$

Since the TLB has 64 entries and starts empty:

1. **The first 64 pages** will cause **compulsory misses**, as the TLB initially has no entries.
2. **The next 64 pages** will also miss due to **capacity misses**—the TLB cannot hold all 128 pages, so as new pages are accessed, they replace older entries.

For sequential access, once the TLB fills, it replaces pages in a round-robin fashion. Thus, each of the 128 pages will miss every time it is accessed sequentially, as there are no repeated hits under this pattern.

Suppose a file system uses a block size of 4 KB, and each inode is 256 bytes. The inode table starts at block 3. Calculate the byte offset of inode number 15 within the inode table, given that inodes are stored sequentially.

Step 1: Calculate the starting address of the inode table

The inode table starts at block 3, and each block is 4 KB (4,096 bytes). Thus, the starting byte address of the inode table is:

$$\text{Starting Address of Inode Table} = 3 \times 4,096 = 12,288\,\text{bytes.}$$

Step 2: Calculate the offset of inode number 15 within the inode table

Each inode is 256 bytes, and inodes are stored sequentially. The byte offset for inode number 15 can be determined as:

$$\text{Byte Offset} = 15 \times 256 = 3,840\,\text{bytes.}$$

Step 3: Add the byte offset to the starting address

The absolute byte address of inode number 15 within the file system is:

$$\text{Absolute Byte Address} = \text{Starting Address of Inode Table} + \text{Byte Offset}$$

$$\text{Absolute Byte Address} = 12,288 + 3,840 = 16,128\,\text{bytes.}$$

Consider a system with three processes: A, B, and C. Process A has a runtime of 5 ms, process B has a runtime of 10 ms, and process C has a runtime of 15 ms. All processes arrive at time 0. If the system uses the First-Come, First-Served (FCFS) scheduling algorithm, calculate the turnaround time for each process and the average turnaround time.

Step 1: Turnaround Time for Each Process

Turnaround time is the time from process arrival to process completion. In FCFS scheduling, processes complete in the order they arrive.

- **Process A:**
  - Completion Time: $5\,\mathrm{ms}$
  - Turnaround Time: $5 - 0 = 5\,\mathrm{ms}$
- **Process B:**
  - Completion Time: $5 + 10 = 15\,\mathrm{ms}$
  - Turnaround Time: $15 - 0 = 15\,\mathrm{ms}$
- **Process C:**
  - Completion Time: $15 + 15 = 30\,\mathrm{ms}$
  - Turnaround Time: $30 - 0 = 30\,\mathrm{ms}$

Step 2: Average Turnaround Time

$$\text{Average Turnaround Time} = \frac{\text{Sum of Turnaround Times}}{\text{Number of Processes}}$$

$$\text{Average Turnaround Time} = \frac{5 + 15 + 30}{3} = \frac{50}{3} = 16.67\,\mathrm{ms}\ \text{(approximately)}.$$

Consider a system with four processes: A, B, C, and D. Process A has a runtime of 8 ms, process B has a runtime of 12 ms, process C has a runtime of 4 ms, and process D has a runtime of 6 ms. All processes arrive at time 0. If the system uses the Round Robin (RR) scheduling algorithm with a time quantum of 4 ms, calculate the turnaround time for each process and the average turnaround time.

1. **Gantt Chart:**

Time (ms)	0–4	4–8	8–12	12–16	16–20	20–24	24–26	26–30
Process	A	B	C	D	A	B	D	B

2. **Completion Times:**
   - **C:** Completes at **12 ms.**
   - **A:** Completes at **20 ms.**
   - **D:** Completes at **26 ms.**
   - **B:** Completes at **30 ms.**
3. **Turnaround Times:**
   - Process A: $20 - 0 = 20\,\text{ms}$
   - Process B: $30 - 0 = 30\,\text{ms}$
   - Process C: $12 - 0 = 12\,\text{ms}$
   - Process D: $26 - 0 = 26\,\text{ms}$
4. **Average Turnaround Time:**

$$\text{Average Turnaround Time} = \frac{20 + 30 + 12 + 26}{4} = 22\,\text{ms}$$