Computer Systems Coursework 2
Anyi Guo
Msc. Data Science, Student ID: 13154855
04/2019

1. Uni and multiprogramming

(a) Uniprogrammed

20s + 30s + 40s + 60s * 3 = 270 seconds = 4 min 30 seconds

(b) Multiprogrammed:

Assuming that there is enough memory for the 3 jobs to be run at the same time, and that there is no resource conflict (i.e. the 3 jobs can do I/O at the same time):

1 minute 40 seconds (1 minute for I/O, 40 seconds for the job with the longest execution time)

2. Paging and TLB

TLB look up 100 *ns*, update 200 *ns*
PT lookup 1 *μs*, update 2 *μs*
Load word from Main Memory to the CPU 10 *μs*
Load page from Disk into Main Memory 10 *ms*

(a) Time it takes to find out the physical address

Assume 100 operations in total. This calculation doesn't include the time it takes to update the page tables & TLB, which is shown in (c) below:

TLB hit
    0.4 * 100 * 100 *ns* = 4000 *ns*
TLB miss (100 *ns*), main memory hit (1 *μs)*
    (1-0.4) * 0.3* 100 * (*100 ns* + 1 *μs)* = 19800 *ns*
TLB miss (100 *ns*), main memory miss (1 *μs*), load page from disk (10 *ms*)
    (1-0.4) * (1-0.3) * 100 * (100 *ns* + 1 *μs* + 10 *ms)* = 420046200 *ns*

Average access time to **find out the physical address**:
    (4000 *ns* + 19800 *ns* + 420046200 *ns)* / 100 = **4200700 *ns* = 4.2007 *ms***

(b) Time it takes to load the reference word onto the CPU

Assuming 100 operations in total.

TLB hit (100 *ns*), reference word is found in physical memory via TLB (10 *μs)*
    0.4 * 100 * (100 *ns* + 10 *μs)* = 404000 *ns*
TLB miss (100 *ns*), main memory hit, reference word is found in main memory via PT (1 *μs* + 10 *μs)*
    (1-0.4) * 0.3 * 100 * (100 *ns* + 1 *μs* + *10 μs)* = 199800 *ns*
TLB miss (100 *ns*), main memory miss, reference word is loaded from disk into main memory (10 *ms*), then to CPU via PT (1 *μs* + 10 *μs)*
    (1-0.4) * (1-0.3) * 100 * (100 *ns* + 1 *μs* + 10 *μs* + 10 *ms*) = 420466200 *ns*

Average access time to **load the reference word onto the CPU**:
    (404000 *ns* + 199800 *ns* + 420466200 *ns)* / 100 = **4210700 *ns* = 4.2107 *ms***

(c) Time it takes to perform the necessary updates to the page tables

Assuming 100 operations in total:

TLB hit: no update to TLB/page table
    0 *ns*
TLB miss, main memory hit: update to TLB (200 *ns*) via PT lookup (1 *μs)*, no update to page table
    (1-0.4) * 0.3* 100 * (200 *ns* + 1 *μs)* = 21600 *ns*
TLB miss, main memory miss (page fault): update to TLB (200 *ns*) via PT look up, update to PT through loading page from disk (10 *ms*)
    (1-0.4) * (1-0.3) * 100 * (200 *ns* + 1 *μs* + 2 *μs* + *10 ms)* = 420134400 ns

Average access time to **perform the necessary updates to the page tables**:
    (0 + 21600ns + 420134400 ns) / 100 = **4201560 *ns* = 4.20156 *ms***

3. Compute the average turnaround time using the multilevel queues (round robin) scheduling algorithm.

	Arrival Time	Run Time	Run Time (Total)	Priority
A	40	1	20	1
B	50	2	60	1
C	40	1	20	0
D	0	2	160	0

I'm using quantum of 1 here:

0 - 40 : D (120)
40 - 50 : A (10), C(20), D(120)
50 - 70: A(0), B (50), C(20), D(120) <— Runtime for A: 70 - 40 = **30**
70 - 120: B(0), C(20), D(120) <- Runtime for B: 120 -50 = **70**
120 - 160: C(0), D(100) <- Runtime for C: 160 - 40 = **120**
160 - 260: D(0) <-Runtime for D: 260 - 0 = **260**

Average runtime:
(30 + 70 + 120 + 260) / (20 + 30 + 20 + 80) = **3.2 seconds**