

Project 1: CPU Scheduling

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1. 設計：

1-1 實驗方法：

本次實驗使用 Linux Kernel 4.19.37 搭配 Ubuntu 16.04 OS System。利用修改 (增加 system call)過的 Ubuntu 16.04 System call 取得系統時間並配合 Linux Kernel 4.19.37 原生文件來達到模擬計算各 Process Execution Time。

為了精準計算時間，我們利用 `sched_setaffinity()` 將 parent process 與 child process 分別 assign 至不同 cpu，以避免當 parent process 在計算 time unit 時 cpu time 被 child process 搶走。

1-2 增加系統 System call：

在 `/home/linux-4.19.36/kernel` 中實作欲新增的 System call，即 `SYSCALL_DEFINE3(hello_3,int,state,int,pid,timespec*,start)` 並於 `/home/linux-4.19.37/arch/x86/entry/syscall_64.tbl` 中增加 System call entry。

此次 Project 增加取得系統時間的 system call，並在每次 `fork()` child process 時使用 `syscall(336, 1, mypid, start)` 取得開始執行時間，並於 child process 結束時利用 `syscall(336, 0, mypid, start)` 取得結束時間。

1-3 FIFO / RR

將每個要執行的 child process 依照 ready time 進行 non-decreasing 排序，並從 ready queue 中依 first in first out(ready time 最早的先完成)的規則抓取執行，同時 parent process 會以 Unit time 的標準計算時間來判斷 child process 執行了多少 time unit。

RR(Round Robin)步驟同上，只是每個 child process 最長執行時間 (time quantum) 為固定的 500 time units。

1-4 SJF：

將每個要執行的 child process 依照 ready time 與 execution time 進行 non-decreasing 排序，排愈前面 priority 愈高。步驟同 FIFO，差別只在於 ready queue 的排序方法(執行時間最短的先完成)。

1-5 Preemptive-SJF：

步驟同 SJF，差別在於 Preemptive 版本會在規定的時間檢查 ready queue 中 child process 剩餘執行時間，並把擁有最短剩餘時間的 child process 插隊置於 ready queue 最前端。

2. 執行範例測資的結果：

FIFO_1

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[28524.171716] [project1] 7527 1556624123.294192664 1556624123.958063613
[28524.831453] [project1] 7528 1556624123.294227481 1556624124.617813048
[28525.492039] [project1] 7529 1556624123.294255092 1556624125.278410805
[28526.151417] [project1] 7530 1556624123.294280479 1556624125.937801170
[28526.811522] [project1] 7531 1556624123.294305878 1556624126.597918899
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

FIFO_2

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[28722.384587] [project1] 7602 1556624215.874859858 1556624322.174928953
[28728.986144] [project1] 7603 1556624216.007890584 1556624328.776629183
[28730.307328] [project1] 7604 1556624216.139056141 1556624330.097841358
[28731.630734] [project1] 7605 1556624216.270943943 1556624331.421276832
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

FIFO_3

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[28810.150521] [project1] 7730 1556624399.394758459 1556624409.942814444
[28816.738174] [project1] 7731 1556624399.659172799 1556624416.530617835
[28820.692676] [project1] 7732 1556624399.791302546 1556624420.485210046
[28822.008976] [project1] 7733 1556624399.923343333 1556624421.801540592
[28823.339491] [project1] 7734 1556624400.055699933 1556624423.132085627
[28824.655608] [project1] 7735 1556624400.055734314 1556624424.448232662
[28829.934588] [project1] 7736 1556624400.187857572 1556624429.727333663
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

SJF_1

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29506.820283] [project1] 8137 1556625103.992737409 1556625106.630268987
[29508.142422] [project1] 8139 1556625104.125851321 1556625107.952443745
[29513.425415] [project1] 8140 1556625104.257515177 1556625113.235579387
[29522.642659] [project1] 8138 1556625103.992781880 1556625122.453073226
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

SJF_2

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29564.403694] [project1] 8171 1556625164.080661143 1556625164.212610327
[29564.668611] [project1] 8173 1556625164.213938853 1556625164.477511941
[29565.823823] sched: RT throttling activated
[29569.943505] [project1] 8172 1556625164.080719461 1556625169.752072138
[29575.213809] [project1] 8174 1556625164.213978938 1556625175.022047963
[29584.440384] [project1] 8175 1556625164.214007116 1556625184.248058513
```

SJF_3

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29720.505250] [project1] 8217 1556625316.356451783 1556625320.305994160
[29720.539914] [project1] 8220 1556625316.490349061 1556625320.340657206
[29720.553322] [project1] 8221 1556625316.490391359 1556625320.354065820
[29725.812108] [project1] 8222 1556625316.628252909 1556625325.612630753
[29731.092027] [project1] 8223 1556625316.761725888 1556625330.892332127
[29737.676638] [project1] 8218 1556625316.356509963 1556625337.476675952
[29746.899226] [project1] 8219 1556625316.356537388 1556625346.698896936
[29758.869234] [project1] 8224 1556625316.898539305 1556625358.668444326
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```


SJF_4

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29874.431288] [project1] 8288 1556625473.962432343 1556625474.226798108
[29874.565892] [project1] 8290 1556625473.976002638 1556625474.361398909
[29874.701110] [project1] 8295 1556625474.030269336 1556625474.496613581
[29874.967151] [project1] 8292 1556625474.002993145 1556625474.762647615
[29875.230191] [project1] 8293 1556625474.003027254 1556625475.025680467
[29875.628636] [project1] 8296 1556625474.030301873 1556625475.424114496
[29875.761456] [project1] 8303 1556625475.293308955 1556625475.556932035
[29876.153789] [project1] 8297 1556625474.069975907 1556625475.949254218
[29876.551563] [project1] 8298 1556625474.109954372 1556625476.347017778
[29876.948435] [project1] 8299 1556625474.137309329 1556625476.743878708
[29877.344528] [project1] 8300 1556625474.177445275 1556625477.139961958
[29877.739034] [project1] 8301 1556625474.204683098 1556625477.534458353
[29878.142317] [project1] 8302 1556625474.244906554 1556625477.937730498
[29878.665437] [project1] 8291 1556625473.989590955 1556625478.460836827
[29879.454441] [project1] 8294 1556625474.003057480 1556625479.249819567
[29880.371403] [project1] 8289 1556625473.962475864 1556625480.166757178
```

PSJF_1

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[28909.973150] [project1] 7782 1556624505.745125466 1556624509.767768442
[28915.281746] [project1] 7781 1556624504.419160615 1556624515.076491024
[28923.248445] [project1] 7780 1556624503.083723606 1556624523.043379911
[28936.175289] [project1] 7779 1556624501.756132983 1556624535.970533842
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

PSJF_2

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29032.176833] [project1] 7848 1556624630.653556094 1556624631.974423187
[29034.791488] [project1] 7847 1556624629.305282181 1556624634.589143449
[29038.843692] [project1] 7850 1556624635.997961197 1556624638.641448027
[29040.190906] [project1] 7851 1556624638.668585475 1556624639.988694914
[29044.025947] [project1] 7849 1556624631.988688538 1556624643.823831876
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

PSJF_3

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29106.336277] [project1] 7889 1556624705.474891756 1556624706.135725816
[29107.002938] [project1] 7890 1556624706.142658886 1556624706.802404293
[29107.674690] [project1] 7891 1556624706.815640198 1556624707.474172618
[29109.632754] [project1] 7888 1556624704.814247249 1556624709.432286631
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

PSJF_4

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29161.081949] [project1] 7929 1556624760.750216770 1556624760.882793406
[29161.215402] [project1] 7934 1556624760.803479260 1556624761.016249261
[29161.469766] [project1] 7927 1556624760.736479317 1556624761.270620754
[29161.740247] [project1] 7931 1556624760.777188848 1556624761.541107911
[29162.019438] [project1] 7932 1556624760.777221375 1556624761.820305970
[29162.417380] [project1] 7935 1556624760.803508942 1556624762.218258478
[29162.554973] [project1] 7942 1556624762.091314160 1556624762.355855426
[29162.946010] [project1] 7936 1556624760.844147900 1556624762.746901983
[29163.345547] [project1] 7937 1556624760.883960096 1556624763.146449411
[29163.743003] [project1] 7938 1556624760.911591894 1556624763.543916402
[29164.141112] [project1] 7939 1556624760.952264275 1556624763.942034885
[29164.542133] [project1] 7940 1556624760.978912799 1556624764.343065931
[29164.938308] [project1] 7941 1556624761.020722168 1556624764.739251770
[29165.463494] [project1] 7930 1556624760.763980403 1556624765.264450756
[29166.248730] [project1] 7933 1556624760.777252879 1556624766.049706925
[29167.139806] [project1] 7928 1556624760.736516111 1556624766.940805720
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```


RR_1

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29229.483234] [project1] 7993 1556624826.225421679 1556624829.285844794
[29229.542504] [project1] 7994 1556624826.225459365 1556624829.345117188
[29229.602776] [project1] 7995 1556624826.225485242 1556624829.405390818
[29229.663014] [project1] 7996 1556624826.225514203 1556624829.465630356
[29229.723722] [project1] 7997 1556624826.225540336 1556624829.526340271
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

RR_2

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29971.381661] [project1] 8359 1556625559.108230786 1556625571.174976478
[29974.011916] [project1] 8360 1556625559.376629110 1556625573.805181682
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

RR_3

```
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$ dmesg
[29423.888259] [project1] 8094 1556625002.007343218 1556625023.696010150
[29424.981253] [project1] 8092 1556624998.842720001 1556625024.789032939
[29426.047747] [project1] 8093 1556625000.427867540 1556625025.855555850
[29435.032927] [project1] 8097 1556625004.906862855 1556625034.840976467
[29437.453002] [project1] 8096 1556625004.115649438 1556625037.261116730
[29438.607332] [project1] 8095 1556625003.586931192 1556625038.415477000
r07922138@r07922138-TUF-GAMING-FX504GD-FX80GD:~/OS_project1_2019/os_project1_2019/src$
```

3. 比較實際結果與理論結果：

TIME UNIT = 1UNIT/0.0013571963198S (小數點以後四捨五入)				
	F I F O	S J F	P S J F	R R
_1	實際:2434 理論:2500	實際:13602 理論:14000	實際:22270 理論:25000	實際:2432 理論:2500
_2	實際:85136 理論:87000	實際:14860 理論:15300	實際:9704 理論:11000	實際:10829 理論:9000
_3	實際:22349 理論:23000	實際:31176 理論:32020	實際:2916 理論:3500	實際:26826 理論:30000
_4		實際:4571 理論:4700	實際:4561 理論:4700	

註：會造成實際值比理論值還小，猜測是因為 Time unit 的計算過大，導致實際值偏小。

4. 各組員的貢獻：

黃謙仁：搜索多數資料提供組員參考，並將觀念和技巧確實運用於報告加速整體流程。

林群崑：實際編組 system call，實現利用真實 linux kernel 來模擬排程的狀況。

傅家靖：詳實記錄方法並完成報告架構，實際執行測資結果並列表。

黃懋翔：組織組員會議，訂定具體完成時間，反覆測試程式正確性。

胡程維：推進計畫流程，提出關鍵個人意見，對報告進行校正和核對。