1. Compute the response time and turnaround time when running three jobs of length 200 with the SJF and FIFO schedulers.

Solution.

Response time = first start time - arrival time

Trunaround time = finish time - arrival time

SJF = shortest job first

FIFO = first in first out

Job1 = burst TIme : 200, arrival Time : 0

Job2 = burst Time : 200, arrival Time : 0

Job3 = burst TIme : 200, arrival TIme : 0

In FIFO
Job 1 = arrival time : 0.000 start time : 0 finish Time : 200 - Response TIme = 0 Turnaround TIme = 200 Job 2 = arrival time : 0 start time : 200 finish Time : 400 - Response TIme = 200 Turnaround TIme = 400 Job 3 = arrival time : 0 start time : 400 finish Time : 600 - Response TIme = 400 Turnaround TIme = 600 평균 Response TIme = 600 / 3 = 200 Turnaround Time = 1200 / 3 = 400
In SJF
Job 1 = arrival time : 0 start time : 0 finish Time : 200 - Response TIme = 0 Turnaround TIme = 200 Job 2 = arrival time : 0 start time : 200 finish Time : 400 - Response TIme = 200 Turnaround TIme = 400 Job 3 = arrival time : 0 start time : 400 finish Time : 600 - Response TIme = 400 Turnaround TIme = 600 평균 Response TIme = 600 / 3 = 200 Turnaround Time = 1200 / 3 = 400
FIFO와 SJF의 결과가 같은 이유는 3개의 job 모두 arrival time이 같고 burst time이 같기 때문이다.
수행 순서가 바뀌어도 평균 response time과 turnaround time은 동일하므로 생략

2. Now do the same but with jobs of different lengths: 100, 200, and 300.

Solution.

Response time = first start time - arrival time

Trunaround time = finish time - arrival time

SJF = shortest job first

FIFO = first in first out

Job1 = burst TIme : 100, arrival Time : 0

Job2 = burst Time : 200, arrival Time : 0

Job3 = burst TIme : 300, arrival TIme : 0

In SJF

Job 1 = arrival time : 0.000 start time : 0 finish Time : 100
- Response TIme = 0 Turnaround TIme = 100

Job 2 = arrival time : 0.001 start time : 100 finish Time : 300
- Response TIme = 100 Turnaround TIme = 300

Job 3 = arrival time : 0.002 start time : 300 finish Time : 600
- Response TIme = 300 Turnaround TIme = 600

평균

Response TIme = 400 / 3 = 133.3333…

Turnaround Time = 1000 / 3 = 333.3333…

Case 1 job1 -> job2 -> job3

In FIFO

Job 1 = arrival time : 0 start time : 0 finish Time : 100
- Response TIme = 0 Turnaround TIme = 100

Job 2 = arrival time : 0 start time : 100 finish Time : 300
- Response TIme = 100 Turnaround TIme = 300

Job 3 = arrival time : 0 start time : 300 finish Time : 600
- Response TIme = 300 Turnaround TIme = 600

평균

Response TIme = 400 / 3 = 133.3333…

Turnaround Time = 1000 / 3 = 333.3333…

Case 2 job1 -> job3 -> job2

In FIFO

Job 1 = arrival time : 0 start time : 0 finish Time : 100

- Response TIme = 0 Turnaround TIme = 100

Job 2 = arrival time : 0 start time : 400 finish Time : 600

- Response TIme = 400 Turnaround TIme = 600

Job 3 = arrival time : 0 start time : 100 finish Time : 400

- Response TIme = 100 Turnaround TIme = 400

평균

Response TIme = 500 / 3 = 166.6666⋯

Turnaround Time = 1100 / 3 = 366.6666⋯

Case 3 job2 -> job1 -> job3

In FIFO

Job 1 = arrival time : 0 start time : 200 finish Time : 300

- Response TIme = 200 Turnaround TIme = 300

Job 2 = arrival time : 0 start time : 0 finish Time : 200

- Response TIme = 0 Turnaround TIme = 200

Job 3 = arrival time : 0 start time : 300 finish Time : 600

- Response TIme = 300 Turnaround TIme = 600

평균

Response TIme = 500 / 3 = 166.6666⋯

Turnaround Time = 1100 / 3 = 366.6666⋯

Case 4 job2 -> job3 -> job1

In FIFO

Job 1 = arrival time : 0 start time : 500 finish Time : 600

- Response TIme = 500 Turnaround TIme = 600

Job 2 = arrival time : 0 start time : 0 finish Time : 200

- Response TIme = 0 Turnaround TIme = 200

Job 3 = arrival time : 0 start time : 200 finish Time : 500

- Response TIme = 200 Turnaround TIme = 500

평균

Response TIme = 700 / 3 = 233.3333⋯

Turnaround Time = 1300 / 3 = 433.3333⋯

Case 5 job3 -> job1 -> job2

In FIFO

Job 1 = arrival time : 0 start time : 300 finish Time : 400

- Response TIme = 300 Turnaround TIme = 400

Job 2 = arrival time : 0 start time : 400 finish Time : 600

- Response TIme = 400 Turnaround TIme = 600

Job 3 = arrival time : 0 start time : 0 finish Time : 300

- Response TIme = 0 Turnaround TIme = 300

평균

Response TIme = 700 / 3 = 233.3333…

Turnaround Time = 1300 / 3 = 433.3333…

Case 6 job3 -> job2 -> job1

In FIFO

Job 1 = arrival time : 0 start time : 500 finish Time : 600

- Response TIme = 500 Turnaround TIme = 600

Job 2 = arrival time : 0 start time : 300 finish Time : 500

- Response TIme = 300 Turnaround TIme = 500

Job 3 = arrival time : 0 start time : 0 finish Time : 300

- Response TIme = 0 Turnaround TIme = 300

평균

Response TIme = 800 / 3 = 266.6666…

Turnaround Time = 1400 / 3 = 466.6666…

결론

SJF의 방법으로는

Response TIme = 400 / 3 = 133.3333…

Turnaround Time = 1000 / 3 = 333.3333…

1가지의 경우의수가 있지만 (항상 1-2-3순)

FIFO 방법으로는 총 6가지의 경우의 수가 있다.

case	1	2	3	4	5	6
order	1-2-3	1-3-2	2-1-3	2-3-1	3-1-2	3-2-1
Response Time	133.3333…	166.6666…		233.3333…		266.6666…
Turnaround TIme	333.3333…	366.6666…		433.3333…		466.6666…

3. Now do the same, but also with the RR scheduler and a time-slice of 1.

Solution. (context switching overhead 계산 X)

Response time = first start time - arrival time

Trunaround time = finish time - arrival time

RR scheduler = designed to reduce response times

Job1 = burst TIme : 100, arrival Time : 0

Job2 = burst Time : 200, arrival Time : 0.001

Job3 = burst TIme : 300, arrival TIme : 0.002

Time	0	1	2	3	...	298	...	499	...	600
running	Job1	Job2	Job3	Job1	...	Job1	...	Job2	...	Job3

In RR

우선 time-slice가 1이므로 time 1 지날때마다 context switching이 발생한다.

각 시간 진행마다 프로세스가 종료할 때 까지 남은 burst time을 계산하면 아래의 표와 같다.

TIme	Job1	Job2	Job3
0	100	200	300
1	99	200	300
2	99	199	300
3	99	199	299
4	98	199	299

즉 수행해야할 프로세스가 3개일경우에는 각 프로세스의 burst time은 3초마다 1만큼 감소된다. 즉 (시간 경과) = (수행된 burst time - 1) * 3 + 1

그러므로 job1의 finish time = 0 + ((100-1)*3+1) = 298

그 후 시간 진행마다 남은 burst time을 확인해보면 아래의 표와 같다.

TIme	Job1	Job2	Job3
298	0	101	201
299	0	100	201
300	0	100	200
301	0	99	200
302	0	99	199

298이후 job1은 종료가 되었으므로 job2와 job3 사이에서만 context switching이 발생

즉 (시간 경과) = (수행된 burst time - 1) * 2 + 1

그러므로 job2의 finish time = 298 + ((101-1)*2+1) = 499

Job2 가 완료된 시점에서 job3의 종료까지 남은 burst time은 101이 된다. 또한 이제 수행해야할 프로세스는 job3뿐이므로 context switching은 일어나지 않는다.

그러므로 job3의 finish time = 499 + 101 = 600

결론

Job 1 = arrival time : 0.000 start time : 0 finish Time : 298

- Response TIme = 0 Turnaround TIme = 298

Job 2 = arrival time : 0.001 start time : 1 finish Time : 499

- Response TIme = 1(대략) Turnaround TIme = 499(대략)

Job 3 = arrival time : 0.002 start time : 2 finish Time : 600

- Response TIme = 2(대략) Turnaround TIme = 600(대략)

평균

Response TIme = 3 / 3 = 1

Turnaround Time = 1397 / 3 = 465.6666…

7. What happens to response time with RR as quantum lengths increase? Can you write an equation that gives the worst-case response time, given N jobs?

Answer.

Quantum length는 다른말로 time slice의 길이라 할 수 있다. 즉 time slice의 길이가 길어지면 context switching 발생하는 시간 빈도가 줄어든다. 그러므로 process의 response time은 커지게 된다.

N개의 job이 있고 time slice를 q라고 하자 그러면 각각의 job은 최대 (N-1)*q초까지 기다릴수 있다. 모든 job이 (N-1) * q초를 기다리는 것이 worst-case이므로 response time은 이 시간을 job의 개수로 나눈 것이다.

그러므로 worst-case response time은 (N-1)*q / N 이 된다.

결론

1. Quantum lengths increase -> response time increase

2. worst-case response time = (N-1)*q / N