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Comparison of Dynamic Time Slice Allocation-Based First Come First Serve and Priority Based Round Robin Job Scheduling Techniques

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Abstract: The First-In-First-Out or First Come First Serve (FCFS) job scheduling technique is a non-preemptive scheduling technique often used in many hardware, software and production systems. For improvement of parameters such as reduction of waiting time in queue and turnaround time, a version of FCFS is developed with a dynamic time slice allocation technique based on job length. The same dynamic time slice allocation technique is used to improve the standard preemptive round-robin priority-based job scheduling technique. Finally, this paper endeavours to attempt a comparative study between the FCFS job scheduling technique with dynamic time slice allocation, and the pre-emptive priority-based job scheduling technique with dynamic time slice allocation, both of which offer better performances than their standard static time slice allocation-based variants.

Keywords: Dynamic time slice allocation, FCFS, Priority Scheduling, Round Robin, Turnaround time reduction.

I. INTRODUCTION

Different job and process scheduling algorithms have been used for a very long time in diverse domains such as microprocessor based systems, software (such as operating systems) and production management techniques (in industrial engineering).

A. FCFS (FIFO) Scheduling

Of the various techniques used, FCFS or First Come First Serve job scheduling (also known as FIFO or First-in-First-Out scheduling) is used in many cases such as in the interfacing of electronic components, despite having higher turnaround times and longer waiting times in average for jobs scheduled to start execution.

This is typically a non-preemptive algorithm where a job or process is not interrupted after it has started execution. To decrease the overheads incurred in such a scheduling method, Schweigelshohn and Yahyapour [1] have proposed a preemptive version of the FCFS scheduling technique.

B. Priority-Based Round Robin Scheduling

Typically, priority-based Round Robin (RR) scheduling schemes are implemented, where possible, instead of FCFS, to decrease average turnaround times and waiting times. Rosemarry et al [2] have investigated the problem with reference to grouping based job scheduling using priority queue and a hybrid algorithm.

Thus essentially the focus has been to essentially approach the ideal turnaround times and waiting times obtained in case of SJF (Shortest Job First) Scheduling, as discussed by Kishor et al [3], which is practically impossible in almost all cases where jobs of random lengths join a queue, since it is impossible to know beforehand the shortest job in the queue. Preemptive techniques with static (or constant) time slice allocations solve the problem to a certain extent but for enhanced performance dynamic time slice allocation based techniques must be studied.

II. DYNAMIC TIME SLICE ALLOCATION

Improvements in performance in scheduling algorithms have also been demonstrated by Kishor et al [4]. In this paper a dynamic time slice allocation technique has been propose to decrease average turnaround time and waiting time for the jobs to be executed. This technique will better the performance of FCFS as well as priority-based Round Robin scheduling.

Let the minimum time slice that can be allocated be equal to n milliseconds where n is an even integer. This is the base time slice allotted for general FCFS. Now the dynamic allocation rules are represented according to the length of job to be executed in the following table 2.1.

Table 2.1 Rules for allocation of time slices to jobs

Job Length L	Allotted Time Slice
L <= 1.5n	n+1
1.5n < L <= 2.25n	2n
2.25n < L <= 3n	2(n+1)
L > 3n	4n

Hence by these allocation rules, allocated time slices shall match the job times more accurately, thus leading to general improvement turnaround times and waiting times.

III. DYNAMIC PRIORITY BASED SCHEDULING

In this paper, dynamic priority scheduling has been used to improve the performance of standard Round Robin algorithm. Highest priority is allotted to the job with the least remaining time requirement for completion. Thus the technique takes an approach similar to SJF scheduling.

IV. MODEL

Here it is assumed that new jobs arrive after each time slice ends. This is maintained for FCFS scheduling, preemptive FCFS with dynamic time slice allocation scheduling as well as priority based Round Robin

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scheduling with dynamic time slice allocation and dynamic priority assignment according to least time remaining for job completion. The processes P1 to P6 are taken and base time slice is assumed to be n=4 milliseconds. The processes arrive sequentially i.e. P1 first, then P2 and so on upto P6. For both types of FCFS scheduling, priorities are set according to arrivals. For priority based Round Robin scheduling, priorities change dynamically with highest priority to the job which requires least time to complete, after ending of each time slice. The durations of P1 to P6 are given in Table 4.1

Table 4.1 Job Durations

Process	Execution Time
P1	5
P2	13
P3	25
P4	8
P5	41
P6	31

V. RESULTS

From the data obtained using the model outlined above, the performance of the three scheduling techniques can be compared. It is found that the FCFS scheduling algorithm with dynamic time slice allocation performs much better compared to FCFS scheduling with fixed time slice allocation in terms of lesser average waiting time for queued jobs as well as lower average turnaround time. The corresponding data are found in Table 5.1 and the results are graphically shown in Fig. 5.1 to Fig. 5.4.

Table 5.1 Comparison of Static Time Slice FCFS with Dynamic Time Slice FCFS

	FCFS with Dynamic Time Slice Allocation			FCFS with Static Time Slice Allocation		
	Execution Time	Wait Time	Turn around Time	Execution Time	Wait Time	Turn around Time
P1	5	0	5	5	0	5
P2	13	0	13	13	5	18
P3	25	0	25	25	13	38
P4	8	9	17	8	34	42
P5	41	9	50	41	38	79
P6	31	49	80	31	75	106
Avg		11.17	31.67		27.5	48

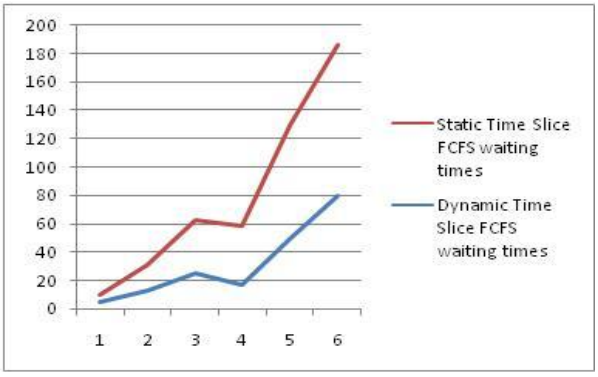

Fig. 5.1 Static Time Slice FCFS waiting times versus Dynamic Time Slice FCFS waiting times

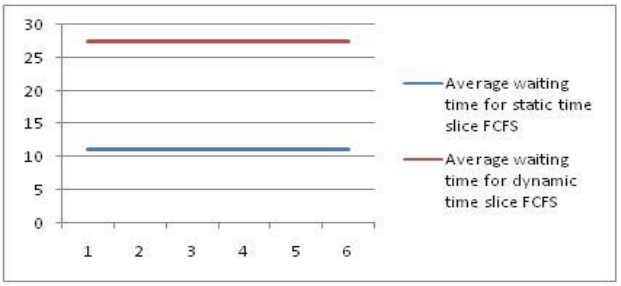

Fig. 5.2 Static Time Slice FCFS average waiting time versus Dynamic Time Slice FCFS average waiting time

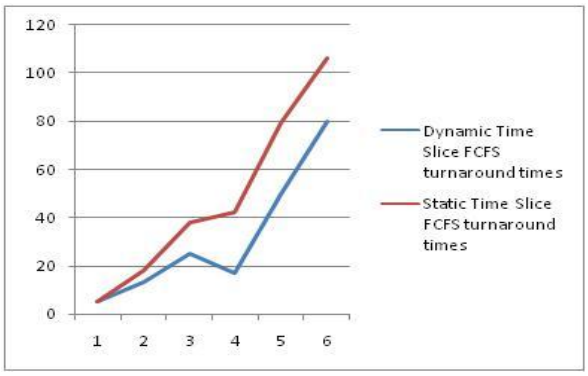

Fig. 5.3 Static Time Slice FCFS turnaround times versus Dynamic Time Slice FCFS turnaround times

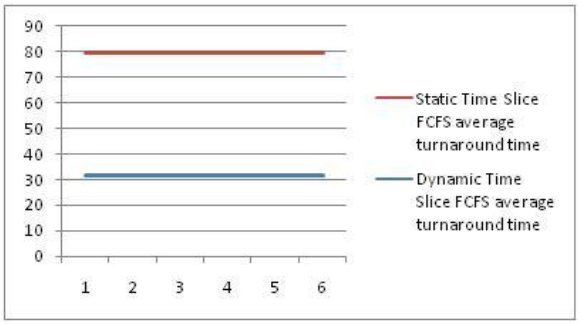

Fig. 5.4 Static Time Slice FCFS average turnaround time versus Dynamic Time Slice FCFS average turnaround time

Table 5.2 Comparison of Dynamic Time Slice FCFS with Dynamic Time Slice Dynamic Priority Round Robin

	FCFS with Dynamic Time Slice Allocation			PRIORITY RR with Dynamic Time Slice Allocation		
	Execution Time	Wait Time	Turnaround Time	Execution Time	Wait Time	Turnaround Time
P1	5	0	5	5	0	5
P2	13	0	13	13	0	13
P3	25	0	25	25	0	33
P4	8	9	17	8	0	8
P5	41	9	50	41	40	81
P6	31	49	80	31	1	32
Avg		11.17	31.67		6.83	28.67

The priority-based Round Robin scheduling algorithm offers better results than the dynamic time slice FCFS scheduling in terms of even lesser average waiting time for

queued jobs as well as lower average turnaround time. The corresponding data are found in Table 5.2 and the results are graphically shown in Fig. 5.5 and Fig. 5.6.

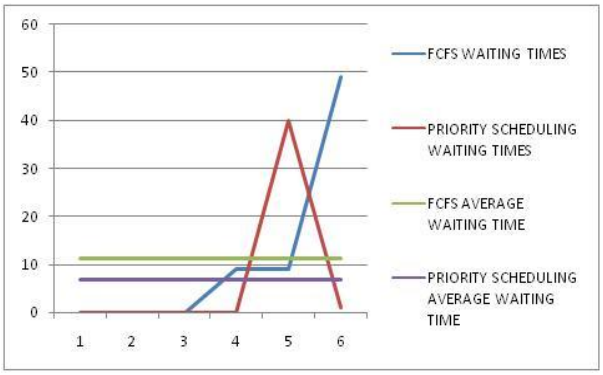

Fig. 5.5 Dynamic Time Slice Dynamic Priority RR waiting time versus Dynamic Time Slice FCFS waiting time

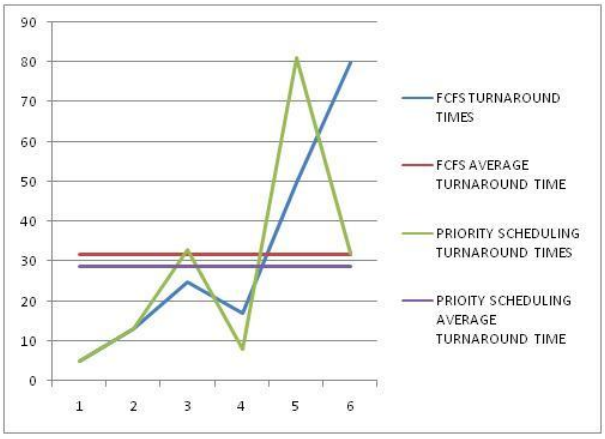

Fig. 5.6 Dynamic Time Slice Dynamic Priority RR turnaround time versus Dynamic Time Slice FCFS turnaround time

Hence it is observed that Dynamic Time Slice allocation improves the average waiting times and turnaround times in case of both FCFS as well as Round Robin job scheduling. It is also observed that RR job scheduling has better performance than FCFS scheduling even in case of the Dynamic Time Slice variants of both techniques. Additionally, Dynamic Time Slice allocation FCFS scheduling allows for shorter job queues in general compared to Static Time Slice allocation based FCFS scheduling.

VI. CONCLUSION

It is found from the results obtained that Dynamic Time Slice allocation improves the average waiting times and turnaround times of jobs in a queue and allows shorter jobs to be completed quicker than in case of Static Time Slice allocation, which is seen through the results for priority-based Round Robin scheduling with Dynamic Time Slice allocation. Additionally, if priority is dynamically modified according to jobs requiring the lowest time to complete currently, then performance is bettered.

Thus future work in this area will focus on determination of a better heuristic measure for dynamic time slice allocation.

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BIOGRAPHIES

Judhajit Sanyal completed his B. Tech. in Electronics and Communication Engineering from NSEC under WBUT, West Bengal and his M. Tech. in Radiophysics from the University of Calcutta. He currently teaches at CIEM Kolkata and is a member of the faculty of the Department of Electrical Engineering. His interests are in the areas of Digital Systems Testing, Electromagnetics, Optimization and AI.