ANALYSIS AND REVIEW OF CPU SCHEDULING TECHNIQUES THROUGH COMPARATIVE STUDY

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Abstract:
Effective scheduling is a basis to achieve system objectives in optimum way. The process manager is responsible for resource utilization in efficient manner and to execute various processes in a perfect way. In scheduling all processes are handled on the basis of particular strategy. The performance of system is primarily based on CPU scheduling. Fundamentally, scheduling is a matter of managing queues and to decide which of the process have to be executed next to achieve high efficiency level. Scheduling algorithms deals to minimize queuing delay and to optimize performance of queuing environment. In this paper, some common scheduling approaches like First Come First Serve, Shortest Job First, Priority Scheduling and Round Robin Scheduling are studied and reviewed on the basis of their working strategy. Scheduling techniques are analyzed on system objectives like waiting time and turnaround time and it is highlighted that which algorithm is appropriate for any particular situation.

Keywords: Scheduling Scheduler, State Diagrams, Performance Scheduling Algorithm, Burst Time, Turnaround Time, Waiting Time

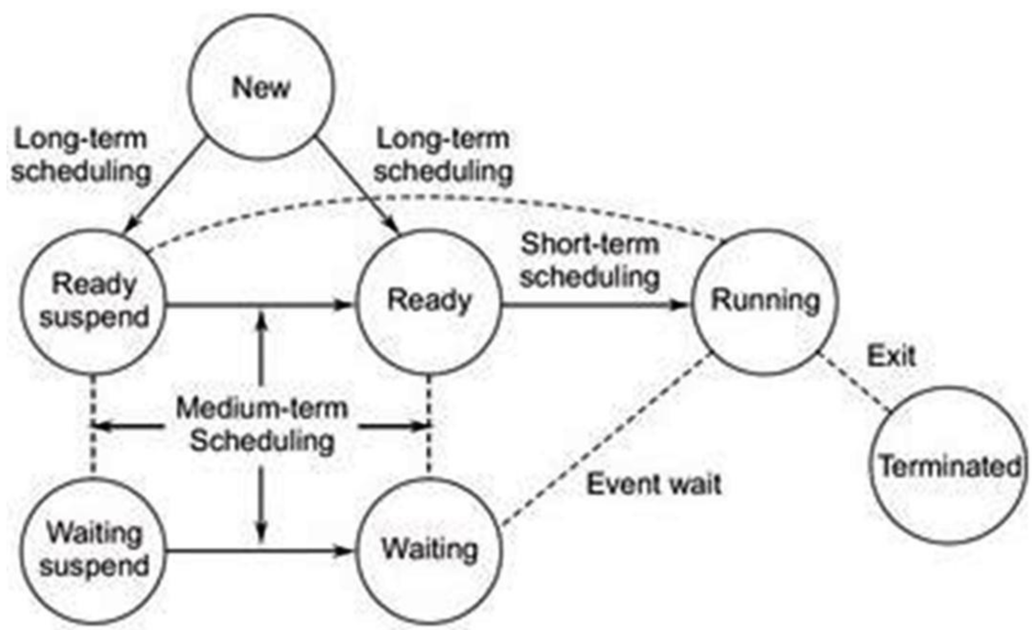
Introduction
Operating system is a collection of system programs which control all operations of computer system and works as an interface between user and system. The fundamental objective of an operating system is to provide an atmosphere where various processes can be executed in convenient manner. It provides appropriate mechanism so that available resources can be used among all processes in an optimum way. It keeps each resource status and decides control over computer resources. It handles I/O programming and controls allocation of resources among various users and tasks and during execution it manages those resources also.

It provides various services like Program Execution, I/O Operations, File System Manipulation, Error Detection, development of programs and software, communication between computer system with multiprogramming and multitasking etc.

As scheduling is a core function of any operating system hence almost all computer resources are scheduled before use. And among all, CPU scheduling is central to operating system design as it determines which processes run when there are many processes available for execution from multiple channels in ready queue.

This Scheduling mechanism is a part of process manager which handles all processes on the basis of particular strategy and try to achieve system objectives such as response time, throughput, and processor’s efficiency. Scheduling affects performance of the system because it determines which process will wait and which will progress. Basically scheduling manages queues so that queuing delay can be minimized and queuing environment can be optimized. Scheduling is divided into Long Term Scheduling, Medium Term Scheduling & Short Term Scheduling.

Long Term Scheduling also called job scheduling selects process from queue and loads it into memory for execution. Process selection is in a balanced way so that degree of multiprogramming can be maintained as stable. Medium term scheduling is a part of swapping function where by paging, process execution is done. It reduces the degree of multiprogramming. Short Term Scheduling also called CPU scheduling is a change of ready state to running state of a process. It is actual decision of which ready process to execute next.



Process State Transition Diagrm

Scheduling factors

Scheduling deals with deciding that which of the processes in ready queue is to be allocated to CPU. For better utilization, each process is assigned a priority and scheduler always choose a process of higher to lower priority by using some scheduling policy. On the basis of these policies, different scheduling algorithms are compared. The factors of comparison are,

CPU Utilization: It is that average fraction of time in which processor is busy.

Throughput: It refers to amount of work done in allotted unit of time. In other words number of processes which are executed in a period of time.

Waiting Time: The average period of time a process spends waiting. Waiting time may be expressed as turnaround time less the actual execution time.

Turnaround time: The total time taken by a process from its submission to its completion.

Response time: Time required for a process from its submission to getting first response for execution.

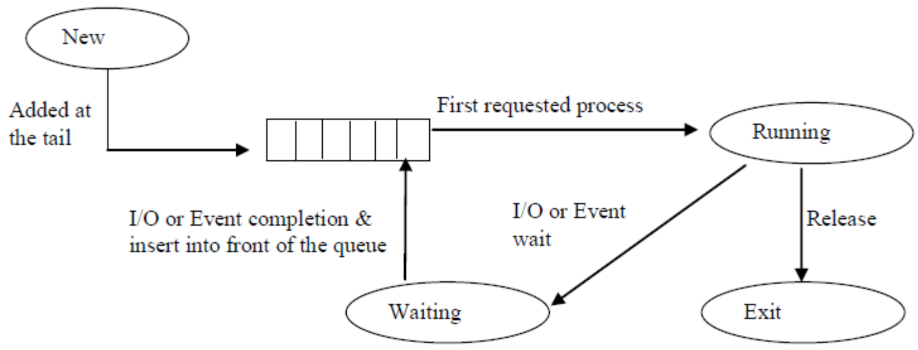
Priority: weightage decided for a process for execution**.**

Scheduling Algorithms

Scheduling algorithms decides which process should be executed next and allocates to the CPU on the basis of scheduling criteria. Scheduling algorithms can be divided into two categories **Preemptive** and **Non Preemptive.** Non preemptive algorithms are designed in such a way that once a process enters in running state; it cannot be removed from the processor until it has completed. i.e. once CPU is allotted to a process, it cannot be taken away from that process. Preemptive algorithms execute processes on the basis of priority. Process with highest priority is always executed first. If a process is currently executing by processor and a new process with higher priority enters, the existing process returns in to ready state and newly entered process will be executed first. The process in ready list will not return to processor until it becomes highest priority process. A process can switches from running state to ready state or, from waiting state to the ready state in preemptive scheduling. Some of common CPU Scheduling algorithms are,

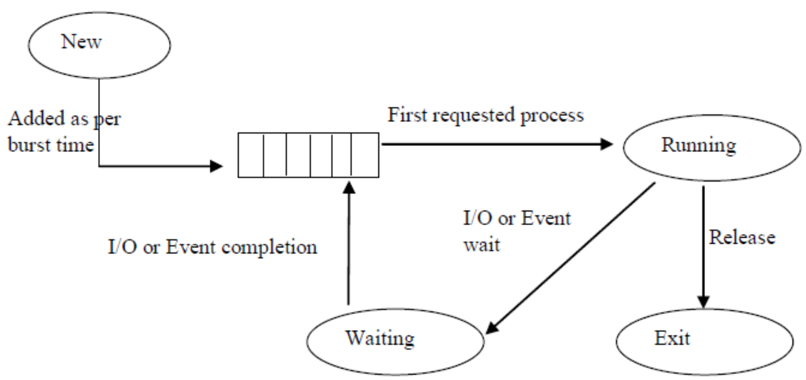
First Come First Serve Scheduling Algorithm (FCFS)

It is one of the simplest Scheduling algorithms. Here a ready queue is maintained as first in first out (FIFO) queue. And CPU allocated to processes in the order they arrive. a process dispatches from head of ready queue for execution. When a process gets completed, it terminates and is deleted from system. The next process is then dispatched from head of ready queue. This algorithm is suitable for batch system and it is non preemptive. Four state diagram of FCFS is,



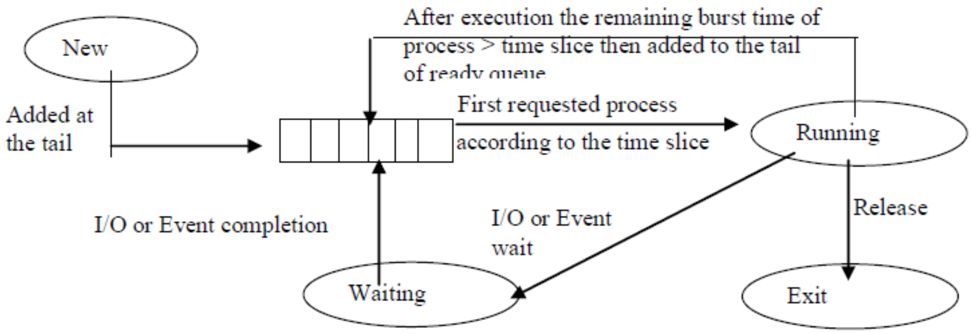
Shortest Job First Scheduling Algorithm (SJF)

This is a Non preemptive algorithm in which ready queue is maintained in order of CPU burst length, with shortest burst length at head of the queue. Here that processes dispatches from head of ready queue for execution which is shortest. Scheduler arranges the processes with the least burst time in head of queue and longest burst time in tail of the queue. When process completed, it terminates and deleted from system. Next process is then dispatched from head of ready queue. The major advantage of this scheduling algorithm is this is usually considered to be an optical algorithm and it gives the minimum average waiting time. This algorithm is designed for maximum throughput in most scenarios and its four state diagram is



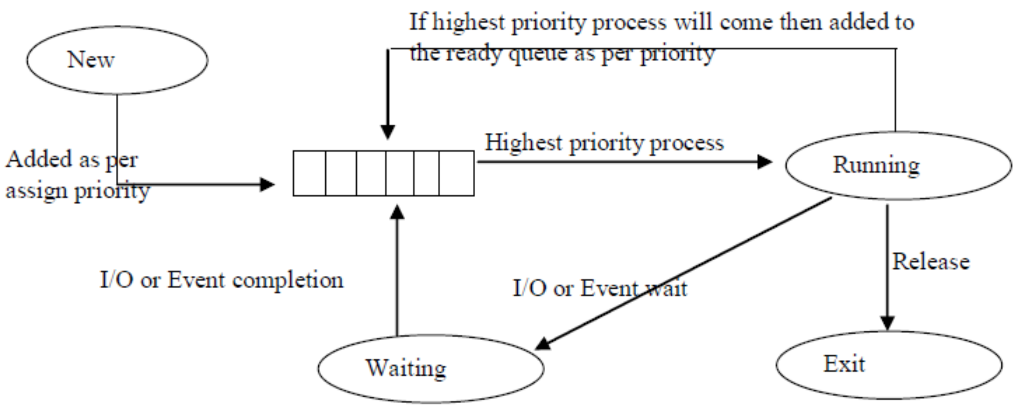
Round Robin Scheduling Algorithm

This algorithm is designed especially for timesharing systems. It is similar to FCFS scheduling, but preemption is added to switch between processes by a small unit of time, called time quantum or time slice. All processes are kept in ready queue which is circular queue and works in FIFO manner. Each new process is added at the end of ready queue. The scheduler allocates CPU to each process for assigned time quantum. If process finishes its burst before time quantum timer expires, then it is swapped out of the CPU just like FCFS algorithm. If timer goes off first, then process is swapped out of CPU and moved to end of ready queue and CPU scheduler select next process from ready queue. The name round robin comes from the principle known as round robin in which every person takes equal share of something in turn. This technique is also known as time slicing, because each process is given a slice of time before being preempted. Here if quantum decided is very small short, then processes having small time will go through the system very quickly. Round robin is generally effective in general-purpose time-sharing systems or transaction processing system.



Priority Based Scheduling

This Scheduling algorithm is preemptive in which priority is associated with each process and according to that priority CPU is allocated to processes. Processes are executed from highest priority to lowest priority. If more than one processes of same priority occurs then CPU is assigned on first come first serve basis. Here Starvation can happen to the low priority process and waiting time gradually increases for those processes having same priority. Here overhead is not minimal, nor is it significant.



Scheduling Algorithms at a glance:

S. No.	Factor Considered	FCFS Algorithm	SJF Algorithm	Priority algorithm	Round Robin Algorithm
1.	**Preemption**	Non Preemptive	Preemptive	Preemptive	Preemptive
2.	**Complexity**	Simplest scheduling algorithm	Simple code but requires length of next CPU request	Simple but may get complex if priority selection is not fair and increases Starvation	Complexity purely depends on size of time quantum
3.	**Allocation**	CPU allocated in the order of processes arrival	CPU is allocated to the process with least burst time	Allocation based on priority order from higher to lower	For allocation of CPU, preemption take place after decided time quantum
4.	**Application**	It is good for non-interactive system	It may beneficial for process having small burst time	For processing on the basis of priority scheduling	It is useful for interactive system. It effective in general purpose time sharing systems as well as transaction processing system
5.	**Waiting Time**	Average waiting time is large.	the Average waiting time is small as compare to FCFS	Average waiting time is small as per FCFS. And waiting time increases gradually for same priority processes. Higher priority processes have smaller waiting time and response time.	In this scheduling algorithm the average waiting time is large. But effective for large as well as small process.
6.	**Usability**	Useful when starvation is to be avoided and scheduling overhead is to be kept as minimal	For getting maximum throughput and to minimize average waiting time this scheduling might be favorable.	It is good where Overhead is to be kept as balanced.	To execute all process fairly
7.	**Feasibility**	Suitable for Batch processing system.	Suitable for Batch processing system where rate arrival of processes is average	Execution needed prioritized	This scheduling algorithm is suitable for time sharing system and transaction processing system

Computation of Gantt chart, Waiting Time and Turnaround Time

Consider four processes with their burst time in milliseconds as shown in table

Table – I

S. No.	Process	Burst Time (in ms)	Priority
1	P1	10	3
2	P2	2	1
3	P3	8	4
4	P4	6	2

Gantt chart:

a) First Come First Serve

P1	P2	P3	P4

0 10 12 20 26

b) Shortest Job First

P2	P4	P3	P1

0 2 8 16 26

c) Round Robin Scheduling Algorithm

P1	P2	P3	P4	P1	P3	P4

0 5 7 12 17 22 25 26

Time quantum allotted as 5 ms for each process

d) Priority Scheduling

P2	P4	P1	P3

0 2 8 18 26

Now for example if we calculate turnaround time and waiting time for Short Job First, then it will be as, turnaround time for processes P1, P2, P3 and P4 is as 26, 2, 16 & 8 and average turnaround time is (26 + 2 + 16 + 8) / 4 = **13 ms**.

The waiting time calculated from Gantt chart as 16, 0, 8 & 2 respectively and average waiting time is (16 + 0 + 8 + 2) / 4 = **6.5 ms**.

In the similar way waiting time and turnaround time is calculated for all other scheduling algorithms as shown in table.

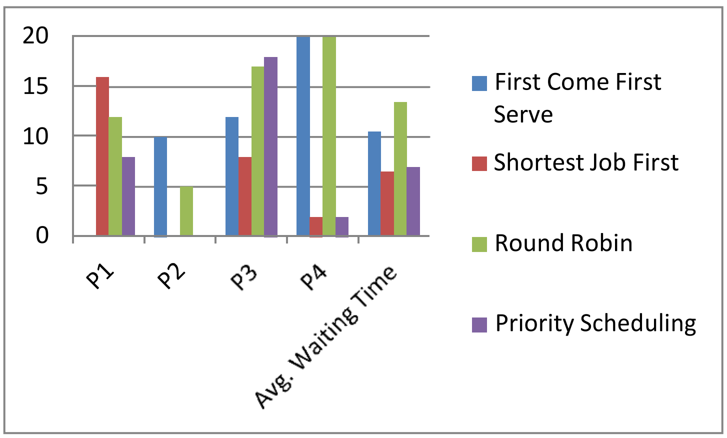
Table – II

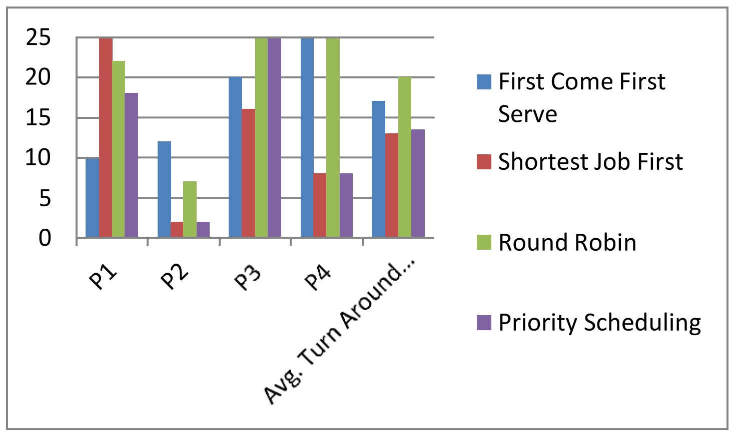
S. No.	Process	Waiting Time (in ms)			
		First Come First Serve	Shortest Job First	Round Robin	Priority Scheduling
1	P1	0	16	12	8
2	P2	10	0	5	0
3	P3	12	8	17	18
4	P4	20	2	20	2
Avg. Waiting Time		**10.5**	**6.5**	**13.5**	**7**

Table – III

S. No.	Process	Turnaround Time (in ms)			
		First Come First Serve	Shortest Job First	Round Robin	Priority Scheduling
1	P1	10	26	22	18
2	P2	12	2	7	2
3	P3	20	16	25	26
4	P4	26	8	26	8
Avg. Turn Around Time		**17**	**13**	**20**	**13.5**

Graphical analysis (on the basis of Waiting Time of scheduling Algorithms)





Conclusion:

From the above calculative discussion and analysis it is infer that First Come First Serve is easy to implement and mostly favorable for batch processing systems where waiting time is large. Short Job First works with optimum scheduling criteria and gives minimum average waiting time. Round robin scheduling is preemptive and based on policy of fair dealing of CPU to each process evenly. It works with interactive time sharing system. The priority scheduling algorithm is based on the priority criteria of execution from highest priority to lowest.

It is recommended that any kind of simulation for any CPU scheduling algorithm has limited accuracy. The only way to evaluate a scheduling algorithm to code it and has to put it in the operating system, only then a proper working capability of the algorithm can be measured in real time systems.

References:

1. Stallings, W.(2012):Computer Organization and Architecture; Designing for Performance, ninth Ed., Prentice Hall
2. Liu, J. (2002):Real time system, Pearson Education
3. Stalling, W. (2004): Operating Systems, fifth Ed., Pearson Education, Singapore, Indian Ed., New Delhi
4. Tanenbaum, A.S. and Woodhull, A.S. (2009): Operating System: Design and Implementation, third Ed., Prentice Hall of India Private Limited, New Delhi.
5. Milenkovic, M.(1992): Operating System Concepts and Design, second Ed. McGraw Hill
6. Nutt, M. Gary (2000): Operating systems – A Modern Perspective, Second Ed., Pearson Education
7. Leland, L. Beck(1997): System Software, third Ed., Addison Wesley
8. Tseng, L.Y., Chin, Y.H., Wang, S.C. (2009): The Autonomy Study of High Performance Task Scheduling Algorithm for Grid Computing System 713-722.
9. Kaladevi, M. Sathiyabama, S.(2010): A Comparative Study of Scheduling Algorithm for Real Time Task, International Journal of Advance in Science and Technology Vol.1, No.4
10. Rachhpal Singh (2012): Task Scheduling with Genetic Approach and Task Publication Techniques, International Journal of Computer Application and Information Technology, Vol.1,No.1
11. Sabrian, F., Nguyen, C.D., Jha, S., Platt, D.(2005): Processing Resource Scheduling in Programmable Networks. Computer Communication, 28:676-687
12. Umar Saleem and Muhammad Younus Javed(2000):Simulation of CPU Scheduling Algorithm, IEEE 7803-6355-8
13. Rashid, M., Adhtar, N. (2009): A New Multilevel CPU Scheduling Algorithm, Journals of Applied Sciences Vol. 6, No.9
14. Bhardwas,A., Singh, R.,(2013):Comparative Study of Scheduling Algorithm in Operating System, International Journal of Computer and Distributed Systems, Vol. No. 3, Issue 1
15. Samih, M., Safwat, H.(2010):Finding Time Quantum of Round Robin CPU Scheduling Algorithm in General Computing Systems Using Integer Programming, International Journal of Research and Reviews in Applied Sciences, vol. 05, no.01