A Survey on Research Trends in Disk Scheduling Algorithms

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Abstract

In operating system, Disk scheduling is the process by which a storage management decides the order that I/O operations are submitted to storage volumes .Disk Scheduling Algorithms are used to decide which of the I/O request have to be served next so that the total head movements and the total seek time of any I/O request could be reduced. Modern disk drives have the ability to queue incoming read and write requests and to service them in an out of order fashion and Disk scheduling involves a careful examination of pending requests to determine the most efficient way to service the requests. In this paper we collected and integrated various researches done in the field of disk scheduling and Disk management, so that this effort can be helpful for new researches to find out the future trend in the same field.

Keywords –Disk scheduling, Markov Chain, I/O request, Modern disk drives.

1. Introduction :

Scheduling is a fundamental OS Function. “Scheduling refers to a set of Policies and mechanism built into the OS that govern the order in which the work to be done by a computer system is completed” in other words “set of rules and policies that govern the order in which resource is allocated to the various processes is called scheduling” A scheduler is an OS module that implements the scheduling policies. The primary objective of scheduling is to optimize system performance according to the criteria seems most important by the system designers.

In operating systems, seek time is another important criteria while an I/O request is being encountered during execution. Since all device requests are linked in queues, the seek time is increased causing the system to slow down. Disk Scheduling Algorithms are used to reduce the total seek time of any I/O request. Modern disk drives have the ability to queue incoming read and write requests and to service them in an out of order fashion.

Multi-programming environment also has multiple users queuing for access to disk and the virtual memory system may requests to load/swap/page many processes/pages simultaneously. We want to provide best performance to all users. So Controlling and managing the Disk to all I/O requests, Operating System uses the Concept of Disk Some of the most popular disk scheduling algorithms are: FCFS, SSTF, SCAN, (C-SCAN), LOOK, C-LOOK.

2. **Literatures review:**

Researchers have introduced various Disk scheduling algorithms from time to time. Suri et al. (1969) advocated to obtain the best scheduling algorithm based on the seek time, rotation time and transfer time for moveable head disks. They designed a simulator for optimizing the performance of disk scheduling algorithms using the Box-Muller transformation. Medhi (1976) developed a Markov chain model for the study of uncertain rainfall phenomenon. The operating system plays a major role in managing processes arriving in the form of multiple queues. The arrival of a process is random along with their different categories and types. All these require scheduling algorithms to work over real time environment with special reference to task, control and efficiency (see Stankovic (1984), Liu and Layland (1973), Garey and Johnson (1977) etc.). The randomization involved in scheduling procedure leads to perform a probabilistic study. Janson, Lockey and Tokuda (1985) attracted the attention of researchers for the model formation over functioning and procedure on operating systems.

Demer et al. (1989) have presented an analysis of Fair Queuing algorithm whereas Seltzer et al. 1990) have Invented the movable head disk based techniques that can be applied to systems with large memories and potentially long disk queues for system. Disk bandwidth utilization can be improved by applying some traditional disk scheduling techniques, which attempt to optimize head movement and guarantee fairness in response time. seltzer, Peter Chen and John Ousterhout (1990) have jointly written a research paper “Disk Scheduling Revisited”. In this paper, the invention of the movable head disk has been discussed. Daniel T. Joyce [2001] in his article “An Investigation of Disk Scheduling Algorithms Laboratory” discussed the behaviour of disk scheduling algorithms by using a simulation program. Chen et al. (1991) proposed two new disk scheduling algorithms for real-time systems. The two algorithms, called SSEDO(for Shortest Seek and Earliest Deadline by Ordering) and SSEDV(for Shortest Seek and Earliest Deadline by Value), combine deadline information and disk service time information in different ways. . Katcher et al. (1993) proposed an analysis of fixed priority schedulers and Horn (1974) generated some new scheduling algorithms useful for managing queues in operating system. David (1994) has a successful contribution over the study of real time and conventional scheduling with a comparative analysis. Gallo et al. (1995), Defined a new class of algorithms for the disk scheduling problem and the relations between this problem and the shortest Hamiltonian path problem on asymmetric graphs are investigated. The problem of deriving realistic upper bounds for the disk utilization factories also addressed. Goyal,Guo,Vin (1996) derieved the Hierarchical CPU scheduler in the environment where the multimedia operating system is used. In the similar line, Cobb et al. (1998) picked up fair scheduling of flaros with the consideration of time shifting approach in the area of high speed networks. Shenoy et al. (1998) described a scheduling framework for meeting the diverse service requirements of applications. The two levels of the framework allocate disk bandwidth at two time scales: the class independent scheduler governs the coarse grain allocation of bandwidth to application classes, while the class specific schedulers control the fine grain interleaving of requests. The two levels of the architecture separate application independent mechanisms from application specific scheduling policies, and thereby facilitate the coexistence of multiple class specific schedulers. Helen D. Karatza (2000) has discussed scheduling in a distributed system. A simulation model is used to address performance issues associated with scheduling. Naldi (2002) presented a Markov chain model for understanding the internet traffic sharing among various operators in a compatetive market. Hieh and Lam (2003) discussed smart schedulers for multimedia users. A time driven scheduling model is proposed by. Katcher et al. (1993) proposed an analysis of fixed priority schedulers and Horn (1974) generated some new scheduling algorithms useful for managing queues in operating system. Barthomew (1973), Medhi (1991 a) and Parzen (1962) have given an elaborate study of a variety of stochastic processes and their applications in various fields.

Hu Ming (2005) has discussed disk scheduling algorithms based on both disk arm and rotational positions. Their time resolving powers are more precise in comparison with those for disk scheduling algorithms based only on disk arm position. Huang (2005) Proposed a novel technique that dynamically places copies of data in file system's free blocks according to the disk access patterns observed at runtime. As one or more replicas can now be accessed in addition to their original data block, choosing the "nearest" replica that provides fastest access can significantly improve performance for disk I/O operations. They implemented and evaluated a prototype based on the popular Ext2 file system. M. Jacobson and John Wilkes (1995) have discussed the disk scheduling algorithm based on rotational position in their research paper. Disk scheduling based on rotational position as well as disk arm position is shown to provide improved performance. The access time based algorithms match or outperform all the seek time ones. The best of them is Aged Shortest Access Time First, or ASATF, which forms a continuum between FCFS and SATF. It is equal or superior to the others in both mean response time and variance over the entire useful range. Martens et al. (2006) focusesed on dynamic scheduling algorithm selection and tuning. Through careful monitoring and analysis of disk activity in real time, disk scheduling algorithms are automatically selected and/or tuned based on heuristics or criteria to ensure that the disk scheduling algorithm in use is well suited to the current workload of the system. This leads to an increase in system performance as the best disk scheduler available for the workload at hand is always in use. Carl et al. 2009) , proposed an extension in the DS-SCAN algorithm so that it can properly account for multiple outstanding I/O requests and guarantee real-time constraints for both outstanding and pending real-time requests, they demonstrated CDS-SCAN's performance on a storage array.

Researchers have also proposed various modeling and analysis tools for evaluating the performances of the existing & proposed algorithms. One of the important investigations is to use Markov Chain models for such evaluation. Medhi (1991) presented the use of stochastic process in the management of queues. Shukla and Jain (2007) have a discussion on the use of Markov chain model for multilevel queue scheduler in an operating system. Shukla and Jain (2009) have a proposed on the use of Markov chain model for scheduling scheme which is the mixture of FIFO and round robin is found efficient in terms of model based study. Yu Zhang et al. (2009) proposed four self-learning disk scheduling schemes: Change-sensing Round-Robin, Feedback Learning, Per-request Learning, and Two-layer Learning. Two-layer Learning Scheme performs best experimentally. It integrates the workload-level and request-level learning algorithms. It employs feedback learning techniques to analyze workloads, change scheduling policy, and tune scheduling parameters automatically. Al-Fares et al. 2010), presented a scalable, dynamic flow scheduling system that adaptively schedules a multi-stage switching fabric to efficiently utilize aggregate network resources. Mohammad et al. described their implementation using commodity switches and unmodified hosts, and show that for a simulated 8,192 host data center, Hedera delivers bisection bandwidth that is 96% of optimal and up to 113% better than static load-balancing methods. Shukla and Ojha (2010) have a discussion on the use of data model based markov chain model for deadlock index analysis of multi-level queue scheduling in operating system. Shukla et al. (2010) have given elaborate study of a general class of multi-level queue scheduling schemes is designed and studied under a Markov chain model. Shukla et al. (2010) have present a new CPU scheduling scheme in the form of SL Scheduling which is found useful and effective. By virtue of this, an attempt has been made to estimate the total processing time of all the processes present in ready queue waiting for their processing. Shukla and Jain (2011) have present an application where the processing time of jobs in ready queue is predicted using the sampling method under the k-processors environment (k>1).The random selection of one process by each of k processors through without replacement method is a sample data set which helps in the prediction of possible ready queue processing time.

Muthu Selvi (2011), proposed a genetic based approach for disk scheduling which optimizes the completion time and number of missed tasks simultaneously. The existing cycle crossover operator is modified by Selvi et al. , to provide more search space. MOGA hybridized by combining with Simulated Annealing (SA) is known as Hybridized GA (HGA). They improved the convergence of the GA by introducing the probability of SA as the criterion for acceptance of the new trial solutions. This hybridization shows more accuracy while finding solutions in later stages of searching process.

Shukla and Jain (2012) have presents an efficient method to predict about total time needed to process the entire ready queue if only few are processed in a specified time. Confidence internals are calculated based on PPS-LS and compared with SRS-LS. The PPS-LS found better over SRS-LS. Shukla and Jain (2013) have suggests two new estimation methods to predict the remaining total processing time required to process completely the ready queue provided sources of auxiliary information are negatively correlated.

Hetal Paida (2013), examined several Disk scheduling algorithms with example, that include: FCFS, SSTF, SCAN and C-SCAN. Honda et al. (2014) proposed Vague Disk Scheduling (VDS) Algorithm, based on vague logic. The proposed framework includes Vague-Fuzzification Technique, Priority Expression, and VDS Algorithm. The Vague-Fuzzification Technique is applied to the input data on each disk access request and generates a priority for each request in the queue. Based on the priority allotted the requests are serviced. Honda Priya et al. (2014) developed an algorithm Fuzzy Disk Scheduling (FDS) that looks at the uncertainty associated with scheduling incorporating the two factors. Keeping in view a Fuzzy inference system using If-Then rules is designed to optimize the overall performance of disk drives. They also compared the FDS with the other scheduling algorithms.Some other useful contributions are due to Silberschatz and Galvin (1999), Stalling (2004) and Tanenbaum and Woodhull (2000).

3. Discussion :

This paper presents an exhaustive deatails of researches done in the area of disk scheduling and Disk management. Although a lots of work has been done in this area but still there is a large gap for evaluating and modeling the performance of existing algorithms and new algorithms should be proposed to achieve better performance, optimum resource utilization, reduced seek time of I/O request and to reduce total head movements. This paper provides detailed survey on the work done so the new researchers can find the research gaps and can initiate new analysis approaches and better algorithms.

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