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Model Based Analysis for Operative Design of Weighted Fair Queuing in Dynamic Deficit Round Robin Pattern

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Abstract: — **In design of network scheduler algorithms, one of significant objective is improved processor utilization in fair manner. Therefore when router scheduling algorithms are designed, certain multiplexing schemes are concerned such that router can achieve fair bandwidth allocation during data flow with minimization of packet delay, packet loss and uncontrolled transmission rate. To attain this objective an extensive Deficit Round Robin scheduling scheme is derived in this paper along with fair queuing as an isolation mechanism to approximate generalized processor sharing. For analysis and comparative study markov chain model is used.**

Keyword: **---Network Scheduling, Fair Queuing, Simulation Study, Transition Probability, Data Model**

I. INTRODUCTION

Scheduling is one of the key aspects in design of multitasking, multiprocessing and real time operating system. Likewise time multiplexing is base of processor utilization for efficient resource sharing. When there is contention for resources, it is essential that they are allocated by streamlining and utilized fairly through proper carrying out of processing. In design of router scheduling algorithms state management, buffer management schemes are concerned to make it fair bandwidth allocation among data flows.

To manage this, an isolation mechanism called Fair Queuing has been proposed which is incorporated from FIFO and priority queuing. It is a technique used in network schedulers which allows each flow passing through a network device to have a fair share of network resources. Its main purpose is to achieve fairness when a limited resource is shared. Its addition is known as **weighted fair queuing**, where instead of giving equal share each class assigned different percentage in terms of priority.

Later on an algorithm based on packet based on implementation of Generalized Processor Sharingpolicy as Deficit Weighted Round Robin is proposed, which use stochastic fair queuing to assign flows to queues.

II. REVIEW OF LITERATURE

An algorithm for efficient fair queuing using deficit round robin was introduced to service the queues in round robin fashion with a quantum of service assigned to each queue. During transmission if a queue was not able to send a packet in previous round because its packet size was too large, then remainder from previous quantum is added to quantum for next round. Thus deficits are kept in record and queues which were shortchanged in a round are compensated in next round [1].

One scheduling algorithm is proposed for packet-switched networks with analyzed study [2].

Performanc analysis of modified deficit round robin schedulers are evaluated through routers on the basis of analytical and simulation study [3] [7]. [4]

Suggested analysis of deficit round robin scheduling for future aeronautical data link with performance study. Dynamic round-robin packet scheduling algorithms for multi-processing environments are contributed with design, simulation analysis and implementation [5] [8] [10].

To achieve fair bandwidth in high speed network core-stateless fair queuing is provided [6].

A weighted fair queuing scheduling mechanism is projected based on fair distributed credit based scheduler for differentiated service networks [9] [11].

Deficit round robin scheduling is put forward in modified wayfor wireless networks for fair channel access [12] [13].

Optimal path computation and resource allocation is discussed through performance analysis with worst-case delay in routing algorithms. [14].

Markov model analysis is done on various scheduling schemes to enhance their performance [15][16][17].

Prime emphasis of all contribution deals with the issue of determining suitable packet scheduling with generalized processor sharing. With this central impression, we picked elemental scheme of weighted fair queuing along with deficit round robin scheduling and an additional scheduling scheme is shapedby imposing certain conditions over it.

III. ANALYSIS THROUGH MODELING TECHNIQUE

Baseline of our analysis is modeling technique which represents a system in symmetric way. It is an interactive process which requires various computation techniques to simulate system behaviour and data models come up with appropriate data sets to be use on the basis of system behaviour. By using mathematical model, various data sets can be formed which can be used for numerical illustration and comprehensive simulation study can be done through graphical analysis.

In this paper for simulation study, our preferential basis of consideration is Markov chain model under probabilistic data model approach to analyze behavior of scheduler over queues of proposed schemes. For data set formation row dependent data model **a + d.i** is considered which is linear ordered having two parameters**'a'** as origin and **'d'** as scale. **'i'**stands for processing queue whose values is according to row (i=1,2,…). Matrix will be as,

	Q_1	Q_2	Q_3	Q_4	Q_5
Q_1	a	a + d.i	a + 2d.i	a + 3d.i	1-(4a + 6d.i)
Q_2	a + d.i	a + 2d.i	a + 3d.i	a + 4d.i	1-(4a + 10d.i)
Q_3	a + 2d.i	a + 3d.i	a + 4d.i	a + 5d.i	1-(4a + 14d.i)
Q_4	a + 3d.i	a + 4d.i	a + 5d.i	a + 6d.i	1-(4a + 18d.i)
Q_5	a + 4d.i	a + 5d.i	a + 6d.i	a + 7d.i	1-(4a + 22d.i)

By this metrical model sequence of transition probability is obtained on a linear range for processing queues. To ensure significant increase in fairness throughout network scheduling with steady data flow, different weightage is given in terms of priority so that generic processor sharing concepts can be applied. For that we used a fairness index 'S' as scheduling probability factor to provide a flexible framework in packet switmched communication networks. 'S' provide equity to last value so that probabilities can be spread likewise among all processing queues. It is calculated by dividing last value to (n – 1), where 'n' is total number of processes and it is added to all values as, a*(0.75*S), (a+d.i)* (0.75*S), ……. Last probability value will reain same as 'S'. Now for different values of 'a' and 'd'along with 'i', data set is created for proposed schemes. For simulation study, markov chain model is applied on obtained transition probabilities.

A stochastic process is a mathematical model that evolves over time in a probabilistic manner. If in a stochastic process outcome of a state depend only on outcome of previous state then it will be said as markov chain or markov property. It is a group of random variables $\{X_n\}$ where 'n' will represent time which develops according to probabilistic rules. The set of possible values of X_n is known as state space.
Markov process is a stochastic model that has Markov property. If 'x_0' is a vector which represents initial state of a system, then there is a matrix 'M' such that, state of system after first iteration is given by vector Mx_0. Thus the chain x_0, Mx_0, M^2x_0, . . . , M^nx_0 is called a Markov chain and matrix 'M' is called transition matrix.

IV. SCHEME CONCEPTION OF WEIGHTED FAIR QUEUING WITH DRR SCHEDULING

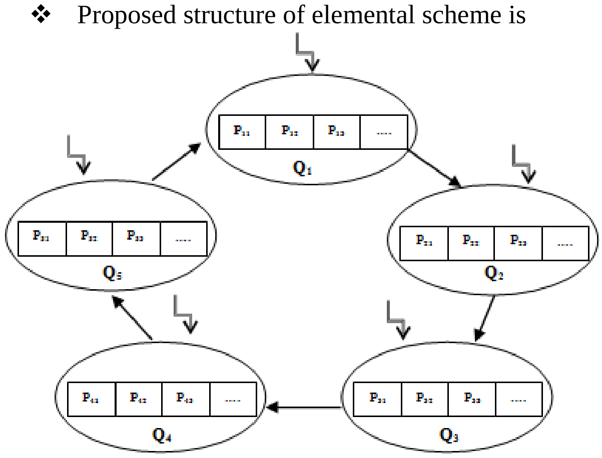
A. *Elemental Scheme*

- Consider a weighted fair queuing deficit round robin scheduling based on randomization with five scheduling queues Q_1, Q_2, Q_3, Q_4, Q_5 each one having number of packets for pass on.

- A time quantum is decided for each slot to processing of queues.

- In this scheme a new packet can arrive in any of above queues. Initial probabilities of packet transmission from queues are equal as pr_1, pr_2, pr_3, pr_4, pr_5.

- Here movement of scheduler is linear over all different states from Q_1 to Q_5.
- In beginning, scheduler can pick any of Q_i with a pre-defined priority and then first packet of that queue will be relayed. After that, scheduler will move to next queue in linear order and will pick its first packet for forwarding.
- At the end when all queues are process once, it comes again to first queue for sending its next packet.
- Proposed structure of elemental scheme is



Elbow arrow in diagram shows that scheduler can pick first packet from any of queue for transmit initially. And arrow shows direction of scheduler after completion of each time quantum. Here 'Q' denotes queue while 'P' denotes packets of each respective queue. State transition probabilities for the above scheme will be

$X^{(n)}$

	Q_1	Q_2	Q_3	Q_4	Q_5
Q_1	0	S_{12}	0	0	0
Q_2	0	0	S_{23}	0	0
Q_3	0	0	0	S_{34}	0
Q_4	0	0	0	0	S_{45}
Q_5	S_{51}	0	0	0	0

Now by applying markov chain model then with indicator function $\mathbf{L_{ij}}$(for i, j=1,2,3,4,5) as,

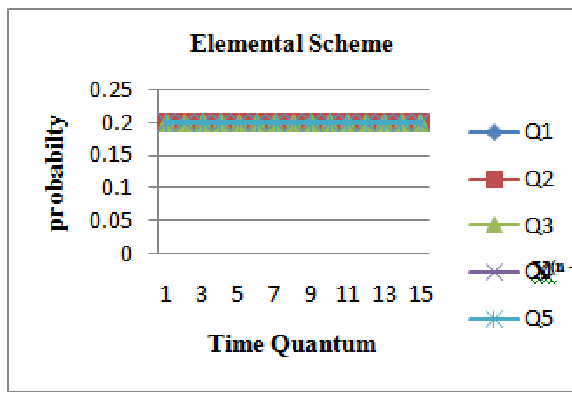
$\mathbf{L_{ij} = 0}$ when (i=1, j=1, 3, 4, 5), (i=2, j=1, 2, 4, 5), (i=3, j=1, 2, 3, 5), (i=4, j=1, 2, 3, 4), (i=5, j=2, 3, 4, 5)

$\mathbf{L_{ij} = 1}$ otherwise

We can obtain generalized expressions for $\mathbf{n}^{th}$ time quantum and for different values of 'a' and 'd', transition probabilities can be obtained to attain state probabilities for graphical analysis. 'a' has different values as 0.010, 0.011, 0.012, 0.013, 0.014 and 'd' has values as 0.001, 0.002, 0.003, 0.004 for each value of 'a' (i=1, 2, 3, 4, 5).

As elemental scheme is designed on linear movement of scheduler, state probability will be remaining as identical for all states throughout the scheduling.

Overall graphical pattern of elemental scheme is,



B. *Scheme1 (Picking Any of Next Two)*

- This scheme is shaped such that scheduler can pick packet from first queue initially.
- After completion of each time quantum, it can pick packet from any of next two subsequent queues.
- This scheduler movement carries on, till all packets from each queue not get transmitted.
- A new packet can arrive in any of queues from Q_1 to Q_5.

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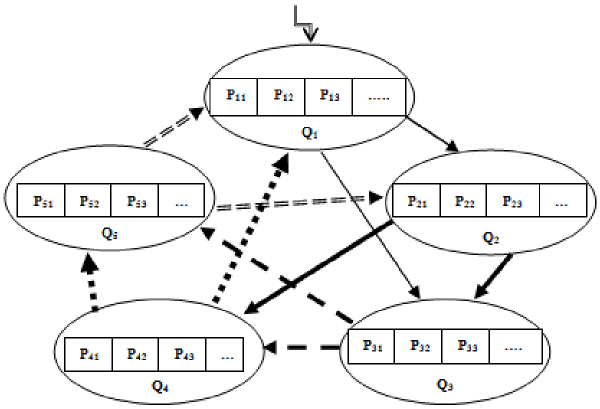
- As scheduler can pick packet from first queue in beginning, initial probability for Q_1 will be 1 and for rest queues it will be 0.



Unit step transition probability matrix will be

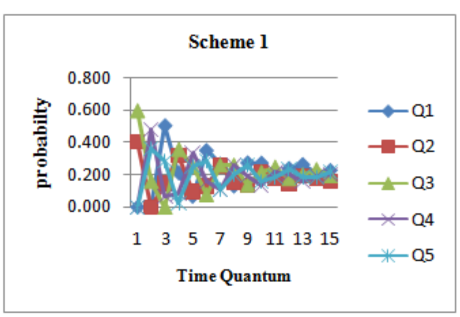
$X^{(n)}$

	Q_1	Q_2	Q_3	Q_4	Q_5
Q_1	0	S_{12}	S_{13}	0	0
Q_2	0	0	S_{23}	S_{24}	0
Q_3	0	0	0	S_{34}	S_{35}
Q_4	S_{41}	0	0	0	S_{45}
Q_5	S_{51}	S_{52}	0	0	0

Markov chain model will be applied on the scheme with indicator function $\mathbf{L_{ij}}$ as,

$\mathbf{L_{ij} = 0}$ when (i=1, j=1,4,5), (i=2, j=1,2,5), (i=3, j=1,2,3), (i=4, j=2,3,4), (i=5, j=3,4,5)
$\mathbf{L_{ij} = 1}$ otherwise

And generalized expressions for $\mathbf{n}^{th}$ time quantum will be obtained. State probabilities obtained same as elemental scheme.
Inclusive graphical pattern of scheme is,



V. CONCLUDING REMARK

To obtain an efficient operative design for network schedulers in terms of generalized processor scheduling, schemes are designed by exploring weighted fair queuing in conjunction with deficit round robin scheduling. They are analyzed and compared by data model approach under markov chain. Exploration study of is described by graphical illustration.

Pattern of elemental scheme is found to be in linear motion for every time. Here depending on number of processing queues, probability of each one is intent for packet dispatching and it remains consistent till end of transmission.

Scheme1 seems to be relevant as it follows basic principle of fair queuing with equitable streamlining of processes. In this scheme, all processing queues are scheduled under a matching range of probabilities after some time quantum. Higher as well as lower probability queues are balanced accordingly to streamlining the fairness of queuing.

After analysis it can be inferred that elemental scheme works on conventional fair queuing with identical probabilities for all scheduling queues. Eventually Scheme1(Picking Any of Next Two)may leads to deliver an operative design for weighted fair queuing in deficit round robin fashion for network scheduling algorithm and can be supportive for fairness in network scheduling to achieve objective of generalized processor scheduling.

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