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Scheduling a Packet in Multi-Gate Wireless Mesh Network Using Deficit Round Robin with CBQ Scheme

[1]Mrs.N.Vanitha,
M.Phil., Scholar, Dr.N.G.P. Arts & Science College, Coimbatore, India.

[2] Mr. K.Kumaravel
Ph.D Scholar, Govt, Arts College (Autonomous), Coimbatore, India.

[3]Dr.A.Marimuthu
Associate Professor, Gov. Arts College (Autonomous), Coimbatore, India.

Abstract:Wireless Mesh Networks (WMN) are a promising solution for next generation wireless access networks since they cherish benefits of having a reliable backbone in an ad hoc nature. This thesis investigates the packet scheduling problem in minimizing the maximum delay required for delivering a given packet in multi gate wireless mesh network. To handle the metering traffic, a multi-gate back-pressure based scheduling algorithm is used. As per this algorithm all the meter nodes should always maintain a separate path to each gateway, this will produce the poor delay performance of the network. This is happening in the existing work. In order to handle traffic in Infrastructure based multi-gate wireless mesh network architecture, we propose Deficit Round Robin (DRR) packet scheduling scheme with CBQ. The objective of packet scheduling principles is to achieve fair and good delay performance. Classful queuing mechanisms were incorporated into this scheme to provide fair and good delay performance. In this scheme any meter node can communicate with any other meter node in this network.

Keywords: Multi-gate, Class Based Queuing, Deficit Round Robin, Classful Queuing

1. INTRODUCTION

Wireless mesh networks (WMNs) are dynamically self-organized and self-configured, with the nodes in the network automatically establishing an ad hoc network and maintaining the mesh connectivity. WMNs are comprised of two types of nodes: mesh routers and mesh clients. Other than the routing capability for gateway/bridge functions as in a conventional wireless router, a mesh router contains additional routing functions to support mesh networking. Through multi-hop communications, the same coverage can be achieved by a mesh router with much lower transmission power. To further improve the flexibility of mesh networking, a mesh router is usually equipped with multiple wireless interfaces built on either the same or different wireless access technologies. In spite of all these differences, mesh and conventional wireless routers are usually built based on a similar hardware platform.

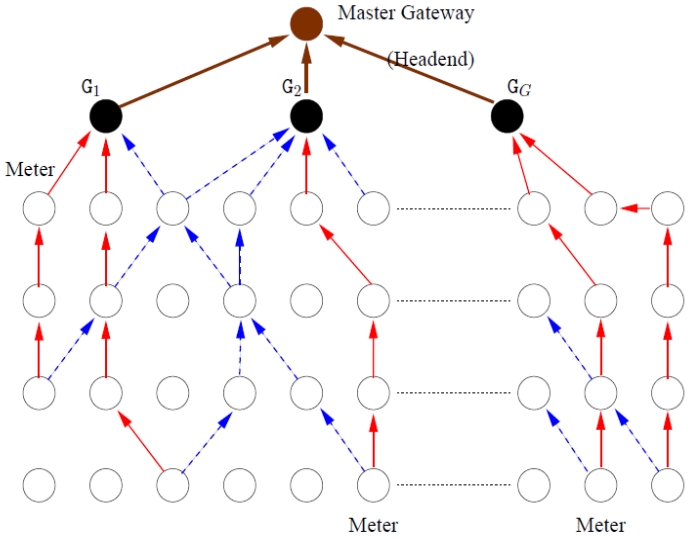

Figure 1: Multi path mesh network architecture consists of n number of Gateways

1.1 Problem definition

The current thesis formulates the problem of scheduling the packet across the gateways and nodes of Multi Gate Wireless mesh network using Deficit Round Robin Scheduling algorithm.

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1.2 Problem Analysis

Packet scheduling:

This research proposes techniques for the packet scheduling in multi-gate wireless mesh network to improve the network characteristics. Packet scheduling is a decision process used to select which packets should be serviced or dropped. Dropping of packets will be based on network characteristics like bandwidth, packet arrival rate, deadline of packets and packet size. Scheduling will be done in a scheduler. The scheduler will find difficult to handle all the packets coming in if the packet rate is high, if the bandwidth is too low or the packet size is large. So the scheduler will select certain packets based on various algorithms.

1.3 Overview of the study

The Deficit Round Robin algorithm is a well-known algorithm designed for wired and Wireless networks. It was a modified version from Weighted Round Robin (WRR) that handles variable packet sizes in fair manner. In DRR algorithm, a Deficit Counter (DC) is associated with each queue. This counter tracks the credits for each queue has the link scheduler. If the size of the Head-Of-Line (HOL) packet is smaller or equal to the DC, then the packet is served and the DC is decremented by the size of HOL packet. The DRR serves packets in the queue as allowed by the DC. When the DC is too small for the HOL packet then the DRR moves to next queue etc. After round finish, the DC for all queues add by fixed amount named quantum (Q) then the DRR starts scheduling again.

ADVANTAGES OF DRR:

- It is a low complexity algorithm which provides good fairness.
- Fast Scheduling.
- Provides Good Delay Performance.
- Normal Queuing Concept is replaced by a Classful Queuing Discipline. There is no built-in queues

2. LITERATURE SURVEY

In the case of a conventional neighborhood area network, a residential area is normally divided into separate regions where meters (i.e., mesh nodes) in each region communicate with the AdvancedMeteringInfrastructure head end through their local gateway point. Under such conditions, meters closer to the local gateway (i.e., last2 hope nodes) are expected to experience more severe congestion than those further away and this could create a bottleneck, especially under outage conditions. In order to allow collective participation in the routing, it is advantageous to combine all the sub-networks into a larger network with multiple gateways where meters can access to any of the gateways based on local traffic activity [6].

The authors of [2], presents a comprehensive performance evaluation of representative algorithms for the uplink traffic in Wimax networks. The behavior of the FIFO, WFQ, Priority Queue, DWRR, and MDRR scheduling algorithms in Wimax has been investigated here. A simulation study has been used to compare the performance of each scheduler on the different QoS classes. The simulations results verified that the Priority Queue scheduling algorithm has the highest throughput value and minimum jitter and packet delay variation for high QoS classes. The average end-to-end packet delay in the Strict-Priority has lesser value for the rtPS traffic.

The authors of [4] presents a survey on wireless mesh networks, WMNs can be built up based on existing technologies, field trials and experiments with existing WMNs prove that the performance of WMNs is still far below expectations. As explained throughout this article, there still remain many research problems. Among them, the most important and urgent ones are the scalability and the security. The objective of the paper [6] is to propose a packet scheduling scheme achieving max-min fairness without changing the existing IEEE 802.11 medium access control (MAC) protocol. A probabilistic packet scheduling scheme achieving max-min fairness is proposed as number of nodes increases the overall throughput significantly degrades due to the hidden node problem. To resolve this problem, the four way handshake is used but it's not possible in multi hop communications. This paper focuses on throughput unfairness, in which the end-to-end throughput of a packet flow degrades significantly with the increase in the number of its transmission hops.

3. PROPOSED WORK

The proposed techniques to handle the metering traffic in Multi gate wireless mesh network is Deficit Round Robin scheduling algorithm, it is a well-known algorithm designed for Wired and Wireless networks. It was a modified version from Weighted Round Robin (WRR) that handles variable packet sizes in fair manner. In DRR algorithm, a Deficit Counter (DC) is associated with each queue. This counter tracks the credits for each queue has the link scheduler. If the size of the Head-Of-Line (HOL) packet is smaller or equal to the DC, then the packet is served and the DC is decremented by the size of HOL packet. The DRR serves packets in the queue as allowed by the DC. When the DC is too small for the HOL packet then the DRR moves to next queue etc. After round finish, the DC for all queues add by fixed amount named quantum (Q) then the DRR starts scheduling again. We have incorporated class based Queuing mechanism to classify the packets.

Scheduler Elements:

1. Classifier: Assigns packets to different class.
2. Scheduler: Selects packets to be transmitted from class.

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Advantages:

- It is a low complexity algorithm which provides good fairness.
- Fast Scheduling.
- Provides Good Delay Performance.
- Normal Queuing Concept is replaced by a Classful Queuing Discipline. There is no built-in queues

4. IMPLEMENTATION OF DRR WITH CBQ SCHEME

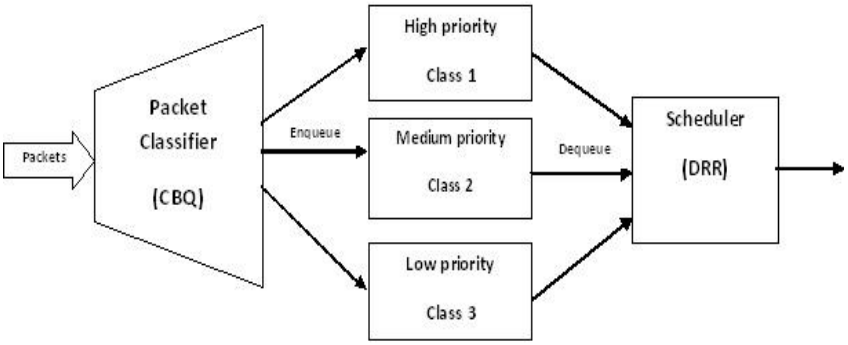

Figure 2:Structure of Classification and Packet Scheduling

In DRR algorithm, a Deficit Counter (DC) is associated with each queue. This counter tracks the credits for each queue has the link scheduler. If the size of the Head-Of-Line (HOL) packet is smaller or equal to the DC, then the packet is served and the DC is decremented by the size of HOL packet. The DRR serves packets in the queue as allowed by the DC. When the DC is too small for the HOL packet then the DRR moves to next queue…etc. After round finish, the DC for all queues add by fixed amount named quantum (Q) then the DRR starts scheduling again.The DRR is very fast algorithm.

In order to classify the packet, **w**hen the packet arrives first the classifier classifies the packets based on the TTL value using CBQ scheme and enqueued the packets into the corresponding classes. This CBQ is a queuing discipline for the network scheduler that allows traffic to share bandwidth equally, after being grouped by classes. If the packets were not classified then it will be dropped.

5. SIMULATION RESULTS AND DISCUSSIONS

Simulation is done with NS2.35 NAM. Experiments used to improve the performance of a multi-gate wireless mesh network is Deficit Round Robin scheduling algorithm that uses Class Based Queuing for classifying packets and determination of the delay.

The experimental results were averaged over 12 mesh nodes along with 3 gateways, one router and computed at 100 packets ps.

Table 1: Parameter for the implementation

Parameters	Value
Number of Nodes	12
Number of Gateways	3
Agent	UDP, Null
Traffic Source	CBR
Packet size	125 Bytes
Data Rate	100 kbps
Start Time	0.25 sec
End Time	0.5 sec
Simulation Time	60 sec
Transmission interval	0.1 sec
Bandwidth	0.01Mbps
Routing	Given (ie. Meter-4 to meter-8) (by default DSR adhoc routing protocol is used)
Queuing Discipline	DRR with CBQ

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Table 2: Parameter changes during the simulation and its results

parameter Changes	Size (Bytes)	rate (kbps)	time (secs)	time (secs)	end time (secs)	delay (secs)
M4-M8	125	100	0.25	0.50	0.4632	0
M4-M2-GW2-M6-M8	125	100	0.25 0.25 0.25 0.25	0.50 0.50 0.50 0.50	0.4231 0.5026 0.5013 0.4320	0+0.002610 +0.001321+0 =0.003931
M4-M2-GW1-M6-M8	125	100	0.25 0.25 0.25 0.25	0.50 0.50 0.50 0.50	0.4231 0.5010 0.5061 0.4320	0+0.001011+ 0.006113+0 =0.007123
M4-M7-M8	125	100	0.25 0.25	0.50 0.50	0.5010 0.4135	0.0010+0 =0.0010
M4-M5-M8	125	100	0.25 0.25	0.50 0.50	0.5023 0.5024	0.0023 +0.0024 =0.0047

The following figure shows the performance of the existing scheduling algorithm. The measurement based on the number of packets and the delay performance has been measured by kilo- bits per second. The effective and the performance were high when the packet size was low. When the number of packets and the arrival rate increases, length of the queue become very large so that the delay will be increased. This is the main drawback of Backpressure Scheduling algorithm. To overcome those issues the proposed system has been implemented. The parameter was same for the comparison. The implementation of Deficit Round Robin with Class Based Queuing was tested with some limited number of packets the figure implies that.

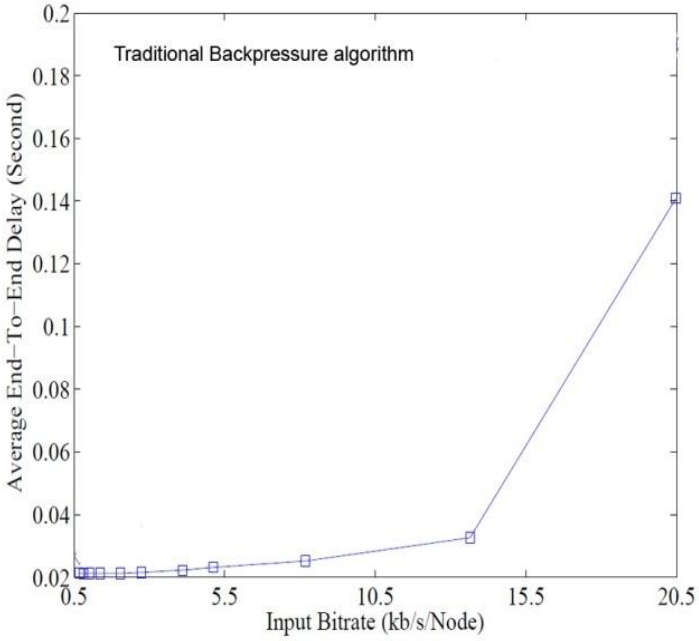

Figure 3:Delay performance of Backpressure algorithm

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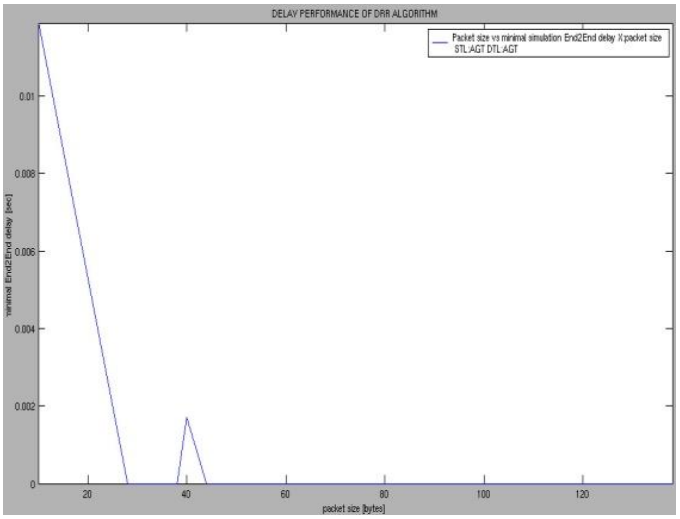

Figure 4:Delay performance of DRR algorithm

6. CONCLUSION AND FUTURE WORK

In this paper, a new scheduling scheme was proposed for multi gate wireless mesh networks. The proposed Packet scheduling scheme has successfully implemented using DRR with CBQ algorithms. The scheme was a fair scheduling approach with multiple gateways. In this scheme, we proposed Class Based Queuing for classification of incoming packets and Deficit Round Robin Algorithm for scheduling the packet. For the scheme, performance evaluation was carried out using network simulator Ns2.35. The scheme was compared against existing approaches. Both the schemes were same when calculating throughput. But our results show that there is a slight difference in delay performance. Our proposed scheme gives better delay performance than the existing system.

In future it will be enhanced by applying routing algorithms. The QOS metrics will be considered more in future. By default Dynamic Source Routing (DSR) Routing algorithm is used in this thesis. In future have to concentrate on routing by applying effective routing algorithms and techniques.

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AUTHORS

[1]. Mrs.N.Vanitha MCA., Serving as a Asst.Professor in Computer Science, Dr.N.G.P. Arts & Science College, Coimbatore. She has presented many papers in various conferences and published referred journals. She is pursuing M.Phil, programme in computer science.

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[2]. K.Kumaravel MCA., M.Phil.,CCNA., Serving as a Asst. Professor in Computer Science, Dr.N.G.P. Arts and Science College, Coimbatore. He has presented many papers in various conferences and published referred journals. He is pursuing Ph.D programme in computer science. He has more experience in teaching and research for 10 years.

[3]. Dr.A.Marimuthu Serving as Govt. Arts College (Autonomous) Coimbatore. He as presented many research papers in international Seminars & published many papers & published books in his research. He has more than two decades of Research.

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