Performance Analysis of FIFO And Priority Packet Queuing Mechanisms In MANETs

Erac Ombati Momanyi, V .K .Oduol, S. Musyoki.

Abstract- Prudent resource allocation in Mobile Ad Hoc Networks (MANETs) requires scheduling mechanisms that manage buffering of packets during waiting time. Various scheduling algorithms may be implemented to govern packet transmission and control packet loss. Such mechanisms include first-in-first-out (FIFO), priority queuing (PQ), and weighted-fair queuing (WFQ). In this paper, a comparison is made between use of FIFO and PQ mechanisms in a mixed traffic scenario (file transfer and VoIP applications). PQ is implemented on the basis of packet Type of Service (ToS) with VoIP data packets being given the upper hand. It will be shown that PQ gives a better Quality of Service (QoS) as opposed to FIFO. This can be observed via the results of the simulations. OPNET simulator is utilized in this paper.

Key words:-Mobile Ad Hoc Networks, OPNET, Priority queuing, FIFO

I. INTRODUCTION

Ad Hoc architecture has many benefits, such as self-reconfiguration, ease of deployment, and so on. However, this flexibility and convenience come at a price. Ad hoc wireless networks inherit the traditional problems of wireless communications, such as bandwidth optimization, power control, and transmission quality enhancement [1], while, in addition, their mobility, multihop nature, and the lack of fixed infrastructure create a number of complexities and design constraints that are new to mobile ad hoc networks. The challenges include: being infrastructureless hence lots of design issues and hard network management issues, topologies dynamically keep changing, radio interface at each node uses broadcasting for transmitting traffic and usually a limited range leading to issues such as hidden terminal problems, limited link bandwidth, poor quality of links, variation of link and node capabilities, energy issues [2] robustness and unreliability, poor network security, scalability issues [2] and quality of service.

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A quality of service (QoS) guarantee is essential for successful delivery of multimedia network traffic. QoS requirements typically refer to a wide set of metrics including throughput, packet loss, delay, jitter and error rate [3] Wireless and mobile ad hoc specific network characteristics and constraints described above, such as dynamically changing network topologies, limited link bandwidth and quality, variation in link and node capabilities, pose extra difficulty in achieving the required QoS guarantee in a mobile ad hoc network. [1]

II. FIRST IN FIRST OUT (FIFO)

FIFO is an acronym for First In First Out. This expression describes the principle of a queue or first-come first serve behavior: what comes in first is handled first, what comes in next waits until the first is finished etc. Thus it is analogous to the behavior of persons "standing in a line" or "queue" where the persons leave the queue in the order they arrive. First In First out (FIFO) is the most basic queuing discipline. In FIFO queuing, all packets are treated equally by placing them into a single queue, then servicing them in the same order they were placed in the queue. FIFO queuing is also referred to as First Come First Serve (FCFS) queuing [4].

Fig 1. Single server FIFO Queue

The queue can also have multiple servers. Packets wait in a FIFO queue, and when a server becomes free, the first packet goes into service [5]

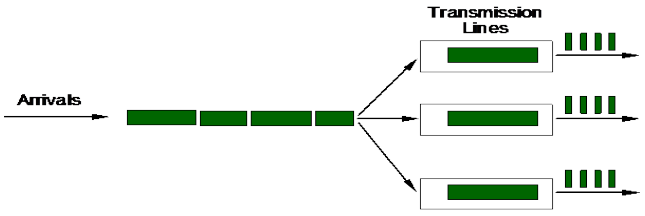

Fig. 2. Many servers FIFO queue

III. PRIORITY QUEUING

Priority queuing assigns multiple queues to a network interface with each queue being given a priority level. A queue with higher priority is processed earlier than a queue with lower priority. Priority Queuing can have four preconfigured queues: high, medium, normal and low priority queue.

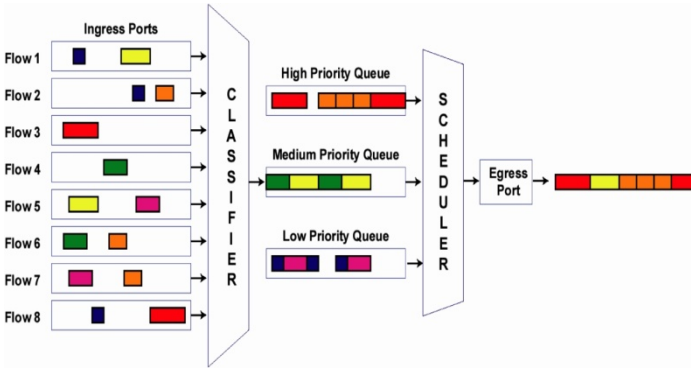

Fig.3.Priority Queuing System.

If packets arrive in the high queue then priority queuing drops everything it is doing in order to transmit those packets. [6]. When a packet is sent out on an interface, the priority queues on that interface are scanned for packets in descending order for priority. The high priority queue is scanned first, then the medium priority queue and then so on. The packet at the head of the highest queue is chosen for transmission. This procedure is repeated every time a packet is to be sent. The maximum length of a queue is defined by the length limit. When the queue is longer, the limit packets are dropped.

IV. OPNET

Optimized Network Engineering Tool (OPNET) is a top discrete event network simulator used both by research and commercial communities [7]. It provides a wide-ranging framework for modeling wired and wireless network scenarios. Simulation models are organized in a hierarchy consisting of three main levels: the simulation network, node models and process models. The top level refers to the simulation scenario or simulation network. It defines the network layout, the nodes and the configuration of attributes of the nodes comprising the scenario. The node models are at the second level in the hierarchy and consist of an organized set of modules describing the various functions of the node. The modules in the nodes are implemented using process models, the lowest level in the hierarchy. Process models consist of finite state machines, definitions of model functions, and a process interface that defines the parameters for interfacing with other process models and configuring attributes. Finite state machine models are implemented using Proto C, which is a discrete event library based on C functions. The hierarchal structure of the models, coupled with support for C and C++ language programming, allows for easy development of communication or networking models [8]

V. NETWORK DESIGN AND CONFIGURATION

A MANET network comprising of 10 mobile nodes is setup. Each node is configured to move randomly at a speed of 5m/s within the confinements of an area of 1000 square meters. A data rate of 2Mbps is set. Transmit power threshold is set at 0.005Watts. Packet reception Power Threshold is -95dB. The summary of the set up is shown in the table 1.

Table 1: MANET configurations settings.

Parameter	**Value**
Data rate	2 Mbps
Transmit power	0.005 Watts
Packet reception power threshold	-95dB
Buffer size	64,000
Mobility	Random (at 5 m/s)

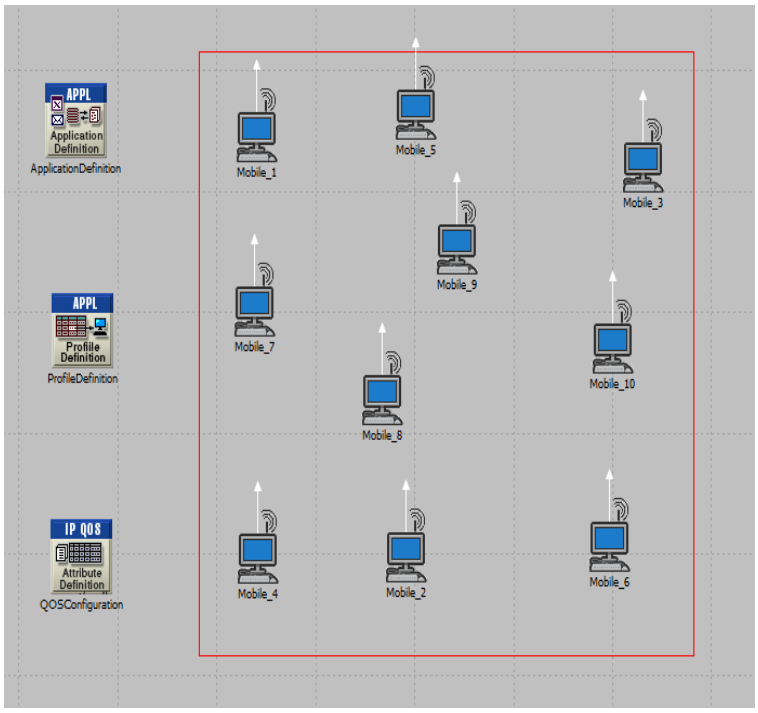

Fig 4: MANETS as located in the OPNET simulator.

A VoIP application is configured to run between two mobile nodes (node 1 and node 2). A file transfer application is configured to run between nodes 3 and 4.The VoIP application is configured as per the Table below:

Table 2:Voice (configurations).

Parameter	**Value**
Encoder scheme	G.711
Voice frames per packet	2
Compression delay	0.02 seconds
Decompression delay	0.02 seconds

The file transfer application is configured to transfer a file of size 50,000 bytes repeatedly till end of simulation time.

VI. SIMULATION RESULTS

a) File transfer application

Table 3: Simulation results for file transfer application

Time (sec)	**AV. Packets per sec (FIFO)**	**AV. Packets per sec (PQ)**
0	0	0
180	0.00462963	0.00462963
360	0.005050505	0.005050505
540	0.003472222	0.005208333
720	0.003968254	0.005291005
900	0.003205128	0.004273504
1080	0.002688172	0.003584229
1260	0.002314815	0.003858025
1440	0.00203252	0.003387534
1620	0.002415459	0.003623188
1800	0.002178649	0.003812636
1980	0.002480159	0.003968254
2160	0.00273224	0.003642987
2340	0.002525253	0.003787879
2520	0.002738654	0.004303599
2700	0.00255848	0.004020468
2880	0.002743484	0.003772291
3060	0.002583979	0.003552972
3240	0.003052503	0.003663004
3420	0.002893519	0.003472222
3600	0.002783568	0.003583643
AVERAGE	**0.002811771**	**0.003832662**

Two compared simulations are done for each data type in OPNET software as per the settings above.

b) Voice Application

Obtained Mean Opinion Scores (MOS) values are shown in Table below

Table 4: Simulation results for voice application

Time (sec)	MOS (FIFO)	MOS (PRIORITY)
0	3.348345774	3.536304959
180	3.334574431	3.535608476
360	3.335878693	3.534240479
540	3.338332446	3.533710469
720	3.339564351	3.533500926
900	3.340481261	3.533525894
1080	3.341305128	3.533647058
1260	3.342143911	3.533759102
1440	3.342805588	3.533968175
1620	3.34330392	3.534114192
1800	3.343565456	3.534217644
1980	3.343882665	3.534330239
2160	3.344258642	3.534418797
2340	3.344524555	3.534529306
2520	3.344723205	3.534614007
2700	3.344918408	3.53470071
2880	3.345109936	3.534777334
3060	3.345278638	3.534818699
3240	3.345433304	3.534883277
3420	3.345581911	3.534933361
3600	3.346756768	3.534946763
AVERAGE	**3.342893761**	**3.534454756**

VII. ANALYSIS

A. File transfer application

Figure 5 is a plot of the results from table 3. It is shown that the number of packets per second delivered at t=0seconds is Zero. For both the FIFO and the Priority Queue, this rate drastically increases as time moves from t=0 seconds to about t=100seconds. At this point, the difference between the two starts to show up.

The output per second (in bot PQ and FIFO) decrease with time. This can be attributed to congestion in the queue, the shifting of the positions of the MANETs involved in the simulation, hence the fluctuating of the wireless channel thus affecting the multi-hop flows, scramble for resources among the many MANETs which have to be contend for te shared media on adjacent links of a flow and interference which might effect transmissions at nodes beyond the neighbours.

Its noted that the two Graphs in figure 5 follow the same trend but the Priority Queue has a better performance in the throughput as compared to the FIFO Queue. The number of packets dropped for the FIFO queue is higher than that of Priority Queuing.

See the graph below.

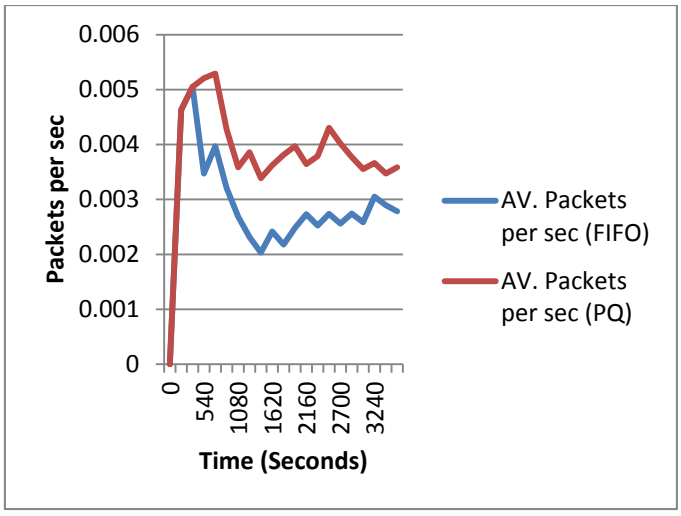

Fig 5: plot of packets delivered per second for both FIFO and PQ for Data.(from table3 above)

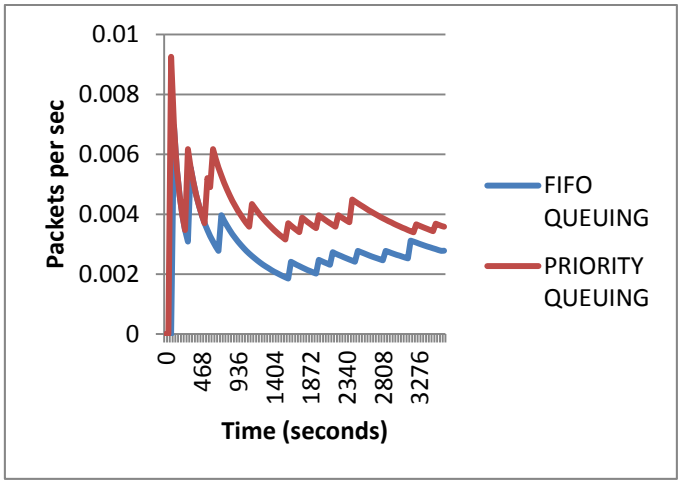

Fig 6. plot of packets delivered per second for both FIFO and PQ for Data.(from all te data)

B. Voice Application

The analysis of te VOIP application is done using te MOS values [4]. The values usually range from 1 to 5. 1 indicates the bad quality, 2 indicates poor quality, 3 indicates fair value, 4 indicates the good quality and 5 indicates excellent quality. In this case, the actual reccorded value of MOS reccorded is used. They are then compared in the two scenarios and presented in the figure 6 and figure 7.

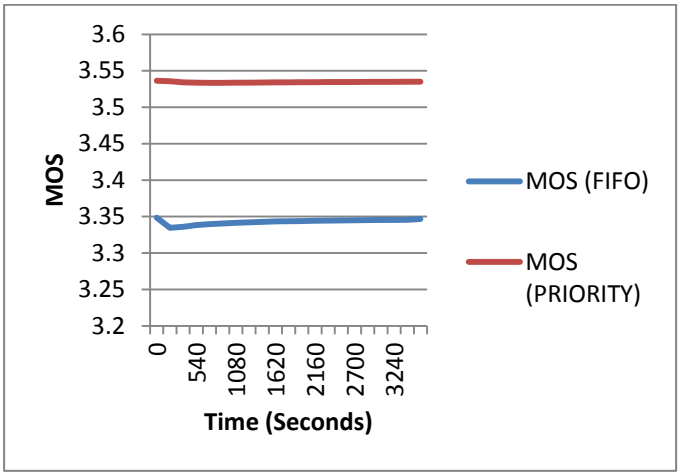

Fig. 6: Plot of MOS for both the FIFO and Priority queuing in voice application (from data in table 4 above).

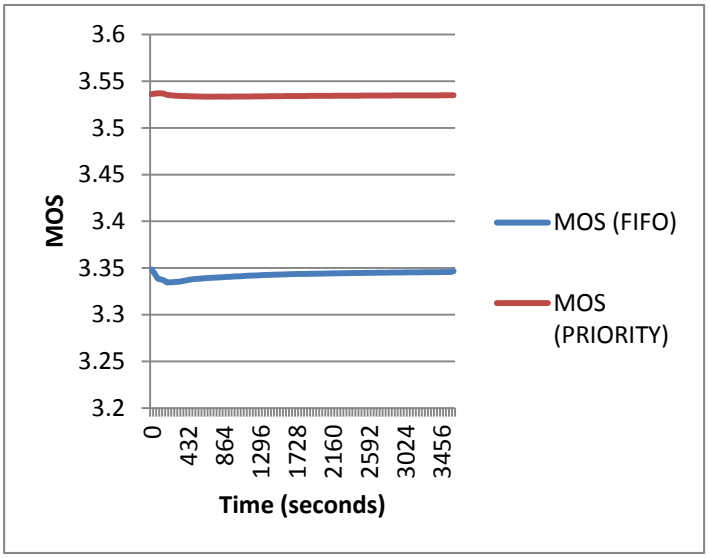

Fig 7: *Plot of MOS for both the FIFO and Priority queuing in voice application (from entire simulation data).*

From the plots, it is clearly seen that the MOS values for PQ is better when compared to that obtained from the FIFO data.

This means that PQ is still in a better position to deliver better QoS in Voice communication in MANETs

VII. CONCLUSION

Queues of routers play important role in packet delivery especially when the network is congested and MANET buffer space is not enough especially when dealing with frequent changes in topology.

After the comparison of the results of the simulations, its clear that Priority queuing is found to yield better performance in the simulated MANET when compared to FIFO. Since MANETS require special attention when it comes to QoS, it is therefore important to note that the traditional FIFO mechanisms cannot guarantee this.

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