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EVALUATION OF TWO QoS SUPPORT ALGORITHMS IN AD HOC NETWORKS ENTITLED PA AND QPART

Today, support of quality of service in ad hoc networks is the topical issue among the network science researchers. Several different algorithms and methods were proposed to differentiate among the existing flows in ad hoc networks and support of quality of service (QoS) in such networks. In this research we are going to evaluate the performances of PA (the authors of this paper have proposed the PA algorithm) and QPART algorithms in different conditions. These two algorithms are able to support quality of service in ad hoc networks. It should be noted that we have used ns-2 simulator software to compare these two algorithms.

Key words: *Ad Hoc, Quality of Service, Scheduling, Differential Service.*

1. Introduction

A wireless ad hoc network consists of a number of nodes communicating with each other on wireless links without infrastructure support. In a multi hop ad hoc network the packets of traffic are relayed by one or more intermediate nodes until reach the destination.We can create ad hoc networks easily and without the need for any sub-structures. Regarding the ease of the installation of these networks, it is estimated that this type of networks will be used commonly and thus the use of the multimedia applications will increase in this type of networks. Gradually the need to support QoS in these networks will be felt more. As we know Best-effort services cannot render services for this type of applications.The Best-effort service characterizes a service in which the network does not provide any patronages and guarantees that packets are delivered and a QoS be done.Thus, as it can be observed the best-effort services treat all flows of the network similarly and do not differentiate them. However, real-time flows related to multimedia applications are more important than other flows and should be served specifically.

Many algorithms and frameworks have been proposed to improve QoS parameters in ad hoc networks [1–5]. Most of the available algorithms do not have any control over rate reception of new flows. These protocols do not attend to this fact that admission and transmission of the new flows in a node may decrease the bandwidth of the available nodes in the scope of the node transmission. A solution to this problem is that the effort rate of the nodes in the path of the new flow transmission to obtain an environment be taken into account in deciding about the reception of the new flow. This method can exert too much overhead on the network.

Recently, other works have been proposed to support of service differentiation in Ad hoc networks. Many of them specifically target IEEE 802.11 [6]. For example, studies in [7–10] propose to tune the contention windows sizes or the inter-frame spacing values to improve network throughput, while studies in [11,12] propose priority-based scheduling to provide service differentiation. Most of these works utilize different back-off mechanisms, different DIFS lengths, or different maximum frame lengths, based on the priority of the traffic. All of these techniques are in static mode. In other words, these algorithms do not act fully automatically when priorities are given to the flows.

In continue and before the comparison of the efficiency of the two algorithms of QPART and PA, we will have a brief look at their functions.

2. QPART Algorithm

The QPART [13] algorithm is considered to be one of the best algorithms to establish QoS in ad hoc wireless networks. This algorithm is completely distributional and it performs its functions with the least overload into the network. It divides the total flows and the existing traffic into three groups of flows sensitive to delay, sensitive to bandwidth, and best-effort services. Then, it creates several queues to control back-off amount of flows in every node. About the present queues in every node, it should be noted that for all best-effort flows crossing each node, one queue is created and for every real-time flow a separate queue is provided. In other words, in each node, one queue for n number of best-effort flows and n queues of real-time flows crossing the node are created. The creation of these queues is locally carried out and there would be no overload for the network. Below some formulas used by this algorithm to control CW related to flows will be investigated.

- The QPART algorithm use the following formula to control the CW of delay-sensitive flows:

$$CW^{(n+1)} = CW^{(n)} * \left(1 + a \frac{d/m - D^{(n)}}{d/m}\right) \quad (1)$$

Where the superscript n represents the n^{th} update iteration, D denotes the actual peak packet delay at the node during a update period and α is a small positive constant (α=0.1).

- The QPART algorithm use the following formula to control the CW of bandwidth-sensitive flows:

$$CW^{(n+1)} = CW^{(n)} + \beta(q - Q^{(n)}) \quad (2)$$

Where q is a threshold value of the queue length that is smaller than the maximum capacity of the queue, Q represents the actual queue length and β is a positive constant ($\beta=1$).

- The QPART algorithm use the following formula to control the CW of best effort flows:

$$CW^{(n+1)} = CW^{(n)} \times (1 + \gamma(f - F^{(n)})) \quad (3)$$

Where f is a *congestion threshold* for idle channel time, F is the actual idle channel time and γ is a positive constant ($\gamma=0.1$).

QPART algorithm uses above formulas to regulate CW of flows and it tries to improve the parameters related to QoS of the flows existingin the network with the same formulas. It should be noted that this algorithm uses the formula proposed in IEEE 802.11 to calculate the amount of back-off of each of the flows.

3. PA Algorithm

Before studying PA [14] algorithm, we will aknowledge about the problem related to QPART. In QPART algorithm, to establish flows' QoS, the status of the network has not been considered carefully. Each of the flows uses the formulas and related queues to calculate its CW and tries to gain a communicative medium and then send data packets. Mean while, due to the acceptance of a lot of flows, the probability of the existence of overpopulation and chaos in some areas in the network is inevitable. In this case, the status of the network should be taken into consideration when we calculate the amount back-off of a flow. In other words, when a node is trying to send data packets and face more number of collissions, this means that the network has heavy traffic. If any of the nodes faces this situation, it should be noted that the network is in busy staus and consider this in calculating CW and choose a higher amount for the CW and avoid the quarrel to gain channels. This should continue untill the channel is vacant and the collissions reduce.

The aim of PA algorithm is to present an intelligent framework to send flows intelligently in wireless ad hoc networks. This framework should be light, fast and prevent the delays by using the least overload and protect operation capability of real-time traffics.Regarding the fact that using ad hoc network is increasingly developing it is possible that the broadness and as a result the number of users who use these networks in the same environment is enhanced. As it is known, the management of all networks and specifically ad hoc networks' management become complicated by increasing the number of users and the QoSs posed decreases. In our proposed algorithm we take into consideration the status of the network to resist against this problem and control the existing flows of the network better. In addition to paying attention to the network's status in calculating CW, it is possible to use fixed wireless routers or slow moving wireless routers during path found.

In the algorithm presented here, we have used the following formula to manage and control network's status besides using the formulas proposed by QPART algorithms.

$$Back\!-\!off = Rand[0,(2^{r} + R_{col})*CW_{\min}]*Slot\_Time \quad (4)$$

Where R_{col} shows the collision rate between the two successful frame transmissions of a station and r is a positive number.

Back-off Time

{

Get minimum CW($CW_{\min}$) from network layer.

Calculate Back-off time according to: $Back\!-\!off = Rand[0,(2^{r} + R_{col})*CW_{\min}]*Slot\_Time$

}

4. Model Validation

In this section, we evaluate the performance of PA algorithm in supporting QoS through simulation experiments in NS-2 and compare the given results by QPART algorithm. NS (network simulator) is a name for series of discrete event network simulators. All of them are discrete-event network simulator, primarily used in research and teaching. NS is free software, publicly available under the GNU GPLv2 license for research, development, and use.

In this simulation we have used AODV routing algorithm in a network that bandwidth of it is 11Mb. The used parameters are shown in Table 1:

Table1

Parameters of simulation

a	0.1	f	1ms	q	5 Packets	
β	**1**	r	0.1	CW update Interval		0.1

4.1. Evaluate of packet scheduling in PA algorithm

For corroborateof packet scheduling capability in PA algorithm, we have supposed that there is single hop network with eight nodes (figure 1) in 500 m*500 m are athat there are two competing flows among them. One of these flows is delay-sensitive flow that will be started at 10th second of simulation and should be reached at destination node within 20ms and another is bandwidth-sensitive that will be start at 55th second of simulation. The sent rate of them is 30 packets per second and each packet size is 512 byte. The average delay of these flows is shown in figures 2.

This figure shows that in the light weight load both algorithms (PA and QPART) have controlled the flows. But PA algorithm has done this by a better strength and ability. In other words, it appears to be stronger than QPART algorithm. The optimal performance of PA algorithm will be observed when the number of nodes and the flows present in the network increase (refer to experiments carried out later-figure 4).

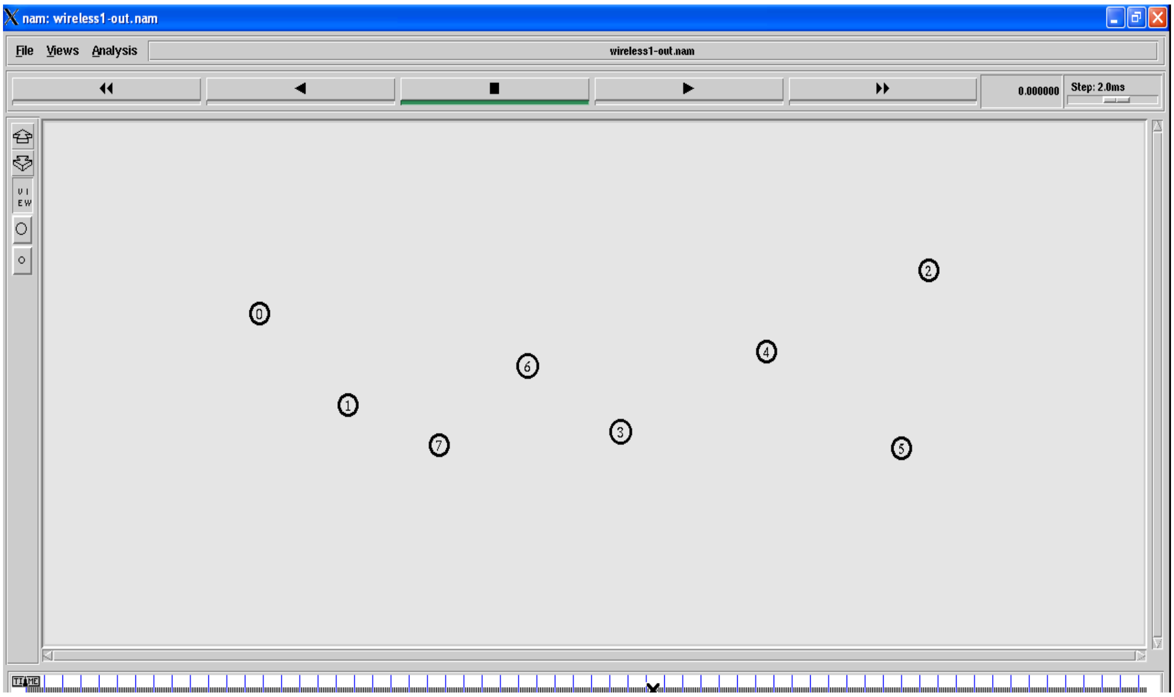

Figure 1. Network Topology

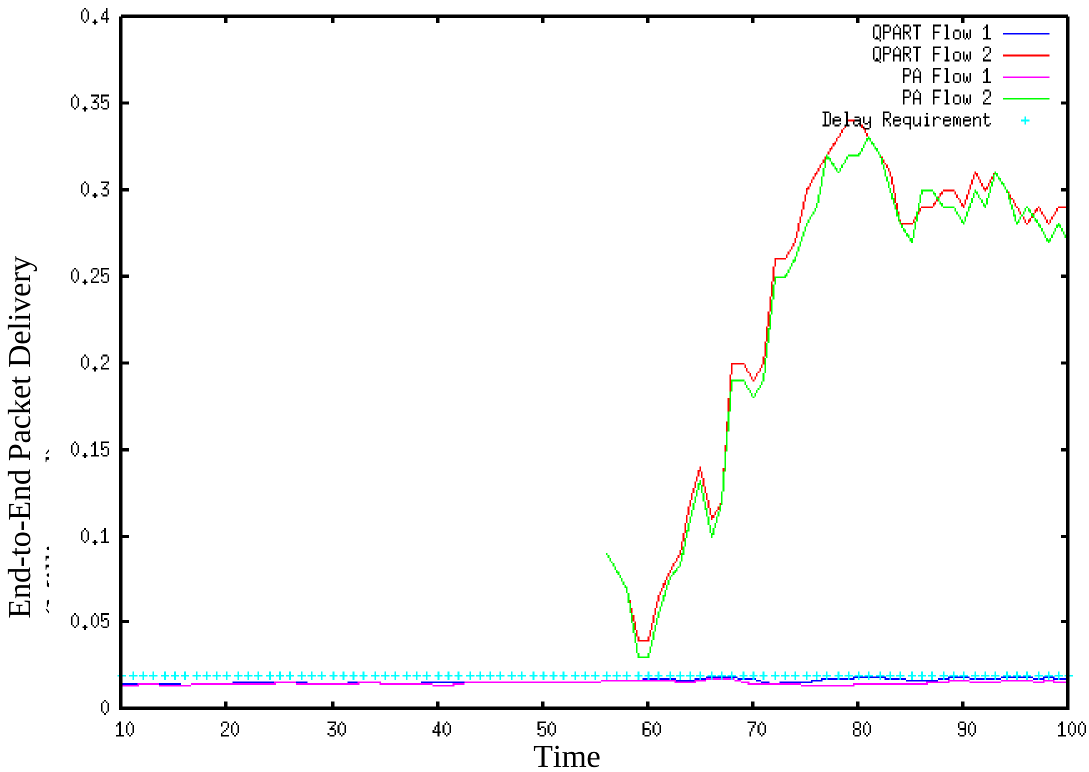

Figure 2. End-to-End Average Delay

4.2. QoS guarantee in multi-hop networks

In this section to compare the ability of PA and QPART algorithms we have increased the network size to 1000 m * 1000 m and evaluated their operations in multi-hop status. In this simulation there are 24 delay, bandwidth sensitive and best effort flows, 8 flows for each type. The hop counts of flows are 1 to 7. The delay sensitive flows should reach to destination node within 100ms.These flows generate 50 packets per second, that the size of each packet is 512 byte. Each bandwidth sensitive flows generate 50 packets per second, that the size of each packet is 512byte. The size of best effort packets are 512byte. The average delay of delay-sensitive flows has shown in figure 3. The PA and QPART algorithms maintain the delay of delay-sensitive flows below of their requirements (100ms). It means that both of them could support QoS in this situation. But as it can be seen in the figure, due to the use of fixed nodes and also considering the present status of the network, PA algorithm has had a better function than QPART algorithm and the reached QoS by the PA is better than reached QoS by the QPART. It seems that the PA algorithm is able to manage networks with a lot of nodes. In our next experiment, we will increase the number of nodes and will study the performances of algorithms.

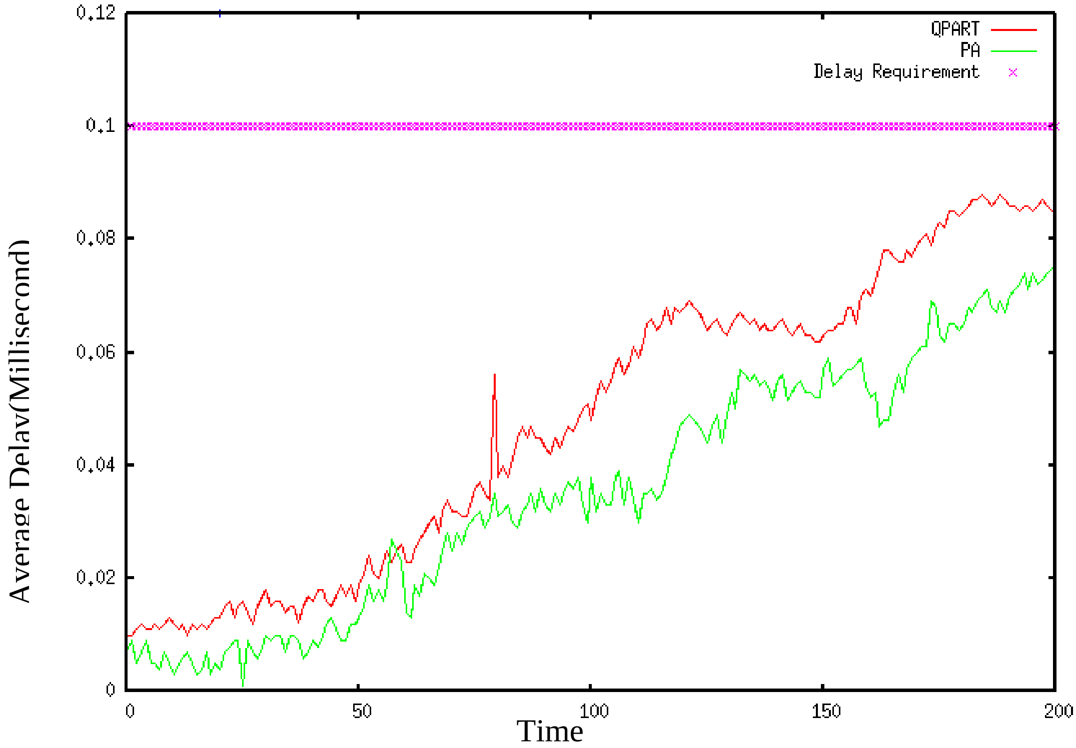

Figure 3. Average delay of delay-sensitive flows

4.3. QoS guarantee in networks with many nodes

In this chapter we evaluated the behavior of algorithms in a network which there are a lot of nodes in this network. We considered the size of the network to be 2000m*2000m in which 180 nodes were scattered randomly in the network environment that 10 nodes of them have moved slowly. This network entails both real-time and best-effort flows. We consider the number of real-time flows to be 32 and best-effort flows 50. The number of real-time flows in this test is double related to previous test. Also the number of all flows is four fold compared to previous evaluation. Randomly some nodes are chosen and then start communication with each other by sending some flows. Regarding that our aim of this experiment is to study the behavior of the algorithms in networks having a great deal of nodes, we took into consideration the size and production rate of real-time and non- real-time packets as the previous test. In first 50 seconds of the test, 8 real-time flows were transmitted among the nodes of the network. As it can be seen in figure 4, both algorithms mentioned send their flows with a little less amount of delay compared to the needed delay. The rest of real-time flows are sent in 50thsecond. As you can see, QPART algorithm loses its management and control over the flows in the network and the delay amount of the flows increase more than what is needed. In other words, this algorithm can not realize service quality of the flows in this situation. However, PA algorithm by considering the status of the network and taking advantage of the less moving nodes could manage the acceptance rate and realizes the needed QoS of flows. In 80thsecond16 flows of real-time flows have finished, then, QPART algorithm gains the control of itself gradually on the flows present in the network and realizes their service quality. But as it can be observed in the figure, the time needed to return to the usual status in QPART algorithmis more than the PA algorithm.In other words the PA algorithm could adapt itself with more situations, so, we could say this is quick, lightweight and better than QPART.

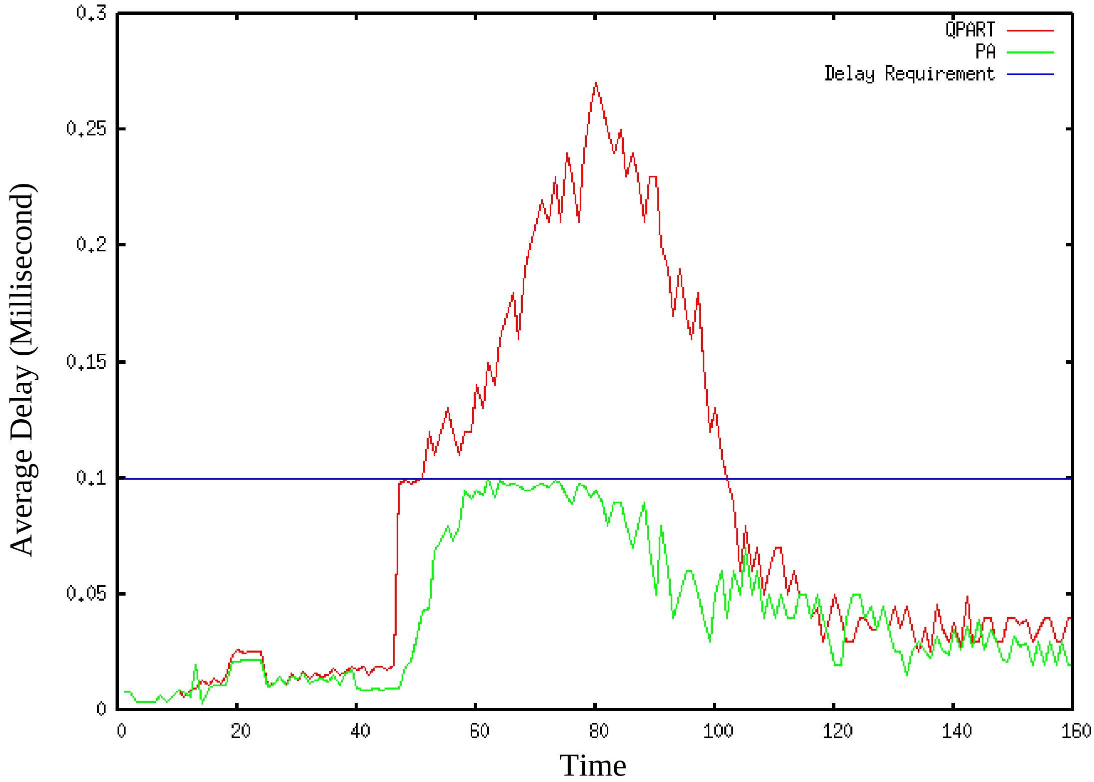

Figure 4. Average delay of real-time flows

5. Conclusion

In this paper we introduced some methods and frameworks used to establish QoS in ad hoc wireless networks. Then, we compared two algorithms entitled PA (proposed by the authors of the present research) and QPART algorithm. Both algorithms are able to support QoS in ad hoc networks. The difference between them is that in calculating CW of flows, the QPART algorithm coinsiders only the persent status of the flows. This means that if service quality of a flow is not realized in a certain time,without attention to network status, this flow tries to lessen its CW and solve the problem. This action can result in some problems when there are a lot of flows in the network. Thus, when the network is busy and the resources of the network are occupied, the flows using QPART algorithm try to reduce thier CW and compensate the past. However, the flows should leave out the challenges and try to evacuate the network. We took into consideration the algorithm proposed by us. This means that every flow should consider the status of the network besides considering its own status when it is calculating its CW. Thus, when the network is busy, it tries to forget challenging with other nodes to achieve the channel needed and it helps to make it calm. So, by considering the result of this paper, we could claim that the PA algorithm is more intelligent than QPART algorithm.

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Ad hoc şəbəkələrində QoS-u dəstəkləyən PA və QPART alqoritmlərin qiymətləndirilməsi

Hal-hazırda ad hoc şəbəkələrində xidmət keyfiyyətinin dəstəklənməsi tədqiqatçılar arasında aktual məsələdir. Ad hoc şəbəkələrində mövcud olan axınlar arasında fərq qoymaq uçun və həmçinin xidmət keyfiyyətinin dəstəklənməsi uçun çoxlu müxtəlif alqoritm və platformalar hazırlanıb. Bu məqalədə müxtəlif şəraitdə PA və QPART alqoritmlərin çıxışlarını qiymətləndirməyə cəhd edilmişdir. Bu iki alqoritm ad hoc şəbəkələrində xidmət keyfiyyətini dəstəkləyə bilər. Bu iki alqoritmin müqayisəsi uçun ns-2 simulator proqramından istifadə edilmişdir.

Açar sözlər: *Ad hok, Xidmət keyfiyyəti (QoS), PA alqoritmi, QPART alqoritmi, ns-2 simulator proqramı.*

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Оценка алгоритмов PA и QPART для поддержки качества обслуживания в одноранговых сетях

В настоящее время актуальным вопросом среди исследователей является качество сервисной поддержки одноранговых сетей. Для того чтобы различить существующие потоки и для поддержки качества обслуживания в одноранговых сетях разработаны различные алгоритмы и платформы. В данном исследовании мы попытались оценить производительность алгоритмов в PAи QPARTв различных условиях. Эти два алгоритма могут быть поддержаны качеством обслуживания в одноранговых сетях. Следует отметить, что для сравнения этих двух алгоритмов мы использовали программу сетевой симулятор ns-2.

Ключевые слова: *одноранговые сети, качество обслуживания, алгоритм PA и алгоритм QPART, сетевой симулятор ns-2.*