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OPTIMAL DELAY BOUND FOR MAXIMUM WEIGHT SCHEDULING POLICY IN WIRELESS NETWORKS

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ABSTRACT- This paper analysis delay properties of the well known maximum weight scheduling algorithm in wireless adhoc networks. We consider wireless networks with either one hop or multi-hop flows. Specifically, this paper shows that the maximum weight scheduling algorithm achieves order optimal delay for wireless ad hoc networks with single-hop traffic flows if the number of activated links in one typical schedule has the same order with the number of links in the network. This condition would be satisfied for most practical wireless networks.This paper focuses themethod is general and it can be used to derive bounds for the sumof even higher moments of the stationary queue sizes. However,for the approximate **MWS** policy, the bounds for the second orhigher moments are only valid when the average arrival ratevector is limited to a subset of the capacity region that dependson the order of the moment.

KEYWORDS: Wireless networks, Maximum Weight Scheduling, Single hop, multi hop and subnet.

1. INTRODUCTION

Wireless scheduling has been known to be a key problem for throughput/capacity optimization in wireless networks. The well-known maximum weight scheduling algorithm has been proposed by Tassiulas in his seminal paper [1] where he proved its throughput optimality. Latter developments in this area include extension of this maximum weight scheduling algorithm to wireless networks with rate/power control [2], [3], network control when offered traffic is outside the capacity region [4], and other scheduling policies with lower complexity [5]. While most existing works in the area of stochastic network control focused on throughput performance of optimal and suboptimal scheduling policies, delay properties of most scheduling policies proposed for wireless ad hoc networks remain unknown.

There are some recent works which investigated backlog/delay bounds for the sup optimal ***maximal scheduling*** algorithm in wireless ad hoc networks and *maximum weight* scheduling algorithm in the downlink/uplink of cellular networks. Specifically, in [6] Neely showed that maximal scheduling achieves delay scaling of *O* (1=(1 ¡ ½)) for traffic inside the reduced stability region derived in [7]. This reduced stability region can be as small as 1=*I* of the capacity region, where *I* is the maximum number of links in any link interference set which do not interfere with one another. In [8], [9], Neely also proved the "order optimal" delay for the maximum weight scheduling algorithm in the wirelesscellular uplink/downlink with ON/OFF wireless links.

In this paper, we consider a wireless ad hoc network with either one-hop and multi-hop traffic flows. We show that average delay for the case of one-hop traffic flows scales as *O* (1=(1 ¡ ½)) if we can construct a set of distinct schedules to cover the network where the number of activated links in each of these schedules has the same order with the number of network links. This condition would be satisfied for most practical large-scale wireless networks. This delay scaling holds for both i.i.d and Markov modulated traffic arrival processes with at most two states. To the best of our knowledge, these are the first delay optimal results for the maximum weight scheduling algorithm in wireless ad hoc networks. For wireless ad hoc networks with multihop traffic flows, we also derive a tight backlog bound which scales as *O* (*N*=(1 ¡ ½)) where *N* is the number of wireless nodes. The remaining of this paper is organized as follows. Section II for materials and methods, Delay analysis for single-hop and multi hop traffic flows is presented in section III and IV respectively.

II MATERIALS AND METHODS

Aksenti, et al [10] proposed a MM (Modified Max-weight) urgency weight method which solves conventional problems in scheduling. This method considers the application of the packet as an important parameter in scheduling mechanism and in assigning priority. In order to control the congestion in scheduling process, fuzzy parameters for prioritization process are applied. Performance analysis of Modified Max-weight (MM) scheduling algorithm for urgency weight calculation for congestion control in mobile ad hoc grid layer has been presented. The proposed MM urgency weight is capable of resisting congestion and accomplishes modest number of handovers than the existing methods. The priority of the job has been calculated with fuzzy parameters and the mathematical model computes urgency weight with priority.

G.Sivakannu, et al. [11] one of the main challenges in safety critical applications built using **VANETs** requires guaranteeing Quality of Service (QoS) like communication without delay or jitter bounds and avoiding degradation of communication channels due to congestion in dense mobile network traffic. Such guarantee can be provided by scheduling techniques. Among many congestion avoidance scheduling techniques, this paper proposed a Weighted FairQueuing (WFQ) techniques. This proposed system is responsible for reliable message transmission in VANETs and congestion control in the rapidly changing network.

A Charles, et al [12], research paper used a weighted fair queuing technique to attain QoS in MANET. Initially, the BFMLM-FQ (Bounded-Fair Maximize-Local- Min Fair Queuing) algorithm is used. It maintains a local table at every node to record the details of each packet flow through the node. Then based on the information recorded, the start tag and the finish tag are assigned to each packet by the **OWFQ (Opportunistic Weighted Fair Queuing)** scheduler. Next, the packet with lowest value in the finish tag is transmitted. This ensures that the lowest delay packet is transmitted first so as to ensure quality of service in the network.

Bin Li, et al [13] studied a parametric class of maximum-weight-type scheduling policies, called **Regular Service Guarantee (RSG)** Algorithm, where each link weight consists of its own queue length and a counter that tracks the time since the last service, namely **Time-Since-Last-Service (TSLS).** The RSG Algorithm not only is throughput-optimal, but also achieves a tradeoff between the service regularity performance and the mean delay, i.e., the service regularity performance of the RSG Algorithm improves at the cost of increasing mean delay.

Ali Ghiasian, et al [14] in this paper, studied the effect of network topology on delay of throughput optimal Max-Weight link scheduling algorithm in wireless networks with single hop traffic flows. Based on the interference model we have used, two different bounds are obtained. First derived an upper bound for the delay under 1-hop interference model in terms of edge-chromatic number of network graph and loading factor. The result is of interest due to an interesting property of graphs that the Edge-chromatic number is either or $\Delta + 1$; where Δ is the largest vertex degree of the graph and can be obtained easily from network topology. Then, another upper bound for delay under general interference model has been established in terms of chromatic number of network conflict graph and loading factor.

III. ANALYSIS OF SINGLE-HOP FLOW CASE

System Models and Assumptions

We model a wireless ad hoc network as directed graph $G =(V;E)$ where V is the set of wireless nodes and E is the set of wireless links. Suppose the cardinalities of V and E are N and L, respectively. We consider single-hop traffic flows in this section. Data from all flows traversing a particular link l is buffered at the corresponding transmitter of the link. Assume time is slotted with fixed-size slot intervals. For now, traffic arriving to source nodes of single-hop flows is assumed to be independent and identically distributed (i.i.d) over time. Assume that packets arriving during time slot t can only be transmitted from time slot $t + 1$ at the earliest. Let denote by $Al(t)$ the number of packets arriving at link l in time slot t and $^1l(t)$ the number of packet transmitted on link l in time slot$t$. For simplicity, assume that $^1l(t) = 1$ if link l is scheduled in time slot t, otherwise $^1l(t) = 0$. In the remaining of this paper, we will use $\sim r$ to describe a column vector with elements rldenoting quantities such as queue length, scheduled links, etc. The queue evolution for the flow at link l can be written as follows:

Ql(*t* + 1) = *Ql*(*t*) ¡ ¹*l*(*t*) + *Al*(*t*):---------------(1)

IV.ANALYSIS OF MULTIHOP FLOW CASE

System Models and Assumptions

We consider the same network model as section III. We assume that there is set of multi hop flows *F* where flow *f* 2 *F* has a fixed route from a source node *s*(*f*) to a destination node *d*(*f*). We denote the set of links and nodes on the route of flow *f* as *L*(*f*) and *R*(*f*), respectively. For simplicity, we assume that packet arrivals to source nodes of all flows are i.i.d stochastic processes. We denote the queue length of flow *f* at node *n* at the beginning of time slot *t* as *Qfn*(*t*) and the number of packets arriving at the source node of flow *f* as *Af s*(*f*)(*t*). Note that data packets of any flow are delivered to the higher layer upon reaching the destination node, so *Qfd*(*f*)(*t*)=0. In addition, let ¹*f n*(*t*) be the number of packets of flow *f* transmitted from node *n* along link (*n;m*) of its route which is buffered at node *m* if *m* 6= *d*(*f*). Again, we assume that ¹*f n*(*t*) = 1 if we activate link (*n;m*) on the route of flow *f* and ¹*f n*(*t*) = 0,otherwise. Given the routes for all flows, the maximum weight scheduling algorithm is used for data delivery [1]. Specifically, the scheduling is performed in every time slot as follows:

Each link (*n;m*) finds the maximum differential backlogs as follows:

$$w_{nm}(t) = \max_{f:(n,m)\in L(f)} \left\{ Q_n^f(t) - Q_m^f(t) \right\}. \quad \text{--------} \quad (2)$$

V.CONCLUSION

A class of wireless networks with general interference constraints and heterogeneous transmission rates under single-hop traffic. The delay analysis of throughput optimal (queue length based) scheduling policies in such systems is extremely difficult due to complex correlations arising between the arrival, service and the queue length process. In this paper discussed about **Max Weight Scheduling Policy (MWS)** to improve the throughput optimal then explained the details of estimation delay of **MWS**. This paper clearly discussed about the importance of ***MWS policy*** in case of single hop and multi hop flowin wireless networks.

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