A REVIEW ON MAXIMUM WEIGHTED SCHEDULING IN AD HOC NETWORKS

B.SindhuPiriyaa ,
Research Scholar,
Department of Computer Science,
Sri Vijay Vidyalaya College of Arts & Science,
Dharmapuri, Tamilnadu, India.

Dr.D.Maruthanayagam,
Head cum Assistant Professor,
Department of Computer Science,
Sri Vijay Vidyalaya College of Arts & Science,
Dharmapuri, Tamilnadu, India.

Abstract: MaxWeight scheduling has gained enormous popularity as a powerful paradigm for achieving queue stability and maximum throughput in a wide variety of network system. 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. This paper explain about 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. And also explain the weight function calculation, upper and lower bound then the estimation of delay for achieves order optimal delay for wireless ad hoc networks.

Keywords: Wireless adhoc networks, Maxweight scheduling Policy, Maximum Weighted Matching, lower bound and upper bound.

I.INTRODUCTION

A large number of studies on wireless ad hoc networks have been devoted to system stability and throughput maximization. These schemes are often called throughput-optimal scheduling schemes. The delay performance of these systems, however, has largely been an open problem. In this paper study about fundamental lower bound and upper bound on the expected delay of any scheduling policy. And also studied about [1][2] throughput-optimal scheme called the Maximum Weighted Matching (MWM).

The arbitrary graph of wireless network is G = (V, E) with time varying links. Packets arrive in the system from independent exogenous sources and are stored in separate queues awaiting transmission. The links can have different capacities depending on the distance between the nodes, interference etc. Channel conditions on each link very independently every slot according to ON/OFF Bernoulli processes, so that a link l can transmit Channel packets when it is in the ON state and cannot transmit in the OFF state. Such ON/OFF channel states might arise from channel fluctuations or fading. Every timeslot, a network controller views the channel conditions and schedules a set of non-interfering links (matching). The set of all valid matching does in the system can be arbitrary, allowing for any interference model. Under the MWM scheme, the weights of each link are chosen as the product of its backlog with the capacity of the link. With this choice of weights, the maximum weighted matching is scheduled at every time slot.

The design of a delay optimal policy that achieves minimum possible average delay of packets in the network for a given routing matrix has proved to be very challenging. Except for a delay optimal scheduling scheme for the tandem queue under the node exclusive interference model derived in [3], no result is known for more general systems. The analysis of scheduling policies is difficult because of correlations among mutually interfering queues. Moreover, throughput optimal algorithms like MWM use the queue length information while making the scheduling decisions. This results in complex interactions of arrival, service, and backlog processes and significantly complicates the analysis.

In this paper describes lower and upper bound on the average delay of a packet in a wireless network with single-hop traffic under a throughput-optimal scheme. A throughput optimal scheme can stabilize the system whenever there exists any other scheduling scheme which can stabilize the system.

II. MAX WEIGHT SCHEDULING POLICY

In this section we evaluate the performance of the Max-Weight scheduling policy in terms of the delay stability of traffic flows. Informally speaking, the "weight" of a feasible schedule is the sum of the lengths of all queues included in it. As its name suggests, the Max-Weight policy activates a feasible schedule that has maximum weight, at any given time slot. More formally, under the Max-Weight policy, the scheduling vector S (t) satisfies

$$\mathrm{S(t)} \in \arg\ max_{(s\ f) \in S} = \sum_{f=0}^{F} \mathrm{Q}_{\mathrm{f(t)}} \,.\, \mathrm{S}_{\mathrm{f}}$$

If the set on the right-hand side includes multiple feasible schedules, then one of them is chosen uniformly at random.

A. Weight function

All scheduling policies introduced in this paper are matching policies. Any matching policy is defined relative to a specific weight. For the definition of the weights, we will make use of a family of real positive functions $f_{k(x)}\mathbb{N} \to \mathbb{R}, 1 \leq k \leq K$ that satisfy the following property:

$$\lim_{n\to\infty} \frac{fk(n)}{n} = {}^{1}/_{w^{\mathrm{k}}}$$

We define as $d^{-k}(n) = \sum_{m \leq n} d^k\ m$ the cumulative number of services at queue q^k up to time n: Here, we assume that all switches start service at the same time $m = 0$ and all switches continuously work until time n: We define the weight of the queue q^k at time n as

$$Ø^k_n = n\text{-}f_k)\ d^{-k}(n))$$

This choice of the weights is motivated by the fact that it will allow us to derive the relation [7], which in turn is used for the proof of the rate stability in Theorem 1. We set $\phi = (Ø^1_{n,\ldots,}Ø^k_n)$ we note that the relations [4] and [5] imply that for any given positive integer v; there is

$$|Ø^k_n - Ø^k_{n+v}| \leq c_2(v)$$

Where $c2(v)$ is a positive constant depending on v:

In an example for $f^k(n)$ is given. The cumulative function of external arrivals for the logical queue q^k is given by $a^{-k}(n) = \sum_{m \leq n} a^k\ m$. The inverse function $[a^{-k}]^{-1}(p)$ maps the packet number p to the arrival slot. Setting $f_k(p)=[a^{-k}]^{-1}$,the weight $Ø^k_n = n\text{-}[a^{-k}]^{-1}(p)$ denotes the age of the p-th packet at time n. At its departure time n; the age of the p-th packet is $n\text{-}[a^{-k}]^{-1}(d^{-k}_n)$.

B. Computation of Lower Bound

This paper is used to calculate a lower bound on the delay of the system, independent of the scheduling policy used. The definition of the exclusive sets, of link in the system is that only one of the queues in can be scheduled at any given time slot. The notion of exclusive sets is helpful for deriving fundamental lower bounds on the expected delay of the system. The value of the lower bound is incremented and the links in the chosen exclusive set are removed from further consideration. This process is repeated until every link in the system has been used. Since each link appears in exactly one exclusive set, the system wide lower bound on the expected queue length can be obtained as the sum of the contribution of each link toward the lower bound. Consider X is the set of N number of Systems connected in the Network.

Step 1: Initially set a bound value to 0. This bound value is used for storing the Lower bound value in the extreme subset X1 from the set X.

Step 2: Take exclusive subset X1 from the set X, which maximize the lower bound value.

Step 3: Calculate the bound value by adding the bound and lower bound value of the exclusive subset X1.

Step 4: Divide the entire number of system connected in the network by the subset of the system.

Step 5: Repeat the steps 3, 4 and 5, until the X is equal to null.

Step 6: Return the Bound value.

C. Minimization of Upper Bound

This paper analyses a class of generalized maximum weighted matching policies, parameterized by Weights. The MWM policy is a special case, where all the weights are unity. We prove that GMWM achieves 100% throughput using the Foster- Lyapunov drift criteria for Countable Markov chains. The Algorithm to minimize the upper bound by computing the network utility maximization using convex optimization techniques is stated below. Let **a** be the set of prices and **ç** be a variable.

Step 1: First initialize **a** to the power of **h.**

Step 2: Optimal value **µ** is calculated by using the queue length value l and the price of the set a.

Step 3: The sum of optimal value for each subset from the entire set is calculated and the each subset upper bound value is minimized.

Step 4: Increment the price value for calculating the upper bound value for the entire network.

Step 5: Repeat the steps 3, 4 and 5, till the optimal value.

Step 6: Return the boundary value.

D. Estimation of the Delay

This paper analyses the delay of the wireless network when operated with a stationary randomized scheduler. The service process can be analyzed as follows. The scheduler is unaware of the backlog and chooses to schedule link independent of whether the queue is empty or not.

In every slot, if the link is scheduled, exactly one packet is served, otherwise the packets in the queue wait for the next available slot. The following parameters must be defined for the system.

- Length of the queue at the beginning of time slot.
- Number of arrivals at link during the time slot.
- Random variable that is 1 if link is scheduled and is 0 otherwise.
- Average delay in the system.

The lower bound may not be achieved by any policy because it may not be possible to schedule a link in every exclusive set due to the interference constraints. Therefore, we attempt to develop an accurate estimate for the delay performance in this section. The lower bound analysis suggests that those exclusive sets that have a large must have longer queues lengths. However, since a scheduling policy like MWM also balances the queue lengths in the system, the effect of congestion in a particular exclusive set is distributed over the whole system. Hence, instead of estimating the queue length at each link, we estimate the contribution of each link toward the aggregate expected queue length.

III. LITERATURE REVIEW

Aksenti, et al [8] 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. [9] 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 Fair

Queuing (WFQ) techniques. This proposed system is responsible for reliable message transmission in VANETs and congestion control in the rapidly changing network. Usage of WFQ fairly allocates bandwidth in the different traffic flows of message and the implementation of IEEE 802.11p protocol in the vehicular node greatly enhances the throughput and the needed QOS in VANET.

A Charles, et al [10], 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 [11] 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. This motivates us to investigate whether satisfactory service regularity and low mean-delay can be simultaneously achieved by the RSG Algorithm by carefully selecting its design parameter.

Ali Ghiasian, et al [12] 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. The results of this paper reveal the relation between average delay and network topology in the order sense and add to the understanding of the impact of topology on delay.

Kiruba, J. et al [13] the paper aims at developing an estimate for the expected delay of wireless networks with mutually independent arrival streams operating under the well-known maximum weighted matching (MWM) scheduling policy. A scheduling policy MWM balances the queue lengths in the system; the effect of congestion in a particular exclusive set is distributed over the whole system. The simulation results shows that the delay performance of the MWM policy is often close to the lower bound, which means that it is not only throughput optimal, but also provides excellent delay performance.

Zheng Dong, et al [14] in this paper, focused on network coding based broadcast scheduling in wireless networks with the packet delay constraint and aims at minimizing the number of packets miss their deadlines. Study the coding based scheduling problem with the packet delay constraint using a graph model. By assigning vertex weight as a decreasing function of packet deadline, proposed an encoding algorithm based on the maximum weight clique in the graph. Simulation results show that our algorithms can reduce the deadline miss ratio which is an important performance metric in the delay sensitive applications.

Koushik Kar, et al [15] in this paper, two classes of scheduling policies are considered the question of obtaining tight delay guarantees for throughout-optimal link scheduling in arbitrary topology wireless ad-hoc networks. The two policies are,1) a maximum queue-length weighted independent set scheduling policy, 2) a randomized independent set scheduling policy where the set scheduling probabilities are selected optimally. Both policies stabilize all queues for any set of feasible packet arrival rates, and are therefore throughput optimal. For these policies, the average packet delay is bounded by a constant that depends on the chromatic number of the interference graph, and the arrival slack in the system – a metric representing the overall load on the network. Prove that this upper bound is asymptotically tight in the sense that there exist classes of topologies where the expected delay attained by any scheduling policy is lower bounded by the same constant. Extend upper bounds to the case of multi-hop sessions. Through simulations, studied how analysis compares with actual delays computed for i.i.d., Markovian and trace-driven packet arrival processes.

Gagan Raj, et al [16] established a fundamental lower bound on the performance of a wireless system with single-hop traffic and general interference constraints. This result can be used to study the relative performance of any scheduling policy. This paper presented analysis of the GMWM (Generalized Maximum Weight Matching) type of scheduling policies on the expected queue lengths and expected delay in the system. The GMWM policy analyzed in the paper, uses the information of the arrival rates to the links to achieve load balancing by assigning higher weights w_i to more congested links, and also able to obtain a sharper upper bound on the delay performance.

Leandros Tassiulas, et al [17] proposed the scheduling policies for maxmin fair allocation of bandwidth in wireless ad hoc networks. A formalization of the maxmin fair objective under wireless scheduling constraints which gives a fair scheduling by assigning dynamic weights to the flows, such that the weights depend on the congestion of the neighbourhood and schedules the flows which constitute a maximum weighted matching. It attains both short term and long term fairness.

Tzung-Pei Hong, et al [18] proposed an efficient approach, called the weighted clustering algorithm, to determine the cluster heads dynamically in mobile ad hoc networks. The cluster heads chosen will act as the application nodes in a two-tiered wireless sensor network and may change in different time intervals. After a fixed interval of time, the proposed algorithm is re-run again to find new applications nodes such that the system lifetime can be expected to last longer. Experimental results also show the proposed algorithm behaves better than Chatterjee's on wireless sensor networks for long system lifetime.

Long Bao Le, et al [19] 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 result holds for both i.i.d and Markov modulated arrival processes with two states. For the multi-hop flow case, also derive tight backlog bounds in the order sense.

Mainak Chatterjee, et al [20] in this paper, proposed a ***weighted clustering algorithm*** **(WCA)** which takes into consideration the ideal degree, transmission power, mobility and battery power of a mobile node. This on-demand execution of WCA aims to maintain the stability of the network, thus lowering the computation and communication costs associated with it. The algorithm is executed only when there is a need, i.e., when a node is no longer able to attach itself to any of the existing cluster heads. This algorithm performs significantly better than both of the Highest-Degree and the Lowest-ID heuristics. In particular, the number of re affiliations for this algorithm is about 50% of the number obtained from Lowest-ID heuristic. Though this approach yields marginally better results than the Node-Weight heuristic, it considers more realistic system parameters and provides the flexibility of adjusting the weighing factors.

Javad Ghaderi, et al [21] showed that it is possible to design max weight algorithm that provides soft priorities to links with larger queue lengths. Another advantage of max weight algorithm is that the long files do not block the transmission of short files and hence, the overall delay performance can be improved. The key element of the algorithm is an appropriate choice of a weight function. Interestingly, by using such weight functions, design a distributed version of the algorithm with proven throughput optimality. In the distributed algorithm, each node only needs to know its own MAC information and its carrier sensing information.

IV.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 various scenario.

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AUTHORS PROFILE

B.Sindhupiriyaa received her M.Phil Degree from Periyar University, Salem in the year 2015. She has received her M.C.A Degree from Anna University,Coimbatore in the the year 2011. She is pursuing her Ph.D Degree at Periyar University, Salem, Tamilnadu, India. Her areas of interest include Mobile Computing and Wireless Networking.

Dr.D.Maruthanayagam received his Ph.D Degree from Manonmanium Sundaranar University, Tirunelveli in the year 2014. He has received his M.Phil Degree from Bharathidasan University, Trichy in the year 2005. He has received his M.C.A Degree from Madras University, Chennai in the year 2000. He is working as Head cum Assistant Professor, Department of Computer Science, Sri Vijay Vidyalaya College of Arts & Science, Dharmapuri, Tamilnadu, India. He has above 14 years of experience in academic field. He has published 1 book, 19 International Journal papers and 23 papers in National and International Conferences. His areas of interest include Grid Computing, Cloud Computing and Mobile Computing.