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# Dynamic Congestion Control with Multihop Scheduling Algorithm For Mobile Ad-Hoc Network

Naveena.G[1], Hemal Babu.H[2]

PG Scholar, Department of CSE, Sri Shakthi Institute of Engineering and Technology, Coimbatore, Tamilnadu, India[1]

Assistant professor, Department of CSE, Sri Shakthi Institute of Engineering And Technology, Coimbatore, Tamilnadu, India[2]

**ABSTRACT:** Wireless devices are designed to work in co-operative manner in Mobile Ad Hoc Networks (MANETs). These devices are connected via wireless link to communicate with each other. In MANET, transmission failure occurs due to several reasons, such as node mobility, channel collision and abnormal channel conditions. The solution must have capability to handle bad channel condition and connectivity failures in unicast transmission. Joint congestion control scheme with scheduling algorithm is improved for dynamic wireless network by changing scheduling scheme with adaptation model. Our end-to-end delay and throughput bounds are in simple and closed forms, and they explicitly quantify the tradeoff between throughput and delay of every flow. Furthermore, the per-flow end-to-end delay bound increases linearly with the number of hops that the flow passes through, which is order-optimal with respect to the number of hops. This dynamic adaptation mechanism achieves better performance in terms of packet delivery ratio, throughput and end to end delay.

## I. INTRODUCTION

In recent years, there has been a lot of study of Mobile Adhoc Networks (MANETs). A MANET is a self-configuring network of mobile devices connected by a wireless link without fixed infrastructure. Mobile Ad hoc Networks (MANETs) are composed of mobile nodes, having limited resources, extreme mobility and exchanging data through wireless communication without any fixed infrastructures. Due to shorter radio transmission range, multiple hops are essentially needed for communication. Further, node mobility causes the topology of the networks to be dynamically changed, frequently re-initiating the route discovery procedure. However, most existing work is based on non-Qos requirements, that is the source node attempts to transmit data to the destination node without any network constrains like bandwidth, delay, packet delivery ratio and throughput . Hence, losses in wired networks can be seen as an indication of congestion. This is different in wireless networks where losses often occur for various reasons, for example due to interference or poor link quality (high distance between the base station and the mobile device).

However, a smaller step size is needed to ensure that the joint congestion control and scheduling algorithm converges to close-to-optimal system throughput. Although one may use the step sizes to tune the throughput–delay trade-off, a change of the step size on one node will likely affect all flows passing through the node. Hence, it is difficult to tune the throughput–delay trade-off on a per-flow basis. In this paper, we will provide a new class of joint congestion control and scheduling algorithms that can achieve both provable throughput and provable per-flow delay. However, the key difficulty in analyzing the end-to-end throughput and delay under this algorithm is that the services at different links are correlated. Hence, a Markov chain analysis will no longer provide a closed-form solution.

The rest of the paper is organized as follows: We formulate the related works in Section 2. In Section 3 details the proposed scheduling algorithm scheme. In section 4 and 5, performance evaluation and conclusion and future work is enumerated.

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## II. RELATED WORK

Due to space limitations only a small representative sample of prior cross-layering approaches attempting to make routing and channel access more efficient in mobile ad hoc networks. Chen and Heinzelman et.al [1] provides a comprehensive survey on routing protocols that provide some sort of support for QoS in MANETs, and Melodia et. al.[2] presents a survey of cross-layer protocols for wireless sensor networks. Multiple Access Collision Avoidance with Piggyback Reservation (MACA/PR) was one of the first approach proposed by Lin and Gerla [3] attempting to integrate channel access, routing and traffic management. MACA/PR, which supports only unicast traffic, extends the IEEE 802.11 Distributed Coordination Function (DCF) to incorporate a bandwidth reservation mechanism and includes a modified version of DSDV that keeps track of the bandwidth of the shortest paths to each destination and the maximum bandwidth available over all possible paths. Reservations are made taking into account only two-hop neighborhood information and without coordination with the routing protocol. Distributed End-To-End Allocation of Time Slots for Real-Time Traffic (DARE) by Emma Carlson et.al. [4] is a channel access protocol for MANETs that provides end-to-end reservations. Destinations replies with clear-to-reserve messages that travel along re-verse paths establishing the actual reservations.

Data packets also contain reservation information and are used to refresh the reservations tables. The main limitations of DARE are that reservations are established at each hop of a path independently of the other hops in the path, and routing decisions do not consider information regarding reservations or any other data collected for channel access. Cai et al. [5] propose an algorithm for end-to-end bandwidth allocation that focuses on maximizing the number of flows with bandwidth restrictions that a MANET can accommodate. The disadvantage of this algorithm is that it requires global resource information along with the route and the route itself is not considered in the optimization algorithm. Setton et al. [6] propose a cross-layer framework that incorporates adaptations across all layers of the protocol stack. The proposed framework, however, is mostly based on centralized algorithms and a link-state approach is needed, which is not well suited for the highly dynamic MANETs or very large ad hoc networks.

## III. DESIGN PROCEDURE

There are many approaches available to solve congestion control and scheduling problem and most of them do not consider delay performance. A typical optimal solution can be obtained by a duality approach that results into the back-pressure algorithm and a congestion-control component at the source node. Furthermore, a considerable amount of effort has focused on developing low-complexity and distributed scheduling algorithms that can replace the centralized back-pressure algorithm and yet still achieve provably good throughput performance. Like the back-pressure algorithm, these low-complexity scheduling algorithms are usually also queue-length-based. The drawback of these approaches, however, is that the end-to-end delay of the resulting queue-length-based scheduling algorithm is very difficult to quantify under certain cases the back-pressure algorithm can have poor delay performance.

The congestion control algorithm is based on window based flow control, which deterministically bounds each flow's end-to-end backlog within the network and prevents buffer overflows. Furthermore, each flow's throughput–delay tradeoff can be individually controlled. Our algorithm is fully distributed and can be easily implemented in practice with a low per-node complexity that does not increase with the network size. We use a novel stochastic dominance method to analyze the end-to-end delay. This method is new and could be of independent value.

### 3.1 Rate-Based Scheduling Algorithm

At each time-slot:

1) Each link l first computes $P_l = a_l(t) \log(F/x_l(t))$.

2) In the scheduling slot, each link then randomly picks a backoff mini-slot (B) with distribution: $P\{B=F+1\} = e^{-Pl}$ and $P\{B=f\} = e^{-Pl((f-1)/F)} - e^{-Pl(f/F)}$, f=1,2….F. If F+1 is picked by link l, it will not attempt to transmit in this time-slot.

3) When the back-off timer for a link expires in the scheduling slot, it begins transmission unless it has already heard a transmission from one of its interfering links. If two or more links that interfere begin transmissions simultaneously, a collision occurs, and both transmissions fail.

4) When a link begins transmission, it will randomly choose a passing flow m to serve with probability $r_m(t) / a_l(t)\, c_l$

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### 3.2 Window-Based Flow Control Algorithm

Now, we describe the congestion control component. Our approach is to use the window-based flow control. For each flow, we maintain a window at the source node, and we only inject new packets to the queue at the source node when the total number of packets for this flow inside the network is smaller than the window size. This can be achieved by letting the destination node send an acknowledgement (ACK) back to the source node whenever it receives a packet. There are two advantages for this approach. First, for each flow, we can tightly control the maximum number of packets in each intermediate node along the route. This will prevent buffer overflows, which is an important.

### 3.3 Routing Model for Data Transmission

The routing model for transmission uses two different optimized solutions to transmit and forward the data packets, which is briefly described in following sections.

#### 3.3.1 Channel Reservation

Distributed election method is modeled to reserve the channel to transmit data over wireless medium.

For each time slot nodes have data or control packet to transmit, send election message over medium, which is dissimilar to RTs message in 802.11. The priority assignment model added in MAC frame gives the priority to the nodes while sending the reservation packet.

#### 3.3.2 Connection Management and Maintenance

Connection management starts functioning by establishing connection with neighbor nodes and maintain second hop connecting list. Each slot node sends hello message that includes node id, latitude, and longitude, current energy level, moving speed and direction with its one hop neighbor list that is updated during last time slot. The message is broadcasted over the wireless medium and based on its communication radius (R), it is received by neighbor nodes within its coverage area. Nodes receiving hello message of its neighbor create a new entry or update the existing neighbor entry.

The protocol is working in both proactive and reactive manner, since it is maintaining second hop covered node list. Nodes receiving the hello message update its routing table for both one hop and two hop neighbors. The criteria is that nodes that included in one hop list are ignored in two hop list.

#### 3.3.3 Connection Maintenance

All nodes create its neighbor list with specified expire time which is updated by the time of last hello message reception. If the expire time is less than the current clock time of the node, then it is removed from the neighbor list. Whenever node is removed from the neighbor list then it also removed from the forwarding route list. This will lead to dynamic updation of route which is used to handle routing packet. Hence route failure handling is effectively modeled in connection management.

#### 3.3.4 Route Reservation

Route reservation process is initiated after establishing complete path from source to destination and it is maintained during the route failure handling. For this purpose each node maintains two tables, namely forward table. The table format is given in fig 4.1

| Source id | Destination id | Forward entry | Alternate forward entry | Priority data | Expire time |
|---|---|---|---|---|---|

**Fig 4.1. Forwarding table**

### 3.3.5 Route Failure Handling (Link failure prediction)

By using link layer detection process i.e., by transmitting RTS - CTS and data message transmission the current link failure detection process is achieved. Once link failure occurs, node initiate route recovery process by sending reroute establishment message in unicast transmission and recovery is done by alternate sub trace establishment process in multicast transmission.

## IV. PERFORMANCE EVALUATION

Simulation is performed using discrete event simulator (NS-2) version 2.32 with CMU extension. Simulation results show the comparison of JCCSA against DJCCSA for unicast traffic. Network protocol performance is evaluated in terms of packet delivery ratio, end-to-end delay, throughput and bandwidth utilization ratio for unicast traffic. The routing protocols are evaluated with IEEE 802.11 DCF as underlying MAC protocol and all communication packets are sent in broadcast mode for multicast protocols. The considered mobility model is random way point for simulation. The proposed work is simulated by considering 50-150 nodes with a packet size of 1024 bytes at a transmission range 250m. The simulation environment is illustrated in table. 1.

| SIMULATION ENVIRONMENT PARAMETERS | |
|---|---|
| Number of nodes | 50, 75,100,125 and 150 |
| Maximum Speed | 4m/sec |
| MAC Type | MAC 802.11 DCF |
| Antenna Type | Omni Directional Antenna |
| Network Type | 1000 X 1000 $m^2$ |
| Transmission Range | 250 meter |
| Type of Connection | UDP |
| Traffic Type | CBR & FTP |
| Traffic Interval | 0.1 Sec |
| Packet Size | 1024 Bytes |
| Mobility Model | Random way point |
| Simulation Time | 10 Sec |

**Table.5.1. Scenario for Implementation**

## V. CONCLUSION AND FUTURE WORK

The proposed DJCCSA, a cross layer protocol for wireless MANET generalizes the channel access management and routing process by including management of traffic, connection maintaintence and distributed scheduling for concurrent transmission. The integrated components sharply works together to provide better outcome for end-to-end delay and bandwidth utilization for both unicast & multicast transmissions in multihop wireless network. The performance evalulation shows that the DJCCSA is highly stable and robust for unicast data transmission. DJCCSA also improves the relaying of packets in all mobility situations, compared to JCCSA for unicast transmission. Furthermore, the scheme can be improved by applying optimization model for channel access and transmission scheduling. This may improve the protocol robustness and can achieve better performance for unicast & multicast transmission.

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