A Solution for Congestion and Performance Enhancement by Dynamic Packet Bursting in Mobile Ad Hoc Networks

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Abstract. In mobile ad hoc networks, most of on demand routing protocols such as DSR and AODV do not deal with traffic load during the route discovery procedure. To solve the congestion and achieve load balancing, many protocols have been proposed. However, existing load balancing schemes just avoid the congested route in the route discovery procedure or find an alternative route during a communication session. To solve this problem, we propose a new scheme which uses the packet bursting mechanism in congested nodes. The packet bursting, which is originally introduced in IEEE 802.11e QoS specification, is to transmit multiple packets after channel acquisition. Thus, congested node can forward buffered packets quickly and prevent bottleneck. Each node begins to transmit packets in normal mode whenever its congested status is dissolved. We also propose two threshold values to define exact overloaded status adaptively; one is interface queue length and the other is buffer occupancy time. Through a experimental simulation study, we compare our protocol with normal on demand routing protocols and show that the proposed scheme is more efficient and effective especially when network traffic is heavily loaded.

Keywords: Ad hoc networks, Medium Access Control (MAC), Packet bursting, Load balancing.

1 Introduction

A mobile ad hoc network (MANET) is a self-configuring network of mobile hosts connected by wireless links without fixed infrastructure like a base station. In MANETs hosts are free to move randomly, and thus network topologies may change rapidly and unpredictably. Devising an efficient routing protocols for MANETs has been a challenging issue and DSDV (Destination Sequence Distance Vector) [1], DSR (Dynamic Source Routing) [2], AODV (Ad-hoc On-demand Distance Vector) [3] are such protocols for tackling the issue. One of the most popular MAC protocols for MANETs is the IEEE 802.11 [4, 5] which defines the distributed coordinated function (DCF) as a fundamental channel access mechanism to support asynchronous data transfer.

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Recently, the requirements for real time and multimedia data traffic have been requested more seriously. In this situation, the occurrence of congestion is inevitable in MANETs due to their limited bandwidth constraints. Furthermore, by the route cache mechanism in the existing protocols, the route reply from intermediate node during the route discovery procedure leads to traffic concentration on a certain node. When a node is congested, several problems can occur such as packet loss by buffer overflows, long end-to-end delay of data packets, poor packet delivery ratio, and much control packet overhead related to reinitiating the route discovery procedure. In addition, the congested node consumes more energy to route lots of packets, resulting in much more network partitions.

In this paper, we propose a new effective scheme called Dynamic Packet Bursting Algorithm (DPBA), which is intended to dissolve traffic congestion and can be easily implemented with current on demanding routing protocols such as AODV and DSR. This scheme is motivated from the IEEE 802.11e [6] QoS operation, which uses packet bursting mechanism. When a certain node is believed to be congested, it begins to make burst packets until overloaded status is dissolved. To decide whether congestion occurs or not, each node monitors number of packets in its interface queue and defines dynamical threshold values, which is the length of buffer and the period of packet buffered time. By using the packet bursting scheme in the congested node, we can achieve traffic alleviation, and improve performance in terms of packet delivery ratio and end-to-end delay, etc.

The rest of this paper is organized as the follows. In Section II, we review standard IEEE 802.11 MAC protocol including its enhanced version, IEEE 802.11e and other related works with load balancing. In Section III, we illustrate the detail operation of our proposed protocol. Performance evaluation by simulations is presented in Section IV. Finally, concluding remarks are given in Section V.

2 Related Works

2.1 IEEE 802.11 DCF Protocol

The overall operation of IEEE 802.11 DCF is described in Figure 1. The basic operation is a Carrier-Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism with a random back-off time. Before a station starts transmission, it should contend for shared medium. To avoid packet collision in transmission, the DCF also defines an optional mechanism for unicast frames, which are Request-To-Send (RTS) and Clear-To-Send (CTS) control frame. When the wireless medium is detected as idle for fixed interval, which is Distributed Inter-Frame Space (DIFS), the sender and receiver start to exchange RTS and CTS, respectively, prior to the actual data frame transmission to reserve the channel. Between control frames are transmitted, the Short Inter-Frame Space (SIFS), which is smaller than DIFS, is used. The other stations which overhear the RTS or CTS frame defer their transmission by maintaining Network Allocation Vector (NAV) which is a timer for the remaining time of any ongoing packet transmission. Another mechanism of the IEEE 802.11 is that an acknowledgment (Ack) frame which is sent by the receiver on successful reception of a data frame. The Short Inter-Frame Space (SIFS), which is smaller than