An Efficient Algorithm for Broadcast Scheduling in TDMA Packet Radio Networks

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Abstract

Packet radio (PR) was introduced in order to apply packet switching communication to a shared radio channel. Using a radio channel as the broadcast medium to interconnect nodes, a PR network provides flexible data communication services among a large number of geographically distributed, possibly mobile, radio units. PR can be used in Satellite Communication System, Wireless LAN and Wireless Data Communication System as well as Computer Radio Network. A PR unit consists of a radio, antenna, transceiver (transmitter and receiver) and a control unit. The radio provides connectivity to a number of neighboring radios, but typically is not in direct connectivity with all radios in the network. Thus the control unit needs to provide for store-and-forward operation, relaying packets to accomplish connectivity between the originating and destination users. The task of transceiver is to broadcast outgoing packets and to listen for incoming packets. The arrangement of a PR unit and its attached device (such as PC, Workstation, notebook PC, etc.) is often called *station*. In a PR network, since all stations share a single channel by multiple access protocol, unconstrained transmission may lead to the time overlap of two or more packet receptions, called *collision or interference*, resulting in damaged useless packets at the destination. Collided packets must be saved in a buffer and retransmitted, thus increase the system delay. Therefore, the transmission for each station must be scheduled to avoid any collision.

The time division multiple access (TDMA) technology can be used to schedule collision-free transmission. In a TDMA PR network, time is divided into frames which consists of fixed-length time slots. A schedule must guarantee that each station can transmit at least once in a frame. Collision will occur when certain stations transmit at the same time slot or a station receives two or more packets at the same time slot. Therefore, any two stations that may result in collision

must be scheduled to transmit at different time slots, while stations some distance away may be arranged to transmit at the same time slot without causing collision.

There are two kinds of optimization problem in the broadcast scheduling for TDMA PR network. One is the minimization of the frame length (the number of time slots in a frame) to achieve lower delay and the other is the maximization of the slot utilization to achieve higher throughput. These two optimization problems have been studied extensively but independently. It was shown that both are NP-complete. In 1997, Wang and Ansari first proposed an algorithm to solve both optimization problems concurrently.

In this paper, we propose a centralized algorithm to find a collision-free time slot schedule in a TDMA frame. The optimal schedule is the one that has the minimum frame length and provides the maximum number of collision-free transmission. The proposed algorithm is based on the sequential vertex coloring method. Numerical examples and comparisons with the algorithm of Wang and Ansari have shown that the proposed algorithm can find near-optimal solutions with reasonable computational complexity.