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Study of Parameter in Time Division Multiple Access (TDMA) MAC protocol in wireless Ad Hoc Environment

Pinki Dabas[1], Sanjeet Kumar[2], Vinay Panwar[3]
[1](M-Tech Scholar, PDM College of Engineering, Bahadurgarh)
[2](Lecturer, World Institute of Technology, Gurgoan)
[3](Lecturer, CRRIT, Kanjhwala, Delhi)

Abstract: *Control phase plays a critical role in the performance of time-division multiple access (TDMA)-based wireless networks. Control phase of TDMA-based medium access control (MAC) in wireless sensor networks is proposed. Wireless ad hoc networks depend upon medium access control (MAC) protocols for allocation of channel resources among mobile users. This paper studies TDMA-based timeslot allocation, convergence time and throughput parameters of TDMA using MAC protocol.*

Keywords: *TDMA, QoS, Medium Access Control, Wireless Ad hoc networks.*

I. INTRODUCTION

Wireless ad hoc networks (WANETs) are gaining a lot of attention in research lately due to their importance in enabling mobile wireless nodes to communicate without any existing wired or predetermined infrastructures. Mobile ad hoc networks (MANETs) have rapidly gained a considerable amount of attention in research lately[5][6]. As more and more smart, small, portable, and powerful computing devices are introduced into everyday life, the need for such devices to communicate on the fly in a seamless manner and without any pre existing network wiring or infrastructure is growing. It is also natural to expect such devices to support multimedia and real time applications, which are becoming increasingly feasible due to the significant advances in CPU power, memory, speed, storage, and communication capacity of mobile devices. Such applications require the underlying network to provide certain guarantees that are manifested in the support of several important Quality of Service (QoS) parameters such as bandwidth, delay, and bit error rate. Maintaining these QoS commitments in MANETs is not an easy task. This is due to the unpredictability and variability of many factors such as bit error rates, mobility, and continuous change in the connectivity of the different nodes in the network.

The design of an efficient Medium Access Control (MAC) is challenging in ad-hoc networks where users can enter, leave or move inside the network without any need for prior configuration. Ad-hoc networks require no infrastructure and nodes are free to enter, leave or move inside the network without prior configuration [3]. Fig 1 shows the example of Ad hoc network.

The main objective of this paper is to study the time division multiple access based MAC protocol behaviour in the wireless Ad hoc Networks.

The paper is organized as follows: Section I introduces a description for the TDMA based MAC protocol. Description of TDMA multiple access schemes is presented in Section II. In section III, Medium access control protocol is explained. Simulation results are given in Section IV, and finally conclusions are reflected in Section V.

Fig: 1 Ad hoc Network

II. TIME DIVISION MULTIPLE ACCESS

In a TDMA cellular radio system, several users time-share a common carrier frequency to communicate with the base station. Each user, transmitting low bit-rate digitized speech or other digital data, is allocated one or more timeslots within a frame in the downstream (base to users) and upstream (users to base) directions, as illustrated in Fig. 2

In the downstream direction, the base station broadcasts to the active users in a Time Division Multiplex (TDM) format [1]. In the upstream direction, each active user terminal transmits to the base station only in its own assigned timeslot or slots. Inter-user interference is prevented by strict adherence to timeslot schedules, and by guard times and time-alignment procedures between upstream timeslots, in order to prevent overlaps due to different propagation times [2].

Each individual terminal's receiver and transmitter operates with a duty cycle of **1/N** if there are ***N*** user terminals with equal bit rates sharing a common bit stream. Upstream and downstream traffic is separated either by using different carrier frequencies i.e., Frequency Division Duplex (FDD), or by alternating in time, i.e., Time Division Duplex (TDD).

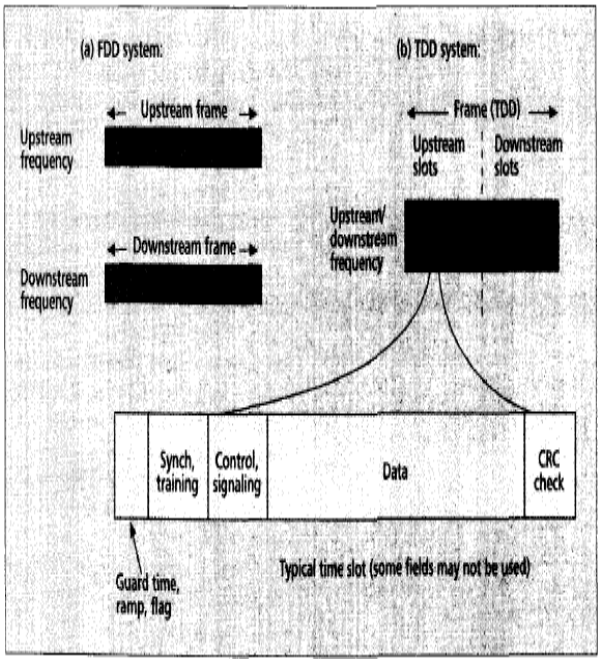

Fig: 2 TDMA frame and Time slots

III. MEDIUM ACCESS CONTROL (MAC)

MAC layer, sometimes also referred to as a sub-layer of the Data Link layer, involves the functions and procedures necessary to transfer data between two or more nodes of the network [5]. It is the responsibility of the MAC layer to perform error correction for anomalies occurring in the physical layer. The layer performs specific activities for framing, physical addressing, and flow and error controls. It is responsible for resolving conflicts among different nodes for channel access.

Since the MAC layer has a direct bearing on how reliably and efficiently data can be transmitted between two nodes along the routing path in the network, it affects the Quality of Service (QoS) of the network. The design of a MAC protocol should also address issues caused by mobility of nodes and an unreliable time varying channel [4].

In TDMA-based schemes, the transmitting node first senses the medium to check whether it is idle or busy. The node defers its own transmission to prevent a collision with the existing signal, if the medium is busy. Otherwise, the node begins to transmit its data while continuing to sense the medium. However, collisions occur at receiving nodes. Since, signal strength in the wireless medium fades in proportion to the square of distance from the transmitter, the presence of a signal at the receiver node may not be clearly detected at other sending terminals, if they are out of range. As illustrated in Fig. 3, node B is within the range of nodes A and C, but A and C are not in each other's range. Let us consider the case where A is transmitting to B. Node C, being out of A's range, cannot detect carrier and may therefore send data to B, thus causing a collision at B. This is referred to as the *hidden-terminal problem*, as nodes A and C are hidden from each other [7].

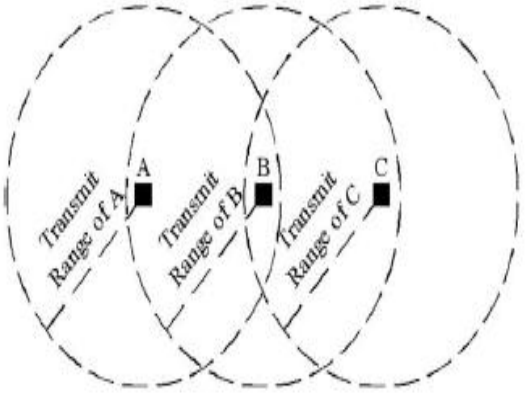

Fig: 3 hidden and exposed terminal problems

Let us now consider another case where B is transmitting to A. Since C is within B's range, it senses carrier and decides to defer its own transmission. However, this is unnecessary because there is no way C's transmission can cause any collision at receiver A. This is referred to as the *exposed-terminal problem*, since B being exposed to C caused the latter to needlessly defer its transmission [7]. MAC schemes are designed to overcome these problems.

IV. SIMULATION RESULTS

In this section the simulation results are shown and discussed. We will investigate the performance of the TDMA scheme using MAC protocol in wireless Ad hoc network. The convergence time is defined as the duration of time within which all nodes across the network collaboratively and in a distributed manner obtain conflict-free slots.

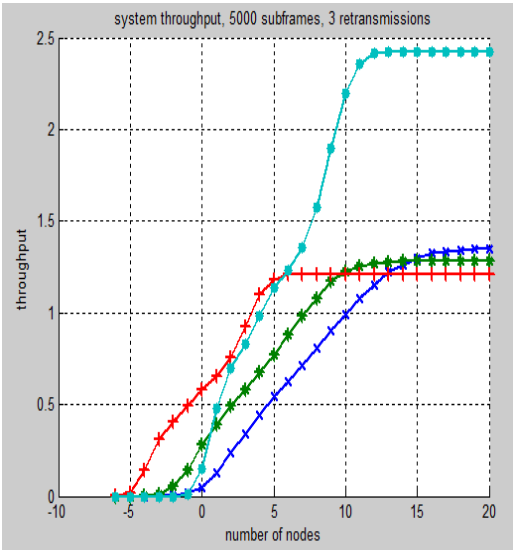

Fig: 4 Throughput of TDMA MAC with 5000 sub-frames and 3 transmissions

We have presented the Throughput for the TDMA using MAC protocol in Ad hoc Networks with 5000 sub-frames and with no HARQ. We have presented the convergence time for the TDMA using MAC protocol in Ad hoc Networks with 5000 sub-frames and with no HARQ.

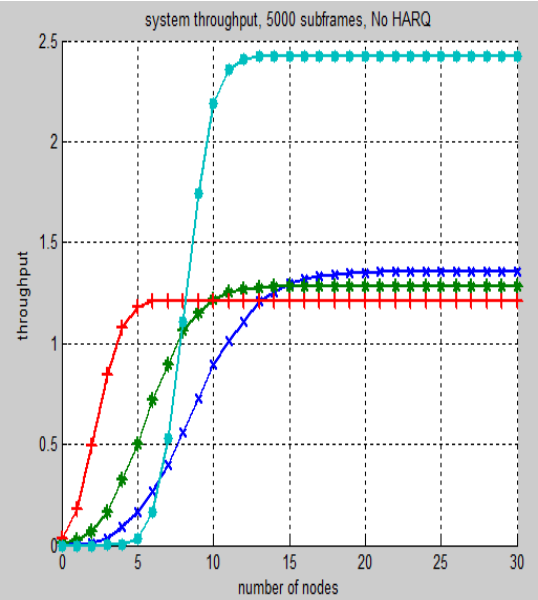

Fig: 5 Throughput of TDMA MAC with 5000 sub-frames with no HRAQ

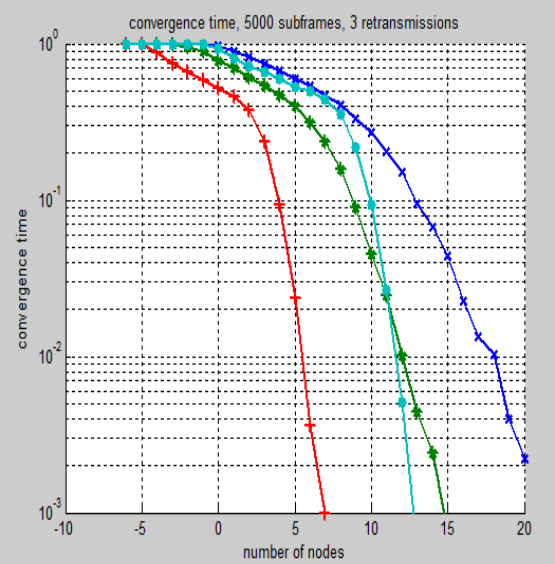

Fig: 6 Convergence time of TDMA MAC with 5000 sub-frames and 3 transmissions

Fig: 4 shows the Throughput of TDMA MAC with 5000 sub-frames and 3 transmissions and fig: 5 shows the Throughput of TDMA MAC with 5000 sub-frames with no HRAQ. Fig: 6 shows the convergence time of TDMA MAC with 5000 sub-frames and 3 transmissions and fig: 7 shows the convergence time of TDMA MAC with 5000 sub-frames with no HRAQ.

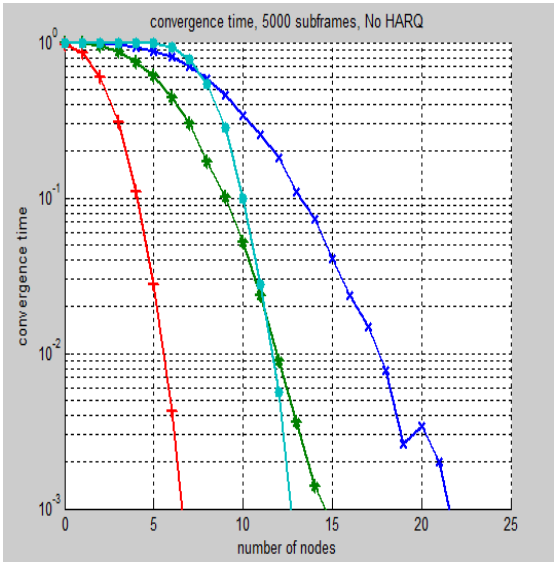

Fig: 7 Convergence time of TDMA MAC with 5000 sub-frames with no HRAQ

V. CONCLUSION

In this paper, we presented the performance of ad hoc wireless networks with respect to MAC protocols using TDMA. Parameters, Throughput and convergence time are study to present the behaviour of the MAC protocol with TDMA.

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