Analyzing Impact of TDMA MAC Framing Structure on Network Throughput for Tactical MANET Waveforms

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Abstract- With the advancement of networking technology it is anticipated to have Internet like functionality in tactical network. However, unlike commercial network the tactical networks operate under severe environment and resources constraints. Moreover, the MANET architecture and shared resources of wireless medium further put limitation on network design for high throughput. The access to the shared radio channel, within the mobile ad hoc network is managed by the medium access protocol (MAC). To achieve greater capacity and enhanced performance in the network, dynamic TDMA MAC is employed in tactical MANET waveforms.For such waveforms an important operational requirement is to address a variable number of nodes in a network to support the scalability of tactical deployment and have provision to respond promptly to voice calls with a short delay and small jitter.However, the large radio range and incorporation of ECCM further complicate the MAC frame design. In this paper, we analyze all these constraints for MAC frame design and demonstrate how it affects the network throughput.

Keyword: *Tactical network, MANET, MAC, TDMA, Framing, network size, channel constraints*

I. INTRODUCTION

In tactical network, radio nodes operate under severe environment constraints. Such region is highly dynamic in nature, consisting of a variety of network elements, largely comprised of mobile wireless nodes. In such environment the Tactical Data Link (TDL) based MANET systems provide a means for rapid exchanges of tactical digital information between air, land, sea and command center units as illustrated in figure 1. A TDL system is the key component in providing situation awareness in a modern warfare and interoperability between different systems[1,2].

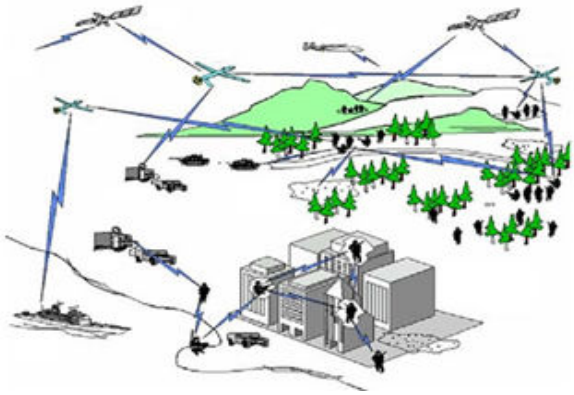

Figure1:Tactical Network

The TDL system waveform is governed by a MAC protocol and a physical link technology enablingdigital data to be transferred from one source to other destinations through a communicationchannel. To enable the sharing of a channel in aTDL system among members, an efficient medium access protocol (MAC) must beimplemented.

One approach for MAC design is, to use the time division multiple access (TDMA) protocol, whereeach node transmits or receives at given time slots. TDMA protocols being a scheduled MAC protocol are potentially better suited to networks with heavy or unbalanced load [3]. The TDMA MAC also suits to tactical MANET environment because of its capability to support QoS, which is not guaranteed in contention protocols [4].In static TDMA schemes the node's time slot gets wasted when it does not have traffic to transmit. That's why a mechanism that conserves the channel bandwidth is needed in such scenarios. Moreover, in a fully connected network, it comes natural that the channel bandwidth is evenly shared among all nodes using a suitable MAC protocol; because the priorities of nodes or links are uniformly distributed. However, in tactical ad hoc network, where nodes are randomly placed over an irregular plane, bandwidth allocation to a node is much more complex.

To achieve greater capacity and enhanced delay performance in the network, dynamicTDMA scheme is employed at the MAC layer [5,6]. In dynamic TDMA,which is an extension of TDMA, time is divided into time slots.Multiple transmissions can be scheduled as long as the receiving nodes do not get their packets interfered with. In this manner, dynamic TDMA takes advantage of the spatial separation between nodes to reuse the time slots.Generally, such schemes require strict time synchronization among participating nodes for efficient transmission and reception among the nodes. In addition, as a result of mobility of nodes in MANETs, periodic changes in the network require that the schedulesfor transmission rights of nodes must be updated with minimal latency andcomputational complexity. Furthermore, the updated schedule must be propagated to all nodes in the network in a timely and efficient manner.

The literature is rich with work conducted in the area of scheduling and synchronization for MANETs. Several survey articles and research work have been published on MACscheduling and synchronization schemes from different perspectives indicate the continuing challenges in this topic area. However,there is a lack of published models and references in one important aspect of MAC, which is, Framing of TDMA slot structure and its impact on network performance. We consider it as one of the critical areas of MAC design for tactical environmentsbecause unlike the

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