Traffic-Based S-MAC: A Novel Scheduling Mechanism for Optimized Throughput in Mobile Peer-to-Peer Systems

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ABSTRACT

Mobile Peer-to-Peer (MP2P) is a networking paradigm that will be exploited in the future to support technological advances and systems for the efficient provision of multiple services to mobile users. In a general context, the mobile community seeks to invest in on-the-fly services, by minimizing the effort and the increasing mobile users’ performance. In this framework, the mobile Ad-Hoc Networks provide mobile nodes the flexibility of operating as flexible networking points, without the use of a centralized entity, where issues such as the energy consumption and the data packets transmission failure arise along with many more. Towards minimizing the factors that contribute to the increased consumption of the energy and the resources, as well as the loss of data, a Traffic-based S-MAC protocol is proposed in this paper to increase the data exchange and preserve the energy conservation, among the nodes in mobile Ad-Hoc Networks. The performance of the proposed protocol was thoroughly evaluated, by conducting multiple experimental results. The results verify the efficient performance of the protocol and indicate fields for further research and experimentation.

Keywords: Ad-Hoc Networks, Duty Cycle, Energy Conservation, Medium Access Control, Scheduling Mechanism, Sleep Wake State, Throughput, TS-MAC

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1. INTRODUCTION

As mobile networks evolve, the mobile devices (e.g., smart phones, tablets etc.) have shrunk in size and also incorporate more advanced functions. This allows a node (or device) to act as a wireless terminal, as well as a repeater and still be compact enough to be mobile. A self-organizing and adaptive collection of such devices connected with wireless links is now referred to as a Mobile Ad Hoc Network (i.e., MANET). An Ad Hoc Network is not in need of any centralized control. The network should be able to detect any new nodes in range and induct them unobstructed. Nevertheless, if any node moves out of the range of the network, the remaining nodes should automatically reconfigure themselves, in order to adapt in the new topological scenario. A working group named MANET has been set up by the Internet Engineering Task Force (IETF) for promoting research in this area. Most usually, there are two types of architectures in Ad Hoc Networks: the flat and the hierarchical architecture (Chakrabarti & Mishra, 2001; Toh, 2002). Each node has a transceiver, an antenna and a power source. The properties of these nodes can vary regarding their size, transmission range, battery power and processing ability. It is common that some nodes can be used as servers, by lending themselves, others as clients and even some may be operational to act in conjunction (server and client), depending on the situation. There are specific cases though, where each node may need to act as a router, in order to channel information between nodes (Royer & Toh 1999; Haas & Tabrizi1998).

In this context, a Traffic Sensor Media Access Control (TS-MAC) protocol is examined in this paper, based on S-MAC, a Sensor Media Access Control that uses three atypical techniques to reduce energy consumption and support self-configuration. In order to bring energy consumption to the lowest level possible in listening to an idle channel, nodes periodically sleep. Neighboring nodes form virtual clusters so that they can auto-synchronize between sleep schedules. S-MAC, which was influenced by PAMAS, also sets nodes to sleep during transmissions of other nodes. Unlike PAMAS, it only uses in-channel signaling. Finally, S-MAC applies message passing to reduce contention latency for sensor-network applications that require store-and-forward processing as data move through the network (Ye, 2002). In addition, the latency, connectivity, energy and memory are the essential elements of today’s mobile environments, whose performance may be significantly improved by caching techniques. The TS-MAC protocol can be used in various topological patterns with varying packet sizes.

Adaptively, the proposed TS-MAC scheme modifies the duty cycle of a node, adapting the nodes’ sleep wake time in order to save power and maximize both the throughput and the network lifetime. Therefore, the proposed TS-MAC scheme manipulates the network state in a distributed form and actively controls each node’s sleeping duration, by using specific methods, in order to minimize the energy cost of peer-to-peer communication among mobile terminals. In addition, this protocol provides schemes for both delayed sensitive packets, as well as without deadlines (also known as don’t-care packets). Finally, this model could be applied to Ad Hoc networks of various nodes position, number and topology. In this framework, the organization of the paper is as follows: Section II discusses the related work that has been performed on various MAC protocols, sleeping mechanisms and functions, as well as on implementation techniques. Section III discusses the system model and mechanisms of the S-MAC, which further on introduces the proposed Traffic Sensor Media Access Control (TS-MAC) protocol, followed by Section IV which provides the evaluation and simulation results of the proposed scheme. Finally, Section V concludes with a summary of our contribution and further research.
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