Chapter 20

FH–MAC: A Multi–Channel Hybrid MAC Protocol for Wireless Mesh Networks

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ABSTRACT

In this article, the authors propose a new hybrid MAC protocol named H-MAC for wireless mesh networks. This protocol combines CSMA and TDMA schemes according to the contention level. In addition, it exploits channel diversity and provides a medium access control method that ensures the QoS requirements. Using ns-2 simulator, we have implemented and compared H-MAC with other MAC protocol used in Wireless Network. The results showed that H-MAC performs better compared to Z-MAC, IEEE 802.11 and LCM-MAC.

INTRODUCTION

Wireless mesh networks are an attractive field for several research labs, and they were the subject of many papers in the few last years. These intensive works try to solve different open issues which concern mainly the capacity of the wireless mesh network protocols, and especially MAC protocols capacity (Akyildiz, Wang and Wang, 2005).

MAC protocols for wireless networks suffer from many problems such as scalability; data throughput degrades significantly when increasing the number of nodes or hops in the network. Furthermore, many other MAC problems persist for example the interference effect and radio channel allocation strategies. These problems are caused by using advanced radio technologies such as directional antenna, omnidirectional antenna and multi-channel/multi-radio systems. Thus,
Researchers have started revising the design of wireless networks MAC protocols, especially MAC protocols of ad hoc and sensors networks. The international standard groups are also working on the specification of new technologies for wireless mesh networks that includes IEEE 802.16, 802.11s, 802.15.5, and ZigBee. Several research issues still exist and need to be solved. In particular, the interesting research problem related to the scalability issue of existing IEEE 802.11 networks. The most addressed solution intends to develop a hybrid MAC protocol that combines the strengths of TDMA and CSMA while offsetting their (Akyildiz, Wang and Wang, 2005). In the wireless mesh network, it is important that the underlying MAC schemes could be able to provide high bandwidth by exploiting channel diversity and support QoS requirements. It must have the capacity of self-organizing, self-configuring, and self-healing.

In Wireless MAC protocols, using hybrid schemes outperform random-based and schedule-based schemes. In case of random-based schemes, throughput drops significantly when increasing traffic intensity, number of nodes, or hops in the network. In addition, random-based schemes cannot guarantee contention-free transmission. The one hop packet loss probability increase when the number of nodes trying to transmit simultaneously increase. This probability cumulates across multiple hops. Schedule-based schemes provide for contention-free transmission slots to each node. The schedule comprising of these transmission slots is based on the network traffic and topology. To derive and propagate the schedule, traffic and topology information needs to be collected, which involves network overhead. Thus, the frequent changes in the network conditions results in high overheads, and leading to poor performance of schedule-based schemes.

In this article, we study the problems which persist at wireless MAC layer in multi-hop wireless Network. In addition, we propose a new hybrid MAC scheme, called H-MAC (Hybrid MAC) for wireless mesh network that combines the strengths of TDMA and CSMA. H-MAC extends the hybrid multi-hops scheme defined in Z-MAC (Rhee, Warrier, Aia, and Min, 2005) to support channel diversity and QoS requirements for wireless mesh network. The main feature of H-MAC is its adaptability to the level of contention in the network. In fact, under low contention, H-MAC behaves like CSMA, and under high contention, it behaves like TDMA.

H-MAC uses two contention modes: Low Contention Level (LCL) and High Contention Level (HCL). It also implements two allocation algorithms. The first Receiver Based Channel Assignment Algorithm (RBCA) is used for channel allocation and the second Sender Based Slot Assignment Algorithm (SBSA) is used for slot allocation. We have evaluated the performances of our protocol by comparing it to other used MAC protocols. In this evaluation, we have used the ns-2 simulator and we have conducted several simulation scenarios. The obtained result showed that H-MAC performs better compared to Z-MAC, IEEE 802.11 and LCM-MAC.

This article is organized as follows. In the second section we describe the related works and discuss the different protocols proposed for wireless MAC. We present and detail H-MAC protocol in section 3. In section 4, we present our simulation and the obtained results. We conclude our work in section 5.

RELATED WORKS

We classify MAC solutions in three main classes. The first class is the hybrid protocols that combine CSMA and TDMA. The second class contains multi-channel MAC protocols, and the third class includes MAC protocols with QoS support. In the next sections, we will outline the strengths and weaknesses of these classes.
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