Chapter 10

Incidence of the Improvement of the Interactions between MAC and Transport Protocols on MANET Performance

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ABSTRACT

In this chapter, the authors present an improvement to the interactions between MAC (Medium Access Control) and TCP (Transmission Control Protocol) protocols for better performance in MANET. This improvement is called IB-MAC (Improvement of Backoff algorithm of MAC protocol) and proposes a new backoff algorithm. The principle idea is to make dynamic the maximal limit of the backoff interval according to the number of nodes and their mobility. IB-MAC reduces the number of collisions between nodes. It is also able to distinguish between packet losses due to collisions and those due to nodes’ mobility. The evaluation of IB-MAC solution and the study of its incidences on MANET performance are done with TCP New Reno transport protocol. The authors varied the network conditions such as the network density and the mobility of nodes. Obtained results are satisfactory, and they showed that IB-MAC can outperform not only MAC standard, but also similar techniques that have been proposed in the literature like MAC-LDA and MAC-WCCP.

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INTRODUCTION

A MANET (Mobile Ad Hoc Network) (Basagni, Conti, Giordano, & Stojmenovic, 2004) is a complex distributed system which consists of wireless mobile or static nodes. These nodes can freely and dynamically self-organize. In this way they form arbitrary and temporary “Ad hoc” networks topologies, allowing devices to be interconnected wirelessly in areas with no pre-existing infrastructures.

In such network, MAC (Medium Access Control) protocol (Karn, 1990; Bhargavan, Demers, Shenker, & Zhang, 1994; Parsa & Garcia-Luna-Aceves, 1999) must provide an efficient access to the wireless medium and reduces the data interference. Important examples of this protocol include Carrier-Sense Multiple Access CSMA with collision avoidance which uses a random backoff algorithm (IEEE, 1999). CSMA can use a virtual carrier sensing mechanism using Request-To-Send/Clear-To-Send (RTS/CTS) control packets (Mjeku & Gomes, 2008). Both techniques are used in IEEE 802.11 MAC protocol (IEEE, 1999) which is the current standard for wireless networks.

TCP (Transmission Control Protocol) (Holland & Vaidya, 1999; Hanbali, Altman, & Nain, 2005) is the transport protocol used in most IP networks (Kurose & Ross, 2005) and recently in MANETs (Kawadia & Kumar, 2005). It is important to understand the TCP behavior when coupled with IEEE 802.11 MAC protocol in such network.

When the interactions between the MAC and TCP protocols are not taken into account, this can degrade the MANET performance notably, by affecting to the performance of the TCP parameters, i.e. throughput and end-to-end delay (Jiang, Gupta, & Ravishankar, 2003; Nahm, Helmy, & Kuo, 2004; Papanastasiou, Mackenzie, Ould-Khaoua, & Charissis, 2006). In order to adapt the behavior of these protocols for better QoS (Li, 2006), it is very important to study their interactions. In Hamrioui, Bouamra, and Lalam (2007), we presented a study of the interactions between the MAC and TCP protocols. We showed that TCP performance (notably throughput parameter) is degraded while the number of nodes increases in a MANET using IEEE 802.11 MAC as access control protocol. In Hamrioui and Lalam (2008), we proposed a solution for the problem notified in Hamrioui et al. (2007), but we were just limited to a chain topology and also to the influence of the number of nodes on the TCP performance. In Hamrioui and Lalam (2010) we studied the validity of the solutions proposed previously with several routing and transport protocols and also with different static topologies. The results showed that the proposed solutions are not only influenced by the change of the network topology but also by the routing and the used transport protocols.

Our contribution in this paper is to improve TCP protocol performance by exploiting the backoff algorithm of the MAC protocol. The work done in this chapter is the next step that follows the works (Hamrioui et al., 2007; Hamrioui & Lalam, 2008, 2010). In addition to the number of nodes, we improved our previous solutions by taking into account another parameter which is the mobility of the nodes. We also compared our solution with others solutions which have been proposed in the same context. After a short presentation of MAC and TCP protocols, we will present our IB-MAC (Improvement of the Backoff algorithm of the MAC protocol) and study its incidences on some TCP performance parameters (throughput and end-to-end delay). IB-MAC proposes a dynamic adaptation of the maximal limit of the MAC backoff algorithm. This adaptation includes the number of nodes in the network and their mobility.

Our paper is structured in five sections. Section two gives a short presentation of MAC and TCP protocols. In section three, we present the IB-MAC improvement and in Section four we study its incidences on the TCP performance parameters. We finish our chapter with section five which provides the conclusion and future work.
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