Chapter 21
Routing in a Custom-Made IEEE 802.11E Simulator

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Abstract The custom-made IEEE 802.11E simulator in this chapter is an evolution of the previous one. To provide support for multi-hop environment it was necessary to implement the routing algorithm above the already existing Medium Access Control (MAC) plus Physical (PHY) layers. After the random placement of all the stations in the field, the simulator determines which can communicate directly. With this data, the selected routing algorithm determines the shortest path from a station to all the others. For these initial tests we chose the well-known Dijkstra’s algorithm. In this work, however, we present no cross-layer at all, and the routing table is not modified during the simulations. The engine starts collecting events at the beginning of the simulation. For the end user, this simulator allows for simulating a network with an unrestricted number of nodes, in any configuration type. By using the chosen routing protocol, it supports connections to every reachable station from its neighbours, allowing for a message to reach any destination.

Keywords IEEE 802.11E Simulator · Custom-Made · Routing · multi-hop environment · network simulation

21.1 Introduction

Wireless networks are gaining more and more importance in our world. Cellular phones with GPRS/UMTS, Wi-Fi, and WiMAX networks are very common these days, and they share a common feature: they require some sort of backbone infrastructure in order to allow for packets from different communication peers to reach each other. For example, if someone makes a phone call, the conversation will always pass from the cell phone to the operators’ infrastructure, and then to the
receivers phone, even if they are both in the same building. Resources would be certainly saved if somehow the cell phones could connect directly to each other.

In an ad-hoc network, all the participants (also called nodes) can communicate directly with their neighbours. Two nodes are considered neighbours if their communication devices can reach each other. Nodes wanting to communicate to others that are not neighbours will simply send a message to another node which is located nearer the destination. As so, a centralised infrastructure to establish the connectivity is not required, since each node will determine by itself to where it should forward its data. The specification IEEE 802.11 refers to this type of network as Independent Basic Service Set (IBSS).

This chapter is organized as follows. Section 21.2 presents some background information about the previous simulator and about IEEE 802.11e. Section 21.3 describes the features of the new simulator highlighting the modifications we performed. Section 21.4 presents the results of the initial simulations, while Section 21.5 presents conclusions and suggestions for future work.

21.2 Previous Work

This simulator is based on the one developed at the Instituto de Telecomunicações, Laboratório da Covilhã, as part of the IST-UNITE project. The purpose of that previous version was to create a trustworthy simulator to be used in the context of IST-UNITE, allowing the study of the interoperability between Wi-Fi and High Speed Downlink Packet Access (HSDPA), [1]. This involved the creation of an HSDPA time-driven simulator and a Wi-Fi event-driven simulator that may be able to run separately or together for the coexistence scenario. In the latter case, there is communication between the two simulators which will run separately in a synchronous way.

The Wi-Fi simulator was initially built only for the infrastructure mode, i.e., an architecture with one access point (AP) and several wireless stations (STAs) attached to it. It can simulate traffic from one STA to the AP and vice-versa, and calculates the throughput (total in the simulation and per unit of time), packet delay (total in the simulation and average), lost packets, retransmissions, and collisions. This computation is oriented to the support of the Quality of Service (QoS), i.e., it implements IEEE 802.11e with four access categories. As a consequence, these metrics are calculated for each traffic type: voice (VO), video (VI), background (BK) and best-effort (BE).

The IEEE 802.11e standard was conceived to implement Quality of Service (QoS) in IEEE 802.11a/b/g. QoS refers to the way resources are reserved for certain applications, guaranteeing that the most urgent data flows will have higher priority levels. The IEEE 802.11 Medium Access Control (MAC) coordination functions are the Distributed Coordination Function (DCF) and the Point Coordination Function (PCF). They establish the timing and sequence for each station to access the shared medium. The latter is only used in the infrastructure mode, with the AP