Chapter 1
Hybrid Approach to Integrated QoS Capable Protocols for Wireless LANs

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ABSTRACT
The recent evolution of wireless networking has led the market to increased service demands. Thus, the emerged necessity is to develop specialized mechanisms that provide efficient QoS (Quality of Service) for both traditional and modern network applications in the challenging wireless environment. The respective IEEE proposal comes from the 802.11e workgroup which has developed the Hybrid Coordination Function (HCF). HCF is definitely capable of providing QoS, however, it exhibits significant limitations. This work presents an alternative protocol with improved behavior and performance. The Priority Oriented Hybrid Access (POHA) is a complete channel access mechanism able to provide integrated QoS for all types of traffic and network applications. POHA combines a polling based and a TDMA access scheme, adapts to the dynamic conditions of modern WLANs, improves channel utilization and station feedback, provides medium contention fairness, eliminates collisions, differentiates traffic based on priorities, supports dynamic resource assignment, and instantly negotiates the quality levels of the offered traffic streams trying to support multiple streams with best possible quality. POHA, compared with HCF, exhibits generally superior performance.

INTRODUCTION
Nowadays, users expect the wireless networks to provide qualitative services similarly to the wired ones. The initial role of the WLANs gradually changes, so they are no longer considered to be simple extensions of the wired networks with limited capabilities. The modern needs for extended mobility, real-time communications, and multimedia traffic transmissions have significantly increased the network requirements. Lately, great development has been observed in the area of the wireless physical layer. In a few years, the maximum throughput has risen from 1 Mbps, in legacy IEEE
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802.11 (IEEE 802.11 WG, 1999) to 100 Mbps or more, as measured at the MAC data service access point in IEEE 802.11n (IEEE 802.11n/D11.0, 2009). This development has provided the opportunity to employ WLANs for demanding network applications. However, the wireless environment exhibits special characteristics that make it rather unreliable. Thus, specialized access mechanisms are needed to optimize the wireless network performance.

Efficiently serving different types of simultaneous traffic flows under the harsh wireless conditions is challenging. Modern networks have to be able to provide extended QoS, so that the final user experiences no deficiencies in any kind of communication. The medium access control mechanism plays a crucial role in QoS provision. However, it is definitely inefficient to adopt a wired LAN access control protocol in a wireless LAN. The wired LANs are characterized of fixed links, while, nowadays, the use of inexpensive switching devices has eliminated their collision domains. On the other hand, in a wireless LAN the links are variable and the bandwidth is shared to all the nodes through the common transmission medium (the air), that comprises a large collision domain. Furthermore, there are some phenomena which are only met in the wireless environment, like the hidden station and the exposed station problems.

The IEEE proposal regarding QoS in WLANs comes from the 802.11e workgroup and is called HCF (IEEE 802.11e WG, 2005). Of course, there are several relative access mechanisms proposed in literature, however, HCF is the most promising one, since it belongs to the well known 802.11 family of standards, it is backward compatible with the dominant 802.11 network, it seems to be supported by the industry (although there are hardly yet any network products adopting it), and it is generally a high-quality approach. The HCF scheme considers a contention based (Enhanced Distributed Channel Access - EDCA) and a contention free protocol (Hybrid Control Channel Access - HCCA). Besides their qualitative characteristics, EDCA and HCCA exhibit some significant limitations regarding the provided QoS, while efficiently supporting integrated traffic in a wireless environment is rather challenging.

This chapter discusses a hybrid access scheme capable of efficiently supporting all types of network communications under the harsh conditions of the wireless medium. The Priority Oriented Hybrid Access (POHA) protocol (Lagkas et al., 2007b) is a combination of two different channel access control mechanisms, POAP (Priority Oriented Adaptive Polling) and POAC-QG (Priority Oriented Adaptive Control with QoS Guarantee). POAP (Lagkas et al., 2008) is a polling-based access scheme which uses an efficient network feedback method in order to improve decision making regarding medium allocation. It is a flexible random access control protocol able to provide QoS by exploiting packet priorities and stations’ status information without necessitating QoS requests. At this point, it should be clarified that in this chapter we call “packets” all the data units that require transmission without differentiating between frames (lower layer data units) and packets (higher layer data units). There is no need for this kind of differentiation in this work, thus, we intend to keep terms simple and clear. POAC-QG (Lagkas et al., 2007a) is a resource reservation access scheme which dynamically allocates time slots to the QoS requesting stations. It is capable of guarantying QoS to real-time Traffic Streams (TSs) of variable bandwidth demands, while instantly negotiating the best combination of the served applications’ quality levels.

The chapter initially provides some background information about QoS supportive MAC protocols. Then, the IEEE 802.11e HCF protocol is presented and the behavior of the EDCA and the HCCA access schemes is discussed. The description of the POHA protocol follows next, where the combined operation of POAP and POAC-QG is analyzed. After that, we present our simulation environment and we comment on the comparison