

Chapter 11

Management, Monitoring and QoS in Multi-Cell Centralized WLANs

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ABSTRACT

Large deployments of access points in wireless local area networks (WLANs) based on the IEEE 802.11 standard require management, configuration and control mechanisms. Centralized WLANs are defined as multi-cell wireless access networks that implement some of these functions in a centralized manner. In this chapter the authors illustrate how the mechanisms designed for the management of centralized WLANs can also be used for monitoring parameters related to QoS support and for pursuing QoS goals. They describe the Control and Provisioning Wireless Access Protocol (CAPWAP), a recent IETF standard for the management of centralized WLANs which is currently in the final stages of the definition process, its implementation for the existing types of centralized WLANs, and its use for monitoring and QoS management. The authors discuss the QoS goals that can be pursued in this framework, such as access control, load balancing, cell resizing, and Medium Access Control parameters adaptation, as well as the algorithms and strategies that can be used to fulfill them.

INTRODUCTION

The notion of Mobile Internet relies on scenarios where mobile users may have access anytime and anywhere to conventional and emerging Web ap-

plications requiring multimedia and interactive communications. Wireless access networks are the key element to implement these scenarios and much work has been done in recent years to develop and improve wireless technologies, including the introduction of support for mobility and Quality of Service. In this respect, special interest has been

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paid to wireless local area networks (WLANs) based on the IEEE 802.11 standard (I.S. 802.11, 2007), that exhibits characteristics useful to pursue the goals of the Mobile Internet, including a large number of installations in a wide range of contexts.

Three main trends have emerged in the last years in the evolution of wireless access networks. The first one is the deployment of large access networks based on wireless technologies, with the aim of providing uniform coverage and connectivity to wider areas. This aim has been pursued either by the installation of new large access networks, or by integrating existing networks in a single administrative federation. A major problem in this respect is the lack of standard configuration tools to manage the access network, and the consequent need for inter-operable solutions. A second trend is the integration of networks based on heterogeneous technologies to enhance connection opportunities. The most cited case is the integration of cellular data networks with IEEE 802.11 WLANs. This trend has triggered much research effort in the area of mobility management, specifically vertical hand-off among heterogeneous networks, and in the area of adaptive behavior to variations of network conditions. The third trend is the enhancement of the service provided by wireless access networks with the introduction of features like security, fast and transparent mobility support, quality of service, access control, accounting, etc.

In this chapter we discuss how the introduction of a network management protocol specifically designed for wireless networks can be of help in pursuing the above goals. To this end, in the rest of the chapter we describe the current proposal for the CAPWAP protocol and its current implementations, together with its utilization as a tool to monitor and manage wireless access networks. An attractive feature of this approach is that the resulting schema can be considered as a framework in which specific solutions to individual problems can be integrated to provide a global enhancement in the functionalities of wireless access networks.

BACKGROUND

The Rationale behind Centralized WLAN Architecture

Born as a wireless extension of small office or home networks, WLANs have experimented a growing success as access networks that are efficient and easy to deploy. Their popularity has triggered the deployment of larger wireless networks in areas such as university campus, corporate buildings and also metropolitan areas. The early implementations of a WLANs followed a pattern known as *Autonomous WLAN architecture*: a single Access Point (AP), or a small collection of Access Points, related to some geographically restricted area such as an office or a building. An autonomous network is manually configured, it defines its own access rules and it is substantially unaware of other nearby WLANs. However, the management of a large multi-cell WLAN as a collection of separate autonomous networks is both complex and inefficient. On one side, for lack of coordinated management functionalities, there is the need to manually configure each cell, which may prove unfeasible or too expensive. On the other hand, the problems or opportunities due to the interaction of the cells cannot be managed. A classical example is the problem of planning the frequencies used by the Access Points in a large WLANs: it is intuitive that the problem of reducing the interference among overlapping channels cannot be solved at each Access Point since it requires some kind of global coordination. Another typical issue is related to the load balancing among adjacent cells. In situations when many users are concentrated in a single cell (think of a classroom that is using wireless connectivity for some task), it makes sense to balance the number of associated users by moving some of them to adjacent cells. This in turn may require to increase the transmission power of nearby Access Points while reducing the power of the Access Point of the original cell to facilitate the

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