

# Chapter XLVII

## Automated Fault Management in Wireless Networks

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### ABSTRACT

*In the near future, several radio access technologies will coexist in Beyond 3G mobile networks (B3G) and they will be eventually transformed into one seamless global communication infrastructure. Self-managing systems (i.e. those that self-configure, self-protect, self-heal and self-optimize) are the solution to tackle the high complexity inherent to these networks. In this context, this chapter proposes a system for automated fault management in the Radio Access Network (RAN) of wireless systems. The chapter presents some basic definitions and describes how fault management is performed in current mobile communication networks. Some methods proposed for auto-diagnosis, which is the most complex task in fault management, are also discussed in this chapter. The presented systems incorporate Key Performance Indicators (KPIs) to identify the cause of the network malfunction.*

### INTRODUCTION

There is no doubt that during the last decade mobile communications have played an increasingly important role in the telecommunication business, and it will continue to do so in the years to come. In the last years, 3G networks, called Universal Mobile Telecommunications Service (UMTS)

networks in Europe, have started to be deployed throughout the world. In the near future, thanks to 3G, mobile internet-services are expected to be available “anywhere and anytime”. Users will surf the Web, check the email, download files or have real time videoconference, in a shopping mall, the airport, the city center or their homes. Beyond 3G mobile networks (B3G) (Jamalipour, 2005)

will comprise a set of interrelated and rapidly growing wireless networks, applications which will require increasing bandwidth, and users who will demand high quality of service at low cost, all within a limited spectrum allocation. In these networks, the highly complex and heterogeneous Radio Access Network<sup>1</sup> (RAN) will be composed of different technologies, such as GSM, UMTS and WLAN.

Until now, most operational tasks have been manually performed, requiring dedicated staff, with subsequent, inflexibility and delay of response. However, network operators are currently showing a growing level of interest in automating most network management activities. This has stimulated intense research activities in the field of self-managing networks (Pras, 2007; Kephart, 2003; Strassner, 2004). In this context, the self-managing property refers to the capability of the network to self-configure, self-protect, self-heal and self-optimize. All these issues have been the main driver behind recent studies dealing with automation and optimization of cellular networks (Halonen, 2003; Johnson, 2004; Lempiäinen, 2001; Laiho, 2002a).

In a mature cellular network that has undergone most of its site roll-out, the major cost is associated to the operation of the network. As the network consists of a high number of pieces of equipment that are distributed across the entire country, maintaining and operating this large and technically complicated system is a difficult task that requires operator personnel around the clock in several regional offices. For example, a GSM network in a typical European country may consist of about 10.000 sites. Due to the large size of the networks, it is common that some of the deployed pieces of equipment do not work as planned. The consequence of such problem is poor end-user service. As in most countries several operators are competing for subscribers, it is imperative to rectify such occurrences because otherwise users will be dissatisfied with the service and thus will likely switch to competing network

operators. Hence, fault management, also called troubleshooting (TS), is a key aspect of operating a cellular system in a competitive environment. As the RAN of cellular systems is by far the biggest part of the network, most of the TS activities are focused on this area.

TS comprises the isolation of faulty cells (*fault detection*), the identification of malfunctions (*diagnosis*) and the proposal and deployment of healing actions (*solution deployment / fault recovery*). Currently, in most cellular networks, TS is a manual process, accomplished by RAN experts. These engineers are applying a series of customized checking routines on a daily basis in order to identify the cause of the problem. During the procedure, several applications and databases have to be queried to analyze performance indicators, cell configurations and alarms. The speed in identifying faults depends on the level of expertise of the troubleshooter, the type of information available and the quality of the tools displaying relevant pieces of information. This means that, in addition to a good understanding of the possible causes of the problems, a very good understanding of the tools available to access the sources of information is also required.

In this scenario, the benefits of automating TS are numerous. With the help of an automated TS tool, the time required to identify the reason for a fault causing a problem is greatly reduced. This means that network performance is enhanced as the downtime and the time with reduced quality of service (QoS) are significantly limited. In addition, by automating the TS process, fewer personnel and, thus, fewer operational costs are necessary to maintain a network of a given size. The TS process is de-skilled as the majority of problems can be rectified with the help of the automated TS tool. Then, the knowledge of highly experienced staff, which is released from the TS work, can be utilized for other aspects of network optimization, thereby further increasing network performance. One additional benefit is that the knowledge in TS can be stored in the TS tool, therefore not being

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