Chapter XXXIII
Cellular Network Planning:
Evolution from 2G to 4G

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ABSTRACT

The cellular industry is evolving at a very fast pace. In fact, cellular networks have experienced significant changes over the last few years. In order to keep up with this constant evolution, planning tools must also adapt in order to reflect the particularities and architecture of each generation. In this chapter, we will first present the characteristics and the architecture of the four main generations of cellular networks (1G, 2G, 3G and 4G). We will then expose different planning problems related to each generation followed by a short description of different solutions that have been proposed in the literature.

INTRODUCTION

The cellular industry is a very competitive market in which every service provider wants to maximize their net revenue. A clever way to maximize revenue is to carefully plan the network infrastructure. Due to the extreme complexity of this task, good planning tools are necessary. These tools helped and will continue to guide the network planners in their decision-making process.

The cellular industry is evolving at a very fast pace. In fact, cellular networks have experienced significant changes over the last few years. We saw the first generation (1G) of cellular network in the early 80s followed by a second generation (2G) in the early 90s. A few years later, a third generation (3G) was launched. To date, researchers are already focusing on a fourth generation (4G). In order to keep up with this constant evolution, planning tools must also adapt themselves in order

to reflect the particularities and architecture of each generation.

The objective of this chapter is threefold: to present the architecture of each generation of cellular networks; to expose different planning problems related to each generation and finally, to briefly describe different solutions that have been proposed in the literature.

FIRST GENERATION CELLULAR NETWORKS

The first generation of cellular networks appeared in the early 80's. This generation was analog and only used for voice communications. The transmission speed was very limited and the size of the devices was huge compared to what we have today. The following are the main 1G standards.

- Advance Mobile Phone System (AMPS)
- Total Access Communication System (TACS)
- Nordic Mobile Telephone (NMT)

It is important to note that these three standards were not compatible with each other. In fact, mobile users were not able to roam between two different networks thus providing a very limited mobility. A few years later, a second generation was born. That's really with the advent of this generation that the interest started to appear for cellular networks.

SECOND GENERATION CELLULAR NETWORKS

The advent of 2G networks was a huge milestone since they were digital and capable of carrying voice and data traffic at a maximum speed of 9.6 kbps. Several 2G standards were developed.

- Global System for Mobile Communications (GSM)
- Interim Standard-95 (IS-95)
- Interim Standard-136 (IS-136)

However, the GSM standard was, and still is, the most popular system worldwide. As we can see in Figure 1, GSM networks are composed of two main parts: a Base Station Subsystem (BSS) and a Network Switching Subsystem (NSS). On one side, the BSS is composed of Base Transceiver Stations (BTS) and Base Station Controllers (BSC). The BTS are used to transmit/receive information to/from the mobile users via the air interface. The BSC are mainly used to manage

Figure 1. 2G network architecture