Evolution of GSM Network Technology

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INTRODUCTION

The explosive growth of Global System for Mobile (GSM) Communication services over the last two decades has changed mobile communications from a niche market to a fundamental constituent of the global telecommunication markets. GSM is a digital wireless technology standard based on the notion that users want to communicate wirelessly without limitations created by network or national borders. In a short period of time, GSM has become a global phenomenon. The explanation for its success is the cooperation and coordination of technical and operational evolution that has created a virtuous circle of growth built on three principles: interoperability based on open platforms, roaming, and economies of scale (GSM Association, 2004a). GSM standards are now adopted by more than 200 countries and territories. It has become the main global standard for mobile communications; 80% of all new mobile customers are on GSM networks. GSM has motivated wireless adoption to the extent that mobile phones now globally outnumber fixed-line telephones. In February 2004, more than 1 billion people, almost one in six of the world's population, were using GSM mobile phones.

Some developed European nations such as the United Kingdom, Norway, Finland, and Spain have penetration levels of between 80 to 90% with other European nations not far behind. However, there are some countries such as Hong Kong and Italy that have a 100% penetration level. The importance of the mobile telecommunication industry is now apparent: A recent study commissioned by a UK mobile operator establishes that the United Kingdom's mobile-phone sector now contributes as much to the UK gross domestic product as the total oil- and gas-extraction industry (MMO2, 2004).

Technical developments, competition, and deregulation have contributed to a strong growth in the adoption of mobile phones in the third world. In Africa, recent research has shown that mobile telephony has been extremely important in providing an African telecommunications infrastructure. The number of mobile phone users on the African continent has increased by over 1,000% between 1998 and 2003 to reach a total of 51.8 million. Mobile-user numbers have exceeded those of fixed line, which stood at 25.1 million at the end of 2003. The factors for success in this region include demand, sector reform, the licensing of new competition, and the emergence of important strategic investors (ITU, 2004). Another region experiencing rapid growth is India; it is one of the fastest growing markets, with its subscriber base doubling in 2003. It is anticipated that India will have 100 million GSM subscribers by 2007 and 2008 compared to 26 million subscribers as of March 2004 (3G Portal, 2004). Most Latin American operators have chosen GSM over the North American code-division multiple-access (CDMA) standards, and GSM growth in North America is higher than CDMA.

This article describes the evolution of the telecommunication networks from the first-generation networks of the '80s to the revolutionary fourth-generation networks.

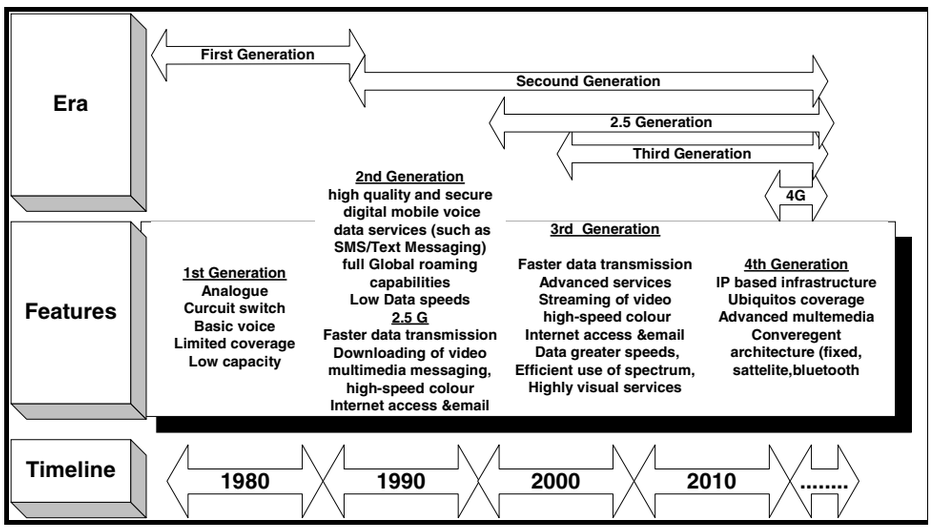
FOCUS: EVOLUTION OF GSM NETWORKS

Mobile communications can be divided into three distinct eras identified by an increase in functionality and bandwidth, as illustrated in Figure 1. These eras relate to the implementation of technological advancements in the field. The industry is currently on the verge of implementing the third technological era and at the beginning of defining the next step for the fourth era.

First-Generation Networks

The first-generation (1G) cellular systems were the simplest communication networks deployed in the 1980s. The first-generation networks were based on

Figure 1. Mobile telecommunication eras



analogue-frequency-modulation transmission technology. Challenges faced by the operators included inconsistency, frequent loss of signals, and low bandwidth. The 1G network was also expensive to run due to a limited customer base.

Second-Generation Networks

The second-generation (2G) cellular systems were the first to apply digital transmission technologies for voice and data communication. The data transfer rate was in the region of 10s of Kbps. Other examples of technologies in 2G systems include frequency-division multiple access (FDMA), time-division multiple access (TDMA), and code-division multiple access.

The second-generation networks deliver high-quality and secure mobile voice, and basic data services such as fax and text messaging along with full roaming capabilities across the world.

To address the poor data transmission rates of the 2G network, developments were made to upgrade 2G networks without replacing the networks. These technological enhancements were called 2.5G technologies and include networks such as General Packet Radio Service (GPRS). GPRS-enabled networks deliver features such as always-on, higher capacity, Internet-based content and packet-based data services enabling services such as colour Internet browsing, e-mail on the move, visual communications, multimedia messages, and location-based services. Another complementary 2.5G service is Enhanced Data Rates for GSM Evolution (EDGE). This network upgrade offers similar capabilities as those of the GPRS network. Another 2.5G network enhancement of data services is high-speed circuit-switched data (HSCSD). This allows access to nonvoice services 3 times faster than conventional networks, which means subscribers are able to send and receive data from their portable computers at speeds of up to 28.8 Kbps; this is currently being upgraded in many networks to 43.2 Kbps. The HSCSD solution enables higher rates by using multiple channels, allowing subscribers to enjoy faster rates for their Internet, e-mail, calendar, and file-transfer services. HSCSD is now available to more than 100 million customers across 27 countries around the world in Europe, Asia Pacific, South Africa, and Israel (GSM, 2002)

Current Trend: Third-Generation Networks

The most promising period is the advent of third-generation (3G) networks. These networks are also referred to as the universal mobile telecommunications systems (UMTSs). The global standardization effort undertaken by the ITU is called IMT-2000. The aim of the group was to evolve today's circuit-