STRATEGY WHITE PAPER

Wireless Networks in Turkey: A Jewel in the Crowd

In a pervasive wireless world, the ultimate goal is to serve customers with advanced mobile services along with high QoS (Quality of Service). New services enabled by new technologies must be introduced while ensuring the seamless service continuity to end – users. All these aspects are in an unbalanced fashion in emerging countries compared to industrialized ones. This is basically due to the partial deployment of their networks and low spending power of the population. Specific approaches are required for application of new technologies in those countries. In this article, we have considered Turkey having 70 million inhabitants as an example country and we have given all the vital wireless telecommunication figures and discussed her future perspectives. It seems that with a high growth rate in GSM usage and a young population eager to adopt new technologies, Turkey will soon lead Europe in the penetration of Mobile Services.

ALCATEL

C. Evci, K. Ciliz, E. Anarim, B. Sankur

WIRELESS NETWORKS IN TURKEY: A JEWEL IN THE CROWD

The mobile telecom market in Turkey, with her 70 million inhabitants, is growing fast. Soon Turkey will lead Europe in the penetration of mobile services as the youthful population takes on board new technologies and services.

Introduction

The wireless telecommunication industry is growing exponentially, and as a result today the world's 1.5 billion mobile cellular subscribers outnumber fixed telephone lines by 11%. Several European countries already enjoy mobile penetration rates of over 90%, while the less developed countries are exploiting the opportunity afforded by mobile technology to boost their lagging telecommunication infrastructures. Many analysts forecast that by early 2006 there will be over two billion mobile subscribers worldwide.

Today's wide area cellular networks (2G mobile) – based on the Global System for Mobile communication (GSM), Code Division Multiple Access (CDMA) or Time Division Multiple Access (TDMA), that is, IS-136 – are evolving towards the General Packet Radio Service (GPRS), then Enhanced Data rates for GSM Evolution (EDGE) and finally to the third generation International Mobile Telecommunications system (IMT-2000) and the Universal Mobile Telecommunications System (UMTS), which is the European implementation of IMT-2000 that exploits Wideband CDMA (WCDMA) technology. These systems provide wide area outdoor and indoor coverage with projected Third Generation (3G) rates of up to 2 Mbit/s. In addition, a variety of wireless transmission technologies are being deployed, including Digital Audio Broadcast (DAB) and Digital Video Broadcast (DVB) for wide area broadcast, as well as Local Multipoint Distribution Systems (LMDS) and Multichannel Multipoint Distribution Systems (MMDS) for fixed wireless access.

In this complex, rapidly changing environment, system deployment requires different strategies and follows different technological patterns between the industrialized countries and the emerging countries. Planning and setting up mobile technologies in emerging countries raise major challenges. Often the networks in these countries are not fully developed and access networks do not cover the whole population for telecommunication services. In such cases, the need to import the capital goods to build the required telecommunication infrastructure makes services expensive. This is why solutions that meet the specific needs of emerging countries are considered here. Mobile services can easily leapfrog fixed-line services in such countries. In that respect, the Republic of Turkey, with her 70 million inhabitants and a dynamic mobile market perspective, is taken as a case study for emerging countries or a Group B[1] country [1]. This article summarizes the status and expected near-term developments in the mobile telecommunication industry in Turkey, a country which is knocking at the door of the European Union.

Alcatel in Turkey

Alcatel is the major telecommunications equipment and solutions provider in Turkey, supplying turnkey leading-edge technologies and retaining its leading position in networking and optic solutions as well as space systems. During the period of transition into the information age, Alcatel is making use of its experience in worldwide Research and Innovation in Internet technologies and solutions to build Turk Telekom's TTnet, the national Internet infrastructure network. In addition, Alcatel has significant investments in the national GSM/GPRS mobile infrastructure of TT&TIM (Telecom Italia Mobile), a GSM1800 operator in Turkey.

Turk Telekom is the key account for Alcatel. Other major accounts include TT&TIM, Telsim and Bota[§]. Alcatel in Turkey is also a hub for its activities in the Turkish Republic of Northern Cyprus, India, Azerbaijan and Iran.

Experience and Current Status in the Turkish Mobile Market

Turkey is an upper middle-income economy with a per capita Gross Domestic Product (GDP) of about US$ 3,383 in early 2004. The country's economy has grown rapidly over the past two decades at an average rate of 6 to 7%.

[1] Group B countries are middle income (mainly upper middle) countries with a high or middle Human Development Index (HDI) and a present telecommunication penetration (fixed and mobile) of over 36% like new and future European Union members.

The country's telecommunication history is over a century old. She was one of the founding members of the predecessor organization of the International Telecommunications Union (ITU) in 1865. A telegraph line was installed in 1847 and the first automatic telephone exchange in the Balkans was installed in Ankara in 1926 [2]. Türk Telekomünikasyon Aş (Turkish Telecom) took over the telecommunication operations of the General Directorate of Post, Telegraph and Telephone (PTT) at the end of 1993. In April 2000, the Telecommunications Amendment Law (No 4502) facilitated the establishment of the Telecommunications Authority (TA) as well as a Communications High Council.

The TA, which operates as an autonomous body, is Turkey's telecommunications regulatory body. It reports to the Ministry of Transport, which grants licenses, drafts policy and authorizes activity on the recommendations of the TA. The regulatory path is shown in *Figure 1*. As of 1st January 2004, the market has been officially liberalized. However, no voice licenses have yet been awarded by the TA, although some are expected to be issued before the end of the year.

Privatization of Turkish Telecom (TT) has been on the government's agenda since 1993. In recent years, two tenders to privatize TT failed to attract any interest from international operators and investors. Since then the company has been undergoing restructuring in preparation for sale. All legal obstacles have been lifted by constitutional amendments and new legislation introduced in 2001. Accordingly, 100% of the company's shares may now be sold, with the exception of a "golden share" retained by the state which provides veto rights to protect the national interest.

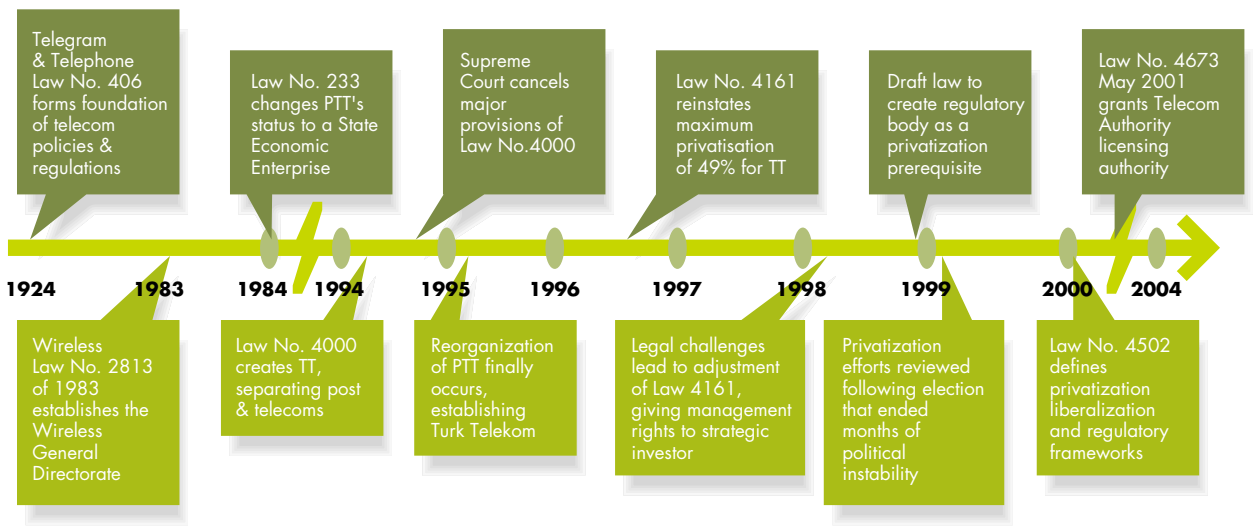
Mobile networks in Turkey

There is little competition in the telecommunication sector, with the exception of mobile telephony. Over the past decade, Turkey's mobile market has grown rapidly. The first wireless operation in Turkey was an analog Nordic Mobile Telephone (NMT) network, which was launched by Türk Telekom in 1986. In 1994, two digital GSM operators, Turkcell and Telsim, launched GSM900 services in a revenue-sharing arrangement with Türk Telekom. In April 1998, this was converted into a 25 year license, with each company paying US$ 500 million. Each company has invested in excess of US$ 3 billion in the infrastructure, and currently has approximately 90% coverage of the urban areas in Turkey [3].

The mobile market was further opened up in 2001 when two new GSM1800 operators introduced services. İş-TIM (brand name Aria), owned by Telecom Italia Mobile and Türkiye İş Bankasi, a large Turkish bank, paid US$ 2 525 million for its license in a tender which had five bidders. Services were launched in March 2001. Aycell, a subsidiary of Turkish Telecom, was granted the second license for the GSM1800 band; it started operations as the fourth GSM operator in December 2001.

Basically, because of a failure to negotiate national roaming agreements with Turkcell and Telsim, neither Aria nor Aycell has been able to attract the anticipated number of subscribers since launching their operations. In mid-2003, pushed by the Turkish and Italian Governments, Aria and Aycell merged to minimize costs and increase revenues, and to obtain access rights for national roaming. Finally, TT&TIM was officially founded on 19th February 2004 with TIM and Turk Telekom each owning a 40% stake in the merger, while Türkiye İş Bankasi holds 20%. The Aria and Aycell brands have been retained under the

Fig. 1 Turkish Telecommunications Regulatory Path



umbrella of TT&TIM. At the end of 2002, there were around 23.32 million GSM subscribers in Turkey, compared with 18.91 million Public Switched Telephone Network (PSTN) subscribers. Fixed and mobile subscriber penetration rates are shown in *Figure 2*.

Fig. 2 Fixed line and mobile user penetration rates in Turkey [4]

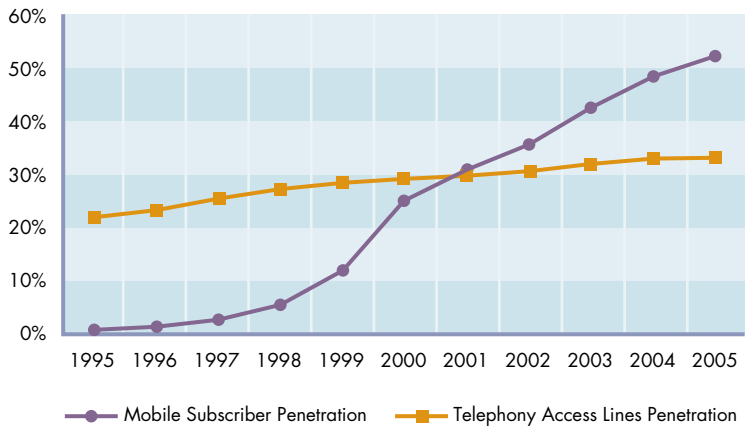
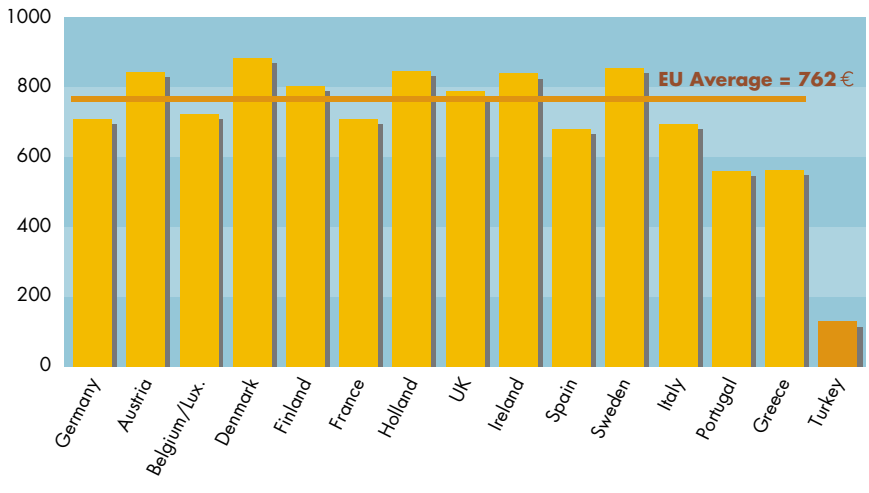


Fig. 3 Per capita telecom expenditure in Europe and Turkey (2000)



Trends, services and market size

The monopoly in fixed-line services has hindered diversification of the Turkish telecom market. However, GSM services, which were originally launched in 1994, have had an enormous impact on growth over the past decade. In particular, substantial investments by Turkcell and Telsim have been instrumental in achieving impressive growth rates between 1995 and 2002. Average growth turned to negative as the result of a general downturn in the world telecom market and a serious financial crisis that hit the country in 2001. Consequently, planned investments were postponed until the second half of 2003 and 2004.

Following market deregulation in January 2004, it is anticipated that several companies will enter the market for telecom services as alternative operators. Various groups and individual companies have already announced their intentions to offer such services. Industry analysts agree that the telecommunication sector is ready for the next expansion cycle. As seen in most European countries, the overall market is expected to grow after liberalization. *Figure 3* shows the per capita telecom expenditure in several European countries and in Turkey. Note that Turkey's per capita expenditure of 134 € is very low compared with the European average of 762 €. As explained earlier, this shows that there is serious room for growth both in mobile and fixed-line services. The increasing use of telecom services by both corporate users and the large, generally young, Turkish population is seen as a major force behind future growth. The average age of the population is about 27; the proportion of the population in the 0-14 age group is 28%, compared with only 16% in Western Europe.

As opposed to the slow growth in fixed-line services, the mobile sector in Turkey has grown dramatically in the past decade. Similar patterns have been observed in developing countries with monopolistic telecommunication administrations. This rapid growth also reflects the country's appetite for accepting and adopting new technologies. Current and projected mobile subscriber growth and the percentages compared with overall users are shown in *Table 1*. Note that within two years, the subscriber base is expected

to reach 40 million, which corresponds to a penetration rate of approximately 57%. However, also note that the increase in the subscriber base is mainly due to *prepaid* services as opposed to *postpaid* mobile services. The low penetration rates compared with rates in Western Europe (Finland, for example) indicate that the market has not yet reached its saturation point.

Table 2 shows the subscriber numbers for the four GSM operators in Turkey with their percentages of market share over the past four years. Turkcell, being one of the first operators in the market, enjoys a clear market dominance with 66% [5].

In recent years, mobile operators have launched additional value-added services aimed at a young population receptive to new and emerging technologies. Telsim launched the first GPRS service in 2000, followed by Turkcell which launched its GPRS service in 2001 and a Multimedia Messaging Service (MMS) in 2002. The MMS application combines videotext, graphics and voice within a single message. Turkcell was one of the first mobile operators in Europe to promote MMS technology to its subscribers. In 2001, the company launched one of the world's largest mobile portals, called GPRSLand. This unique service provides Turkcell customers with access to a host of data applications. The objective of the service is to provide customers with faster access to the Internet than does the Wireless Application Protocol (WAP). In 2003, GPRSLand migrated to a new interactive platform 'Shubuo', which offers customer services ranging from sports to news and finance to music.

On the mobile data market, Sonera-Zed started operations in Turkey in 2000 with the intention of offering entertainment services over mobile networks. The operation was not successful and Sonera ceased operating in 2002.

Although the mobile market is expected to continue growing in the coming years, Turkey's economic crisis in 2001 seriously affected the monthly minutes per subscriber. Whereas subscribers had been spending on average more than 100 minutes per month online prior to the economic crisis, that fell dramatically to about 60 minutes per month at the end of 2003. This usage is low compared with the average in other industrialized and emerging countries. Average usage is about 430 minutes in the USA, 350 minutes in Hong Kong, 237 minutes in Israel, 199 minutes in China, 181 minutes in Norway and 105 minutes in Brazil. The low rate of usage is possibly partly due to the high per-minute rates in Turkey because of the surcharges and taxes imposed by the Government. On average, Government surcharges make up about 30% of each mobile phone bill in Turkey.

Currently there is no national roaming agreement between the four GSM operators in Turkey. This was widely debated when Aria launched its services in 2001 and requested national roaming from Turkcell and Telsim. Both declined this request, leading to a dispute in the market. The case is still to be resolved by the Telecommunications Authority.

GSM operators interconnect with each other via Turkish Telecom's fiber infrastructure. The typical interconnect infrastructure between the GSM operators and Turkish Telecom is shown in *Figure 4*. There is not yet a private exchange point for mobile and voice services in the country, similar to a private exchange point (Turkish Internet Exchange; TIX) that was established in 1998 [6]. Potential telecom operators are currently attempting to start an exchange node for voice services. A large number of high capacity fiber links are being used by the GSM operators for their network interconnections, which represents a high cost base in this monopolistic telecom market.

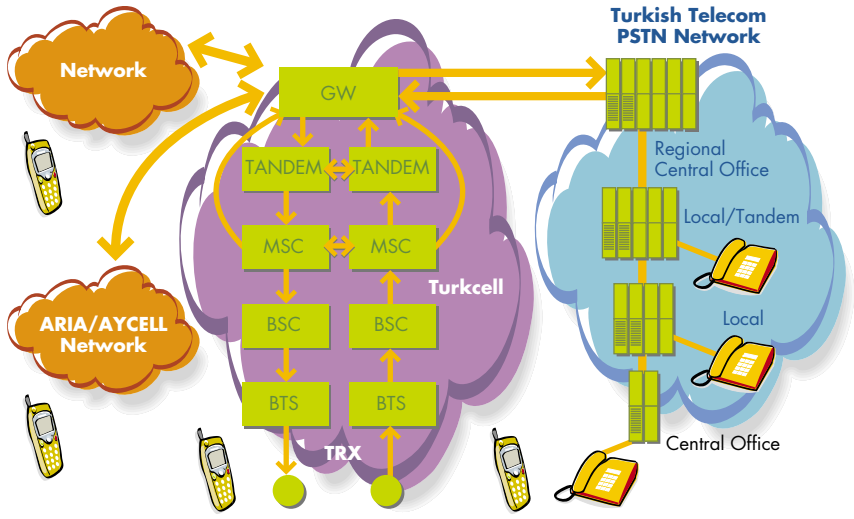
Tab. 1 Breakdown of mobile subscribers in Turkey from 2000 to 2006 [4]

Mobile Users and their %	2000	2001	2002	2003	2004	2005	2006
GSM	14 893 992	16 386 236	23 323 124	29 000 000	31 600 250	36 500 200	40 750 000
Postpaid GSM and %	7 968 996 (53%)	5 847 204 (35%)	6 197 693 (26%)	6 670 900 (23%)	6 851 579 (21%)	7 439 301 (20%)	7 878 773 (19%)
Prepaid GSM and %	6 924 996 (47%)	10 539 032 (65%)	17 125 431 (74%)	22 329 100 (77%)	24 746 664 (79%)	29 469 514 (80%)	32 861 97 (81%)

Tab. 2 Turkish mobile subscribers for each GSM operator in 2000 to 2003

Operators	License Expiry	2000	2001	2002	2003
Turkcell (Market Share)	04/2023	9 210 000 (69%)	12 234 192 (64%)	15 729 080 (67%)	19 000 000 (66%)
Telsim (Market Share)	04/2023	5 683 992 (31%)	3 496 203 (33%)	5 970 749 (25%)	6 500 000 (22%)
Aria (Market Share)	10/2025	–	619 767 (2%)	1 160 691 (5%)	1 800 000 (6%)
Aycell (Market Share)	01/2026	–	36 074 (1%)	462 604 (2%)	1 700 000 (6%)
Total Users		**14 893 992**	**16 386 236**	**23 323 124**	**29 000 000**

Fig. 4 Interconnections between Turkish Telecom and GSM operators



BSC: Base Station Controller
BTS: Base Transceiver Station
GW: GateWay
MSC: Mobile Services Switching Center
TRX: Transceiver

GSM infrastructure in Turkey

Recent market figures (1st quarter 2004) clearly indicated that somebody, somewhere in the world became the one billionth GSM subscriber. Today there are more than one billion GSM users (share base is 75%) compared with 202 million CDMA users (share base is 14.5%). These figures prove that the European GSM is the dominant mobile technology worldwide, including Turkey.

GSM originally used two 25 MHz cellular bands set aside for all member countries, but today it is used globally in many bands. Turkey uses the GSM frequency bands specified by the European Telecommunications Standards Institute (ETSI); nowadays, ETSI recommendations on the subject are being handled by the Third Generation Partnership Project (3GPP). The lowest frequencies permit propagation over longer distances and provide deeper penetration. Consequently, it is much less expensive to meet the coverage requirement using GSM900 than using GSM1800. Real competition between the incumbents and newcomers requires the availability of the GSM900 bandwidth.

The GPRS system deployed by all four operators in Turkey complies with the ETSI GSM standard for GPRS. The GPRS system is integrated with the GSM circuit-switched architecture. However, GPRS provides packet mode transfer for applications that frequently transmit small volumes of data (e.g. typical web request). Compared with existing data transfer services, GPRS should use the existing network resources more efficiently for packet mode applications, and should provide a selection of Quality of Service (QoS) parameters for the service requesters. Network providers could support this model by charging according to the volume of data and not on the basis of connection time, as is done today for traditional GSM data services and for high speed circuit-switched data. By introducing GPRS into the GSM system, it is possible to coordinate, attach, authenticate and handle subscriber and terminal data for both circuit-switched and packet-switched communications. The packet data function does not interfere with the circuit-switched GSM services. GPRS, in common with other packet data systems, is characterized by the fact that a radio channel is shared between several mobile stations. No radio channels are allocated to the mobile stations. When a mobile station generates a data packet, the network forwards this to its addressee on the first available radio channel. One mobile station can use up to eight radio timeslots simultaneously. In Turkey, current GPRS services utilize a maximum of four channels, delivering a throughput of 56.7 kbit/s.

The GPRS system in Turkey operates on the same radio frequencies as the circuit-switched part of a GSM system. In the 900 MHz band, the GPRS system also operates on the frequencies added for extended GSM (E-GSM). GPRS then operates over the whole E-GSM frequency band (i.e. the original P sub-band and the extended G1 sub-band).

New Services and Opportunities

Deregulation of the Turkish telecommunication market in early 2004 will bring new challenges and opportunities to existing and new players. With a 2.5G mobile infrastructure offering value-added services like GPRS, GSM operators should hopefully be ready for the deployment of 3G services.

WiFi is another broadband wireless technology that is taking a foothold in Turkey. This technology, which does not require a license, already enjoys wide penetration rates in some Asian and European countries. According to Forrester Research, the number of European WiFi users will reach some 20.6 million in 2006. There are pilot applications in Turkey for implementing hot-spots in urban areas; there has been some demand for these, primarily from corporate users [7].

GSM operators currently lease fiber from Turkish Telecom for interconnecting their regional networks and for interconnecting with other operators. In the current monopolistic market, leasing fiber is more expensive than in more mature, competitive markets. Thus Turkish GSM operators suffer from a significant cost disadvantage. After the deregulation of telecom services, the price of fiber is expected to drop, and will be directly reflected in the cost structure of the GSM operators.

One other opportunity for GSM operators in the new deregulated environment is international long distance services. *Table 3* shows the incoming and outgoing minutes to Turkey via the Turkish Telecom network between 1997 and 2000. Note that there is quite an imbalance between incoming and outgoing traffic. This is typical of emerging/developing countries in which wireless solutions are more widely used (penetration rate of 42% compared with about 30% for fixed-line services [4]) and *prepaid* is more important. Consequently, incoming traffic significantly outweighs outgoing traffic because of the high pricing strategy of Turkish Telecom in a monopolistic market. Following deregulation, new telecom operators and GSM operators will have the opportunity to interconnect with global telecom operators for comparable termination rates, giving them the potential to offer more competitive rates for international calls.

Tab. 3 Incoming and outgoing international traffic to Turkey [4]

Millions of Minutes	1997	1998	1999	2000
Total	843.3	973	1122.6	1190
Growth (%)	11.5	15.3	15.4	6

Incoming international call traffic by origin

Millions of Minutes	1997	1998	1999	2000
Total	557.5	644.10	698.40	739.60
Growth (%)	17.8	15.5	8.4	6

Outgoing international call traffic by origin

Perspectives for 3G in Turkey

In parallel with GSM expansion, the deployment of new 3G/UMTS technology is already underway in many European countries. 3G promises to connect users anytime, anywhere and provide them with the same experience as a fixed broadband user receives.

Although the 3G killer applications, such as mobile Internet, rich voice, multimedia messaging services, and location-based services, will drive the technology forward, in some emerging countries voice will continue to be the killer application, as can be seen from the prepaid subscriber (sometimes called the low-end market) figures in *Table 1*. In Turkey, this figure was 77% in 2003, and is expected to reach 81% in 2006. Another example is China where 92% of new subscribers use the prepaid service. Consequently, local manufacturers are developing a 3G low-end voice only (+Short Message Service; SMS) terminal.

Based on the frequency allocations made at the WRCs in 1992, 1995 and 1997, many administrations took the actions needed to make these bands available by 2002. By the end of 2003, almost 130 licenses had been awarded to operators worldwide for the use of the IMT2000/3G spectrum to offer 3G mobile services. As of December 2003, in Europe there were about 700 000 UMTS subscribers using WCDMA technology. In Japan, 3G/FOMA (Freedom Of Mobile - Multimedia Access) – also based on WCDMA – was serving 3 million subscribers in March 2004.

With their 2.5G mobile infrastructures, GSM operators in Turkey must prepare for the deployment of 3G services, despite the fact that the Telecommunications Authority does not yet have a concrete plan for licensing 3G. Although licenses are expected to be granted in the 2005-2006 timeframe, we still do not know what type of licensing process will be used. However, a new National UMTS Co-ordination Committee (UMTS Task Force), consisting of telecom players, was created in 2002 to prepare Turkey's mobile market for the introduction of 3G. This committee believes that the fourth quarter of 2004 or the first quarter of 2005 is a very optimistic starting date for the 3G licensing process in Turkey, and might not be feasible. We hope this will not prevent Turkey from catching up with future technologies in time.

Conclusion

This article has highlighted the recurrent patterns of mobile network situations in emerging countries like Turkey, which almost always culminate with mobile networks having more subscribers than fixed networks. Turkey has been selected as a test case because of the sizeable potential market, dynamic economy, high GSM usage growth rates and a versatile young population that likes to adopt new technologies. Moreover, Turkey is also at a turning point with the restructuring and liberalization of her telecommunication sector, along with concomitant reforms required for full membership of the European Union.

Finally, it should be emphasized that because of the different requirements of network deployment in emerging countries like Turkey, Alcatel (one of the main actors in the game of 2G, 3G and its applications, and a recognized global solution supplier) can provide its considerable know-how to these countries.

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References

[1] "Services and Market Aspects of future evolution of IMT2000", *France Telecom, Doc. no. 8F/28,* 11th ITU-R WP8F meeting, Edinburgh, Scotland, October 2003.

[2] M. Minges: "Turkey ICT Profile", *ITU White Paper*, March 2002.

[3] "Communication Market in Turkey", *UK Trade and Investment Report*, London, 2003.

[4] "Turkish Telecommunications Market Analysis", *IDC Report*, Istanbul, 2003.

[5] "Global Wireless Matrix", 3Q2003, *Merrill Lynch Report*, December 2003.

[6] K. Ciliz: "Turkish Internet Exchange (TIX)", *White Paper by Comnet*, Istanbul, 2001.

[7] A. Reinhart: "Why 3G May Still Come up Short", *Business Week*, 22nd March 2004.

Cengiz Evci is the Chief Frequency Officer in the Mobile Radio Division (MRD) within the Alcatel Mobile Communications Group (MCG) in Vélizy, France. He is also a Board Director of 3G3P International Patent Ltd. Company. Since 2001, he has been a Regular Member of the Alcatel Technical Academy. (cengiz.evci@alcatel.fr)

Kemal Ciliz is an Associate Professor in the Electrical and Electronics Engineering Department of the Bogazici University in Istanbul, Turkey. He has also been a consultant in the IT and telecommunication sectors in Turkey. (ciliz@boun.edu.tr)

Emin Anarim is a Professor in the Electrical and Electronics Engineering Department of the Bogazici University in Istanbul, Turkey. He has frequently acted as a consultant for various telecommunication companies in Turkey. (anarim@boun.edu.tr)

Bulent Sankur is a Professor in the Electrical and Electronics Engineering Department of the Bogazici University in Istanbul, Turkey, where he has been active in establishing laboratories, and guiding research in digital signal processing, image, video compression and multimedia systems. (sankur@boun.edu.tr)

Abbreviations

2G Second Generation
3G Third Generation
3GPP Third Generation Partnership Project
BSC Base Station Controller
BTS Base Transceiver Station
CDMA Code Division Multiple Access
CO Central Office
DAB Digital Audio Broadcast
DVB Digital Video Broadcast
EDGE Enhanced Data rates for GSM Evolution
ETSI European Telecommunications Standards Institute
FOMA Freedom Of Mobile - Multimedia Access
GDP Gross Domestic Product
GPRS General Packet Radio Service
GSM Global System for Mobile Communications
GW GateWay
HSCSD High Speed Circuit Switched Data
IMT2000 International Mobile Telecommunications
ITU International Telecom Union
LMDS Local Multipoint Distribution Systems
MMDS Multichannel Multipoint Distribution Systems
MMS Multimedia Messaging Service
MSC Mobile Services Switching Center
NMT Nordic Mobile Telephone
PSTN Public Switched Telephone Network
QoS Quality of Service
SMS Short Message Service
TA Turkish Telecommunication Authority
TDD Time Division Duplex
TDMA Time Division Multiple Access
TT Turkish Telecom
UMTS Universal Mobile Telecommunication System
WAP Wireless Access Protocol
WARC World Administrative Radio Conference
WiFi Wireless Fidelity
WLAN Wireless Local Area Network
WRC World Radio Conference

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