SLAVKO ŠARIĆ, D.Sc.
DRAGAN PERAKOVIĆ, B.Eng.
draganp@fpz.hr
ZVONKO KAVRAN, B.Eng.
kavranz@fpz.hr
Fakultet prometnih znanosti
Zagreb, Vukelićeva 4

Traffic Infrastructure
Review
U. D. C.: 654.164
Accepted: Dec. 1, 1999
Approved: Jan. 8, 2001

ANALYSIS OF MOBILE TELEPHONY DEVELOPMENT IN CROATIA

ABSTRACT

Mobile telephony appeared in 1955 and its development in the world and in Croatia can be divided into two generations: analogue mobile system and digital mobile systems. Mobile telephony is a part of the telecommunication market experiencing the fastest growth. Already in 1990, the mobile telephones accounted for 4% of the world market in telecommunication services, and their share is increasing daily. Liberalisation of the Croatian market of mobile telephony was a necessity for establishing competition as a necessary prerequisite for providing high-quality services and reducing their prices, and it corresponds to the mobile telephony system development worldwide. At the beginning of the 90s, the Republic of Croatia was lagging behind the telecommunication-developed world, and today she has a modern infrastructure that supports highly sophisticated services by two digital and one analogue mobile telephone network.

KEY WORDS

GSM, NMT, telephony, mobility, prospects

1. INTRODUCTION

Since the discovery of telephone in 1876, all the way to the eighties of this century the main role in the world of telecommunications belonged undoubtedly to the so-called wire telephony, which used metal wires for transmission of audio signals. It provided numerous advantages the most significant of which include: high quality connection regardless of weather conditions and a relatively low cost of devices. Wire telephony is even today the most widespread type of telecommunications. However, it has one big disadvantage, and that is the impossibility of establishing telephone connection by a user in motion. It is the fixed characteristic of telephone communications that cannot be accepted by the modern, dynamic way of living, with a great need for mobility both in private life and even more so by spending a lot of working hours in various vehicles and travelling on business.

Along with the advantages offered, the drawback is the substantially reduced safety in using mobile telephones during car driving. The number of mobile telephones in cars is growing steadily, but unfortunately the same is happening with the number of accidents caused by motorists who have been using mobile telephone while driving.

The development of mobile telephony system can be considered through constant improvement of the network operation quality, increase of the signal covered area and the introduction of new services. Legislative regulations in some countries that forbid using mobile devices while driving have stipulated the development of apparatus which provides "hand-free" mode in order to increase safety.

2. DEVELOPMENT OF MOBILE TELEPHONY SYSTEM IN CROATIA

The discovery of radio-telephony (1915), provided the possibility of wireless telephone connections, but the time had not matured then for a more widespread usage, since such mobile connections required necessarily the adaptation not only of terminals but also of commutation devices. Wireless telephony, i.e. telephony in which audio signal is not transmitted by current through wires, but by radio-waves, developed in two directions.

In one type of wireless telephony meant for shorter ranges, with the so-called "cordless telephones", only the cord connection between the micro-telephone (MT) combination and the plugged-in base telephone unit was replaced by radio-connection. This enabled the user to move at least a little away from the fixed telephone, carrying around only the MT combination.

In the other type of wireless telephony meant for longer ranges, the so-called "mobile", a part of the wire connection between the telephone and the telephone exchange has been replaced, thus enabling the user to be completely mobile.

Mobile telephony appeared in 1955, when the Swedish company "L.M. Ericsson" produced the first radio-telephone. It became more widely used only some thirty years later. Until 1970 experiments were carried out in the frequency range of around 40 MHz, and between 1970 and 1980 around 150 MHz. The first mobile radio-telephone network covering the smallest territory started to operate in Japan covering the area of Tokyo, in 1979.

The development of the mobile telephony system in Croatia can be divided into two generations:

a) analogue mobile system, and
b) digital mobile systems.

2.1. Analogue mobile telephony system

The first generation of mobile telephony system in the world is characterised by analogue systems, intended exclusively for audio communication, single-layer cellular structure, and relatively big user terminals, meant primarily to be installed and used in vehicles. There are three dominant standards of the first generation of these systems: NMT (Nordic Mobile Telephone), AMPS (Advanced Mobile Phone Service) and TACS (Total Access Communication System).

Common characteristic of all standards of the first generation is the frequency modulation of audio signals (FM), and FSK (Frequency Shift Keying) modulation of control signals, whereas they differ regarding operating frequency area, number and width of the channels, duplex spacing, and some other parameters.

The idea of introducing the first generation of mobile telephony system in the Republic of Croatia appeared on the eve of the sports manifestation – "Univerzijada '87" – the Students' Olympic games. In 1985 the construction of a pilot mobile radio network for the needs of "Univerzijada 87" was planned according to the NMT protocol with capacity of 800 connections. Due to financial problems and problems regarding the frequency range around 450 MHz already used by other users, the plan for the pilot network failed.

In October 1990, the public network of analogue mobile telephony, MOBITEL, started to operate experimentally, and in January 1991 continued to operate commercially. It operates according to NTM 450 standard with a somewhat lower frequency range:

- transmitting frequencies of base stations from 411,675 to 415,850 MHz,
- transmitting frequencies of mobile stations from 421,675 to 425,850 MHz.

Figure 1 - Map showing MOBITEL network coverage of Croatia

MOBITEL is primarily a national system of mobile communications providing its users with communication in the Croatian region but also covering the two neighbouring countries – Slovenia and Bosnia and Herzegovina. The constant trend of increase in the number of subscribers to MOBITEL network is the result of qualitative improvements in the network, and good territorial coverage of the country. A significant prerequisite for increasing the number of MOBITEL network subscribers was also the reduction of network subscription prices as well as the fall of very high prices for the mobile telephone units, which depended on the usage of non-standard frequencies, and also by the reduction in size and mass of the devices, which further increased their mobility.

One should not overlook the fact that the prices of conversation in Mobitel network are getting closer to those in fixed telephony, and the policy of reducing prices is continuing. It should be mentioned that the competition on the mobile telephony market did not cause closedown of the analogue system, but on the contrary its further development and increase in the number of subscribers.

Figure 1 shows the map of coverage by MOBITEL network in Croatia, making it clear that the network coverage in Croatia is high (about 95% of the country has been covered).

2.2. Digital mobile telephony systems

The need for higher capacities, i.e. more efficient use of the frequency spectrum, along with other factors such as: possibility of data transfer, the need for information protection, use of small handy subscribers' units, hierarchical cellular structure, global area of operation, etc., have caused both in the world and in Croatia the development of digital systems of the public mobile telephony of the second generation systems. The development of the second generation standard in the world of public mobile telephone systems started in the middle of the eighties, and the first commercial system started to operate in 1992.

There are three leading standards of the second generation: D-AMPS (Digital – Advanced Mobile Phone Service), PDC (Personal Digital Cellular) – at first called JDC (Japan Digital Cellular), and GSM (Global System for Mobile). The development of digital network in Croatia started according to the GSM standard with the network commercially named CRONET.

2.2.1. CRONET

Due to suddenly increased need for the mobile telephony in the Republic of Croatia, during 1994, HPT

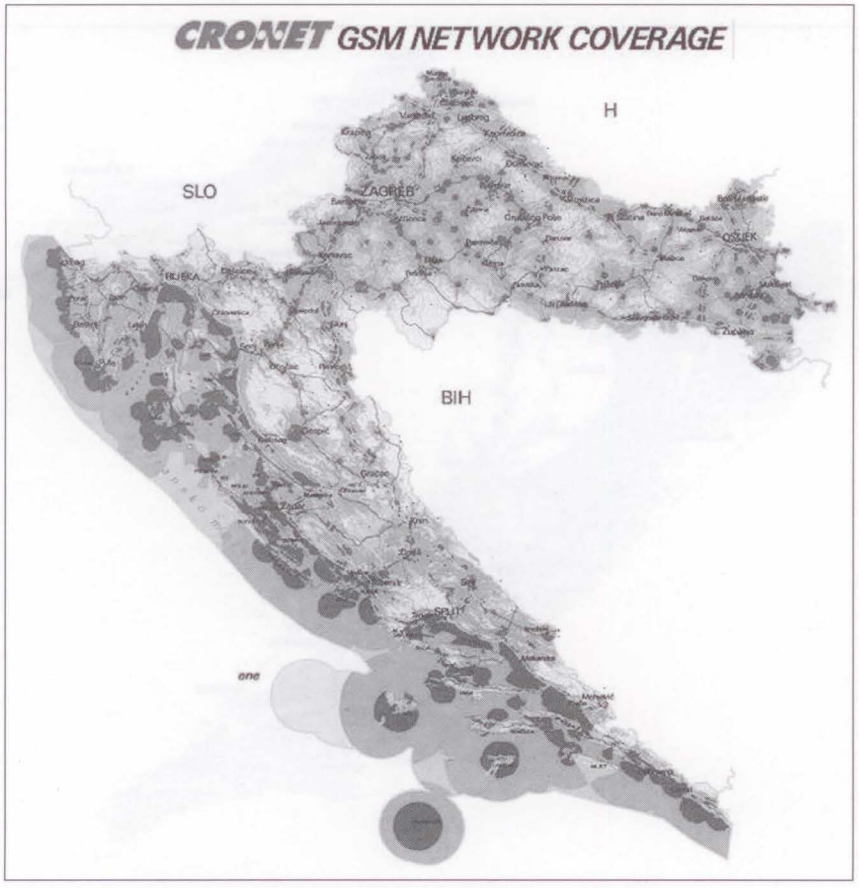

Figure 2 - Map of CRONET network coverage in Croatia

(Croatian Post and Telecommunications) carried out intense preparations to introduce the second generation of mobile telephony system using GSM technology, into the Croatian mobile telecommunication network, and to integrate into the Pan-European digital system of mobile radio-telephony. In August 1995, CRONET, the public network of digital telephony started to operate experimentally, and in March 1996 commercially. It operates according to the GSM standard in the frequency range:

- transmission frequencies of base stations from 935 to 960 MHz, and
- transmission frequencies of mobile stations from 890 to 915 MHz.

The main advantage compared to the old analogue system is the undisturbed communication not only in the country, but also from all the countries with the developed network and agreement on mutual usage i.e. roaming. This difference helped fast expansion of CRONET, naturally with improving territorial coverage, capacities increase, introduction of additional services, reduction of prices and liberalisation of the GSM apparatus market by simplifying the purchase procedure and the individual import of mobile devices.

The competition caused higher investments in better coverage of the network. Thus, for instance, the total capacity of CRONET network in May '99 included about 200,000 users, and today this system is ready to accept and service 400,000 subscribers. In May available for some 50 thousand users in the area of Zagreb and Zagreb County, CRONET has today space for 145,000 subscribers, out of which as many as 110,000 from the very city of Zagreb.

Figure 2 shows the map of CRONET network coverage in Croatia.

2.2.2. VIP Net

Liberalisation of the Croatian market of mobile telephony was a necessity to create competition necessary as a prerequisite for providing higher quality services and reducing their prices. Telecommunication services were regulated also under the conditions when HT (the former HPT) was the only one providing the services. However, regulation was relatively simple and it neglected the economic aspect of the business. Liberalisation of the telecommunication services market, which turns public service into the market business activity with a greater number of participants, requires fundamental change in the way the telecommunication sector was regulated. In the European Union and in other developed countries of the world, there are standards of regulating the telecommunication sector, which need to be implemented in

Figure 3 - Map of the VIPNet GSM network coverage in Croatia

Table 1 - Increase in the number of mobile telephones in Croatia

Year	Analogue system	Digital system		Users - total
	NMT-450	CRONET	VIPNet	
1990	500	0	0	500
1991	2019	0	0	2 019
1992	6320	0	0	6 320
1993	11 239	0	0	11 239
1994	21 664	0	0	21 664
1995	32 984	0*1	0	32 284
1996	50 554	11 421	0	61 975
1997	52 328	68 265	0	120 420
1998	76 978	115 058	0	192 036
1999*2	87 000	126 660	120 000	333 660
Number of countries with contracted roaming partners	Slovenia and Bosnia and Herzegovina	49	56	–

*1 – start of experimental operation
*2 – data for HT from Mobile Communications Internacionale, Issue No. 66, and VIPnet assessment and unofficial data

Croatia as well, taking into account the specific circumstances and needs of the Croatian market.

The logical development of GSM network in Croatia showed the need to grant a concession for another GSM operator in the country. Thus, on June 15, 1998, public tenders were invited for a concession to develop another national GSM network and on September 7, 1998, by the decision of the Telecommunications Council, VIP Net GSM d.o.o. was granted a ten-year concession for development, construction and use of the second national GSM network. Thus VIP Net GSM is regarded as the second GSM operator in the Republic of Croatia. The contract was signed on October 30, 1998.

Immediately after the experimental phase, it started to operate commercially. International know-how experience in planning, construction and exploitation of the mobile telephony system was introduced in the ownership structure of VIP Net and caused a real "boom" by good advertising campaign and by introducing service packages, and an especially good reaction was caused by prepaid services.

CRONET reacted to the challenge by reducing the prices and by preparing for prepaid services which is expected by the end of 1999. However, the introduction of VIP.internet – a new VIP network service allowing VIP.package users (subscribers) an unlimited access to all the Internet contents by VIP mobile telephone, using free E-mail address, forwarding E-mail messages to another E-mail address, possibility of receiving E-mail messages to the user's mobile phone confirm that the real fight for future users is only beginning.

Coverage, and thus also the quality of VIP network will continue to increase, and the plan is that by the middle of the year 2000 it will cover more than 90% of Croatian population or more than 75% of Croatian geographic territory.

Figure 3 shows the map of VIP GSM network coverage in Croatia.

Table 1 shows the increase in the number of mobile telephones in Croatia in the period from 1990 to 1998 and the plan for 1999.

The table shows the great growth rate in the number of subscribers, and according to Mobile Communications Internacionale, Issue No. 66 (which does not record the existence of VIP network due to unofficial data) shows the increase in the number of users of the analogue network by 27.3%, and of the digital by 23.4% over the period from August 31, 1998 to August 1, 1999, with 4.71% of population as mobile telephony users.

3. PROSPECTS OF FURTHER DEVELOPMENT OF MOBILE TELEPHONY IN THE WORLD AND IN CROATIA

Mobile telephony is part of the telecommunication market which has shown the fastest growth. As early as 1990 the mobile telephones formed 4% of the world market of telecommunication services, and their share is growing daily. This growth requires intensive investments in the development of new technological solutions into mobile telephone networks. This led then to

the development of the third generation of mobile telephony systems, whose commercial use will not start in this century, but the work on its definition and standardisation is fully underway. FPLMTS (Future Public Land Mobile Telephone Systems) under the auspices of ITU and UMTS (Universal Mobile Telecommunications Services) was established within ETSI.

Their vision is to take and improve the best characteristics of the fixed and mobile communication systems and to combine them in a unique world mobile communication system which will enable any required communication service. The third generation systems will operate in multi-media environment, substantially different from the today's telecommunication environment, and they will be controlled by various factors (telecommunication, computers, software, TV and video industry, etc.) with strong emphasis on the diversity of applications and services.

Unlike today's environment in which service carriers are the elements of the network infrastructure, the emphasis will probably be on the introduction of services into users' terminals, whereas the network will be primarily used for transmission of program agents between them. A significant difference between the second and third generation systems lies in the fact that the third generation systems have wide area networks, supporting various services of data transmission up to speeds of 2 Mbit/s. This objective will be reached gradually, and the first step is supporting 64 kbit/s ISDN of basic access. The third generation of mobile communication systems will insure quality of speech equal to that in fixed network, it will enable the application of videophones, plan the use of ground and satellite network elements for global coverage, multi-mode terminals, hierarchical structure of cells with several layers, and multi-operative environment.

Legislative regulations regarding application of mobile telephones in cars and the number of traffic accidents caused by the use of mobile telephones while driving, was the reason to study the possibilities of hand-free dialling from the mobile phone, e.g. using only voice. The prospects require high degree of voice dialling recognition, with the application of artificial intelligence system.

Competition in the field of mobile telephony has opened up a new era in the development of Croatian telecommunications, as well as in the development of Croatian economy in general by means of the big sums of money that have to be invested in the network development. On October 14, 1999, VIPnet signed a 120 million EUROs worth project credit (about 915 million Kunas). The credit will be used to build and develop VIP GSM network, and will be funded by the banks with good experiences in telecommunication industry. The credit conditions are extremely favourable for the Croatian market. This is the highest foreign credit granted to a private company in Croatia this year, and proves the profitability of investing in telecommunication infrastructure both in the world and in Croatia.

4. CONCLUSION

Liberalisation of Croatian market of mobile telephony was a necessity for establishing competition, as a necessary prerequisite for providing high quality services and reduction of prices, and it corresponds to the development of the mobile telephony system worldwide. Owing to liberalisation, a good part of the Croatian market was taken over by the VIPNet company through well forced advertising and dynamic introduction of new services. This invited a counter-response by HT with the end profit for the users through higher-quality, more diverse and cheaper services and a wide offer of devices.

The future of mobile telephony lies in the expansion of users' services, further miniaturisation of telephone devices, and constant expansion of coverage. The Internet access through mobile phones is no future any more, but provides every user with a limitless office for doing business, even in Croatia. Sending or receiving E-mail messages, finding out the latest news or simply looking at somebody's web page are the needs of every modern user.

At the beginning of the nineties the Republic of Croatia was lagging far behind of the telecommunication developed world, and today it has a modern infrastructure supporting highly sophisticated services through two digital and one analogue mobile telephone network.

Until today, 327 GSM networks in 133 countries in the world have been established. The number of users of GSM mobile communication systems is expected to grow annually by 80,000,000, and by the end of 2003 it will have 541,000,000 users (estimate by: Udruga InfoCenta GSM – GSM InfoCent Association). The current number of users in the world is estimated at more than 170,000,000.

SAŽETAK

ANALIZA RAZVOJA SUSTAVA MOBILNE TELEFONIJE U RH

Mobilna telefonija pojavila se još 1955.g, a razvoj se u svijetu i RH može podijeliti u 2 generacije: analogni mobilni sustav i digitalni mobilni sustavi. Mobilna telefonija je dio telekomunikacijskog tržišta koji ostvaruje najbrži rast. Mobilni telefoni su već 1990. g. činili 4% svjetskog tržišta telekomunikacijskih usluga, a njihov udio svakog dana raste. Liberalizacija hrvatskog tržišta pokretne telefonije bila je nužnost za stvaranje konkurentskih odnosa, koji su nužni preduvjet za pružanje

kvalitetnijih usluga i snižavanje njihovih cijena, i poklapa se sa razvojem sustava mobilne telefonije širom svijeta. Republika Hrvatska je početkom 90-ih bila na repu telekomunikacijski razvijenog svijeta, dok danas ima suvremenu infrastrukturu koja podržava visokosofisticirane usluge kroz dvije digitalne i jednu analognu mobilnu telefonsku mrežu.

LITERATURE

[1] **M. Mikula, S. Šarić, D. Peraković**: "*The Development of Mobile Telephony in the World and in Croatia*" , Promet - Traffic- Traffico, Vol. 10, No 1-2/98, Trieste, 1998

[2] **M. Mikula, Z. Kavran, D. Peraković**: "*Speech Recognition Using Neural Networks in Cellular Phones*", ISEP "99, Ljubljana, studeni 1999.

[3] **Mallinder B.**: "*An overview of the GSM system*", The third Nordic Seminar on Digital Land Mobile Radio Communications, Copenhagen, September 1998.

[4] **Maloberti A.**: "*Some aspects of GSM radio interface*", The third Nordic Seminar on Digital Land Mobile Radio Communications, Copenhagen, September 1998.

[5] **Pinezić V., Krajnović M.**:"*Mobilna telefonska mreža*", NT revija, 1991. g.

[6] **Mikula M.**: "*Razvoj bežične telefonije u svijetu i u nas*", Bilten znanstvenog savjeta za promet JAZU br. 3/90

[7] **Mikula M.**: "*Planiranje telekomunikacijskih mreža*", Zagreb, FPZ, 1996. g.

[8] **Mikula M.**: "*Razvoj telekomunikacija*", Zagreb, ŠK, 1994. g.

[9] *Mobile Communications Internacionale*, Issue No. 66, November 1999.

[10] Internet addresses:
http://www.itu.int
http://www.tel.hr
http://www.vip.hr