

A Century and a Half of Telecommunications: Which Way Afterwards

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It has been a little over a century and a half since the first electrical system for transmission of written messages - telegraphy - was put into commercial operation. It was launched on 24 May 1844 to cover the distance between the Baltimore railway station and the Parliament buildings in Washington. This date is universally recognized as birthday of electrical telecommunications. The inventor of telegraph, American painter Samuel Morse, reported his invention, the apparatus weighing 90 kilograms, to the Senate seven years earlier, in 1837, and then had received the amount of 30,000 dollars for realization of his project.

The 19th century was an inventive one. As it usually occurred at that time, the invention of telegraph was reported simultaneously in several places worldwide. Cook and Wheatstone offered the system of telegraphy to the British Railways, which was soon accepted to improve security and efficiency of traffic. In Prussia, a young artillery officer Werner Siemens, together with a skillful mechanic, Simon Halske, proposed the use of telegraph to the army in 1847. In 1852, when Louis-Napoleon Bonaparte came to power in France, he supported the installation of telegraph. The telegraph came to Russia in 1853 and to Japan and Australia in 1860.

In this brief survey of telecommunications of the time, we can also find the Principality of Serbia holding a prominent position.

In early September 1854 cavalry colonel A. J. Nenadović, in the name of the Serbian Ministry of Domestic Affairs wrote to the Parliament the following: "So rapid is the growth of both official and private, especially commercial correspondence that the mail service, which operates only twice weekly, is failing to keep up with the needs. As they cannot afford to wait for the postal day, tradesmen send out their own messengers. This exhausts the postal horses and therefore their number at the stations increases daily. However, should we take into consideration the fact that maintenance of postal horses is far more expensive than installation of telegraph lines and that mail is not so fast as telegraph, we can conclude that we should consider building of the telegraph line, as advanced nations have already done."

On 20 September 1854, upon the Council's proposal, The Prince of Serbia, Aleksandar Karađorđević, proclaimed "...that 2,000 talirs should be invested in project preparing and calculation of expenses to cover the installation of telegraph line to the southern town of Aleksinac."

In November 1854, only ten years after the invention of telegraph, digging in of the telegraphy poles began and on 27 March 1855 the line Belgrade - Kragujevac - Aleksinac was put into operation and a cable was laid across the Sava river to connect Serbia with the Austro-Hungarian Royal Telegraph.

On 20 January 1855 the first Telegraphy Act in Serbia was ratified. Its first article read as follows: "He who out of meanness harms the honor of the telegraphy system, like for instance cut or pull down the pole or tear the wires, shall be considered a villain and shall be imprisoned in shackles for one to three years. Should this happen in carelessness, recklessness or mischievousness, the delinquent shall be punished by six-month to one-year imprisonment."

In this early phase of the telegraphy system installation some important details of the telecommunications development could already be envisaged.

In the first place, which is of no wonder, is the fact that the telegraph network faithfully followed the commercial and the political mainstream of the time.

In the second part of the last century there was a tremendous development of traffic. In 1840 there were 770,000 km of laid railway tracks in the whole world. In 1913 this number increased to 1,100,000 km. Main transcontinental routes were built, such as New York - San Francisco in 1869 and Halifax - Vancouver in 1869. Building of the trans-Siberian railway commenced in 1890 and was finished in 1903. Istanbul was connected with Baghdad. This was the time of the Railway Revolution: in early 19th century mail traveled at 100 km a day, in 1900 at 250, and today surface mail travels at 1,200 km a day.

The telegraph gave spirit to the railway traffic, closely following it, ensuring punctuality and security as well as other services accompanying transportation of goods and people.

When the steam-ships, which replaced clippers, were added to the surface railway transportation, American cotton and Australian wool began the arriving at Manchester, the wheat from America and Russia flooded Europe, industrial products reached the Far East - the world market was created. Telegraph supported the market globalization, contributing to its efficiency and enabling the ship-owners and the tradesmen to optimize transportation and to purchase and sell goods, to establish prices and exchange rates.

The telegraph lines followed not only the commercial routes but also the political streams of the time. The Serbian line Belgrade - Kragujevac - Aleksinac went along the Istanbul road. It was not difficult to trace the influence of the Austrian General Consul in Belgrade who made efforts to establish connection between Vienna and the Porte in Istanbul. The British Empire was also interested in linking London to India via the Asia Minor.

Another feature of the telegraphy is that it soon became commercialized. In 1851 there already were 50 operators in the USA. The American Secretary of Mail Department then saw fit to say that "telegraph does not seem to be just a toy". In 1851 a cable was laid across the Channel and in 1858 the first trans-Atlantic cable between Newfoundland and Ireland. 354 English gentlemen had invested 1,000 pounds each and the two countries had subventioned with 14,000 each annually in the course of 25 years with 6% dividend. On 18 August of the same year Queen Victoria cabled to the then American President Buchanan the following: "England and America are united. Glory be to God in Heaven and peace on earth among the people of good will." However, the transmission hardly worked. It took 16 hours to transmit a 96-word cable. The insulation got damaged. 460,000 pounds were gone. But the human spirit and will did not give up. In 1866 a new cable was laid, fresh 700,000 pounds were invested and the profits amounted to 25%.

Massive expansion of telegraphy initiated the industrial production of equipment, which was going to take an important part in the telecommunications business.

Let us at this point mention yet another characteristic of telegraph. The lines crossed the national borders. International consent on tariffs and agreements on connection techniques were required. First contracts of the kind were signed between Prussia and Austria in 1849, then between Prussia and Saxony as well as other German monarchies.

This all led to an international conference convened by Louis-Napoleon Bonaparte, which took place in Paris on 17 May 1865. Twenty countries -

participants in the conference founded Union Internationale Telegrafique and the First Telegraphy Regulation Book was introduced. This conference is also remembered for its two details: France, as the organizer did not invite Great Britain because the British telegraphic companies were privately owned. Secondly, the Principality of Serbia was invited but only as a part of the Turkish delegation. Serbia insisted on being independent but it was denied by Ali Pasha, Turkish minister of foreign affairs. At the Second Conference in Vienna, Serbia was admitted as a full-right member of the Union.

It should also be mentioned in this review that the telegraph was first used for military purposes in the American Civil War (1863-1865).

If we recapitulate what we have tried to describe so far, we shall come to a conclusion that the extension routes of the telegraph, its stimulation of surface and sea traffic development, its promotion of trade and travel, its contribution to the creation of the world market, its support of the political mainstream, the commercialization of the telegraphy by the operators, equipment industry, international cooperation, military applications contributed massively to an overall and progressive impact of telecommunications upon human life, society and economy.

It would take us very far to continue with featuring of transmission of other forms of messages such are speech, music, picture and data of all kinds. Nowadays even small children are acquainted with the notions of telephone, radio, television, optical cable, satellite, electronic mail, radar, navigation, computer networks, informatics, etc. The same goes with the names of Maxwell, Faraday, Hertz, Popov, Lorenz, Bohr, Einstein, Pupin, Tesla or Marconi.

Actually, the telecommunications are fascinating for its effect upon time and space. In 1492 it took six months for Isabelle of Castile to learn that Christopher Columbus discovered the New World. Four hundred years later, in 1865, it took twelve weeks for the British Government to find out that Abraham Lincoln had been assassinated and 1.3 seconds for the world to see that Neil Armstrong had set his foot on the Moon.

Apart from the chronological order of events in its 150-year history usually taught at schools, development of telecommunications may also be viewed as a sequence of three homogenous periods.

The first period began in the middle of 19th century, at the time of colonialism. The market of telecommunications was developing. Britain, which used to be the most powerful colonial empire, soon established a global telecommunications network with the aim to link its colonies to the metropolis. This

was when the reputable company of Cable & Wireless was set up. Other European countries followed this path. In the late 19th century the Danes laid down the first marine cable connecting China and Japan. In fact, the competition began among the Western powers for acquiring licenses to lay and exploit the sea and surface telegraphic lines. The global network was being shaped.

Later the similar happened to the radio. The British company of Marconi ensured many licenses to set up radio stations worldwide and thus the dominant position in exploitation of the radio traffic. The German efforts to share in the world radio market were discouraged by all possible means.

This first era, strongly marked by competition in acquiring rights to set up and exploit telecommunication lines ended up by the end of the Second World War when the colonial imperialism was also brought to an end.

The second period commenced after the Second World War had been finished and it continued until the 80's. It was characterized by creation of numerous international institutions. These were the United Nations, the International Monetary Fund, the World Bank, GATT, UNESCO, FAO, International Telecommunication Union (1947) with its International Frequency Registration Board. Newly founded independent countries of Asia and Africa joined in during the 50's and 60's respectively. This era was distinguished by the principle of equality of all sovereign states. Both China and Malta and the USA and Vatican got radio frequencies through the ITU World Radio Conferences with the equal right to vote. The international telecommunications were based on fifty-fifty partnership. Profits were divided proportionally to investments. This was the era of stable cooperation among state monopolies based on political equality.

The last period has started in mid 80's. It coincided with the revolutionary changes in the telecommunications. USA, Great Britain and Japan initiated the reform of telecommunications based on two main principles: free competition and privatization. Monopoly state operators are being abolished, their two main segments: mail service and telecommunications are being separated, new, privately owned operators are being incorporated. In this strong competition the service prices are falling down, new networks are installed and new services are introduced. In early 90's the members of the European Community initiated deregulation too. Developing countries have taken the same course. Heavily indebted, these countries are selling their telecommunications institutions, like Mexico or Argentina have done.

Competition has also resulted in other effects. For example, the British operator of Mercury does not

charge the subscribers for local calls in the less busy hours. Almost all countries have initiated deregulation in this field.

Should we try and analyze these phenomena in detail, we shall find the answer to the question from the title: which way afterwards?

INDEED, WHICH WAY AFTERWARDS?

One of the basic human needs, besides food, energy and shelter, certainly is the inherent need to communicate. Telecommunications have become a part of almost everyone's life. They have their economical implications as well as enormous impact on the society.

The following is to illustrate the economical importance of the telecommunications: in 1992 total value of the telecommunications market amounted to \$535 billion, the share of services being 78% and that of equipment production 22% (415 and 120 billion respectively). The share per continent was as follows: America 40%, Europe 36%, Asia 20% and the rest of the world 5%. Or, we may also put it like this: OECD countries, which include only 16% of the world population make 85% of the profits. These data fully feature the social aspect of telecommunications.

The year of 1992 is distinguished by deep recession in the world economy. However, telecommunications turned out to be insensitive to recession: compared to 1991, services increased 8% and equipment production 9%. Let us only remember that this was the year of heavy losses for almost all airline companies.

Economical power of telecommunications is best evaluated through its share in the world production: 2.2% of the world gross production is realized within the area of telecommunications.

In 1992, 5,144,000 people were employed in the telecommunications. Financial health of this area is reflected in the fact that over the five-year period (1988-1992) the world income amounted to \$1,800 billion, the profits totaling \$200 billion or 12%. Social aspect of telecommunications is reflected in availability of telephone, facsimile, mobile radio, data bases, television, teletext, etc.

For example, in 1992 the international telephone lines were in average used 7.3 minutes per capita. The statistics in various countries are as follows: Tanzania 0.1 min., Burkina Faso 0.2 min., Turkey 3.4 min., Spain 18.4 min., OECD countries 21.1 min., Austria 81.5 min., Switzerland 209 min. and Luxembourg 423 min.

Actually, there is a firm correlation between the national gross production and the number of

telephone subscribers: increase of \$1,000 gross production matches the increase of 2.4 subscribers per 100 inhabitants. It goes without saying that the proportion is inverse.

In order to find an answer to the question what should be expected from telecommunications in future, technology evolution along with the phenomenon of globalization in general should be viewed.

Technology evolution is at the same time the cause and the consequence of the socio-economical development. New products and new services are being created and the quantity of the old ones increases, so that prices of both production and services are reduced. At the same time, socio-economic development generates the need for permanent technology evolution due to tendency to create new markets and competition. This is a spiral.

It is our opinion that there are six key technologies and as many as that directions of future development in telecommunications. These are: transmission, switching, mobile radio, satellites, electronic messaging and broadband telecommunications.

1) Transmission systems represent the most important resource in telecommunications. The one that owns them does not need to be afraid of competition because investments in them are enormous. There are four prevailing tendencies that will characterize the forthcoming decade.

In the first place, this is the fast-growing application of optics in both public and private networks, between both national and international switching centers and, very soon, locally, on the subscriber's level.

Application of data compression techniques will hold a special position in the transmission systems as it can achieve much better performances in the existent networks. So, twisted copper wire pairs are expected to enable the transmission of 10 Mbit/s or even of the video signal.

A very important place in the field of transmission is held by the mobile radio systems, not only in the sense of user's mobility but as a complement or a substitute of local lines in rural areas.

Finally, these are telecommunications satellites of growing power, which enable usage of smaller and cheaper earth terminals.

2) Three trends are envisaged in the switching systems of the future.

The first is an absolute acceptance and application of digital switching and as fast as possible substitution of electro-mechanical telephone exchanges.

Secondly, there is a demand for fewer number of bigger switching centers of modular type. Logically, such a trend is leading to application of optical switching so that, theoretically, one telephone exchange could be sufficient for one region or a smaller country.

Finally, as much as possible intelligence should be incorporated in the networks (routing of phone calls, identification of callers, phone conferences, etc.).

Basically, a modern switching center is closer to a computer than to an electro-mechanical telephone exchange. From this viewpoint, industry of modern telephone exchanges is determined by the same factors as the ones that shaped the computer industry. They are: designing of microchips and of software. Two companies, Intel and Microsoft, which benefited the most from the technological evolution of the personal computer market, have now turned to the telecommunications market. Both companies have jointed with the telecommunications industries in order to develop the application program interfaces. Penetration of software and microchip companies into the telephony market will certainly result in comparatively easy designing and building of telephone exchanges by simply buying the relevant ROM chips or software modules. This means broadening of market and price reduction. How strong is the Computer-Communications marriage is best shown by the statistics: in 1985 it was less than 5% and nowadays it is more than 60% of computers in USA that are in the networks for data transmission.

3) Mobile radio communications represent the field that has grown the most in both industry and services over the last ten years. And it is only a beginning. By the end of 1992 there were around 23 million users and the system was introduced into over a hundred countries. Each subscriber was counted to pay an average of 750 dollars annually so that in 1993 the service had an income of around \$17 billion. If we add the prices of devices, terminals and mobile switching centers, the total turnover amounts to \$34 billion. In the last three years the increase rate was 45%. 56% of users are on the American continent, 26% in Europe, 16% in Asia and 2% in the rest of the world.

Until recently the majority of the mobile systems used to be of Nordic Mobile Telecom (NMT) analog type. Nowadays, many countries have introduced Global System for Mobile Communications (GSM), which is a digital cellular system, probably the most

refined thing in telecommunications in the technical sense. A new era is coming along with the GSM - the era of personal communications. People are no longer tied to a fixed telephone terminal. An access to a public network and thus a connection with any place in the world is possible by a handset that fits into a pocket.

Mobile radio is of a special importance for the countries that have underdeveloped public switched telephone networks. In Mexico City, for example, one can get a mobile phone in a few hours' time while for the fixed phone one must wait for more than one year. The global penetration level is 1 per 244 inhabitants or 1 per 26 telephone subscribers.

4) Actually, full globalization of telecommunications has been enabled by satellites. In the time ahead of us a special place is reserved for global personal communication satellite systems. Instead of geostationary orbit (GEO) satellite systems, low earth orbit (LEO) satellite systems will be put into operation, the typical representative of which is the Iridium. This is the joint venture of Motorola, Lockheed and some other renowned companies. The Iridium constellation features 77 satellites at an altitude of 780 km with 11 satellites in each of 7 orbit planes. The number of 77 matches iridium in the Mendeleev's table and this is how the system got its name. By using a handset station of 350 g weight and 0.5 W power, with the autonomous operation of 45 min. daily, connectivity with any other user on the Earth, at sea or in the air will be obtained. The price of such a station will begin at 2,000 dollars and one minute service will be charged 3 dollars. The price of the whole project will amount to \$3.4 billion and the system should be put into operation in 1997 with some million and a half subscribers.

5) The facsimile service holds a special position in electronic messaging. It sneaked onto the market quietly and made the greatest boom. In early 1993 there were around 25 million fax terminals in the world. The global level of penetration is 1 per 200 inhabitants and will certainly continue the growth. From its beginning, fax has contributed the most to a general growth of international traffic, especially between countries of different time zones. For example, the international traffic between USA and Japan has grown from 72 million-minutes in 1983 to 356 million-minutes in 1991, which represents the annual growth of 22%. However, it can be noticed that sale of fax terminals has declined but fax traffic is increasing nonetheless due to growing sale of PC fax modems. Many companies have included fax modems into their local networks thus enabling

sending of fax messages directly from PC displays and their receiving at laser printers.

Particularly important technology of electronic messaging that flourished from 1980 until 1990 are PC to PC communications. However, development of this field was hindered by the lack of standard, especially for documents of complex format. In the mid 80's the Open Systems Interconnection (OSI) emerged. Some of its standards were successful, like X.25 (packet switched data communications) or V Series of modem standards. However, X.400 for electronic message processing never became a standard of mass market for electronic mail because the tariffs were based on the traffic volume imposed by PTT.

The Internet took advantage of this vacuum and introduced itself. This is actually a network of networks that enables connectivity between various computer networks. The protocol used by the Internet has become the global standard. The Internet has at least three advantages: it exists, works and is free of charge. In 1993 there were 50,000 registered networks on the Internet, providing connectivity for 1.8 million PCs. Should this trend continue, it may be expected that in 1994 the Internet will take over fax terminals. It should also be pointed out that the capacity of the Internet is limited only by the total number of PCs in the world which amounts to 100 million, i.e. 1/5 of number of telephone subscribers.

6) Broadband telecommunications are in fact a response to grown needs for transmission of the video signals, high definition TV, rapid data transmission, PC-PC connectivity. In general, these are multimedia networks.

It is however not realistic economically to expect building of such networks, i.e. networks provided with optical cables, to become available at an average subscriber level. It is more realistic to encourage research in domain of signal compression and switching technologies in order to improve existent voice transmission networks and make them capable of multimedia servicing. So, it is our viewpoint that it is better to introduce intelligent terminals than to replace copper wires.

Of course, this has its implications. As the main investment would be that in devices, and the network would remain untouched, the monopoly of those possessing the networks would weaken and the tariffs would probably turn flat. Further on, should the telephone networks be used for transmission of radio and television signals, it will inflict changes in economy. Consequently, it will become logical to ask oneself, if the telecommunications companies enter the computer and radio diffusion market, why not the other way round. There already are such signs: in

Britain, cable TV companies offer local phone services, such is the case of Mercury.

On the other hand, we should not forget what happened to the ISDN system. In 1970 standards were ready and the service defined but the ISDN began its real life only in 1980. Today there are 340,000 subscribers in France, 140,000 in Germany and 84,000 in Japan, which is not so many. In the period of pregnancy of ISDN, which lasted ten years, the needs for more rapid transmission grew so much that many operators are tactfully waiting to see what will happen and are not offering ISDN to their subscribers. It is recommendable to be most cautious in predicting which course will applications of broadband telecommunications take. What is certain is that their development will be rapid.

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This has been an attempt to observe the situation in telecommunications of today and to find an answer to the question which way afterwards.

One thing is for sure: development of telecommunications in future will broaden the choice of services and will contribute to further globalization.

Maybe the day will come when it will not be necessary to travel to Geneva to attend conferences, to go to banks to get checks, not even to concerts or football matches. It may even become possible to do the office work from home. Telecommunications have changed considerably the way of our lives and will certainly continue to do so.

Heinrich Hertz was right when in 1866 upon managing to prove the existence of the radio waves he exclaimed: "The great domain of telecommunications has become a mighty kingdom!" Telecommunications of today indeed represent a mighty kingdom.

Abstract: After a short historical review in which the important events are recalled, the special emphasis has been given to the first steps of telecommunications in Serbia, ten years after the invention of telegraph. The main part of the paper is devoted to the future development in telecommunications. Six directions are envisaged: transmission, switching, mobile radio, satellites, electronic messaging and broadband telecommunications. For each of them, economic and social aspects are discussed and their impact on the society, industry, operators and users is assessed.

(Translation by Ms. Nevena Španović, B.A.)

Professor Ilija Stojanović was born at Otočac, Lika. He is a Professor at the School of Electrical Engineering in Belgrade, a Member of the Serbian Academy of Science and a Senior Member of IEEE. He wrote a great number of scientific papers and a number of books, among which the schoolbook Basics of Telecommunications. He also designed many telecommunication systems in Yugoslavia such as radio relay lines, television systems and, recently, mobile telephony systems.