

Challenges before National Institute of Telecommunications after fifty years of its activity

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Abstract — In the year 2001 we celebrate the fifty anniversary of the activity of National Institute of Telecommunications under its present name (in Polish: Instytut Łączności). Although we can date earlier the beginnings of the Institute, we will not present here its detailed history that is discussed in other papers. This paper presents rather the transformation of the Institute in last years, resulting from the systemic transformation of Poland. We describe: new mission of the Institute, the results of structural changes of the Institute in last five years, an outline of long-term research programme. Finally, the paper addresses the challenges before the Institute on the verge of the new millennium.

Keywords — *National Institute of Telecommunications, mission, research programme.*

1. Introduction: new mission of the National Institute of Telecommunications

The history of the National Institute of Telecommunications extends from the year 1934, when professor Janusz Groszkowski, a world-known specialist in radiocommunications, founded the first Polish national research institute in telecommunications. Before the second world war, the institute had several achievements in telephony, radiophony and television. Experimental television transmissions in Poland were started in the year 1937, using a system developed in the laboratories of the institute. After the second world war, the institute was re-established as the State Institute of Telecommunications, but in 1951 it was divided into several parts. A large part of the institute was moved into Miedzeszyn close to Warsaw (now a part of Warsaw) and named Instytut Łączności (official translation: National Institute of Telecommunications). This Institute served Polish economy and government by providing knowledge and expertise in the field of modern telecommunication technology. In the time of planned, closed economy in Poland, the Institute employed up to 1200 specialists; majority of them prepared Polish equivalents of international solutions of telecommunication devices. Such prototypes were subsequently transferred to be produced in Polish telecommunication industry and used by Polish telecommunication operator, or were used in co-operation with other countries of Middle and Eastern Europe.

In the last decade, National Institute of Telecommunications had to adapt itself to the opening of Polish economy. In the former, closed economy the Institute provided mostly technical expertise, with large part of tasks related to technical implementation and technology transfer or experimental production of telecommunication equipment. The opening of Polish economy resulted in an essential change of these tasks. In order not to lose the knowledge and expertise of the specialists employed by the Institute, we have chosen a difficult way of gradual changes of the character of the Institute. The difficulty related to the necessity of diminishing the size and changing the structure of employment, attracting young specialists, changing the priority to more basic research, and all the time preserving the economic viability of the Institute. In the beginning of the transformation, the long term tasks and goals of the Institute were not clear; but gradually become obvious that Poland needs a national research institution in such strategic field as modern telecommunications.

After the systemic transformation of Polish economy and society, gradual but rapid opening and liberalization occurred first on the market for telecommunication equipment, later on the market for telecommunication services. The National Institute of Telecommunications had to change accordingly its orientation. But the deep knowledge of Polish telecommunication sector, resulting from the earlier role of the Institute, essentially helped in finding new directions. Thus, the Institute changed:

- from serving closed economy towards new international and European dimensions and co-operation;
- from concentration on applied technological research towards more basic research on new themes;
- in serving telecommunication industry – from prototype development towards testing quality and admissibility of telecommunication devices;
- from strictly disciplinary research in telecommunications towards interdisciplinary and integrated research including computer science and other information technology disciplines, law and economics of telecommunications, etc.;
- from strictly research and development orientation towards combining research with education activities, in particular – continuing and distant education;

- from concentration on telecommunication hardware towards increasing concentration on telecommunication software;
- from financing the Institute mainly from state subsidies towards financing the Institute mainly from market activities.

These changes were accompanied by an essential change in the size and structure of employment. In the five years of 1990–95, the number of employees decreased almost twice, to 670 in 1996. In the five years 1996–2000, the number decreased almost twice again, to 390 in 2000. At the same time, the Institute tried to employ 15 ÷ 20 new young specialists yearly. Although labor markets in telecommunications are fluid and only 8 young specialists yearly remained for longer time at the Institute, the average age of specialists employed at the Institute decreased from 55 in 1996 to 49 in 2000¹ at the same time, the share of statutory public funds in financing of the Institute diminished to ca. 20%; the rest is obtained partly from competitive grants and mostly from market service.

During all these transformations, a new mission of the Institute was defined and formulated in 1999 as follows:

The mission of National Institute of Telecommunications is the development and application of knowledge and expertise – in the integrated fields of telecommunications, computer science (informatics) and other information technology sciences, including also legal, economic and social aspects of information technology – in the liberalised market of telecommunication and information services, according to the needs of emerging information society. Such knowledge and expertise should serve not only the operators and consumers on this market, but also governmental regulatory agencies responsible for this market. This is because the emergence of information society creates not only new and tremendous development chances, but also serious threats and dangers. For example, the development of new communication technologies creates large market chances, but also endangers correct market functioning, might violate the interests of consumers. Thus, it is necessary to understand well not only the developing technology, but also legal, economic and social issues related to its applications. A basic example of such relations are network interconnection issues in telecommunications. Therefore, an important element of the mission of the Institute is service with its knowledge and expertise to governmental regulatory agencies responsible for the functioning of telecommunication markets.

This mission – with small modifications – remains actual today. The programme of the Institute and the challenges it faces are strongly related to this mission. In order to understand better these challenges, we shall first discuss shortly more detailed results of structural changes of the Institute in last five years.

¹This average is relatively low when compared with other research and development institutions in Poland, where a generation gap in science is developing.

2. Results of structural changes in National Institute of Telecommunications in five years 1996–2000

Structural changes had the objective to adapt the Institute to the fast changes in telecommunication technology and markets as well as to the liberalisation of telecommunication services. Several new units of the Institute had been formed, old units restructured or disbanded. New units include:

- Independent Section of Computerised Decision Support in Telecommunication;
- Independent Section of Theoretical Foundations of Telecommunications;
- Independent Section of Computer Networks, later transformed into Centre of Informatics;
- Division of Regulation and Economic Problems of Telecommunications;
- Division of Teletransmission and Fiber Optics;
- Division of Network Development and Applications of Informatics in Telecommunications;
- Independent Section of Marine Telecommunications and Radiocommunications in Gdańsk.

Restructured units include Centre of Scientific Information and Centre of Education and Promotion; the latter specialises in continuing postgraduate education for telecommunication engineers. Three small-scale production units – Division of Construction and Implementation in Warsaw and Production Division in Pułtusk as well as Production Section in Gdańsk were transformed – either in private enterprises or a smaller service units. At the same time, a Centre for Implementation of Information Technology and Services in Telecommunications specialised in implementations of computer technology, more in software than hardware.

At the same time, various administration and service units in the Institute were modernised, mostly with the help of a modern computer network organised in the Institute.

All these changes resulted in the following effects.

- The percentage of employees with university degrees was increased above 50%, the share of specialists with doctoral degrees and scientific titles² also increased significantly.

²In Polish scientific system there are two doctoral degrees and the term “scientific title” denotes the title of professor granted by the President of the Republic of Poland (corresponding roughly, but with higher prestige, to the position of full professor at Western universities).

- As the result of the increase of employed specialists with second doctoral degree or scientific title, the Scientific Council of the Institute regained its rights to grant doctoral degrees and exercised this right by starting to grant these degrees in the year 2000.
- The Institute obtained the highest category (1A) in the classification performed by the State Committee for Scientific Research.
- The Institute continued to organise the sequence of International Wroclaw Symposiums on Electromagnetic Compatibility and started to organise three new cyclical international conferences: International Experiences on Interconnection Issues, Research for Information Society, International Conference on Transparent Optical Networks. On the occasion of its 50-th anniversary, the Institute starts a new international conference – on Decision Support for Telecommunications and Information Society.
- In the year 2000, the Institute started to edit two new journals: one technical in Polish, *Telekomunikacja i Techniki Informacyjne* and one scientific in English, *Journal of Telecommunications and Information Technology*.
- Nine equipment-testing laboratories of the Institute obtained and maintained certified testing rights, issued by Polish Centre for Testing and Certification and by High Office of Measurements of Poland.
- The Centre for Education and Promotion of the Institute started postgraduate education in three specialities: the management of telecommunication networks, radiocommunication systems and multimedia telecommunication systems.
- The international co-operation of the Institute was strongly increased, including collaboration with many research institutions and international standard-setting organisations, with Framework Programmes of European Union, etc.

3. New tasks of the Institute

These results form a solid basis for further necessary changes of the Institute. A new law concerning research and development institutions introduces a new category of State Research Institute (SRI). Although full specification of this category is not available yet, the National Institute of Telecommunications aspires to this category and thus has to start several further changes in the years 2001–02. The most important of such changes are:

- 1) changes in the strategic research programme;
- 2) further changes in Polish and European co-operation, concentrating on the concept of centers and networks of excellence;

- 3) changes in the character of state services rendered by the Institute;
- 4) changes in the character of testing laboratories and certifications given by the Institute;
- 5) changes in the collaboration with diverse actors on telecommunication markets;
- 6) changes in the management system of the Institute, based on the concept of quality management.

Without describing all these directions in detail, we shall comment here only on the changes in the strategic research programme.

4. An outline of a strategic research programme

The preparation of a strategic research programme started with the discussions of the Scientific Council of the Institute that outlined several possible directions of future concentration of research, such as:

- the development of information society in its technical, legal and socio-economic aspects;
- terabit optical telecommunication networks;
- integration of diverse telecommunication and information technology systems together with their security aspects;
- planning and design of modern telecommunication networks;
- future trends of telecommunication and radiocommunication terminal devices;
- new techniques of telecommunication network management, in particular for IP protocol;
- new techniques of data analysis and computerised decision support in telecommunication and information services;
- new multimedia services, quality and standards of services, analysis of consumer demand on service markets;
- regulatory and economic aspects of Polish telecommunications, compatibility with European directives and standards.

Starting from these possible directions as an initial platform, several other considerations were included into discussions. These were:

- the ISTAG (*Information Society Technology Advisory Group* of European Commission) scenarios for ambient intelligence, prepared in co-operation with European Institute for Prospective Technologies in Seville in preparation of a new framework programme;

- an assessment of special chances of Polish telecommunication and information technology in the view of these European preparations;
- an assessment of the needs of forming information society in Poland and of the known programmes of scientific computer network infrastructure, such as *PIONER* of the State Committee for Scientific Research.

After such considerations, an outline of a strategic research programme was prepared, including a cooperation with several other research institutes in Poland. This outline consists of the following subprogrammes.

4.1. Design and management of secure and intelligent, integrated networks and systems with terabit capacities

The challenge in the development of modern communication networks is multimedia integration – not only of mobile and stationary telephony or data transmission, but also of internet and other communication services. The trend in stationary networks is towards fiber-optics and photonic technology, with migration towards IP protocol and an increase of transmission rates towards terabits per second. The technological development in this field will require costly research. In Poland, we must keep essential elements of knowledge in this field, but a chance and possible concentration of research should relate to necessary software development and the issues of *ambient intelligence* in such networks. Thus, especially interesting are the problems of design and management of such networks, together with the problems of security and quality of services. In these fields, it is possible to form a Polish research speciality. The goals of long-term research programme might include:

- methodology of design and planning of multimedia IP networks, together with their management systems;
- methods of monitoring and enhancing quality and security of services in multimedia IP networks;
- optics and photonic technology in terabit DWDM networks;
- wireless access systems to terabit backbone networks.

4.2. Decision support in telecommunications

The growing transmission rates, growing complexity of modern telecommunication networks, the diversity of services rendered and technologies applied, liberalisation of telecommunication markets and growing competition, all will increase the demand for computerised tools of decision support not only in management of telecommunication networks, but also their operators. This will concern diverse areas, such as acquiring and servicing clients

as well as maintaining client relations, financial management, strategic management, negotiation of interconnection agreements, etc. This trend, visible internationally, will concern not only business actors on telecommunication markets, but also market regulation or electromagnetic spectrum management offices. We can take advantage of the fact that this is a relatively new field and that Poland has a strong, internationally known research school in decision theory and computerised decision support. Moreover, this field relates mostly to computer programming, hence the cost of research is lower than in technological fields. It is thus possible to make decision support in telecommunications a Polish speciality, concentrating e.g. on the following long-term research goals:

- data processing and analysis for decision support and the management of integrated multimedia networks;
- methods of decision support for the analysis of quality and security of integrated multimedia networks;
- decision support systems in monitoring electromagnetic spectrum use and the management of spectrum resources;
- methods of decision support in regulating interconnection issues.

4.3. Systems research and mathematical modelling for supporting e-business and e-banking

Electronic business and banking are today one of the most dynamic applications of integrated multimedia networks. Poland has good traditions of basic research in system and decision sciences as well as mathematical modelling; these tools are applicable to electronic business and banking. Thus, a cooperation of the National Institute of Telecommunications with such institutions as the Institute of Systems Research of Polish Academy of Sciences or the School of Applied Informatics and Management related to this Institute can result in the formation of a centre of excellence in this field. The research goals might include:

- mathematical models of electronic commerce transactions and their applications in the analysis of the development of electronic markets;
- systems of consumer support on electronic markets with application of software agents;
- mathematical models of electronic banking and their applications to the analysis of financial market development;
- systems of supporting investors in electronic banking, using multicriteria decision support and software agents.

4.4. Integrated teleinformatic systems for monitoring environment and supporting management of preventive actions in cases of natural impedences and disasters

Monitoring of diverse aspects of environmental pollution and hazards is subject of intensive research in Europe and in Poland, e.g. by such institutions as the Institute of Meteorology and Water Resources Management, or the Industrial Institute of Automatic Control and Measurements. Less developed is the integration of such monitoring systems. In cases of such natural disasters as deluges, it is necessary to integrate various sources of information in a multimedia network and to use them for supporting management and coordination of preventive actions. Such systems are being implemented, but they do not necessarily take into account the fast development of integrated multimedia telecommunication networks; thus, it is necessary to work on future generations of such systems. Possible research goals might include:

- review of diverse systems of monitoring natural environment, sources of information in such systems, and demand on diverse information services by various participants of preventive actions in cases of natural disasters;
- the development of a data model, use of data mining and analysis techniques and decision support methods in the management of preventive actions;
- the development of new concepts of integrated but dispersed teleinformatic systems for monitoring environment, with specific requirements for the security and quality of information services;
- the development and implementation of a pilot system on a regional level;
- the development of a prototype of a national coordination center based on next generation technology, together with requirements for data security, co-operation with preventive services in neighboring countries, etc.

4.5. Secure systems of information exchange for state and local administration, with special emphasis on information concerning labor market and distance learning

There are many technological variants, models and protocols of multimedia information exchange, including typical internet technologies, that can be used by central and local administration. An essential difficulty is related to the necessity of providing various levels of security in a network that must have public access for services such as electronic discussion groups, group review of proposed documents, electronic voting, etc. services needed in the concept of *e-democracy* on one hand, and provide high security in more special applications on the other hand. The development

of cryptography, of diversified organisation of public and private keys, of electronic signature systems can provide necessary security levels even in networks with diversified access, but currently such techniques are expensive and are rapidly further developed – also by various institutions in Poland, e.g. by the National Academic Computer Network Institute. At the same time, the applications of such systems for information exchange concerning labor markets, or helping in distant, continuing education is an essential tool of fighting unemployment, with high priorities in European Framework Programmes. Thus, the challenge relates to the development of a system with diversified security requirements with applications to the integration of local information on labor market and on continuing education possibilities. This research should involve several institutions beside the National Institute of Telecommunications and the National Academic Computer Network Institute. The research goals might include:

- a review of multimedia information exchange techniques for an integrated system of supporting local and central administration, with elements of distance learning;
- a review of methods of providing graduated security levels for systems with diversified users;
- the development and pilot implementation of exchange of information about local labor markets and the possibilities of continuing education;
- the development and pilot implementation of an independent subsystem of continuing distant education with diversified levels and profiles of learning;
- the development and implementation of an education portal for the subsystem of distant education;
- implementation of such pilot systems for selected local administrations and for a selected central administration unit.

4.6. Multidisciplinary systemic analysis of social, economic, legal and technical aspects of information society and knowledge-based economy

The social, economic, legal and technical consequences and conditions of the development of information society and knowledge-based economy are a typical example of a complex multidisciplinary problem which should be addressed today by using the techniques and methodologies of systems analysis. The National Institute of Telecommunications started already preliminary research of such issues and organises since four years cyclic international conference *Research for Information Society*. However, there is a visible need of intensifying such research and searching for a systemic synthesis of its results. There might be several institutions involved in this research – beside National

Institute of Telecommunications, also Systems Research Institute of the Polish Academy of Sciences, Technical University of Warsaw, Main School of Commerce, Academy of Mining and Metallurgy in Cracow, etc. The goals of such research might include:

- the European Union before the challenges of information society and knowledge-based economy – a study of priorities, history, legal solutions;
- the conflicts of information civilisation era – the antithesis of uniformity of world information systems and the need of preserving cultural diversity, of information and work, of getting richer and increasing digital divide – and the means of overcoming them;
- an analysis of countries using intensively knowledge-based economy (such as Finland), their institutional and other means of promoting development;
- the role and character of educational systems and science systems in information civilisation and knowledge-based economy;
- the distinction of information and knowledge, types of knowledge representation, their standards, conditions and techniques stimulating knowledge exchange;
- the impact of telecommunications and information technology on information civilisation and knowledge-based economy; social and economic aspects of social acceptance of new technologies;
- the development of information society in rural areas; methods of neutralising digital divide.

5. Challenges before National Institute of Telecommunications at the turn of milenium

Many countries have national institutes working on telecommunications and information society technologies. Examples are *Federal Institute of Telecommunication Sciences* in Boulder, Colorado, USA, or *Royal Institute of Telecommunications* in Belgium. All such institutes have similar problems concerning financing research and attracting top-level researchers. Not all financing of such institutes comes from public funding, part comes from competitive grants or even directly from telecommunication market. The salaries of top-level specialists in this rapidly developing field are naturally much higher at telecommunication operators or equipment providing firms than at research institutes. There are diverse approaches to this problem; a typical one is treating the employment in a research institute as continuing education. Some of such institutes have majority of employees young but employed only for limited periods.

Thus, one challenge before the National Institute of Telecommunications is finding a way to implement such a recruitment model – where most young researchers would stay at the Institute only for a limited time. Such schooling of young employees is expensive, however, and would require a larger part (from 33% to even 50%) of the financing of the Institute provided from public funds. Two ways of reaching such proportion are possible. One is based on participating in long-term research programs, such as outlined above; the field of telecommunication and information society technology is certainly important enough strategically to deserve creating such long-term programs. Another way is further decrease of numbers and rejuvenation of the working force at the Institute. This is more difficult way, but it cannot be excluded, since typical institutes of this type in the world have no more than 200 employees.

The recruitment of new researchers might be intensified by broadening the educational activity of the Institute. The postgraduate studies and courses of continuing education, organised by the Education and Promotion Centre of the Institute, can be supplemented by a more close co-operation with diverse universities on engineer- and master-level education. In this, the idea of a center of excellence might help, stimulating the co-operation with educational institutions. Another challenge relates to the growing interdisciplinarity of modern telecommunications and information society technologies. This challenge can be met by using systemic, multidisciplinary approach to research, as outlined in some of above sections.

The perspectives of the National Institute of Telecommunications, assuming that we can meet these challenges, are huge. The field of information society technologies for many decades yet will be decisive for the economic development of the world. We hope that after another fifty years, the National Institute of Telecommunications will celebrate the centennial anniversary of its activity.

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