Original models of NGN/IMS-networks surrounded by circuit-switched systems

On obtaining of the Alexander Graham Bell a patent for invention of the telephone in 1987, the communication system consistently has gone through several evolutionary stages: from analog lines and manual switches to video telephony and IMS architecture. Each of the stages can be described by specific switching systems, data transmission systems and types of transmitted information. After implementation of such solution, it is possible to create a number of access nodes in the Operators IMS-network during very short time. From point of view of IP-telephone network, there are 10 000 subscribers connected to each of such nodes. As after reconstruction all exchanges are connected to IP-network, all intermediate entities (IISE and OISE) could be dismantled completely. After such modernization, subscribers of ex-analog segment get full access to IMS services and functionality.

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Telephone networks evolution

Each of the stages can be described by specific switching systems, data transmission systems and types of transmitted information. In the most general sense, the following stages of the fixed network could be distinguished:

1. **Analog telephony.** It was the longest stage, which had begun in the late XIX century. It characterized by analog lines with physical or frequency division multiplexing. As connectors was used manual switches and later decade step-by-step and crossbar exchanges.

2. **Digital telephony.** In the second half of XX century began to develop a communication system based on time division multiplexing (TDM). With the development of microprocessor technologies, electronic exchanges have appeared. In addition to traditional telephony, within Integrated Services Digital Network (ISDN) it became possible to transmit video and user data. 1980-1990s were the dawn of digital telephony. Covering the whole world, ISDN and signaling system SS7 allowed to develop actively both fixed and mobile networks.

3. **IP-telephony**, has got active development in 2000s is characterized by new packet switching technology. Development of Ethernet, increasing of data rates and quality of IP-networks has resulted in the appearance of the Session Initialization Protocol (SIP), Softswitches Class 4 and 5, the introduction of "Triple play", the emergence of the conception of Next Generation Networks (NGN). It is difficult to imagine the modern world of telecommunications without all of these entities.

4. The concept of IP Multimedia Subsystem (IMS), which is an extension of NGN is being promoted right now. In many ways, it is associated with the development of mobile technologies and the LTE-standard. It aims to create a single information space of telecommunications, including fixed and mobile subscribers, implementing Fix-mobile Convergence (FMC) and number portability.

The above steps are approximate and do not account for transition processes, such as the creation of quasi-electronic exchanges. Furthermore, the creation and modernization of real phone network is a complex process: each country pass its own unique way.

In Europe and North America stages of evolution can be distinguished clearly enough: each of the stages is quite clearly expressed; there is a consistent implementation of each new technology. Only when the upgrading is almost finished, the next-generation technology starts (See Figure 1). This approach has its pros and cons. On the plus side, we can highlight what subscribers get the latest technology in the shortest possible time, while telecom operators (in they turn) have the ability to get revenues for new services and new quality of services. In addition, the serial changing of technologies creates new jobs, stimulating development and buying new equipment by all market players: users, operators, vendors — it fits into the concept of "Society of consumption", which formed on the West in the XX century.

However, such step-by-step modernization is very expensive, it may be noted as the main disadvantage of such approach. Crisis of several big manufacturers of telephone equipment (as AT&T, Siemens, etc.), which has occurred in the early 2000s was caused by their forces in development and production of TDM equipment were devalued by rapid development of IP-telephony.

Stages of modernization of telecommunication networks in developing countries, for example Russia, have much more blurred borders (See Figure 1). Various technologies could coexist with each other for a long time. For example, in St. Petersburg the last decade step-by-step exchange was officially closed in 2006, and in Moscow in December 2011. At the same time on both networks core of NGN or IMS has built already.

Such situation, when the modern telecom technologies are being introduced nearby antique communication systems, generates original approaches of different generation's equipment interoperability. Models analysis of constructing of NGN/IMS networks, surrounded by circuit-switched systems, has scientific value, since this question almost doesn't described in the literature.

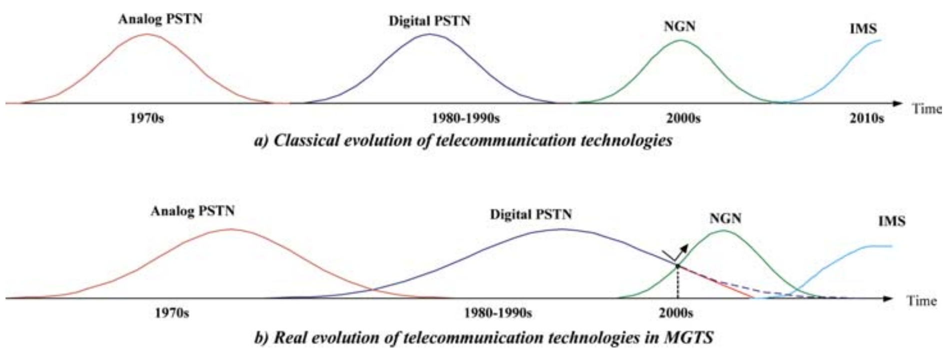

Figure 1. Technology evolution

Actual conceptions of creation of IP-based networks either involve a complete reconstruction of existing equipment, or coupling with it via standard converters or gateways. The possibility of convergence of equipment with various technologies does not recon previously.

Moscow's telephone network

Consider the network model on the example of public telephone network of Moscow — the largest city in Europe.

Moscow City Telephone Network — "MGTS" — was built and developed during more than 100 years. MGTS has an extensive telecommunications infrastructure on the territory of Moscow and Moscow region, serving subscribers in several telephone network numbering zones (495, 499, 498). Both modern and obsolete transmission and switching equipment there are in the network of MGTS.

By the moment of active implementation of IMS hierarchy, there were about 5.4 millions of subscribers on the MGTS network (see Figure 2):

• 1,5 million connected to analog crossbar exchange, connected to each other via incoming and outgoing information switching entities (IISE & OISE);

• 2,6 million connected to digital reference & transit exchanges (RTE) based on TDM technology;

• 1 million connected to the NGN equipment, built on Softswitches Class 4 and 5, subscriber access gateways and trunk gateways;

• IMS-segment is not enough developed, including 300,000 of subscribers; but the IMS core has been created completely and has the ability to further increasing of its capacity.

There was a task for the telecom Operator of expanding its IMS-segment by modernization of crossbar exchanges, which serves about 30% of the total subscriber capacity of MGTS.

Among the pushing-factors for the Operator to the earliest realization of IMS concept and crossbar exchanges reconstruction there are following:

• the need to match to international level by the range and quality of services provided to all subscribers of MGTS;

• the need to modernize the operation and maintains of switching equipment;

• the need to switch-over to a closed telephone numbering system and implementing a common emergency telephone number "112";

• the need to reduce customers flow-out, caused by lack of modern additional services;

• the need to reduce OPEX: the cost of the power supply, repair of old equipment, maintenance of analog modules.

Concepts of analogue segment modernization

To solve the problem, the following concepts of MGTS modernization were discussed:

1. Upgrading of analog equipment without replacing switching equipment (stage of switching) and connecting line.

2. IMS concept realization, by sequential replacement of terminal exchanges by multi-service access nodes (MSAN).

3. Access network modernization by migration to passive optical network (PON).

Considering these strategies, we can say that the 1st concept, involves replacement of analog registers and markers of crossbar exchange by modernized digital modules, which considers new numbering plan requirements. However, this "modernization" in reality is not real modernization. Such efforts could solve one of five tasks.

The undoubted advantage of this approach is immediately economy, as the cost of new equipment is minimal. However, the preservation to the uttermost of analog stations is contrary to the existing vector to "digital society", to creation of e-government and to other innovative programs. In the long term strategic perspective, these investments are useless.

The 2nd concept assumes a migration to the concept "All-IP", being classic scheme of "IMSization". But it requires significant investments, both financial and temporal. An additional disadvantage of this approach is the complex configuration of the analog telephone segment of Moscow. A large number of interconnections between local exchanges not allowed realizing a sequential exchanges upgrading. It was required to carry out the reconstruction of whole junction areas.

The 3rd concept shows the best correlation with the ideology of IMS and allows to provide to every user not only voice, but data and video transmission as well. However, the rate of switching to PON technology was too small. Subscribers refused to install additional PON equipment. In addition, during the migration to PON it was impossible to survive previous phone number, so that prevent the introduction of new service.

Thus, it was necessary to use original approach for constructing of IMS-network, modernizations of crossbar exchanges and solving the set of tasks completely. It was decided to use analog exchanges themselves as IMS-network access equipment directly. The proposed approach was effective in terms of long-term development of the telecommunication system as a single organism.

Mediator of plan of numeration

Under the proposed concept, part of analog equipment of crossbar exchanges was replaced by new complex, known as "Mediator of Plan of Numeration" (MPN). Complex MPN is equal to MSAN for technical features, functionality and principles of connectivity to the IMS-core, but it does not have the disadvantages of the MSAN or PON strategies.

Each crossbar exchange after reconstruction can be seen as a combination of two main elements. The first element includes the line-link and subscriber-link frames. Subscriber lines are connected into it; there are no changes of the access network. The second element, called MPN, performs all the functions of the trunks stages of crossbar exchange, and forms standard Gigabit Ethernet

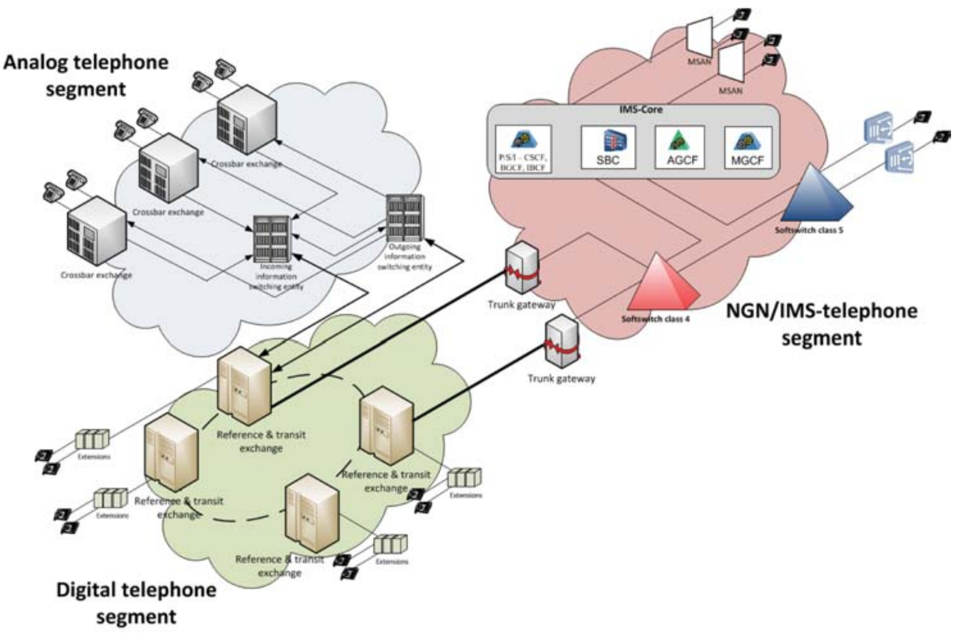

Figure 2. Structure scheme of MGTS

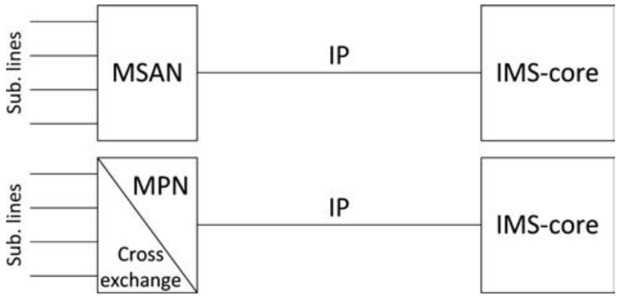

Figure 3. MPN and MSAN comparison

interfaces. MPN connects to NGN/IMS-telephone segment. Interaction with external IP-equipment and call control are realized by SIP protocol.

Mediator of plan of numeration provides conversion of speech signal received from the analog equipment of exchange, into form suitable for transmission over packet switching networks. MPN encodes speech information, pack information into RTP/IP-packets and vice versa. MPN supports the exchange and conversion of signaling messages both, with the switching or control exchange equipment, and with IMS-core, Softswitch or IP-terminal. MPN processes and converts signaling messages of channels switching equipment into signaling messages of packet switching network (SIP). It supports different numbering plans, and provides set of supplementary services for all connected subscribers.

Results

After implementation of such solution, it is possible to create a number of access nodes in the Operators IMS-network during very short time. From point of view of IP-telephone network, there are 10 000 subscribers connected to each of such nodes. As after reconstruction all exchanges are connected to IP-network, all intermediate entities (IISE and OISE) could be dismantled completely. After such modernization, subscribers of ex-analog segment get full access to IMS services and functionality.

References

1. *Goldstein B.* Evolution of Telecommunication Protocols /SPb.: BHV-2002.

2. *Kulikov N.A., Fitsov V.V.* Application Mediator Numbering Plan (MPN) of "SEC Proteus" when upgrading ASCT (Y) on MGTS in accordance with the concept of IMS / 64 Scientific and Technical Conference faculty, researchers and graduate students. St. Petersburg, 2012.

3. Goikhman V.Yu., Kovalev E.I., Kulikov N.A., Sibiryakova N.G. Mediators numbering plan. St. Petersburg, 2012.

4. 3rd Generation Partnership Project. IP Multimedia Subsystem (IMS) Stage 2, Release 12 TS 23.228 V12.4.0 (2014-03).

5. TS 183 043 — V3.4.1 — Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); IMS-based PSTN/ISDN Emulation; Stage 3 specification (April 20, 2011).