MODERN TELECOMMUNICATION EQUIPMENT INTRODUCTION IN RUSSIA AND THE NEW REPUBLICS

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Introduction

In this paper we would like to describe the process of the new equipment introduction on the telecommunication networks of the former USSR taking into account our personal experience. First of all we want to mention, that we were dealing mainly with the local switching, so the examples below are mainly from this particular field.

Today the former Soviet Union is still a united country from the point of view of telecommunications (and telephony in particular). Though different countries have gained their independance, the telephone network is still united and built according to the same technical standards and regulations.

In all the new countries the local calls are not charged yet and the additional services are virtually non-existing, so it is impossible to generate income providing them. So the local administrations have to install new equipment in order to upgrade their services, thus making it possible to get more money from the users. There are three main sources of income:

- installation and subscriber fee;
- payments on per call or per time unit basis;
- payments for the services and the special features.

Right now administrations are trying to increase the first item, which can be achieved by upgrading of the old electromechanical switches and the analog network. As an example we can mention the development and production of the modernized crossbar equipment with stored programme control ÀÒS-ÀÌÅ in Russia.

In order to have the second source you have to install the new electronic equipment on the existing exchanges. The problem is addressed for more than fifteen years and is not solved yet.

Of cource the introduction of the modern digital switches can boost all the three parts mentioned. Moreover the network digitalization can bring such a level of service, that per call (per time unit) charging of the local calls will become uninteresting to the operators (like it is in Canada).

Now less than one percent of the users have access to fundamental additional services and there is still the great demand for the plain old telephone service, this made the commenwealth of Independent States (CIS) market to be a very attractive one to the digital equipment producers. Now most of them are already aware of the difficulties waiting for them in this field.

The new equipment is inserted into the existing analog environment. The interface standards are specific. The long distance and the local switches are belonging to the

different entities. Switches have to be adapted to the country specific call handling and signaling procedures. The Pulse Code Modulation (PCM) transmission equipment has to integrate channel banks performing signaling conversion according to the standards as defined by the Public Switched Telephone Network (PSTN) Set of Rules and Regulations [1].

Back in 1980s it was decided that the digital switches are to be connected to the public network only through the digital interfaces. In this case a new switch introduction can be described in general by the figure 1.

Figure 1. New digital switch installation

In Russia this policy is still strictly persued on the public networks of the metropolitan areas, with exception of PBXs for which analog interfaces with the PSTN are allowed due to the marketing reasons. They say that in some new republics this approach is not mandatory, thoug we think that it is the most reasonable one from the point of view of the further development of the network - when the existing analog switching equipment is substituted by the digital one there is no problem with interfaces, and the PCM converter can be used somewhere else to upgrade the network.

Alas this approach is not very well working on the rural and long distance network, because due to the fact that the country is rather big, the cost of the new (digital) line equipment installation is very high.

All these problems we will briefly discuss in the first section "What is needed for the adaptation", also we will touch it in the third ("Different Variants of Adaptation") and the forth ("Accompanying Problems") sections.

The adapted switch has to be type approved by the relevant authorities and we think that some idea about the procedure can help to understand the subject, that is why we have devoted the second section to this issue. The fifth section "Some Examples" will illustrate the main ideas.

What is needed for Adaptation

The name of this section is a little bit ambigous. The first of all it means "What requirements are to be met to install the equipment in the former USSR?". The second meaning is "What can be done to meet these requirements?". The most general answer to the first question is - you need to read the document called "The PSTN Set of Rules and Regulations" [1] and to implement the features required from the equipment you intend to introduce to the market. This recommendation is easy to make, but is hard to follow. First of all it is a rather spacious document - more than 700 pages of Russian text (the English copy can be acquired also). Many of the parts of the document can be understood only if you have some experience in the field.

The main task is to define what requirements are mandatory for your particular piece of equipment and which of them differ from the international ones. The greatest difference lies within the field of signaling protocols and some call handling procedures.[2] The authors have a big experience of these protocols specifications using SDL (Specifications and Description Language). One can find 30-35 signaling types on the CIS PSTN and a little bit more on the private networks (we are speaking about just country specific ones).

So to make an equipment which can work in the former USSR one need to make the steps as shown on the figure 2.

Figure 2. Stages of the adaptation

One can say for sure that the major noncompliances are usually:

- signaling and call handling procedures
- attenuation plan

- input/output impedances

The main effort of course lies within the step number four, but to ensure its success one has to be careful in all other items.

This process usually corresponds with the other one that is type approval.

Type approval procedure

The type approval is performed by one of the laboratories of the Ministry of Communication. There is a list of such entities and their fields of responsibility. The producer has to make application for type approval and make a Contract with the designated laboratory. We shall just briefly mention the main steps of the type approval and their correspondance with the adaptation process (figure 3). One can find more information in [3].

Figure 3. Type approval procedure

After the initial steps (Stage 1) the official document called "Technical Terms and Conditions" (TTC) is prepared. It describes the main parameters and features of the

product to be installed in the CIS. On the later stages the product will undergo the Type Approval Tests (usually in two steps: so called factory or parametric tests and line or functional tests) to prove that all the requirements of the TTC are implemented. That is why it is necessary be very serious with this document. The problem is that it is just plain text, so we think that a lot of additional information is needed on these stages of the Type Approval/Adaptation process to specify the signaling and call handling procedures [4].

The tests is the most crucial stage. You have to prove both to your customer and yourself that the product fits the requirements. Usually it is done by testing the product in the real environment. And it was the only mean to test the signaling and call handling features.

This approach has a lot of disadvantages, because if you have a problem, the test usually give you just a negative result without any identification of the problem and there are no means to support its debugging.

That is why the new approach has been adopted. First of all it was decided that the switch will be regarded as a "black box" because many producers are reluctant to let any alien engineers to have information about the design. So the model of virtual switch has been developed.

The software of this switch is considered to consist of five main blocks: Call Handling, Operational System, Operation Maintenance, Subscriber Signaling and Line Signaling.

This software has interfaces with physical level of signaling (firmware of subscriber line units and trunk line units).

Signalling blocks of the model are specified formally using Z.100 ITU-T SDL. This high level model of the protocol based on the requirements (R) was thoroughly tested and proposed to the suppliers as a protocol specification. As a result all compulsury states are defined

$S = \{S_o, \ldots S_i, \ldots S_m,\}$ which are the part of SDL expression (L), or $S \subseteq L_{SDL}$.

Afterwards all signals (c) transferring the signalling process from one state to another and tusks to be fulfilled (T) are defined

$C = \{C_o, \ldots C_i, \ldots C_n\}$ $C \subseteq LSDL$

$T = \{T_o, \ldots T_i, \ldots T_v\}$ $T \subseteq LSDL$

So requirements are transformed from text form to an algorythm $R \dashrightarrow L_{R\ SDL}$

This gives possibility to test the switch in a step-by-step way providing that its external interfaces function is following the specified algorythm.

The testing equipment uses signals transmitted by the switch as signals {C} transferring from one state of the formal model to another.

The states of the testing equipment and the switch should match each other on every stage. If at least once they do not correspond each other the test can not be considered as passed and the debugging process can be started. This approach is much

more convenient than the conventional one because the problem can be localised a lot easier.

When the testing equipment passes all the branches of the algorythm the results can be confirmed by the connection of the switch to real lines. After this the procedures are considered to be implemented.

It is also expedient to test the implementation of the protocols when the traffic is generated. So it is proposed to connect local calls simulators to extension lines and to loop outgoing and incoming trunks and to assess all the delays and failures. The troubleshooting on this stage should be done by the switch software designers because no protocols discrepancies can be found. All the failures can be attributed only to the particular implementation items (e.g. bus access, reservation ets) and not to the model used.

For the purposes of testing of the switches and signaling convertors the PC based public Central Office simulator (protocol-tester) was developed.

After the tests, if their results prove successful adaptation, the protocols together with the conclusion of the type approval laboratory are sent to the Ministry of Communication. The materials are considered by the Type Approval Board of the Ministry and than the Type Approval Certificate is issued.

Different variants of adaptation

It is evident that there should be different approaches towards adaptation of different types of equipment.

For the transmission equipment the implementation of the international standards is usually sufficient. Of course when the signaling conversion is needed the channel banks are to be modified. For the switching equipment we can distinguish several classes.

The first one is the small private switches (key-systems) serving less than 100-150 lines. They can be connected to the public network via two wire subscriber loop. So usually no adaptation is needed. The items to be checked are:

- transmission parameters;
- rings and tones;
- subscriber loop parameters.

The second class is PABX's. Here a big adaptation effort is needed. But one has to distinguish the things needed to get type approval and the demands of the market. In this case the mandatory type approval requirements are just the subset of the items which can be required by the customer. In addition to the issues mentioned for the small switches one has to keep in mind the following ones:

- country specific interfaces (physical and protocol levels);
- country specific calling party identification procedure.

For the type approval just one interface implementation (so called "three wire" or PCM channel associated signalling - CAS) is sufficient. But the users, especially ones owning big nationwide private networks, can ask for a lot more.

The same applies to the rural switches, but here we can also mention:

- maintenance of the existing exchanges of the lower level of hierarchy;
- support of the telegraph and cable radio broadcasting signals transmission.

For the urban switches the number of mandatory interfaces is rather limited. As it was already mentioned the PCM CAS with calling party identification and multifrequency adress signaling is mandatory.

The long distance offices also have to support some types of the in-band supervision signaling as well as to provide interworking with existing operator positions (manual switch boards) and neutralization of echosuppressors.

Accompanying problems

The history of the former USSR telecommunications networks digitalization can be subdivided into three phases.

During the first half of 1980's the installation of mainly Finnish and Yugoslavian (made under the license) switches took place.

Since the beginning of deregulation more than ten foreign producers have proposed their equipment on our market.

Now we are at the beginning of the next phase: some regulations are introduced once more. First of all only two types of the switching equipment are allowed to be used as international gateways in Russia, and only three types for national long distance calls switching. And it is recommended to use no more that two different types of the digital switching equipment in each region of the country. All these regulations are aimed to reduce the cost of the operation, maintenance and repair. They are applicable only to public networks. Private operators have to resolve these problems individually.

Now we also see the clear tendency to demand the comprehensive solution of the problems. The customers are mainly interested in the integration of the equipment into the existing environment. This means that the switch should be accompanied by the transmission equipment, cables, terminals, etc. The installation should be done and the "key" should be presented to the customer. Also the repair and maintenance problems are to be solved. So we can make a list of the issues to be considered during the implementation of the project

1. Switching and transmission equipment adaptation and type approval.
2. Implementation of the specific features needed by the customer.
3. Choice of the network and equipment configuration.
4. Operation and Maintenance center organization.
5. Billing center organization.

6. Repairments.

Even at the initial stage of digitalization Telenokia (Finland) has proposed together with their switches the PCM equipment to ensure connectivity with the existing analog networks. The weight of this problem can be illustrated by the following figures. In 1993 in the Volga/Ural area 21 digital switching systems of nine different types were installed. They serve about 120000, the total number of the PCM primary systems needed is 1954. 1222 of them are used for the connection with the central offices of the public network, 548 are needed to provide the connections between modules of the newly installed switches and 184 support remote switching units (RSU). There are no special requirements to the PCM equipment supporting RSU's and internal interfaces, but the majority of the systems used for external connections has to support the conversion of the analog super vision signaling into the digital channel associated one.

The producers, who want to provide general solution, have to adapt their transmissions equipment also. This was done by Telenokia Finland in the early 1980's for the PCM primary systems or by Nicola Tesla Yugoslavia for the frequency multiplexors with the in-band signaling for the toll switch. This is done by Siemens Germany and NEC Japan right now. Other companies use the equipment produced inside CIS taking advantage of its relatively low cost.

Another problem which becomes more and more important is the operation and maintenance of the equipment. That is why it is strongly advised by the Ministry of Communication not to use more than two different systems in one area. This problem becomes very complicated on the rural networks where the new digital switch, if it is installed as a Central Office, has to support remote maintenance of the terminal switches of different electromechanical systems.

The problems of repairment, training etc. also exist, but we do not think that thay are specific for our countries.

Some examples

In this chapter we would like to show some examples of the new equipment installation in the different areas of the former USSR.

The first project we will touch is the digital of the Fergana/Kokhand area in the Republic of Uzbekistan. There several digital switches produced by Korean company DAEWOO TELECOM are installed. The network diagram is shown on the figures 4 (Fergana) and 5 (Kokhand).

The newly installed exchanges, adapted with the assistanse of the authors, are connected to the existing network by means of fiber cables. The number of channels is shown on the links, the number of subscriber lines served by the switches are shown near the circles representing the exchanges.

There is another feature of the project worth mentioning. One of the specific types of equipment used in CIS is the so called Special Services Node (SSN) - a switch providing access to the emergency services (like fire brigade, law enforcement and emergency medicare) and information services (more about it see in [4]). In this project we have a distributed SSN and the services are organized on the several exchanges.

The existing environment is electromechanical. The main type of the switches is ÀÒSÊ or ÀÒSÊ-U, which is the branch name of the Soviet crossbar exchanges. The new nodes are connected to then via 30 channel (2 Mbit/s) and 120 channel (8 Mbit/s) PCM links with analog-to-digital and signaling convertors installed on the analog exchange side.

The toll switch in Fergana is a Soviet semielectronic one with a software control (brand name is QUARTZ). It is rather flexible and that has eased an integration problem on this particular site.

Figure 4. Network Diagram of Fergana Area

Figure 5. Network diagram of Kokhand Area

Figure 6. STAREX installation in Samara Network Diagram

Figure 7. Khrakov Network Diagram

Kohhand network uses Fergana toll switch with connection via frequency division multiplexors. That is why the special signaling convertor called AZTS is needed to convert the out-of-band signals into the in-band ones.

There was another rather specific problem. The PABXs used in the area are mainly small crossbar switches used normally on rural networks. So there was a dilemma whether to implement rural interfaces in the digital switch or to modify the signaling via the links to PABXs. Luckily the local administration has chosen the second option thus saving a lot of money, though it was an effort for the operator engineers. It is unlikely that such a problem can be encountered in big industrial centers, but it is typical enough for some areas to be mentioned.

There is no much examples of such a modernization of the telephone network of the whole region. More frequently operators install just single switches.

Next example is the typical one. That is introduction of one new digital switch into the existing environment. The switch is the STAREX-TX1, produced by the Gold Star Information and Communication (GSIC) company from Korea. The city is Samara,

situated on the banks of the Volga river. The environment is mainly electromechanical (see diagram on fig. 6). There is only one digital switch (number 41) MT-20/25, produceed in Russia (Ufa city, company BETO) under the license of Tomson CSF France. The connection with the existing network is done by means of the PCM transmission equipment with secondary multiplexion PCM system. In comparison with the case of Fergana/Kokhand we can highlite that there is SSN concentrated in one place. It is based on the digital equipment (MT-20/25).

The last example we want to cousider is the introduction of the ALCATEL 1000 E10 switch in the city of Kharkov (Ukraine) as shown on the network diagram (fig. 7). This case is very intresting because E10(#14) is connected to the network via MT-20/25 (#10/11) using CCITT R2 signalling which is supported by both systems.

This shows us the difference in the technical policy of Ukraine. The R2 signalling is not allowed on the interoffice link anywhere else in the CIS, though it is used inside PENTACONTA crossbar switches and as internal interface in some PABX. It is considered not feasable to allow another signalling system now, when the intruduction of CCITT CCS7 has started. But it was decided to use R2 in Kharkov, though E10 is fully adaptated, to reduce the complexity of the project.