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DISTINCTIVE CHARACTERISTICS OF CALL-HANDLING PROCEDURES AND SIGNALING LOGIC IN A RUSSIAN PUBLIC TELEPHONE NETWORK

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***Abstract*–This article describes main peculiarities of former Soviet Union public switched telephone network (PSTN), signalling systems, call hadling procedures, charging principles, etc. General information about PSTN is also included. The primary goal of the paper is to show some specific PSTN features and give the classification of the existing interfaces rather than to describe existing exchanges in detail.**

I. INTRODUCTION

ALTHOUGH the Russian Ministry of Telecommunications is introducing digital local telephone exchanges, there remains the necessity for this new equipment to interwork with the existing analog switches and with operator-controlled toll switches. This article describes major distinctive characteristics of the Russian Public Switched Telephone Network, in particular, characteristics of the signaling systems, call-handling procedures, and charging principles. General information about the Public Switched Telephone Network is also included. The main sections are: Section I, an overview of the signaling systems used in Russia as well as on all of the territories of the former Soviet Union; Section II discusses types of line signaling systems; Section III: automatic number identification (ANI); Section IV: signaling–a mixture of almost CCITT Rl frequencies and almost CCITT R2 signaling logic; Section V: long-distance incoming call status.

The primary goal of this paper is to show some specific Public Switched Telephone Network features rather than to describe existing switching systems in detail.

II. OVERVIEW OF THE SIGNALING SYSTEMS USED IN THE TERRITORY OF THE FORMER SOVIET UNION

It is known that the former Soviet Union covered one-sixth of the globe. This was the country which had no apparent aspirations either to have close ties with the other parts of the world or to use international standards. One of the most vivid proofs of this is its distinctive telephone network interfaces. All the peculiarities appear to be juslifted[1] if looked upon from the inside, but are extremely hazardous in the era of global integration. However, nobody can throw away the whole telephone network of fifteen countries and substitute it with a new one, similar to the American or the European networks.

The core of the Public Switched Telephone Network of the former USSR is the electromechanical switches, crossbar, and step-by-step. The existing protocols are designed to suit them. For a rather long time, new digital switches will coexist with the old analog ones. The necessity of implementing the interfaces with existing networks has a big impact on the newly installed equipment. The existing signaling procedures are mainly end-to-end ones, which is quite understandable in the context of analog networks providing metallic connections between the parties involved in the call set-up. Almost every electrical signal can be transferred through

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wires and relay contacts. That is not so in the case of digital switches with internal time-division switching networks. There, link-to-link signaling seems to be more appropriate. That should be kept in mind when the signaling systems of the former USSR are considered. Here, we have a paradoxical situation in that the old electromechanical switches can offer better performance than the digital ones, despite the fact that the old switches are not sophisticated enough for intermodule communication within themselves. The existing protocols do not make it possible to use all the advantages of modern technology, though they are extremely convenient in the old technology. The only way to resolve this contradiction is to install more and more digital switches using interfaces which do not disrupt their digital functionality and to wait for the COCOM restrictions on CCS to be lifted. We shall now try to explain what our signaling system is, how it has appeared how it can be tested, and what is its internal logic.

Some of the distinctive characteristics of the signaling methods to be considered have appeared not only due to the mostly electromechanical environment, but also due to the structure of the national network and its economical performance. We will say just a few words about this. Those interested in further details should consult other sources (eg., [1]).

First, we have to look at the structure of the network. The Public Switched Telephone Network existing on the territory of the former USSR consists of a number of local networks connected among themselves by means of toll or long-distance trunks. The Public Switched Telephone Network structure is roughly represented by Fig. 1, where UTN stands for the urban telephone network.

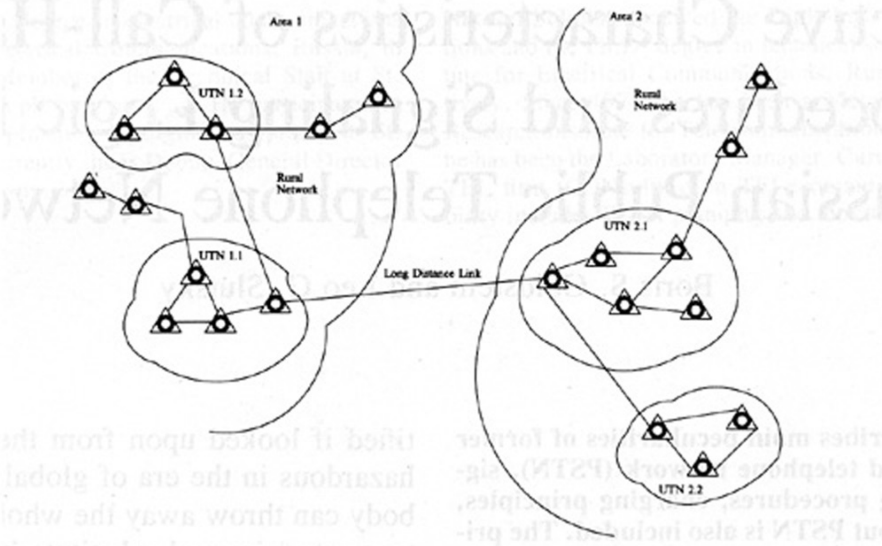


Fig. 1. Simplified PSTN structure.

The national network shown in Fig. 1 consists of a number of separate entities, which differ both in their position in the hierarchy and in their function. One can distinguish two main levels: the local and the long-distance (toll) networks.

Local networks covering regions within one area do not charge subscribers for the calls terminated within their limits. The only revenue these enterprises receive are the installation and flat-rate fees. That is why they cannot support themselves and were originally subsidized by the state. As soon as a call is bound for a destination in another local network, even within the same area, it has to use toll facilities, and is charged according to its duration and the distance between the parties. The simplified structure of a local urban network is given in Fig. 2.

Fig. 2 shows a network of a big metropolitan area, such as Moscow or St. Petersburg. Such a network is characterized by the seven digits closed numbering plan, which provides for up to eight million subscriber lines to be us in the area. In every city, the digits zero and eight are reserved for use as access codes to the toll switch and the special services node (SSN), respectively. If an urban network is smaller than eight hundred thousand lines, the incoming tandems are absent; in the network, smaller than eighty thousand lines each of the central offices are conested to each other. It is clear that in the structure shown in Fig. 2, each central office connects to three functional groups of trunks: one outgoing and two incoming ones. There are two kinds of interfaces, local interfaces and toll incoming interfaces.

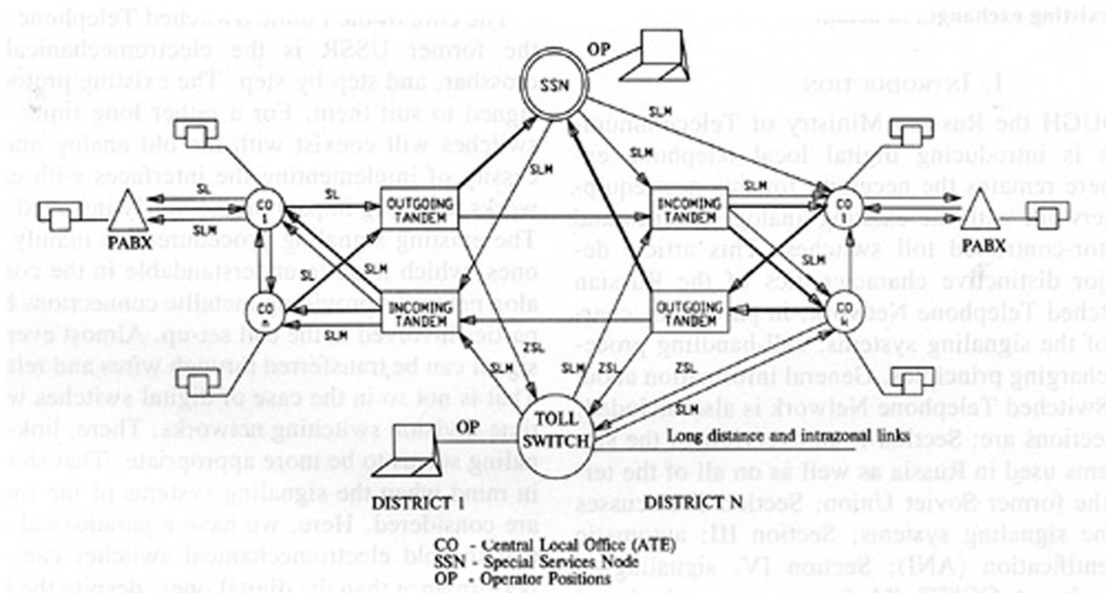


Fig. 2. Metropolitan network structures.

The difference in call handling of toll calls makes it necessary to provide some criteria to recognize the call as long distance one. The simplest way is to organize different trunk groups, a system actually used in the urban networks. At this point, we should just mention that in rural areas the trunk groups are relatively small, much more expensive, and their usage is lower; therefore common trunk groups are frequently used, and the criteria is provided by means of signaling protocol. One can predict that digitalization of rural networks will decrease the number of such common groups, and the signaling system will be more like the type used in urban areas. Thus, we can anticipate that the most frequently used urban signaling systems will stay in place for the time being, until CCS/SS7 is introduced into the system.

The following should be kept in mind when considering the signaling system of the former USSR:

1. only long-distance calls (calls coming through toll switch) are charged;
2. no tones are transmitted through the toll (interurban) network;
3. toll calls are serviced with priority by a local switch.

In consideration of item 1, the calling party identity should be transmitted to the toll switch, that provides the capability of making the calling party identification (CPI) remotely from any destination on the local network.

In consideration of item 2, the status of the called party should be defined by the terminating local CO and transmitted to the originating toll switch by means of supervision signals.

In consideration of item 3, the incoming toll call handling by the terminating central office differs greatly from the local call setup and should be supported by the signaling protocol. In the former USSR network, the calling party identity can be transmitted all over the analog electromechanical network, a feature mostly available only on fully digital networks with common channel signaling.

This feature is called automatic number identification, or ANI, and is already very well known to the western telecommunication equipment producers trying to introduce their systems in the former USSR countries. We will refer to this function by its internationally recognized name, calling party identification (CPI) and describe it generally in the appropriate part of this paper. What remains to be mentioned here is that this advanced network feature is implemented in a way which is rather simple to use in electromechanical switches. These switches pose no problems, such as stability loss, and the connection setup process involved is not sophisticated. In digital exchanges, the implementation of this feature leads to some performance degradation of the modern system and takes up a lot of resources.

III. Signaling Systems Classification

As it was already mentioned, there are two big classes of signaling systems in the public telephone network of the former Soviet Union: the local and the long-distance signaling. They are different as a result of the differences in the call set-up procedures.

The local signaling systems, in their turn, are subdivided according to their application, rural or urban, and according to the physical appearance of the signals.

We should mention that the signaling protocols in all the cases differ slightly from one another. In addition, one can distinguish, as everywhere else in the world, supervision signals and address or register signals.

A rough classification of the signaling systems is shown in Fig. 3.

The existing types of local supervision (line) signaling are presented in Fig. 4.

The abbreviations used in Fig. 4 are as follows:

- *DC* direct current.
- *FDM* frequency division multiplexing.
- *CO* central office.
- *PCM* pulse-code modulation.
- *VF* voice frequency.
- *CAS* channel-associated signaling.
- *AC* alternative current.

The field of application of each of these systems is defined in accordance with the distinctive characteristics of the network. As it was already mentioned, the protocols supporting two-way trunks with the possibility of calls coming both from local and toll switches are used mainly in rural areas. Sometimes, however, they exist in the cities to provide, for example, a connection between the old types of PBXs and central offices, especially when a PABX is situated in some remote area with no switching facilities in the neighborhood.

The rules regulating the use of this or that system exist, in principle, but frequently they are not complied with. Nevertheless, there is a tendency to follow some rules while introducing new equipment: any digital urban public office should have only 2Mbit PCM interfaces, according to CCITT G.703, G.711, and the main signaling system is the two-bit channel-associated signaling with different outgoing, incoming, and toll trunk groups.

In rural areas, PCM 2Mbit interfaces are the most preferred, but in many cases, bi-directional versatile trunks have to be supported, so another protocol is to be used.

Other kinds of transmission media can also be used according to the local circumstances. The most unusual but frequently used media are PCM-15 (IMbit) and PCM-12. The network share of the latter is shrinking now, but the former is still widely in place, though it does not comply with any international standard.

Along with the line status, information on the called and calling party directory numbers may be needed. This information can be presented either in the form of dial pulses (DP) or in the form of voice-frequency combinations. Dial pulses are transmitted in the same way as the supervision signals. This transmission occurs in the form of direct current signals in a direct current trunk, as a modulated in-band or out-of-band frequencies, or as a sequence of ones and zeros in the corresponding time slot in case of PCM channel-associated signaling.

The presentation of the address information in the form of an in-band multifrequency code (MFC) makes the transmission faster and more reliable. There are three major types of the MFC: MFC shuttle, MFC packet, and

MFC train. All of the three use the same frequencies: 700, 900, 1100, 1300, 1500, and 1700 Hz. A combination is valid if it consists of two and only two frequencies out of the six mentioned.

Thus, this is a typical constant weight code with fifteen six-bit signals and with the Hemming distance between the combinations equal to two.

Only ten digits are used for the address information, so additional combinations can support some auxiliary features of the protocols. The classification of the register signaling types is shown in Fig. 5.

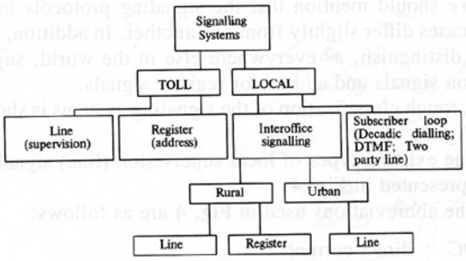


Fig. 3. Signaling system classification.

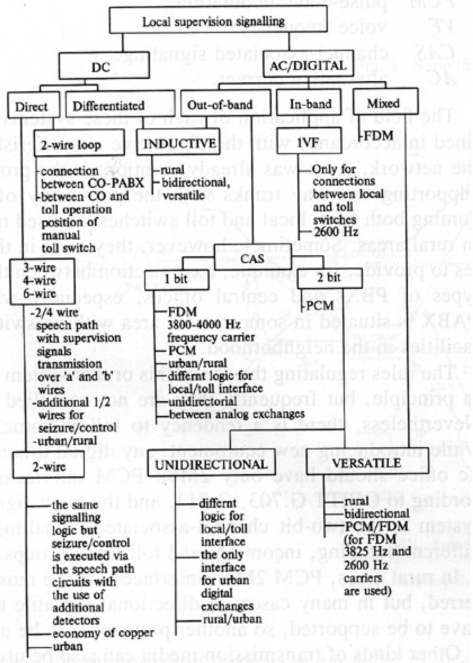


Fig. 4. Classification of the existing supervision signaling systems.

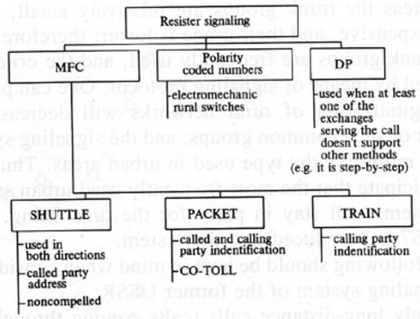


Fig. 5. Register signaling types.

TABLE I

SIGNALING APPLICATION AREAS.

N	Type	System Dependency	Network Level Dependency	Used for Called Party Address (BDN)	Used for AMI Calling Party Identification (ADN)
1	Dial Pulse	Step-by-step Cross-bar and digital do not Support MF Shuttles	Anywhere	Yes	No
2	MF Shuttle	Only Crossbar and digital (preferable)	The same level of descending	Yes	No.
3	MF "Packet"	Toll Switches AMTS-2, AMTS-3, Quanz, Metaconta		Yes	BBDN(3)
4	MF "Train"	Anywhere	No Anywhere	If BDNd((1) orBDN(2)	

It should be mentioned here that a polarity-coded-number transmission is used mainly between different control devices of the rural crossbar ATSK-100/2000 switches. Sometimes, however, it is also used on the trunks between the exchanges of the same type, in order to speedup the connection setup. Here, polarity, as well as the number of pulses, is important.

In our discussion of MFC, the use of R2 code should also be mentioned. This code is used within such crossbar switches as PENTACONTA 1000, but it is not used on the trunks between central offices, although a significant number of foreign-made exchanges can support it.

Table I specifies the cases in which different signaling types are used to transmit information on the called B-party directory number (BDN) and on the calling A-party directory number (ADN). ADN is generally used for the purposes of toll calls charging or malicious call indication (MCI). The terms "descending call" or "ascending call," as used in the table, should be understood as calls going from the toll switch towards the local switch, and from UTN to the toll switch, respectively.

We would like to highlight once again that all of these systems are country-specific and that their specifications are unlikely to be found in the international standards. The only source of information is the national regulations. For the past several years, work has been done to formalize these regulations in order to support the development of stored program controlled switches [2], as well as to develop simulation equipment [2].

At the end of this brief review of signaling systems, it should be mentioned that the CCITT No. 7 signaling system will be used in the networks of the former USSR as soon as the COCOM restrictions are lifted. The nationalspecific features will have only a minor impact, and the combinations reserved for national use will be utilized to support them. This will provide for an easier integration of the new digital switches into the future digital networks.

IV. Calling Party Number Identification

As previously mentioned, the billing is still done only for the long-distance calls. That is why it is crucial for the toll switch control devices to "know" the calling subscriber directory number. In addition, when other services are provided from some center, the number must also be known.

Some specific arrangements were made to achieve this network-wide identification of the calling party. Though many digital switch producers are now strongly dissatisfied with this feature, the technical decisions made in the late sixties were quite original, taking into account the following considerations:
1. Multifrequency shuttle equipment had already existed.
2. Only electromechanical switches were available. Both factors were favorable to the end-to-end signal transmission, so the party in need of the information could request it directly from the originating office.

Thus, the challenge was to prepare this information and to make an identifiable request for it. The first task was accomplished by using five frequencies of the MF shuttle signaling method. This method provides a capability of encoding 10 digits.

All of the exchanges were to be equipped with the encoding devices at the level of the subscriber access to switch. In order to activate this equipment, conventional supervision signals had to be used. It was decided that the *answer* signal was best for this purpose.

The main consideration in favor of this signal was that the conversation path is switched through before the *answer* signal is generated, which is characteristic of the electromechanical network. When the receiver answers, the code combination corresponding to the originating line of this particular speech path has to be emitted. To be sure that the information is not heard by the called party, any requesting device has to confirm the supervision signal by a tone (500 Hz). The main problem was to eliminate the influence of the speech currents on the information transmission process. Using frequencies from the lower part of the tonal spectrum is quite dangerous because the signals can be easily simulated by the vowels. Precautions must be taken to avoid this problem. The easiest way is to disconnect the originating party from the speech path, so that it cannot influence the information transmission.

All of these arrangements are called automatic number identification (ANI), highlighting the fact that there was no more need to ask the calling party about its identity. Thus, the possibility of automatic long-distance call charging was provided. Prior to the ANI development, the operator had to be called first and had to recall the calling party using the information provided by it. In some cases, for example, when a subscriber had to dial his own number this procedure was modified, and was checked by making a test loop. The aforementioned procedures are well known.

After the new procedure had been developed, the need for the calling party participation in his number identification ceased to exit. Moreover, it was necessary that the caller maintained silence during the identification procedure. Although this mentioned has proven to be good, it has many negative impacts on the digital switch.

The automatic number identification equipment is used to ensure that the information about the calling party (A-party) number be obtained at any point of the local network.

The aforementioned information can be used for

- issuing a bill for a long-distance (toll) call;
- issuing a bill for services requiring payments (inquiries, post-office services, etc.);
- malicious call tracing;
- immediate information about the caller reaching vital services (fire department, emergency medical care, law enforcement officials).

The calling number may be needed at any time during the period of connection. The request for it consists of two parts: the *answer* supervision signal, sometimes called *positive A-wire polarity* due to its direct current representation in the physical lines, and the tonal frequency (500 Hz) signal. On receiving both of these signals, the outgoing equipment should send the requested information in the form of the gapless train of multifrequency code combinations, or the "ANI codogram."

The request can be expected after the trunk seizure in the case of an outgoing call to the toll exchange (the prefix is "8"); before the actual answer in the case of the special services (the first digit of the prefix, as a rule, is "0"); during the time of the called subscriber answer, in the case of the paid services call (no prefix limitations); anytime during the conversation for malicious call tracing purposes (any prefix). There can be numerous ANI requests during the connection, but in any case, the transition from preanswer to answer state is mandatory.

The average proportion of the toll calls is approximately 7%, and in 15% of these cases, a second request is needed due to the distortions of the received information. For 5% of the toll calls, the third identification attempt will be made. After a toll exchange identification attempt is finished, whether or not it was successful makes no difference; the *answer* signal is removed. Between 0.3 to 1.2 seconds can pass between requests. The maximum duration of the attempt is 2.2 seconds, but the last attempt (the second or the third one, depending on the type of toll exchange) is longer–up to 2.8 seconds, though for some types of long-distance nodes, the attempt lasts no longer than 900 ms.

The special services can make an unlimited number of requests with the transition to the preanswer state afterwards.

The number of malicious call source identification attempts is virtually unlimited, but in practice, the existing electromechanical exchanges request information only once, and the electronic exchanges twice without mandatory transition to the preanswer state after the last attempt.

There can be only one ANI attempt when the request is made upon the B-subscriber answer, and, naturally, there can be no removal of the *answer* signal.

There are two possible ways of sending the request, both are shown in Fig. 6. The first one, called *a fixed diagram*, is used mainly by toll exchanges; it is characterized by the fixed duration of the frequency request (90-110 ms). This request is emitted after a certain amount of time (200-275 ms) expires after the beginning of the *answer* signal. The main feature of the other way, called *flexible diagram*, is the termination of the frequency request after the detection of the first digit of the ANI combination. In this case, the 500 Hz signal is generated simultaneously with the *answer* signal and is sent for up to 800 ms, if no information is received earlier.

After the validation of the *answer* signal, the outgoing exchange equipment should switch the speech path from the subscriber set to the frequency request receiver input. If the 500 Hz signal is not recognized in 400 ms, the speech path should be restored.

The frequency request should be detected in a wide dynamic range because the request can come from rather great distances. Short signals, even of high level, should not be accepted.

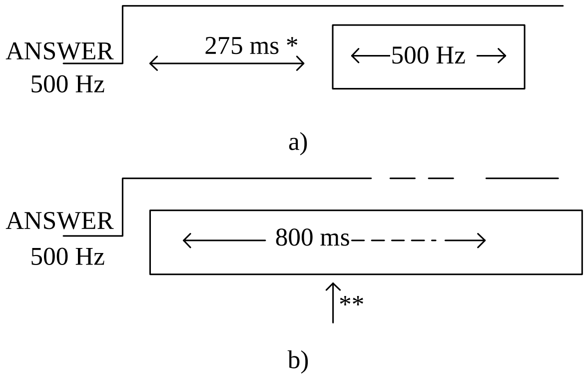
The ANI codogram should be emitted immediately after the frequency request validation. Transmission of the information takes place over the speech path, which remains to be switched off the subscriber set. ANI information consists of nine digits, which are placed within it in following order:

- the beginning signal;
- subscriber category (containing information on the restrictions on access to different services and longdistance network);
- seven digits in the order of increasing decimal positions.

This information is transmitted cyclically, starting from any digit, but, of course, the codogram received on the incoming end should contain all of them. Since the requesting equipment compares the first received digit with the tenth one, and, sometimes, the second with the eleventh, it is reasonable to transmit at least twelve digits. Thus, the transmission takes place over a certain amount of time, or until the trunk signal *request removal* is received. Then the speech path is restored.

Each digit is represented by two frequencies out of the set containing the following six frequencies:

$f0$ = 700 Hz; $f1$ = 900 Hz; $f2$ = 1100 Hz;
$f4$ = 1300 Hz; $f7$ = 1500Hz; $f11$ = 1700 Hz.



*) This time may be absorbed by the ANSWER signal propagation across the network.

) The requesting device can switch off the 500 **Hz signal any moment after the detection the beginning of the ANI codogram.

Fig. 6. Time slot diagrams for ANI request. (a) The fixed diagram. (b) the flexible diagram

TABLE II
ANI CODES

Signal No,	Frequency Components (Hz)	Information
1	700 & 900	Digit "9"
2	700 & 1100	Digit "8"'
3	900 & 1100	Digit "7"-
4	700 & 1300	Digit "6"
5	900 & 1300	Digit "5"-
6	1100 & 1300	Digit "4"
7	700 & 1500	Digit "3"
8	900 & 1500	Digit "2"
9	1100 & 1500	Digit "1"
10	1300 & 1500	Digit "0"
13	1100 & 1700	Beginning
14	1300 & 1700	Repetition

Signals that make up ANI codograms are given in Table II.

Only twelve combinations are used for the ANI information transmission: from No. 1 to No. 10 for ten digits, No. 13, for the beginning signal; No. 14 for the digit repetition.

Since the train contains no pauses between the ftequency combinations, the receiving equipment can recognize a new digit only when the code combinations is changed. Therefore, if a subscriber number and category contain several equal digits occupying adjacent positions, every other one of them in the natural order transcription of the number has to be substituted by the combination No. 14. For example, the subscriber number 222-33-33 (if the subscriber has the second category) will be represented by the following codogram:

13 – 2 – 14 - 3- 14 – 3 - 2
- 14 - 2 - 13 - 2 • • • .

V. MULTIFREQUENCY SHUTTLE REGISTER SLGNALING

Before the mid 1960s, the switching system dominating the Soviet networks was of the step-by-step type characterized by the direct pulse control of the call setup process by the calling party. This had influenced many desigrners of the other, newer systems. (As an example, some Ericsson crossbar systems had to establish a connection through a switching stage during an interdigit time interval.) This led to a number of restrictions on the operation of control devices and, also, to a number of brilliant technical decisions, such as the use of low mass relays, etc.

When the first Soviet crossbar exchange was being designed, it was decided that such principle would be too expensive, so all the digits had to be collected from the originating party at the early stages of the call setup. That resulted in capabilities of changing the code and the protocol of the called party directory number transmission, making it faster and more reliable. It was decided to use multifrequency bursts to transmit the information. The significant parameters in this case are the frequencies of the components of the burst. The most reliable multifrequency signaling system is CCITT R2. In order not to make twelve different filter systems, the Soviet designers have rejected the idea of using different frequencies in different directions, thus also rejecting the handshake procedure of the R2 system. Therefore, in this signaling method, the request and the answer had to be separated in time. This procedure is referred to as a shuttle procedure. The frequencies used by CCITT Rl signaling were chosen to carry the information.

It proved to be rather difficult to develop devices providing a reliable operation in the existing conditions, and it is still a rather challenging task because these conditions have not changed drastically. Although the exchange of information takes place in the absence of the voice currents, the noises, and the spurious disturbances produced by the electromechanical switching elements can greatly influence the process. Moreover, the existing analog network requires detector operation in the wide range of levels, and a different attenuation of different frequencies has to be considered.

The following explanation adds detail to the idea of the MFR shuttle.

Each burst is a combination of the constant weight code "two out of six," comprising the total of 15 elements. Every signal is formed by two frequencies out of the following: *f*0 = 700 Hz; *f*l = 900 Hz; *f*2 = 1100 Hz; *f*4 = 1300 Hz; *f*7 = 1500Hz; *f*ll = 1700 Hz. All requirements concerning time parameters and dynamic range are specific to the networks of the former USSR. The signal duration is 45 + 5 msec. The range of acceptance of different frequency components is shown in Fig. 7. There are various other requirements which pose great difficulties to the designer.

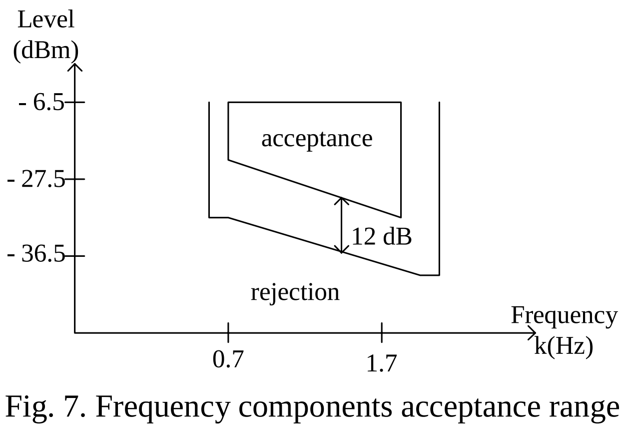


Fig. 7. Frequency components acceptance range

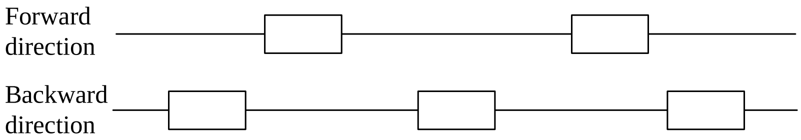


Fig. 8. Multifrequency shuttle register signaling.

First, two frequency components can have different levels due to the signal transmission over the metallic line. In the case of the Moscow network, these lines can also incorporate the Pupin coils. The combination can be accomplished by a disturbing signal with the frequency components belonging to the code set, but with levels of 15 dB below. The relays of some junctors can imitate the MFR signaling pulses up to the time length of 16 ms. They are not expected to disrupt the normal operation of the receiver.

In addition, the receiving equipment has to work normally in the case of a disturbance with frequency 3.8 to 3.85 kHz and a dBM level of up to 17.4 on its input (it can be traced from the carrier of the FDM equipment out-of-band signaling facilities).

The components with frequencies different from the nominal values mentioned previously, up to 15 Hz, should be accepted as valid.

Almost every signal set should be answered by a signal in the reverse direction, as shown in Fig. 8. That is the reason why the discussed method of information exchange is called MFR shuttle signaling. It is thus distinguished from other methods using the same frequencies.

The incoming end equipment will initiate the information exchange by issuing a request to send the required digit of the called subscriber number. The outgoing end equipment waits for this request for up to 4 seconds following the corresponding trunk seizure. An answer should be sent about 70 ms after the end of the request. If something goes wrong with the MFR signaling, the outgoing exchange can release the trunk and can make another attempt to establish the connection.

On the incoming end, 2-2.5 seconds should be given to receive all the information needed.

The MFR shuttle signals set and signaling code are given in Table III.

It is clear that the protocol provides capabilities for increasing the reliability of the information transmission. If there is any doubt about the signal received, a repetition should be requested. The number of such requests has to be limited either by a number of possible attempts or by a guard timer. An example of a signaling scenario in the case of detection of distorted signals is shown in Fig. 9.

The signaling method which was just briefly described will be used in the former USSR networks for a long time.

Note: Signal No. 11 can be used by the local office to request the call category from the toll switch. Signal Nos. 14 and 15 can be used by electronic toll exchange to answer this request, marking the automatic call and the call from an operator, respectively. Signal No. 11 in the forward direction can mark the priority call.

Table III
MFR HUTTLE SIGNALS AND SIGNALLING CODE

Signal Number	**Frequencies**	**Information**	
		Forward Direction	**Backward Direction**
1	2	3	4
1	f0. fl	Digit 1	Requesting the first digit of the called number, in MFR code
2	f0, f2	Digit 2	Requesting the next digit, in MFR code
3	fl, f2	Digit 3	Requesting the previously sent digit (MFR code)
4	f0, f4	Digit 4	The called subscriber is free
5	fl, f4	Digits	The called subscriber is busy
6	f2 f4	Digit 6	Requesting the previously sent digit, received in error (Repetition request)
7	f0, f7	Digit 7	Congestion signal
8	fl, f7	Digit 8	Request to transmit the whole number in DP form
9	f2, f7	Digit 9	Request to transmit all remaining digits in DP form
1	f4, f7	Digit 0	Request to transmit all digits beginning with the previously sent in DP form
11	f0, fll	Spare (*)	Spare (*)
12	fl, fll	Confirmation of the backward direction signals Nos. 4, 5, 8, 9, 10	Spare
13	f2, f11	Request to repeat the previous signal, received in error	Spare
14	f4 ,fll	Spare (*)	Spare
15	f7, f11	Spare (*.)	No information received

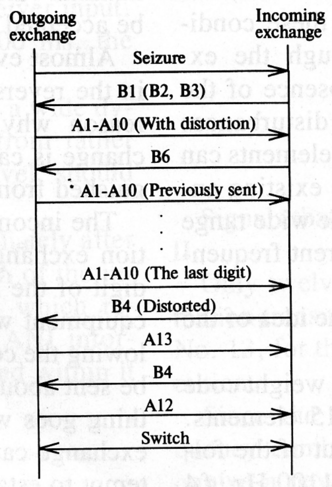


Fig. 9. Signal distortion during call setup to a free subscriber.

VI. CALLED PARTY STATUS TRANSMISSION

One of the most distinctive characteristics in call-handling procedures is the capability for a long-distance operator break-in. This capability is supported by the signaling protocol with the called party status transmission by means of supervision signals. This feature can be used by various services. For example, when a long-distance call is booked in advance, the subscriber expects a longdistance operator to announce it at a certain time which is not very well defined (eg., "at 7 p.m., within a hour"). The break-in feature makes it possible for the subscriber to use his telephone and not miss the booked call; the outgoing operator will break in to inform the subscriber about the coming connection.

Some restrictions that should be imposed on this feature are as follows.

The first restriction is that the person waiting for the call should not be interfered with if he is involved in a long-distance communication. However, electromechanical switches do not distinguish outgoing local and outgoing toll calls. Thus, any outgoing call is considered to be local and is a possible victim of an operator break-in. Of course, software controlled switches can protect calls on the basis of an access code analysis, but the feasibility of this is rather doubtful.

Sometimes, such intrusion can be disastrous to the information transmission process. Of course, such things as facsimile, data transmission, e-mail, etc. did not exist before WWII, but now one has to keep them in mind. We think that the best way to decrease the probability of a trunk offering is to provide some time for automatic toll switches to disconnect before the actual break-in.

This solution becomes evident after the following scenarios (Figs. 10 and 11) are considered. Fig. 10 shows a case of operator break-in when the called party is busy with a conversation (This feature is known as *trunk offering).*

The *called-party-busy* supervision signal is returned by the terminating exchange. It is displayed by a flashing lamp on the operator position. At the same time, offering is taking place, and there is a three party connection. When the called party decides to clear the existing connection and hangs up, the *called-party-free* supervision signal is sent. It is displayed on the operator position and the long-distance connection is set up.

When the long-distance call setup is automatic (Fig. 11), the *called-party-busy* causes disconnection. A short-duration three-party connection can take place, so that it is possible to delay the break-in in order to avoid undesirable calls. The delay should be sufficient for the automatic toll switch to generate a disconnect procedure. This will reduce the number of conference bridges needed at the local office because the operator-assisted calls are far less numerous. Also, the probability of disrupting data transmission will be reduced. The time-out will not be noticeable to the operator.

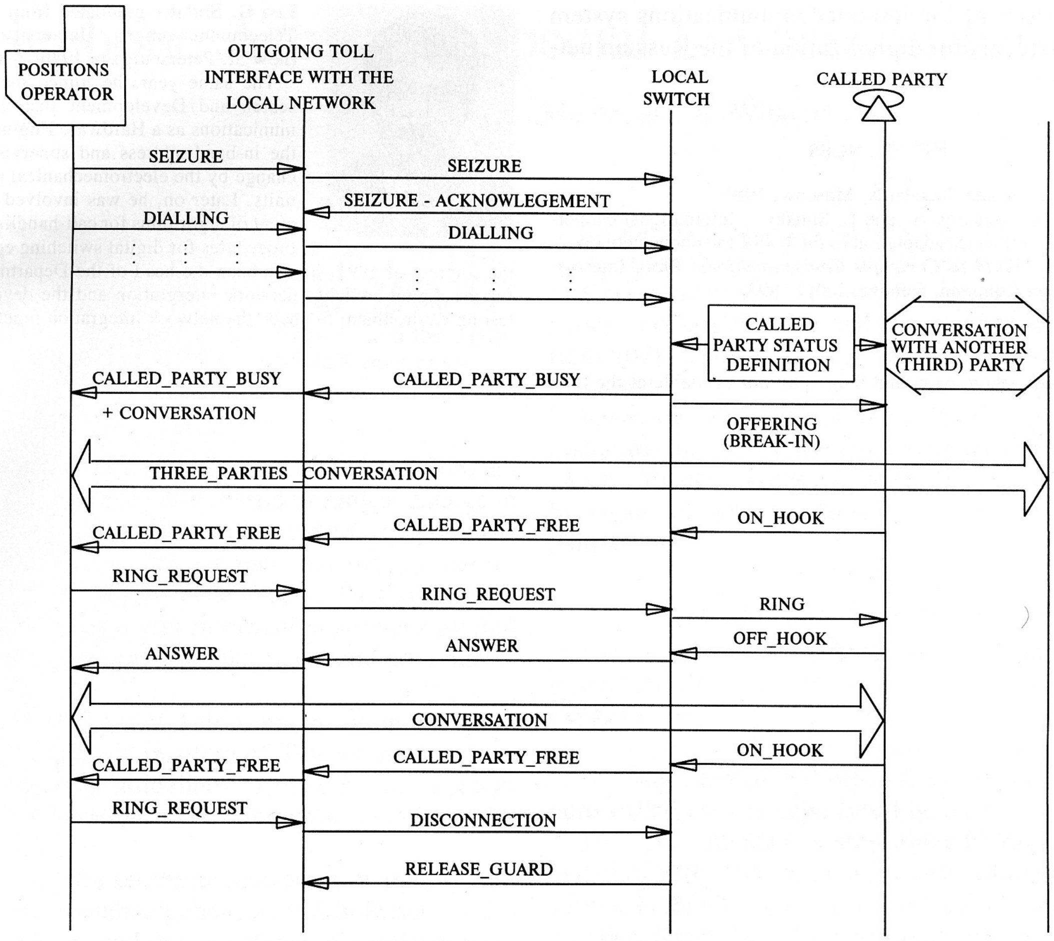


Fig. 10. Operator controlled connection. Called party is busy Operator break-in

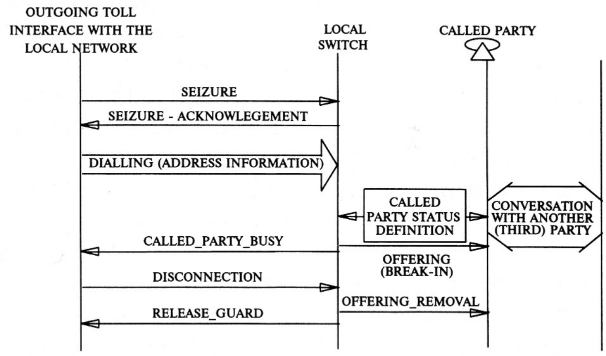


Fig. 11. Automatic call set-up. Called party is busy.

VII. Conclusion

We have described the most important distinctive characteristics of the network. Many other specific characteristics exist. Altogether, the important and numerous distinctive characteristics are to be taken into account in the process of digitalization of the Russian telecommunications network. Significant efforts will be needed for that, and we hope that this paper will serve as an introduction into understanding the differences between the features and characteristics of foreign telecommunications system and the requirements for digitalization of the Russian networks.

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Boris S. Goldstein, photograph and biography not available at the time of publication.