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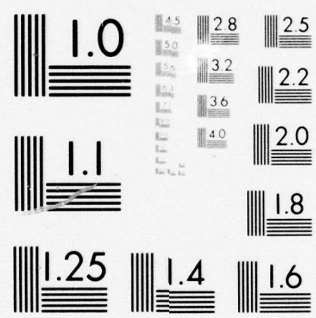

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NATIONAL BUREAU OF STANDARDS-1963-A

U S ARMY INSTITUTE FOR ADVANCED RUSSIAN AND EAST EUROPEAN STUDIES

STUDENT RESEARCH REPORT

Mr. Richard A. Rothermel

THE SOVIET INTERCITY TELEPHONE NETWORK
IN
THE AGE OF OVERLOAD

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IN

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F O R E W O R D

This research project represents fulfillment of a student requirement for successful completion of the overseas phase of training of the Department of the Army's Foreign Area Officer Program (Russian).

Only unclassified sources are used in producing the research paper. The opinions, value judgments and conclusions expressed are those of the author and in no way reflect official policy of the United States Government; Department of Defense; Department of the Army; Department of the Army, Office of the Assistant Chief of Staff of Intelligence; or the United States Army Institute for Advanced Russian and East European Studies.

Interested readers are invited to send their comments to the Commander of the Institute.

RICHARD P. KELLY
LTC, MI
Commander

SUMMARY

This study is an attempt to determine the overall condition of the intercity (long-distance) telephone system of the Soviet Union. The focus of the paper is on the telephone system of the USSR Ministry of Communications, with its nationwide network of intercity telephone stations; it touches only briefly on "departmental" telephone service (not a part of the Ministry of Communications), and it deals not at all with military communications. Local (city and rural) telephone facilities are discussed only to the extent that they relate to the intercity system.

Prefaced by an introductory survey of some of the technical features of telephone service pertinent to this study, the paper goes on to provide a lengthy discussion of specific problems in the Soviet intercity telephone system, presents detailed descriptions of operational procedures at the intercity stations, and describes some of the Soviet plans for the future. Nearly all of the foregoing is based on original research of Soviet literature on the subject (textbooks, professional journals, and numerous local and national Soviet newspapers).

Some of the findings of this study are as follows: the Soviets find their intercity telephone system to be inadequate in a number of ways; they are occupied with modernization and expansion on a broad scale, gradually replacing outmoded equipment with more reliable modern gear, expanding and

increasing the channel capacity on their cable and radio-relay mainline systems, and are gradually changing over to a unified automated system designed to handle the huge volume of digital information generated by the introduction of electronic computers in the management of the national economy. As a result of obsolete and heavily overloaded systems prevalent in the network as a whole, the Soviets are forced to rely to a great extent on manual operations just to cope with the current workload, while the system in general will require "radical" improvement before it is able to cope with the demands placed on it by the computerization of the economy. In all probability, the modernization campaign will go on for a long time.

(In treating this rather complex subject, the paper attempts--with varying degrees of success--to satisfy both the layman and the communications expert by limiting as much as possible technical details and jargon in the report proper and including such detailed descriptions in the appendices, where they might be helpful to those who possess detailed knowledge, or to those who aspire to such knowledge, or who are just naturally curious.)

* * *

Special thanks are due to Captain John C. Reppert, U.S. Army Signal Corps, for his encouragement, his counsel and support, and his careful criticism of this project.

Figure a-1. Clockwise from lower left: M-60 switchboard (Vestnik Sviazi No 9-1969); radio relay towers (Tekhnika Molodezhi No 3-1976); Switchboard room of large intercity telephone station with M-60 switchboards (Vestnik Sviazi No 1-1976); and probably "Mars" antenna (Tekhnika Molodezhi No 3-1976).

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INTRODUCTION

The XXIVth Congress of the Communist Party of the Soviet Union, which was held between 30 March and 9 April 1971, called for a significant improvement in the telecommunications system of the USSR during the 1971-1975 Ninth Five Year Plan. In the late 1960s and early 1970s, in the nation as a whole, an extensive project was already under way for complete automatization of its telephone facilities. Obsolete, unreliable switchboards, and outmoded electromechanical switching equipment were to be dismantled and replaced with the more reliable electromagnetic switching frames of the "crossbar" system. Presently, when the Soviets speak of modernization of their telephone stations, for the most part they are referring to the introduction of the crossbar system, which uses electromagnetic contacts of precious metal to perform its switching and line-finding functions, is faster, more reliable, and requires less maintenance than the equipment it is intended to replace. In 1970, the Soviets reported that approximately 15 percent of the districts (raions) of the nation were equipped with crossbar equipment. The telephone industries of Sweden and Hungary are deeply involved in the manufacture and installation of crossbar telephone stations in the USSR.

But introduction of modern switching equipment is only part of the Soviet telecommunication problems. It is also necessary to "force", to use the Soviet term, the construction of "mighty" intercity cable and radio-relay lines using the "most modern methods" of multiplexing. One Soviet answer to this problem is a 1,920-channel system (developed in cooperation with the Hungarians), which provides a theoretical capacity of over 11,000 channels for a planned 7,000 miles of long-haul circuits. This system reportedly completed its trial period in 1973; however, by 1975 its capabilities were not being realized, partly owing to bottlenecks and lack of coordination in procurement and installation of the necessary peripheral equipment (antennas, cable-matching gear), and partly owing to noise problems (the system operates on vacuum tubes). A 3,600-channel basic capacity system, said to be "automatized and more reliable" was also being "developed."

As of the early 1970s, the USSR Ministry of Communications did not have a reliable, high-speed data transmission system. Yet there is an urgent requirement for improving reliability, speed, and flexibility in their telecommunications system as a whole. At the same time, the Soviets were discussing a "secondary" telephone and telegraph network, which was to use pulse-code modulation for transmission of "all types" of information (but which is particularly advantageous for sending digital information).

Fearlessly disregarding the GIGO concept (Garbage In - Garbage Out), the Party has decreed that massive computerization will be the salvation of the Planned Economy (A prominent Soviet economist estimated that, otherwise, every adult in the nation would be involved in the planning process by the 1980s).

The XXIV Party Congress called for significant growth in the production of electronic computers during the Ninth Five Year Plan. A prerequisite for the development of a nationwide network of computer centers, however, was a "radical improvement" in communications facilities. The Soviet answer was the EASS (Edinaia Avtomatizirovannaia Sistema Sviazi - United Automatized Telecommunications System), a unified network of central exchanges, stations, and lines of communications to be erected all across the USSR, for transmission of "all types" of information, and which is to be controlled by electronic computers.

That the Soviets intend to improve and expand their telecommunications system is no doubt true. The scope of their planning clearly indicates that Soviet planners have been neglecting their telephone system for many years, so that it is a potentially serious bottleneck in their system of directing the economy. (In the Planned Economy, nothing is supposed to happen without the Plan.) For many years, the Soviets relegated their telephone system to the group given secondary attention in their economy (the first group being heavy industry and defense-related industries); now they appear to be paying the price for that neglect.

Analysis of operational processes (methods of establishing connections, organization for intercity telephone service) reflected in current Soviet literature reveals a significant degree of manual operation, partly owing to the predominance of obsolete control and switching equipment, and partly to a significant lack of channel capacity, characterized by the extensive use of an advance-booking system via manual switchboards for placing intercity calls--all of which testifies to a heavily-overloaded system that it may take years to modernize and replace, other things being equal.

Thus, in spite of official Soviet optimism, the future may not be as rosy as their rhetoric suggests. They are faced with an enormous project, and the sophisticated equipment their planning calls for is of the type which requires very high standards of uniformity and quality--an area in which the Soviet (non-defense) industry has inherently performed poorly. Therefore, the Soviets will be depending to a great degree on foreign assistance in order to complete their modernization campaign.

In spite of the difficulties, the Soviet system will, of course, ensure that their most important functions receive first priority in the use of the telecommunications system at the expense of all the rest, and the Party, the key industries, and the military who use the facilities will not suffer as much--yet from all indications the Soviets will be a long way from optimum service for some time to come, and without optimum transmission facilities, the "computerization" of the economy cannot be fully realized.

PREFACE

The Age of Overload

An American journalist writing in Newsweek[1] describes a crisis in the American telephone system, in which "circuits are overloaded beyond anybody's wildest dreams." We are living, the author declares, in "The Age of Overload," but we are experiencing a revolution in telephone service at the same time. One means for coping with the problem of overloaded circuits is to design switching and control systems which operate at extremely high speed. "The transistor," the Newsweek article continues, "...makes the modern telephone office identical with the modern computer... The new switchboards can be altered now like a computer, by reprogramming."

The Chief of the Soviet Central Scientific Research Institute of Telecommunications, writing in Vestnik Sviazi (Herald of Communications)[2], flatly stated that existing Soviet switching and control systems are not suitable for computer control, partially because of the relatively low speeds at which the switching gear operates, and partially because of the unreliability of Soviet computers. (More than likely the unreliability factor is deciding; after all, as long as the computer is faster than the switchboard, one should be able to interface; it is possible that peripheral gear for interfacing is lacking also.) Electromechanical switching devices were the mainstay of the Soviet intercity telephone network at that time (1970); this equipment performs mechanical operations "with clanking regularity" at speeds measured in seconds. Relatively newer equipment, which began to be introduced in the USSR in the mid-1960s (Crossbar system), operates on electromagnetic principles, and performs its switching and line-finding functions at speeds measured in milliseconds. Electronic computers, on the other hand, are capable of executing millions of operations per second. In the early 1970s, electronic switching devices of Soviet manufacture were present only in the experimental stages.[3]

There is considerable evidence in Soviet literature to indicate that the Soviet Union is also feeling the effects of the Age of Overload. In this paper, some of the features of the Soviet telephone system which create difficulties for them, and some of their plans for modernization will be discussed. Additionally, the paper discloses some of the ways in which they are attempting to cope with the situation in the meantime.

A Soviet engineer-scientist, writing for a journal of the Novosibirsk division of the Soviet Academy of Sciences, Economics and the Organization of Industrial Production (No. 1-1975), has a few interesting thoughts to share on contemporary use of the telephone:[4]

> A scientific investigation completed in the late 1960s revealed that, while such persons as dispatchers spend up to 70 percent of their time on the telephone, and workers in the service industries--up to 50 percent, the average specialist spends an insignificant amount of his or her working hours on the

> telephone; which, it would seem, does not have a great effect on the accomplishment of other duties. It turns out to the contrary: people are spending more and more time on the phone, and the number of times one turns to the phone per day is growing steadily. A few years ago, the average length of telephone conversations was 110 seconds. Today it is more than twice that amount. At the same time, the total number of telephones in the world has doubled in the last ten years.

(The growth rate was even greater in the USSR. Please see Appendix A, the table showing the number of phones.)

The Soviets are planning and building a "United Automatized Telecommunications System" as the overall solution to their problems. The same Soviet engineer-scientist relates an incident which reveals some of the frustrations in the interim period:

> Now we are actively enjoying the use of automatic intercity telephone communications, which is a part of the EASS being built in our country. When using this type of communications [however], we frequently forget about the fact that we no longer have an operator to advise us as we are accustomed: "Is this 25-30? Novosibirsk is calling. Go ahead, please." The party in Moscow, hearing your voice and thinking it is just a local call (not really listening to what you said--your call interrupted his train of thought) says, "No, Petrov isn't here; he's in the next office," and hangs up on you!
>
> Now you have to start all over again and dial that eighteen digit number again and again. As it turns out it is already busy, and the automatic system hasn't helped you a bit!

<u>8-801-0621242-2712979</u>

It will be explained later just how the Soviets arrived at a system that requires dialing <u>eighteen</u> numbers in order to "direct dial" from Novosibirsk to Moscow, and also why. (By the way, this is about the same distance as from Chicago to Los Angeles.) But first, it may be helpful to examine the workings of a telephone station in some detail, and gain some appreciation of what goes on there. This will provide a basis for evaluating the Soviet System.

Manual Servicing

A brief outline of the major operations occurring in making a call through a manual office (this is an office in which the connections are made by the telephone operator rather than automatically as in a machine switching office) will illustrate the principles.

Removing the receiver from the hook, or, for hand sets, the removing of the hand set from the cradle, closes switch contacts connecting the instrument across the line to the central, where a signal lamp associated with this particular phone lights up on the switchboard. The operator responds by plugging into the corresponding answering jack on the board, asking for the number, and then completing the connection by means of another plug cord. Ringing is then usually done automatically until the called party answers or the calling party hangs up. When the call is over and the parties hang up, other supervisory lamps on the board light and indicate to the operator that the connection should be removed.

When a community has more phones than it can handle, more offices must be provided to handle them. The various offices serving a community constitute an exchange or exchange area. Calls from one office to another can be handled by an extension of the simple process given above, the calling party's operator passing the call on to an operator in the called office who completes the connection. Separate switchboards are used for taking calls, i.e., answering the calling party and requesting the number, and for connecting to the called line.[5]

Automatic Servicing

Dial, or more accurately, machine switching performs the connecting functions automatically under the direction of the dial of the calling telephone. Dialing the number sends pulses to the central office, these pulses being used to control the necessary switching. The simplest dial system [Emphasis mine-RR] is the rotary selector or step-by-step system,

> which will be outlined to illustrate the principles involved.
>
> When the calling party removes his receiver from the hook, the line circuit is closed through the dial contacts. Instead of a lamp lighting on a board as in the manual system, a line finder starts searching for the calling line. This searching is initiated by the closing of the hook switch contacts at the calling subscriber's phone and is terminated when the finder locates the line. The subscriber then hears the dial tone indicating that the office circuits are ready to receive the call. The subscriber then dials the number, one digit at a time. For each digit a number of pulses are sent over the line, the number corresponding to the number being dialed. These pass through the line finder connections to a switching device called a selector. This is a notching relay mechanism, which will be notched up one step for each pulse, there being ten steps to handle the range of possible values for each digit. When the sequence of pulses stops (this happens when the subscriber rotates the dial for the second digit), the selector automatically rotates by steps until it connects to a second selector which is not busy. This second selector responds to the second digit pulses in the similar manner, and so on. When all the digits have been dialed, if the line is not busy, the connection is completed automatically and the called phone is rung. Upon <u>completion</u> [Emphasis mine--RR] of the conversation, the parties hang up and all switches return to normal.[6]

The first commercial automatic exchange went into operation in La Porte, Indiana, in 1892. It employed the step-by-step principle, much like that described above. (Originally the customer operated a push-button to generate the pulses. The dial system was not invented until 1896.)[7]

Establishing Connections: Switching

Establishing a connection between any two phones out of a large group is a complicated process, even in the simplest situation, where both phones are served by the same switchboard. It is necessary to:

(1) observe that a customer wishes to make a call;

(2) connect the switching mechanism to his line;

(3) determine what telephone he wishes to be connected with

(4) select a speech path between them which is not already in use;

(5) determine whether the wanted telephone is idle or busy;

(6) if idle, ring the bell, or, if busy, inform the calling customer;

(7) determine when the call has ended; and

(8) restore all equipment to its original state, in readiness for other calls.

If the phones are served by different switchboards, perhaps in widely separated cities, it is also necessary to determine what switchboard serves the wanted telephone and how it may be reached.[8]

Common Control Systems

Thus far we have considered only one automatic switching system, the step-by-step system. Several other switching systems have been invented (in the United States and Sweden). For example, an automatic switching system which operates on the principle of "common control," stores the dialed pulses for a short time in a device which then controls the switches either directly or through some intermediate mechanism.

The distinguishing feature of such systems is that the common control mechanisms (known as registers, senders, translators, directors, markers, etc.) are not assigned to the customer for the duration of his call but are used only as long as they are needed and are then free to serve other customers. Thus, each serves many calls per hour, and few are required. Systems using common control have great flexibility and efficiency in the use of channel groups and are especially advantageous for large exchanges and for automatic routing of long distance calls.[9]

The earliest "common control" systems were developed by Western Electric in 1906; a "panel" system was in operation in Newark, New Jersey, in 1915. The most recent common control systems have been crossbar systems (which are manufactured by Bell, ITT, and the L.M. Ericsson Co. of Sweden.) (The Soviets are doing a lot of business with the latter.)[10]

It is important to go into the crossbar system in more detail, since it involves a number of very important concepts in the modernization of a telephone system. (Each of the concepts represents a problem area to the Soviets with their existing--largely obsolete--control and switching equipment.)

The Crossbar Exchange (Please see, Appendix J, page 107.)

The most important concepts in the evolution of the modern types of crossbar exchanges were probably translation, the sender, the marker, the crossbar switch, and the principle of call-back operation:

Translation - 1906 - makes it possible to convert incoming dial pulses from decimal to nondecimal form and, thus, affords flexibility and efficiency in the use of trunk groups;

The Sender is essentially an automatic mechanism which generates new dialing signals, either in the code given by the translator or in other appropriate codes;

The Marker - its basic function is to make a preliminary test of several alternative paths to a wanted destination through an array of switches, before any of the switches are closed, so as to void the possibility of encountering a busy switch after part of the switching operation has been performed. It was invented in Sweden in 1912. As used in the crossbar systems of the Bell System, the marker has been developed into a complex assemblage which serves as the basic control element for the entire switching operation. Among other things, it tests the circuits before connections are established; seeks out alternate paths when needed; and reports trouble conditions, which may be encountered in its preliminary tests. Since it can examine a large number of circuits practically simultaneously, it uses them with great efficiency.[11]

(The management in the Soviet Ministry of Communications is constantly exhorting its intercity telephone operators to "increase the effectiveness of their productivity" through more efficient utilization of their channel groups--a clear indication of their limitations in this regard--one need not exhort a machine!)

The Crossbar Switch - is essentially a multiple relay structure affording fast operation and reliable contacts of precious metal. The first satisfactory design was worked out in Sweden in 1919, and was put into operation in 1926.

Most of the crossbar switches used in America and other countries follow the Swedish design.[12]

<u>Call-Back</u> - a principle of operation invented in 1938, which has been effectively used in crossbar systems. When a customer originates a call, the register stores not only the wanted number but also the identity of the calling telephone, which is determined automatically. The connection with the calling subscriber is then disconnected, and an entirely new connection established, from a favorable point within the exchange, to both the calling and wanted telephone.[13]

(In the Soviet telephone system, until quite recently, the above operations were either performed manually, semi-automatically, or automatically in a rather clumsy way--by dialing 18 digits.)

* * *

All of the automatic switching systems described were built around the electro-magnetic relay and other electro-magnetic devices. The relay employs magnetic attraction produced by an electric current to move a magnetic armature and, thus, open or close electrical contacts so as to perform switching or other operations. (The device dates to the early 19th century.)[14]

Modern switching systems require approximately 1,000 relay operations to establish a single telephone connection, and some systems have as many as 10 relays per subscriber.

Reliability is extremely important. Less than one failure in 40 years is a normal criterion for satisfactory operation.[15]

(In contrast with these requirements for reliability, it was reported in 1973 that the telephone system of Tbilisi, the capital city of the Georgian SSR, experienced nearly 35,000 failures in the previous year. At times, every second telephone in the city was not working. It was frequently impossible to contact someone located on the other side of town, on the opposite side of the river.)[16]

Crossbar Tandem Equipment - the modern version of the tandem principle developed originally for manual systems, handles traffic between opposite sides of a large metropolitan area through one or more intermediate (tandem) offices which act as clearing houses for these relatively small amounts of traffic, handling them more efficiently than if direct paths were provided and, thus, reducing the number of trunk circuits required.

Another type of crossbar system is especially adapted to the automatic switching of long distance circuits. The first crossbar switching system in the long-distance field (introduced in Philadelphia in 1943) enabled operators, but not customers, to dial long distance calls.[17]

(Operator-dialed long distance calls are quite common in the Soviet Union. This will be discussed later under "semiautomatic system.")

Direct Dialing and Automatic Recording of Billing Data

The US advance which permitted operator-dialed long distance calls was followed by another which permitted direct dialing by customers without the aid of an operator. The switching mechanism selects the route to the distant phone. Should it find all circuits busy, it explores in succession as many as five alternate routes, and establishes the connection along the least circuitous one available. All this is done automatically. Necessary information regarding direct and alternate routes to the destination is permanently available in a translator, which supplies it to the control circuits as required.

Closely related to automatic switching is the automatic recording of data for preparing the customer's bill. The simplest means for this purpose, used in either manual or automatic offices, is an electromechanical counter, known as a message register, which records the number of calls made by a customer. In a more elaborate arrangement, the register can be operated more than once in a single call, the number of operations depending upon the distance and duration of the call. Each customer is billed on a bulk basis for all of the "message units" totaled on his register. This plan is widely used in America and almost universally elsewhere. Another method of charging is automatic ticketing first introduced in Belgium, where automatic equipment prints for each call a ticket similar to one that might be prepared by an operator.[18]

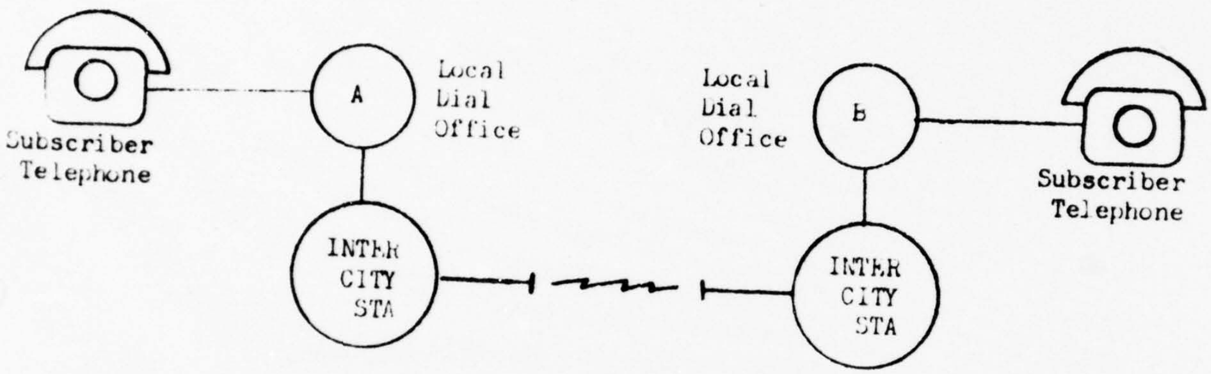
In America, where distances are great and the tariff structure complicated, a highly versatile type of message registration system, called Automatic Message Accounting (AMA) was developed in the mid-1950s. In this system the information needed for billing calls is recorded in the form of coded holes in paper tape. Automatic processing of the tapes in an accounting center yields bills with any desired amount of detail. The AMA system is extensively used in association with direct distance dialing.[19]

(In the Soviet Union, the above functions are performed for the most part by hand, where the operator monitors the duration of the call using a stop watch. Herald of Communications, moreover, reported the astounding news that an exemplary central accounting center had begun using adding machines to aid in computing customers' bills.)[20]

In the U.S. most long-distance calls can be dialed directly to the distant point (either by the operator, or by the subscriber). This requires a system of control-switching points; regional centers (for large geographic areas); sectional centers (for part of a region); primary centers (for part of a section); and toll centers (serving a cluster of local offices).[21] For direct-distance dialing a special tape records in code the details of the call--the telephone number called, the number of the caller, the time the phone is answered, and the time the call is disconnected. The tape is processed by a special accounting machine, which details the charges for the customer.[22]

Concept of Long Distance Telephone Operations

(City A to City B without intermediate switching):



I. PROBLEMS IN THE SOVIET INTERCITY TELEPHONE NETWORK

General. Now that a number of operating principles pertinent to the study have been covered, attention may be returned to the Soviets. Current Soviet literature reveals a great many problems in their telephone system: their physical plant is aging, and is in some cases clearly obsolete; manual operations are maintained "to a great extent," and delays in service are not uncommon; intermediate switching for through-calls is not fully exploited because certain essential equipment is lacking; "a very large number" of stations are equipped with obsolescent switching gear; automatic number identification and cost accounting equipment is largely lacking, which presents a serious obstacle to fully automatic direct distance dialing. To these problems, we may add some rather serious personnel problems (owing largely to poor working conditions)--a high rate of staff turnover, and a continuing lack of well-trained technicians. Finally, the low efficiency of the Soviet socialist system is reflected in frequent complaints of shortages, delays and shoddy workmanship in construction, and in indifference on the part of the workers (reflected in the constant exhortations to work harder, to "increase the effectiveness of productivity."*) [*NOTE: "Productivity," in Soviet terms is defined by the income received for various types of services performed by the communications enterprises.]

The Soviets recognize the need for modernization, and a program has been underway for several years; nevertheless, the problem areas cited are current enough to provide a general impression of the situation in the USSR over the past 10 years. Now some of the problem areas will be taken up in detail.

Methods of Operation: Manual and Semiautomatic Operations

An inter-regional exchange designed for manual operation was introduced on the intercity telephone network in the USSR in 1950. These stations were subsequently equipped with 1960-model switchboards, and are now capable of both manual and semi-automatic operations, although "certain switchboards of obsolete types are also found." At the present time, "a very large number" of intercity telephone exchanges equipped with the 1960-model switchboards are in operation in the USSR.[23] (See photo montage at beginning of paper.)

Manual Switching To Be Phased Out: In practice, one encounters situations when both methods of establishing long-distance connections--manual and semiautomatic--are combined. But the Soviets predict, that for the large-capacity inter-city telephone stations, the purely manual method of servicing connections "will practically cease to exist." The manual method of establishing connections "is steadily decreasing everywhere (on a percentage basis), and the time is not far off when it will be used only in exceptional cases or in general will not be used at all. In the near future, manual switching will cease to be used in local telephone stations as well."[24] [Emphasis mine-RR] (In order to be able to use the "semi-automatic" method of making the long distance connection, where the intercity operator dials the number, the destination telephone station must have automatic switching.)

The Advance Booking System--Prime Symptom of Overload--A Manual Operation

In order to permit better utilization of the long distance channels, an advance booking system is used--which means, that a customer has to wait a relatively long time for his call to be completed. (A discussion of this, and the "immediate," and the "rapid" systems of operation is found in Part II.)

> Advance bookings are made by telephone operators at so-called booking switchboards, while the connections are made by operators at the intercity switchboard. Servicing the booking consists of two stages: recording the pertinent information with the booking operator, and making the connection (in order of receipt of the booking) by the long-distance operator. At the present time, the greater part of the bookings made are serviced with a certain amount of delay, and, without employing call-back, it is not possible to complete the connection at all. Call-back is often necessary in any event to verify the number given by the person who booked the call. [Emphasis mine-RR]
>
> One of the shortcomings of the advance booking system arises from the practice of assigning a number of channels to a given switchboard, which creates difficulties when calls come in from a number of channels simultaneously.[25]

Routing Through-Calls Via Intermediate Switching Points--A Sore Spot

The capabilities for semi-automatic and automatic methods of establishing connections are not yet sufficient for widespread utilization of connection by means of intermediate (transit) switching stations, without using what the Soviets call "straightened" channels. ("Straightened" channels are those which are joined in advance by technicians in the line-equipment room of the telephone station.)[26]

Delays. Actually, if the connection passes through "transit" stations, delays may occur. Under the manual method of establishing one-time intermediate switchings, the time required for servicing connections increases:

> The problem is, that for a long time now, the advance-booking system of operation and the manual method of establishing contact has been used on the intercity network of the Soviet Union and on many communications routes. Because of this, connections between the intercity telephone stations on the mainline network have been accomplished for the most part without using intermediate switching points, or through a single switching point.[27]

Single "Transits". The Soviets report, that at the present time, in practice, connections are very frequently made through only one transit station. When making intermediate switchings, differences in attenuation on the channels sometimes causes great difficulties. In "rare cases" the quality of the speech channel is especially poor because of the switching equipment used at the transit stations.[28]

Scheduled and Semi-Permanent Through Channels

On certain lines, and especially during peak traffic hours, intermediate switchings are made in the line-equipment room of the station, either on a semi-permanent basis, or according to a daily schedule, to provide through-communications between major population centers. But, the Soviets report that:

> Scheduled intermediate switchings will gradually be phased out as automatic switching is introduced and the number of channels is increased. Now, when the semiautomatic and automatic methods of establishing intercity connections have found widespread use on the network of the Soviet Union, and a number of transit stations have appeared, the need for register-retranslator equipment at those stations through which automatic through-routing is established becomes exceptionally critical. For a long time automatic transit was used in a very few cases in the Soviet Union, and, therefore, register-retranslator equipment was not used. Where these registers are not installed, whenever a connection passes through a transit point, the telephone operator at the calling station has to dial a large number of digits and wait for the readiness signal at each transit point.[29]

(This is why Herald of Communications lavishly praised a certain operator as an example to her fellow workers, for her willingness to "cheerfully" make transit connections! She probably deserved the award, what with having to fulfill her daily norms (servicing a given number of calls), and then having to service time-consuming transit connections as well.)

Lack of Equipment Hinders Intermediate Switching. The Soviets admit that their intermediate switching capabilities have been "insufficiently exploited," and recognize that all transit stations must be "gradually equipped with register-retranslator equipment." (Also see Appendix E and Preface, page xxi, regarding translation, call back.)

> Maintaining to a great extent the manual method of establishing connections does not permit exploitation of intermediate switching capabilities,

> since the establishing of intermediate connections by manual means through several central exchanges causes great difficulties and significantly slows down the process of establishing connections.[30]

Obstacles to Automatization. Manufacture and supply of certain peripheral equipment for automatic cost-accounting is a prerequisite. "Automatic intercity telephone communications cannot be introduced without rather complicated auxillary equipment for automatically accounting for the cost of the long distance call," says the author of "Intercity Telephone Stations."

> The original solution to the problem of calculating costs--which at the present time continues to be used everywhere--is the registration by the telephone operator of the basic information (date, time, city, number calling, number called, duration of call).
>
> Some switchboards are equipped with a manually-operated counter [but] in practice, the switchboards are often not equipped with counters, and the telephone operators use watches to determine the costs of conversations.[31]

Lack of automatic number identification equipment is another obstacle, which is the reason a customer has to dial 18 numbers in some cases:

> To establish number identification equipment at all local dial offices in a short period is practically impossible. Such equipment will not exist in the majority of city dial offices for a long time. As a temporary measure, where number identification equipment is lacking, the customer will dial his own number (which will be recorded by an automatic accounting apparatus at the intercity telephone station) immediately after dialing the number of the party being called.[32] [Emphasis mine-RR]

Reliable, Modern, High-Speed Equipment Is Needed. Nearly all the shortcomings are associated with their equipment, most of which requires modernization or replacement, to say nothing of expansion to meet their growing needs.

As the Soviets delicately put it, "in spite of a number of good qualities, the intercity telephone stations which are currently in operation in the Soviet Union do not completely satisfy the requirements of a modern automatized intercity telephone system."[33]

The impetus for the modernization campaign, one can be sure, was not the fact that Ivan Ivanovich has to wait five hours to place a long-distance call. Modernization of the telephone network is an integral part of the "computerization" of the Soviet economy. The Soviets declare that the existing network cannot meet the need for transmitting the digital information generated by the "extensive introduction of computer technology" into the management of the economy. The author of "Intercity Telephone Stations" states:

> Up to the present, reliable high-speed methods of transmitting signals and digital information practically do not exist on the intercity telephone network of the Soviet Union.[34]

Now we have begun to understand some of the reasons for the Soviets' "Overload"--an increase in the number of telephones (Appendix A), and an increase in the average amount of time spent on the phone, together with a lack of modern switching and control equipment, the supply of which Soviet industry has evidently failed to provide in sufficient amounts and fitting types. The mandatory requirement for modernized equipment to provide quality suitable for data transfer has merely brought the situation to a head.

We may now turn to a discussion of how the Soviets have organized their intercity telephone network, of their systems of operation, methods of establishing connections, and types of services offered.

NOTE: When discussing the Soviet situation vis-a-vis the telephone, it is difficult to avoid the suggestion that these generalizations apply universally across the vast Soviet telephone network. The fact is, that we do not really know to what degree these shortcomings prevail. The Soviets themselves are fond of generalizations ("to a great extent," or "a very large number"). But, just as one learns not to completely trust Soviet statistics displaying their successes, one tends to suspect that there is more than meets the eye in the problems discussed in the Soviet press, which does not as a rule report isolated instances, where problems are concerned. Furthermore, the fact that one of the major sources for this report is a textbook intended for students in a technical school for long distance telephone operations, and not the average propaganda sheet, lends credence to the statements.

One can probably be sure, that certain sectors at key points receive priority in installation of modern equipment (this is only logical)--the mainline network, lines serving key industries, the defense establishment, high party organs, and major tourist areas (i.e. the Black Sea area), no doubt receive special attention. Nevertheless, taking Soviet statements at face value, it seems clear that the bulk of the Soviet economy must depend on the system as it is described here, and must accept services which are more typically "average."

II. ORGANIZATION FOR INTERCITY TELEPHONE SERVICE IN THE SOVIET UNION.

General. In order to make a study of the basic design and operating principles of the existing Soviet intercity telephone network, one has to consider a number of subjects: for example, the methods of making connections between cities; the system of operation employed at the station; the design of the networks and the numbering system; the rules of operation; the types of services offered to the clients; and so on.

Methods of Establishing Connections. (Also see Appendix B) Intercity telephone connections can be established by one of three methods: manual, semiautomatic, and automatic. The use of one or another method depends on the degree of automatization of the local telephone networks in the communities between which the contact is being made; on the capacity of the channel groups between the intercity telephone stations (MTS--Mezhdugorodnaia Telefonnaia Stantsiia) participating in the connection; on the type of switching gear used at the MTS; and on the system of operation.[35]

Manual Method. Under this method all connections are made by telephone operators, one at each station through which the connection is to be made. If the local telephone network on either the calling end or on the other end is not automatic, then, of course, the number of operators required to make the connection increases, which significantly increases the time required for completing the call.

Semiautomatic Method. In contrast to the manual method, the semiautomatic method is characterized by the fact that in all cases the call is completed through only one telephone operator--the operator at the originating MTS. At the destination MTS and at any intermediate switching points, the connections are established automatically with the aid of automatic switching gear.

Automatic Method. With this method, the caller completes the call without the aid of an operator on either end, by dialing the appropriate sequences of digits.

Combined Methods. In practice, one may find situations where both manual and semi-automatic methods are combined. On one and the same connection, at some sectors, or in one direction, the contact may be made by the semiautomatic method, and at others manually.[36] The Soviets declare that "there is very extensive use of one-way channels in intercity telephone networks, i.e., separate channels are used for incoming and outgoing communications [at the intercity telephone stations]."[37]

The manual method is obviously the least desirable; in the long run it is the most expensive, not only in terms of the customer's time, but in terms of large expenditures for wages as well. At the same time, the quality is relatively poor, and decreases in proportion to the amount of cords and contacts used in making the connection. With semiautomatic and automatic methods, the process is speeded up significantly, although the initial expense for installation of equipment is very great.[38] (It is fair to ask, whether the Soviet Union was unwilling or unable to abandon the manual method of operation for a long time.)

Systems of Operation in Intercity Telephone Communications (Appendix C)

General. Depending on the level of sophistication of an intercity telephone network, three systems of operation may be employed: the advance-booking system, the immediate system, and the rapid system. Combinations may be used, in which one part of a channel* is serviced by the advance-booking system, and the other by the immediate system.

> [*NOTE: A "channel" is defined, in the Soviet conception, as "the combination of line and station equipment which provides the possibility for holding a single two-way telephone conversation." A channel may be physical, that is, with a separate wire line for every channel, or it may be multiplexed, where a single physical wire can be used to organize a number of channels by means of an apparatus of high-frequency multiplexing (as in carrier telephony). These principles (i.e., multiplexing) also apply to radio relay systems, extensively employed in the Soviet telephone system.]

Various systems may be used at the same MTS, depending upon the time of day and the workload (i.e., the relationship between the number of calls to be placed and the number of channels available to handle these calls).[39]

The Advance Booking System. Under the advance booking system, various operators at different working positions are involved in completing a call. A station which employs this system must be organized to include the following: a booking desk, a control and distribution desk, an information desk, intercity switchboards, production control switchboards, and an accounting desk. Depending upon the workload, a number of booking desks may be set up at a station, or in the case of a small station, some of these functions may be combined.[40]

Advance bookings are made by the operators at the booking switchboard (desk), and the connection by the operator at the intercity switchboard. Among the functions of the control and distribution desk (from which the bookings are distributed to the appropriate intercity switchboard) is the verification of the right of the customer to book a call, since "certain customers" do not have the right to place a call on credit.[41]

One of the main features of the advance-booking system is that the customer has to wait a relatively long time for his booking to be completed; on the other hand, where the station's workload exceeds the capacity of its channels, this system is the most efficient means of channel-utilization. As a rule, the operators call their next customers before the conversation in progress is completed; then, immediately upon the completion of that conversation, the next customers are connected with the just-vacated channel.[42]

<u>The Immediate System</u>. There is also a waiting period under the "immediate" system of operation, but not so great as under the "booking" system, and a large percentage of the connections requested are completed in not more than 10 minutes from the receipt of the request--a certain portion are completed either right away or within one or two minutes.[43] Here the booking desk and the control and distribution desk are not required, since the operator who receives the customer's call requesting the connection is the same as that which makes the connection. (The "booking" or paperwork is completed by the operator who services the connection.)

While under the advance booking system, the booking is carried out via one line and the connection via another, under the "immediate" system, only one line is used, a so-called "booking-connecting line."[44]

The "immediate" system should be used when and where the traffic load does not exceed the channel capacity.[45]

<u>The Rapid System</u>. This system is used for making connections by automatic means in local networks. Each request for making a call and ringing the required party is carried out immediately. If it is not possible to complete the call (the party doesn't answer), the customer must repeat his request later. The introduction of the "rapid" system of operation

is directly associated with the automatization of inter-city telephone communications.[46]

Assessment: the "booking" system is a manual operation, and indicates overloaded channels--it is known to be used in spite of automatization.

Under the advance booking system, as a rule, the manual method of establishing connections is much more acceptable. The semiautomatic method is also permitted; however, with this there is no possibility to employ the technique of preparing both parties in advance without using the channel (advance preparation was designed to alert both parties while the channel was still in use). Thus, combining the "booking" system with the semiautomatic method might actually increase the time the channel is in use for one conversation.[47]

The semiautomatic method is much more appropriate with the "immediate" system of operation: the number of operators participating is reduced, the process of establishing the connection is speeded up, and the channels are used more efficiently. Of course, it would be rather pointless to use the manual method with the "rapid" system.[48]

A vicious circle: with the increase in the number of channels on a link* and growth in intercity traffic, the difference in the degree of efficient channel utilization under the "booking" and the "immediate" systems of operation becomes insignificant. [*NOTE: A "link" may be defined as any system of telecommunications between two terminals.]

At the same time, using the immediate and rapid systems--which are more convenient to the customer--increases telephone traffic![49]

Organization of the Intercity Telephone Network and the Method of Assigning Numbers.

General. Several years ago, the Soviets embarked on a long-term project for changing over to a "zonal" concept of operation. (See Part III, page 43 for a discussion of the planned, modernized network.) The completion of the changeover is predicated on modernization of the stations, or "exchanges" in the intercity network. (See Appendix D for a general discussion of principles of organization of a telephone network.) When we speak of an intercity "network," we are describing the system by which the MTSs are organized to make connections between widely separated points. The plan for communications between the stations is based on the size and shape of the territory, the customers who are to be served, the volume of traffic between different cities, and the degree of sophistication of the MTSs involved.[50]

The Intercity Telephone Network of the Soviet Union. (See Appendix D). The intercity telephone network of the Ministry of Communications of the Soviet Union, as it existed in the early 1970s, was organized on the "radial-tandem central exchange" principle (Appendix D) and was designed to include five classes of central exchanges:[51]

1. The central exchange of the Soviet Union in Moscow, the "Central Intercity Telephone Station" (TsMTS--Tsentral'naya

Mezhdugorodnaya Telefonnaya Stantsiya);

2. Main central exchanges (GU--Glavnye Uzly), situated in the capitals of the 15 union republics;

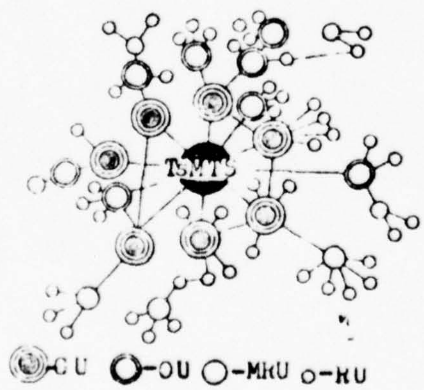
3. Oblast' central exchanges (OU--Oblastnye Uzly), situated in the oblast' centers*; [*NOTE: Oblasts and Raions (or Provinces and their Districts) are administrative-territorial subdivisions of the republics (the "SSRs") of the USSR.]

4. Inter-raion central exchanges (MRU--Mezhduraionnye Uzly): These central exchanges were introduced in order that all the MTSs on the territory of a given oblast' not be directly connected with the MTS of the oblast' exchanges. (In a number of situations, it is more convenient to connect the MTS of different raions with the MTS of the oblast' center through an intermediate switching point, rather than directly.)[52]

5. Raion* central exchanges (RU--Raionnye Uzly), which are the terminal intercity stations, which provide intercity telephone communications between customers of the various local telephone networks of that raion and between customers of the local networks of the raion and the customers of different raions, oblasts, and republics, by intermediate switching through central exchanges of ascending classes.

[*NOTE: The "raion" is roughly the equivalent of a U.S. county; there is no equivalent to the "oblast'" in the USA. There are approximately 125 oblasts and 3,100 raions in the USSR; more than 500 raions are within the limits of larger cities.[53]]

Intercity telephone network organized along political-administrative lines: As the schematic of the intercity telephone network of the Soviet Union as it existed in the early 1970s shows, all the main central exchanges (GU) are connected to the TsMTS, which serves as the intermediate switching station for intercity calls between customers of different union republics, and for a number of the oblasts of the USSR. (Certain of the other central exchanges are directly connected where the "mutual attraction" requires.) According to this principle of organization, the intercity telephone network of the Soviet Union was divided into a mainline intercity network and into intra-oblast' intercity networks.[54]



Principles of organization of the intercity network of the USSR (1972).

The Numbering System. (Appendix E and J) The system of numbering is one of the most important problems in automatizing the intercity telephone network. In the step-by-step, non-register systems, adding to the number of digits requires, as a rule, installation of yet another stage of selectors for each additional number. In the register system, increasing the number of digits leads to an increase in the makeup of the registers, which in turn in some cases increases the time required to dial, and may make switching more difficult in the event of overloads at different sectors of the network.[55]

A system of numbering which assures selection of a required populated area or a certain territory (zone) with the minimum and constant number of digits is by far the most rational one for organizing automatic and semiautomatic intercity telephone communications.[56]

In the early 1970s, the Soviets were engaged in changing over their numbering system to a zonal concept, a process, which in the words of a Soviet expert "will...in all probability...turn out to be lengthy." During the changeover period, which coincides with the automatization of the intercity telephone network, an interim numbering system is being used. This numbering system provides the possibility for gradual changeover to the planned zonal system of numbering, but involves separate numbering for the mainline and the oblast' networks, while retaining the numbering for customers in the local networks.[57]

Access to the AMTS--Dialing Outside the Local Network: Under automatic intercity telephone communications, access to the automatic MTS (AMTS) is provided by dialing a preparatory suffix (the "intercity suffix"), which is not a part of the intercity code and is intended for dialing outside of the local network. A three-digit code is assigned to each provincial center and to each intra-province telephone network. Separately designated cities on the mainline network (which are not provinces) are also assigned an independent three-digit code.[58]

Unified Numbering. The numbering is unified for both automatic and semiautomatic intercity telephone communications. Customers and telephone operators use one and the same intercity code regardless of the possible routes through which the connections are made, either by means of or without bypass routes. The intercity suffix dialed by the customer differs for automatic and for semiautomatic intercity calls, however, since in the one case the customer must gain direct access to the automatic equipment, and in the other only to the telephone operator, who dials the intercity code and the number of the party being called for the customer.[59]

The Intercity Number: Not counting the intercity suffix, an intercity number has 10 digits. Of these 10 digits, three make up the intercity code and seven the number of the customer in the local network.[60]

Services Provided--Categories of Service

General. Intercity telephone stations provide their clients with connections either through an advance-booking system, or in the case of automatic communications, offer the possibility of dialing their own number.*

Direct Subscribers.[61] As the Soviets rather delicately put it, "subscribers who use intercity communications regularly" may be hooked up directly to the MTS, bypassing the local dial office--which obviously reduces the time required for completing a call.

Since direct subscribers are connected with the MTS bypassing the switchboard apparatus of the local dial office, neither booking lines nor booking-connecting lines, nor connecting lines are required to service their incoming and outgoing calls.

The complex of lines of the direct subscriber provides the possibility for the subscriber to call the operator at

[*NOTE: However, since the earliest days of the Stalin Era, the telephone was used primarily as an instrument of centralized control. Use of the telephone in the form of "official" communications emanating from the Kremlin by direct wire--automatically considered secret, and administrative-ministerial communications, where each ministry had its own (radio) telephone network, has been at the expense of the general public. The "clients" offered the advance-booking system would naturally include the general public in its order of priority (last).[62]]

the MTS (for booking a call), and for the operator to call the subscriber for an incoming call on that same line.

Intercity telephone stations which have automatic or semiautomatic capabilities may maintain a small automatic telephone station for intra-station communications; the direct subscribers are hooked up to these substations in such cases, and, thus, have the capability of establishing outgoing and incoming connections through them.

Connections and conversations are divided into three categories, outgoing, incoming, and intermediate switching.[63]

"Outgoing" applies to connections, the bookings for which were received at a given MTS from a subscriber of the local network, public phone stations, or direct subscribers.

"Incoming" applies to connections established with customers in a given location by subscribers from other populated areas.

"Intermediate switchings" provide connections between the clients of the MTSs of two different cities not having direct contact with one another, and are accomplished either by a telephone operator or by automatic equipment at an intermediate (transit) station.

Because of the wide variation in traffic load at different hours of the day, intermediate switchings may be established on a schedule to handle the anticipated traffic flow between two points, in which case the channels between those two points would in effect be direct channels, at least temporarily.

Allocations of channels for working according to schedule are made by the Chief Directorate of Intercity Telephone Communications of the Ministry of Communications of the USSR, for inter-republic communications, and for inter-oblast' communications within the RSFSR. Republic-level ministries of communications, and Oblast' or Krai* directorates of communications handle allocation of channels at their respective levels. [*NOTE: A "krai" is a very large administrative division of the USSR, generally an undeveloped, remote area, such as the Maritime Region of the Soviet Far East.]

Categories of Conversations.

For intercity telephone conversations, three categories have been established: Highest Government Category, Government, and Routine.[64]

Special Cases. When the scheduled time for (transit) operations arrives, two intercity telephone stations make their direct hookup regardless of whether there are calls booked or not. Only in special cases do the stations have the right to a channel allocated at that time for work with another MTS. These include:

- Natural disasters, emergencies, and accidents;

- Connections established upon use of a special "password";*

- Connections granted under Highest Government Category. (Calls booked at Highest Government Category are serviced on an equal basis with "special password" calls.)

[*NOTE: A bold Soviet dissident named Dremlyuga tells a tale of his prison camp days: when assigned cleanup detail in the camp commandant's office, Citizen Dremlyuga (in the absence of the guard) permitted himself the use of the commandant's phone and official password to hold a lengthy long-distance conversation with a friend living in Moscow--at the expense of the Chief Administration of Corrective Labor Camps. The incident occurred in 1970.[65]]

Calculating Costs for Intercity Telephone Conversations

General. The costs for intercity phone calls recovered from the clients on the network are based on the duration of the conversations and the distance between the terminal intercity stations through which the call is placed.

The rates established by the Ministry of Communications[66] are determined not by the path by which the call is routed, but by the direct distance shown on a geographical map. Rates are quite reasonable; whether the connection is made by manual or semiautomatic means, the minimum charge is for a three-minute conversation, after which the charge is computed by the minute.

Typical rates (depending on distance) range from a minimum of six kopeks for three minutes up to 25 kilometers, to 84 kopeks for three minutes between 1201 and 2000 kilometers, after which three kopeks are added for each increase of 200 kilometers.[67]

Determination of rates is the easy part. Accounting for the costs of conversations, however, is a significant bottleneck today to automatization of service: accounting is accomplished by the telephone operator in most cases.

Centralized accounting equipment is being installed at intercity telephone stations, where data is recorded for subsequent detailed preparation of the customer's bill. (Standard metering equipment does not distinguish between local and long-distance calls.) In order to permit fully automatic operation, the local dial office must be able to automatically submit to the intercity station the number of the calling party. Automatic number identification equipment also can determine and send to the MTS the category of the calling customer (See Part II, page 22), which is extremely important, since it permits determination of the right of subscriber to specific types of connections and service, to apply specific limitations for certain groups of subscribers, and offer privileges to others.[68] [Emphasis mine-RR]

With centralized accounting, the basic task is to determine and record the number of the party placing the call. It has not yet been possible to install number identification equipment at all local dial offices; "this will take a long time," says a Soviet expert. Since it is so important to providing good service that automatic capabilities be exploited, the practice of the customer dialing his own number was adopted.[69]

The calling customer dials the intercity suffix, which connects his subscriber line with the intercity station; he then dials the intercity number of the party he is calling (the three-digit code plus the seven-digit subscriber number);

and immediately afterward dials his own seven-digit number--for a total of 1+3+7+7, equalling 18.

Dialing so many numbers reportedly often leads to mistakes. If the subscriber either by mistake, or intentionally dials a number other than his own, a special test circuit detects the mistake, and the call cannot be put through.

Automatic number identification equipment is gradually being installed at the local dial offices, and the requirement for the calling party to dial his own number "will also gradually fade away," say the Soviets. As this occurs, the basic method for accounting will be for the automatic cost accounting apparatus (at the MTS) to send an interrogation command to the number identification device (at the local dial office), and then recording the number along with the other data for accounting costs.[70]

* * * * *

III. PROBLEMS AND PROSPECTS ON THE ROAD TO MODERNIZATION

Modernization: Planned and In-Progress.

General. There is no need to remind anyone that the telephone plays an important part in the life of a nation. This part is especially important in a country with a planned economy (where a little over a decade ago, overhead wires were the primary means for carrying telephone traffic).[71]

With the continuing growth of the volume of information being exchanged among Soviet enterprises in the directing of the economy, there is at the same time a "huge and uninterrupted" growth in the demand for reliable and rapid communications facilities. (The growth rate of the volume of information is said to equal the square of the growth of the production of these enterprises.)[72]

As the flow of various types of information increases, the need for corresponding growth in the capacity of lines and equipment grows as well. The Soviets have high hopes that the introduction of new multiplexing equipment for 300 channels and then (according to the five-year plan) for 1,920 channels, will solve their problems in operational communications between cities.[73]

"We have to hold our course on automatization," writes a Soviet engineer from Uzbekistan, "We have to introduce crossbar stations on a wide scale, since they are more sophisticated and more reliable...Automatic stations will appear in all large cities of the republic," he predicts; "But," he warns,"without a sufficient number of channels, they will not produce the desired results. Therefore, it will [also] be necessary to force the construction of mighty intercity cable and radio relay lines on the mainline trunks, using the most modern methods of multiplexing."[74]

The Soviet press reports that, between 1971 and 1974, the enterprises and populace of more than 81 cities had been provided with automatic intercity telephone communications. As a result of the introduction of new mainline cable and radio-relay lines, telephone and telegraph communications with the industrial centers of the Urals, Western and Eastern Siberia, the Far East, and the Transcaucuses has grown.[75] The Minister of Communications of the USSR declared in an interview given in 1970, that the government planned to spend 40 percent more on the development of communications during the Ninth Five Year Plan (1971-1975) than in the previous one.[76]

In the nation as a whole, an "extensive" project is under way for complete automatization of the telephone facilities of the raions. "The obsolete switchboards, and the relay and the 10-step automatic telephone stations--which do not function smoothly owing to shortcomings in their design and circuitry--are being dismantled," writes another Soviet specialist. Crossbar equipment has been used in the Soviet Union since 1963, and by 1970, 480 districts in the USSR could boast being "completely automatized" i.e., where both the district center and the territory of that district have only automatic telephone stations.[77] The number represents about 15 percent of the total of nearly 3,100 districts in the USSR.

The Soviets also have plans for using electronic computers to control the operations of their automatized telephone stations. Creating such a system along with future construction of multichannel intercity lines requires extensive automatizing of operation of the stations themselves, and the processes of switching, calling, calculating charges, and other complex technical operations must all be accomplished automatically. One such station (which is equipped with "unique" equipment) was to be put into operation at the end of 1971 in Alma-Ata, the capital of the Kazakh SSR. In the course of the Ninth Five Year Plan, the Soviets planned for almost all of the oblast' centers in the Kazakh SSR to be connected to an automatized system of intercity telephone communications.[78] (Here, "unique" means "crossbar.")

Upgrading Station and Line Facilities.

A certain unevenness in the introduction of new systems is to be expected; to be sure, inequities in the course of modernization are felt in the USSR. Certain "inequities" are no doubt created according to plan. For instance we can logically assume that the more important centers, beginning with Moscow, would be among the first to undergo modernization. For this reason, it would seem more instructive to examine the pace of modernization in the outlying areas of the Soviet Union, and thus obtain a more balanced indication of progress. A number of the examples cited below concern the areas of the Trans Caucusus and the Central Asian republics (the huge Kazakh SSR, the Uzbek SSR, Kirghiz SSR, and the Georgian SSR, for instance):

Crossbar Automatic Telephone Stations.

In general, when the Soviets speak of modernizing their automatic telephone stations, they are referring to the crossbar system. (See Appendix J).

Although "two-thirds of the mainline intercity telephone communications [in the Uzbek SSR] operate on automatic and semiautomatic systems," writes a Soviet correspondent in

1971, "much remains to be done...New equipment will be extensively introduced into all branches of communications... This means...crossbar automatic city and rural telephone stations..."[79]

In 1972, the Ministry of Communications of the Georgian SSR was severely criticized, the minister was sacked, for having "one of the worst telephone systems in the country."[80] But in mid-1973, the First Deputy Minister of Communications of the Georgian SSR declared that "so far" the republic still had no automatic intercity telephone stations; the first was to go into operation in the first half of 1974, followed by a "very large" station to be put into operation in 1976.[81] "The equipment in the telephone stations which are operating right now," writes another Soviet correspondent, "is, from a modern point of view, rather cumbersome and unsophisticated."[82]

Also in 1972, the Chief of the Tashkent MTS reported that his station had received <u>the first automatic intercity telephone station in Central Asia</u>, which was a crossbar station. He proudly described the capabilities of his station as follows:

> The majority of ATS (Automatic Telephone Stations) in Tashkent have had special equipment for automatic number identification installed. Thus, the majority of subscribers on the intercity network will dial not 17 or 18, but 11 or 12 digits. I'll give you an example:
> In order to make a connection with Moscow from Tashkent [about 1700 miles, or the same as New York to Denver], you have to dial the number "9". When you get the steady tone (the answer of the AMTS), you dial the code "095" and the seven-digit number of the Moscow phone, that is, 12 [sic] digits in all. If the number is not busy, the connection will be made in <u>30-40 seconds</u>. [Emphasis mine-RR].

> To call another party in the Tashkent Oblast', one has to dial only 10 digits. Thus, in order to call Almalyk [A city of over 10,000, about 50 miles south of Tashkent], one dials the "9", and after the AMTS answers, the code "2140" and the four-digit number in Almalyk.[83] [Author evidently assumes additional digit-RR]

The Soviets are producing a large-capacity AMTS for automatic intercity communications with the capability of hooking up from 2,500 to 3,000 intercity lines, and a medium capacity AMTS with up to 1,500 intercity lines; both stations are of the crossbar type. For local telephone communications, the basic types of crossbar stations are the ATSK50/200 and the ATSK100/2000 (for rural communications); there are also ATSK for city communications, designed both for medium capacity networks (above 2,000-4,000 numbers), and for capacities in tens and hundreds of thousands.[84]

Cable/Radio-Relay Lines and Multiplexing Systems

Party Directives from the Ninth Five Year Plan (1971-1975) call for increasing the total distance (in channel-kilometers) of intercity telephone lines by nearly two times. In order to fulfill this ambitious plan, thousands of kilometers of new cable and radio-relay lines must be installed.[75,85] Work toward these ends is proceeding simultaneously in intra-oblast' networks and on the mainline network. Pravda Vostoka (Pravda of the East) told of progress in these areas as of early 1972:

> During the current five-year plan, the number of channels at the Tashkent intercity telephone station has increased by two and one-half times. On the basis of cable and radio-relay systems, and multi-channel systems, there has been a significant increase

> in the number of channel-groups between Tashkent and the oblast' centers, and between Tashkent and the capitals of the neighboring [Central Asian] republics.. The construction of a mainline cable from Moscow to Tashkent has exceptional significance: it is equipped with a multichannel system which permits formation of hundreds of telephone channels...[86]

Cable. The basic types of cable for the mainline inter-city network are high frequency symmetrical and coaxial cables. The Soviets planned to commence serial production of a single coaxial cable, which was to accommodate a 120-channel system in 1970. Then, "in the near future," development of combined coaxial cables was to be completed. Two types were to be produced--one accommodating up to 3,600 channels and another up to 1,300 channels. When used in combination, many thousands of channels (nearly 20,000) may be organized on these cables. For short-haul circuits, a 30-channel system is being used for connecting lines to the city telephone stations.[87]

Radio Relay. In the early years of the Ninth Five Year Plan, the Soviets were discussing radio-relay systems of 60, 120, 300, 600, and 1,920-channel basic capacity (but with the provision for creating greater or lesser capacities, depending upon the number of channel groups employed, and whether or not television channels were to be transmitted; the latter occupy a comparatively great deal more "space" in the spectrum than telephone channels).[88]

The R60/120: This system operates in the frequency band of 1600-2000 MHz, and has three "trunks," two of which are intended for telephone channels (from 60 to 120 channels), while the third "trunk" is for sending TV programs (up to 600 miles). In late 1970, the Soviets were continuing to construct radio relay lines equipped with this and "other" unspecified multichannel equipment.[89]

The R300: "In the future," say the Soviets, "lines equipped at the present time with the R60/120...will be equipped with the R300." The radio-relay device of the R300 type is produced by the industries of the Hungarian Peoples' Republic and the German Democratic Republic. Both systems operate on the principle of direct radio wave propagation with an average of 25 miles between towers. The Hungarian and German models differ in that the former operates in the range of 7900 to 8400 MHz, and the latter from 10700 to 11700 MHz. Both are intended for transmitting either TV (maximum 350 miles) or telephone conversations (up to 1,500 miles).[90] These systems reflect the trend for the gradual change of radio relay lines to shorter wavelengths.[91]

The R600 and similar high-capacity radio relay systems: More sophisticated, more powerful, and more stable systems have been designed as replacements for the extensively deployed R60/120 and R600 systems. These systems employ different frequency bands. The R600-2M and R600-2MB, which will have 900 (sic) channels in a supergroup, will use the 3.4 to 3.9 GHz band. (The "Voskhod" system will also use the 3.4 - 3.9 GHz band.)[92]

"Druzhba" (Friendship): In 1973 the Soviets reported that the"experimental sector" of a new radio-relay system called "Druzhba" had successfully completed its trial period. This device, which was jointly developed by Hungarian and Soviet specialists, permits the construction of radio-relay lines up to 7,000 miles in length, which is "two and one-half times longer than the present ones." Each of the six trunk groups of "Druzhba" has 1,920 channels, which permits holding about 12,000 telephone conversations at the same time, or transmitting six TV programs. (Druzhba uses the 5.67 to 6.17 GHz band.)[93]

Multiplexing Systems: A number of multiplexing systems which permit organizing from six to 3,600 channels on a single cable or wavelength, are in use in the Soviet Union.[94]

For multiplexing symmetrical cables on the intercity network, a 60-channel apparatus of the type K60P will be used. The K60P operates entirely with semiconductor components. Owing to the use of transistors, the K60P not only permits the use of unmanned amplification stations at intervals of up to 180 miles, its operational reliability is 10 times greater than the old (vacuum tube) K60.[95]

The first device of Soviet manufacture for transmission on coaxial cable was the K-1920, which was put into operation in 1959-1960. The K-1920 system, which employs a spectrum of 300 kilohertz to 8.5 megahertz can provide either a television channel plus 300 telephone channels, or 1,920 telephone channels. A system called K1920U, a more refined system was "recently" developed for operation on combined cables. This system employs "tubes with a very long lifetime" which significantly increases the operational reliability of the system.[96] (In 1975, it was reported that the K1920 was used for multiplexing radio-relay lines on many lines of communications, but that it was not being used effectively, and its traffic load is "far below" the designed capacity. It seems there are noise problems as well, and the system requires not only continued preventive maintenance, but also regular replacement of bad tubes.)[97]

The K300 device is designed for multiplexing small-diameter coaxial cables. It is completely transistorized, and provides for the organization of 600 telephone channels. Herald of Communications No. 7 for 1970 reported that the mainline cable using a small-diameter coaxial and the K-300 device completed in the Bashkir ASSR (southern Urals) was the first in the Soviet Union. (Besides the above mentioned K-60P and K300, a K60P has been developed for use with symmetrical one-quarter cable, and a K-120 for a single coaxial cable, for use where not more than 120 channels are required.)[98]

For rural communications, a Czech-made six-channel multiplexer is widely used.[99]

Two systems, the K3600 and the K10800 are being developed for coaxial cables with larger diameters.[100] The K3600, designed for combined coaxial cable, can handle two TV channels, or one TV channel and 1,800 telephone channels, or 3,600 telephone channels. The K3600, which will be entirely transistorized, will be used for sending data for long distances. Repeater stations will be installed every 900 miles. Along with the K3600 system, a complex of "modular" terminal equipment has been developed (for cable and radio-relay lines). When used with a combined eight-coaxial cable, the K3600 will permit organizing nearly 17,000 channels (4x3600 and 2x1300). The cost in channel-kilometers will be less than for the K1920; furthermore, owing to the high degree of reliability, and automatization, maintenance costs will decline also.[101]

Satellite Communications. The Soviets have been using the Molniia series of satellites for "relay of central television programs" to isolated areas for more than 10 years. The spacecraft are known to be used for the relay of telephone calls as well; however, curiously, this role is usually played down in the Soviet press. In 1970, the Minister of Communications of the USSR answered a question regarding "future developments of cosmic communications" in a rather evasive manner. He modestly acknowledged that, "Soviet achievements in the realm of cosmic communications are enormous," and that "communications via satellites means not only telephone conversations but also relay of central TV programs," and went on to speak only of television.[102] In another article, the Molniia satellite is called a "cosmic television system,"[103] which suggests that the telephone capability to which the minister referred is either not fully exploited or is not just for plain old Ivan Ivanovich.

(For details on the Molniia and Raduga/Statsionar communications satellites, please see Appendix I, page 92)

Foreign Assistance. The Soviet Union enjoys the assistance of both Bloc countries and Western firms in securing and installing equipment in its telephone network. Bloc support is principally provided by the Hungarian Peoples Republic, with a somewhat lesser role played by the East Germans and the Czechs. Although the Soviets have displayed an interest in an electronic switchboard produced by the Matsushita Co. of Japan, clearly their foremost Western supplier (and no doubt the most significant to their future development) is the L. M. Ericsson Co., of Stockholm, Sweden.[104]

Hungarian Support. A Hungarian engineer writing for the Soviet press in 1973 modestly acknowledged the "enormous" success his country enjoys in development of communications equipment: telephones of various types, city and intercity telephone stations, multichannel equipment for carrier telephony, multichannel radio-relay equipment for mainline and intercity lines, etc. In fact, he pointed out, a crossbar telephone substation of the type CA-41 won a gold medal at the annual Leipzig fair, and an automatic telephone station with electronic control received a gold medal at an exposition in Brno.[105] Hungarian projects in the USSR include the following:

Between 1961-1970, automatic telephone stations with a total capacity of more than half a million subscribers were set up in the USSR, and a large amount of multiplexing gear was installed.[106]

A "brilliant example" of the cooperation of the Soviet and Hungarian specialists is the "joint development of the wideband radio relay apparatus, 'Druzhba'."[107]

Another joint project was the "modernization" of automatic telephone stations, in which the Riga State Electrotechnical Factory (VEF), the Leningrad plant "Krasnaia Zaria" (Red Dawn), the Belgorod plant, and the Leningrad Scientific Research Institute of City and Rural Telephone Communications (NIITS) took part; on the Hungarian side, the Beloyanis Plant of Communications Equipment participated. (The Hungarian was "pleased to hear that Hungarian equipment works well even in sunny Uzbekistan--this means our rural automatic telephone stations.")[108]

In addition to the above-mentioned "rural" automatic telephone stations, the Hungarians also developed a new "locking relay" automatic telephone station (ATS 10/40) and a "rural crossbar" station (ATSK 100/2000), on the basis of working documentation received from the USSR. Stations of the latter type have been installed in the Georgian SSR.[109]

Swedish Support.

The L.M. Ericsson Co., a pioneer in the telephone industry, is to a great extent also responsible for the growth of the telephone network in Russia. An Ericsson plant had been engaged in the production of automatic telephone equipment and switchboards in Russia since at least 1913. Just prior to the revolution Ericsson employed 3,500 people in

Russia. There then developed a rather curious relationship (based primarily on necessity) between the bolsheviks and Ericsson. While the latter was being roundly excoriated as a wicked capitalist in Soviet literature, Ericsson was busily producing nearly all types of telephone equipment in the Soviet Union--output rose to 117,000 telephones in 1929/30, and from 1923 to at least 1930, Ericsson was the sole producer of telephones in the USSR. (Later, small groups of Russian engineers were trained in the Ericsson Stockholm plant and then returned to Leningrad, ultimately to take over production control.)[110] More recent contributions of the L. M. Ericsson Co. are as follows:

The"first automatic intercity telephone station in Central Asia" was installed by Ericsson. Besides Tashkent, the Ericsson firm was installing similar stations in Kiev, Rostov-on-the-Don, Alma-Ata, and "other cities of the Soviet Union," in 1970.[111] (In 1971, a new automatic intercity telephone station of the crossbar type, called ARM-20 was installed in Kiev, "the mightiest in the land.")[112]

In 1970, the Ericsson firm took part in an international symposium on communications technology held in Kiev. "The aim of the symposium," the Soviet writer blandly states, "was to acquaint Soviet electrical communications specialists with the equipment put out by the firm of L. M. Ericsson, and with the methods of its technical operation." Prominently featured at the symposium was an automatic telephone station of the "system AKE-13, with centrally programmed control, and with coded selector switches in the switching circuitry for speech channels..." [Emphasis mine-RR] Also featured were terminal equipment for pulse-code modulation (ZAK 30/32), cable equipment, etc.[113]

* * *

New Directions

Electronic and Quasi-Electronic Systems. "Those who frequently use the telephone," a Soviet journalist writes in 1974, "know quite well that one does not always succeed in getting the number one wants." There is an urgent requirement for increasing the reliability, speed, and flexibility in the operations at the telephone stations.[114] Primarily, this means introduction of electronic systems.

In 1970, a Soviet specialist disclosed plans for setting up quasi-electronic automatic telephone stations in rural areas to satisfy the requirements of the United Automatized Telecommunications System: "In the future," he writes, "it is planned to introduce...modernized automatic telephone stations of the ATSK 50/200 and ATSK 100/2000 [crossbar] types and set up quasi-electronic ATSs, which are distinguished by their compactness, their reliability in operation, and high-speed establishing of connections. A mockup of such a quasi-electronic ATS, which operates on hercons [hermetically sealed contacts], has been fabricated by our industry in the variant of a city substation of 1,000 numbers, and has been checked out under operating conditions in the Moscow city telephone network..."[115] [Emphasis mine-RR]

Writing on 'The Equipment of Tomorrow" in 1974, a Soviet journalist reports that, "They've already built models of the first electronic ATS at the State Electrotechnical Factory in Riga. At these stations, all controlling is accomplished by electronic circuits, while the switching frame itself is constructed using hermetically-sealed contacts --'hercons'." The author predicts that mass production of electronic switching systems would commence in the USSR "in the next two or three years," and states that, "in the future, the basic system of switching will be electronic."[116]

Pulse-Code Modulation (PCM). In order to satisfy the needs of all government agencies in the transmission of various types of information which might be expressed as electrical signals, including digital information from electronic computers, the Soviets are designing a special network (a "secondary telephone and telegraph network"), which provides the possibility of transmitting all the types of information, for which there is a requirement today, via standard channels.[117]

The multiplexing and transmission systems discussed previously (R60/120, R300, R600, R1920) are FM systems, that is they are "multiplexed" by dividing the channels by frequency, in which the so-called "analogue" method of transmission is used (that is, the signal is in the same form on the receiving end as it was on the transmitting end). Another method of transmission is achieved by converting the signal into a sequence of impulses. Such a method of transmission is called "discrete." Systems with pulse-code modulation (PCM) are based on this system of transmission. In these systems, after separation of the signal into impulses, the latter are "encoded," that is, each impulse is changed into a code group consisting of several impulses with identical amplitude. Sequences of impulses (code groups) enter the line, and the information is contained in the code of each code group.[118]

With the analogue method of transmission, all the interference and noise which arises at each amplifying station along the line of communications accumulates, which limits the distance of transmission, and decreases the quality of transmission. With the discrete method of transmission the signal is restored at each amplifying station, that is, it is regenerated and static does not accumulate. This is the great advantage of systems using PCM. Thus, PCM is particularly advantageous for transmitting digital information, where tolerances for error owing to static or interference are very low. There is a significant drawback to PCM systems, in that for the transmission of speech they require a band of frequencies 15 times as large as with the analogue method of transmission.[119]

Systems with PCM were first used in city and rural networks. At the present time, a system called IKM-32 [IKM=PCM] is being developed for city telephone networks, and in the next few years such equipment will become standard for creating connecting lines between the automatic telephone stations. The IKM-32 device can be installed on existing telephone cables.[120]

Along with development of multichannel systems with PCM, work has begun on a system for encoding 60-channel trunk groups, which will permit solving the problem of compatibility of PCM systems with FM systems without changing over to lower frequencies.[121]

Wave Guide or Wave Duct Lines. "Several years ago" the Central Telecommunications Scientific Research Institute designed an experimental sector of a wave-guide line several kilometers in length. "At the present time" (1970), a 14 kilometer experimental wave-guide line is being built. Wave guide or wave duct lines are based on the phenomenon of propagation of waves in the SHF (millimeter) band in hollow tubes.[122]

Laser Communications. In 1966, the Central Telecommunications Scientific Research Institute, investigating the possibility of using lasers in communications, built an experimental optical line between two ATS in Moscow. Then several others were built in various locations. However, it was found that, under conditions of heavy precipitation, along with urban pollution, breaks can occur in optical lines in the open air. It was tentatively concluded that using optical lines for short distances for creating auxiliary trunk groups might be economically feasible.[123] More recently, experiments have been conducted at high altitudes (over 13,000 feet) in the clear cold air of the mountains of

Kirghizia, which the Soviets consider a "magnificent natural laboratory for the study of radiometeorology and the dispersion of laser beams."[124] Wave ducts and optical lines of communications permit the creation of super-powerful trunk groups of 100,000 telephone channels or 100 television channels, which would permit a significant reduction in costs-per-channel.[125]

The United Automatized Telecommunications System (EASS).

General. The Directives of the XXIV Party Congress called for significant growth in the production of computers during the 1971-1975 Ninth Five Year Plan. Premier Kosygin stressed the need for a statewide network of computer centers, which would comprise a network of automated information collecting and processing systems for accounting, planning, and management of the national economy. Such a system would require, first of all, a "united automatized telecommunications network" for the country. The President of the USSR Academy of Sciences, M. V. Keldysh, allowed that "the use of computer units in controlling technological processes is a powerful lever for increasing labor productivity." But a prerequisite for the development of the five-year plan is "a radical improvement in the development of communications facilities."[126] [Emphasis mine--RR]

Requirements and Capabilities in the EASS. The EASS will consist of a unified network of central exchanges, stations, and lines of communication, to be erected all across the USSR, and will be designed for transmission of all types of information. The EASS must unite in both organizational and technical respects all nationwide and "departmental" transmission facilities in the country (with the exception of the communications within a single industry). Departmental transmission facilities, as a rule, must be linked up with the EASS and must satisfy its unified technical standards and requirements.[127]

The requirement for such a unified system was created, on the one hand, by the ever-increasing flow of an enormous amount of information required by government organizations for their work in directing the nation's economy--industrial enterprises, state farms and collective farms, societies, organizations, etc.

On the other hand, the extensive introduction of computer technology into the national economy has generated a requirement for the transmission of a great deal of digital information across the communications lines, information which either serves as the basis for calculation by electronic computers or which is the result of such calculation.

In order to transmit the entire flow of information on a timely basis, the Soviets must not only expand their network of cables, radio relay lines, and satellites which they already have, they must also take the important qualitative forward step of uniting all the separate means of communication into a unified system which operates automatically.

Automatization and control on the EASS will be accomplished via electronic computers, which will be continually receiving information about the density of traffic, about its degree of importance and urgency, about the condition of the equipment, and the workload of specific channels and routes; the computer will choose the optimum route for the information, or, if necessary, store the information for transmission when the lines are not busy. Calculating and processing of billing documents will also be automatized at the terminal intercity telephone stations. From these stations, the documents will be sent to a central processing center.[128]

New Types of Telephone Exchanges.

The Soviets plan to put into operation "within the next few years" a new type automatic intercity telephone station called the AMTS-4 (which will employ hercon relays, integrated circuits, and programmed control) and automatic switching centers (UAK - Uzly Avtomaticheskoi Kommutatsii). AMTS-4 and the UAK are being developed with the new requirements in mind. The newest AMTS will be able to provide the following types of connections:[129]

Outgoing semiautomatic and automatic connections both within the zonal network, and between zonal networks (intercity) from:

- subscribers to the city telephone systems (providing that automatic number identification is installed at the city dial office);

- from customers in the rural network;

- from computer centers;

- from governmental departments on special connecting lines;

- and from intercity telephone booths.

Outgoing semiautomatic connections will be provided via the channels of the intrazonal network, or on a line to another zone from:

- the intercity switchboard at the MTS of district (raion) centers;

- from central and district public telephone booths;

- from the intercity switchboards at another AMTS.

Incoming automatic connections will be provided to the subscribers to the zonal network, computer centers, subscribers of the departmental (government) networks, and to public telephone booths, from:

- an AMTS of the new type, on the incoming channel (by automatic and semiautomatic methods);

- from automatic switching centers (i.e., UAKs equipped with the same equipment as the new type AMTS);

- from the existing MTSs;

- and from international stations

EASS: Relationship to the Zonal Network

The EASS will encompass both the zonal and the mainline communications networks, and will permit direct-dialing, between any two subscribers to any point in the nation. This means the entire country will be divided into zones, which will take in all the cities and villages. A customer in any zone will have access to the central exchange in his zone, and with the intercity stations. In order to place a call within a given zone, one must dial as a rule seven digits. In order to call someone in another zone, one will have to dial 11 digits: one for access to the intercity network, three--the number of the appropriate zone; and seven--the number of the party being called.[130]

The zonal network consists of a unified intrazonal (intra-oblast') and local (city and rural) telephone network under a single seven-digit numbering system. In certain situations, depending upon the number of subscribers and the size of the zone, several small oblast's may be combined into one zone, or on the other hand, a large oblast' (or Krai) may have several zones.[131]

The basic equipment of the zonal network will be the AMTS-3, a medium-capacity crossbar station (up to 1,400 channels). There will be no intercity telephone stations in the district centers, and all subscribers of the rural networks (rural soviets, collective and state farms) on its territory will belong to the same numbering scheme and will receive access to the appropriate AMTS-3 of the zonal network via a booking-connecting line. An AMTS-3 will be located in each provincial (oblast') center.[132]

(For the communications plan of the EASS, please see Appendix F.)

In the transitional period, that is, until the required number of AMTS-3 stations are received from the manufacturer, and until automatic number identification equipment is installed in the local offices, the automatization of the zonal network is envisaged with retention of the subscriber dialing his own number too (18 digits).[133]

The Soviet Intercity Telephone System in Operation

Quality of Service. For routine intercity telephone communications, the quality of service has improved in those sectors where equipment has been upgraded, where operational organization has been rationalized, and especially where a sufficient number of channels are available to handle the workload. The introduction of the immediate system of operation has had a profound effect on the quality. In 1969 the immediate system of operation was extensively introduced in a number of oblast's for intraoblast' communications (between the oblast' and raion centers), where the number of channels permits. For example, at the Cherkassk MTS, where 19 intraoblast' lines of communication were changed over to the immediate system, the average waiting time for a conversation on these lines was reduced from 23.2 to 6.2 minutes; at the Vinnitsa MTS (23 lines), from 36.9 to 5.5 minutes; at the Ivano-Frankovsk MTS (15 lines), from 30.5 to 4.3 minutes.[134] From Central Asia, there is a similarly favorable report, "Not long ago," the author declares, "if you wanted to phone from Tashkent to Dushanbe [i.e., from the capital of Uzbek SSR to the capital of Tadzhik SSR] it would take quite a while. But today you can do it without hanging up the receiver."[135] The Soviets obviously consider extensive introduction of the immediate system of operation a fundamental improvement in the quality of operations at an MTS.

Work norms and standards vary according to the size of the station, the system of operation, and the method of establishing contact. For instance, at the Rostov-on-the-Don MTS (which was still using the advance-booking system of operation with the manual method of making connections in 1974 despite a claim that a crossbar station was being installed there in 1970; see page 38), there are 34 switchboards just for receiving bookings, and 120 intercity switchboards for making the connections.[136] (Switchboards may have five or six manual outgoing channels.)[137]

There is a plan for everything: a plan for the station, a plan for the shift on duty, and a plan for the individual operator (according to skill level). In the advance-booking system with the manual method of operation, the average time for each operation for an intercity operator is as follows:

Preparing the subscriber	40.7 seconds
Connecting the subscriber	85.6
Checking a second time	3.4
Sending and Receiving the booking	3.8
Disconnecting the subscriber	2.8
Peripheral tasks	4.8
In all	141.1 seconds

For the average operator, the norms are to make 154 connections per six-hour shift. For the Hero of Socialist Labor or the

Shock Worker of Communist Labor, the number may be as high as 250 calls per shift. (Advance booking, manual methods.)[138]

Attempts to Spur Productivity

"Socialist Competition" is steadfastly fostered by the Party in its relentless efforts to get the people to work harder and produce more. The spirit of socialist competition is to set the standards to which each loyal citizen should aspire. In a certain sense, the examples cited (i.e., Heroes of Socialist Labor) reflect the need for improvement; in another sense, they indicate the best they can do. The two passages cited below are richly illustrative of these factors; the reader is invited to draw his own conclusions:

In 1970, Zinaida Ivanovna Lototskaia, an operator at the Vladivostok intercity telephone station, was honored for her productive work. The central committee of her trade union recommends that all of the workers' collectives take note of her experience and introduce her techniques at their agencies:

> As a result of her initiative and hard work, Zinaida Ivanovna was assigned to a responsible sector--communications with Moscow. When the immediate system of operation was introduced at the station (using the semiautomatic method of making connections), Zinaida quickly mastered the techniques and achieved a high degree of quality in the service she offers her subscribers. Her technique? Combining operations, to reduce the time spent in making the connection.
>
> Answering the call from the booking line, she gives her personal number [Operator 05] and starts to take down the booking information from the subscriber. If the channel on the required line is busy, she asks the subscriber to wait; if not, she informs the subscriber, "I'm making the connection." She inserts a plug into the channel, and dials the number of the

party in the other city with her right hand. At the same time, her left hand is inserting the cord circuit into an unoccupied connecting line, and, if she hears the phone ringing, she dials the number of her subscriber. When the party in the other city answers, she switches her subscriber from the booking line to the connecting line, inviting them to begin the conversation. (Or, if the number is busy, she politely informs the subscriber and promises to call back.)

Changing the sequence of her operations while making a connection allows Lototskaia to save from 14-16 seconds for each connection. She knows the number for getting an estimate on the charges by heart; she knows the passwords for many subscribers, and their names; she knows the numbers in the city and the direct subscribers. And she uses, as a rule, one and the same connecting line, which saves wasted motion looking for a line. During the peak hours, she finds out in advance the suffixes for intermediate switching stations through which one gains access to the cities in Western Russia; she has memorized a number of suffixes, which permits her to save a significant amount of time when completing calls which have been booked on lines leading to the West.

By using advanced working habits, Lototskaia finds it possible to reduce the time required for making a single connection to 64 seconds (this is while other operators require 85 seconds or more for the same operation). [Emphasis mine-RR] And this permits her to offer more intercity conversations and to utilize the communications channels more effectively.

Zinaida was among the first to be given the title Shock Worker of Communist Labor. The title Master of Communications, and an honorary award from the Ministry of Communications of the USSR and the Central Committee of the trade union were bestowed upon her.[139]

Telephone Operator First Class at the Ivanovo MTS, Zh. Kazarina tells how she was able to service 7,000 conversations above that which her plan required in 1975, namely: economizing every second of work time by means of combining several operations (of course, while maintaining excellent quality).

While awaiting the answer from the other city, I register the booking, I remove the cord circuit from the just finished conversation right away, and I write down the length of the conversation. I do all this precisely and calmly, and I never forget to check on the audibility of the channel for the subscriber. While dialing the number of the party being called, I check the data on the booking, which also promotes the quality of operations on the line. As a result of combining operations, I've managed to confine the <u>time required for making one connection</u> to 79.5 seconds. This time is divided up as follows: answering the call--1.5 seconds; taking down the booking--15 seconds; finding an unoccupied line and channel--6 seconds; dialing the number of the party placing the call--12 seconds; dialing the number of the party being called--17 seconds; sending the ringing signal to the subscriber in the other city--6 seconds; informing the party placing the call that the phone is ringing--8 seconds; awaiting the answer from the party being called--9 seconds; and checking on the beginning of the conversation--5 seconds.

I reduce the time spent for one connection to the minimum. This economical method of using my time permits me to not only achieve a high degree of productivity (I overfulfill my norms by 130 percent each month), and to successfully service communications by the immediate system of operations without making a mistake, but also, I believe, I make people happy by just doing my job.[140]

Although similar articles appear in nearly every issue of <u>Vestnik Sviazi</u> (Herald of Communications), the figures cited for the specific operations vary little, which suggests either, that they are approaching the outer limits of possibilities, or that similar results are attainable only by the super heroes. One is entitled to doubt, of course, that such paragons of socialist virtue actually exist. (As the old Soviet joke puts it, "Yes, the plan was fulfilled, but only in the newspaper.") That the Soviets seem to feel the need to repeat such hortatory articles without letup suggests that the actual time spent on the operations described is much greater than they desire, but that any resulting improvement is better than nothing. At any rate, it is clear from "testimonials" such as the above, that what the Soviets lack in automatization they are trying to make up for by putting pressure on the operators to work harder and produce more--which is typical Soviet practice.

Continuing Problems

If Socialist competition is a device for pointing the way to the True Believers, Criticism and Self-Criticism is a virtue made of necessity. A great deal of breast-beating occurs in print in the Soviet Union (after a decent interval--usually preceded by recitation of enormous successes). Some of the situations revealed in this manner are merely interesting; others are astounding. Taken as a whole, they tend to present a fairly comprehensive picture of Soviet conditions. The problems, as a whole, tend to fall into two interrelated and often overlapping categories: economic, and social or human problems.

Economics, defined as the science of satisfying unlimited wants with finite resources, would seem to be an area in which the Soviets excel: they have a Plan. Yet recent reports indicate that more and more they must face the problem of shrinking resources, especially in personnel. The evidence cited in this paper thus far reveals a significant amount of manual operations in carrying out the functions of the telephone station. But the days of adding more and more bodies to cope with the increasing workload are over.

A declaration of the December, 1969 Plenum of the CC CPSU reveals the seriousness of the problem:

> Increasing the effectiveness of social productivity has become the key problem, primarily because of the fact that the main factors of [Soviet] economic growth have been changed. If in the past the economy was developed by means of increasing the number of workers and increasing capital investments, at the present the situation is not the same. Nine out of ten people in the country who are capable of working are either already at work, or are in school. [Emphasis mine-RR] There aren't enough workers to meet the demands. Automatization is the only answer.[141]

Stated another way--at an automatized telephone station, the productivity of labor is said to be six times as great as that of a manual station, measured in rubles (wages v. receipts).[142]

Introduction of crossbar stations in place of the 10 step variety reduces the operating staff by three persons for every 1,000 numbers of capacity.[143]

The Chief of the Tashkent Intercity Telephone Station puts it this way:

> The significance of automatization can be expressed as follows: In order to provide the number of conversations which are now offered by means of the automatic and semiautomatic systems, we would have to have an additional 300 telephone operators on the staff, which amounts to 320,000 rubles in annual wages. At the same time we have a lot of problems. Offering intercity conversations at the present time is connected with the expenditure of a large amount of time and manual labor. Under these conditions, a lot depends on the telephone operator.[144]

In 1973, the Minister of Communications of the Georgian SSR stated, that "with us, problem number one is the personnel problem...We felt this very severely not long ago in the lack of operators at the intercity station...there is also a severe lack of repairmen and technicians..." The latter are also not trained in maintaining automatic equipment.[145]

If some of the Soviets' problems are because of the inexorable laws of economics, others appear to be endemic to the Soviet system, or simply a result of bad management. There are some astounding examples of neglect or ineptitude on the part of management revealed in articles on Scientific Organization of Labor or in investigations conducted by the Committee for the Peoples' Inspection (KNK-Komitet Narodnogo Kontrolia).

For example, a study was made of the causes for the large number of uncompleted bookings at the Kishinev (Moldavian SSR) MTS. A complex plan was made to study the organization of labor in the switchboard room. Analysis of the incoming workload was begun according to the type of operation, the line of communication, etc. Each booking received was recorded, and the time of receipt and time of execution were noted. The following problems were revealed:

- Part of the telephone operators were poorly qualified;
- The bookings were allocated among the various working positions without considering the size of the workload in the peak hours;
- Incorrect manning at certain hours of the day: one of the primary causes was an insufficient number of telephone operators to handle the workload at certain hours.

As a result of the analysis, channels were distributed and assigned to the various switchboards to correspond with the incoming workload during the peak hours (0900-1700). The number of switchboards required was based on a chart showing the workload at certain hours of the day. As a result, it was determined that a portion of the bookings for calls within the republic could be placed using the immediate system of operations.[146]

In the Ukrainian SSR, the KNK found in 1969 that channels were being used exceptionally poorly on many lines of communications. An analysis was conducted; the personnel level was brought up to strength, the traffic load of overloaded working positions was decreased, and the positions with the heaviest workload were assigned to the best-qualified operators. In addition, specialized training was given to thousands of operators in advanced working procedure and rules of inter-city operations.

It is truly hard to believe that they are just getting around to analyzing the productive processes in the Year of our Lord, 1970. This says a lot about the type of management they have. But these examples appeared in the trade journal of the communications workers of the USSR. The message is clear: "Go and do thou likewise."

Working conditions are indeed grim in many of the communications organizations in the USSR. One could cite literally dozens of instances reported in Herald of Communications. The work of the telephone operator is described as "exhausting," "nerve-wracking." The buildings lack the elementary amenities which a Western worker would not do without. The furniture is crude; many operators work their entire shift in a straight-backed wooden chair. Heating, lighting, ventilation are frequently cited as either lacking or inadequate. Sanitary facilities are often lacking, as are dining facilities in some cases. And then the Soviets suggested it was time to make a study on the reasons for the high turnover in personnel.

The indifference of the average Soviet worker is certainly understandable in the light of their working conditions--all this, and then overloaded circuits to boot. A new Soviet proverb is said to be making the rounds these days: "They pretend they're paying us, and we pretend we're working."[147] (Average wages vary from 80-115 rubles per month, where one ruble is about $1.33.)[148]

Finally, two perennial problems are noted in the Soviet Union: the problems of construction and supply. It is said that in all the years of Soviet power, not a single construction project was completed on time. This is partly a result of the supply problem, and is one of the favorite whipping boys in the Soviet press:

> We have reached the stage, where the rate of growth of rural telephone communications is limited only by the capabilities of industry to supply the required amount of equipment (carrier multiplexing equipment, power supplies, and cables)," writes a Soviet specialist in Herald of Communications.[149]

Finally, an assessment of reasons for delays in plan-fulfillment, in the last year of the Ninth Five Year Plan:

> Frequently the assimilation of the planned capability of newly-built mainline facilities is delayed, partly because of disproportions in the building of cable and radio relay lines and in the building of intercity telephone stations. Radio centers are occasionally put into operation without the necessary antenna installations. For this reason, the traffic on the cable and radio relay lines is greater...
> [Finally] the Ministry of Communications Facilities Industry is delaying the preparation of a number of different devices and other equipment, and the Ministry of Electrical Technical Industry is holding up the supply of cable equipment, which slows down the development of the communications network.[150]

CONCLUSIONS

That the Soviets intend, as was announced at the XXIV Party Congress, to introduce computers on a wide scale to rescue their faltering economy is no doubt true. That "a radical improvement in the development of communications facilities," is a prerequisite is also no doubt true.

There are two important considerations to bear in mind as one approaches the end of this study. One is that a number of disproportions in the Soviet economy are directly related to the Soviet decision to militarize their economy. Those enterprises in the defense industry or which are fundamental to industrial development reportedly receive all the goods they require to fulfill their plan. Thus, there is actually a second economy which operates behind the scenes, which is not discussed so openly in the press. And the enterprises belonging to the other category get "what's left." It would seem then, that this study has been examining a portion of the Soviet telecommunication system that is most in need of upgrading.

The second is, that the telecommunications system of the Ministry of Communications is indeed important to the functioning of the national economy. If the "computerization" of the Soviet economy, based on the creation of EASS, becomes the darling of the Party leadership, as was the development of the Virgin Lands in the 1960s, then one might expect to see some improvements.

Yet, the expense involved in upgrading the entire system is no doubt enormous. It remains to be seen whether the Soviets will be able to find the resources to complete such a project.

Commenting on the various nationwide systems mandated by the XXIV Party Congress, Academician Viktor M. Glushkov (Vice-President of the Ukrainian SSR Academy of Sciences and Director of the Kiev Institute of Cybernetics) said, "The main problem--the design of a nationwide automated control system--cannot be solved in the absence of a control system industry...[where] maximum standardization is presupposed."[151]

If the modern telephone office is "identical with the computer,"[152] then the technology required is also identical, or nearly so. And Western experts have serious doubts that the Soviets will ever be able to create a viable computer industry: standardization, and the high quality this technology demands are precisely the areas in which Soviet (non-defense) industry has inherently produced poorly.[153] The remarks of the editor of <u>Soviet Cybernetics Review</u> address the point very well:

> Most of the considerable effort devoted so far to management and process control systems in [Soviet] industry has been characterized by fragmentation, inefficiency, poor planning, and lack of standardization. The Ninth Five Year plan...takes note of these problems...But the pressure to implement, to get anything at all up and running, could result in more of the same. The outlook here is not as bright as the Soviets would hope...The recent history of unsuccessful and inefficient attempts to implement the needed systems [reflects the severe problems of] bureaucratic resistance, not to speak of political and ideological problems...One has the feeling that [certain Soviet authors] have a considerable appreciation for the importance of the subject and for its context within the total economic picture. [However] what the Party Directives propose may be much too ambitious within the constraints of the political and economic system, especially for just the next five-year plan. We must reserve judgement on the ultimate potentials for success...[154]

Of course, a great deal of additional research could (and no doubt needs to) be done on this problem. There certainly is abundant literature with which to work. Yet, typical Soviet practice tends to support the conclusions presented here. That is, so long as the Party refuses to relax its rigid, highly centralized control from above, one <u>ought</u> to entertain "serious doubts" about the technological potential of the Soviet Union. With some of the finest scientists and engineers in the world, the Soviets nevertheless "enjoy" one of the world's lowest levels of productivity, for an industrialized nation. According to Messrs. May and Friendly[155], "the problem seems to be that foreign technology, like the domestically generated variety, is no match for the bureaucratic and overcentralized Soviet planning structure... Reforming the Soviet economic system would appear to be a solution, but that is precisely what technology transfer was intended to avoid in the first place."

Therefore, one ought to pay closer attention to what the Soviets are doing and have already done, than to what they've "planned" to do--at least in the short run. In the past, the Party has forced their system to operate through extensive capital investment and introduction of additional labor into the process (rather than trying to modernize or make more efficient that which already exists). Now, however, the Soviets appear to be running out of resources, certainly human resources.

Whether the Soviets will be able to satisfy today's demands on their telecommunications facilities and still cope with the problems of tomorrow using yesterday's methods--making vast plans and then issuing orders, will be the subject of continuing research.

As the old Russian proverb puts it, "We'll live a bit longer, and then we'll see."

A P P E N D I C E S

to

THE SOVIET INTERCITY TELEPHONE NETWORK

IN

THE AGE OF OVERLOAD

APPENDIX A Growth in the Soviet Telephone System

Part One - Overall Growth Statistics[156]

YEAR	Total intercity calls completed	Nr of phones (Ministry of Comm)	Of these Nr "automatic" phones	Total nr of phones of all governmental departments (excluding military)
1913	0.3 million	+	+	+
1940	93 "	+	+	+
1955	135 "	+	+	+
1956	143 "	+	+	+
1957	152 "	+	+	+
1958	163 "	+	+	+
1959	172 "	+	+	+
1960	185 "	+	+	+
1961	197 "	+	+	+
1962	210 "	+	+	+
1963	219 "	3,550,000	2,174,000	6,800,000
1964	227 "	4,000,000	2,500,000	6,600,000(ap)
1965	256 "	4,300,000	3,400,000	+
1966	285 "	5,000,000	3,900,000	7,900,000
1967	314 "	5,729,000	4,590,000	+
1968	343 "	6,600,000	5,500,000	+
1969	386 "	7,500,000	6,500,000	+
1970	431 "	8,400,000	7,500,000	+
1971	480 "	12,200,000	11,000,000	+
1972	535 "	13,200,000	11,800,000	+
1973	593 "	14,500,000	13,200,000	+

(the "+" indicates figures were not shown.)

Part Two - "Departmental" Telephone Communications[157] (Not a part of the system of the Ministry of Communications)

NUMBER OF TELEPHONE STATIONS			Estimated*
Year	Overall	Of These,Nr "Automatic"	Nr of Telephones
1940	6,837	146	1,709,250
1950	13,852	943	3,463,000
1959	24,335	4,542	6,083,750
1962	27,861	8,104	6,965,250
1965	27,554	11,187	6,888,500
1967	30,579	15,040	7,644,750
1969	31,181	17,803	7,795,250

* Estimate based on comparison of figures in Part One in the years 1963-64 and 1966, which provides an average of 250 phones per station

(APPENDIX A, Continued)

Estimates on the number of Soviet telephones vary widely. A prominent Western journalist estimated that, "In 1970, the Soviet Union had 11 million phones, compared to 120 million in America."[158] According to our figures, the combined total of Ministry of Communication and Departmental phones for that year would likely be closer to 17 million. When you consider the number of military phones (a state secret) as well, the total may approach 20 million or more for the entire nation.

APPENDIX B Operational Process of Establishing Intercity Connections by the Semiautomatic Method[159]

To establish an intercity connection using the semi-automatic method (i.e., where the operator dials the number for the subscriber), the telephone operator at the inter-city switchboard plugs one end of a cord circuit into the jack of the line which connects to the city telephone station (the "local dial office"), and dials the number of the subscriber who booked the call. The other end of this cord is plugged into the jack of an available channel on the required line of communications, thus occupying that channel. (A light on the switchboard indicates which channel is available.)

When the operator inserts the plug into the jack for the desired channel, a sequence of events occurs automatically to prepare the equipment at the incoming intercity telephone station (MTS) to receive the numerical information (the code of the required MTS). If register-retranslator equipment is installed at the incoming MTS, then, under the influence of the initial signal, the equipment for incoming voice-frequency dialing* is hooked up to the incoming code register.

[*NOTE: The Soviets use a dual-frequency generator and a dual-frequency receiver of voice-frequency dialing for sending and receiving control and dialing signals on the telephone channels. (The frequency 1200 and 1600 Hz were selected to permit the use of narrow-band "divided" channels.) By adding to the standard dual-frequency semiautomatic system an apparatus for automatically determining the cost of the conversation, and by joining the connecting gear with register-retranslator equipment, the semiautomatic method can be replaced with automatic "direct distance dialing". (The "dual-frequency semiautomatic system" began to be mass-produced in the USSR between 1950 and 1953)[160]

After the equipment at the incoming MTS is ready to receive the numerical information, an answering signal is sent to the originating MTS. A lamp blinks on the intercity switchboard next to the cord circuit the operator has made. Next, the operator hears a steady tone, and proceeds to dial the code of the required MTS.

Semiautomatic Working Without Register-Retranslator Equipment. When dealing with alternating frequency semiautomatic signaling without register-retranslator equipment, in order to employ intermediate (transit) switching, the intercity operator at the originating MTS has to dial--digit by digit--and must await the readiness signal from each transit MTS before dialing the next digit. The readiness signal ceases each time when the first dialing impulse is sent.

The last digit of the number of the required location is the number "1", which is characteristic of a terminal connection (and gives access to the local dial office at the required location). Upon completion of dialing of the number of the required MTS, the terminal incoming MTS sends a short control signal (through all of the intermediate MTS) to the originating MTS, indicating readiness to receive the customer's number. This signaling also causes the lamp to blink at the cord circuit the operator made. The incoming MTS either sends a recorded announcement ("Patch Kaserne, dial your number.")*, or a dial tone. [*NOTE: i.e., for those familiar with the military phone system in Europe.]

The operator at the originating MTS then dials the number of the party being called, which is relayed through all of the intermediate (transit) MTSs.

Where register-retranslator equipment is installed, the intercity operator at the originating MTS simply dials the three-digit code of the required MTS.

This three-digit code is recorded by the incoming voice-frequency dialing equipment, to which a translator is connected. The translator converts this code into digits which determine the required line of communications, and sends these digits to the mainline selector. The latter, under the influence of the pulses it receives, establishes a connection with the outgoing voice-frequency dialing equipment of the required line of communications from a given transit MTS. (If the latter equipment is occupied, a busy signal is sent.) The outgoing code register, when it receives a readiness signal, sends the information it had recorded to the next MTS.

The process of sending the three-digit code from one MTS to another continues until the connection is established with the required terminal MTS, to which (instead of a three-digit code), the digit "1" is sent, which gives access to the city automatic telephone station.

After contact has been made with the city telephone station, a brief signal is relayed to the originating MTS, indicating readiness to receive the number of the party being called. (Once again, a light blinks on the originating intercity switchboard.) The operator hears a recording of "dial your number," or a dial tone, and proceeds to dial the number of the party being called. (The dial impulses are corrected at each transit MTS and at the terminal incoming MTS.)

If the operator hears a busy signal, and the party being called is already occupied with an intercity connection, she must pull the cord circuit, and try to make the connection at a later time. But, if the called party is engaged with a local call, the long-distance operator will hear the conversation, and may interrupt to inform of the long-distance call (she does not hear a busy signal), and with the subscriber's consent she may break the local connection in favor of the long-distance call.

(NOTE: In this description we have been considering cases in which the operator, having dialed the number of the MTS, receives the readiness signal for dialing the number of the called party. Actually, if the connection passes through intermediate MTSs, this does not always occur without delays.)

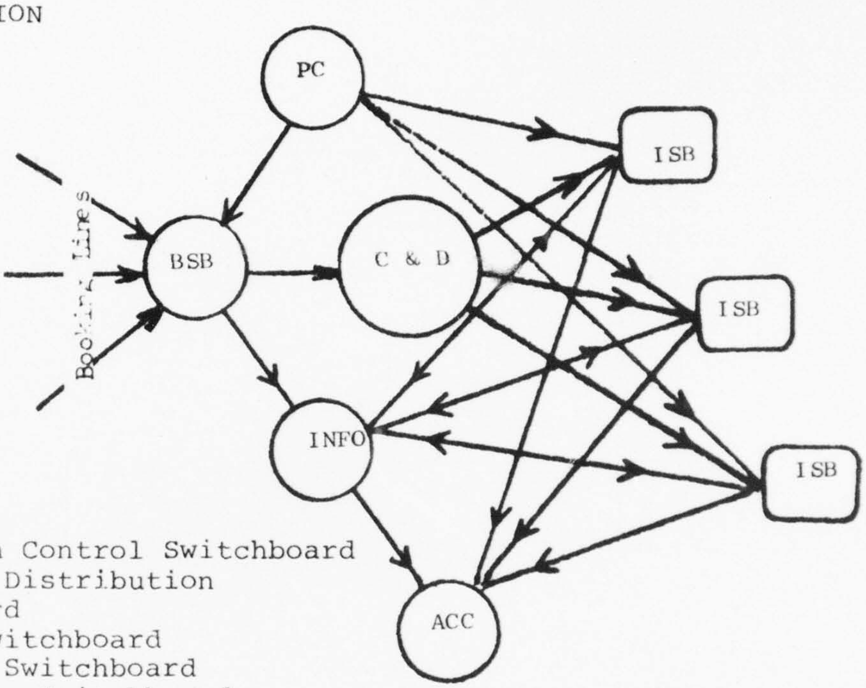
APPENDIX C Organization for Advance Booking and Immediate Systems of Operation.[161]

The advance-booking system of operation is employed by the Soviets to make maximum effective use of telephone channels where the traffic workload at a given station exceeds the capacity* of a group of channels on a given line of communications. (Where the traffic does not exceed the capacity, the "immediate" system is used.) Connections are generally made by the manual method, to permit the intercity operators to alert the subscribers next in line of their impending connection (before the channel they have booked is actually vacant).

[*NOTE: "Capacity" of a channel or a group of channels refers to the number of conversations which may be held in a given length of time (for example, in one hour). The "workload" is the sum of all the advance bookings made at the MTS for that period of time. Capacity depends on how many channels there are in the group, the average duration of the conversations, and the time spent in establishing the connection: that is, depending upon the time of effective and ineffective use of each channel. Of course, the shorter the duration of ineffective use of the channel, the greater is its capacity.]

The receipt of bookings and the process of completing these orders is carried out by various telephone operators at different working positions as shown on the following page.

ORGANIZATION FOR ADVANCE BOOKING SYSTEM AT INTERCITY TELEPHONE STATION



PC   Production Control Switchboard
C&D   Control & Distribution Switchboard
BSB   Booking Switchboard
ISB   Intercity Switchboard
INFO   Information Switchboard
ACC   Accounting Desk

Depending upon the workload, an appropriate number of booking desks are established at the intercity telephone station (MTS). The booking lines are connected in multiple to the booking desks (switchboards), which permits any free operator to make a connection with any of the booking lines on which the booking call is received. Receipt of the booking involves completing of a special form or ticket with data required for making the connection, and accounting for the costs. After completing the form, the operator breaks the connection with the customer and the line is free for the next booking.

The booking ticket is then sent to the control and

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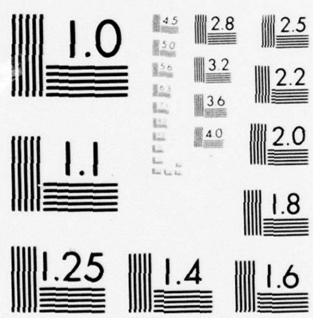


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

distribution desk (switchboard). Among the functions of this position are: verifying the right of the subscriber to place a call via the booking system*; checking the ticket for correctness and completeness; and distributing the tickets to the appropriate intercity switchboard (based on the channels assigned to a given switchboard and the workload).

[*NOTE: "Certain" subscribers do not have the right to place a call on credit. The C&D desk has the "necessary materials" for verification. When the call-back system is employed, the problem of checking the veracity of the calling subscribers' numbers does not arise. Since if he does not give his own number, he cannot be called via the connecting line, and the call cannot be completed. Under the "immediate" system, if the booking is received on the booking-connecting line and the connection is made right away-and the subscriber gives a false number, someone else will get the bill! In the "newest" telephone stations, automatic number identification equipment will prevent cheating.]

Telephone operators at the booking switchboards and the intercity switchboards are connected with the information desk, which furnishes the subscribers and the operators information on problems of using long-distance telephone services.

The operator at the intercity switchboard completes the connections in order of receipt of the booking tickets. When the time comes for completing the next order, the operator calls the subscriber who booked the call, and proceeds to make the connection.

The tickets from completed calls are then sent to the accounting desk, where the charges are computed.

Each stage of the process is subject to control (inspection), which is the function of the production control switchboard. The inspection may be carried out without an operator's knowledge. The length of time a subscriber has to wait*, the time spent in making the connection, the degree to which the channels are exploited, the quality of transmission, etc., is subject to control. [*NOTE: In 1970, the Soviets proudly announced that, owing to the installation of automatic switching equipment at the Ufa switching center, the waiting time for customers was "significantly reduced." Now bookings for calls "to any point in the republic are filled within an hour of their placement..."[162]]

The Immediate System of Operation. In contrast to the advance booking system, here the booking desk and the control and distribution desk are not required, since receipt of the booking and completion of the call are performed by one and the same operator. The procedure varies for incoming and outgoing calls. For incoming intercity calls, an incoming intercity switchboard is equipped with a patch panel with multiple connections to intercity channels. (As a rule, the channels are connected for one-way utilization; that is, separate channels are used for outgoing and incoming calls) Outgoing intercity switchboards are divided into groups, and each is assigned channels from a specific line of communications (i.e. Moscow-Leningrad).

Outgoing. Under the grouping system any of the operators in a group can occupy any channel assigned to the group, which is not in use. Advance preparation of the customer is not required, and the semiautomatic method "is preferred." The process of servicing a call is as follows:

Upon receipt of a call on the booking line, a call-lamp lights up on each working position in the group of intercity switchboards on this booking line. (In the local telephone network, booking lines must be divided into corresponding groups, each with its own number.)

Any of the unoccupied operators of the group may answer an incoming call, receive the booking information, and establish the connection. If there is at least one unoccupied channel on the required line, the call can be made immediately. In order to do this, the operator contacts the calling subscriber by dialing his number on one of the lines which connect to the local network, and then releases the line by which the booking was received.

If there is no vacant channel on the required line, the operator requests the subscriber to hang up and wait for a call from her, and breaks the connection on the booking line. When a channel becomes available, the operator calls the subscriber who made the booking via a connecting line, and proceeds to make the long-distance connection.

At the incoming MTS, when a call is received, call-lamps light up at all working positions which serve incoming calls on a given line of communications. One of the unoccupied operators connects her position with the channel on which the call is coming in, establishes a cord circuit to the line which leads to the local network, and then dials the number of the subscriber being called.

As a rule, booking lines and connecting lines are not compatible, since the attenuation is greater on the booking lines (which are not intended for holding long-distance conversations and may be constructed more cheaply). Since, under the booking system, bookings are received and connections are established at different positions, in general it is not possible to combine both types of lines to the local network into one.

With the newer types of telephone stations, which employ the crossbar system, it is possible to make the long-distance call over the same line on which the booking is made, through a so-called booking-connecting line. In this case, the operator at the intercity switchboard, having received a booking, does not have to call the subscriber back by means of dialing his number on a connecting line, but can immediately connect the booking-connecting line with a channel on the desired line of communications, provided there is an unoccupied channel at that moment.

The availability of booking-connecting lines does not exclude employing connecting lines, since at the present time the greater part of the bookings are serviced with a certain amount of delay, and without call-back it is not possible to make the connection.

If, after several attempts, the intercity operator is not able to make the connection, the booking ticket is passed to the outgoing switchboard for delayed connections. (The organization at an MTS employing the immediate system of operations includes, besides outgoing and incoming intercity switchboards: information desks, a production control desk, and an outgoing switchboard for delayed connections.)

In practice, all three systems of operation (advance booking, immediate, and rapid) may be employed at a given station, on different lines of communication. Selection of one or the other depends upon which provides better utilization of channels: where a heavy workload exists, advance preparation of subscribers next in line can provide uninterrupted loading of the channels; the advance-booking system best meets this requirement at present. Use of the booking system is continually decreasing, while the percentage of connections made by the immediate and the rapid system is growing, along with the rapid increase in the number of channels available through introduction of multi-channel systems of multiplexing and the automatization of intercity telephone communications.

NOTE: The "rapid" system of operation does not differ in principle from that of the "immediate" system, except the bookings may be received only on a booking-connecting line. The rapid system requires that the connection be made right away; if this is not possible, the subscriber is sent a busy signal, and must try again later.

APPENDIX D Principles of Organization of a Soviet Telephone Network.

Intercity telephone networks are designed and built to assure maximum utilization of channels by increasing accessibility to them.[163] With this in mind, one might conceivably organize the network in one of three ways: (1) by the everyone-with-everyone principle, where each telephone station has direct contact with all the other telephone stations (which is physically impossible and prohibitively expensive); (2) by the radial method, where each individual station is connected to one great central station (which, if out-of-order, would paralyze the whole network); and (3) by the tandem-central exchange method.

Under the tandem-central exchange method, a number of central exchanges are built on a given territory; these exchanges are connected with one another under the "everyone-with-everyone" method. Each of these exchanges serves as the central station for a group of terminal intercity telephone stations in different locations. Within the confines of its group, each terminal MTS is connected with its tandem central exchange by the radial method. (See diagrams on following pages).

In actual Soviet practice, a radial-tandem central exchange system is used. By this method, the central exchange themselves are connected with one another through a radial method, with some in direct contact with one another. Central exchanges are divided into several classes: main exchanges, first-class central exchanges, and so on. Second-class exchanges, which come under first-class exchanges, are connected to the latter by the radial method; third-class exchanges are connected to their second-class exchanges in the same manner, and so on.

Considering the entire national telephone network, the first-class exchanges are the intermediate switching centers for the entire country; second-class exchanges the intermediate switching centers within a portion of the country; third-class within the territory of the second class in the same manner, down to the terminal MTS in the network (which may in fact be a second-class or third-class exchange). (See diagram.)

Appendix D - Diagrams of Network Organisation

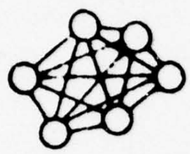


Figure D-1.
Everyone-with-
Everyone

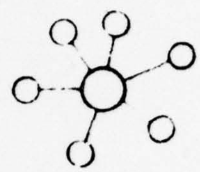
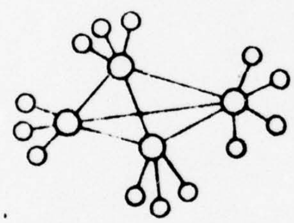
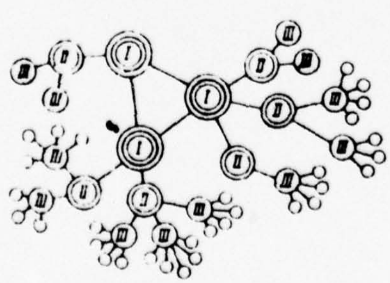


Figure D-2.
Radial Method



○—Central Exchange
○—Terminal MTS

Figure D-3. Tandem
Central Exchange Method



○—Terminal MTS

Figure D-4. Radial-Tandem Central Exchange System, showing First (I), Second (II), and Third (III) Class central exchanges.

APPENDIX E System of Assigning Telephone Numbers on the Soviet Intercity Telephone Network[164]

The Intercity Code

In the numbering system for intercity telephone communications, the number which is assigned to a definite point is called the intercity code. Where the national network is divided into zonal networks, the intercity code characterizes the zone being called. The Soviet Union, along with the gradual automatization of its intercity telephone network, has adopted a system of numbering which will allow gradual changeover to the planned zonal system of numbering. (The process is expected to be a lengthy one.)

Gradual Change to Zonal Concept.

The system of numbering for the changeover period, in accordance with the existing system of mainline networks and intra-oblast' networks, envisages separate numbering for the mainline, and for the oblast' networks, while retaining the numbering for subscribers in the local networks. A three-digit intercity code has been adopted for the mainline telephone network.

A three-digit code is assigned to each oblast' center and to each intraoblast' telephone network. (Separately designated cities on the mainline network which are not oblast's, are also assigned a unique three-digit code.)

This numbering is the same for both automatic and semiautomatic intercity communications. Subscribers and telephone operators use one and the same intercity code for establishing connections, regardless of the possible routes through which the connections are made, either by means of or without bypass routes.

Access to the Automatic Intercity Telephone Station (AMTS)

Under automatic intercity telephone communications, access to the automatic intercity telephone station is accomplished by dialing a preliminary suffix (the intercity suffix), which is not a part of the intercity code, and is designed for dialing outside of the local network.

The intercity suffix dialed by the subscriber differs for automatic and semiautomatic communications, since in the one case the subscriber must gain direct access to the automatic equipment for establishing the connection and in the other only to the telephone operator who dials the intercity code and the number of the party being called. (The intercity code together with the party's number is called the "intercity number.")

Abbreviated Code. When making a connection by semiautomatic means (with the aid of an operator) on a direct line between two points (no intermediate switching involved), instead of the three-digit intercity code, the abbreviated code "1" is dialed. For this reason, intercity codes cannot start with "1".

The Intercity Suffix "8" In the Soviet Union, the number "8" has been selected as the intercity suffix, which is not part of the intercity code.

The intercity codes of the oblast' centers and the intercity codes for accessing the network of this oblast' differ only by the first number. If the oblast' center is assigned, for example, the code 8XX, where X is any number, then the code for the network of this oblast' might be 7XX or 5XX.

Constant Number of Digits. An intercity number without accounting for the intercity suffix has 10 digits. Of these 10 digits, three make up the intercity code and seven the number of the subscriber in the local network. A seven-digit subscriber number is the maximum number of digits. When the subscriber numbering consists of five or six digits, an equalizing number of zeroes are dialed prior to the actual subscriber number, to total seven.

Complete intercity subscriber numbers, thus, will appear as follows (where M is the number 8 or 0, and X is any number):

For Cities with seven-digit customer numbering,

MXX XXXXXXX;

For cities with six-digit numbering,

MXX 0XXXXXX; and

For cities with five-digit numbers,

MXX 00XXXXX.

With the two first digits 8 and 0 there can be 200 three-digit intercity codes for oblast' centers. If this number of codes turns out to be insufficient, then the number 9 can also be used in the first position.

The numbers 5 and 7 may be used as the first number of the intercity codes within the oblast' networks, and the number 6 may be added to these if required.

The numbers 3 and 4 have been set aside for the first digit in assigning numbers for cities on the mainline network (cities included in the mainline network like the oblast' centers, but without the internal network of the latter).

Purpose of System.

This system of numbering was worked out for the transitional period, in the anticipation of installation of register and retranslator equipment at all intermediate switching centers on the mainline network. The translators are designed for translating the numbers of the three-digit code into the sequence required for selecting a trunk on the required line of communication (direct or bypass). After selecting the trunk, the intercity code which has been recorded in the register is transmitted to the register of the next station. If the next station is a terminal intercity station, then the abbreviated code "1" is sent. (Also see Appendix J and the numbering used with the "Oblako" system.)

The Number "2": Access to One's Own Network

In order to assure the possibility of establishing intra-oblast' connections by means of dialing an abbreviated code (that is, for access to one's own intra-oblast' network without dialing its complete intercity code), the number "2" has been reserved; therefore, this number and the number "1" are not permitted as the first number of a three-digit intercity code.

In this manner, with automatic intercity telephone communications, customers obtain access to their own intra-oblast' network by dialing the suffix "8" (access to the AMTS) and "2" (access to the intra-oblast' network), that is, "82". After dialing "82", the seven-digit number of the subscriber may be dialed.

Zonal Organization of the Network.

Under the zonal organization of the network, the unique intercity three-digit codes (ABC) will be assigned not to the oblast's, but to the zones. Subscribers will have a seven-digit number for communications within their zone, and a 10 digit number for intercity communications (between subscribers of different zones.)

The seven-digit zonal number of the subscriber will consist of a two-digit code representing a group of 100,000 subscribers (ab), and a five-digit number for the subscriber in this group.

The complete intercity subscriber number will consist of ten digits--a three-digit zone code, and the seven-digit number of the subscriber in that zone.

With semiautomatic and automatic intercity communications, it will be necessary to dial: 8XX ABC ab XXXXX, where X represents any number; A any number except 1 and 2; and B, C, and b, any numbers; and a, any numbers except 8 and 0.

Under automatic telephone communications between subscribers in the same zone, when this contact is established through the AMTS, the subscriber must dial 82 abXXXXX.

Thus, in general, the difference between zonal numbering, and the numbering in the changeover period is, that subscribers in the zone will always have a seven digit number, while the first two digits ab will stand for a group of 100,000 subscribers.

APPENDIX F. Principles of Organization of the United Automatized Telecommunications System (EASS).[165]

The "EASS," which comprises a nationwide automatically-switched telephone network, is intended for the transmission of speech, of facsimile and photographic information, and for transmission of digital information at medium speed. It will be divided into an intercity network and zonal networks, that is, it will provide interzonal communications. The intercity network includes the AMTS, automatic switching centers (UAK), and channel groups which connect the different AMTS (AMTS-AMTS), an AMTS and a UAK (AMTS-UAK), and one UAK with another (UAK-UAK). This system envisages using the UAK only for intermediate switching and for distribution of the traffic load along the lines of communication.

The principles of organization of an intercity telephone network which unites the zonal networks are depicted in Figure F-1. This network uses two classes of automatic switching centers: first class (UAK-I), and second class (UAK-II).

All first class automatic switching centers will be connected with one another according to the principle "everyone with everyone." Each UAK serves a definite territorial district. Each UAK-I is the center of a network of the radial-central exchange design and connects a group of UAK-II and the AMTSs. The AMTSs are connected to a UAK-II or directly to a UAK-I. The UAK-II provides a shorter path for the traffic load between separate groups of AMTSs which are far away from a UAK-I; they assure access to the UAK-I and the neighboring territories. The role of the UAK-II might in an emergency be carried out by an AMTS.

The diagram shows a variety of possible connections between the AMTS, the UAK-I and the UAK-II. Connections shown as solid lines are called the "path of last resort." The high-utilization path is the basic path by which the connections will be established. This path, during peak hours, will have fewer channels than that required for satisfactory handling of the load. The paths of last resort will carry the excess load from the high-utilization paths; in principle, the paths of last resort are bypass routes.

Where there is sufficient "attraction" between any two AMTSs, direct paths of high utilization (the dotted lines) are organized. The surplus load which is "lost" on these direct paths is sent through the automatic switching centers. If the "attraction" between separate MTSs is very small, then the latter will be connected only with the UAK, through which the entire load will be routed. Such a network design assures good utilization of channels by passing the greater part of the traffic via the shortest possible route with the least amount of intermediate switching. The path of last resort will be used only if all other possible channels are occupied.

The intrazonal network is organized according to the radial-central exchange principle. (See figure F-2.)

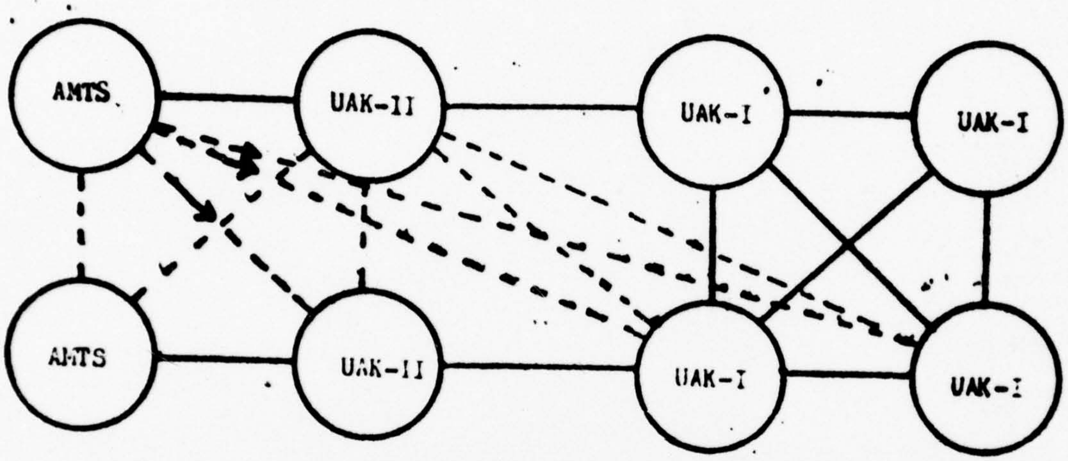
The role of the first-class central exchange is played by the AMTS which at that time represents a terminal station on the intercity network.

The Central Stations (TsS--Tsentral'nye Stantsii) of the rural network are directly connected with the AMTS, as are the district (raion) ATS (RATS), and central switching centers for outgoing and incoming communications (UIS, Uzel Iskhodiashchei Sviazi; UVS, Uzel Vkhodiashchei Sviazi) of the city telephone network.

Tandem central exchanges of the rural network (US, Uzlovie Sel'skie Stantsii) are hooked up to the central rural stations, while terminal rural stations (OS, Okonechnie Stantsii) are connected to the former. Separate terminal stations may be hooked up to the central station, bypassing the US (as depicted).

(Appendix F)

Figure F-1. Zonal Network Organization



- - - - -High-utilization Path
———Path of Last Resort
UAK=Automatic Switching Center
AMTS=Automatic Intercity Telephone Station

Figure F-2. Network Intrazonal Organization

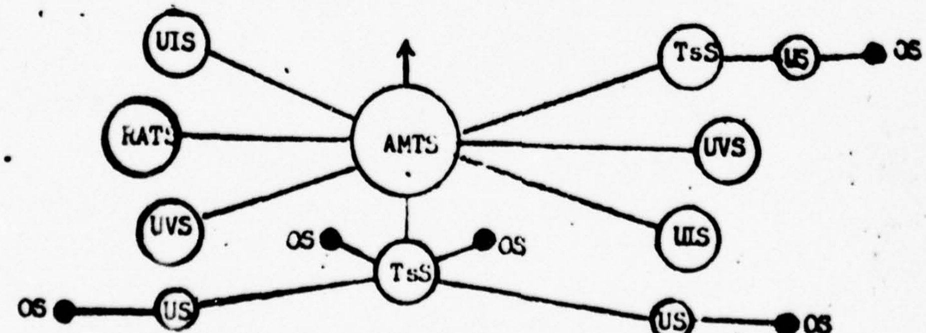


fig. F-2

APPENDIX G Abbreviations

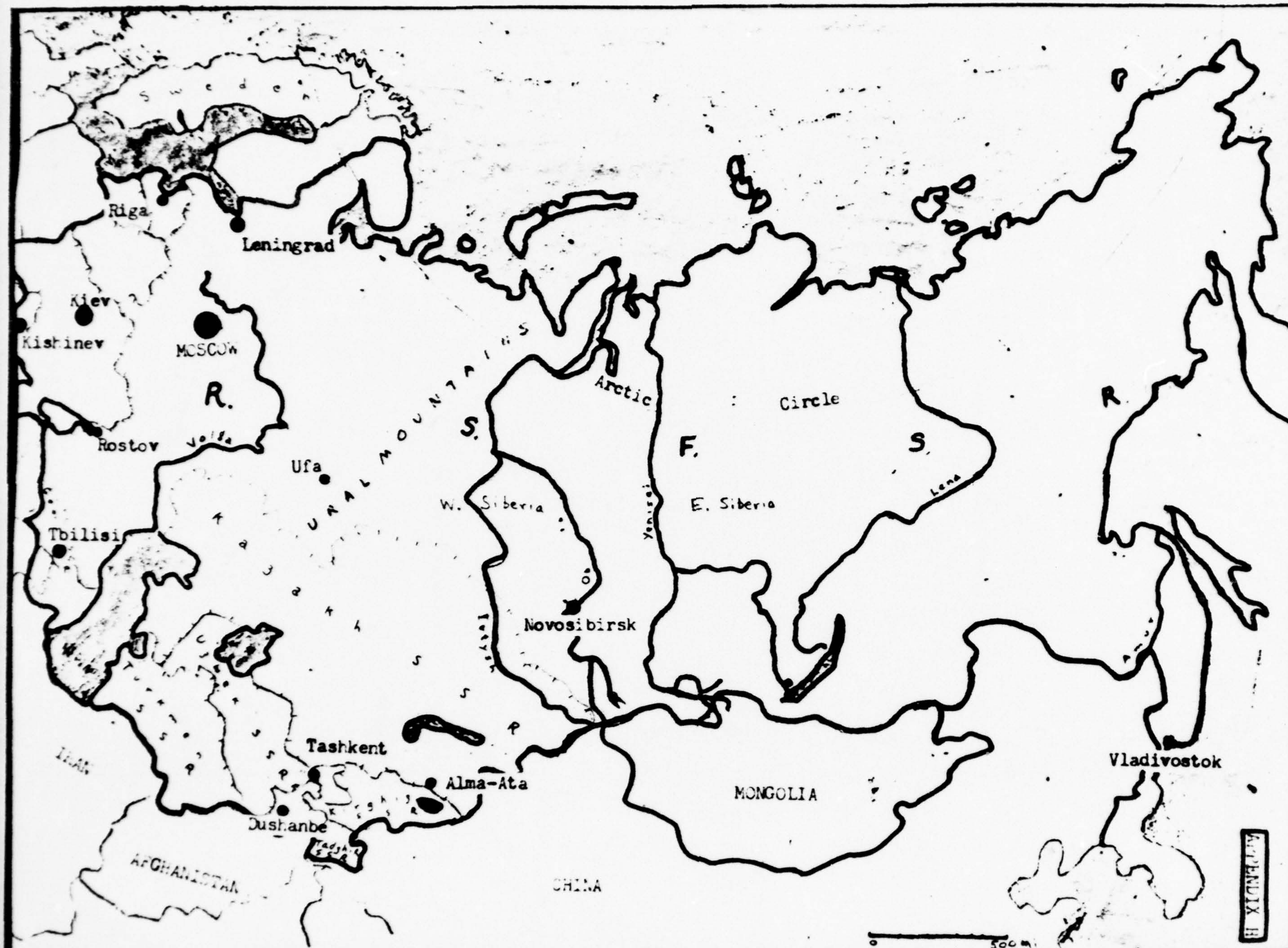
In order to avoid confusing abbreviations for Soviet titles, etc., with those which might be used by Western telephone experts (and which might represent an entirely different concept), this paper uses the Soviet abbreviations throughout, rather than attempt to create "original" abbreviations.

Abbreviation	Expansion	Translation
AMTS	Avtomaticheskaia Mezhdugorodnaia Telefonnaia Stantsiia	Automatic Intercity Telephone Station
ATS	Avtomaticheskaia Telefonnaia Stantsiia	Automatic (city) Telephone Station
ATSK	Avtomaticheskaia Telefonnaia Stantsiia, Koordinatnaia	Automatic Telephone Station, Crossbar System
EASS	Edinnaia Avtomatizirovannaia Sistema Sviazi	United Automatized Telecommunications System*
GU	Glavnyi Uzel	Main Central Exchange (in each SSR)
IKM	Impul'sno-kodovaia Moduliatsiia	Pulse-code Modulation*
MRU	Mezhduraionnyi Uzel	Inter-District Exchange
MTS	Mezhdugorodnaia Telefonnaia Stantsiia	Intercity Telephone Station
NIITS	Nauchno-issledovatel'skii Institut Gorodskoi i Sel'skoi Telefonnoi Sviazi	Scientific Research Institute of City and Rural Telephone Communications*

[*NOTE: Zalucki, Dictionary of Russian Technical and Scientific Abbreviations, Warsaw, 1968.]

Abbreviations	Expansion	Translation
OU	Oblastnoi Uzel	Oblast' Central Exchange (in each oblast')
OS	Okonechnaia Stantsiia	Terminal Station (lowest echelon in network)
RATS	Raionnaia ATS	The ATS of a District (raion)
RSFSR	Rossiiskaia Sovetskaia Federativnaia Sotsialisticheskaia Respublika	The Russian Soviet Federated Socialist Republic
RU	Raionnyi Uzel	District Central Exchange
SSR	Sovetskaia Sotsialisticheskaia Respublika	Soviet Socialist Republic (One of 15-Russian, Ukranian, etc.)
TSMTS	Tsentral'naia Mezhdugorodnaia Telefonnaia Stantsiia	The Central Intercity Telephone Station, Moscow
TsS	Tsentral'naia Stantsiia	Central Station (Rural network)
UAK	Uzel Avtomaticheskoi Kommutatsii	Automatic Switching Center (transit station)
US	Uzlovaia Sel'skaia Stantsiia	Rural Central Exchange

APPENDIX H



Sweden
Riga
Leningrad
Kiev
Kishinev
MOSCOW
R.
Rostov
Volga
Ufa
URAL MOUNTAINS
S.
Arctic
Circle
F.
S.
R.
W. Siberia
E. Siberia
Yenisei
Lena
Ob
Novosibirsk
Tbilisi
Kazakh S S R
Tashkent
Alma-Ata
Dushanbe
IRAN
AFGHANISTAN
MONGOLIA
CHINA
Vladivostok
Amur
0
500 mi

APPENDIX I. Soviet Satellite Communications

General. The Soviet (non-military) communications satellite program is administered by the Chief Cosmic Directorate of the USSR Ministry of Communications. The Soviets currently utilize two types of communications satellites: those launched into highly elliptical orbits; and those launched into circular, stationary orbits. This appendix gives the general characteristics of the spacecraft and the ground stations used with them, as described in original Soviet sources. (Note: Aviation Week & Space Technology, July 8, 1974, announced that: "The Soviet Union is accelerating deployment of a tactical military communications satellite network of dozens of small satellites in low-altitude near-circular random orbit." No indications of such spacecraft were noted in sources available for this paper, however.) (See Figure I-1.)

Beginnings of the Soviet Communications Satellite Program. The development of satellite communications was begun in the Soviet Union with the launch of the first "Molniia" (Lightening) in 1965, and the creation of an experimental system of long-distance radio communications. The basic task of this system was to work out the principles of designing a network of telephone and telegraph radio communications, plus relay of programs from the central television studios, with the aim of subsequently constructing an operational communications satellite system.[166]

A transmitting station near Moscow, and a network of ground stations (called "Orbita") for receiving signals from the Molniia spacecraft, were put into operation in 1967. The network, which consisted of 20 stations by the end of this first year, provided for "transmission of central television to 20 million people living in the Far North, Siberia, and the Far East."[167] The number of ground stations has since more than doubled. Orbita stations use a relatively simple antenna system with a parabolic reflector about 40 feet in diameter, but employ highly sensitive low-noise amplifiers.[168]

The Molniia Program. The Soviets currently employ three series of communications satellites designated "Molniia."

"Molniia-1" is a satellite "designed to provide operational systems of long-distance telephone and telegraph communications, radio communications, and transmission of programs from the central television studios to points on the 'Orbita' network (situated in the regions of the Far North, Siberia, the Far East, and Central Asia)," according to Aviation and Cosmonautics.[169]

Soviet communications satellites in the Molniia-1 series are launched into a highly elliptical orbit at an inclination of 65° from the Equator. (See figures I-1 and I-6). In a single 24-hour period, the satellite makes only two orbits. The greater part of the orbit of the satellite, which becomes "slower" in the area of the apogee, over the northern hemisphere, "illuminates" the entire USSR.[170] The spacecraft are orbited in such a manner that, as one falls below the horizon for a given ground station, another satellite is there to take the place of the former. Thus, multiple satellites are required for the "Molniia" system.

The parameters for Molniia-1 are as follows (on the average); apogee, 24,400 miles; perigee, 305 miles; period of orbit, 12 hours; inclination of orbit, 65°. The system operates in the 800-1,000 MHz range, using two nominal frequencies for two-way communications on each "sector" (earth-to-space and space-to-earth), and frequency modulation for retransmission of the signals. The power of the on-board transmitter reaches about 40 watts.[171]

The system of communications used with the Molniia-1 series permits organizing either duplex multichannel telephone communications (with the possibility of submultiplexing the telephone channels with voice frequency telegraphy or phototelegraphy), or relay of television programs.[172]

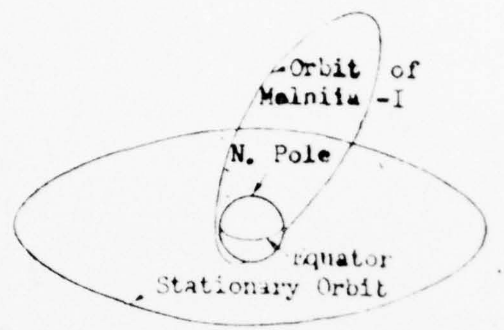


Figure I-1. Communications Satellite Orbits.

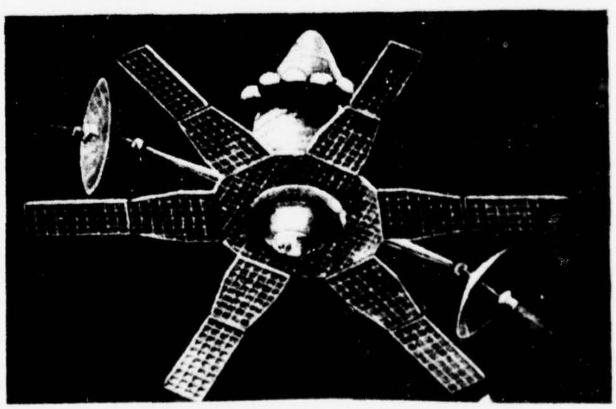


Figure I-2. Communications Satellite "Molniia-1". Note extended antennas and solar batteries.

Molniia-2. Although orbital parameters are nearly identical to those of the Molniia-1 series, the Molniia-2 operates in a different frequency band, and is referred to as a more "advanced" system than its predecessor series (which continues in use). *The first* satellite of the Molniia-2 series, whose on-board relay equipment operates in the 4-6 GHz band, was launched 25 September 1971. New receiving equipment called "Orbita-2" was developed for use with the Molniia-2.[173]

According to the Soviets, the system was designed for "providing telephone and telegraph communications, as well as TV, newsprint, and radio broadcasting, to the 'Orbita' network, as well as to points established within the framework of international cooperation."[174]

[Note: The latter statement evidently refers to the use of a Molniia-2 satellite in the Moscow-Washington "hotline" system. According to Aviation Week and Space Technology of August 21, 1972, "a duplex voice-bandwidth channel on the Molniia-2 system will go from a Molniia station at Vladimir, USSR, to a Molniia Station at Ft. Dietrich, Md." U.S. News and World Report of April 8, 1974 adds that, owing to the highly elliptical orbit, "the Molniia-2's period of mutual visibility to Moscow and Washington is 8 hours. To fill the 16 hour gap, Russia will have to orbit two more satellites along the same track at precise intervals."]

Molniia-3. The Molniia-3 satellites operate according to the same principles as the Molniia-2, but have "greater capabilities and higher quality characteristics." The first of the Molniia-3 series was launched into an elliptical orbit on November 21, 1974. Its equipment operates in the "centimeter" band. The Soviets have applied to the International Telecommunications Union to register the Molniia-3, and in 1976, the "international" organization of cosmic communications called "Intersputnik," will rent out channels on the Molniia-3 for telephone communications, as well as exchange of TV programs, among the countries which belong to that organization: Mongolia, Czechoslovakia, Poland, East Germany, the Soviet Union, and Cuba. "Using the Molniia-3 in a highly elliptical orbit," the Soviets state, "will permit communications between all of these stations...which will present new possibilities for expanding international cooperation."[175]

"Orbita-2" and "Mars". New receiving equipment developed by the Soviets called "Orbita-2," reportedly "completely satisfies the requirements of international standards," and permits transmission of color television. Orbita-2 stations have been in use since the end of 1971, when the first satellite in the Molniia-2 series was launched. According to the Soviets:

> Orbita-2 not only provides for relay of television programs, but also for multichannel telephone communications between the center of the country and

> the Far East and Eastern Siberia. Several types of equipment were created for relaying telephone calls, in which (together with the widely-used methods employed in the conventional ground systems) principles are used which conform to the spacecraft system. For example, frequency division multiplexing of the supergroup in the on-board transmitter, and frequency modulation of the signals, allows <u>multi-station access</u> to the system.[176] [Emphasis mine-RR]

Along with the stationary ground stations of the Orbita-2 type, the Soviets have designed and built a <u>transportable</u> station called "Mars." The station reportedly successfully completed its testing in 1974, having organized direct television transmission from India, Cuba, Bulgaria, and Mongolia, on the arrival there of a Party-governmental delegation headed by Brezhnev.

A comparatively simple, compact, and mobile <u>transmitting-receiving</u> station, "<u>Mars</u>" operates through the <u>Molniia-2</u> communications satellite. The Mars station operates in the frequency band reserved for space communications (4-6 GHZ), and services the transmission of the picture and sound (on separate channels), as well as telephone and telegraph service communications (for which one supergroup of the spacecraft transceiver is used). "Frequency modulation is used for sending the images...[while] the sound, as well as the service communications (telephone and telegraph) are sent by appropriate methods of time and frequency multiplexing," the Soviets report.[177]

The antenna of the Mars station consists of a completely rotatable quasi-paraboloid reflector 7 meters in diameter with a quasihyperboloid counter-reflector 1.1 meters in diameter. "In spite of its small dimensions," the Soviets say, "signal quality received from the spacecraft Molniia-2 is satisfactory." All radiotechnical equipment (except the output stage of the transmitter) in the Mars station is based on the transistor with integrated circuits.[178]

The total weight of the Mars station is said to be about 30 tons, and it can be transported by rail, truck, sea, or air transport in three large crates. These three crates, when joined together, form the sides of the station. The joining together of the three containers, however, the assembly and installation of the antenna system on the roof, mechanical installation, and tuning up the station requires two to three days. The station is said to be capable of operating in "any climatic conditions," even in high winds. (See figures I-3 through I-5)

Figures I-3, I-4 and I-5. New Soviet Transportable Satellite Communications Station called "Mars".

This receiving-transmitting station can be sent to just about any point on the globe, set up, and put into operation in just a few days.

Stationary Satellites. A stationary orbit is very convenient: a satellite launched into a circular orbit at a distance of about 22,000 miles, in line with the equator, makes one orbit every 24 hours along with the earth. In this case, it is easier to track the satellite with the ground station antennas, and there are no breaks in communication owing to regular transfers from one satellite to another, as in the Molniia system. (However, stationary satellites do not provide good coverage for the polar regions.) (See figure I-6).

The Soviets are developing a system called "Statsionar-T." This system operates in the "decimeter" frequency band, where TV signals are sent to the satellite at frequencies on the order of 4-6 GHz, while the space-to-earth link operates in the 702-726 MHz band. The transmitter on the spacecraft has a large output (in the order of 300 watts), while the antenna has "high-standard transmitting characteristics," which reportedly permit reception from the satellite by simpler and less expensive systems than are employed with the "Orbita-2" stations.[179]

The "Statsionar" satellites will be so arranged in geostationary orbit that two or three will provide "TV coverage" all across the territory of the USSR. "The territory," say the Soviets, "on which reception of... signals from the 'Statsionar-T' system is possible, covers about 10 million square kilometers, and extends from the southern borders of the Soviet Union up to 75 degrees North latitude" (which is roughly in the area of Cape Cheliuskin, or just to the south of Severnaia Zemlia).[180]

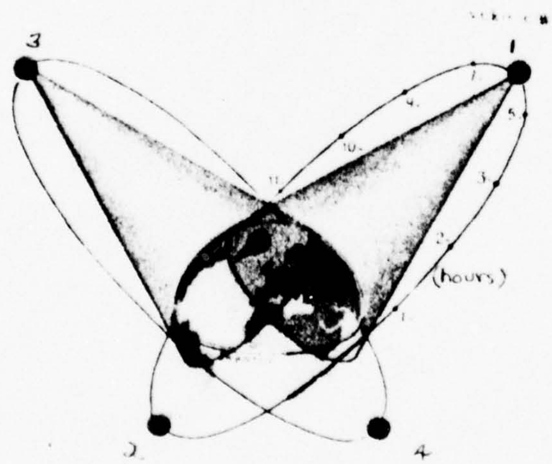
Thus far, the Soviets have successfully launched at least three satellites into geostationary orbit: Molniia-1S, "a communications satellite with equipment for experimental transmission of TV and long-distance radio communications," was launched on 29 July 1974, and achieved a circular orbit of 21,870 miles with a period of 23 hours and 59 minutes. The satellite called "Raduga" was launched on 22 December 1975 into a circular orbit of about 21,840 miles, with a period of 23 hours and 54 minutes.[181] The Soviets had the following to say about their "Raduga" satellite:

> "Raduga" (the international registration suffix is Statsionar-1) is a communications satellite with onboard relay equipment designed for providing uninterrupted, round-the-clock telephone-telegraph radio communications and simultaneous transmission of color and black and white programs of central television to the network of "Orbita" stations. Launched into a nearly stationary circular orbit, the satellite has a constant position with respect to the earth's surface.[182]

In addition, the Soviet journal Aviation and Cosmonautics reported the launch of "Kosmos 775" on October 8, 1975 into an orbit very similar to that of "Raduga." The satellite was not further identified in that journal, however.[183]

Figure I-6

a. Positioning of space vehicles in geostationary orbit. Three satellites, whose orbital period matches the Earth's own rotation, provide communication between any two points on the Earth's surface.



b. Positioning of satellites in an orbit such as that of "Molniia." Relieving one another, these satellites can support continuous radio contact across the entire Northern Hemisphere.

Some Applications of Soviet Satellite Communications. In addition to their obvious advantages in providing a global communications capability, the participation in a system of satellite communications of a network of stations (such as the Orbita network), makes possible operational redistribution of telephone channels, that is, switching unloaded channels over to those lines where there are not sufficient channels at the time, via satellite relay.

The Soviets envision such a possibility, because:

> The transmitting and receiving circuitry at satellite stations have a lot in common with the equipment employed on conventional radio relay lines. Satellite lines, just as radio relay lines, employ frequency modulation (with one important difference, in that the satellite lines strive to realize maximum results in noise suppression). Nevertheless, the telephone circuits use the very same methods of formation of the combined spectrum of telephone channels and their submultiplexing as are used in the communications systems on Earth.[184]

At the same time, the Soviets report, that "at the present time," because the communications satellites and radio relay systems often transmit in the same frequency band, "they tend to interfere with one another...[which] places limitations on their transmitting power."[185] The Soviets reportedly plan to raise the frequencies used for satellite communications to the relatively free spectrum above 10,000 MHz, which will also permit increasing the capacity of the satellite systems. (As a general rule, the higher the carrier frequency, the greater the volume of information that can be sent at the same time.)

Telephone communications organized for satellite systems can be designed on the basis of using either fixed or non-fixed channels between stations, the latter being offered the subscriber on demand. In the latter case, the system can be very flexible, permitting concentration of channels on the required lines of communications at any time, in order to remove the peak workload.[186]

"Qualitative indicators" of the communications channels aboard Soviet communications satellites reportedly "correspond to international standards for all types of information." The Soviets plan to reserve certain channels for "international" usage under the "Intersputnik" system, and declare that:

> For this purpose, receiving-transmitting stations have already been built on the territory of Cuba, the Czechoslovak SSR, and the Polish Peoples' Republic. A receiving station is in operation in the Mongolian Peoples' Republic, and a receiving-transmitting station is being built in the GDR. Stations are planned for other countries as well.[187]

Summary. Over the recent five-year period, the Soviets have continued to launch satellites in the Molniia series at (on the average) four-month intervals within each series. Thus, between July 28, 1971 and January 22, 1976, fourteen satellites in the Molniia-1 series were launched; between November 24, 1971 and December 17, 1975, thirteen of the Molniia-2 series were launched; and satellites in the Molniia-3 series were orbited on November 21, 1974 and on April 14 and November 14, 1975.[188] (See chart on following page.)

SUMMARY OF MOLNIIA ACTIVITY, 1971-1975: (launches)

YEAR/MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1975		M-2		M-1 M-3		M-1	M-2		M-2 M-1	(S)	M-3	(R)
1974				M-1			M-1S M-2			M-1	M-3	M-2
1973		M-1		M-2			M-2	M-1		M-2	M-1 M-1	M-2
1972				M-1	M-2				M-2	M-1		M-2 M-1
1971									M-1		M-2	M-1

M-1 = Molniia-1 (etc.); S = Statsionar; R = "Raduga"

APPENDIX J. The "Cordless" Intercity Telephone Station "Oblako" (AMTS-2)

The AMTS-2, also known as "Oblako" (cloud), is a high-capacity (1,500-3,000 channels) intercity telephone station which incorporates "cordless" switchboards (See Figure J-1) and automatic switching equipment for making all types of connections, including automatic transit connections, even on channels where the opposite terminal is equipped with manual switching equipment. The switching equipment used at the AMTS-2 is the relatively more sophisticated crossbar system. (See Figure J-2 and J-3)

An article which appeared in the Soviet journal Science and Life entitled "Oblako, The Automatized Telephone Station" in April 1970 is quoted extensively below:

> Up to now, only manual stations were in use in our country for servicing intercity telephone calls. Such stations are serviced by telephone operators, whose work is tense and exhausting.
>
> The Riga State Electrotechnical Factory (VEF) has produced an intercity telephone station of the cordless type, which will make it easier to carry on intercity conversations. Such stations have been named "Oblako." The first "Oblako" is already installed in Moscow. Similar stations are being installed in Minsk and Riga.
>
> An MTS of the cordless variety makes possible extensive automatization of the processes of making connections, as well as a number of technical operating processes, such as figuring up a subscriber's bill for making a long-distance call.
>
> (The Moscow "Oblako" station is in a 10-story building next to the Metro station on Taganskaia Square; the building was especially designed to house a modern telephone station.)

The following paragraphs compare and contrast the manner in which an intercity conversation is "normally" conducted, and how one is made using the "Oblako" system:

> How is an intercity telephone conversation normally conducted:
>
> "Intercity," answers the telephone operator, after the subscriber dials the appropriate number for "Intercity calls" (for most cities in the USSR this is "07"); the operator inquires with which city the subscriber wishes to be connected, under which category (routine or urgent), the name and number of the party being called, and, of course, the name and number of the party placing the call.
>
> All of these questions are asked by a telephone operator, whose job is only to take down the booking and fill in the booking ticket. Besides this, she doesn't do a thing, and cannot do anything else--only a single line is connected to her switchboard, the so-called "booking line." This line is not connected with any other city.
>
> The completed booking ticket is passed on to the "connection service," where yet another telephone operator dials the number of the party who wishes to place the call, from her switchboard, at the same time checking on the correctness of the subscriber number and the accuracy of the booking ticket. Following this operation, the connection can be made with the party being called: the telephone operator selects an unoccupied channel, inserts the plug of a connecting cord into the jack of a channel for the appropriate city, and sends a signal.
>
> Well, if she doesn't have a direct channel to that city on her panel, then she has to make a connection with a telephone operator at the switchboard where there is access to the required channel. And <u>such a chain of telephone operators might be extremely long</u>. [Emphasis mine-RR]

With the <u>"cordless" MTS</u>, as the name implies, there are no cords at the connecting switchboards. (Where the automatic system is used, there are no operators either.)

Following is a very detailed description of the process of establishing an intercity connection <u>using the newer "Oblako" system</u>: (See figure J-4)

> When the subscriber lifts the receiver of his telephone, a certain number of devices at the

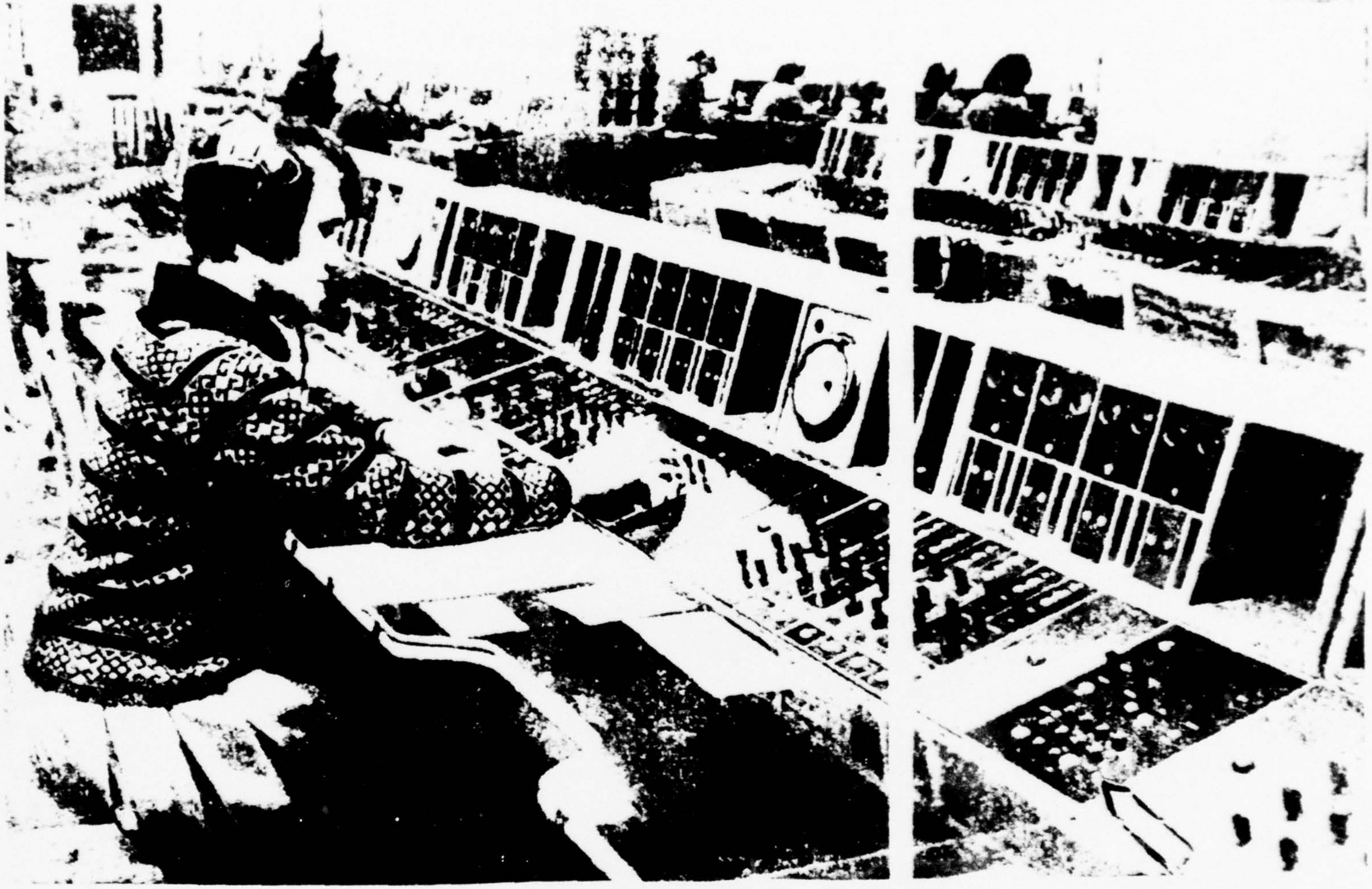


Figure J-1. AMTS-2 "cordless" intercity switchboard, which provides automatic distribution of subscriber calls among working positions, establishes order of priority of incoming calls (if no operator is available) and services delayed calls in order of appearance. Operators indicate readiness to receive calls by pressing a key. Eight digital lights have been installed on the front panel, on which number of subscriber making call, and his category, are automatically displayed. Note "touch tone" buttons (arrow) rather than dial. (Photo: Nauka i Zhizn' No. 4-1970) station are activated; these devices hook up the subscriber with an electronic device, which "remembers" the number which was dialed by the subscriber.

The dial on the subscriber's telephone, rotating, closes and opens contacts which send impulses of electrical current to the automatic telephone station (ATS). One impulse is equal to the number "1", two impulses--the number "2", and so on. The registering equipment at the station receives these impulses and stores them in its "memory" for transmission to the switching equipment.

In order to understand the subsequent activity of the automatic equipment, one needs to know just what the number of the party being called represents: this number is nothing other than an indicator of the direction of the connection.

The Intercity Number

The first three digits at the intercity station represents the city code. Many such codes begin with the number "8". Let's say the code of the city being called is 801. After the code comes the subscriber's number. Let's say the subscriber's number is 621242. The first two digits are the code of the ATS--the district (raionnoi) switching station, to which the subscriber's telephone is connected. The remaining four digits are the number of the subscriber's line at that station.

The registering equipment, having received the impulses "8", "10", and "1", which corresponds to the code "801," converts them and transmits this information to the relay equipment, called the "marker." The marker, with the aid of its relays, seeks out a free line-channel to the city being called. To do this, it first of all seeks out an unoccupied MKS (Mnogokratnii Koordinatnyi Soedinitel' - Multiple Crossbar Switch).

The Multiple Crossbar Switch (MKS)

The MKS is the basic switching mechanism of the crossbar automatic telephone station. The operation of the MKS is based on the operations of a group of relay contacts.

The simplest type of MKS has 100 groups of contacts, in the form of relay-type springs and stationary bars. The groups of contacts are arranged in a rectangular frame (figure J-3) in such a manner, that a field of contacts is created,

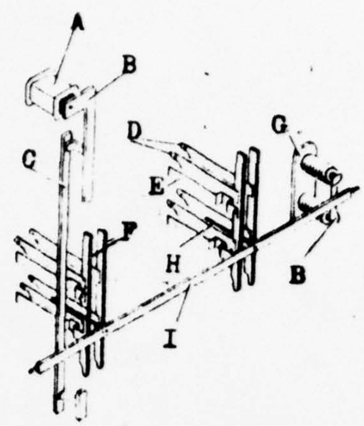


Figure J-2. Detail of Multiple Crossbar Switch.

A. Retaining Electromagnet
B. Armature of Retaining Electromagnet
C. Operating "Strip"
D. Contact Springs
E. Operating Spring
F. Contact Bars
G. Selector Electromagnet
H. Selector Spring
I. Selector Bar

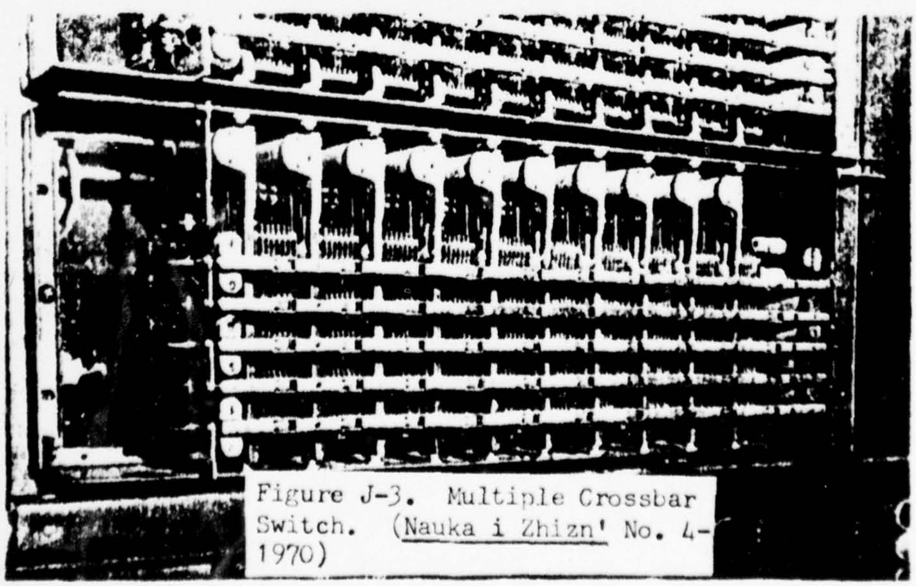


Figure J-3. Multiple Crossbar Switch. (Nauka i Zhizn' No. 4-1970) with 10 vertical, and 10 horizontal rows. There are electromagnets situated along both sides of the frame. These are called "selectors," since with their aid the required horizontal group of contacts is selected, in which the required connection is situated.

Upon operation of one of the selector electromagnets, the selector bar moves, and the selector pin of this bar is placed opposite the bend (chamber) of the operating contacts of all groups of contacts on the given horizontal row, that is, in all 10 of the vertical rows. In the vertical rows are located so-called "retaining electromagnets." If at this time one of the retaining electromagnets of the vertical row has been activated, then the operating bar (strip) of this vertical row, having moved in the direction of the contact groups, meets a selector pin, sticks to it and presses on the operating spring. This forces the contact spring of the selected contact group to lock with the stationary contact bars.

As soon as the retaining electromagnet has completed its operation, the selector electromagnet loses its electric current and releases its armature. The selector bar, under the influence of the return spring, takes up a neutral position, while only the selector pin remains stuck to its contact. Although it remains stuck for the entire time of the conversation, it does not prevent the bar from moving and making other connections.

Upon completion of the connection, the retaining electromagnet releases its "anchor" (armature), and the selector pin returns to the neutral position.

All of the above operations occur in a fraction of a second, therefore, one may say that by means of an MKS having 10 vertical bars, 10 connections can be made one after the other almost instantly.

If the required line is unoccupied, the ringer contact closes, and the phone of the party being called begins to ring. If, however, the line is busy, all the systems are disconnected, and the busy signal is connected.)

As is well known, once access to the calling complex has been achieved, the marker must receive the information about the required connection. Since the marker reacts to the signals instantly, the information it requires must arrive as rapidly as possible. Therefore a special high-speed transmitting device is used, by means of which the information is transmitted from the ATS to the MTS at a speed of 10 digits per second.

Automatic Number Identification and Subscriber Billing.

When the party being called picks up the receiver, still another group of complex systems are connected at the MTS, the task of which is to carry out the calculating of charges for the calling party.

The automatic number identification equipment (AAON - Apparatura Avtomaticheskogo Opredeleniia Nomera) determines the line from which the call came in--and once you've found the line, you've found the number. In fact, the AAON determines the number and the category instantly, at the time the booking is made: automatic devices must "know" from which telephone the other city is being called-whether it is a phone in an apartment, in a government office, in a hotel, or from an ordinary public phone booth. (If the call originates at a public phone booth,the AAON "forbids" automatic connection with the other city.)

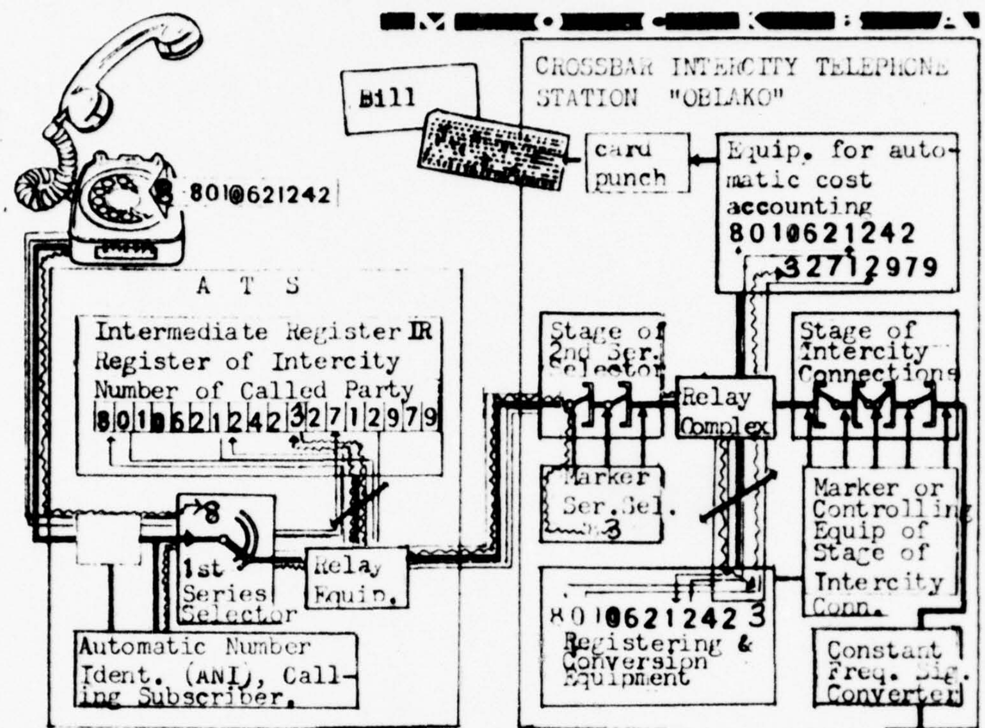
The AAON makes its decisions in the register stages:

From the moment the party being called picks up the receiver, a device starts to operate, which sends an electronic impulse every six seconds. (Ten impulses equals one minute.) At the conclusion of the conversation, the calculation of impulses ceases. If, however, the number of impulses totals 300, the automatic equipment cuts off the conversation [Emphasis mine-RR]--conversations of over 30 minutes are frowned upon--one also ought to think of other subscribers who may wish to speak with that same city.

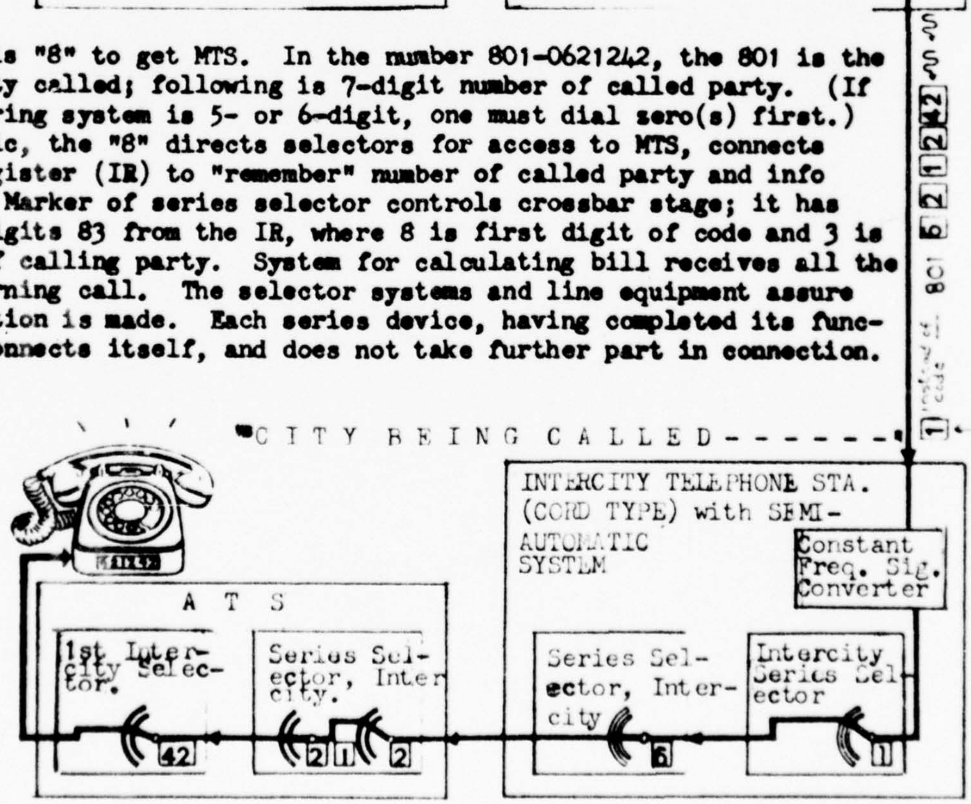
The registering equipment, having received the number of the calling party and the party being called in its electronic brain, as well as the every-six-seconds impulses, "inquires" of special clocks about the time of day (in order to establish the tariff category--as you know, its cheaper to call after six). Based on the code category of the subscriber being called, the electronic memory receives the costs for one minute of conversation. These costs are also stored in the computer.

On the basis of all these data, the calculating equipment determines the cost of the conversation, and the computer sends the data to the card perforator, having already determined the priority for printing the billing cards. If the conversation originated at a hotel, for instance, then the card must be prepared out-of-sequence, so the caller can pay his charges before checking out of the hotel.

Figure J-4



Caller dials "8" to get MTS. In the number 801-0621242, the 801 is the code of city called; following is 7-digit number of called party. (If city numbering system is 5- or 6-digit, one must dial zero(s) first.) In schematic, the "8" directs selectors for access to MTS, connects initial register (IR) to "remember" number of called party and info from ANI. Marker of series selector controls crossbar stage; it has received digits 83 from the IR, where 8 is first digit of code and 3 is category of calling party. System for calculating bill receives all the data concerning call. The selector systems and line equipment assure the connection is made. Each series device, having completed its function, disconnects itself, and does not take further part in connection.



"Oblako" at the Introductory Stage

"Oblako" is an extremely complicated system. At this time, as was stated previously, only the first stage has been put into operation; therefore, not all connections [Emphasis mine-RR] are conducted via automatic lines. There are also still communications serviced by telephone operators. But even some of these telephone operators are already working at cordless switchboards.

Operator Servicing at Cordless Switchboards

In the switchboard room, there is a control panel for the "immediate system" [See Appendix C-RR] for each telephone operator. After the booking is received, the same operator who fills out the ticket immediately--using a touch-tone device--a push button system, "dials" the required number and turns on the timing device. A single telephone operator can make up to six connections [Emphasis mine-RR] on any link within the Soviet Union.

The senior telephone operator on the shift controls the work of the entire switchboard room from her control panel. There are instruments at her panel which display the number of channels active, the intensiveness of the workload, and even the time the telephone operator required to answer the call of a subscriber.

Trouble Indicator Lamps

There is also a special signal system for problems on the line. Illuminated display lights are arranged along a number of equipment racks. When a blue lamp lights up, it means the fuse blew on that rack; a white lamp also indicates a blown fuse, but a less important one; if, however, a red lamp lights up, you need a maintenance man right away.

In the future, the automatic equipment will not have to wait until the maintenance man comes. In order that a telephone conversation not be interrupted, a special relay instantly connects one to an unoccupied line in good working order, and the conversation is shifted to that line. At this time, the maintenance man is guided to the faulty equipment with his test gear and eliminates the problem.

Conclusion. At such a complex station as "Oblako," which has up to 3,000 communications channels, it is of course not possible to check the condition of the lines by the old, manual method. For this purpose, a whole complex of automatic control and testing equipment has been created.

An so, with this we will complete the excursion through an intercity telephone station of the "Oblako" type. It goes without saying, that it was not exhaustive: such a description would take up hundreds of thick tomes, and many of them would be comprehensible only to a professional. [The author is in complete agreement with these sentiments-RR]

In conclusion, one may emphasize that, today's station known as "Oblako" was intended for up to 200 lines of communications, and in each of these around 200 communications channels.

* * *

FOOTNOTES

1. "The Age of Overload," Newsweek, September 29, 1969, pp. 36-37.

2. Adzhemov, C. A., "The Chief Directions of the Development of Technology of Wire Communications," Vestnik Sviazi No. 4-1970, p. 25.

3. Vinogradov, P. N., "To the Workers of the Villages," Vestnik Sviazi No. 5-1970, pp. 29-30.

4. Vlasov, L. V., "Do We Know How to Speak on the Telephone?", Economics and the Organization of Industrial Production, No. 1-1975, pp. 198-208.

5. "Telephony," Van Norstrand Scientific Encyclopedia, 1958, p. 1654.

6. Ibid., p. 1655.

7. "Telephone," Encyclopedia Brittanica, 1964, Volume 22, p. 901.

8. Ibid.

9. Ibid.

10. Ibid.

11. Ibid.

12. Ibid., p. 902.

13. Ibid.

14. Ibid.

15. Ibid.

16. "Communications--Yesterday, Today, and Tomorrow," Zaria Vostoka, April 14, 1973, p. 3.

17. Brittanica, op. cit.

18. Ibid.

19. Ibid.

20. "Information: Machines Do the Calculating," Vestnik Sviazi No. 6-1970, p. 28.

21. "Telephony," Collier's Encyclopedia, Vol. 22, p. 129.

22. Ibid.

23. Solov'ev, Sh. G., Intercity Telephone Stations, Sviaz' Publishing House, Moscow, 1972, p. 9.

24. Ibid., p. 13.

25. Ibid., p. 21.

26. Ibid., p. 38

27. Ibid.

28. Ibid., p. 68.

29. Ibid., p. 188.

30. Ibid., p. 38.

31. Ibid., P. 134.

32. Ibid., p. 141.

33. Ibid., p. 301.

34. Ibid., p. 302

35. Ibid., p. 13.

36. Ibid., p. 16.

37. Ibid., p. 33.

38. Ibid., p. 18.

39. Ibid., p. 20

40. Ibid., p. 21.

41. Ibid., p. 24.

42. Ibid., p. 23.

43. Ibid., p. 21.

44. Ibid., p. 27.

45. Ibid., p. 29.

46. Ibid., p. 28.

47. Ibid., p. 29.

48. Ibid., p. 31.

49. Ibid., p. 29

50. Ibid., p. 32

51. Ibid., p. 36

52. Ibid., p. 37.

53. Yearbook, The Great Soviet Encyclopedia, 1975, p. 10.

54. Solov'ev, op. cit., p. 38.

55. Ibid., p. 43.

56. Ibid.

57. Ibid.

58. Ibid.

59. Ibid.

60. Ibid., p. 44.

61. Ibid., p. 46.

62. Lecture by Prof. Konstantin Arkad'evich Krylov, "Communications Facilities in the Soviet Union," U.S. Army Russian Institute, February 27, 1976.

63. Solov'ev, op. cit., p. 46

64. Ibid., p. 49.

65. Lecture by Mr. Vladimir Aleksandrovich Dremluga "Treatment of Dissidents in the Soviet Union," U.S. Army Russian Institute, March 21, 1976.

66. "Listing of Subscribers to the Moscow City Telephone Network," Sviaz' Publishing House, Moscow, 1966, pp. XXI and

    Solov'ev, op. cit., p. 133.

67. Solov'ev., op cit.

68. _Ibid._, p. 141.

69. _Ibid._

70. _Ibid._, p. 142.

71. Korol', V. I., "The Working Habits of the Communicators of the Ukraine," _Vestnik Sviazi_, No. 4-1970, p. 34.

72. Adzhemov, _op. cit_.

73. Elibaev, A., "On to a New Phase," _Kazakhstanskaia Pravda_, May 6, 1971, p. 3.

74. Kudinov, A., "Communications at the Service of the Economy and the Culture," _Pravda Vostoka_, November 22, 1970, p. 2.

75. "Communications in the Final Year of the Five Year Plan," _Ekonomicheskaia Gazeta_ No. 19, May 1975, p. 1.

76. Timofeev, A., "The Intercity Telephone," _Pravda Vostoka_, March 22, 1972, p. 2.

77. Vinogradov, _op. cit_.

78. Elibaev, _op. cit_.

79. Kazimov, V., "Problems of the Five Year Plan: Communications and the National Economy," _Pravda Vostoka_, October 23, 1971., p. 2.

80. "On Serious Deficiencies in the Activities of the Ministry of Communications of the Georgian SSR," _Zaria Vostoka_, November 30, 1972, p. 1.

81. "Winning the Battle with Time and Distance," _Zaria Vostoka_, May 6, 1973, p. 3.

82. Tsiskaridze, A., "I'd Like You To Meet the Electronic Automatic Telephone Station," _Zaria Vostoka_, March 31, 1974, p. 3.

83. Timofeev, _op. cit_.

84. Adzhemov, _op. cit_.

85. Kazimov, _op. cit_.

86. Timofeev, _op. cit_.

87. Adzhemov, op. cit.

88. Petrushin, I. P., "The Technology of Communications in the Intrazonal Networks," Vestnik Sviazi No. 9-1970, pp. 16-17.

89. Ibid.

90. Ibid.

91. Amanov, S., "Television--Across the Mountain Ranges," Sovetskaia Kirgizhiia, November 26, 1974.

92. Blokhin, A., "Transmission Systems with Frequency Division of Channels: Their Growth, and Their Prospects for the Future," Vestnik Sviazi No. 4-1975, p. 28.

93. Karbelashvili, A., "Born in Hungary," Zaria Vostoka, February 6, 1973.

94. Adzhemov, op. cit.

95. Ibid.

96. Ibid.

97. Piskacheva, L., "Proper Organization of Production--the Guarantee of Raising the Quality of Communications," Vestnik Sviazi No. 12-1975, p. 33.

98. Adzhemov, op. cit.

99. Ibid.

100. Ibid.

101. Blokhin, op. cit.

102. Timofeev, op. cit.

103. Sadykov, E., "From 'Morse' to 'Orbita'," Sovetskaia Kirgizhiia, October 10, 1974, p. 2.

104. Posysaev, N. S. "Communications Technology from Abroad: The Electronic Switchboard," Vestnik Sviazi No. 12-1969, p. 22.

105. Karbelashvili, op. cit.

106. Ambrush, Y., "'Budavox' in Tashkent," Pravda Vostoka, September 14, 1971.

107. Ibid.

108. Ibid.

109. Ibid.

110. Sutton, Antony C., Western Technology and Soviet Economic Development 1917-1930, (Stanford, California: Stanford University, Hoover Institute, 1968), pp. 185-196.

111. "Information--They are Installing 'Ericsson'," Vestnik Sviazi No. 5-1970, p. 33.

112. "The Energetic Relay Race for Socialist Competition Goes On," Vestnik Sviazi No. 12-1974, pp. 12-13

113. "Information--International Symposium on Communications Technology," Vestnik Sviazi No. 8-1970, p. 23.

114. Tsiskaridze, op. cit.

115. Vinogradov, op. cit.

116. Tsiskaridze, op. cit.

117. Adzhemov, op. cit.

118. Ibid.

119. Ibid.

120. Ibid.

121. Ibid.

122. Ibid.

123. Amanov, op. cit.

124. Adzhemov, op. cit.

125. Amanov, op. cit.

126. Holland, Wade B., "Party Congress Emphasizes Computer Technology," Soviet Cybernetics Review (The Rand Corp.), July 1971, p. 7.

127. Blokhin, op. cit.

128. The Great Soviet Encyclopedia, 1974, Vol. 9, p. 63.

129. Solov'ev, _op. cit._, p. 302.

130. _The Great Soviet Encyclopedia_, _op. cit._

131 Petrushin, _op. cit._

132. _Ibid._

133. _Ibid._

134. Gerchikov, E. Ia., "Effectiveness Is the Most Important Thing," _Vestnik Sviazi_, No. 7-1970, p. 29.

135. Timofeev. _op. cit._

136. Neelov, N. & Skorenko, Zh., "The Effects of Mechanization of the Distribution of Booking Tickets," _Vestnik Sviazi_ No. 4-1974, p. 38.

137. Zhelezina, T., "Raising Production Standards Means Improving Service," _Vestnik Sviazi_ No. 1-1975, p. 10.

138. Beliaeva, N. & Semenova, E., "The Supervisor of a Young Shift," _Vestnik Sviazi_ No. 3-1975, pp. 20-28.

139. "The Progressive Workers Share Their Experience," _Vestnik Sviazi_ No. 3-1970, p. 44.

140. "The Rhythm of the Decisive Year of the Five Year Plan," _Vestnik Sviazi_ No. 12-1975, p. 8.

141. Ivchenko, A. E., "How the Ruble Works," _Vestnik Sviazi_ No. 7-1970, p. 23.

142. _Ibid._

143. Svistel'nikov, G. A., "Reserves for Increasing the Productivity of Labor in the Management of the Communications of Latvia," _Vestnik Sviazi_ No. 6-1970, p. 25.

144. Timofeev, _op. cit._

145. _Zaria Vostoka_, April 14, 1973, _op. cit._

146. Rekhlina & Stoliarova, "A New Road Has Been Opened: Scientific Organization of Labor at Communications Enterprises," _Vestnik Sviazi_ No. 10-1970, pp. 38-41.

147. May & Friendly, "Russia--The Technology Gap," _Newsweek_, February 9, 1976.

148. Beliaeva & Semenova, _op. cit._

149. Vinogradov, op. cit.

150. Ekonomicheskaia Gazeta No. 19-1975, op. cit.

151. Holland, op. cit.

152. "The Age of Overload," Newsweek, op. cit.

153. Interview with representative of UNIVAC Corp., Marketing Manager for Eastern Europe, at U.S. Army Russian Institute, February 19, 1976.

154. Holland, op. cit.

155. May & Friendly, op. cit.

156. Bol'shaia Sovetskaia Entsiklopedia (The Great Soviet Encyclopedia), "Sviaz'," Ezhegodniki (Yearbooks), 1964-1974.

157. Transportation and Communications of the USSR, Central Statistical Directorate of the Council of Ministers of the USSR, Moscow, 1972, p. 288.

158. Smith, Hedrick, The Russians, Quadrangle--The New York Times Book Co., 1976, p. 209.

159. Appendix B is based on translation of selected portions of Solov'ev, op. cit., Chapter 12, pp. 182-192.

160. Solov'ev, op. cit., p. 10.

161. Appendix C is based on translation of selected portions of Solov'ev, op. cit., Chapter 2, pp. 20-29.

162. Volkov, S. G., "With the Communications Workers of Bashkiriia," Vestnik Sviazi No. 7-1970, p. 27.

163. Appendix D is based on translation of selected portions of Solov'ev, op. cit., Chapter 3, pp. 32-36.

164. Appendix E is based on translation of selected portions of Solov'ev, op. cit., Chapter 3, pp. 42-45.

165. Appendix F is based on translation of selected portions of Solov'ev, op. cit., Chapter 3, pp. 39-42.

166. Dudkin, V., "The Broad Horizons of Satellite Communications," Vestnik Sviazi No. 4-1975, p. 33.

167. Dudkin, V. & Fomantsov, V. P., "Several Directions in the Growth of Satellite Communications," Vestnik Sviazi No. 1-1976, p. 14.

168. Dudkin, op. cit.

169. "Table of Launches of Space Devices," Aviatsiia i Kosmonavtika No. 4-1974, p. 41.

170. Kantor, L., "Successes and Problems in Satellite Communications Systems," Vestnik Sviazi No. 5-1969, p. 5.

171. Dudkin, op. cit.

172. Ibid.

173. Ibid.

174. Aviatsiia I Kosmonavtika, op. cit.

175. Dudkin & Fomantsov, op. cit.

176. Dudkin, op. cit.

177. Privalova, N., "The First Transportable Communications Satellite Station of Soviet Manufacture," Vestnik Sviazi No. 5-1975, p. 19.

178. Ibid.,

179. Dudkin & Fomantsov, op. cit.

180. Ibid.

181. Aviatsiia i Kosmonavtika, op. cit.

182. Ibid.

183. Ibid.

184. Dudkin, op. cit.

185. Kantor, op. cit.

186. Dudkin, op. cit.

187. Ibid.

188. "Table of Launches of Space Devices," appears in the April issue of Aviatsiia i Kosmonavtika each year. The sources for the chart summarizing Molniia activities were the April issues for 1972 through 1976.

189. Birkenfel'd, V., "'Oblako' the Automatized Telephone Station," Nauka i Zhizn' No. 4-1976, p. 60.

BIBLIOGRAPHY

1. Adzhemov, C. A., "The Chief Directions of Technology of Wire Communications" (Glavnye Napravleniia Razvitiia Tekhniki Provodnoi Sviazi), Vestnik Sviazi No. 4-1970, pp. 23-25.

2. "Administrative-Territorial Composition of the USSR and Union Republics" (Administrativno-Territorial'noe Sostavlenie SSSR i Soiuznykh Respublik), The Great Soviet Encyclopedia, Yearbook (Bol'shaia Sovetskaia Entsiklopediia, Ezhegodnik), 1975, p. 10.

3. Amanov, S., "Television--Across the Mountain Ranges" (Televidenie--Cherez Gornye Khrebty), Sovetskaia Kirgizhiia, November 26, 1974, p. 3.

4. Ambrush, Yanosh, "'Budavox' in Tashkent" ('Budavox' v Tashkente), Pravda Vostoka, September 14, 1971, p. 3.

5. Beliaeva, N. & Semenov, E., "The Supervisor of a Young Shift" (Brigadir Molodykh), Vestnik Sviazi No. 3-1975, pp. 20-28.

6. Birkenfel'd, V., "'Oblako'--The Automatized Telephone Station" ('Oblako'--Avtomatizirovannaia Telefonnaia Stantsiia), Nauka i Zhizn' No. 4-1970, p. 60.

7. Blokhin, A., "Transmission Systems with Frequency Division of Channels: Their Growth, and Their Prospects for the Future" (Sistemy Peredachi s Chastotnym Razdeleniem Kanalov: Razvitie i Perspektivy), Vestnik Sviazi No. 4-1975, p. 28.

8. Central Statistical Directorate of the Council of Ministers of the USSR, Transportation and Communications of the USSR (Transport i Sviaz' SSSR), Moscow 1972, p. 288.

9. "Communications and the Final Year of the Five Year Plan" (Piatiletka, God Zavershaiushchii, Sviaz'), Ekonomicheskaia Gazeta No. 19, May, 1975, p. 1.

10. "Communications--Yesterday, Today, and Tomorrow" (Sviaz'--Vchera, Segodniia, i Zavtra), Zaria Vostoka April 14, 1973, p. 3.

11. Dremluga, Vladimir Aleksandrovich, U.S. Army Russian Institute, Lecture: "Treatment of Dissidents in the Soviet Union," March 21, 1975.

12. Dudkin, V., "The Broad Horizons of Satellite Communications" (Bol'shie Gorizonty Sputnikovoi Sviazi), Vestnik Sviazi No., 4-1975, p. 33.

13. Dudkin, V., & Fomantsov, V. P., "Several Directions in the Growth of Satellite Communications" (Nekotorye Napravlenie v Razvitii Sputnikovoi Sviazi), Vestnik Sviazi No. 1-1976, p. 14.

14. Elibaev, A., "On to a New Phase" (Na Novuiu Stupen'), Kazakhstanskaia Pravda, May 6, 1971, p. 3.

15. Gerchikov, E. Ia., "Effectiveness Is the Most Important Thing" (Glavnoe--Effektivnost'), Vestnik Sviazi No. 7-1970, p. 29.

16. Griaznov, Iu. M. & Sagapovich, L. I., City Telephone Stations (Gorodskie Telefonnye Stantsii), Moscow, Vyshaia Shkola, 1972.

17. Holland, Wade B., "Party Congress Emphasises Computer Technology," Soviet Cybernetics Review (The Rand Corp.), July 1971, p. 7.

18. "Information: International Symposium on Communications Technology" (Informatsiia: Mezhdunarodnyi Simpozium po Tekhnike Sviazi), Vestnik Sviazi No. 8-1970, p. 23.

19. "Information: Machines Do the Calculating" (Informatsiia: Schitaiut Mashiny), Vestnik Sviazi No. 6-1970, p. 28.

20. "Information: They are Installing 'Ericsson'" (Informatsiia: Montiruet Erikson), Vestnik Sviazi No. 5-1970, p. 33.

21. Interview with U.S. Army Officers, recent travelers to the USSR, who used Soviet telephones: U.S. Army Russian Institute, December, 1975.

22. Interview with representative of UNIVAC Corp., Marketing Manager for Eastern European Sales: U.S. Army Russian Institute, February 19, 1976.

23. Ivchenko, A. E., "How the Ruble Works" (Kak Rabotaet Rubl'), Vestnik Sviazi No. 7-1970, p. 23.

24. Kantor, L., "Successes and Problems in Satellite Communications Systems" (Uspekhi i Problemy Sistem Sputnikovoi Sviazi), Vestnik Sviazi No. 5-1969, p. 5.

25. Karbelashvili, A., "Born in Hungary" (Rozhdeno V Vengrii), Zaria Vostoka, February 6, 1973, p. 3.

26. Kazimov, V., "Problems of the Five-Year Plan: Communications and the National Economy" (Problemy Piatiletki" Sviaz' i Narodnoe Khoziastvo), Pravda Vostoka, October 23, 1971, p. 2.

27. Korol', V. I., "The Working Habits of the Communicators of the Ukraine" (Trudovaia Postup' Ukrainskikh Sviazistov), Vestnik Sviazi No. 4-1970, p. 34.

28. Krylov, Konstantin Arkad'evich, U. S. Army Russian Institute, Lecture: "Communications Facilities in the Soviet Union," February 27, 1976.

29. Kudinov, A., "Communications at the Service of the Economy and the Culture" (Sviaz' Na Sluzhbe Ekonimiki i Kul'tury), Pravda Vostoka, November 22, 1970, p. 3.

30. May, Clifford D. and Friendly, Alfred , Jr., "Russia--the Technology Gap," Newsweek, February 9, 1976, pp. 11-17.

31. Moscow Telephone Directory, "List of Subscribers to the Moscow City Telephone Network" (Spisok Abonentov Moskovskoi Gorodskoi Telefonnoi Seti), Part I, Moscow, 1958.

32. Moscow Telephone Directory, "List of Subscribers to the Moscow City Telephone Network" (Spisok Abonentov Moskovskoi Gorodskoi Telefonnoi Seti), Part I, Moscow, 1966, p. xxi.

33. Neelov, N. & Skorenko, Zh., "The Effects of Mechanization of the Distribution of Booking Tickets" (Chto Dala Mekhanizatsiia na Raznoske Blankov Zakazov), Vestnik Sviazi No. 4-1974, p. 38.

34. "On Serious Deficiencies in the Activities of the Ministry of Communications of the Georgian SSR" (O Ser'eznykh Nedostotkakh v Deistviiakh Ministerstva Sviazi Gruzinskoi SSR), Zaria Vostoka, November 30, 1972, p. 1.

35. Petrushin, I. P., "The Technology of Communications in the Intrazonal Networks" (Tekhnika Sviazi Vnutrizonovykh Setei), Vestnik Sviazi No. 9-1970, pp. 16-17.

36. Piskacheva, L., "Proper Organizations of Production--The Guarantee of Raising the Quality of Communications" (Pravil'naia Organizatsiia Proizvodstva--Zalog Povysheniia Kachestva Sviazi), Vestnik Sviazi No. 12-1975, p. 33.

37. Posysaev, N. S., "Communications Technology from Abroad: The Electronic Switchboard"(Tekhnika Sviazi za Rubezhom: Elektronnyi Kommutator) Vestnik Sviazi No. 12-1969, p. 22.

38. Privalova, N., "The First Transportable Communications Satellite Station of Soviet Manufacture" (Pervaia Otechestvennaia Perevozimaia Stantsiia Sputnikovoi Sviazi), Vestnik Sviazi No. 5-1975, p. 19.

39. Rekhlina, S. C. & Stoliarova, R. V., "A New Road Has Been Opened: Scientific Organization of Labor at Communications Enterprises" (Novoe Prokladyvaet Dorogu: Nauchnaia Organizatsiia Truda na Predpriiatiia Sviazi), Vestnik Sviazi No. 10-1970, pp. 38-41.

40. Sadykov, E., "From 'Morse' to 'Orbita'" (Ot 'Morze' do 'Orbity'), Sovetskaia Kirgizhiia, October 10, 1974, p. 2.

41. Smith, Hedrick, The Russians. New York: Quadrangle-The New York Times Book Co., 1976.

42. Solov'ev, Sh. G., Intercity Telephone Stations (Mezhdugorodnye Telefonnye Stantsii). Moscow: "Sviaz'" Publishing House, 1972.

43. Sutton, Antony C., Western Technology and Soviet Economic Development, 1917-1930. (Stanford: Stanford University, Hoover Institute), 1968, pp. 185-191.

44. Svistel'nikov, G. A., "Reserves for Increasing the Productivity of Labor in the Management of the Communications of Latvia" (Rezervy Povysheniia Proizvoditel'nosti Truda v Khoziaistve Sviazi Litvy), Vestnik Sviazi No. 6-1970, p. 26.

45. "Sviaz'", The Great Soviet Encyclopedia, Yearbooks (Bol'shaia Sovetskaia Entsiklopediia, Ezhegodniki), 1964-1974).

46. "Table of Launches of Space Devices" (Tablitsa Zapuskov Kosmicheskikh Apparatov v SSSR), Aviatsiia I Kosmanovtika No. 4-1974, p. 41

47. "Telefon," The Great Soviet Encyclopedia (Bol'shaia Sovetskaia Entsiklopediia), Vol. 42 (1955), pp. 166-180.

48. "Telephone," Encyclopedia Brittanica, Vol. 22 (1964), pp. 892-903.

49. "Telephony," Collier's Encyclopedia, Vol. 22 (1963), pp. 125-132.

50. "Telephony," Van Norstrand Scientific Encyclopedia (1958), pp. 1654-1655.

51. "The Age of Overload," Newsweek, September 29, 1969, pp. 36-37.

52. "The Energetic Relay Race for Socialist Competition Goes On" (Boevaia Estafeta Sorevnovaniia Prodolzhaetsia), Vestnik Sviazi No. 12-1974, pp. 12-13.

53. "The Progressive Workers Share Their Experience" (Peredoviki Deliatsia Opytom), Vestnik Sviazi No. 3-1970, p. 44.

54. "The Rhythm of the Decisive Year of the Five Year Plan" (Ritm Zavershayushchego), Vestnik Sviazi No. 12-1975, p. 8.

55. "There's Information, and There's a Story" (I Spravka, I Skazka), (Interview with the Chief of the Moscow City Telephone Network), Ogonek No. 3-1974, Pravda, Moscow, pp. 30-33.

56. "The United Automatized Telecommunications System" (Edinaia Avtomatizirovannaia Sistema Sviazi), The Great Soviet Encyclopedia (Bol'shaia Sovetskaia Entsiklopedia), Vol. 9 (1974), p. 63.

57. Timofeev, A., "The Intercity Telephone" (Mezhdugorodnyi Telefon), Pravda Vostoka, March 22, 1972, p. 2.

58. Tsiskaridze, A., "I'd Like You To Meet the Electronic Automatic Telephone Station" (Poznakomtes', EhATS), Zaria Vostoka, March 31, 1974.

59. Vinogradov, P. N., "To the Workers of the Villages" (Truzhennikam Sela), Vestnik Sviazi No. 5-1970, pp. 29-30.

60. Vlasov, L. V., "Do We Know How to Speak on the Telephone?" (Umeem-li My Govorit' po Telefonu?), Economics and the Organization of Industrial Production (Ekonomika i Organizatsiia Promyshlennogo Proizvodstva) No. 1-1975, pp. 198-208.

61. Volkov, S. G., "With the Communications Workers of Bashkiriia" (U Sviazistov Bashkirii), Vestnik Sviazi No. 7-1970, p. 27.

62. "Winning the Battle with Time and Distance" (Pobezhdaia Vremia i Rasstoianie), Zaria Vostoka, May 6, 1973, p. 3.

63. Zhelezina, T., "Raising the Standards of Production Means Improving Service" (Povyshat' Kul'turu Proizvodstva--Znachit Uluchshat' Obsluzhivanie), Vestnik Sviazi No. 1-1975, p. 10.

The following were extremely helpful in translating technical articles:

Macura, Paul, Russian-English Dictionary of Electrotechnology and Applied Sciences, John Wiley & Sons, Inc., New York, 1971.

M.H.T. and V.L. Alford (Alford & Alford), Russian-English Scientific and Technical Dictionary (two volumes), Pergamon Press, Oxford, 1970.

Zalucki, H., Dictionary of Russian Technical and Scientific Abbreviations, Elsevier Publishing Co., Amsterdam, 1968.