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MEMORANDUM FOR: The Director of Central Intelligence

FROM : John N. McMahon
Deputy Director for Operations

SUBJECT : MILITARY THOUGHT (USSR): Communications in an Automated Troop Control System at the Operational Level

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". This article discusses communications in an automated troop control system, the demands made upon it, and the possible ways of increasing the viability of the communications system under conditions of nuclear war. An automated troop control system demands higher quality of communications channels, their traffic capacity and their accuracy and security of information transmittal. To ensure viability, communications centers must be protected against enemy radiotechnical reconnaissance and concealed from air observation, and they must be rapidly deployable and highly mobile. This article appeared in Issue No. 1 (68) for 1963.

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned

John N. McMahon

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Intelligence Information Special Report

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DATE 20 April 1978

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SUBJECT

MILITARY THOUGHT (USSR): Communications in an Automated Troop Control System at the Operational Level

OURCE Documentary

Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 1 (68) for 1963 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". The author of this article is Engineer Lieutenant Colonel Yu. Elterman. This article discusses communications in an automated troop control system, the demands made upon it, and the possible ways of increasing the viability of the communications system under conditions of nuclear war. An automated troop control system demands higher quality of communications channels, their traffic capacity and their accuracy and security of information transmittal. To ensure viability, communications centers must be protected against enemy radiotechnical reconnaissance and concealed from air observation, and they must be rapidly deployable and highly mobile.

End of Summary

[redacted]ers Comment:

The SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970.[redacted]

TOP SECRET

Communications in an Automated Troop Control System at the Operational Level

by

Engineer Lieutenant Colonel Yu. ELTERMAN

In a modern operation, a sharp increase is taking place in the demand for speed in troop control and in the demand that it be implemented without error. As a consequence of the frequent and abrupt changes in the situation, it will be necessary to evaluate it anew and to adopt new decisions (with regard to using missile/nuclear means, eliminating the aftereffects of enemy nuclear strikes, etc.) not once or twice per day, as during the Great Patriotic War, but every one or two hours or even more often. The specific characteristics of using missile/nuclear weapons compel us to greatly increase control precision. All of this entails changes in the methods and technical means of troop control.

One of the characteristics of control in the modern operation is that the commander of the operational formation must rely on an effective communications system to enable him to receive continuously and in the shortest possible time (reckoned in tens of minutes) reliable information on the status of our own troops and on enemy actions and, with the aid of electronic computers systematizing this information and performing the necessary calculations with great speed, to select the optimal decision variant.

Questions of using electronic computers at various levels of troop control have been dealt with repeatedly in military literature. However, there has not always been adequate emphasis on the importance of a suitable communications system.

Let us examine the basic features of the communications system in an automated troop control system, the demands made upon it, and the possible ways of increasing the viability of the communications system under conditions of nuclear war.

Among these features must be included the substantial growth in the number of communications channels required and the increased branching out of army and front nets after the last war. The increase in the number of channels was caused, on the one hand, by the organization of special armed forces branches (rocket forces) and automated systems (air defense, antimissile defense, radiation-chemical and radiotechnical reconnaissance) and, on the other hand, by the appearance of new types of communications, particularly telecode. The latter represents communications among different electronic computers, primary data sensors, display equipment, etc. and requires additional communications channels (over and above telephone and telegraph channels). The increase in branching out and in the overall length of the communications nets was caused by the need to concentrate troops and the need to obtain information on the enemy, on the contamination of territory, etc., from the entire zone of army or front actions.

In an automated troop control system, increased demands are made on the quality of communications channels: their traffic capacity and their accuracy and security of information transmittal. With manual operating methods (key, telegraph), the traffic capacity of communications channels (radio communications in particular) had to be relatively limited; for example, it could not exceed 50 binary impulses per second (50 bauds). With electronic computers, the limitations on the input speed of information into a communications channel disappear, and the channel is required to have the capacity to handle a large volume of telecode information at a speed of 1,000 bauds or more.

A very stringent demand is made on the accuracy of information transmittal. Quantitatively, losses in accuracy are measured by comparing the number of garbled single impulses to the total number of impulses transmitted. Thus, if the permissible loss in radiotelegraph communications is considered to be one impulse per 500 transmitted, in transmitting telecode information it is not more than one impulse per 100,000 transmitted. Under these conditions, shortwave communications, especially when the transmitters are insufficiently powerful, become of little use for transmitting current types of information. The necessity to make all types of messages that are being transmitted automatically secure (particularly when using radio and radio-relay communications) also complicates communications transmission.

Particularly important under conditions of nuclear war are the increased demands on the viability of the communications system as a whole and of the communications lines and centers of the control posts. The communications lines of the operational level must ensure stable transmission of information over long distances, including across enemy-occupied sectors and zones of radioactive contamination. Communications centers must be protected against enemy radiotechnical reconnaissance and concealed from air observation, must be rapidly deployable, and must ensure a troop control capability during relocation of command posts. This applies first and foremost to so-called central communications centers, which are usually located with control posts. Increasing their mobility also ensures the viability of the army and front control posts themselves.

Experience from exercises of recent years indicates that army and front command posts, together with their communications centers, have many tens of motor vehicles, are slow to deploy, and do not ensure uninterrupted troop control during relocations. Satisfying the need for communications channels, introducing new types of work, introducing security, etc., lead to further proliferation of communications equipment at control posts, making them even more cumbersome and difficult to camouflage. If the problem of increasing mobility is less acute for front control posts in view of their relatively infrequent relocations and the opportunity for more reliable preparation of engineer shelters, the problem is exceptionally pressing for command posts of armies.

It is clear from the foregoing that in order to support an automated troop control system in a modern operation, it is necessary to have not only a large number of high-quality communications channels but also an overall communications system satisfying the requirements for mobility and viability.

It should be noted that at the tactical level (from the division down), the task of setting up mobile control posts is in principle being accomplished through the use and further improvement of ultra-shortwave radio sets installed in command-staff vehicles.

However, an army communications system cannot be based only on direct radio communications means. At the existing level of radio communications technology, such attempts would not bring the anticipated results. The reasons for this are the following: none of the existing types of radio sets provide the required range for direct communications (100 to 150 kilometers) during relocation of army and division command posts; a great many of the stations in the army net (100 to 150) would require, to ensure communications with them, an extremely large number of powerful vehicle-mounted radio sets at the army command post; the security of the post would be very poor if many powerful radio sets were operating at the same time.

In recent years attempts have been made to create an effective communications system at the operational level on the basis of other principles. In particular, the "grid" type communications system consisting of radio-relay stations is well known; using low-power ultra-shortwave radio sets installed in command-staff vehicles, transmissions are made to the supporting centers of the "grid". Such a communications system in principle accomplishes the task of relieving command posts of extra communications means and at the same time makes it possible to control troops in transit. However, very great difficulties arise in implementing it.

Low-power duplex ultra-shortwave sets in motion do not have a large operating range (10 to 15 kilometers), and the distance between "grid" centers can therefore not exceed 25 to 30 kilometers; in order to ensure communications with any point, an impermissibly large number of communications centers would be required -- about 100 in the offensive zone of an army. Because of the complexity of the equipment at all centers, assuming a large number of channels, such a system would be extremely costly and uneconomical. It also appears clearly unrealistic to deploy "grid" supporting centers in an army offensive zone when the troops are moving forward at a rate of 80 to 100 kilometers a day. The viability of such a system overall would be very low because of the vulnerability of the radio-relay stations, with their tall antenna masts, to the shock wave from a nuclear burst and because of the impossibility of deploying these stations in extensive zones of radioactive contamination.

This suggests the conclusion that the presently existing means and methods of organizing communications do not make it possible to guarantee, within an automated system, stable control of troops in movement by the operational level. It is necessary to find new methods of organizing communications and to work out new means corresponding to them.

In our view, the most promising way of ensuring uninterrupted communications during relocations of army and division command posts will be a rational combination of the direct radio communications system, using powerful ultra-shortwave radio sets, with a system made up of a limited number of supporting communications centers. The latter should be placed at a distance from one another such that it would be possible to support communications with moving installations on which sufficiently powerful (realistically achievable for these installations) radio sets can be installed.

Preliminary calculations, based on experience from using existing ultra-shortwave radio sets, show that with a transmitting power of 100 to 150 watts (suitable for one single-band voice channel), and if operating with a stationary radio set having a high-mounted antenna, stable communications during movement can be attained over a range of 40 to 50 kilometers. Under these conditions, the maximum distance between supporting centers is 80 to 100 kilometers; there will be not more than six to eight such centers in an army offensive zone (150 x 400 kilometers).

Increased mobility and security of army control posts can be attained, in our view, not only by reducing the total number of motor vehicles located at these posts but also by suitably subdividing the command post into several independent units (groups) having reliable communications means making it possible to decentralize the location of the main staff directorates and departments and not to relocate them independently one from another.

Allocated as one of these groups, in our opinion, should be those elements of the command post which can independently ensure control of troops in movement. They will actually represent a mobile army control post. The independent group should include elements of the communications centers which are not adapted, at the present level of technology, to operate during movement: shortwave radio sets with zenith-radiating antennas, computers, and communications means linking the stationary supporting center with the mobile elements of the command post. These elements of the control post, representing a combination of the radio group and the computer center, we shall designate provisionally as the central communications center. It should be located near the supporting communications center or directly connected with it via a common center and should be relocated in leapfrog fashion from one supporting center to the next, along the main axis, in order to provide for the reserve communications means and the computers.

Another reason for bringing the computers to the central communications center, in our view, is that this reduces the number of connecting lines to the command (mobile) post. Only a few request channels and video channels will run into it, while all telecode communications channels (70 to 80 in the army system) will be switched into the central center.

It should be noted that it is not a question of changing the structure of command posts of operational formations and renouncing the practice by which they are located at present but a question of expanding the capabilities of the communications organization within an automated troop control system.

Depending on the circumstances, the central communications center can be located either next to the command post or jointly with it, as is the practice at the present time, if the situation does not require that command groups be detailed from the complement of the command post or that main departments be located separately.

In order to ensure stability of the control sysem, it is very important to make the correct choice of communications means. For linear communications between support centers it is fully possible in principle to use radio-relay sets, including, despite their several shortcomings, the existing R-400 set as well. Depending on terrain conditions, a distance on the order of 80 kilometers between supporting centers would require one or two relays.

If we speak of future communications means, then, in our opinion, lightweight tropospheric sets in the decimeter band will have important advantages over radio-relay sets. Such sets will make it possible to do without intermediate relaying between supporting centers and consequently to reduce the total number of communications means activated, to simplify the organizing of communications since there are no intermediate stations to require guarding and supplying, to accelerate the setting up of communications lines, and in many instances also to implement communications across zones of contamination or enemy-occupied territory. Lightweight tropospheric sets can have low-mounted high-directional horn antennas mounted directly on the body of the radio set; this substantially increases communications security with respect to aerial and radiotechnical reconnaissance and also stability against the shock wave from a nuclear burst.

It should be noted that for communications over a distance of 80 to 100 kilometers the lightweight tropospheric radio set can be operated in a multichannel mode (for example, on 12 standard telephone channels). At the same time, it is comparatively easy with this set to provide for using it in a one-channel mode for operation over increased distances (150 to 200 kilometers). This technical capability makes it possible to provide for communications via a central point (although with reduced volume of information), which is of great importance in the event that one or more supporting communications centers are put out of action.

It would nevertheless be unwise to base the system of supporting communications centers solely on tropospheric radio sets; in some instances, for example when advancing at a slow pace or going over to the defense, it is advisable to use cable communications as well.

Therefore, the communications system must be based on a combination of the various communications means, must provide for backup, and must employ each of these means depending on the situation and their availability.

Assuming that the communications system will have central and supporting communications centers, we consider that individual correspondents can come into these centers by means of ultra-shortwave radio sets with a power of 100 to 150 watts installed aboard command vehicles (tanks, armored personnel carriers). However, if there are a great many correspondents operating on one link (command post -- central communications center), such a communications system is impractical, since it would be necessary to place several sets in each command-staff vehicle and to concentrate several tens of such sets at the central communications center, clearly decamouflaging its location.

The communications system will be more convenient to operate and more economical if several powerful (one to 1.5 kilowatts) ultra-shortwave sets, adapted to operate in the multichannel mode, are placed at the central communications center of an army command post. There are two technical ways of implementing this capability: to establish a wide-band channel (40 to 50 kiloherz) in such a set, to be implemented by 10 to 12 single-band voice telephone channels by means of standard multiplexing equipment, or to apply the concept of the composite radio set containing several two-channel oscillaters operating into a common power amplifier.*

The value of the first variant is economy, and the values of the second are that it has the capability to switch wavelengths within a limited band of frequencies, which makes it difficult for the enemy to detect the powerful transmitter (which in this case does not differ from tactical sets as regards nature of emission), and also that it produces overall deliberate jamming simultaneously on all radiated channels.

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*Collection of Articles of the Journal "Military Herald" No. 33, 1961.

From the technical side, having several oscillators ensures increased communications reliability and effective redundancy. Presumably composite receivers can also be constructed according to a similar system (with a common input channel).

In order to increase security during staionary operation, it is advisable to use tropospheric sets in the decimeter band as well as ultra-shortwave communications.

Let us take a closer look at the communications means of an army command post. We shall assume that with automated troop control the communications system must provide support for, let us say, six main departments (groups) of a command post (the general precepts set forth here will not change if communications must be set up with, for example, five or eight departments).

Let us assume that in each of these departments there are required, for officers, an average of twelve working places equipped with communications means and located, for example, in at least three staff vehicles. In our example, a total of 18 command-staff vehicles are required for an army staff (not counting servicing vans). They must have a large weight-carrying capacity, since the communications and terminal equipment which must be installed aboard future command-staff equipment vehicles is very heavy.

In each command-staff vehicle there must be a unit of terminal equipment: telegraph equipment with secure communications devices for telegraph traffic and computer communications, phototelegraphy equipment with a security device for exchanging graphic documents (in some vehicles of department chiefs, there may be installed, instead of phototelegraphy equipment, an illuminated screen for situation display by computer), and also two sets of telephone equipment (with outputs for loudspeaker communications) for intra-staff and external communications.

It is undesirable for all four channels to have their outlet through a single radio set. For operation with different correspondents and for redundancy, it is best to have two two-channel duplex radio sets in each motor vehicle, each radio set having one single-band channel (0.3 to 3.4 kiloherz) for voice communications and one such channel for transmitting telecode, telegraph, or phototelegraph information at a speed of 1,200 bauds. The wave band and power of these radio sets must provide for stable duplex communications, while in movement, with a receiving-switching equipment center at a distance of three to five kilometers. In line with the prerequisites, these can be sets of 20 to 30 watts power with a frequency range of 60 to 100 megaherz lying outside the range of the tactical networks. In each department there will be six of these sets, which we shall call distribution sets, and the total number of them in the staff will be 36.

In order for the main staff depatments under consideration here to be assured of uninterrupted and reliable communications during any variants of relocation or deployment, they must have powerful means for linking up with the central communications center. For this purpose it is proposed that each of the departments be given a receiving-switching vehicle and a transmitting vehicle (equipment vehicles).

In the receiving-switching equipment vehicle it is more practical to have not six reciprocal distribution sets (this would be too bulky) but one central distribution radio set with twelve channels. One of the possible and technically feasible variants of constructing such a set would be to use, for a grouping of uniform oscillators, one booster unit, one antenna, a common electric power supply unit, and a common standard quartz generator. If there are a great many units of the same kind (oscillator-receivers), as noted, there will be a significant increase in the operating reliability of the equipment.

In the transmitting equipment vehicle, in our view, the transmitter of a powerful ultra-shortwave radio set should be installed, to be used for linking up with the supporting center. It would be undesirable, however, to base all external communications of a mobile army control post on ultra-shortwave radio sets alone. Because of the difficulty of using high-directional antennas in this band (they are too unwieldy), powerful ultra-shortwave radio sets can decamouflage the staff and be overwhelmed with deliberate jamming.

It is desirable to have a backup means of communication for stationary operation, a means free from this shortcoming. It may, for example, be a lightweight tropospheric set in the decimeter band, able, as calculations show, to provide communications over a distance of 80 to 100 kilometers with power of one kilowatt and with 12 channels in a frequency range of about 1,500 megaherz. It is best to place this set in the same transmitting equipment vehicle with an ultra-shortwave radio set, using a single power source and a common remote control line.

The total communications means of any of the main departments of a staff must also provide the capability for interconnection of the departments during movement. Technically this problem can be solved, for example, by using the same distribution radio sets located in staff motor vehicles. This would require the addition of duty receivers, however, and would complicate the organizing of such communications. For this reason it is more practical for each receiving-switching equipment vehicle to include a second central distribution set having two link-up channels to each department.

The essential organizational advantage of setting up an internal communications system in this way is that in this case the distribution sets installed aboard command-staff motor vehicles do not have to be retuned in order to change stations. By means of a single switchboard located in the receiving-switching equipment vehicle, it is possible (manually or automatically) to call up any station covered by the staff and to link up with the external nets. A model diagram of communications organization and the total communications means of one of the departments of an army staff are shown in Figure 1.

The total number of special motor vehicles at an army command post for our example (not counting the vehicles of the servicing group) is as follows: 24 command-staff motor vehicles and receiving-switching equipment vehicles and, in addition, seven or eight transmitting equipment vehicles (including one or two with a reserve shortwave transmitter).

In the offensive zone of an army, two axial communications lines must be deployed by the forces and means of the front chief of communications. This is necessary in order to provide redundancy. In the opinion of some specialists, there should even be three axial lines, but such a solution should be considered less acceptable on economic grounds. The communications means used should be tropospheric sets, backed up if possible by cable. At the intersections of these lines with lateral lines, supporting communications centers will be placed. The central center, then, with a computer center and groups of shortwave radio sets operating only from a stationary position, will be relocated in leapfrog fashion along the main communications axis.

The army command post, in the event that the central center is situated away from it, can maintain communications with it by means of powerful multichannel ultra-shortwave sets during movement and tropospheric sets in the decimeter band during short halts. A consolidated diagram of the disposition of such a communications system is shown in Figure 2.

Thus, a communications system at the operational level, based on the organizational and technical principles discussed here, creates the prerequisites for ensuring automated troop control through improving the viability of control posts.

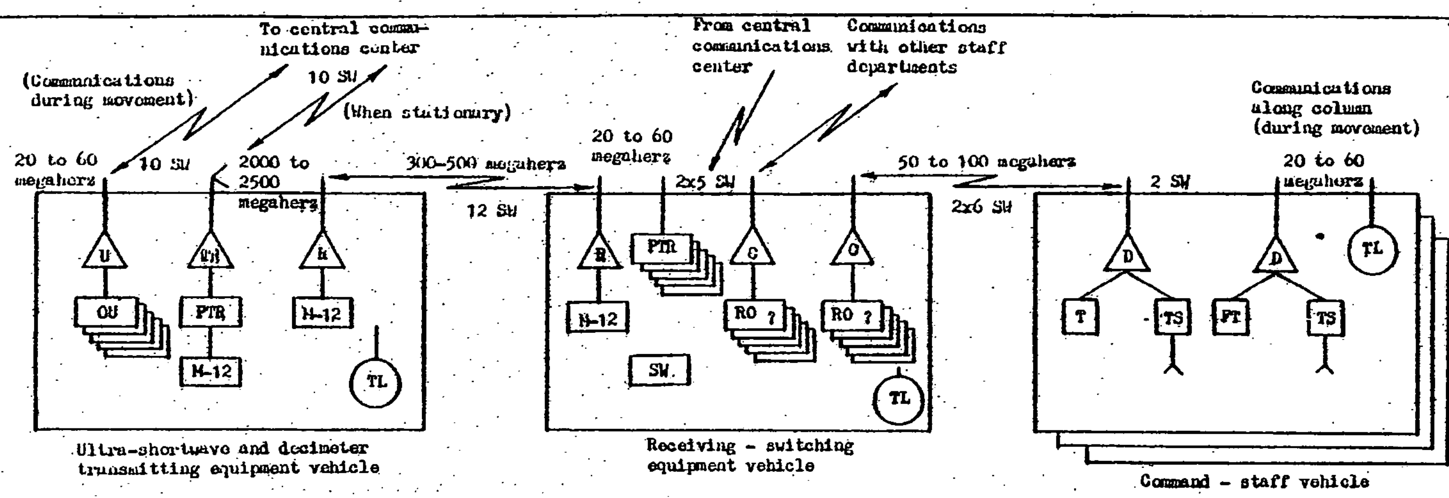
Therefore, in an army communications system, the number of voice and telecode (1,200 bauds) communications channels should be increased to 120 to 130, i.e., 2.5 to three times what they are at present; this number does not include shortwave radiotelegraph channels of low traffic capacity, which in an automated control system are reserved, for example, for communications with reconnaissance elements but will obviously play an auxiliary role.

Increasing the viability of the army control posts and of the communications system overall depends upon the following factors: decreasing the number of motor vehicles by a factor of 1.5 to two in comparison with the present number (30 to 35 against 50 to 60); sharply increasing mobility -- the capability to support 100 percent complete communications while a command post is in movement and during its consequent conversion to a mobile army control post; making the staff departments autonomous during decentralized deployment and independent movement (assuming stable communications); using radio communications means analogous, in their external parameters, to radio sets of the tactical level, which promotes communications security; and using as the main linear communications means (in combination with cable lines) tropospheric sets with low-angle high-directional antennas.

A very important effectiveness indicator for any given communications system is its economy, which determines industry's capability for rapid production of the needed array of means. The relative economy of such a communications system is due first and foremost to the fact that it combines multichannel communications means (for short distances) with reserve means for direct single-channel communications over increased distances -- both using the same powerful ultra-shortwave and decimeter radio sets.

Reducing the cost of equipment must also be promoted by the following measures: using a standardized voice-telecode channel of 300 to 3,400 herz as the common channel for wire, tropospheric, and ultra-shortwave radio lines at the army level; activating only a few types of equipment vehicles at the army central and supporting communications centers, to be standardized with one another; and equipping a relatively small number of supporting centers (six to eight) in the army offensive zone.

Working out such a complex array as the communications system in automated troop control at the operational level naturally demands the combined efforts of military theoreticians, engineers, and communications organizers. This article has presented preliminary considerations on one of the possible ways of solving this most difficult problem.



KEY

U - One-kilowatt ultra-shortwave radio set, OU - its oscillator, RU - its receivers
TR - One-kilowatt tropospheric decimeter radio set, PTR - its receivers
R - Remote control radio set
D - Distribution radio set (staff) 20 watts
C - Central distribution set 200 watts
RO ? - Receiver oscillator
TL - Ultra-shortwave radio set for communications along column (tactical level)
M-12 - Multiplexing equipment for 12 channels
T - Telegraph equipment, FT - phototelegraph equipment
TS - Telephone security equipment
SW - Switch

Figure 1. Variant of communications organization and the array of communications means of one of the departments of an army.

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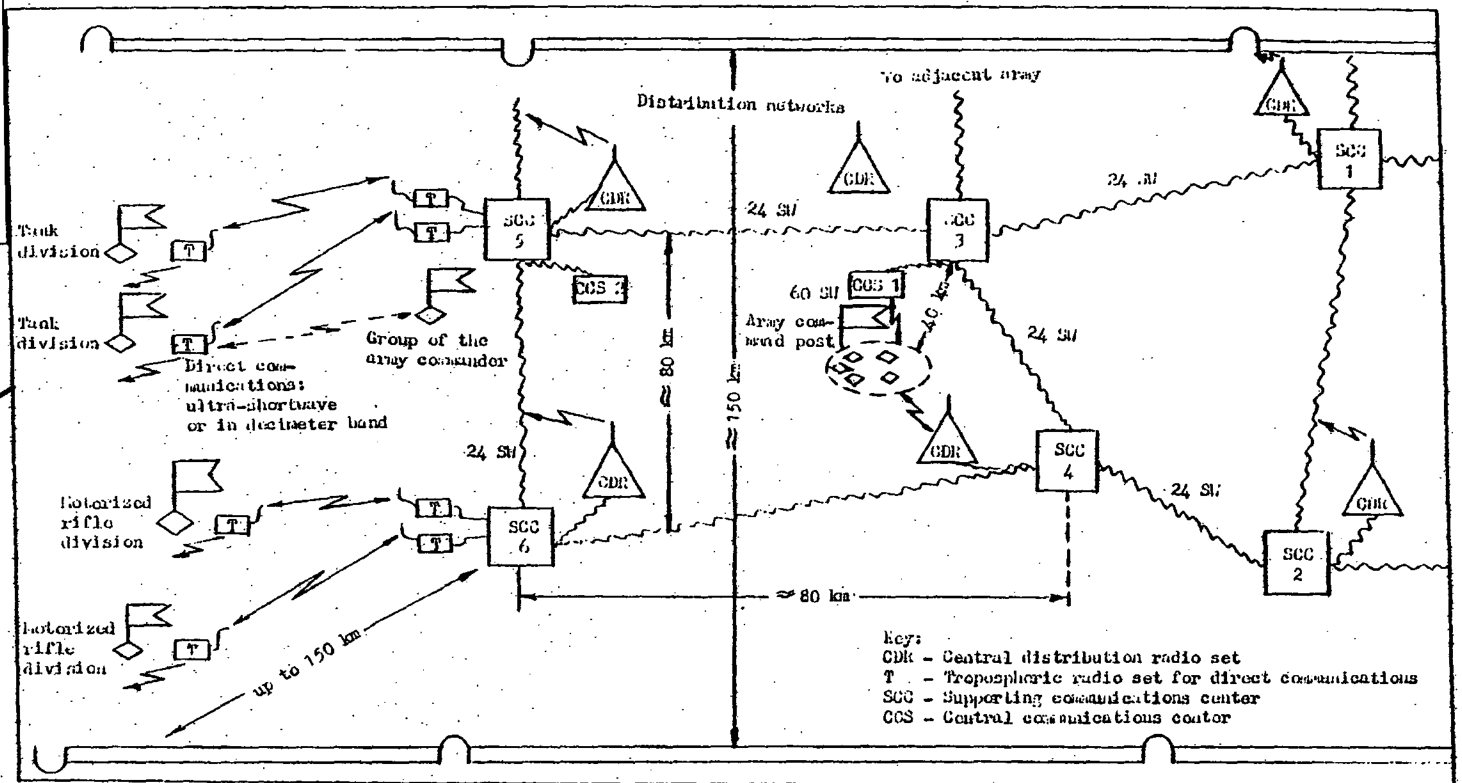

Figure 2. Variant of plan for communications organization in an offensive operation.

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