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Technical Information Report 6.2.1.1

TACTICAL OPERATIONS SYSTEM (TOS)

Interim Report

February 1969

ARMY MATERIEL COMMAND

Prepared by the Research Division, Governmental Affairs Institute, 1776 Massachusetts Avenue, NW, Washington, D.C. 20036, under Contract DAAG39-69-C-0001

DA Project Numbers: 1X663703D512;
1X664703D494-05

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SUMMARY

The tactical operations system (TOS) is being developed to provide field commanders and their staffs with accurate, current information concerning military operations, intelligence, and fire support coordination. This on-line, near-real-time system will consist of mobile computer complexes, input/output devices, storage and retrieval units, display equipment, control consoles, and other peripheral equipment, all linked by communication networks that will make data available very rapidly.

RELATED TIR'S

11-67	TIR 6.1.1.1	Automatic Data Systems Within the Army in the Field (ADSAF)
4-66	TIR 9.6.1.1(1)	Tactical Image Interpretation Facility (TIIF), AN/TSQ-43
12-68	TIR 27.4.4.1	Tactical Fire Direction System (TACFIRE)
4-64	TIR 22-3-1A1	Command Control Information System, 1970 (CCIS-70)

LIST OF ILLUSTRATIONS

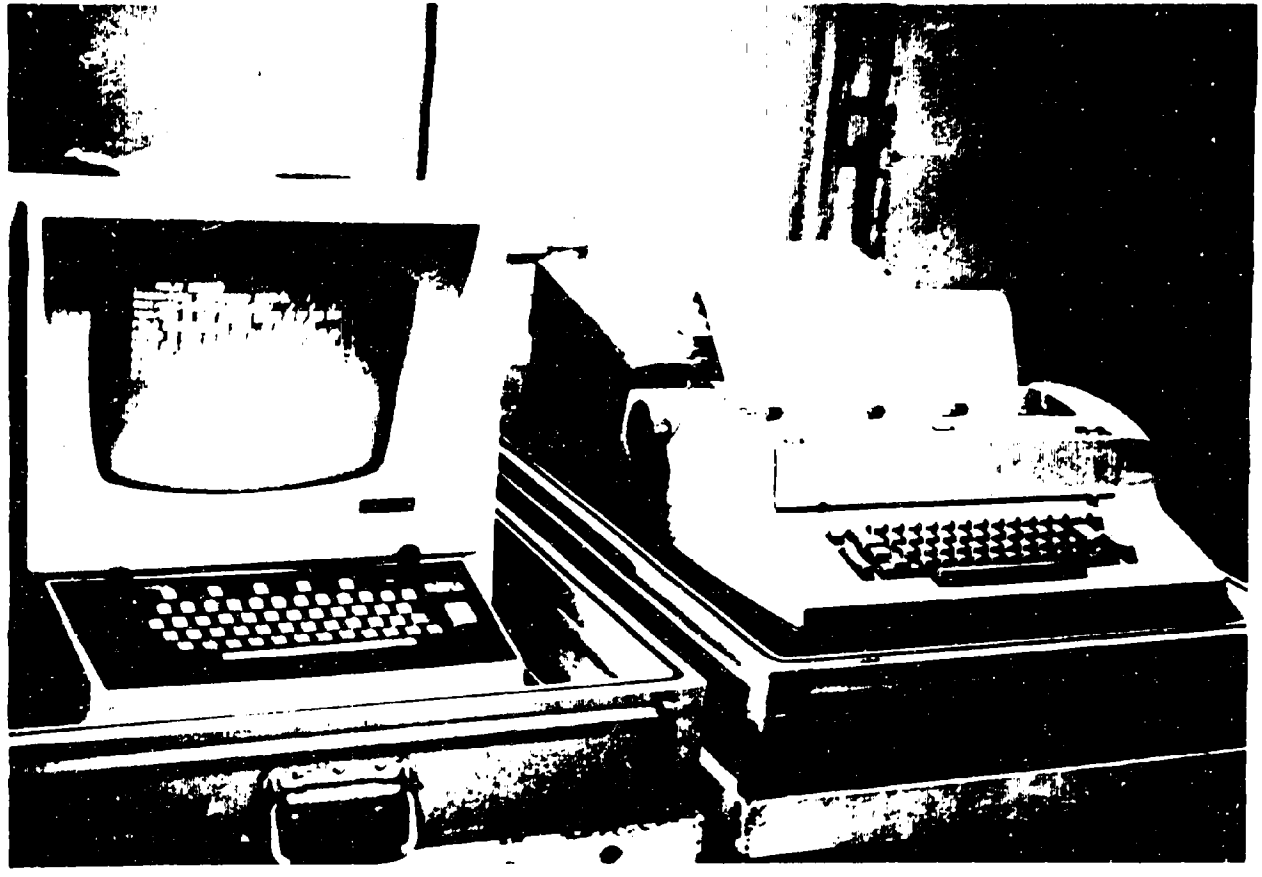
TACTICAL OPERATIONS SYSTEM (TOS)

The tactical operations system (TOS) is being developed to provide field commanders and their staffs with accurate, current information concerning military operations, intelligence, and fire support coordination. This on-line, near-real-time system will consist of mobile computer complexes, input/output devices, storage and retrieval units, display equipment, control consoles, and other peripheral equipment, all linked by communication networks that will make data available very rapidly. With the tactical fire direction system (TACFIRE) and the combat services support system (CS_3), TOS makes up the massive overall program called automatic data systems within the army in the field (ADSAF). TOS will interface with the other two systems so that data can be interchanged. Currently in the concept formulation stage, it will make considerable use of hardware and procedures being developed for TACFIRE, which is in a more advanced stage of development.

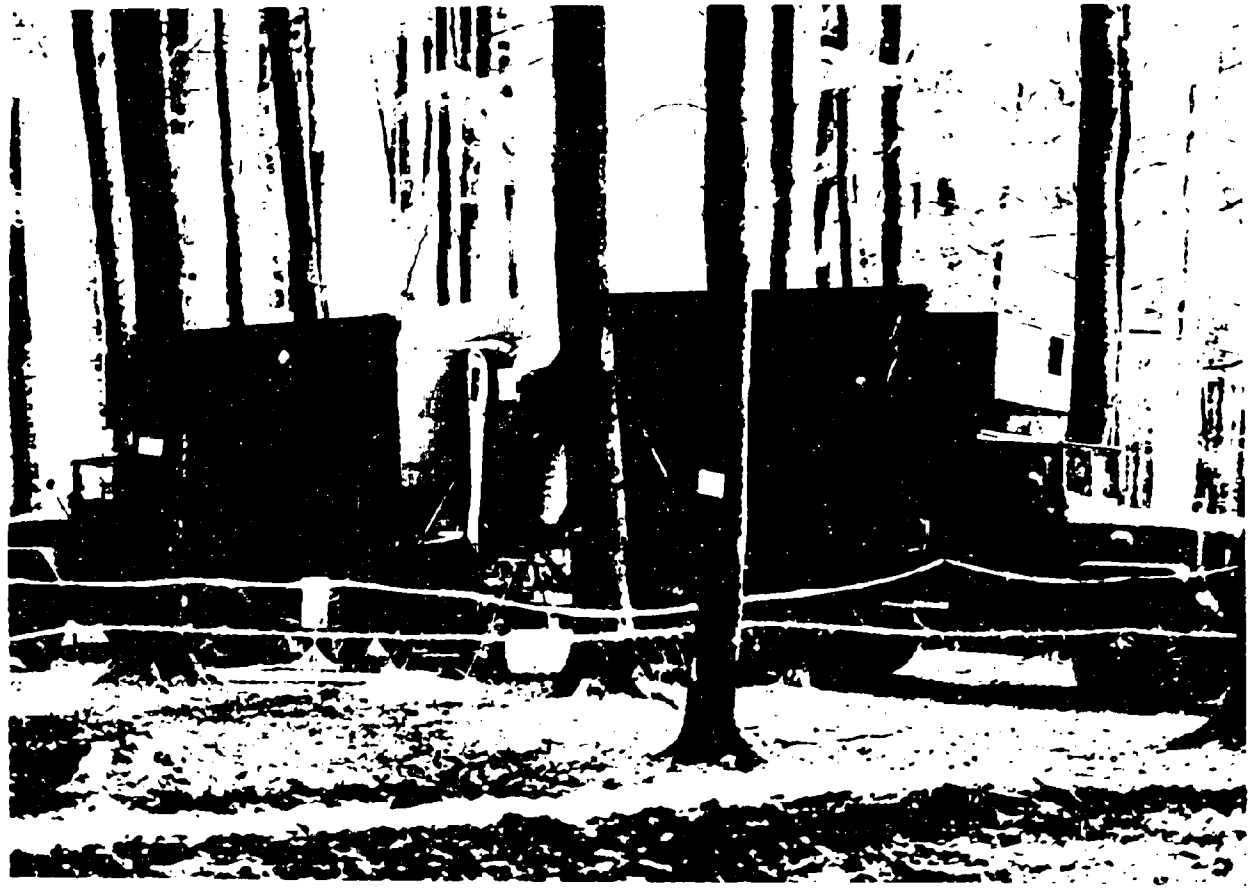
The Army has long been aware of the potential of automatic data-processing (ADP) equipment for rapidly performing repetitive calculations and clerical operations. As early as 1946 Army Ground Forces prepared military characteristics for an automatic fire direction center that included an automatic computer. After considerable study and research, in 1951 the Army began work on an electromechanical (analog) gun data computer. Before completion of the project, however, the development of transistors, improved components, and new techniques made it feasible and desirable to design electronic digital computers.

Accordingly, during the mid-1950's the FIELDATA equipment program was initiated on a modest scale by the Signal Corps. Early in 1960 the Department of the Army published a plan for automating the four basic Army staff functions: G1, personnel and administration; G2, intelligence; G3, operations; and G4, logistics. Fire support was included as a fifth system and the plan was called the command control information system, 1970 (CCIS-70). In July 1962 the Army Materiel Command assigned a project manager to the program.

For automating its basic staff functions the Army developed plans for a compatible family of mobile FIELDATA computers with a high degree of interchangeability of modules and components. Unlike the highly specialized digital computers used as integral parts of radar, fire control, and avionic systems, these data-processing machines were designed for general use. Sizes varied according to the task, from equipment to accompany division and battalion artillery units to systems for use at army and theater levels. The first FIELDATA



USER INPUT OUTPUT DEVICE



REMOTE-STATION DATA TERMINAL FOR TOS-EUR

computer, the large AN/MYK-1 mobile digital computer known as MOBIDIC, was developed in the late 1950's. At present the MOBIDIC system is used at the 7th Army Inventory Control Center at Karlsruhe, Germany. Other FIELDATA computers were built and provided valuable experience in design, manufacture, and field use.

Although the AN/MYK-1 is performing operational missions, the Army realized that advances in ADP technology were rapidly making it obsolete. Accordingly, in May 1965 the Army approved an implementation plan for the development of automatic data systems within the army in the field (ADSAF) under the direction of the Automatic Data Field Systems Command (ADFSC). The earlier developments in ADP for field use are contributing heavily to this project, and the information that has been given about them should be helpful to an understanding of the newer developments.

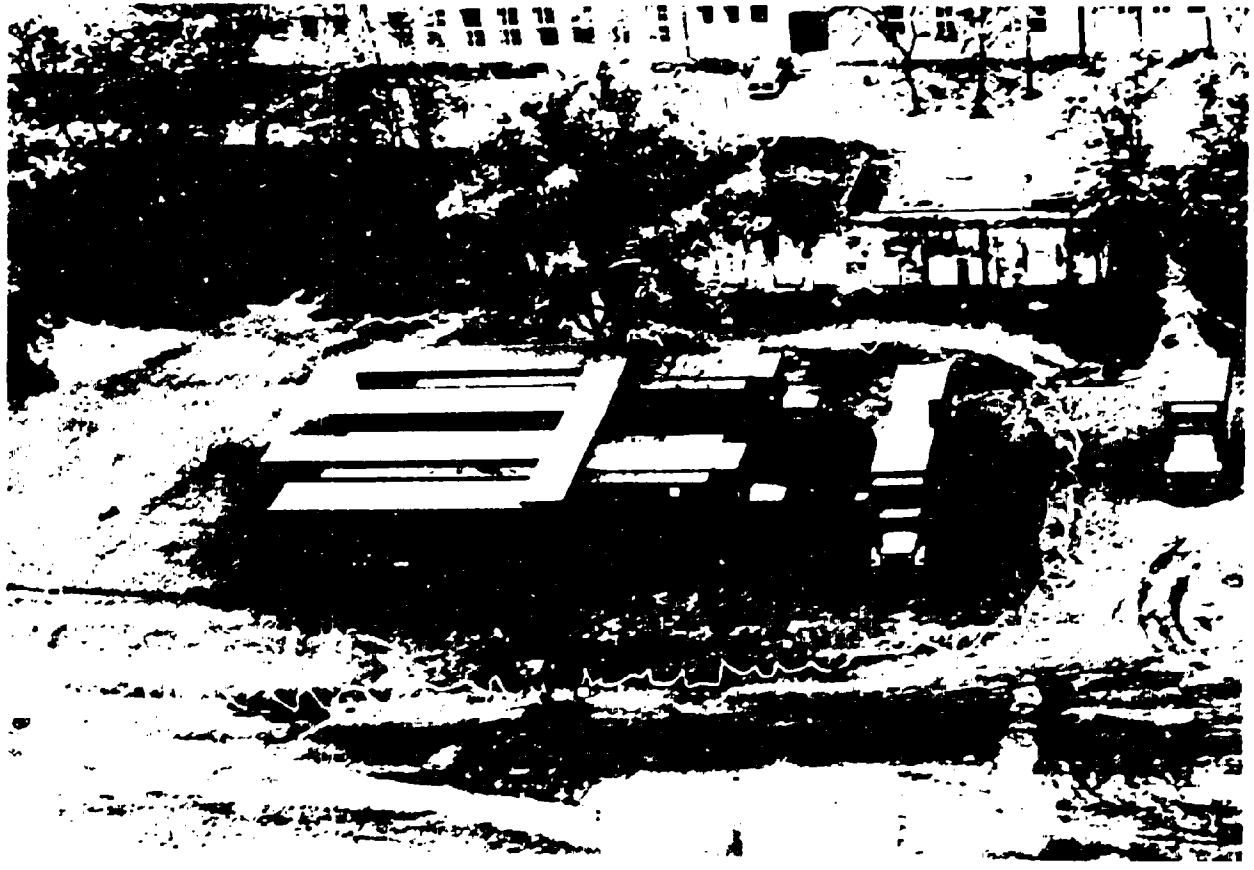
The fire support program required no significant realignment in organization, but was much expanded to make use of new equipment and techniques. The present program is called the tactical fire direction system, or TACFIRE. It was realized that personnel and administration, traditionally under G1, and logistics, G4, are closely interrelated and could be handled together effectively; accordingly, these functions were combined under a major new program called the combat services support system (CS_3). Likewise, the areas of intelligence (G2) and tactical operations (G3) were grouped together to form TOS.

The research and development of TOS is proceeding simultaneously under two distinct programs, each with carefully planned objectives. The basic long-term program is the tactical operations system, 1975 (TOS-75), which will make use of new equipment especially designed for ADSAF. This system, scheduled to become standard in the mid-seventies, will evolve from thorough studies of present and future Army needs and from field experience. All equipment and aspects of the system should be developed and tested by the beginning of 1975, the date that signifies the completion of the program.

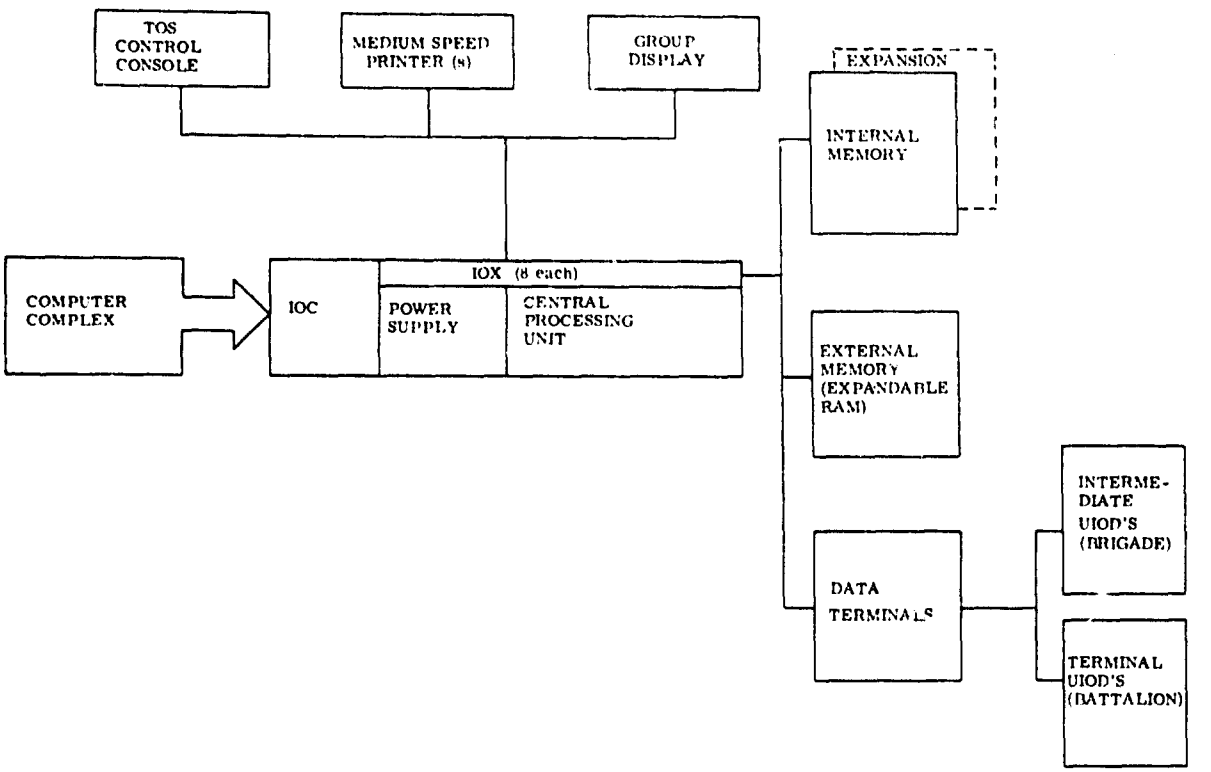
The other TOS program is concerned with developing and testing an interim field system that makes use of current commercial hardware to carry out limited functions adapted to one particular military situation, the Seventh Army in Europe, USAREUR/7A. The overall development, testing, and operation of the system in Germany is the responsibility of the Commander in Chief, US Army, Europe (CINCUSAREUR), with technical assistance from a TOS Development Group. This provisional, test-bed system, which may be designated TOS-EUR, will contribute substantially to TOS-75 and will be discussed first.

TOS-EUR is designed to carry out the following expressed purposes:

1. Identify by field development the areas within a tactical operations system of a field army where automatic data processing can assist commanders in the conduct of tactical operations



CENTRAL COMPUTER CENTER FOR TOS-EUR



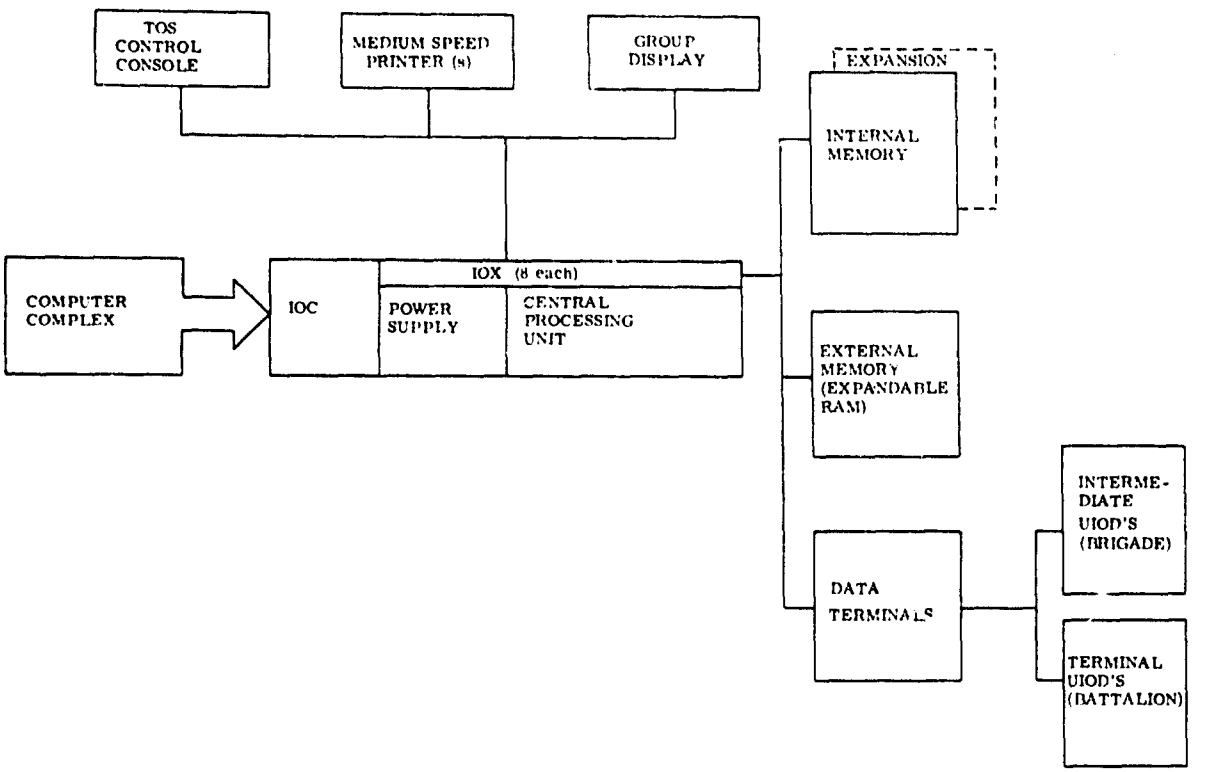
TOS DIVISION CONFIGURATION

2. Conduct, within USAREUR/7A, a field development that will obtain military and scientific data that will assist the Department of the Army in prescribing a tactical operations system for use by the US Army worldwide

3. Identify characteristics of automated storage, retrieval, processing, and transfer of tactical operations information within the system to enable the Department of the Army to prepare the best possible functional system design and qualitative materiel requirements for the Army-wide TOS

4. Produce data, to include time and cost, on maintenance problems and operator training

5. Use, wherever possible in the conduct of the field development, methods of gathering and analyzing



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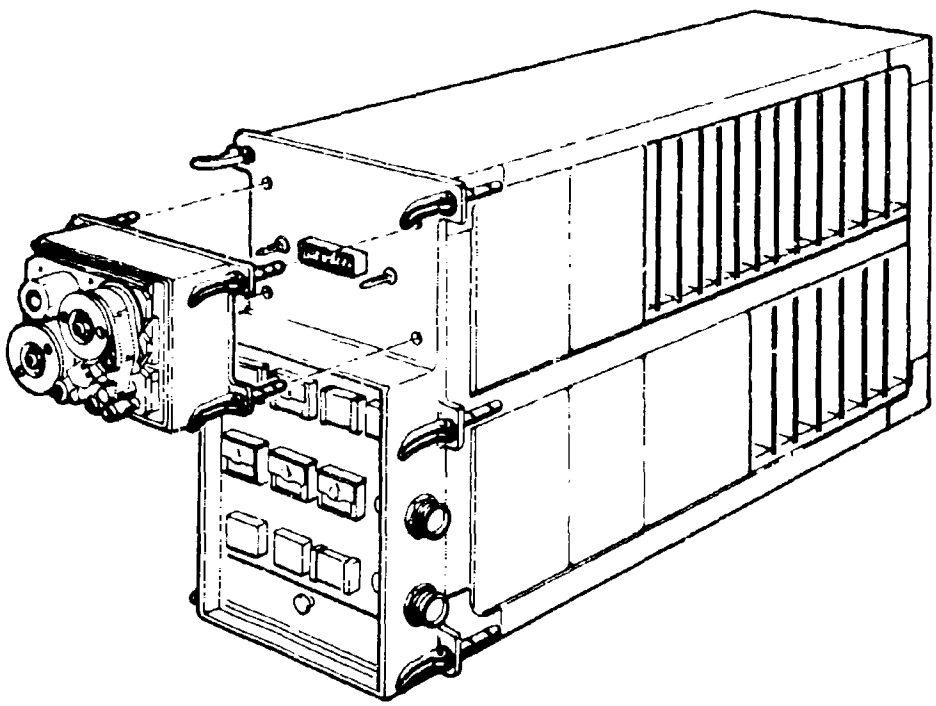
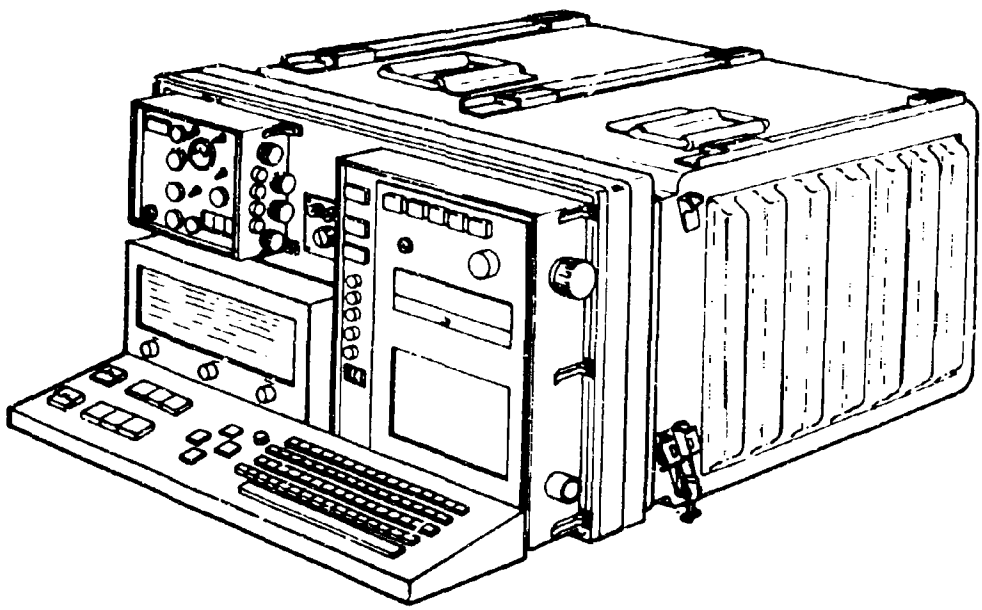


MAGNETIC TAPE DATA STORAGE DEVICES, RMMU AND MLU

military and technical data that will contribute to the design of the Army-wide system, as well as data that will permit an accurate cost-effectiveness study and analysis

6. Provide USAREUR 7A an interim automated operational TOS

The data-processing equipment used in TOS-EUR consists of three basic types: a user input/output device (UIOD), a remote station data terminal (RSDT), and a central computer center (CCC). The UIOD consists of two desk-top devices that enable an operator to insert and transmit information to other parts of the system and to receive information from the system. One of the units is a typewriter station, and the other is an entry and display station, which has a 6x8-

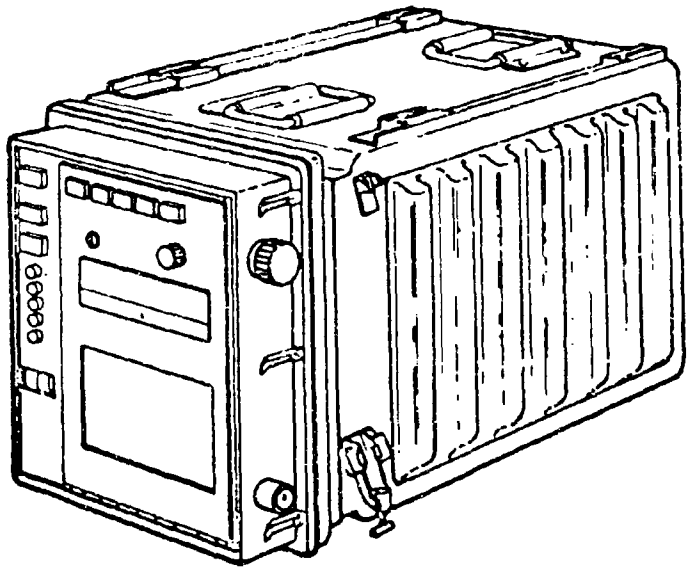


VARIABLE-FORMAT MESSAGE ENTRY DEVICE

inch cathode-ray tube able to display 1,000 characters arranged in 20 lines of 50 characters each. For output, the operator uses the standard keyboard to type an instruction to display the standard format for the type of message he wishes to send. He then inserts his message in the blank spaces provided by the particular format. When he has completed his message, verified it, and made any necessary corrections, he transmits it to the computer by pushing the SEND button next to the keyboard.

Although the display unit can receive some short messages, an electric typewriter will receive most messages from other stations. If desired, this typewriter provides copy on paper of any message sent or received. This machine, which may also serve as an input device, prints at the rate of 150 words per minute in a standard format of 120 characters per line. Both units of the UIOD are quiet, lightweight, and easily transportable in containers designed for field use. They are connected by cable to the second type of station, the RSDT.

The RSDT serves as the local information processing point for up to eight UIOD's, which can be located as far as 300 feet from the RSDT. The latter includes a computer, associated peripheral devices, and secure communica-

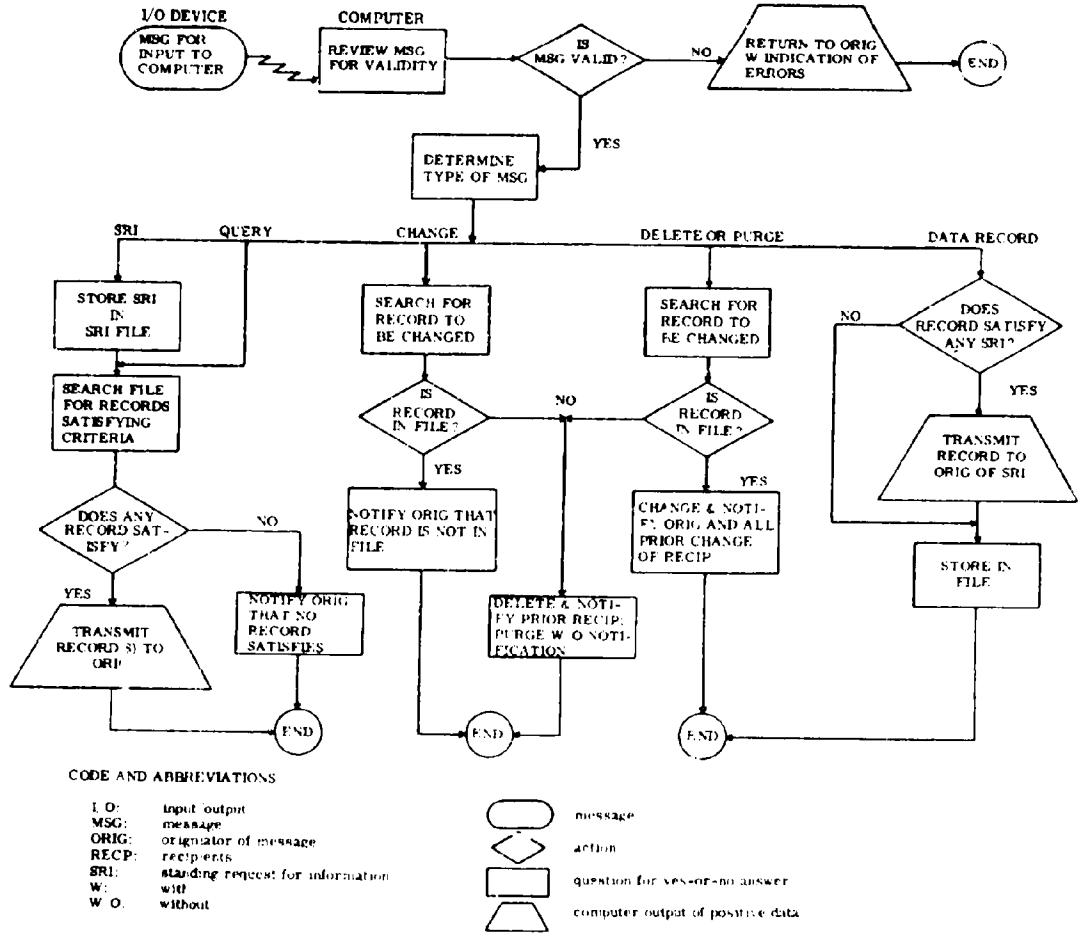


MEDIUM-SPEED PRINTER

tion equipment, all of which are contained in shelters mounted on two 2 1/2-ton trucks. The RSDT stores messages until the operator is ready to send them or encrypts data that require secure transmission. It also acts as a multiplexer so that all users can share one communication line to the central computer.

The heart of the TOS-EUR is the CCC. Each communication circuit from an RSDT terminates at the CCC, which can accommodate up to 13 full-duplex communication circuits. One 40-foot van and three 35-foot vans house the CCC and give it the necessary mobility for field use. All the vans have a standard 8-foot width, but some of them provide extra space by being expandable to a width of 13 feet when emplaced. To reduce the possibility of damage during transit, the vans housing computer equipment have floating floors. Since the chief location requirement of the CCC is to have access to the communication lines, it does not have to be near the tactical operation center (TOC) or at any minimum distance from other stations.

The central processing unit (CPU) of the CCC is the Control Data Corporation Model 3300 computer. It has four core-storage memory units, each with a capacity of 16,384 24-bit words, a total of 65,536 words; two disc files add a storage capacity of 16,384,000 6-bit characters. The CCC has five magnetic-tape units and the usual printer, card reader, card punch, and communication terminals.



TOS DATA FLOW, BLOCK DIAGRAM

The following table indicates the TOS configurations that will be deployed in Europe at various command levels.

Echelon	CCC	RSDT	UIOD's
Field army	1	1	up to 8
Corps		1	up to 8
Division		1	up to 8

In order to make TOS as useful as possible, it was necessary to study activities at current TOC's and identify the areas of information with the heaviest workloads. The classes of data considered most feasible for automation were isolated and organized into functional areas. Some 18 of these areas, carefully defined by means of functional area descriptions (FAD's), were incorporated into initial requirements, but current efforts in Europe, for various practical reasons, are concentrated on the following:

Friendly unit information
Enemy situation
Nuclear fire support
Effects of enemy nuclear strikes
Enemy order of battle

To carry out these functions TOS-EUR will effect high-speed switching of tactical messages, will rapidly store and retrieve information, will automatically route messages to desired destinations, will perform high-speed computations, and will automatically generate prescribed types of reports.

In the latter half of 1967, TOS equipment, built into 21 trucks, vans, and trailers, was sent to the Seventh Army headquarters in Heidelberg, Germany. One CCC, four RSDT's and 18 UIOD's are now on site and being operated by Seventh Army personnel under direction of a TOS Development Group. Early in 1969 the equipment will be decentralized and assigned to the various echelons as indicated in the table. Personnel will be trained and will carry out a field exercise in the spring of 1969, after which TOS-EUR will undergo evaluation testing. Information and experience gained through the operation of this developmental field system will be analyzed and applied to the permanent, standardized system, TOS-75, to which we now turn.

The stated objective of TOS-75 is to increase significantly the effectiveness of tactical operations within the army in the field by doing the following:

Providing better means of receiving, processing, summarizing, disseminating, displaying, storing, and

retrieving selected information that the commander and his staff need for making tactical decisions

Providing electronic computing to reduce reaction time

Enabling the commander and staff to handle information and grasp military situations at an accelerated rate and thereby to make better and faster decisions and to take the initiative rather than merely react

Freeing personnel from routine functions such as recording, processing, displaying, and disseminating information

TOS-75 will accept large masses of information and rapidly process it into useful form to give great assistance in decision making and planning. Since the battalion is a primary source of information, it is a basic goal to expedite the entry of data into the system at this level through improved message entry devices and procedures. The corps and army rear elements will have input/-output devices and communication links to the computer facilities at their respective main headquarters. At first, there will be computer-to-computer digital data links over the tactical communication network up and down the chain of command within TOS; this network will provide for lateral exchange of data. The degree of detail of transmitted information will be responsive to the needs of the receiving station.

Information in one divisional sector, when entered into the system, immediately will become available to all system users. Access to the data, however, will be controlled on the basis of established requirements at each echelon. The users of TOS-75 will be the commanders and staff members at army, corps, and division levels and the assigned organizational units concerned with data handled by the system.

TACFIRE, TOS, AND CS_3, being developed simultaneously under the ADSAF program, must interface and be compatible in various areas; therefore, common equipment modules and techniques will be used as much as possible. TACFIRE, about 2 years ahead of TOS in development, is pioneering a considerable amount of hardware, but it is too early to predict which items can be carried over into the newer system, either intact or in modified form. Nevertheless, in order to give an idea of possible types of TOS hardware, the major TACFIRE units, which are mostly in the mockup stage, will be mentioned here.

Data will be processed by a general-purpose digital computer with a ferrite-core internal memory. . will be small enough to be manually mounted

in and demounted from a van, but large enough to store and process all the data required for the operations and intelligence functions. The computer will transfer data directly to and from multiple peripheral devices and will interface with all stations on the network.

In addition to a large internal computer memory, TACFIRE will use three external memory devices. The first, a memory-loading unit (MLU), receives programming data, stores it on magnetic tape, and relays it to the computer memory for carrying out specific processing operations. Removable media memory units (RMMU's), which are quite similar, consist essentially of two tape cartridges that can quickly be changed according to the operation desired. The third, a random-access memory, is a read-write unit that has drums for storing the programs and the large quantities of data needed for computations.

Two types of message entry device, one (FFMED) for fixed-format messages and the other (VFMED) for variable-format messages, will be used to transmit data to computer centers from forward observer posts and other remote installations. These units incorporate codes to identify the station and type of message and receive an acknowledgment from the center for each message. The more flexible VFMED can receive as well as send messages and can provide a print-out of any transmission.

A digital plotter map (DPM) will receive data from the computer, convert it to symbols and alphanumeric characters, and present them as a graphic display. It will show the tactical situation as an overlay to a 4x4-foot map section. An electronic tactical display, complementary to the map, will produce a display of the terrain and the tactical situation on a 16-inch cathode-ray tube. Using the same 100 symbols and characters, it will provide greater flexibility than the DPM. Although it is almost certain that neither of these particular items will be used in TOS, knowledge and experience that will be gained through them will probably aid in the development of display devices that will meet the needs of TOS.

Medium-speed printers (MSP's) will accept outputs directly from computers and will print single or multiple copies at 500 lines per minute. Data terminal units (DTU's) will be part of the interconnecting system that links the various stations through standard wire and radio communication facilities. MSP's and DTU's will serve as common modules in different types of TACFIRE functional equipment.

Two other items will also be common to the system: an alphanumeric editor keyboard and a display editor. The former will be a means of originating messages and revising data; the display editor is a cathode-ray-tube device that will record, decode, store, and display up to 504 characters.

A piece of equipment included in TOS but not in TACFIRE is an input/-output exchange (IOX) that will expand one communication channel to eight half-duplex channels. TOS is expected to have eight of these units; one will normally be kept idle as a spare, and the other seven will provide 56 channels to a network of users.

TOS-EUR is essentially a major test-bed for determining the software and hardware requirements for the Army-wide TOS-75. The TACFIRE hardware represents equipment fairly firm in design but still to be produced and tested before being evaluated item by item for application to TOS-75. It is anticipated that the final components of this system will be transportable in vehicles organic to each echelon where they will be deployed and thus will be more compact than the bulky equipment being tested in Europe.

The functional areas covered by the software for TOS-EUR are limited by the particular local requirements and by economic considerations. But the US Army Combat Developments Command is conducting a TOS-75 study in the United States to define other functional areas that will be needed by forces deployed in varied environments and engaged in high-intensity, mid-intensity, and low-intensity conflicts. Careful consideration will be given to the suitability of functions to specific echelons and to the Army structure and doctrine as projected for the mid-1970's. These studies, which are an integral part of the Army-75 combat development program, will make full and continuing use of the field experience being gained from the TOS-EUR in Germany.

About 30 functional areas that have been selected will be studied and defined by means of functional area descriptions (FAD's). The functional areas are user oriented and are those considered to be most essential for the planning and conduct of operations at the TOC. The designers will attempt to keep duplication to a minimum and will eliminate any areas that do not prove to be vital. Although the areas are far from being selected or precisely defined, a preliminary list is given below.

1. The enemy situation
2. Friendly unit information
3. Nuclear fire support
4. Nuclear strike effects
5. Reconnaissance and surveillance
6. Enemy order of battle
7. Tactical air support
8. Army air operations
9. Air space coordination
10. Hostile air defense
11. Terrain intelligence
12. Weather data
13. Tactical troop movement
14. Communication planning
15. Target intelligence
16. Counterintelligence
17. Airfield/heliport location and status
18. Air defense information
19. Barrier and denial operations, planning, and status
20. Tactical gap-crossing status

21. Intelligence collection management
22. Intelligence analysis and interpretation
23. Strategic intelligence
24. Chemical contamination
25. Electronic warfare
26. Internal defense and internal development
27. Psychological operations
28. Unconventional warfare
29. Engineer construction planning and status
30. Biological contamination

TOS, being a part of the overall ADSAF program, will be compatible with, and interface with, the two other Army data-processing systems. All will use a common, English-based programming language, which is still to be selected and developed as necessary to meet Army needs. The American standard code for information interchange (ASCII), a uniform code for input, output, and transmission of data, will be used throughout ADSAF. Other aspects of control and data flow will be standardized so that it may be possible for all three major services and the Marine Corps to make use of the data that will be accumulated. As the Mallard international military communication system gradually replaces current wire and radio facilities, it will be used for ADSAF operations.

The selected programs will control data flow within a division to and from more than 30 remote stations down to the battalion level. The computer will examine the code indicating the message type, will relate it to other information previously received, and will sort, store, and disseminate it to those who have signified a need for it. Any of the users linked to the system may ask the computer for information in any functional area. They may, for example, specify an accepted subject heading, a time period, a geographic area, or a combination of the three. The computer will then make a search of the data bank and transmit everything that falls under the specified categories.

To keep current in regard to a particular type of information, a user can write a standing request for information (SRI), which will remain programmed within the computer. The user might ask to be informed of any reported troop movements within a certain radius of his position or of any mortar and artillery fire reported in a specified area. As information satisfying the specifications comes in to the computer, it will automatically be transmitted to the user and to any others who have requested it.

In addition to SRI's, users can send in new data and changes to existing data and can give instructions to delete information or purge a complete entry. These operations and the whole process of message entry and processing are outlined in the accompanying data flow diagram.

The future plans for TOS-75, which are to some extent related to TACFIRE milestones, call for the Commanding General, ADSAF, to establish a test-bed/service center in the United States. This facility will be set up after acceptance of the TACFIRE R&D prototype and will use TACFIRE hardware. Functions selected by the Combat Developments Command will be programmed for automation in TOS-75, and wherever it proves feasible, programs developed in TOS-EUR will be adapted for use. Operating methods will be based as much as possible on those of TACFIRE.

After TACFIRE engineering and service tests (ET/ST) are completed in 1971, the commanding generals of ADSAF and the US Army Test and Evaluation Command (USATECOM) will perform a configuration and adaptation test. Then, testing procedures will be worked out and included in a comprehensive, coordinated test plan.

Development of the final TOS-75 hardware and software should be completed in the first half of 1973. Following a year devoted to ET/ST, final changes will be made, and the first system should be ready for full-scale operation by the latter part of 1974.

TENTATIVE PRINCIPAL CHARACTERISTICS

Complete System

Type	digital data-processing and communications network
Housing and mounting	
Computer centers	in vans
RSDT's	in shelters on 2-1/2-ton trucks
UIOD's	in building, tent, shelter, or vehicle
Transportability	all components by air
Communications	
Facilities	
Early 1970's	contemporary standard wire and radio channels linking computers and multiple peripheral units
Later	Mallard international network
Code for data exchange	ASCII

Components

Computer	
Type	general-purpose digital

Processing speed (required)	
Access time	1 μsec
Execution of an instruction	5 μsec (avg)
Word length	24 bits (minimum)
Memory (internal)	
Type	core, modular, nondestructive
Capacity (required)	64,000 words
Memory-loading unit and removable media memory unit (TACFIRE)	
Type	magnetic-tape cartridge
Tape speed	
Run	15 in/sec
Rewind	36 in/sec
Start time	170 msec
Stop time	50 msec
Tape size	0.5 in wide, 200 ft long
Storage capacity	1,200,000 characters
Data density	556 characters per inch of tape
Data transfer rate	8,000 characters/sec
Random-access memory (TACFIRE)	
Type	read/write drum storage unit
Components	control unit and 1 or more data storage drums
Storage capacity	6.5 million bits per drum
Data transfer rate	3.3 million bits/sec
Access time	20 msec or less
Variable format message entry device (TACFIRE)	
Type	data terminal for receiving and transmitting messages of variable length and format
Maximum message length	500 characters
Medium-speed printer (TACFIRE)	
Line length	72 characters
Printing speed	500 lines/min
Printing characters	ASCII-coded 64-symbol subset
Data terminal unit (TACFIRE)	
Type	interconnecting device for accepting digital data and converting it to serial analog form for transmission
Components	4 independent data terminal assemblies

Input/output exchange	device to expand 1 communication channel to 8 half-duplex channels
Group display device	
Type	unit to convert digital tactical data into graphic form
Display characters	200 to 300 symbols and alphanumeric characters
Map scales to be used	1:50,000; 1:100,000;1:250,000

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1 ORIGINATING ACTIVITY (Corporate author) Governmental Affairs Inst Washington D C Research Div	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3 REPORT TITLE

TACTICAL OPERATIONS SYSTEM (TOS)

4 DESCRIPTIVE NOTES (Type of report and inclusive dates)
Interim Report

5 AUTHOR(S) (First name, middle initial, last name)

6 REPORT DATE February 1969	7a. TOTAL NO OF PAGES 18	7b. NO OF REFS
8a. CONTRACT OR GRANT NO DAAG39-69-C-0001 b. PROJECT NO c. d	9a. ORIGINATOR'S REPORT NUMBER(S) TIR 6.2.1.1 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	

10 DISTRIBUTION STATEMENT

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11 SUPPLEMENTARY NOTES	12 SPONSORING MILITARY ACTIVITY Development & Engineering Directorate Army Materiel Command

13 ABSTRACT

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Security Classification

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
*Automatic data processing, *Command and control systems, *Tactical operations system (TOS), *TOS-75, *Tactical fire direction system (TACFIRE), *Automatic data systems within the army in the field (ADSAF), Fire control systems, Combat service support system (CS_3), Digital computer networks, Tactical data transmission systems, Central computer centers, Remote station data terminals, User input/output devices						

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