Mobile Subscriber Equipment (MSE)

by William E. Kelley

...in less than two years, you will be able to feel, touch, and "kick the tires" of MSE communications assemblages.

Two years ago the Army had little more than recommendations for a new battlefield communications system. Today the Army has signed a basic MSE contract plus the first of six yearly options. And in less than two years, you will be able to feel, touch, and "kick the tires" of MSE communications assemblages. In fact, if you are a member of the 1st Cavalry Division, you will be able to actually use the system. The speed with which MSE is going from the drawing board to the field is possible only through the use of a nondevelopmental item (NDI) acquisition approach.

During the source selection evaluation process, each proposed system was actually demonstrated, in a tactical environment, using early or pre-production type equipment. The winning bidder, GTE, demonstrated a three-node, backbone MSE system, with extension nodes, near Nancy, France, during 11 to 19 March 1985. During the demonstration, Army evaluators and officials from other agencies of the U.S. government were able to use the terminal equipment, as well as observe the network assemblages being moved from one

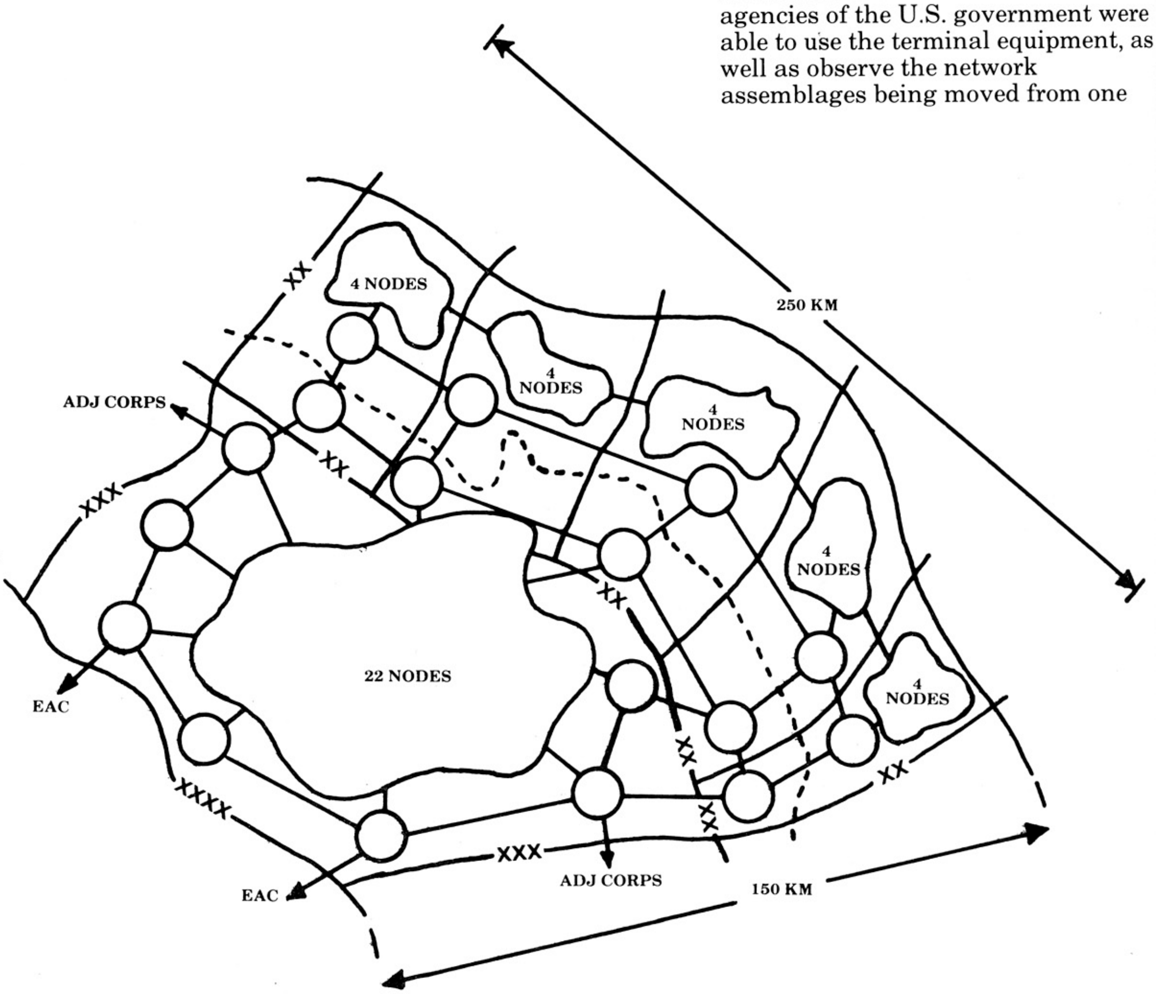

Figure 1. MSE deployment 42 nodes

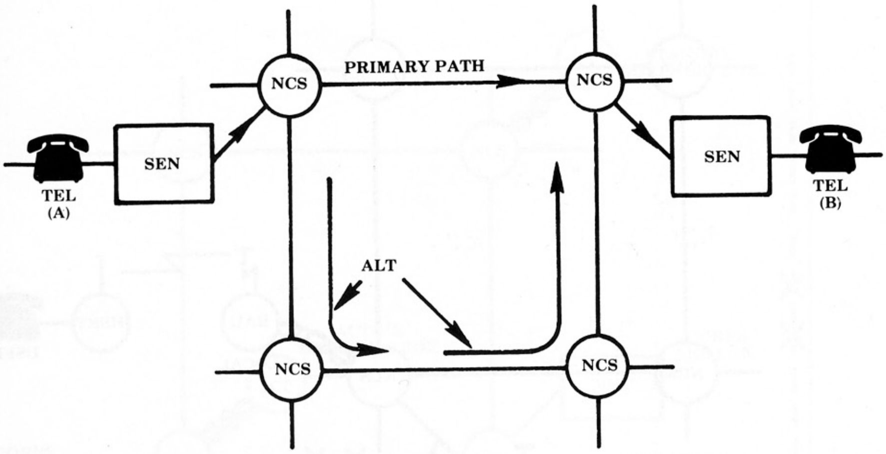

Figure 2. MSE call routing (wire subscribers)

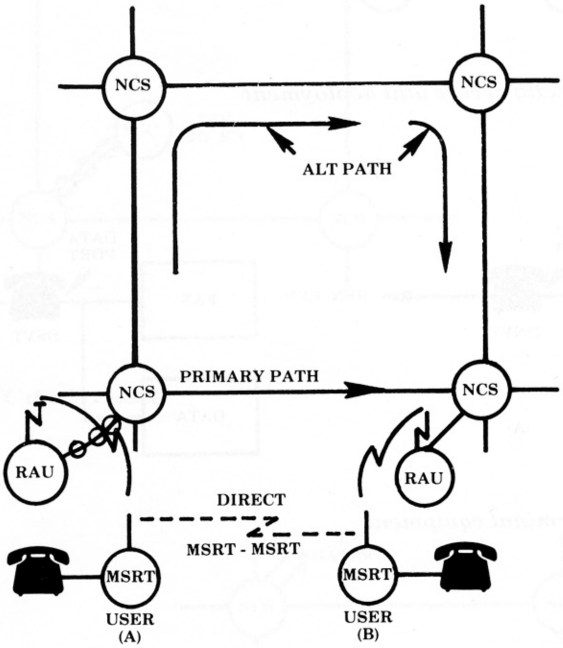

Figure 3. MSE call routing (mobile subscribers)

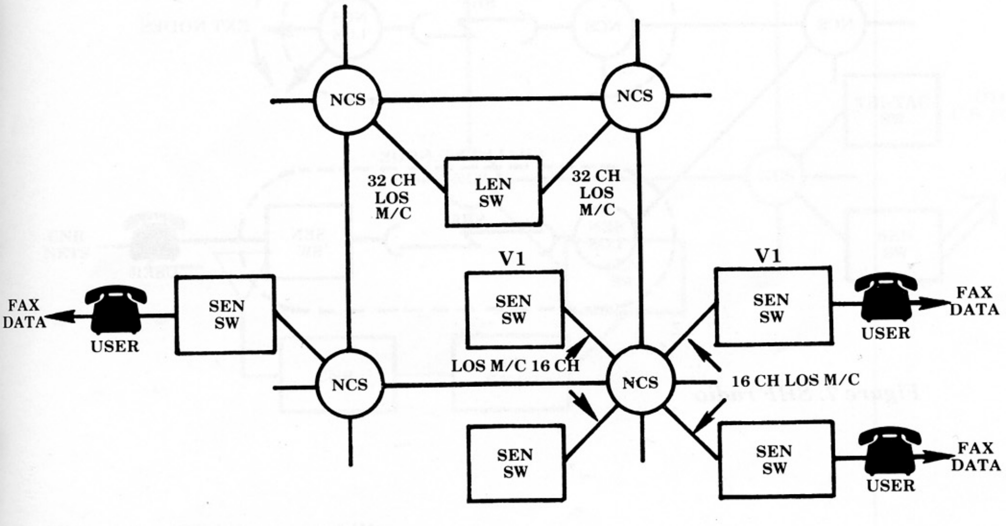

Figure 4. MSE extension switches

location to another. The moves were made in a tactical environment under extreme weather conditions (snow, sleet, rain, high winds).

MSE system architecture

The U.S. Army MSE system will be based on a network architecture that will provide voice and data communications support for a notional five division corps deployed in an air-land battle scenario. The corps MSE network, employing the GTE system, will consist of 42 node center switches (NCSs) connected by line-of-sight (LOS), multichannel (64 channels) communications; this network will form the "backbone" grid system (Figure 1), capable of providing alternate communications paths between node centers (NCs) throughout the corps area of operation to insure a high degree of system survivability. For example, if the primary path between two wire terminals served through specific nodes were disabled, an alternate route through other nodes would be chosen automatically (Figure 2). The same type of path redundancy will also be available for mobile subscribers as depicted in Figure 3. Additionally, a mobile subscriber radio terminal (MSRT) user will be able to communicate directly with another MSRT user if the two are located within radio line-of-sight. All terminal users of the MSE network will gain access into the backbone system through extension nodes deployed by the corps and division Signal battalions.

There will be two types of extension nodes in the MSE system. The first type will consist of extension switches that support wireline subscribers (telephones). These include the large extension switches (LESs) for supporting up to 176 subscribers and the small extension switches (SESs) for supporting either 26 (V1) or 41 (V2) subscribers. All extension switches will be linked to the node center by LOS multichannel communications (Figure 4). The LES will be linked to two different NCSs using two 32-channel trunk groups. The SESs will be linked to a single NCS by one 16-channel group. See Figure 4.

The second type of extension node employed in the MSE system will be the radio access unit (RAU), which will support the MSRTs. Two RAUs typically will be deployed with each NCS to provide geographical coverage for corps area MSRTs. One RAU will be cabled to the node and deployed in the general vicinity of the NCS, and the other RAU will be deployed away from the node through a 16-channel LOS multichannel link (Figure 5.)

There will be two user terminal devices for accessing the MSE network, the digital nonsecure voice terminal (DNVT) shown in Figure 6a, and the MSRT with a digital subscriber voice terminal (DSVT) as the telephone instrument (Figure 6b). Each of the telephone instruments will be equipped with a data port to provide the network interface with either a facsimile terminal or a data terminal device. All terminal devices in the MSE system will be owned, installed, and operated by the user, and classified as general purpose user (GPU) equipment. To provide communications security, all radio frequency (RF) links in the MSE network will be encrypted. The "approved loop" concept will be used to physically secure the wire lines (loops) from the extension switchboard to the users. The MSE system includes the capability to separate the LOS multichannel radio from its supported switch using super high frequency (SHF) radio in a "down-the-hill" (DTH) role (Figure 7).

This capability will allow high electronic signature LOS radios to move away from a command post supported by the small or large extension switches. In the GTE system, each SES will be fitted for one SHF radio, and each LES will be fitted for two SHF radios. Additionally, each LOS multichannel radio assemblage (V3) also will be fitted with one SHF radio. This will provide some flexibility in the physical separation of the NCS from its supporting LOS multichannel radio assemblages.

A series of system control centers (SCCs), deployed as depicted in Figure 8, will manage the MSE network. Although the integrated corps/division MSE network can be successfully controlled through the corps operated SCC with its operational standby, additional SCCs will be allocated to each division for decentralized or autonomous operation of their organic assets. Each SCC will be connected to the network by a 16-channel trunk group linking it to any of the deployed NCSs. A network management terminal (NMT) will also be allocated to each corps area Signal battalion to provide it with the ability to input to and extract system management information from the deployed MSE network.

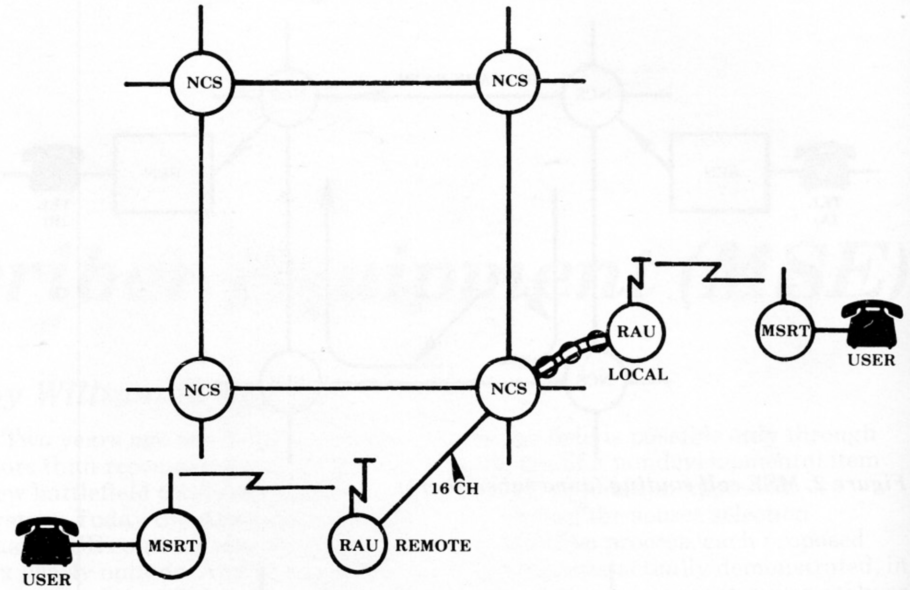

Figure 5. MSE radio access unit deployment

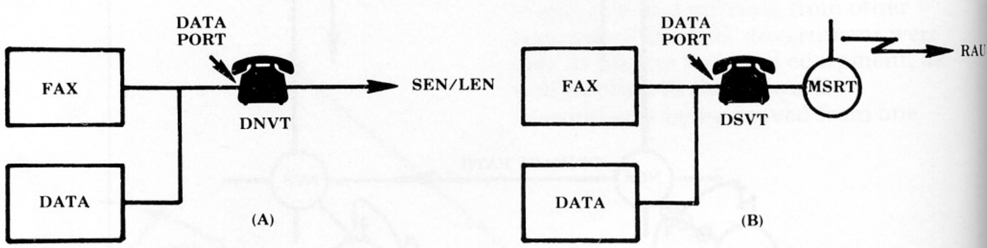

Figure 6. MSE terminal equipment

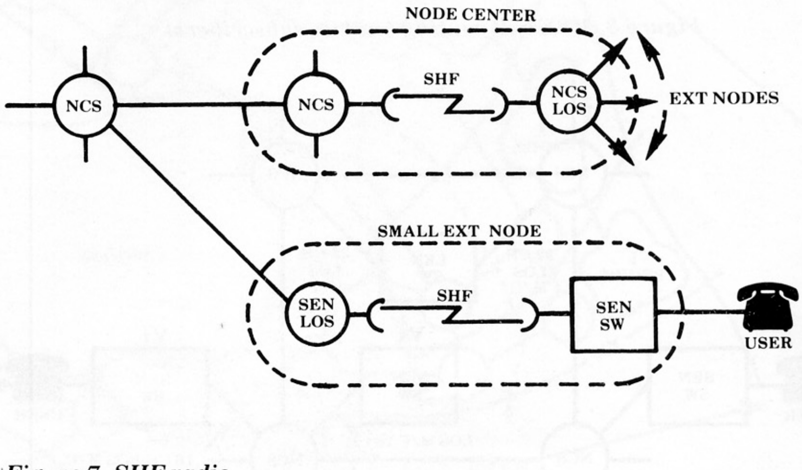

Figure 7. SHF radio

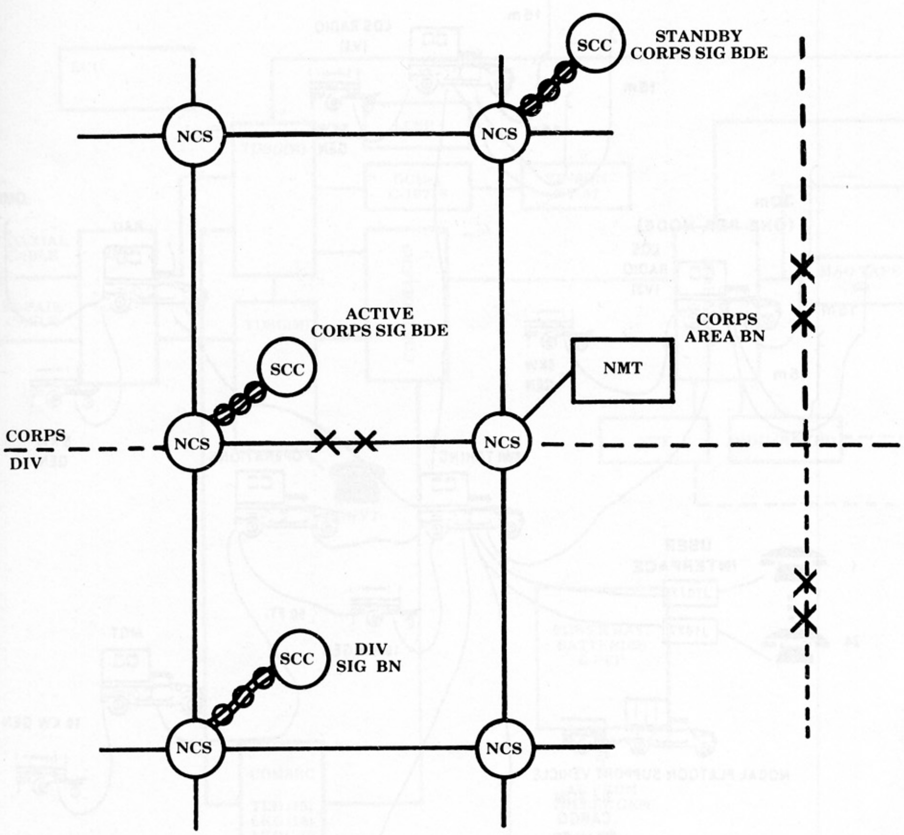

Figure 8. SCC deployment

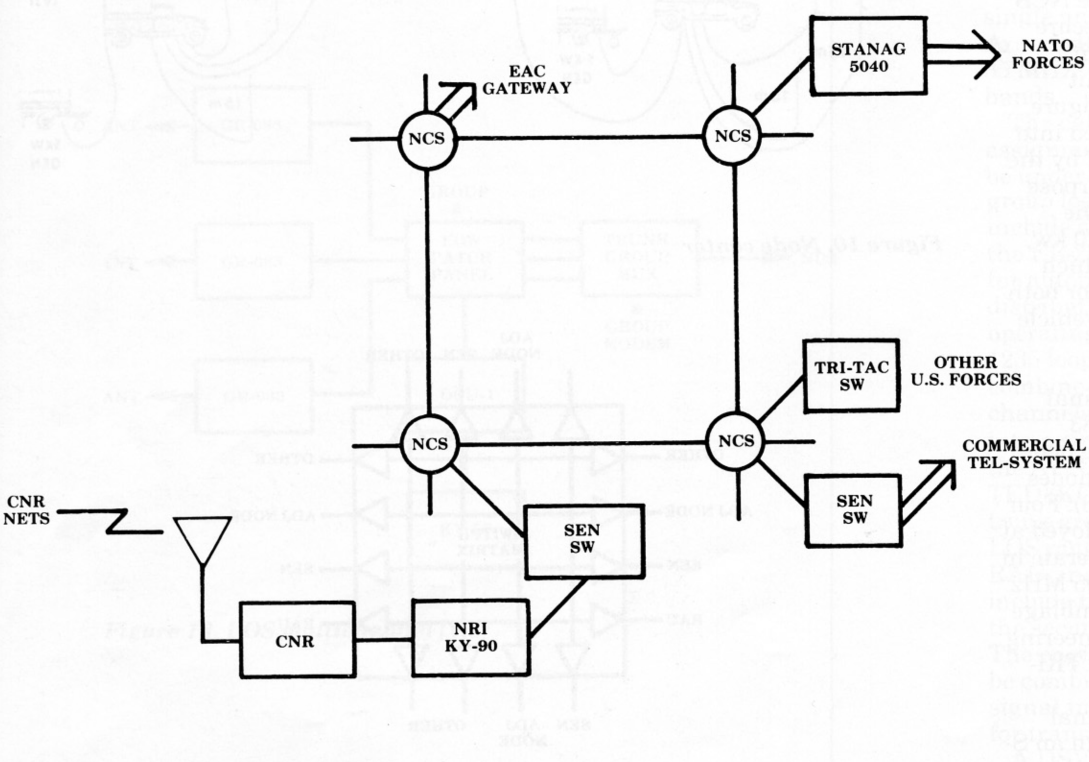

Figure 9. MSE interoperability

The MSE system will interoperate with echelons above corps (EAC), NATO forces, other military forces, and commercial telephone systems through a combination of interface points (Figure 9). Combat net radio (CNR) users may also communicate with MSE users through the net radio interface (NRI) device. Other military forces equipped with Tri-Service Tactical Communications (TRI-TAC) compatible switches will be able to interface with the MSE system through any of the deployed NCSs.

To summarize, MSE will provide the communications that corps and division commanders need to exercise effective command and control of their forces in a tactical air-land battle environment.

MSE equipment description

The MSE system will be fielded as a total package, including the communications-electronic equipment, vehicles, power units, and ancillary items. However, it is primarily the communications-electronics elements of the system that we will examine in the rest of this article. The equipment will be described according to the MSE baseline functional areas: area coverage, wire subscriber access, mobile subscriber access, subscriber terminals, and system control.

The area coverage equipment will consist primarily of those assemblages that make up a node and will include the NCS, RAU, management shelter, and LOS multichannel assemblages (V3) shown in Figure 10. The NCS will be configured into two shelters: operations and switching. The operations shelter will contain the system processors and the operator positions, while the switching shelter will contain the time division switching group, the network timing standards, and the COMSEC equipment.

The NCS is an all digital switch that performs flood search routing for locating subscribers of the network. The switch will be used for tandem switching only, and typically will not provide loop service for subscribers. The NCS will accommodate 16 digital transmission groups (DTGs), 15 of which will be encrypted by KG-94 trunk encryption devices (TEDs). Typically four of the encrypted trunks will be used for internodal trunking, four encrypted trunks for extension switches, and one encrypted (remote) and one unencrypted (local) trunk for the RAU (Figure 11). The remaining trunks will be used for additional LENs, SENs, and RAUs, for the SCC, and to satisfy other network interface requirements.

The NCS will provide switching for 25 local loops for node management and control purposes only. The NCS will also be equipped with a secure engineering orderwire capability using the orderwire control unit (OCU-1) and Vinson KY-57 (Figure 12). The NCS will be configured into two S-250 shelters transported by the Army's high mobility multipurpose wheeled vehicle (HMMWV). The operations vehicle will tow a 10 kw, PU 753/M diesel generator, which will provide operating power for both assemblages, and the switch vehicle will tow a cargo trailer for transporting ancillary items.

The LOS multichannel terminal (V3) will consist of three GR-083 radios capable of providing the node end of the radio links to other nodes and extension nodes (Figure 13). Four of the assemblages will be deployed at each node. The GR-083 will operate in the frequency ranges of 220-405 MHz and 1350-1850 MHz. The assemblage will also include a secure engineering orderwire capability using the TRI-TAC developed OCU-1, with the Vinson KY-57 as the terminal device. The V3 will be housed in an S-250 shelter and transported by the

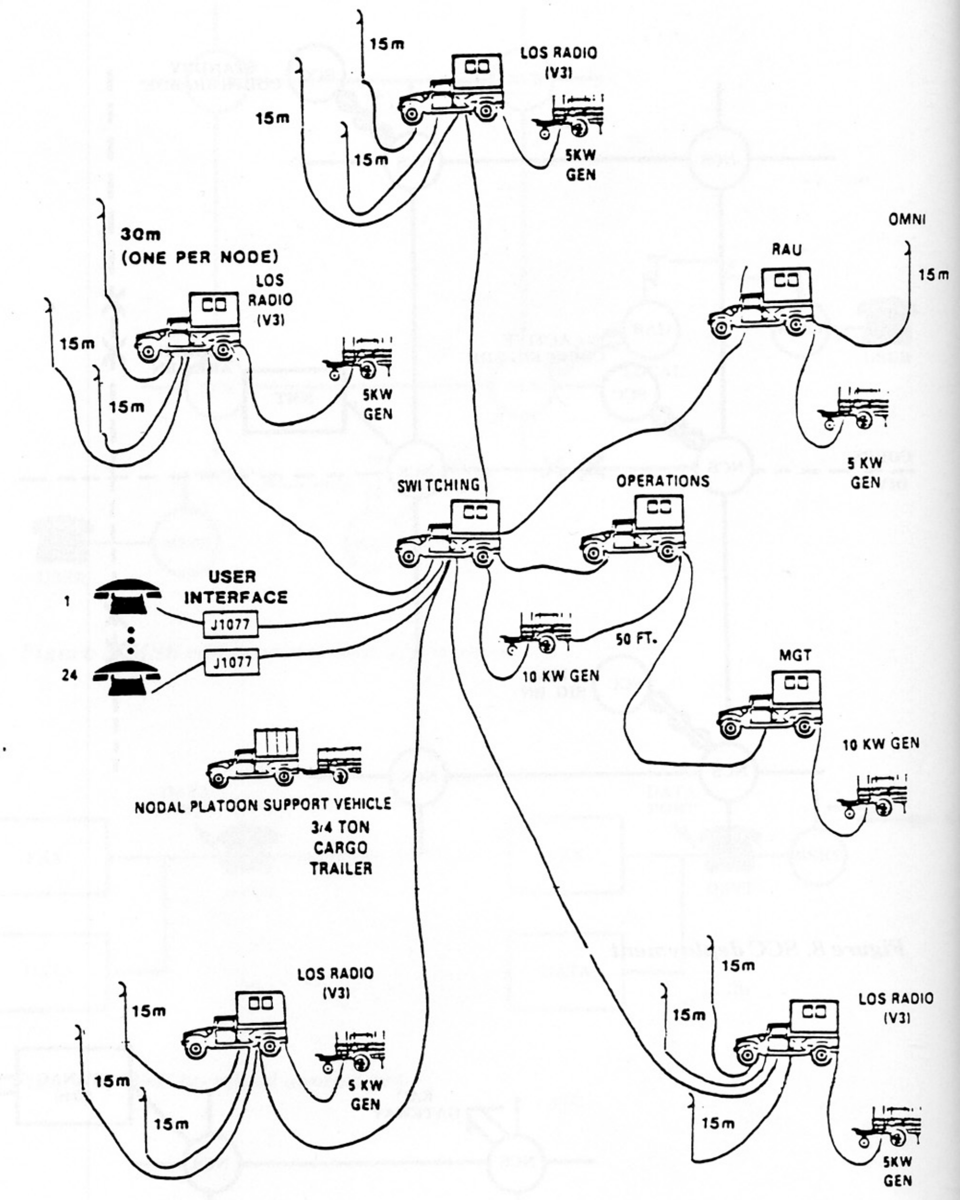

Figure 10. Node center

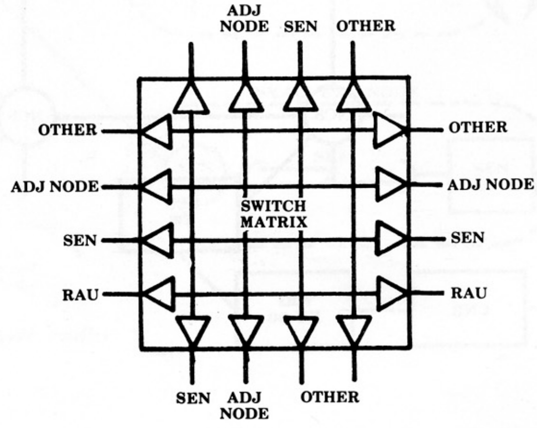

Figure 11. Node switch DTGS

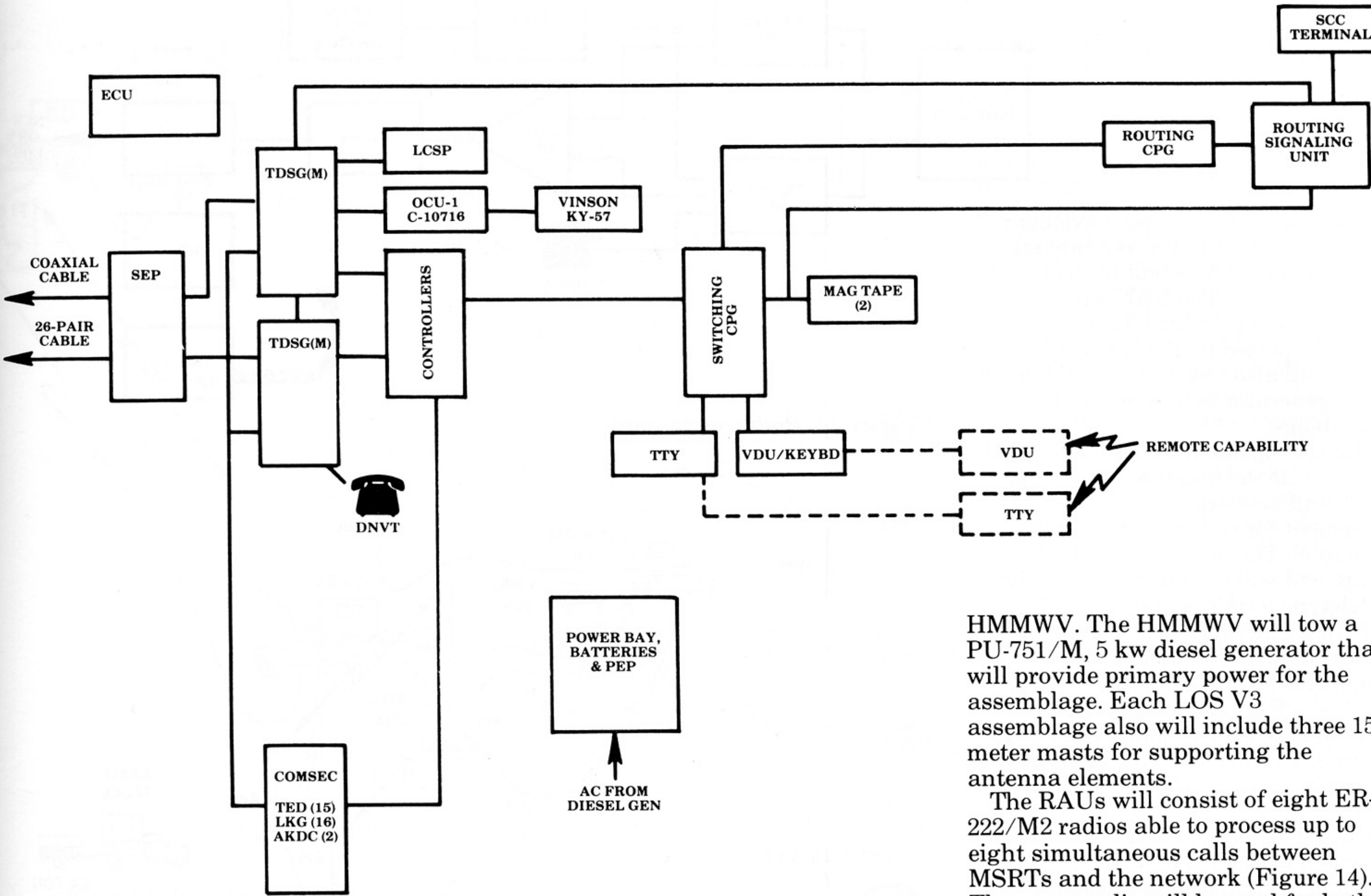

Figure 12. Node center switch

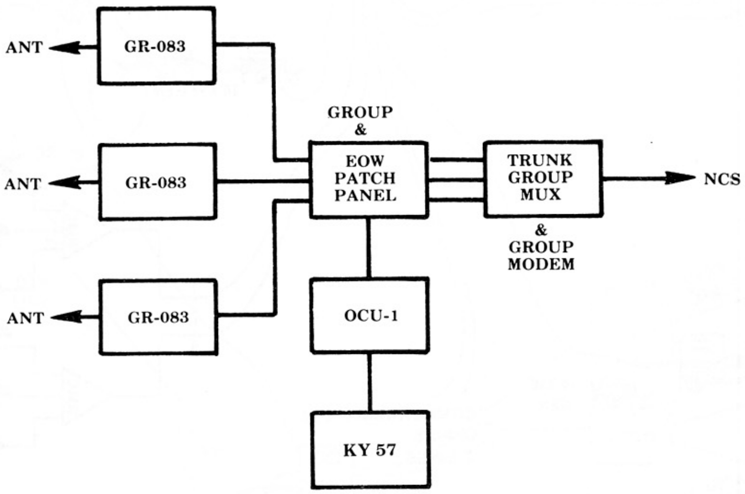

Figure 13. LOS multichannel (V 3)

HMMWV. The HMMWV will tow a PU-751/M, 5 kw diesel generator that will provide primary power for the assemblage. Each LOS V3 assemblage also will include three 15-meter masts for supporting the antenna elements.

The RAUs will consist of eight ER-222/M2 radios able to process up to eight simultaneous calls between MSRTs and the network (Figure 14). The same radio will be used for both the RAU and the MSRT. Though the ER-222/M2s operate over the frequency range of 30-88 MHz using a single antenna and multicoupler, the Army will be using primarily the 30-35 MHz, 40-52 MHz, and 59-85 MHz bands.

The call setup and processing assignments of the eight radios will be under the processor control of the group logic unit (GLU). The GLU will include a frequency fill capability for the ER-222/M2 radios. This will allow for automatic loading and distribution of the RAU and MSRT operating frequency plans. The TD-1235 loop group multiplexer will combine the eight 16 Kbs single channels from the ER-222/M2 radios into a single group for transmission to the NCS or LOS multichannel. The TED (KG-94) will be used to secure the trunk group for transmission over the LOS multichannel link between the RAU and NCS. The RAU will also include the OCU-1, with the KY-57 as the secure engineering orderwire unit. The engineering orderwire signal will be combined with the RAU group signal in the MD-1026 group modem for transmission to the LOS or NCS.

A DSVT will be included in the RAU to allow the assemblage to be

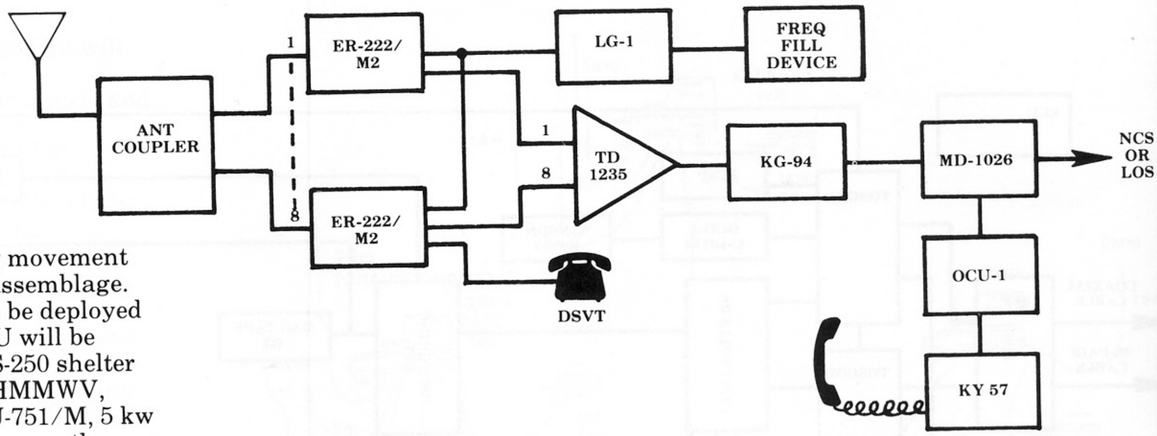

Figure 14. Radio access unit

used as an MSRT during movement and employment of the assemblage. Typically two RAUs will be deployed with each node. The RAU will be housed in the standard S-250 shelter and transported by the HMMWV, which will also tow a PU-751/M, 5 kw diesel generator used to power the assemblage.

The management assemblage (MA) will provide the necessary operating space and network interface equipment for node management personnel. The network interface equipment will include an AN/UGC-74 teletype terminal and a DNVT (TA-954/M2). The equipment will be housed in an S-250 shelter and transported by an HMMWV, which will tow a PU-753/M, 10 kw diesel generator. The generator will be used to power the MA as well as to provide backup power for other node assemblages.

One 30-meter antenna mast will be provided with each node center equipment compliment. This lightweight, quick-erect antenna will be used to provide extended height antenna support for either of the two LOS multichannel or the RAU wideband vertical antennas. The mast will typically be transported on the node support truck.

Wire subscriber access

The wire subscriber access equipment, consisting of the small and large extension switches with their associated LOS multichannel assemblages (V1 or V4) will form small and large extension nodes (SENs and LENs). (See Figure 15.) The LEN, in addition to its LOS radio will also include a management assemblage and cable truck.

The LES will be configured essentially the same as the NCS. Its capabilities, however, will be somewhat different. For example, the LES will accommodate only eight digital transmission groups, three of which will be encrypted by the KG-94 TED. The remaining hardware elements of the switch will be essentially identical to the NCS.

The LOS radio assemblage (V4) will consist of two GR-083 radios for providing independent links between the LES and two separate nodes of the network. In addition to the two radios, the V4 assemblage (Figure 16)

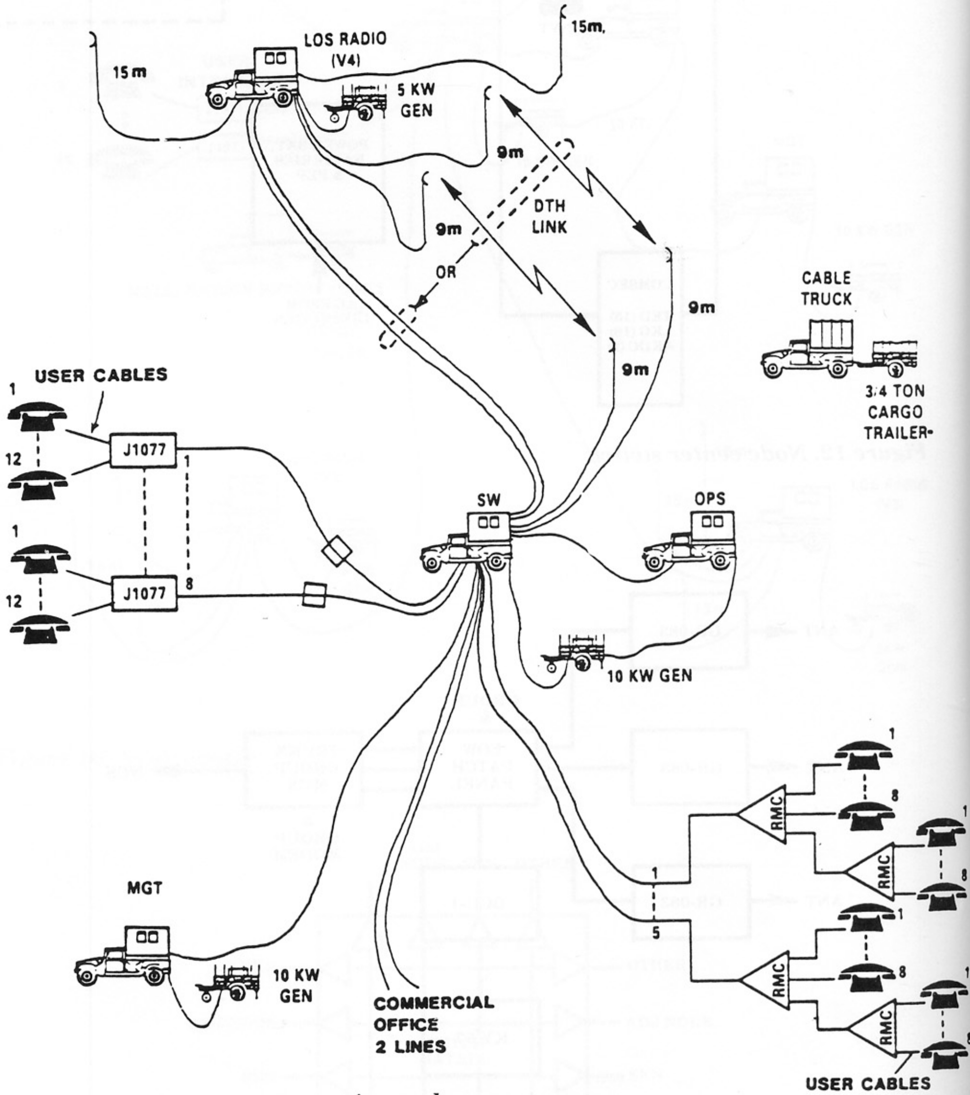

Figure 15a. Large extension node

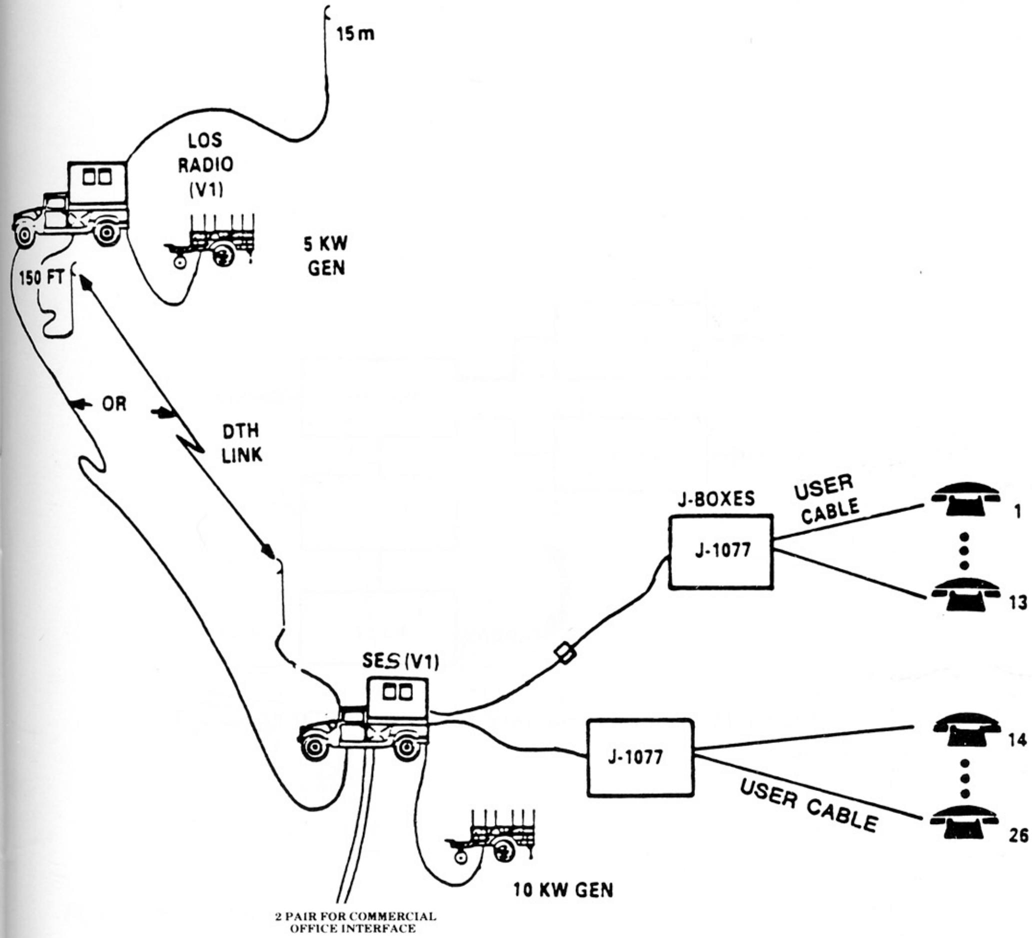

Figure 15b. Typical SEN (V1)

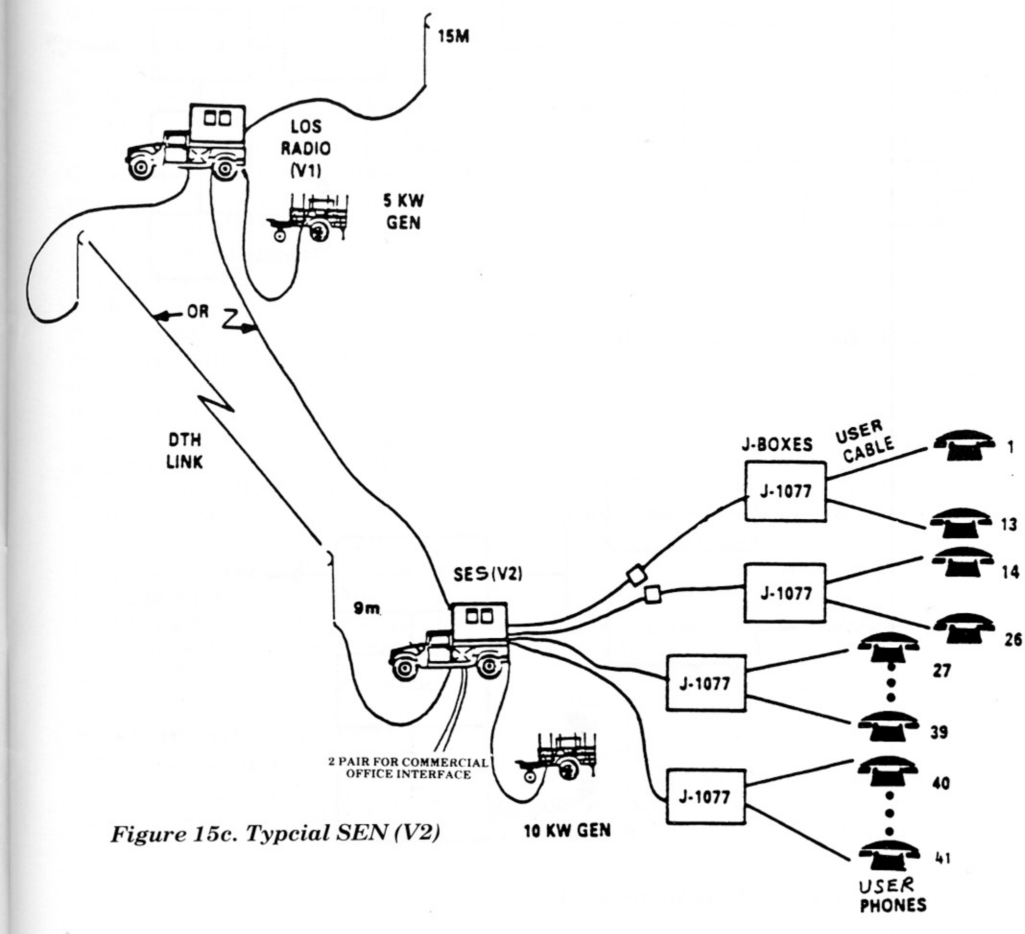

Figure 15c. Typcial SEN (V2)

will include a radio modem (MD-1026) and OCU-1 with the KY-57. The orderwire unit will provide the crew with a secure means of communicating with other network assemblages. The V4 will be housed in an S-250 shelter and mounted on an HMMWV that will tow a PU-751/M, 5 kw trailer mounted diesel generator. Each LOS V4 assemblage will also include two 15-meter masts for supporting the antenna elements.

The MA deployed with the LEN will be identical to the one deployed with the NCS. For a description of the MA, refer to the information under the area coverage section.

The cable truck and trailer will be used for storage and transportation of junction boxes (J-1077), remote multiplexer combiners (TD-1234), and cables that will be used to provide service distribution to LES subscribers. The cable truck will be a cargo version of the HMMWV, M-1037, and the trailer will be the Army standard 3/4-ton cargo trailer.

Small extension node (SEN)

The small extension node includes the SEN switch and its associated LOS multichannel assemblage (V1). The SEN switch (or SES) will be provided in two versions, both of which will be configured with two SB-3614/ATD switchboards, using circuit boards that will provide either 26(V1) or 41 (V-2) subscriber loops, or terminations. The SES assemblage will also include a loop group modem (TD-1235) for combining the output trunk groups from the two SB-3614s into a single group for transmission to the LOS assemblage (Figure 17). The SES will include a TED for securing the trunk group prior to transmission over the multichannel link, as well as a radio modem (MD-1026) and OCU-1, with KY-57, for communicating with other assemblages. Each SES will also be "fitted for" mounting of the net radio interface device (KY-90) and combat net radio (CNR). However, only 44 of the NRIs per five division corps will be procured under the MSE contract.

To make possible the separation of the switch assemblage and the LOS multichannel assemblage, each SES will be fitted for the MF-15, SHF radio. The MSE contract provides a total of 224 SHF radios per five division corps for this particular purpose.

The SES will be housed in an S-250 extended shelter and transported by the HMMWV. The HMMWV will tow a PU-753/M, 10 kw diesel generator, which will be used to power the switch assemblage.

The LOS multichannel assemblage (V1) will consist of two GR-083 radios used to provide primary and standby links to selected NCs. The V1, however, will only be equipped with one antenna, which will have to be reoriented and used with the standby equipment when establishing a link to the alternate node. The V1 will also include the MD-1026 and the OCU-1/KY-57 combination, which will perform the same functions as specified above in the LOS V4 assemblage (Figure 18).

Subscriber terminals

This functional area will include the subscriber telephone facsimile terminals and the interface capability for data terminal equipment (DTE). It should be emphasized that the DTE will not be provided as part of the MSE contract; however, the interface capability is inherent in the DNVT and in the DSVT, both of which will be supplied with the MSRT.

The subscriber telephone terminal of the MSE system will be the DNVT TA-954/M2. The DNVT is basically a digital voice terminal, with an embedded data adapter and external data port, capable of inputting voice and data (including facsimile) into the MSE network. The DNVT will interface with the MSE switches and RMCs at a 16 kbs data rate. When used in the voice mode, the terminal will be able to make the analog to digital conversion.

Mobile subscriber access

This functional area will include the MSRT and the DSVT. The MSRT in the MSE system will be a modified French Rita System (ER-222/M2) single channel VHF radio. The ER-222/M2 operates in the 30-88 MHz band with a maximum transmitter power output of about 20 watts. The receiver-transmitter operates in a full duplex mode with a high and low frequency band containing transmit and receive channels. When operating as an MSRT (the same radio is also used in the RAU), the radio receiver will scan all of the RAU channels looking for its own directory number.

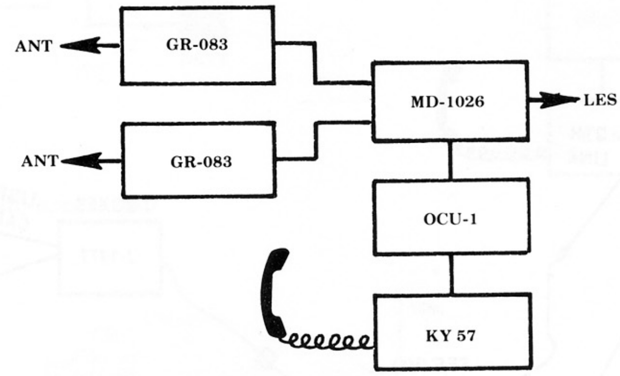

Figure 16. LOS multichannel assemblage (V4)

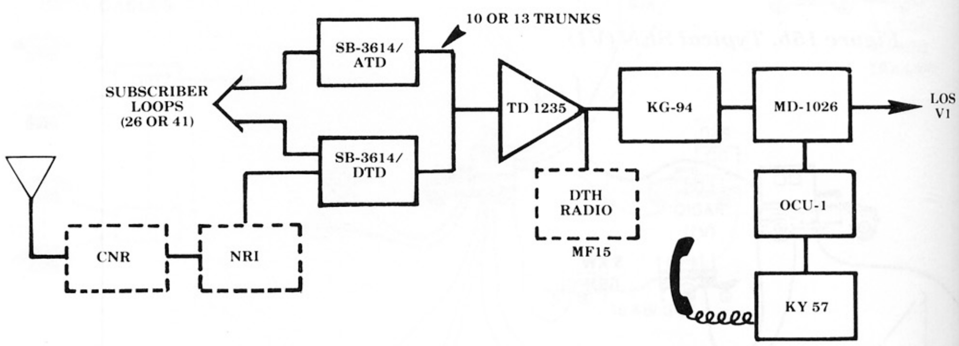

Figure 17. Small extension switch V1, V2

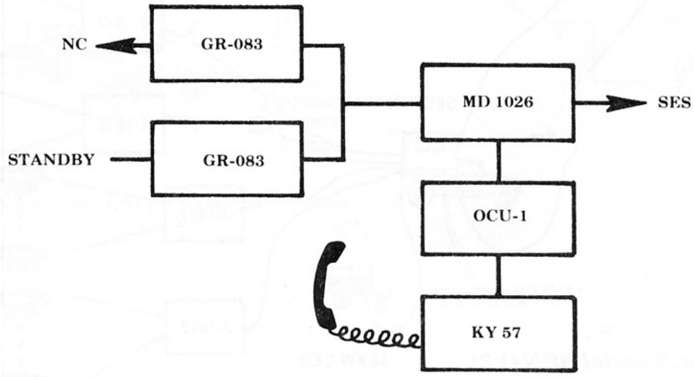

Figure 18. LOS multichannel V1

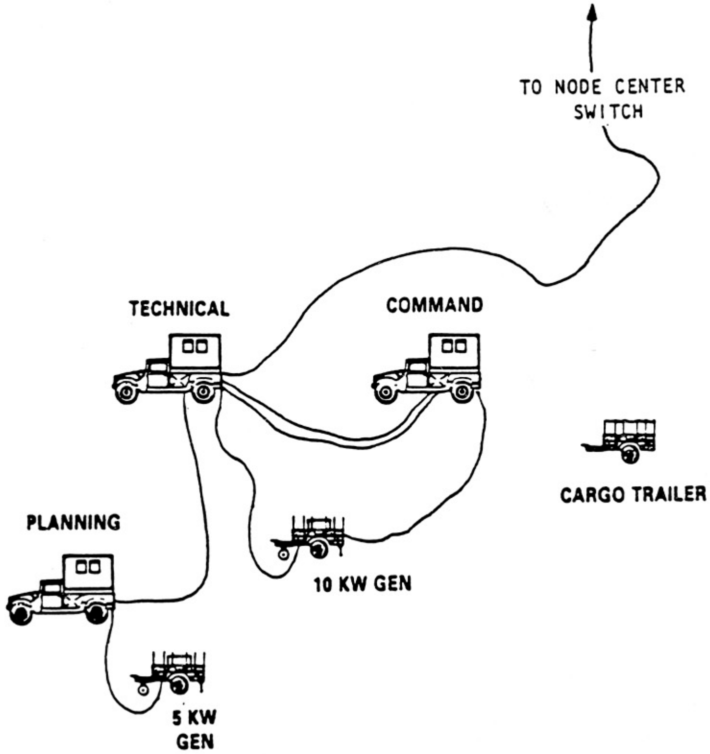

Figure 19. System control center (planning shelter not required for division use)

When it identifies its directory number, the receiver will stop scanning and establish the radio link protocol with the RAU for processing the call.

The MSRT will also include a U.S. COMSEC module used for encryption and decryption of the RF links between the MSRT and RAU, or between two MSRTs in a direct mode.

The DSVT KY-68 will be used in the MSE system as the terminal device for the MSRT. The DSVT will be equipped with an internal data adapter, which will have an external data port enabling it to act as the interface between the facsimile or data terminal equipment and the ER-222/M2 radio. The DSVT will thus enable the MSRT to exchange both voice and data with the MSE backbone network. The MSRTs will be supplied with installation kits for mounting in, or on, various types of wheeled and tracked vehicles used by the U.S. Army.

System control center

The system control functional area will provide the necessary tools for planning and managing the assets of the MSE system and for monitoring the system personnel and equipment.

The system control center (SCC) will provide the network managers with the computer-assisted tools and the working space to:

- Accomplish detailed systems engineering.
- Accomplish LOS frequency systems engineering.
- Direct the deployment and changes of NCs and their associated extension nodes.
- Manage the system assets and mission requirement demands.

Specifically, the VDU workstation of the SCC will provide the system managers access to the following functions:

- Frequency management for the MSE system and single channel combat net radio (CNR).
- LOS terrain analysis and path profiling.
- Automatic planning and direction of the MSE network.
- System link connectivity and status.
- Personnel and equipment status reporting.
- COMSEC key management.
- Automatic updating of NCS, LENS, and standby and reserve SCCs.
- Demographic profile of node and extension node personnel.

The MSE system control center will be composed of the basic hardware and some software of the French Rita CECORE network command center. The three assemblages that make up the hardware elements of the SCC (Figure 19) will be reconfigured, downsized, and mounted in S-250 extended shelters and transported by the HMMWV. The three shelters are the command shelter, the technical shelter, and the planning shelter. A total of seven SCCs will be deployed in a full-up five division corps, with two being deployed by the corps Signal brigade, and one by each division Signal battalion. The division Signal battalion SCC will not include the planning shelter, since most of the network planning will be done at the corps levels.

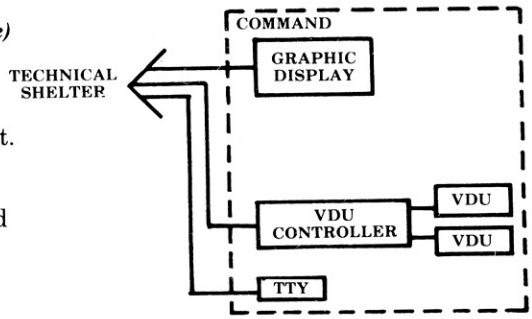

Figure 20. SCC command shelter

The command shelter will consist of the multicolor graphic display subsystem and two management visual display unit (VDU) workstations (Figure 20). The graphic display will provide the network manager with a complete, color coded, network connectivity display depicting the status of interconnectivity links. The work stations will typically be used to manage subelements of the network. For example, one station might manage the NCs and their internodal links, and the other might manage the extension nodes and their associated links. The command shelters interface to the network will be through the SCC technical shelter. The functional elements of the command shelter will be mounted in an S-250 extended shelter and transported on the HMMWV. Operating power for the command shelter as well as the technical shelter will be provided by a single PU-753/M 10 kw diesel generator.

The technical shelter will consist primarily of the SCC central processing subsystem (processor, memory, I/O unit, disk memory, magnetic tape readers) and the network communications interface equipment (loop group multiplexer (LGM), group modem, key generator, and interface equipment). The technical assemblage will provide all of the processor and network interface functions for all three SCC assemblages. The hardware elements of the technical shelter switch will also be mounted in an S-250 extended shelter and transported on an HMMWV.

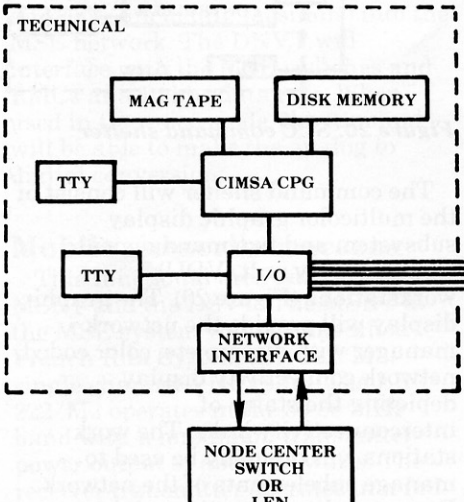

Figure 21. SCC technical shelter

The planning shelter (which will be only at corps level) will consist of two VDU workstations (Figure 22) used to control movement within the MSE network, to control the traffic service functions, and to control the potential capabilities of a particular node at any given time. The planning shelter hardware elements will be mounted in an S-250 extended shelter, which will be transported on an HMMWV.

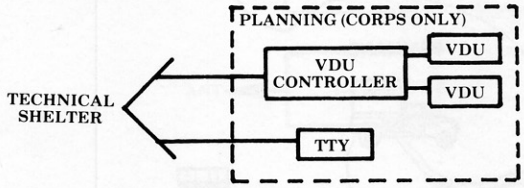

Figure 22. SCC planning shelter

In summary, the inherent capabilities in the MSE system will provide the U.S. Army with a communications system far superior to anything we have ever had before. For the first time, communicators will have the communications means to respond to the user's needs as dictated by the mission requirements of the air-land battle doctrine. This will be accomplished by deploying a highly survivable communications network that will provide the flexibility and dispersibility required to fight the battle and win the war. MSE's high degree of mobility will improve our ability to keep up with the fighting forces on the modern battlefield.

Mr. Kelley is the deputy chief of the MSE Switching and Control Branch, Material Systems Division, Directorate of Combat Developments, Fort Gordon, Ga. A retired CW0 4, he has an A.A. from Chochise College in Douglas, Arizona, and has held many teaching and research positions during his 30 years of active duty. He has published articles on MSE in **IEEE MILCOM '83 Proceedings,** and in **ARMY COMMUNICATOR,** Vol. 9, No. 3.