

Chapter 2

EPLRS Technical Description and Characteristics

This chapter discusses EPLRS component technical descriptions and characteristics. The equipment discussed includes the NCS and its components and the RS.

PERFORMANCE

2-1. EPLRS uses integral cryptographic security, error detection, correction, coding, and frequency hopping to provide robust communications and control in a hostile radio electronic combat (REC) environment. EPLRS contributes significant performance advantages, including–

- Increased rapid response times.
- Effective data throughput.
- Communications security (COMSEC).
- Greater resistance to electronic countermeasures (ECM).
- Lower levels of mutual interference.
- Integrated capability of automatic relay.
- POS/NAV support.
- Greater freedom from voice/data convention.

COMPONENTS

2-2. The NCS and RS are the two main components of EPLRS. The NCS contains tactical computers that provide the focal point for automated technical control and centralized dynamic network management of EPLRS. It is the primary technical control interface. NCS software provides dynamic network monitoring and resource assignment that satisfies communications, navigation, identification data distribution, and position location requirements.

2-3. The RS accepts and implements NCS-issued commands and reports its status to the NCS. These reports are essential for accomplishing the automatic control of the EPLRS. RSs provide the system users with a standard interface via the Army Data Distribution System Interface (ADDSI). The RS is a small, lightweight (manportable) radio providing low-to-moderate data throughput and a sophisticated POS/NAV capability.

NCS COMPONENTS

2-4. The EPLRS NCS is mounted on a high mobility, multipurpose wheeled vehicle (HMMWV). The NCS is made up of a number of components that permit it to accomplish the necessary control, monitoring, and support functions. Figures 2-1 and 2-2 show the interior view of the downsized NCS

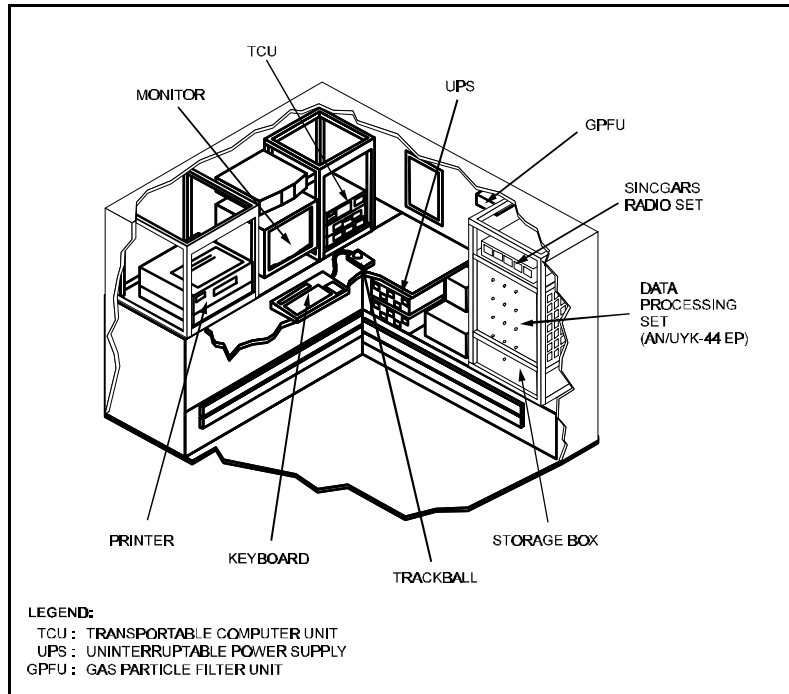


Figure 2-1. NCS Interior Curbside View

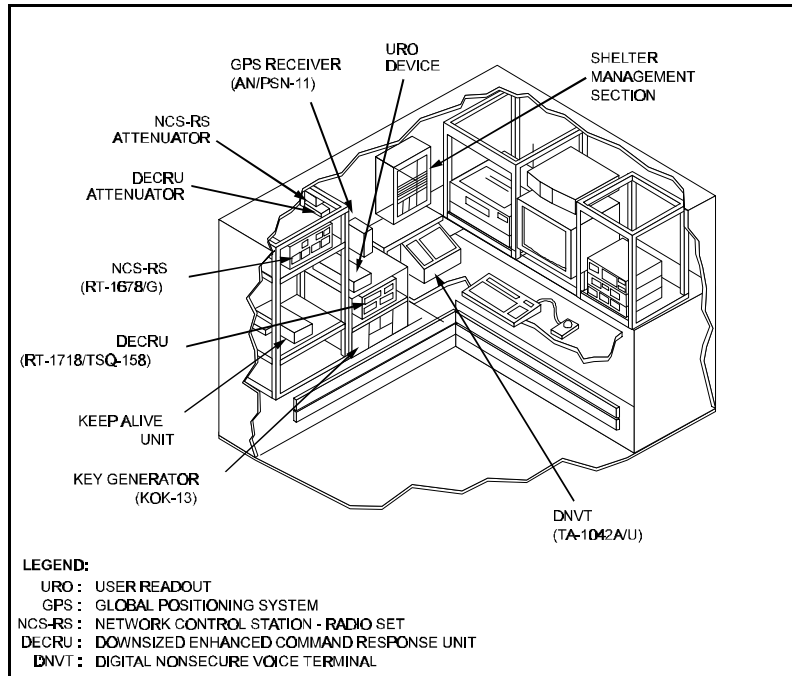


Figure 2-2. NCS Interior Roadside View

2-5. The NCS is a shelter-mounted group of equipment that is outfitted with a 10 kilowatt generator and supports interactive real-time management of the EPLRS network. Figures 2-3 and 2-4 show external views of the NCS.

The NCS is a central processing facility that provides position location, identification, and navigation information to the forces it supports. It sets up and monitors communications needlines used for host-to-host communication between the NCSs and other computer systems.

2-6. The NCS controls the EPLRS control network, performs all the necessary calculations, routes control net messages and queries, and graphically displays the positions of all active RSs. The downsized NCS controls access to cryptographic keys and uses over-the-air rekeying (OTAR) to transmit the keys to RSs that require them.

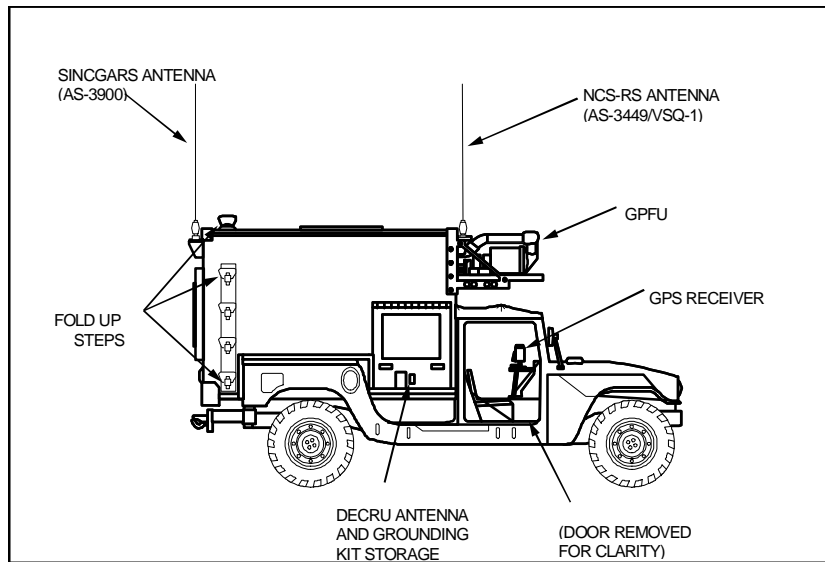


Figure 2-3. NCS External Curbside View

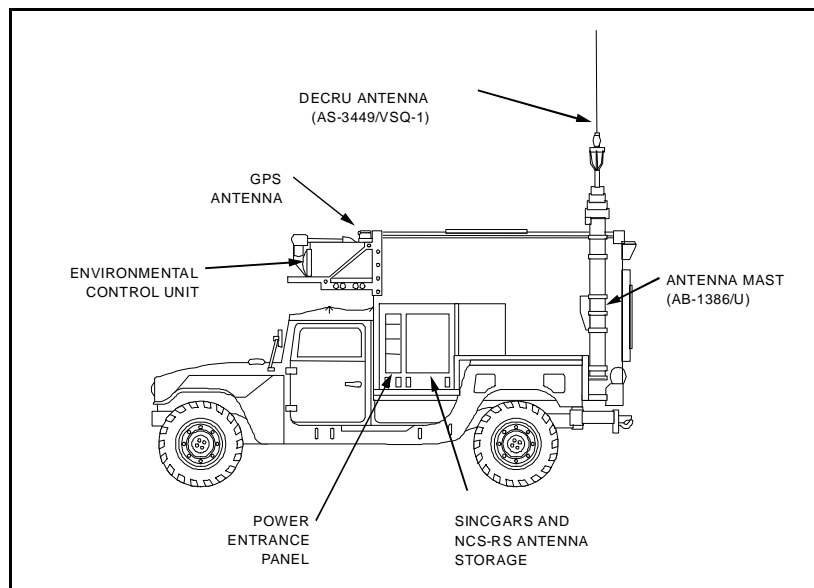


Figure 2-4. NCS External Roadside View

Downsized Enhanced Command Response Unit (DECRU)

2-7. The DECRU provides the radio frequency (RF) interface and timing for the entire EPLRS network. It receives EPLRS data from the network control processor (NCP) and encodes and transmits the message to RSs and/or other NCSs. The DECRU receives and decodes EPLRS transmissions from RSs and/or other NCSs and transfers the received EPLRS data to the NCP. It sends rekey key requests to the key operating key (KOK-13) and receives rekey phase strings from the KOK-13. Rekey phase strings provide rekey keys for user-to-user communications between authorized EPLRS RSs. Rekey keys are used for traffic and command encryption of the control net.

AN/UYK-44EP/Tactical Applications Computer (TAC-4)

2-8. The AN/UYK-44EP is a data processing computer that processes all data transfers taking place between the DECRU and NCS-RS links and the digital computer. The TAC-4 is similar to the Army's computer hardware/software (CHS-2) upgrade. The TAC-4 will replace the AN/UYK-44 computer in the NCS. The TAC-4 is designed to be easily transportable and has three rack-mounting configurations (fits into a standard 19-inch rack). It also can be wall mounted and has direct modular access for fast maintenance and service. Modules may be pulled out for service and replaced in less than five minutes. Removable media devices are placed either in the front or back of the TAC-4 unit.

2-9. Table 2-1 lists the five major program modules involved in the current data processing computer process.

Table 2-1. AN/UYK-44EP Programs

Major Program Module	Function
NCP	The NCP exchanges— <ul style="list-style-type: none"> • Transmit and receive EPLRS data with the DECRU. • Network control data with an alternate NCS. • Time of arrival (TOA) data with the TOA processor (TOAP). • Display data with the display control processor (DCP). It establishes the EPLRS control network by defining the direct NCS-RS transmit and receive paths and the transmit and receive paths for the NCS that must use a relay. The NCP maintains the control network by redefining transmit and receive paths either automatically or under operator control.
DCP	The DCP processes information transfer and display requirements for user readout messages, corridor/boundary data, and user location and status. It exchanges RS location data with the TOAP and exchanges display data with remote displays, the NCP, and circuit management processor (CMP).
TOAP	The TOAP processes TOA measurements for RSs sending or receiving messages and handles tracking and navigation tasks. It provides an automatic interface between the NCP and the DCP.

Table 2-1. AN/UYK-44EP Programs (Continued)

Major Program Module	Function
CMP	<p>The CMP provides display data to the DCP and supports—</p> <ul style="list-style-type: none"> • Management of EPLRS communications networks. • Monitoring of communications path quality. • Exchange of data with the NCS-RS.
TCU	<p>The transportable computer unit (TCU) contains the processing programs for the operator/machine interface. These programs include a software emulator for the cartridge magnetic tape unit (CMTU), real-time EPLRS program (RTEP), and the main graphics program. Other TCU components include—</p> <ul style="list-style-type: none"> • Trackball. Allows the operator to position cursor on monitor screen. • Keyboard. Allows the operator to enter, change, or delete identification, notices, location, needline parameter, and/or navigation data in the EPLRS. • Monitor. Provides the operator with both graphic and text displays of EPLRS data. This includes map data, RS location and identification, RS input/output (I/O) messages, system information, and system warnings and alerts. • Printer. Provides a permanent record of operating parameters, RS data, and test results. • Disk drive. Provides back-up for the RTEP.

KOK-13

2-10. The KOK-13 produces rekey phase strings upon receipt of rekey key requests from the DECRU. The DECRU converts rekey phase strings into rekey keys to provide user-to-user communications between authorized RSs. Rekey keys are also used for traffic and command encryption of the control net.

Shelter Air Conditioners

2-11. Two air conditioners are mounted on the outside wall of the shelter. These air conditioners circulate refrigerated or heated air to the equipment inside the shelter to maintain the operating temperature within acceptable limits.

Communications I/O panel

2-12. The communications I/O panel connects telephone or wire lines to the exterior of the shelter and connecting devices within the shelter that uses the telephone wire lines. This includes digital nonsecure voice terminal (DNVT).

DNVT

2-13. The DNVT is a digital field telephone that provides voice communication with other DNVTs interconnected by external telephone lines and the communication I/O panel.

SINCGARS

2-14. SINCGARS provides two-way secure and nonsecure voice and data communications for the shelter.

Satellite Signal Navigation Set

2-15. The satellite signal navigation set receives signals from the Global Positioning System (GPS), a navigation satellite network that provides three-dimensional position, velocity, and time data. This set develops siting data for the NCS during initial setup. It is also identified as the Precision Lightweight GPS Receiver (PLGR).

Software

2-16. RTEP is the operating software program used in the NCS. The NCS provides network monitoring and resource assignment that satisfies communication, navigation, unit/user identification distribution, and position location requirements. Automatic commands cause EPLRS RSs to accept and implement the commands from the EPLRS NCS and report their status to the NCS.

2-17. RTEP software—

- Performs the processing necessary to control the user community.
- Provides position/tracking.
- Submits transfer reports to supported command centers.
- Transfers information to other NCSs.
- Establishes and maintains communication circuits.
- Provides OTAR and network status monitoring.

Table 2-2 lists RTEP functions.

Table 2-2. RTEP Functions

Name	Function
Control net message traffic control	Controls, coordinates, and monitors the NCS user community.
Network management	Uses the current communication path reliability, communication path values, and operator commands to generate user commands to improve and expand the community.
Position tracking	Accepts measurement data from the user community to locate an RS and its position and establish a velocity track.
Reporting	Processes the results of the position tracking to generate position reports and responds to information queries that the NCS or RS operator initiates. The reporting function also transforms position data between internal coordinates, Universal Transverse Mercator (UTM) projection, Universal Polar Stereographic (UPS) projection latitude/longitude, and the military grid reference system (MGRS) coordinates.
Operator interface	Provides the NCS operator with displays and printouts needed to monitor and control the systems operation. This function accepts and interprets all switch actions and keyboard entries needed to control and communicate with the real-time NCS software and the user community. During playback operations, the operator interface accepts data from the log tape and recreates the previous operational display.
Performance monitoring	Generates information that gives the operator an overview of system performance and hardware operational status.
Start-up	Enables the operator to start the system, load the software, select programs, and select operating modes.
Data distribution	Controls data transfers and monitors the MIL-STD-1553B interface between the NCS and the NCS-RS.
Circuit management	Establishes, monitors, and maintains the circuits required to satisfy the user-to-user communication requirements of the EPLRS user community.

2-18. **Open Software Foundation/MOTIF Window Manager (OSF/MWM).** This provides the graphical user interface for the NCS software programs. The NCS software program uses OSF/MWM that runs with the X Windows system and manages the function of displaying windows on the monitor screen. MWM opens, closes, moves, and resizes windows. MWM controls the display of the three-dimensional shaded frame and title bar on each window. Figure 2-5 shows the window components and where they appear on the monitor screen. Basic components of the OSF/MWM–

- **Title bar.** Identifies the window by name.
- **Maximize button.** Enlarges window shape and size.

- **Minimize button.** Converts a window to an icon and moves it to the bottom of the screen.
- **Window menu button.** Displays a list of functions available to restore, move, size, maximize, minimize, and close windows.

2-19. **Trackball Utilization.** Operators use the trackball to interact with and manipulate the X Windows system. The trackball has three buttons, two that perform different functions and a center button below the ball that is not used. The left button is the select button that manipulates the windows on the monitor screen and performs the RTEP designate operation. The right button is the custom button that performs a one-button hook operation.

2-20. When the display control console replacement (DCCR) program starts, a pointer appears on the monitor screen. As the trackball rolls, the pointer moves correspondingly. The pointer positions the cursor over the desired item on the monitor screen.

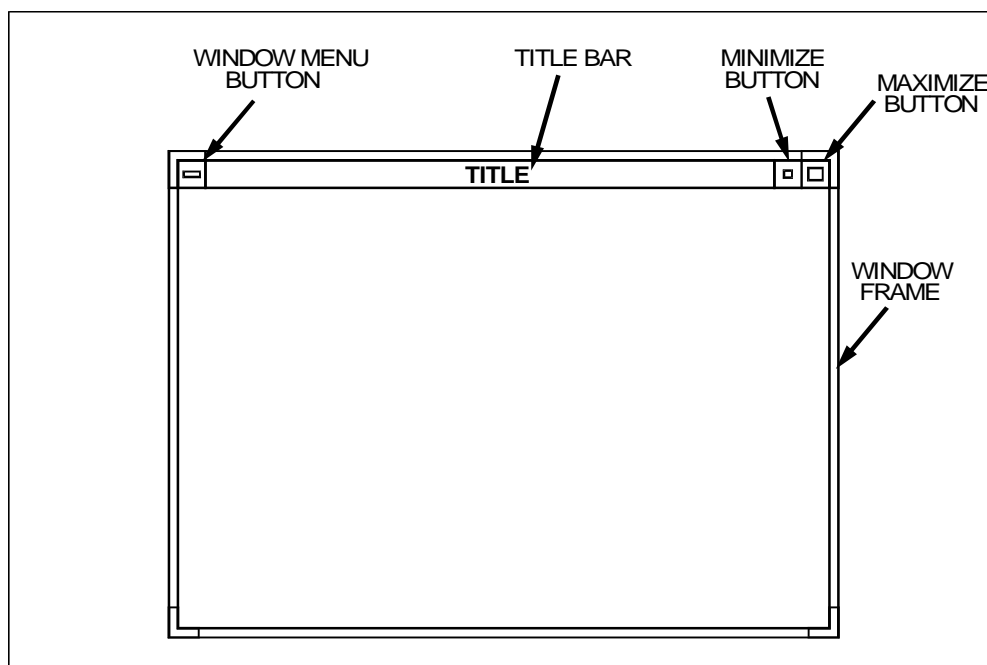


Figure 2-5. Window Components

2-21. **Pointer.** The pointer's location determines the shape of the pointer. For example, when the pointer is inside the borders of the graphics situation window, it appears as a circle shape (red donut), referred to as the designated pointer. When the pointer is directly over the root window (backdrop behind all windows), it changes to a root window pointer (similar to an arrow pointer).

2-22. **Software Focus.** The X Windows system software program associated with the NCS displays multiple windows layered on the monitor screen like papers layered on a desk. To manipulate a window on this type of display, it must have "focus." Focus indicates which window or components within a window accept trackball and keyboard manipulation. When a window is in

focus, the window frame changes color, and the window comes to the front of the monitor screen where it may overlap or completely cover other open windows.

2-23. **Default Windows.** NCS software and OSF/MWM manage operator inputs and multiple windows displayed on the monitor screen. Information displayed in the windows is under the control of X Windows system software program and RTEP.

2-24. The operator controls the position and size of the windows. The operator interacts with the windows using the trackball or the keyboard. The layout of the window display enhances the operator's ability to observe and interpret information displayed on the monitor screen. It allows the operator to rapidly assess and respond to a situation by using a combination of graphic and tabular presentations.

2-25. The default layout display focuses the operator's attention on the tactical situation with the graphics situation window at the center of the monitor screen. The periphery (around the outside of the monitor screen) shows seven other windows, each with its own function and importance. Table 2-3 lists each window and its function.

Table 2-3. Periphery Windows¹

Window	Function
Graphics Situation Window	Displays the EPLRS-RSs deployment and movement within and near the NCS AOR. The operator selects various categories of RSs and amplifies data for display through control actions that are accessible through menu selections on the monitor screen.
System Monitor Window	Provides the status of system performance. Provides general information such as number of active RSs, their track quality, system capacity in use, network throughput, and needline information.
System Alerts Window	Displays a description of the most current alert and the fault code, if applicable. Is displayed when the RTEP generates an alert. Clearing all alerts removes this window from the monitor screen.
Advisories Window	Informs the operator of the number of RTEP unit advisories and system alerts for specific problems and conditions, which the operator reviews individually.
Link Check Window	Provides information on B/R and link reliability between two selected RSs.
Interactive Display Window	Displays interactive information the operator uses to enter data and make selections. It has a menu bar area, control panel area, and push button label (variable function key [VFK]) area for operator interface.
Feedback Window	Plays feedback messages related to the functioning of the system and the RTEP software.

Table 2-3. Periphery Windows¹ (Continued)

Window	Function
Tabular Data Window	Displays– <ul style="list-style-type: none"> • Unit data. Contains last known position status and last data messages sent to, and received from, a hooked RS. • Unit status. Contains current key status, transmitter power level, unit type, oscillator correction factor, the unit identification, and the military identification (MILID) of a hooked RS. • Link data. Shows the most recent RSs in communication with the hooked RS and the current link time/frequency resource element (TREE) assignments, relay level for port or cross links, link reliability, and link period.

¹ See DEP 11-5825-290-10 for a detailed discussion of the NCS computer operation.

Functions

2-26. The NCS–

- Processes position, navigation, and identification information automatically for participating users.
- Exchanges secure digital data between the NCS and network users.
- Furnishes supported C2 systems with EPLRS information.
- Provides data logging and playback.
- Provides real-time display of RSs over an area up to 300 x 300 kilometers (186.3 x 186.5 miles) and within the NCS AOR of typically 47 x 47 kilometers (29 x 29 miles).
- Provides EPLRS services to authorized units.
- Assigns/unassigns timeslot assignments automatically for transmission and reception.
- Provides system initialization and timing.
- Provides self-test and monitoring capabilities.
- Provides display and printing capabilities that perform operational (and nonoperational) functions.
- Provides OTAR, which allows the NCS to send new cryptographic keys to all RSs in the network.
- Supports a normal NCS community size of 126 to 250 RSs.
- Supports a maximum NCS community size of up to 470 RSs (more than 250 simultaneously active RSs result in degraded performance).
- Determines the position of EPLRS RSs under its control.

- Provides control of network management functions necessary for EPLRS user-to-user communications.
- Establishes and maintains EPLRS control and communications networks.
- Monitors and reports systems' performance information for control and communications networks.

Physical Configuration

2-27. The NCS equipment is placed within the shelter for convenient access to all necessary operator controls and indicators. Provisions for heating, cooling, light, security, power, and maintenance are included within the shelter. Equipment is arranged to provide adequate space for its operation and for basic maintenance within the confines of the shelter. The internal shelter configuration supports minimal cable lengths and a low center of gravity during movement.

2-28. All major components that may require maintenance are mounted in drawers that slide out, making them readily accessible while still providing adequate room for maintenance personnel. Mounted inside the shelter are safety and support items, including a fire extinguisher, coat hooks, and rifle racks.

2-29. Electrical power is distributed through circuit breakers and interlock relays to provide protection for operators and the equipment. Direct current (DC) power supplies are provided for the overhead lights, radios, DECRU, and keep-alive system that preserve the KOK-13 and DECRU during a power loss.

RS

2-30. RSs are divided into ground-based RSs and air-based RS. The RS is configured to support manpack, surface vehicle, air vehicle, and grid reference applications (see Figure 2-6).

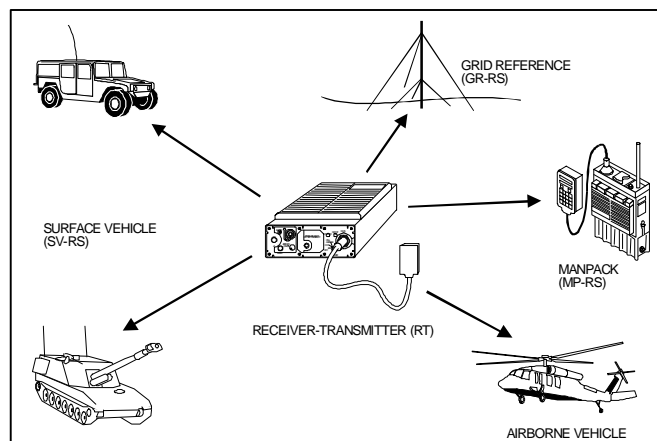


Figure 2-6. RS Support

Ground-Based RS

2-31. Ground-based RSs are divided into three sets: manpack RS (MP-RS), surface vehicle RS (SV-RS), and grid reference RS (GR-RS).

2-32. **MP-RS.** This RS has a receiver/transmitter (RT), URO device, URO cable, and manpack installation kit (MPIK). The kit contains the packframe, all light load-carrying equipment, battery box, antenna, and URO pouch.

2-33. **SV-RS.** This RS has an RT, URO device, URO mounting bracket, URO cable, and surface vehicle unit installation kit (SVUIK). The kit contains the SV-RS mount for equipment installation in the vehicular environment. A selectable power adapter (SPA) provides the unit's prime power, drawing from the battery power of the vehicle.

2-34. **GR-RS.** This RS has an RT, URO device, URO cable, SPA, additional power cable, and the grid reference installation kit (GRIK). The GRIK contains the auxiliary battery case (capable of holding eight batteries), power cables, equipment mounting assembly, antenna, 10-meter antenna mast (AB-1386/U), antenna cable, and antenna mast adapter. Additional power cables allow the equipment to operate from 120-volt alternating current (VAC) or 24 volt direct current (VDC) sources when available. The SPA interfaces with the auxiliary battery case, and the URO device is provided for user data I/O (UDIO). An additional power cable allows the equipment to operate from a 120-VAC source, when available.

2-35. The GR-RS is typically deployed as a static installation. It supports grid reference and ground relay. When functioning as a grid reference, the GR-RS is designated as an EPLRS grid reference unit (EGRU). With additional hardware, the GR-RS supports the gateway functions.

Air-Based RS

2-36. The air-based RS has an airborne vehicle RS (AV-RS) that is used in rotary and fixed wing aircraft. The aircraft vehicle installation kit (AVIK) for rotary wing aircraft has an RT, shock-isolated resilient-mount, antenna, and antenna cable. The kit includes fabrication instructions for the pilot hose and power cables and interface requirements for the bearing direction indicator (BDI). The AV-RS uses an airborne power adapter (APA) for operation from the aircraft power system and a pilot control display panel (PCDP) or URO device for UDIO.

Security

2-37. Each RS uses a controlled cryptographic item (CCI); this item is unclassified, but controlled. However it can be keyed and unkeyed. Only in the unkeyed condition is the equipment unclassified.

2-38. **Access.** A security clearance is not required for unkeyed equipment. However, a security clearance equal to the highest level of keyed equipment is required. Access will be on a need to know basis.

2-39. **Physical Security.** Keyed equipment must be protected to the level of the classification being used. Physical security and accounting controls are required to guard against preventable losses of equipment to an actual or potential enemy. Turning the zeroize knob or opening the RS clears the keys.

2-40. The RS provides data communications, accurate POS/NAV, and unit identification services for EPLRS users. It is a LOS radio that operates in the ultra-high frequency (UHF) band. Each transmission burst occurs on one of eight designated frequencies in the 420-450 Megahertz (MHz) range.

2-41. The RS community, controlled by the NCS, transmits on any single frequency, any combination of the eight frequencies, or frequency hops across all eight frequencies. All transmissions use pseudonoise spread spectrum waveforms. The NCS sets the community's transmit and receive frequency and does not involve the RS operator.

2-42. **Physical Characteristics.** The RSs, including the ADDSI interface module assembly (IMA) or MIL-STD 1553B interface, are approximately 10-inches long, 10-inches wide, and 5-inches high. Total weight of the manportable version of the RS, including battery box with two BA-5590 batteries, antenna, and URO device with cable is 27 pounds.

Interface

2-43. The RS comes with one of two host interface configurations: ADDSI interface or MIL-STD-1553B interface.

2-44. **ADDSI Interface.** This interface is a subset of the Consultative Committee on International Telephony and Telegraph (CCITT) X.25 protocols.

2-45. **MIL-STD-1553B Interface.** This interface is a dual-redundant, one megabyte per second (Mbps) serial data bus that connects the RS and the host bus controller. The 1553B employs command status and data words for data transfers between the RS and the host. It is designed for compatibility with emerging or upgraded weapon systems platforms such as–

- UH-60 helicopter.
- M1-Block III tank.
- Future infantry fighting vehicle (FIFV).
- Advanced Field Artillery System (AFAS).
- Line-of-sight anti-tank (LOSAT).
- Avenger.
- Pedestal Mounted Stinger (PMS).
- Air Defense Anti-Tank System (ADATS).

2-46. EPLRS employs an RS using MIL-STD 1553B interface protocol, located within the NCS, for exchanging data between NCSs and for coordination with associated command centers and the SYSCON.

Transmission

2-47. RSs uses synchronous time division multiple access (TDMA) and spread spectrum technology. Each transmission burst lasts 0.8 or 1.1 millisecond and contains 80, 160, or 240 bits of user data, depending on the waveform mode selected. These data bits constitute an information packet referred to as a transmission unit (TU).

Electrical

2-48. The RT operates on 28 VDC. Its select power source accommodates battery, vehicle alternator, or 110-120 VAC power source. When operating as a manpack RS, which includes the URO device, continuous operation more than 12 hours per each of two standard BA-5590 batteries is possible. Power consumption is less than 20 watts in all RS configurations.

Position Accuracy

2-49. The NCS performs position location calculations based on the TOA measurement reports that RSs within the EPLRS community transmit. These TOA reports form the basis for the EPLRS positioning calculation. Table 2-4 summarizes the RS position location accuracy. The EPLRS POS/NAV accuracy depends directly on the spatial relationships (geometric distribution) between participating RSs and on accurate GR-RS placement.

Table 2-4. RS Position Location Accuracy

RS Type	X, Y Airborne Horizontal Position Accuracy CEP ⁽¹⁾	Z Absolute Altitude Accuracy AEP ⁽²⁾	RS Deployment
MP-RS	10-30 meters	10-30 meters	Primary operating area 47 x 47 km
SV-RS	10-30 meters	10-30 meters	Primary operating area 47 x 47 km
GR-RS	10-30 meters	10-30 meters	Primary operating area 47 x 47 km
AV-RS (all platforms)	25-100 meters	10-30 meters	Primary operating area 47 x 47 km
AV-RS (all platforms)	100-200 meters	15-90 meters	Extended operating area 300 x 300 km

¹ CEP = Circular Error Probable - Median, in the horizontal (X, Y) plane, of the distance from the actual location to each of the computed locations.

² AEP = Altitude Error Probable - Median, in the vertical (Z) direction, of the distance from the actual altitude to each of the computed altitudes.

Operating Procedures

2-50. When locating the best position for RS operation, the RS operator should follow the guidelines in the paragraphs below.

2-51. **Location.** Features in an AO affect radio communications; thus, it is important to select the best possible site. Common features that affect the quality of RS communication are—

- Irregular terrain.
- Large trees.
- Dense forests.
- Building(s).

- Chain link fences.
- Vehicles.
- Power lines.

2-52. For good RS communications, the antenna should have a clear field of view to other RSs. Generally, this means that the antenna should be away from, and at least three to four feet above, any local obstruction. However, in some cases, local obstructions are used to shield the antenna from jammers. In this instance, put the obstruction between the RS and the jammer, five feet or more away from the RS, and maintain LOS to other RSs as much as possible.

2-53. RSs closer to enemy jammers should be better shielded than those in rear areas. Message response times and track quality (TQ) indicate how well the RS is operating in the net. If the RS has communications problems, relocation may be necessary. Often a change in position of 10 to 50 meters makes a significant difference in establishing and maintaining connectivity.

2-54. After RS setup, uncontrolled changes in the locations of reference RSs cause severe problems in system accuracy. The NCS operator must be informed of any changes in the EGRUs' location so that he can make appropriate corrections to the reference coordinates of the device.

2-55. Changes in a reference unit's antenna altitude or antenna cable length affect position tracking for the whole community. It is important to keep the antenna as vertical as possible. The RS operator must set the antenna length using the -C message. Dedicated relay and reference unit operators must keep the NCS operator informed of anything affecting the unit, its siting, or configuration. Propagation losses tend to decrease as antenna height increases. In friendly environments, the antenna should be as high as practical. In jamming environments, compromise between the ideal antenna height and shielding should be used. Unless otherwise indicated, base all planning and siting on the assumption that there will be jamming.

2-56. An RS in a good location hears more RS units than the RS in a poor location. An RS operator sends an -R message when there is doubt of a favorable RS location. The -R message (request RF readiness check) is a communications check to verify the RF transceiver in the RS. When it receives the first response, the RS computes the distance to the responding unit. The RS then displays to the operator the MILID of the responding unit, how far away it is, and how many other units, on average, are responding.

2-57. Geometric dispersion is a key to a good communicating network. RSs in a cluster get poorer service and are not as good for relaying. A cluster loads down the network in a local area and does not provide geometric dispersion for relaying. Ideally, try placing RSs a few hundred meters apart.

2-58. Once planning for each relay and reference RS site is complete, investigate the local conditions at each site whenever it is practical to do so. A site that looks good during the planning phase may not be good for other reasons, such as safety threats, logistical support difficulties, local interference, or local obstruction.

2-59. **Initialization.** EPLRS RS initialization is accomplished by using the RT and URO device components shown in Figure 2-7. Table 2-5 identifies the RT controls and indicators and their functions. Table 2-6 identifies the URO device controls and indicators and their functions. Table 2-7 lists RS power-up procedures.

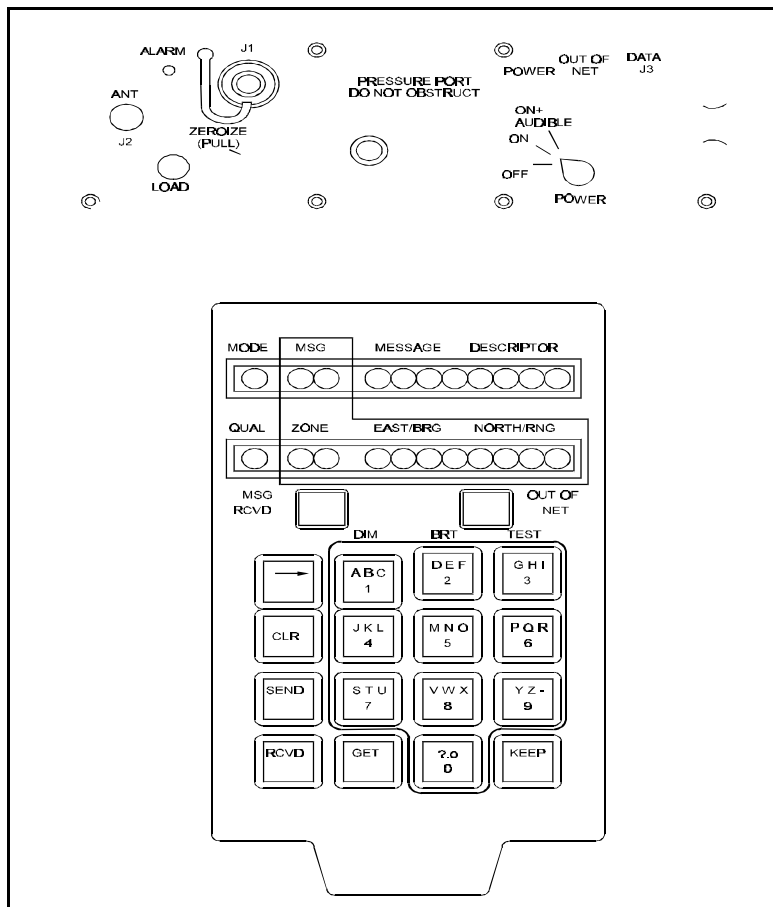


Figure 2-7. RT and URO Device

Table 2-5. RT Controls and Indicators

Control or Indicator	Function
ALARM indicator (red)	Indicates a fault exists or no traffic keys are present if constantly lit.
J1 load connector	Is a connector for key-loading device.
PRESSURE PORT	Provides atmospheric pressure-to-pressure transducer. The NCS uses pressure measurements to compute RS altitude.
POWER indicator (green)	Indicates power is applied to RS.

Table 2-5. RT Controls and Indicators (Continued)

Control or Indicator	Function
OUT OF NET indicator (red)	Indicates different operational status of the RS: <ul style="list-style-type: none"> • Off - when RS is in an NCS-controlled net (ACTIVE), RS is radio silent (RF SILNT) or load device is connected. • Lit - during power-up (POWER UP); remains lit until RS attempts to enter net. • Flashing once per second - RS is attempting to enter net (NET SYNC). • Flashing every four seconds - RS has joined a network of other RSs (TRACK), or RS has entered net but cannot support NCS-related messages. NCS-related services automatically resume when available.
DATA J3 connector	Is a connector for URO device or PCDP cable. Data input to this port is sent over the control net.
POWER switch (3-position)	Indicates power status of the RS: <ul style="list-style-type: none"> • OFF - removes power from the RS except keep-alive power for key. • ON - applies power to RS; audible alert is not enabled. • ON + AUDIBLE - applies power to RS and enables audible alert (buzzer) function (part of RS).
ZEROIZE (PULL) switch ¹	Pull out switch and turn clockwise to zeroize RT; causes all keys to zeroize. Unit is not functional until keys are reloaded.
LOAD switch (push-button)	Load keys into RS during key load procedure. Otherwise, pressing this switch has no effect on RS.
ANT (Antenna) J2 connector	Is a connector for antenna or antenna cable.
J2 Host interface connector	Is a connector for cable from host.

¹Zeroize RS before storage or if in danger of enemy capture.

Table 2-6. URO Device Controls and Indicators

Control or Indicator	Function
MODE field	Displays a character describing displayed mode: <ul style="list-style-type: none"> • E – Edit. • K – Keep in memory. • L – Last known own position. • R – Receive. • S – Send. • 0 through 9 – Memory location for storage or retrieval.
MSG field	Displays a two-character message label describing type of message displayed. During self-test, displays cryptographic key status; when in edit mode, operator edits field.
MESSAGE DESCRIPTOR field	Displays an eight-character descriptor of displayed messages. Not all messages have a descriptor.
QUAL (Quality field)	For certain messages, displays one character (for certain messages) representing quality of position data being displayed: <ul style="list-style-type: none"> • A (Another) – Another NCS tracks RS. • H (Horizontal) – NCS uses RS as a horizontal reference. • L (Last) – NCS is not tracking RS; information is last known position. • M (Manual) – RS's position, which has been manually entered. • R (Reference) – NCS uses RS as full reference unit. • U (Unconfirmed) – Unconfirmed position; NCS is in process of determining RS's confirmed position and velocity. • 0 through 9 – 0 = no position information at NCS; 1 = very poor information at NCS; 9 = excellent information at NCS.
ZONE field	Displays– <ul style="list-style-type: none"> • Two-character grid zone designator of an MGR position. • Knots, kilofeet, nautical miles, or kilometers for navigational aids (NAVAIDS) messages. • First two characters of a free-text message, as well as other assorted messages. When in edit mode, operator edits field.
EAST/BRG NORTH/RNG field	Displays– <ul style="list-style-type: none"> • Eight numbers of a MGR position. • B/R • Last eight characters of free-text message. When in edit mode, operator edits field.

Table 2-6. URO Device Controls and Indicators (Continued)

Control or Indicator	Function
OUT OF NET indicator (red)	Indicates different operational states of the RS (see Table 2-9).
MSG RCVD indicator (red)	Indicates a message is available for review when lit.
→(Cursor) key	Advances cursor one space to right each time pressed and puts URO device in edit (E) mode.
CLR (Clear) key	Clears displayed data; places cursor in first space of MSG display field, and puts URO device in edit (E) mode.
BRT (Brightness) key	Brightens display one step each time it is pressed when URO device is not in edit mode.
TEST key	Initiates URO device self-test and displays current status of RS when URO device is not in edit mode. Enables the RS operator to verify that the URO device and RS are functioning.
Alphanumeric keys	Allows the entering of numbers or letters in edit mode: <ul style="list-style-type: none"> • Press once to display number. • Press twice to display first letter. • Press three times to display second letter. • Press four times to display third letter.
KEEP key	Stores displayed data in one of ten memory locations. The RS operator must enter memory location (press 0 through 9) within three seconds. Stored memory is deleted upon power off.
GET key	Displays previously stored data when URO device is in SEND mode: <ul style="list-style-type: none"> • Press once to recall last sent message. • Press twice to recall last known own position. • Press once immediately followed by a numbered key (0 through 9) to display corresponding KEEP message.
RCVD key	Deletes displayed message (if any) and displays first received message found in memory. If a displayed URO message times out, pressing the RCVD key once restores timed-out message; pressing the RCVD key twice displays the next received message.
SEND key	Transmits displayed message: <ul style="list-style-type: none"> • Press once for one-time responses. • Press twice in rapid succession for automatic updating of requested data (about 10 responses). Operator should wait for responses to ensure message was sent.
DIM key	Dims the URO device display one step each time the key is pressed when URO device is not in edit mode.

Table 2-7. RS Power-Up Procedure

Step	Procedure
1	Set POWER switch to ON or ON+AUDIBLE at the RT. <ul style="list-style-type: none"> • If RS is an AV-RS, set POWER switch to ON. • If RS is an MP-RS, a GR-RS, or a SV-RS, set POWER switch to ON or ON+AUDIBLE.
2	Observe results of self-test; verify that the RS is operating properly and RS parameters (identification and guard channel) are as directed.
3	Load keys, if necessary. (If RS was zeroized, keys must be reloaded). ¹ Before loading keys, verify RT to be loaded has a useable keep-alive battery. An RT with a missing or weak keep-alive battery only holds its keys until its power supply is interrupted. This is especially important for MP-RSs, whose lithium batteries must be changed at regular intervals.
4	Observe OUT OF NET indicator. If EPLRS network is available, indicator should stop flashing within a minute to indicate RS has entered the network
5	Send -C message to verify antenna cable length setting is correct. If antenna cable length is incorrect, enter correct length of antenna cable and resend message
6	Send -L message to verify host-link interface parameters
7	Send -R message (a communications check to see if the RS is receiving from other RSs).

¹The key-loading procedure requires knowledge of the AN/CYZ-10.

2-60. **Warning Lights/Messages.** Table 2-8 provides a list of common EPLRS URO device warning lights/messages.

Table 2-8. URO Device Warning Lights/Messages

Light/Message	Indication
RS OUT OF THE NET indicator light	Indicates status of RS: <ul style="list-style-type: none"> • Flashing one time each second - RS is searching for the NCS; RS has no communications. • Flashing one time each four seconds - RS is communicating with another RS, but not with the NCS. RS is unable to position itself. • Off – RS is operational.
MSG RCVD light	Lit – RS has a message. To read message, press RCVD on the URO device; message is displayed on the device screen.

Table 2-8. URO Device Warning Lights/Messages (Continued)

Light/Message	Indication
RS Track Quality	<p>The URO device QUAL field indicates how well the NCS is tracking the RS. The number field ranges from 1-9; 9 is best and 1 is worst. When 9 appears in QUAL field, it means the NCS is tracking the RS to within 15 meters. The accuracy of the position goes down as the displayed number goes down.</p> <p>“L” in QUAL field indicates the NCS is not tracking the RS and gives the last known position of the RS.</p>
Send/Receive Reports/Messages	<p>Position Reports:</p> <p>To get own position:</p> <p>Step 1 Press the CLR key on the URO device one time to get arrow under the M in the MSG field.</p> <p>Step 2 Press the #6 key two times to change the #6 to P.</p> <p>Step 3 Press SEND; wait for MSG RCVD to light.</p> <p>Step 4 Press the RCVD key. The unit position appears in the lower part of the screen on the URO device. The ZONE field, followed by an 8-digit grid reference, indicates the position.</p> <p>To get the position of another RS:</p> <p>Step 1 Enter P in the MSG field as above.</p> <p>Step 2 Press the arrow key four times to get the arrow flashing under the E in the East/Bearing (EAST/BRG) field.</p> <p>Step 3 Type in all eight characters of the MILID for the unit being located.</p> <p>Step 4 Press SEND.</p> <p>B/R Message:</p> <p>Step 1 Enter B in the MSG field to get a B/R to a grid coordinate.</p> <p>Step 2 Move under the Z in ZONE using the arrow key, and type the two-letter ZONE identifier then an eight-digit grid coordinate; press SEND.</p> <p>Step 3 Press the RCVD key. First part in EAST/BRG field is degrees (Magnetic Azimuth); second part is distance.</p> <p>Time:</p> <p>Step 1 Enter T in the MSG field to get EPLRS network time.</p> <p>Step 2 Press SEND. MSG RCVD lights. Press RCVD; time is DD/HH/MM/SS.</p> <p>Send message to another EPLRS RS:</p> <p>Step 1 Type R in MSG field; arrow down to under the E in EAST/BRG field and type in eight-character MILID.</p> <p>Step 2 Press SEND. MSG RCVD lights. Press the RCVD key. Display shows WILCO (this means NCS found the unit).</p>

Table 2-8. URO Device Warning Lights/Messages (Continued)

Light/Message	Indication
	<p>Step 3 Type Q in MSG field. Arrow down to the Z in the ZONE field. Type 10-character message to send to the unit designated in the above step.</p> <p>Step 4 Press the SEND key. MSG RCVD lights. Press the RCVD key. Display shows WILCO (meaning other unit received message).</p>
	<p>Free-text message to NCS. If you are having problems with EPLRS operations:</p> <p>Step 1 Type F in the MSG field; arrow down to under ZONE field and type 10-character message to NCS; press SEND. MSG RCVD lights.</p> <p>Step 2 Press the RCVD key on the URO device. Display shows STANDBY (this means NCS has received the message).</p>

2-61. **Display mode.** The character in the MODE field of the URO device indicates the function that the device is currently performing. Table 2-9 lists these modes and their descriptions.

Table 2-9. URO Device Display Modes and Descriptions

Mode	Description
E (Edit)	Indicates URO device is in edit mode. Cursor is blinking at current position when in edit mode. New messages are entered in display fields or currently displayed messages are edited. Access this mode by pressing CLR or cursor (→) key. When CLR key is pressed, displayed message clears and cursor appears in first space of MSG field. When cursor key is pressed, displayed message remains in display fields and is edited by moving cursor through each character position to be changed.
K (Keep)	Indicates displayed message is to be stored in 1 of 10 memory locations. To store displayed message, press KEEP key; then immediately press desired numeric key (0 through 9). To keep display on for another 10 seconds, press KEEP key.
L (Last)	Indicates displayed message is last own position received from NCS. To display last received position, press GET key twice.
R (Receive)	Indicates displayed message is a received message. URO device automatically stores last five received messages. When a message is received, MSG RCVD indicator lights. To view received messages, press RCVD key.

Table 2-9. URO Device Display Modes and Descriptions (Continued)

Mode	Description
S (Send)	Indicates displayed message has been sent. Pressing SEND key sends message. To retrieve last message sent, press GET key once.
0 through 9	Indicates displayed message is stored in this memory location. To display stored message, press GET key, then immediately press numeric key of desired memory location.

2-62. **Message Entry.** Follow the steps in Table 2-10 to enter a message in the display fields of the URO device.

Table 2-10. Message Entry

Step	Action
1	Enter edit mode by pressing CLR key. E is displayed in MODE field. Cursor appears in first space of MSG field.
2	Press selected alphanumeric key from one to four times to enter number, letter, or special character printed on that key. Character is displayed at the cursor position, flashing alternately with the cursor.
3	Press cursor key to advance cursor to next desired space. Each time cursor key is pressed, the cursor moves one space to right.
4	Repeat steps 2 and 3 until message is complete.
5	Correct mistakes by pressing CLR key and starting over or by moving cursor around display by pressing cursor key repeatedly until it appears in position of mistake, then reentering that character.

2-63. **Message Edit.** Follow the steps in Table 2-11 to edit an existing message in the display fields of the URO device.

Table 2-11. Message Edit

Step	Action
1	Enter edit mode by pressing cursor (→) key. E is displayed in MODE field. Cursor appears in first space of MSG field, flashing alternately with character in that position.
2	Position cursor to character position to be corrected by pressing cursor key repeatedly as required. Each time cursor is pressed, cursor moves one space to the right.
3	Press selected alphanumeric key from one to four times to enter number, letter, or special character printed on that key. Character displays at the cursor position, flashing alternately with the cursor.
4	Repeat steps 2 and 3 until editing is complete.

2-64. **Message Send.** Follow the steps in Table 2-12 to send message displayed in the display fields of the URO device.

Table 2-12. Message Send

Step	Action
1	Verify that there are no extra or incorrect characters in the display.
2	Press the SEND key (once for one-time response; twice in rapid succession for automatic updating of requested data). In automatic updating, the URO device sends a cancel message to the NCS after 10 updates.

2-65. **Message Received.** Follow the steps in Table 2-13 to display a received message on the URO device.

Table 2-13. Message Received

Step	Action
1	Enter receive mode by pressing the RCVD key. R is displayed in MODE field.
2	Press the RCVD key once to display the next queued message when the URO device display is on. If there are no queued messages when the RCVD key is pressed, the display is blank. The blank message is stored as last received message.
3	Press the RCVD key twice to display a newly received message when the URO device display is off.

2-66. **Get/Keep Message Storage.** Follow the steps in Table 2-14 when it is necessary to send a message in two or more parts or to store information for future reference.

Table 2-14. Get/Keep Message Storage

Step	Action
1	Enter the message into the display field(s).
2	Press the KEEP key.
3	Immediately enter a memory location number (0 through 9); MODE field changes to memory location number, indicating message was stored at the selected location.
4	Press the GET key, immediately followed by the desired memory location number to retrieve the message. MODE field changes to memory number, indicating stored message is displayed.
5	Verify message displayed is correct message. If the message is not the correct message, repeat the retrieval step.
6	Press the SEND key; MODE field changes to S, indicating the message was sent. If the message is in two or more parts, repeat steps 4 through 6 until all parts of the message are sent.

2-67. **Track Quality.** Track quality indicates the reliability of position-location information. The track quality information is displayed in the QUAL field of the URO device. Table 2-15 lists the alphanumeric characters that indicate track quality and a description of what each character represents.

Table 2-15. Track Quality and Description

Track Quality	Description
0 through 9	Numeric value of message information quality: <ul style="list-style-type: none"> • 0 - No position information at NCS. • 1 - Very poor information at NCS. • 9 - Excellent information at NCS.
H (Horizontal)	The NCS is using the RS as a horizontal reference.
L (Last)	NCS is not tracking RS; information is last known position.
M (Manual)	The NCS has manually entered the RS's position.
R (Reference)	The NCS is using the RS as a full reference unit.
U (Unconfirmed)	The NCS is in process of determining RS's confirmed position and velocity.

2-68. **Message Abbreviation Glossary.** Table 2-16 lists the glossary of message abbreviations and their definition.

Table 2-16. Glossary of Message Abbreviations.

Abbreviation	Definition
a	Any alphabetical character.
f	Any alphabetical, numerical, or special character (-, ?, ., °, or blank).
n	Any nonalphabetical character.
oa	Any odd number (1,3,5,7) followed by an alphabetical character.
ea	Any even number (2,4,6,8) followed by an alphabetical character.
x	Hexadecimal character.
b	Blank space.

COMMUNICATIONS SUPPORT

2-69. The communications net and control net provide EPLRS communications support. EPLRS provides communications capabilities through a combination of duplex (two-way) and group-addressed (broadcasts one-way) communication needlines, using host-to-host (RS-to-RS) and free-text message formats.

COMMUNICATIONS NET

2-70. RSs act as senders and receivers of computer data. On the communications net, operators use RSs to establish a connection or circuit (needline) between two computers that want to communicate. The NCS must set up the parameters necessary to define the needlines for each host. Data transfer occurs directly between the senders and receivers and does not go through the NCS. Once the circuit has been assigned, NCS control is not required. See Appendix A for more information on needlines.

CONTROL NET

2-71. The control net primarily provides communications between RSs on which the data I/O is accomplished by use of the hand-held URO device, PCDP, or host computer system. The NCS establishes and continually maintains the control net. Messages are sent between RSs or between an RS and the NCS. Except for RS local subnet communications, all control net messages must be relayed through the NCS.

2-72. Communications on the control net are generally limited to brief messages such as requests for latest position, bearing to a location, current time, predefined responses (ROGER, CANCEL, WILCO), or a 10-character free-text message.

2-73. EPLRS uses short, free-text messages sent over the control network. This is accomplished by—

- User-to-user indirect communications routed through the NCS, using the URO device, PCDP, or other host device.
- User-to-user direct communications over a previously established local subnet, using URO device or PCDP.

HOST PROTOCOLS

2-74. Host messages are input to the RS, using either an ADDSI or a 1553B interface. The ADDSI transfers user information in host packets containing up to 128 bytes (1024 bits). The 1553B interface transfers user information in data blocks containing up to 60 bytes (480 bits). The header of each data message includes the destination address of each needline and is contained within the form of an eight-bit logical channel number (LCN).

2-75. EPLRS ADDSI host packets or 1553 data blocks are designed for hosts in the communications network. In the ADDSI protocol, LCN 0 is used for restarts and link initialization; LCN 1 is not used. LCN 2 is used for host-to-NCS communications over the control network. LCN 3 is used for RS status

and control. LCN 2 and LCN 3 services are a subset of those available via the URO device.

2-76. The 1553B interface is designed to interact directly with 1553B hosts over a MIL-STD 1553B interface. The 1553B interface is planned for use in avionics applications. The key elements of a 1553B system are the bus controller (host), the remote terminal (1553B RS), and the 1553B data bus. The 1553B RS connects directly to the data bus. Its primary function is to accept 1553B data blocks from the host and convert them into a format suitable for transmission over the EPLRS network. The 1553B employs command, status, and data words. Each word consists of 16 bits of data, a synchronization pattern (3 bits long), and one bit odd parity providing a 20-bit format.

2-77. The receiving RS validates error-free message reception by transmitting a status word that contains information about the validity of a message. It also indicates whether the RS is busy. In a similar manner, the host initiates a command to the RS, which requires the RS to transfer a specific message to the host.

2-78. The RS converts ADDSI host packets or 1553B data blocks into TUs. Each TU contains 80, 160, or 240 information bits. TUs are transported through the EPLRS communications network via needlines. The NCS automatically assigns RSs to participate on communication needlines as end points (either source or destination) based on authorization provided in the needline library, the type of needline, and a request to activate the needline by either endpoint. RSs provide needline path coordination and monitoring and TU sequencing, transmission, reception, and error correction. TUs are transported between source and destination RSs through automatic relays controlled by the RSs. TUs are converted back to ADDSI packets or 1553B data blocks at the destination RS and delivered to the host system.

2-79. The source RS formats host data into TUs and transmits each TU over the EPLRS network at the appropriate time. Encryption techniques ensure that only the destination RS recognizes and deciphers data in TUs. The destination RS validates, reformats, and returns the received TUs to host data packets/blocks prior to delivery to the destination host.

2-80. ADDSI host messages greater than 128 bytes are made up of multiple packets, and 1553B host messages greater than 60 bytes are made up of multiple blocks. An ADDSI host exchanges data with a 1553B RS if the two host system data formats are compatible.

FREE-TEXT MESSAGES

2-81. Free-text messages fall into five categories, which are distinguished by destination and method of delivery. Figure 2-8 shows these categories in an example of a free-text message community. Table 2-17 lists the free-text order-wire messages.

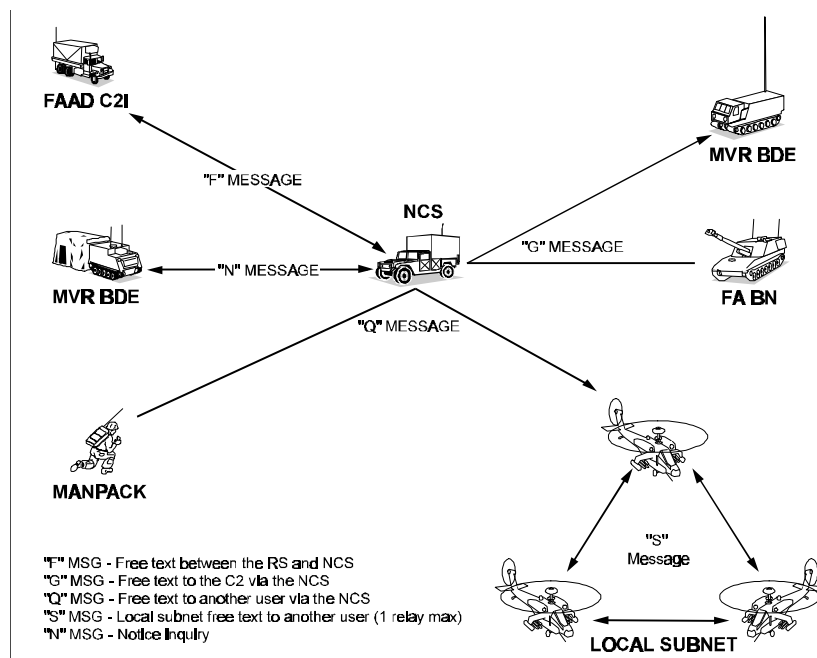


Figure 2-8. EPLRS Free Text Communications

Table 2-17. Free Text Message

Message	Category	Display
F	Between the NCS and RS	A 10-character URO-formatted message stored at the NCS. The NCS operator is notified of receipt by advisory. He reviews the message and determines the sender. He elects to respond or initiate free-text messages to the user directly.
G	To the C2 center	A 10-character URO-formatted message sent to the NCS. The message is forwarded to the designated C2 element (if assigned). If the C2 element is not assigned, the message is queued to the NCS operator.
Q (and R)	Between RSs via the NCS	A 10-character URO-formatted message directed to another unit. Any user sends an R URO-formatted message that includes the MILID of the destination-receiving unit. The NCS maintains one R destination identification for each RS in its library. Each unit, therefore, predesignates a destination unit, using an R message so that all of the Q messages from that unit are forwarded to the designated destination unit. Each user also designates one other user as a recipient of a series of Q messages. The designated recipients are changed through use of a new R message. Because a single unit may be the recipient of free-text messages from multiple sources (a company commander has multiple platoons), the second character in the message label (Q1, Q2, QA, etc.) is advised as a source identification.

Table 2-13. Free Text Message (Continued)

Message	Category	Display
S	Between RSs over a local subnet	A direct user-to-user communication message over a local subnet. Local subnets are assigned and operate independently of the command and communication networks and independently of the NCS. The simplicity with which subnets are assigned facilitates establishment of data exchange across NCS community boundaries. The coordinated assignment of users from adjacent NCS communities eliminates inter-NCS coordination. Candidate applications of local subnet include groups of non-hosted (up to eight) RS users who require frequent communications for coordination (such as scouts and company commanders/platoon leaders). Local subnet support of these services reduces control network traffic, provides faster unacknowledged communications, and limits communication to one level of relay.
N	Controlled and distributed by the NCS	A notice message is used as a type of bulletin board. There may be up to 26 notices stored in the NCS database. Any authorized unit may enter these notices into the system or modify them. Notices are available to all authorized units on request to the NCS. Suggested notice applications include advance weather conditions, alert levels, status of a particular mission, challenge, password, and barometric pressure.

LOCAL SUBNET OPERATION

2-82. In the EPLRS design, there are 32 local subnets numbered 1-8 and A-X for sourcing data. Each user sending data is assigned a unique, non-zero position of 1-8, which is called the source user number. Users assigned a 0 instead of 1-8 as a source user number receives only messages addressed to all units, and cannot transmit user data on the local subnet; they only relay.

2-83. Since the EPLRS architecture supports one level of relay with a source transmit rate of once every two seconds for each of eight users, the maximum receive rate is eight messages per two seconds (four messages per second). The average message latency (the time between sender's depression of SEND button and message display at receiver) is approximately two seconds.

2-84. The division should coordinate before EPLRS deployment to implement local subnets in the most beneficial configuration. Local subnet assignments should be coordinated at a network level to prevent groups of users from employing the same subnet resource (to prevent crosstalk).

2-85. Assignment coordination at a subnet level is desirable so that each user is assigned a unique source user number. If two users are assigned the same source number, INTRUDER messages with descriptive data are sent to all users on the local subnet. Although some coordination is required, any RS assigned to a subnet automatically performs the necessary relaying function.

2-86. The RS operator uses the URO device to input the subnet assignment characteristics (subnet number and source user number). Transmitting is not available from the host terminal, but the ability to receive is. Thus, the RS must use the URO device to transmit data on a local subnet.

SILENT MODE

2-87. In the RF silent mode of operation, the RS only transmits when the operator specifically requests EPLRS services via the URO device. Therefore, automatic features such as tracking, communications relay, and path coordination are no longer operative. In the silent mode, the RS deactivates active needlines. The user retains the option to manually request identification information, exchange free-text messages, and receive messages sent to him. To enter the silent mode of operation, the user enters the message OF (for OFF) via the URO device or PCDP. To go back to the active mode, the user enters the message ON via the URO device or PCDP.

2-88. The silent mode is useful for units that are involved in deep reconnaissance operations where the members do not desire their presence detected and often operate under radio silence for extended periods of time. The probability of enemy electronic support (ES) systems detecting a few 800-microseconds spread spectrum, frequency-hopping, or burst transmissions is extremely small. ES systems are more likely to detect or locate the sources of normal tactical voice transmissions, which often last 20 seconds or more. A covert unit could operate in silent mode most of the time and set their RS to active at frequent intervals to obtain position fix.

DATA TRANSMISSION

2-89. Host-to-host data communications require planning to establish specific needlines and needline parameters, whereas user-to-user data communications over the control network do not require any specific planning. With host-to-host communications, the user must identify his specific communication requirements, using the proper needline format. The NCS operator, if authorized by SYSCON, inputs this information into the system.

GATEWAY OPERATIONS

2-90. Since each division has its own timing and cryptographic keys, communication between divisions cannot occur unless each NCS uses a gateway device. The gateway allows data exchange between hosts in different divisions, as long as they have the same security classification. A gateway consists of two ADDSI RSs (one RS keyed for each division), each connected by a cable to their host interface connector. Gateway functions are discussed below.

Classified Data Sharing

2-91. Because direct communication between divisions is not possible, sharing of encrypted data over the air is not possible. Therefore, shared data must be passed in a decrypted format over a cable. Because data passing through the gateway cable is always red data, physical security must be maintained at all gateways. Additional gateways are necessary if the load through the gateway exceeds the recommended capacity of the gateway RSs or if confidential and secret gateways are required.

Connectivity

2-92. EPLRS intradivision networks share the same synchronization and cryptographic keys. RSs in different division communities can not directly communicate with one another. Therefore, gateways establish data communications that extend beyond the boundary of a division community.

GR-RS

2-93. The NCS operator optionally designates RSs as grid references without affecting the RSs capacity for the users. GR-RSs serve as grid references and dedicated relays. Each function has its separate employment criteria to meet a specific need although overlap does exist. RSs that function as a gateway require some different criteria.

2-94. Employment of a GR-RS as a grid reference/relay RS is based on the deployment and density of the user RSs over the occupied terrain. The specific function of each GR-RS determines its placement.

2-95. GR-RSs supplement the network when unit RSs are not in the most advantageous position for system grid reference. The signal organization controls placement and movement of GR-RSs as grid references. This ensures network maintenance of good GR-RS geometry for highly accurate position location reporting. The NCS operator optionally designates an RS as a grid reference without affecting the RS's capacity for the user.

2-96. Using the GPS, the NCS operator inputs the GPS location information as the grid reference location rather than relies on determining the location through an inexact on-map estimate.

2-97. GR-RS site placement should be set up to increase safety, simplify logistical support, minimize local interference, provide efficient communications, and mask the jamming threat. The antenna should be in a clear view for radio LOS communications and away from, and at least 2-4 feet above, any local obstruction. GR-RSs should be sited away from clusters. Clusters are large groupings of RS users (five or more) in a small geographical area. A cluster reduces the efficiency of automatic relaying and, therefore, users may experience poorer service than if the units were more widely dispersed.

RAU

2-98. The RAU is used in EPLRS when installed in vehicles and shelters. The RAU is a multi-functional interface unit used between the EPLRS user unit and a URO device, and between a user unit and a vehicular intercom system. The unit produces, via a transducer, an acoustic tone signal with a peak output in the range between 2200 and 2800 hertz (Hz).

2-99. The tone signal sounds for $1.00 \pm .25$ seconds each time the logic signal buzzer is activated. The unit provides audibility with a signal-to-noise ratio of at least 10 decibels (dB) in the octave band between 1000 Hz and 4000 Hz at a distance of 3 feet from the unit at 75 ± 10 degrees Fahrenheit. The RAU has—

- Visual message received (MSG RCVD) and power-on indications.
- Ability to zeroize the secure data unit (SDU).
- Tone generation and output to the intercom system.
- Data transfer between user unit and URO device.
- Power and clock signal transfer from the user unit to the URO device.
- Acoustic transducer volume control.
- Acoustic tone output when message is received.
- Contact closure switch to an external device.
- Intercom tone volume control.

FUNCTIONAL AREAS

2-100. EPLRS supports the users' requirements in the functional areas of position location, navigation, navigation aids, identification, and communications.

POSITION LOCATION

2-101. A variety of position location information is available for the individual RS operator or a properly interfaced host automated system. When an operator requests his own position, he receives the data in MGRS coordinates. Typical position accuracy falls within a 15-meter CEP. A relative grid reference capability is provided with direction and range (distance away) presented in either English or metric units. A mutual position location allows the operator to request the location of another friendly RS-equipped unit or any one of up to 104 PDIs. It receives either a MGRS coordinate or a B/R to the other RS or PDI locations.

NAVIGATION

2-102. Battlefield zones, corridors, or barriers (such as minefields or enemy lines) may be specified at the NCS, which transmits automatic alerts to any RS approaching, crossing into, or exiting the boundaries of these areas or barriers. The NCS provides advisories or B/R data to RS operators to assist them in navigating to predetermined checkpoints, landmarks, or other units.

NAVAIDS

2-103. NAVAIDS are NCS service requests that allow users to obtain important information and guidance in performing their operations. Originating at the URO device or the host terminal, the request comes into the NCS via the control net. The NCS sends back the response on the control net. It is possible to enter certain navigational data and request it from the system. However, the majority of the inputs to the system are requests for data or exchange of free-text data.

IDENTIFICATION

2-104. Included in the data stored at the NCS is the MILID of all RSs in the net. An RS may request the identification of an unknown RS by providing the MGRS coordinates of that unknown RS or the B/R to that RS.

2-105. At the NCS, positive identification of all RSs in the net assists the NCS operator in coordinating the operation of those RSs. This is supported by including an eight-character MILID for each RS in the database stored in the NCS. The MILID is normally entered as part of the NCS initialization tapes that the SYSCON generates for identification service requests available to the user through the URO device or host terminal. A local security outpost might use this identification capability to verify the identity of a returning reconnaissance patrol. An artillery observer might use this capability to request information about an unidentified unit. The identification friend or foe (IFF) feature of the W message information is available on RS-equipped units. This information is in addition to traditional IFF techniques and does not replace the traditional IFF transponder channels now in use.

2-106. Requests for position location and identification information occur on either a one-time or an automatic basis. Automatic position updates take place at a preauthorized rate, between once per minute and once per second. The information may be presented to the RS operator via the URO device or the PCDP.

2-107. The NCS performs position location and tracking of all RSs under its control, whether they are stationary or moving. The NCS uses tracking filters to collectively provide accurate position location data on RS communities.

OPERATIONAL FEATURES

2-108. The NCS establishes and controls a jam-resistant network of individual RSs. Transmissions between the NCS and RSs and between RSs themselves are accomplished by assigning timeslots to each RS in the net. The NCS transmits while other members receive. To provide the EPLRS integrated data communications navigation identifier (IDCNI) services, the NCS processes the content of these transmissions and the TOA with respect to the NCS master clock.

FUNCTIONAL DESIGN

2-109. The EPLRS network is organized into a TDMA structure. Each member of a community is assigned one or more timeslots to transmit an RF burst while other RSs receive this RF burst. To accomplish this, each RS must possess a clock that is synchronized to the NCS clock. The synchronization of all network users eliminates the possibility of two users transmitting errantly at the same time and simplifies the maintenance of communication security in a network.

2-110. The time division structure simultaneously accommodates both minimum and maximum network access requirements. For control, these requirements range from MP-RSs requiring update approximately once each minute to high performance aircraft with a desired update rate of 30 times per minute. For communications, these typically range from field artillery needlines requiring 16 source transmissions per second to maneuver control needlines requiring one source transmission each four seconds. Figure 2-9 shows the time division entities that are fundamental to EPLRS: epoch, frame, and timeslot.

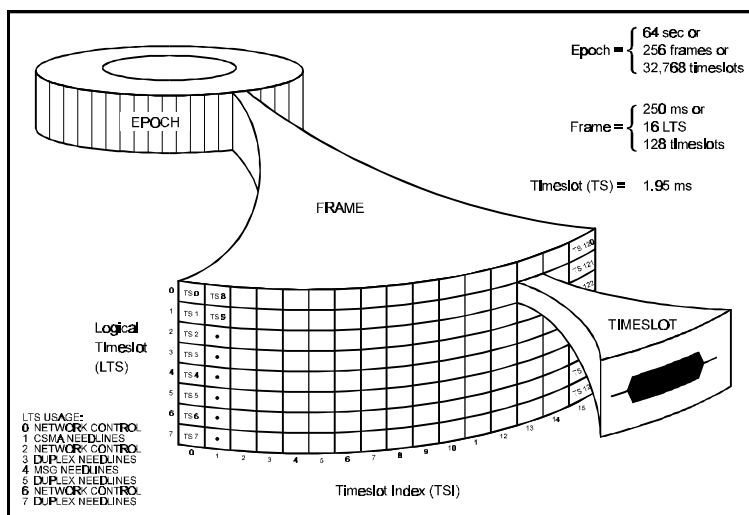


Figure 2-9. EPLRS Epochs, Frames, and Timeslots

EPOCH

2-111. The epoch is the largest network time division and is 64 seconds long. The network is periodic with respect to the epoch. The programmed cyclic transmission and receptions that the NCS assigns do not change from epoch to epoch unless the NCS or RS alters an RS's program for network configuration purposes. The longest period that an RS can be commanded to communicate with the NCS is once every 256 frames, which equals one epoch. The 256 frames that make up an epoch repeat exactly from epoch to epoch, unless purposefully changed.

FRAME

2-112. The frame contains 128 timeslots and has a period of one-fourth second. The frame represents the shortest period at which the RS is programmed to transmit a user measurement report (UMR). For control purposes, a RS is set up to perform–

- A set of functions, including a group of up to four relay actions.
- A set of up to four TOA measurements.
- A report transmission as often as once each frame.

2-113. For communications, RSs are assigned up to four transmissions within a frame on the same needline. The allocation of functions within each frame varies from frame to frame. The 128 timeslots are arrayed as a matrix of eight logical timeslots (LTSs) by 16 timeslot indices (TSIs). One LTS consists of 16 timeslots, one in each TSI.

TIMESLOT

2-114. The fundamental time division is the timeslot. The timeslot length is variable, approximately 1.953 milliseconds, and is adjustable to make the RS's time match the NCS's time. The RF burst transmission accounts for about 800 or 1100 microseconds, depending on the waveform mode (WM) used. A propagation guard band is allocated to RF propagation delay. The balance of the remaining time is required for processing overhead such as message encoding and validation, RF propagation delay, and guard time (buffer time to ensure all processing is completed by the end of the timeslot).

2-115. A timeslot allows one RS to transmit while another RS simultaneously attempts to receive. This time structure, along with the use of multiple frequencies, enables EPLRS to provide both control and communications to many users in a coordinated fashion.

2-116. On control net LTSs, TSIs 0 through 4 are used for NCS-to-RS communications. TSI 5 is used for control network support activities, and TSIs 6 through 15 are used for RS-to-NCS communications. The communication TSIs are allocated into–

- Groups of four TSIs for group-addressed, one-way RS-unacknowledged communications.
- Groups of five TSIs for duplex, two-way RS-acknowledged communications.
- Groups of two or four TSIs for carrier sense multiple access (CSMA), a many-to-many random access RS-unacknowledged communications.
- Interlaced groups of two TSIs for each source for multi-source group (MSG), up to 16 at a time, to many RS-acknowledged communications.
- Interlaced groups of two TSIs for point-to-point (P-P), either or both endpoints being the sources, to the other endpoint RS-unacknowledged communications.

ELECTRONIC PROTECT (EP) CAPABILITIES

2-117. The EPLRS operates in a hostile electronic warfare (EW) environment by implementing anti-jam and EP techniques, such as burst transmission, spread spectrum, integral relay, error correction, and signal encryption. The synchronous EPLRS waveform incorporates a burst transmission that reduces enemy intercept and vulnerability to enemy jamming.

2-118. EPLRS transmits its signal by applying an encoding technique known as direct sequence. The baseband signal is spread in frequency around the carrier frequency and then broadcast over the air.

2-119. Jammers normally affect only a small frequency range in comparison to the EPLRS spread signal. When the RS receives the spread signal and jammer, it processes the reception and extracts the original signal. The processing gathers EPLRS spread signal into a clean baseband signal that is identical to the original signal. The jammer signal is spread in frequency much the same way as the original baseband signal was spread in the transmitter. The signal is filtered to remove all residual jamming.

2-120. EPLRS further incorporates an integral relay capability that permits reliable radio coverage over large deployment areas, with a minimum of relay planning. Under conditions of rough terrain, limited LOS, or enemy jamming, the system automatically selects a good relay path for a circuit.

2-121. EPLRS provides both transmission security (TRANSEC) and COMSEC. All digital data exchanges within the network are encrypted for COMSEC. In addition, the RS uses direct sequence spread spectrum signaling, time-slot scrambling, and frequency hopping to provide TRANSEC.