EW and CP survivability

by Maj. William L. Mundie, Jr.

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The capability of the U.S. Army to be a flexible and responsive force on the modern battlefield is dependent on the command and control of large forces through networks of complex communications systems. However, these systems can be seriously affected by the enemy. Therefore we must improve the methods we use to protect them from electronic warfare (EW) exploitation such as that described in the following scenario.

A battalion tactical operations center (TOC) has established operations near the crest of a hill or ridge to facilitate communications to forward units of the battalion and the brigade TOC. The high frequency (HF) radio teletype (RATT) and five or so very-high-frequency (VHF) frequency-modulated (FM) antennas are erected, and normal tactical radio traffic is sent and received.

The enemy, while conducting normal radio signal intelligence (SIGINT) surveillance, scans the frequency spectrum and picks up a radio emitter. Within 10-15 minutes, a signal analyst is sure of the station's function in the net. If the station is determined to be a net control station, or report-receiving and order-giving station, or uses secured communication devices, it direction-finding (RDF) specialists obtain a fix on the emitter's location. Then, an electronic signature of that area is established and a determination is made as to the type of SIGINT target involved. In this case, the electronic signature shows an HF RATT station and numerous VHF, FM emitters (4-7 FM nets). After this information is collected and analyzed a decision must be made. Are the emissions more important to intelligence as SIGINT sources, or is the destruction of this obvious command and control mode more important in obtaining tactical advantage? The enemy commander decides that the destruction of the TOC is more advantageous and orders a 122-mm multiple rocket battery to fire, using the RDF data.

Survival

The foregoing scenario is not unrealistic and the personnel in that TOC did nothing any differently than is done in most TOCs in command posts (CP) throughout the Army. They did what was expedient. They intended to move often and they wanted to constantly maintain excellent communications with forward units and higher headquarters located to the rear. Those were all excellent objectives, but present-day technology teamed up against their command and control objectives and the equipment they used as radio emitters.

During the 1973 Yom Kippur War, Egyptian and Syrian forces, using Soviet EW equipment and doctrine, located and destroyed Israeli command and control centers within 10-15 minutes. This loss of command and control, in the early stages of that conflict, added significantly to the confusion on the battlefields and was, in no small way, responsible for early Egyptian and Syrian gains.

In an "out numbered" scenario we can ill afford loss of control or flexibility. If our battalion and brigade CPs are destroyed, we lose one of our equalizers — our ability to exercise superior command and control in fluid battlefield conditions. A series of electronic counter-countermeasure (ECCM) techniques can be used to make exploitation by enemy EW specialists more difficult and increase a TOC's chances of survivability.

First, mask emitters that operate in nets to rearward units (next higher HQ, etc.) by placing hills, forests, or buildings between the antennas and the forward edge of the battle area (FEBA) (figure 1). (RDF and intercept equipment will gravitate toward the high terrain on the enemy side of the FEBA.) This will reflect and scatter much of the radio wave and reduce the signal power received by the enemy. If only one or two RDF stations can receive a signal strong enough to get a fix on the emitter, the reliability of the fix is reduced to near worthlessness. To insure reduced signal reception by enemy SIGINT, construct field-expedient unidirectional antennas for radios operating in rearward nets. The reduced wave pattern generated in the direction of the FEBA, when coupled with rear-sloped masking will nearly guarantee unusable DF fixes and greatly reduce the electronic signature seen by enemy ground SIGINT stations. (Simple field expedient construction of unidirectional antennas will be discussed later.)

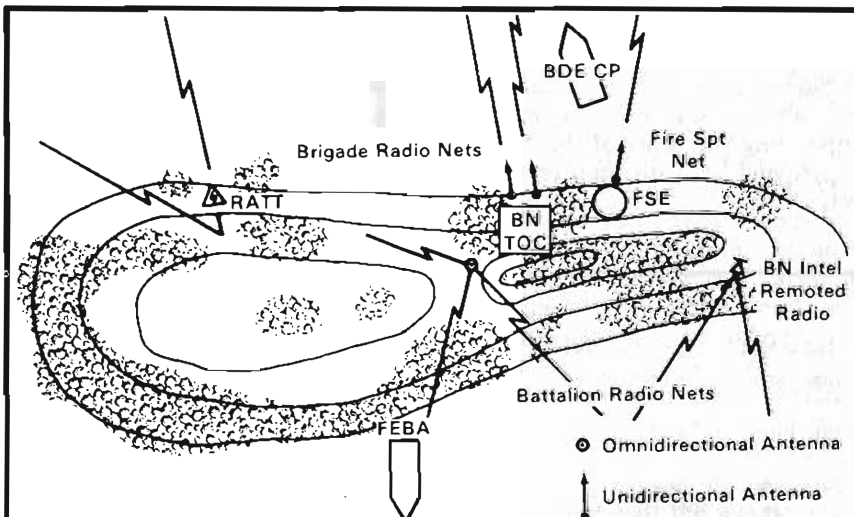

Figure 1. Reverse-slope battalion command post with reduced electronic signature due to unidirectional antenna and reverse-slope sighting.

The second ECCM measure is to position radio emitters as far apart as possible. Placing all your emitters and radios in one remoted location, removed from the CP, will invite the remote's destruction and the loss of communication due to the electronic signature of the remote site. The user should keep his own antenna and radio, with one or two exceptions, and the CP should be spread out more. Operations and intelligence sections can still collocate for effective coordination, but the rest of the CP's communication assets can be spread around one or two grid squares. Runners can carry messages from one area to another until wire lines are layed. Security of the CP will become more difficult, but each section or vehicle crew can provide security to their own area. Perimeter security could be limited to major access routes and reaction force duty. When the techniques just discussed are applied, the HF RATT is separated from the main TOC complex and the FM emitters are spread throughout the area; therefore, an RDF fix in conjunction with an electronic signature of the area may not give adequate data for pinpointing the heart of the TOC, and destroying it with indirect fire weapons.

In the event that the CP's operations net radio transmits often or for longer than 10-second periods, remoting it from the CP area should be considered. Using the AN/GRA-39, the operations radio can be remoted by wire up to 3 km away. However, the distance should be more a factor of setup than obtaining a maximum spread between the operations and intelligence radios.

The third ECCM technique calls for frequent movement of the TOC. The longer a TOC stays in one place, the more methods the enemy is able to employ to pinpoint its location, and the longer he has to react to that knowledge. Rate of movement will depend on the tactical situation and intelligence reports on enemy EW activities in the sector. If an enemy offensive is expected, and you must communicate from the TOC (i.e., radio silence is impractical), move as often as possible, because the enemy will want to target command and control nodes in order to disrupt organized resistance.

The fourth ECCM technique requires the reinforcement of strict radiotelephone procedures. Keep transmissions as short as absolutely possible and use low power to transmit. If the desired station doesn't answer the call in low power, then try to relay the message through another station that has contact. Use high power only as a last resort. The idea is to limit, as much as possible, the distance the wave travels across the FEBA and the duration of transmission. This increases the enemy RDF operator's degree of error and length of time required to locate the emitter. Scattering and absorption of our electromagnetic energy, before it is received by enemy EW stations, is more easily accomplished at low power than at high power.

The ECCM techniques just discussed are not new, but their collective use by TOC or CP sections is often disregarded in favor of simplicity or expediency. When applied, these ECCM techniques take no longer than the incorrect practices, and when they are coupled with good TOC and CP cover and concealment, they will greatly improve the survivability of command and control in each battalion and brigade in a conflict where the EW threat is real and sophisticated.

Table 1

Radio Net	Emitter Net	From	To	Antenna	Power
Bde Opns	FM (secure)	Bde	Bn	*RC-292*	Low
		Bn	Bde	Uni-	Low
Bde Intel	FM (secure)	Bde	Bn	*RC-292*	Low
		Bn	Bde	Uni-	Low
Bde Opns	RATT	Bde	Bn	Omni-	
		Bn	Bde	Doublet*	
Bn Cmd	FM (secure)	Bn	Co	Omni-	Low
Bn Intel	FM (secure)	Bn	Co	Omni-	Low
FSE	FM	Bn	DS Bn	Uni-	Low

*Position doublet on reverse slope and as low to ground as good communications will allow.

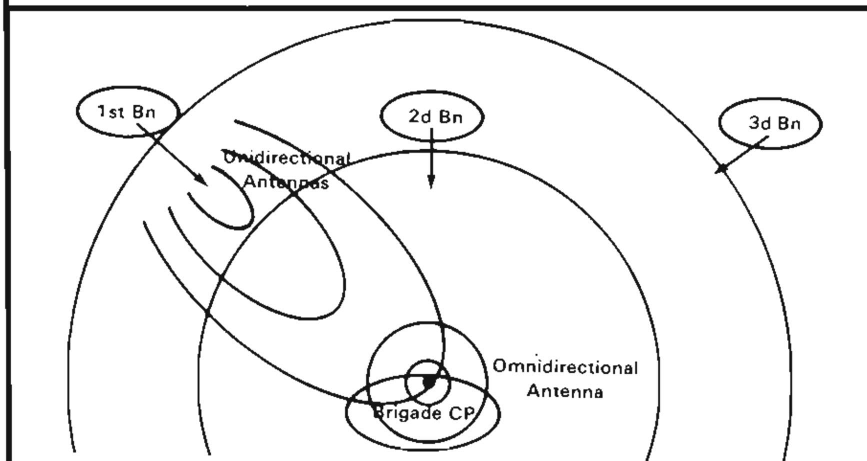

Figure 2

Field Expedient Antennas

The field-expedient, unidirectional antenna is one of the most important ECCMs and will do more to conceal emitters from ground-oriented electronic signature analysis than anything else, short of turning the radio off. The use of the terminated long-wire and the half-rhombic, or inverted-vee, in lieu of the whip antenna or RC-292, within the confines of the TOC, will be of great benefit in countering the Soviet EW threat. Radios used to communicate toward the rear (to higher HQ) will have little or no trouble using low power and reverse slope locations due to the increased antenna gain unidirectional antennas provide. They will also have virtually no exploitable radio emissions crossing the FEBA.

Consider the following situations (figure 2):

If all three battalions CP's use unidirectional antennas in the brigade nets and lst and 3rd battalion orient their antennas halfway between themselves and the brigade TOC, it is possible for all stations to communicate using low power. The brigade will have to use an omnidirectional antenna in the net, especially if the battalion CP's are

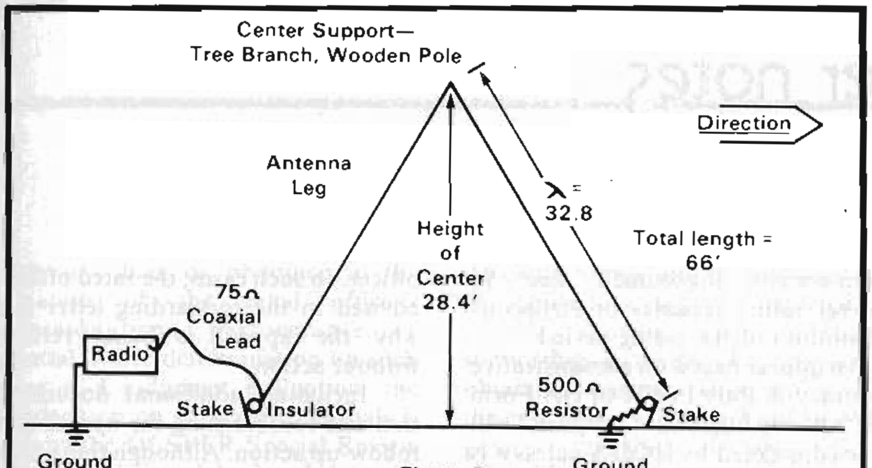

Figure 3

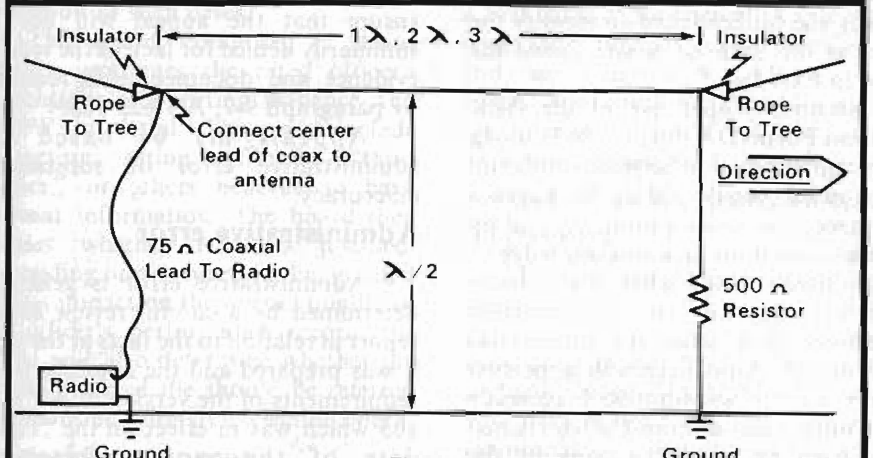

Figure 4

somewhat spread out. However, the low-power signal will not carry as far across the FEBA as it would have at high power. Table 1 shows recommended antenna and power usage for various nets found at brigade and battalion level. The table is not all inclusive and does not hold for all terrain conditions and tactical situations.

The following examples of field expedient unidirectional antennas can be made of WD-1 communication wire. The insulation does not need to be stripped off except at connection points.

Transmission lines can be made from the 75-ohm coaxial cable used by the AN/VRC-12 family of radios to connect the radio to the antenna matching unit. RC-292 cable is also usable.

Insulators can be made of wood, plastic, glass, or even nylon rope.

Terminating resistors should be noninductive, 500 to 600-ohm resistors capable of dissipating about 1 watt in the AN/PRC-77 type and AN/VRC-12 family of radios operating at low power. Ten to twenty-watt dissipating resistors are necessary for the AN/VRC-12 family of radios at high power. These resistors are inexpensive, and any electronics parts store would have them. In a pinch, a field-expedient resistor can be made fom a plastic earplug container, with chain removed and filled with water and a C-ration packet of salt.

Poles used to erect these antennas should be nonmetalic, so as not to change the desired wave pattern characteristics. Wooden poles are best and readily available in most areas. Using trees for antenna suspension is the best alternative to carrying poles everywhere you go.

Unidirectional Half-Rhombic Antenna

This antenna (figure 3) has a complex method of generating its waveform and should be constructed, as close as possible to this design. A change in leg length, center height, or launch angle could change its desirable features. The antenna feed line from the radio to the beginning of the antenna should be 75-ohm coaxial cable. The terminated end should have a 500-ohm resistor of appropriate wattage. The radio and the terminated end of the antenna (after the resistor) should be grounded. A pole or suspended and insulated rope will support the center. The resistor-terminated end should be pointing in the direction in which you want to communicate. There is very little back lobe and negligible sidelobes. For maximum flexibility, cut the antennas for 30 MHz and it will work for the entire FM bandwidth. Total length should be 66 feet (this allows for connections), with each leg 32.8 feet long. When erected, the antenna should form an equilateral triangle (each angle 60 degrees). See figure 3 for the procedure.

Unidirectional Terminated Long-Wire Antenna

This antenna (figure 4) is to be one or more wavelengths in length. For maximum efficiency, it should be cut to the transmit frequencies in multiples of the wavelength. For maximum flexibility, it can be cut for 30 MHz and used for all higher frequencies. Termination is through a noninductive 500-ohm resistor of appropriate wattage. The radio and resistor-terminated end need to be grounded to provide a return path from the termination to the radio. Antenna feed should be through a 75-ohm coaxial cable with the shield grounded to the radio. Antenna height above ground will be one-half the wavelength of the transmit frequency, no matter how long the antenna. Maximum antenna gain will be from the terminated end, so be sure to point it in the direction desired.

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