Technical Report

Ground Surveillance Radars and Military Intelligence

December 30, 2002

Revision No. 2

Prepared by:

Lav Varshney
Syracuse Research Corporation
6225 Running Ridge Road
North Syracuse, NY 13212-2509

Introduction

Sun Tzu, the Chinese strategist and philosopher of war, had an approach to warfare that was based on the principles of superior intelligence, deception, and knowledge of the mind of one's enemy. Modern military doctrines also give great importance to the application of intelligence. Information is the key commodity in the battlefield, so useful that it can even lift the fog of war. Military Intelligence (MI) services are able to provide the superior intelligence that is necessary to win armed conflicts. Some forms of intelligence are obtained through space, near-space, and ground-based sensing technologies. Ground Surveillance Radar (GSR) is one such technology in the MI system. This paper will discuss the nature and classification of intelligence, describe GSR systems, and illustrate the role of GSRs in intelligence collection.

Military Intelligence

The United States Department of Defense defines intelligence as information and knowledge obtained through observation, investigation, analysis, or understanding. Surveillance and reconnaissance refer to the means by which the information is observed. Surveillance is systematic observation to collect whatever data is available, whereas reconnaissance is a specific mission performed to obtain specific data. The primary function of MI officers is the collection, analysis, production, and dissemination of intelligence at both the tactical and strategic levels. This is accomplished through the deployment of intelligence collection assets, the combination and preparation of all-source intelligence estimates, preparation of intelligence plans in support of combat operations, and the coordination of aerial and ground surveillance. Information collected about the enemy or potential enemy is passed on to a decision-maker. The decision-maker could be a top general or a soldier on the ground facing an armed attacker.

Classification of Intelligence

The military services and the intelligence community classify intelligence based on the source. Intelligence that comes from a person observing it is called Human Intelligence (HUMINT). Intelligence derived from photographs and other imagery is called Imagery Intelligence (IMINT). Intelligence obtained from electronic signals such as communications is called Signals Intelligence (SIGINT). Finally, intelligence derived from other technically measurable aspects of the target is named Measurement and Signatures Intelligence (MASINT).

MASINT collection and analysis results in intelligence that detects, tracks, identifies, or describes the signatures of fixed or dynamic target sources. It is obtained by quantitative and qualitative analysis of data derived from specific technical sensors for the purpose of identifying distinctive features. Metric data can provide information on the dynamic capabilities of targets and the tactics for their use. Signature data allows the unique identification of targets. MASINT includes many subfields, including Radar Intelligence (RADINT), Acoustic Intelligence (ACOUSTINT), Radio Frequency/Electromagnetic Pulse Intelligence (RF/EMPINT), and Infrared Intelligence (IRINT).

Radar System Classification

There is no radar system that can perform all of the radar functions required by the military. Some newer systems have been developed that can combine several radar functions, but no single system can fulfill all of the requirements of modern warfare. Different types of radars are built for different types of functions. Search radar is designed to continuously scan a volume of space to provide initial detection of all targets. Search radar is generally used to detect and determine the position of new targets for later use by tracking radar. Tracking radar provides continuous range, bearing, and elevation data on one or more targets. Most of the radar systems used by the military are in one of these two categories, although some radar systems are designed for specific functions that do not precisely fit into either of these categories.

A surface-search radar system's primary function is the detection and determination of accurate ranges and bearings of surface objects and low flying aircraft. A search pattern in a defined angular sector is maintained to detect all objects within line-of-sight of the radar antenna. GSR systems are a type of surface-search radar that detect and recognize moving targets including personnel, vehicles, watercraft and low flying, rotary wing aircraft.

The United States military uses a standardized classification scheme, called the joint-service standardized classification system to identify particular radar systems. A subset of this system is shown in Figure 1.

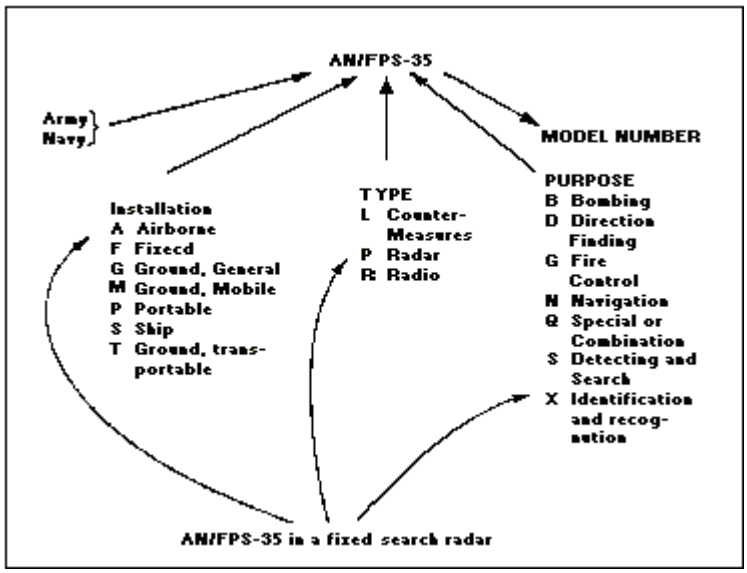

Figure 1. Joint Service Classification System

As shown, the AN/FPS-35 is a fixed search radar. The AN/PPS-5, AN/PPS-6, and AN/PPS-15 are all portable ground surveillance radars.

AN/PPS Ground Surveillance Radar Systems

The AN/PPS-5 Ground Surveillance Radar is an American radar system that has been around since the Vietnam War, having been designed with 1950's technology. Despite its old technology, it has been the workhorse of MI Battalions in the U.S. Army since its original production. The radar is a lightweight, man-portable, ground-to-ground surveillance radar set for use by units such as infantry and tank battalions. The PPS-5 radar is a pulsed Doppler radar, and is capable of detecting and locating moving personnel at ranges of 6000 meters and vehicles at ranges of 10000 meters, under virtually all weather conditions. The radar displays targets in a multimodal manner, both aurally and visually. The visual display is a Plan Position Indicator (PPI), and the aural indicator produces tones corresponding to target velocity. The system can operate in an automatic sector scanning mode or in a manual searchlighting mode. The PPS-5 is rugged enough to withstand rough field handling, and when packed in its watertight container, it can be parachute dropped and undergo repeated submersion. The radar can also be mounted in a jeep or humvee. New versions of this radar system are being developed, which make use of modern computer and Digital Signal Processing (DSP) technology.

The AN/PPS-4, the AN/PPS-6, and the AN/PPS-15 Radar systems are additional GSR systems that are used by the U.S. Army. The AN/PPS-4 system is very small and portable. It is approximately 4 feet high, and can be carried by a single person. This system also has aural and visual indicators. The visual display is not a PPI, but a simple range indicator. The maximum range for target detection of the PPS-4 is much less than the PPS-5. The AN/PPS-6 has a range of approximately 1500 meters for personnel detection, and 3000 meters for vehicle detection. Like the PPS-5, the PPS-6 has automatic and manual searching modes. The AN/PPS-15 is another portable, ground-to-ground battlefield surveillance radar system. This radar is usually operated on the ground, and is usually not mounted on vehicles. The maximum range for personnel detection is 1500 meters, whereas the maximum range for vehicle detection is 3000 meters. All of the AN/PPS series radars can penetrate smoke, haze, fog, light rain, and snow, and are equally effective in day or night.

Foreign Ground Surveillance Radar Systems

The Russian military has historically used many different kinds of GSR systems. A couple of examples include the SBR-3 short-range surveillance radar, and the PSNR-5 portable ground surveillance radar. New radar systems have recently been developed which offer greater target detection range and coordinate measuring accuracy; greater capacity due to automation of target detection and coordinate measurement processes; and data transmission over communication channels via standard interfaces. The FARA-1, for example, is lightweight, not bulky, and can be carried by one man. It is multifunctional, and can be used as a radar sight for automatic weapons, or as a reconnaissance tool. The PSNR-6 radar, a new version of the PSNR-5, features a long operating range, using advanced signal processor technology. It also has a portable computer control console, which presents targets on the background of a topographic map.

The Australian Man-portable Surveillance and Target Acquisition Radar (AMSTAR) system is able to detect and recognize moving targets including personnel, vehicles, watercraft and low flying, rotary wing aircraft. It has target detection and classification capability at ranges up to 35,000 meters. This radar system can also carried by a few men, or can be mounted on Lightly Armed Vehicles (LAVs). A ruggedized laptop computer provides the Human Machine Interface (HMI). There is also an aural indicator.

Ground Surveillance Radar Applications

GSR systems can be used in a variety of applications, including urban warfare maneuvers, covert stakeout surveillance, counterterrorism, maritime surveillance, border patrol and security, observation and protection of remote areas, airport security, nuclear facility security, and tactical battlefield applications.

A battlefield commander requires much intelligence to command and control his assets proficiently. For ground combat situations, information that is useful includes:

- Enemy Troop Concentrations,
- Enemy Vehicle Concentration,
- Enemy Vehicle Classification,
- Enemy Personnel & Vehicle Movement,
- Movement of a Possible Counterattack Force Conducting a Flanking Attack, and
- Information about Avenues of Approach and Infiltration Routes used by Enemy.

This information can be used as targeting data to support effective attacks, as early warning for force protection, or simply as surveillance to find the enemy. In general, GSRs provide timely surveillance and tactical near-real time data and are very versatile.

GSRs are used to search for enemy activity on critical chokepoints, mobility corridors, and likely infiltration routes. They are used to observe point targets such as bridges, road junctions, or narrow passages to detect movements. GSR systems can extend the surveillance capability of patrols by surveying surrounding areas for enemy movement, and survey target areas immediately after an attack to detect enemy activity and determine the effectiveness of the attack. Radars can assist in visual observation of targets partially hidden by haze, smoke, fog, or bright sunlight, and can confirm targets sensed by other types of sensors.

GSR systems have a few weaknesses that must be overcome by using other types of sensors in conjunction with the radar. Radars require line-of-site to the target area, and their performance is degraded by heavy rain, snow, dense foliage, and high winds. Also, they are active emitters, and are subject to enemy detection and electronic countermeasures (ECM). Finally, radars are unable to distinguish between friend and foe, only able to detect and classify moving targets by type.

Fire Support Base and GSR

The dominant U.S. Army ground maneuver in the Vietnam War was the Fire Support Base (FSB), often referred to as firebase. Conceptually, the FSB functioned to provide a secure but mobile artillery position capable of providing fire support to infantry patrols operating in areas beyond the range of main base camp artillery. This concept gave infantry a greater degree of flexibility without sacrificing artillery protection. FSBs were targets for enemy counterattacks and bombardments, so defensive measures were also installed.

The typical cavalry FSB was a defensive area, about 250 meters in diameter, with an 800-meter perimeter. It contained howitzers and enough equipment and supplies to support the infantry with artillery fire around the clock. The firebase also supplied logistics, communications, medical, and rest facilities for the cavalrymen within its area. GSR emplacements were constructed around the FSB to provide surveillance for force protection. Intelligence derived from GSRs was also used to locate enemy positions to direct artillery fire and infantry patrols. A schematic displaying the layout of a typical FSB is shown in Figure 2.

The life span of an FSB depended on the tactical situation in its area. Since firebases were normally established to give a battalion and its direct support howitzer battery a pivot of operations to patrol the immediate vicinity, the firebase was closed when the battalion relocated.

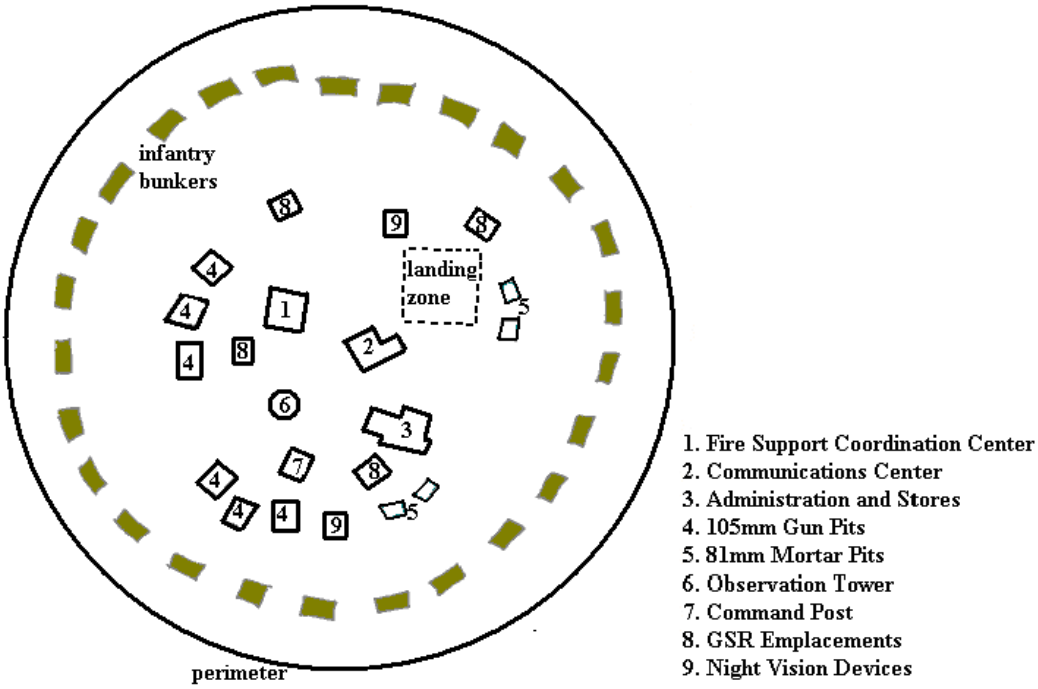

Figure 2. Fire Support Base

Laager and GSR

A laager position is a defensive position occupied by combat units when they are halted for extended periods of time, particularly at night. In the Vietnam War, armor units habitually assumed a defensive posture when not actively engaged in offensive operations. The terrain selected for a laager was usually an open field, such that it would be difficult for an enemy to approach the perimeter unobserved. When armored cavalry units assumed a laager position, vehicles were placed to provide security around the entire perimeter, as well as covering the most likely avenues of enemy approach. Support squads were normally placed within the perimeter established by the vehicles.

One of the most important stages in the establishment of a laager was the creation of a barrier. This critical step involved the emplacement of concertina wire, trip flares, Claymore mines, anti-intrusion devices, and demolitions to assist in preventing the enemy from penetrating the perimeter. The security of the laager was dependent to a large extent on the employment of an aggressive program of ambush patrols, observation posts, listening posts (LPs), and harassment and interdiction (H&I) fires. H&I fires would be carried out by artillery, and mortar fire, aimed at enemy positions directed by emplaced GSR systems. The purpose of LPs was to provide the commander with early warning of enemy approach. The LP was usually situated at sufficient distance from the laager so as to be able to provide enough of an early warning for the laager to be prepared. Each LP was equipped with a GSR system and a radio. The positions of LPs were carefully plotted in order to avoid friendly fire casualties. A schematic of a typical armored cavalry troop laager is shown in Figure 3.

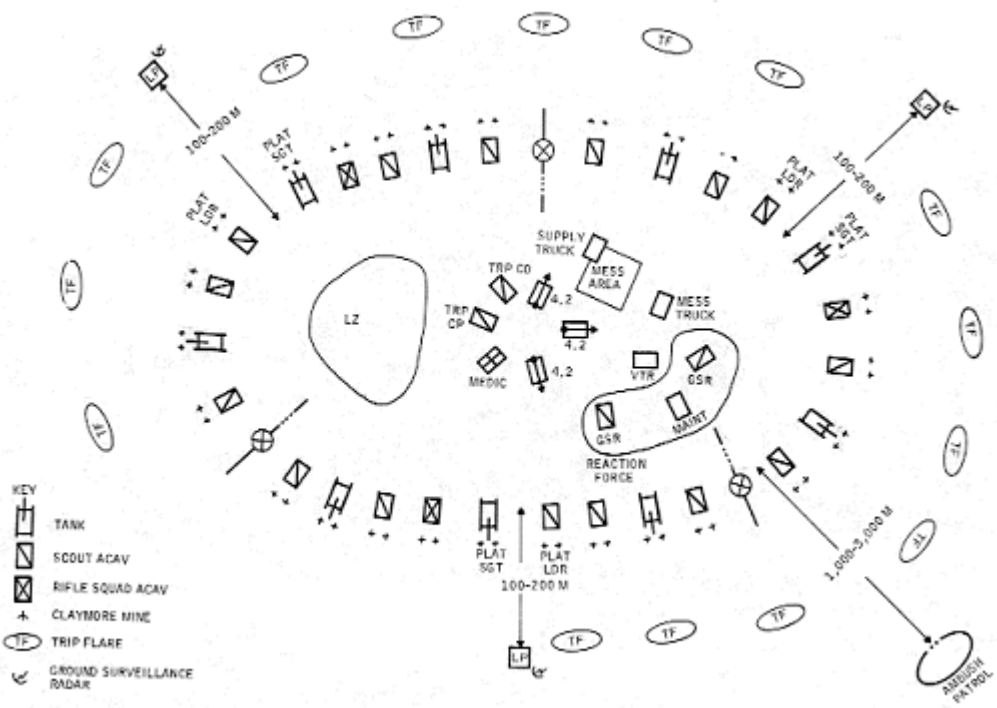

Figure 3. Armored Cavalry Troop Laager

Military Mission using GSR Technology: Peacekeeping in the Sinai

The Multinational Force and Observers (MFO) is an independent peacekeeping mission created as a result of the 1978 Camp David Accords and the 1979 Treaty of Peace. The mission of the MFO includes the operation of checkpoints, reconnaissance patrols, and observation posts along the international boundary between Israel and Egypt, and within designated parts of the Sinai Peninsula. The purpose is to observe and report whether the terms of the treaties are followed throughout the treaty zone.

The MFO operates under the premise that there is minimal expectation of hostilities between the Israelis and Egyptians or of threats directed at the peacekeepers themselves. Based on the mission and this premise, the MFO is a lightly armed force, which relies on a physical presence to perform the functions of observation, reporting and verification, and to provide the political symbolism and weight of a neutral third party.

The symbolic role of a third party requires a large force of personnel on the ground. Highly advanced surveillance techniques and equipment, with limited personnel requirements, therefore cannot be used. The technical requirements of the mission call for ground surveillance

over large swaths of territory. GSR systems are able to meet both the political and technical requirements of the MFO. In addition to GSRs, other observation tools that are used include night vision devices (NVD), radars on ships, and human patrols. Maritime verification in the Gulf of Aqaba and the Strait of Tiran is an additional mission that uses ground surveillance systems.

Sensor technologies assist the peacekeeping mission in collecting information and in self-protection. Movement sensor technologies such as GSRs have been used to monitor roads, passages, and other chokepoints. The only deficiency with this type of monitoring is that classification is minimal. Most of the alerts received from these sensors are caused by wildlife, illegal economic activity, and movements by Bedouins, United Nations members, and authorized Israelis and Egyptians. Newer ground-based, sensor networks with seismic, acoustic, infrared, magnetic, chemical, and radar sensors may be combined with the current GSRs in operation to better classify the alerts. Other sensor technology may assist in verification, for example the capability to electronically tag and track accountable weapons.

The surveillance equipment that is used must work under the extremes of heat and sand infiltration present in the Sinai. The surveillance systems that are used must also be user-friendly, and easy to learn, since the military personnel in the force are from several different countries, rotate frequently, and may have minimal prior familiarity with the equipment. Hardiness and easy of use are the key requirements, rather than hypersensitivity.

Conclusion

Ground Surveillance Radar systems are a key military intelligence technology. They are able to provide intelligence that is vital to the success of many military tactics and strategies. When RADINT is combined with other types of intelligence, a battlefield commander can get a clear picture of the battlespace, resulting in well-informed decisions. The versatility of GSR systems makes them useful for a variety of military missions, ranging from war making to peacekeeping.

List of Acronyms

ACOUSTINT	Acoustic Intelligence
AMSTAR	Australian Man-portable Surveillance and Target Acquisition Radar
DSP	Digital Signal Processing
ECM	Electronic Countermeasures
FSB	Fire Support Base
GSR	Ground Surveillance Radar
H&I	Harassment and Interdiction
HMI	Human Machine Interface
HUMINT	Human Intelligence
IMINT	Imagery Intelligence
IRINT	Infrared Intelligence
LAV	Lightly Armed Vehicle
LP	Listening Post
MASINT	Measurement and Signatures Intelligence
MFO	Multinational Force and Observers
MI	Military Intelligence
NVD	Night Vision Device
PPI	Plan Position Indicator
RADINT	Radar Intelligence
RF/EMPINT	Radio Frequency/Electromagnetic Pulse Intelligence
SIGINT	Signals Intelligence

References

[1] *AN/PPS-6*, STANO Components. [Online]. Available: http://www.stano.night-vision.com/html/pps6.html.

[2] *Army Branch Information*, University of Wisconsin Oshkosh, 1997. [Online]. Available: http://www.uwosh.edu/departments/military_science/spring/ra8.htm.

[3] Chizek, Judy G, *Military Transformation*: *Intelligence, Surveillance and Reconnaissance*, Report for Congress, 2001. [Online]. Available: http://www.fas.org/irp/crs/RL31425.pdf.

[4] *Fire Support Bases*, Grunt! The Online Vietnam Resource. [Online]. Available: http://www.soft.net.uk/entrinet/arty9.htm.

[5] *GSS Operations*, JRTC Intelligence Division. [Online]. Available: http://www.jrtc-polk.army.mil/OPS/Intel/Presentations/Masint.ppt.

[6] Henry, Ryan, and C. Edward Peartree, "Military Theory and Information Warfare," *Parameters*, pp. 121-135. [Online]. Available: http://carlisle-www.army.mil/usawc/Parameters/98autumn/henry.htm

[7] *Land 53 - Project Ninox*, Australian Defence Organization: Defence Material Organization. [Online]. Available: http://www.defence.gov.au/dmo/lsd/land53/gsr.cfm.

[8] *MASINT: Measurement and Signals Intelligence* in IC21:The Intelligence Community in the 21st Century, Permanent Select Committee on Intelligence, House of Representatives, 1996. [Online]. Available: http://www.access.gpo.gov/congress/house/intel/ic21/ic21007.html.

[9] *Multinational Force and Observers (MFO)*, Multinational Force and Observers. [Online]. Available: http://www.mfo.org.

[10] *Radar Principles,* United States Navy Electrical Engineering Training Series. [Online]. Available: http://www.tpub.com/neets/book18/index.htm.

[11] *US Armored Cavalry in Vietnam – Troop Laager*, Grunt! The Online Vietnam Resource. [Online]. Available: http://www.soft.net.uk/entrinet/arm_cav3.htm.

[12] *US Army in Vietnam – Ground Surveillance Radar*, Grunt! The Online Vietnam Resource. [Online]. Available: http://www.soft.net.uk/entrinet/radar1.htm.

[13] Zaitsev, Nikolai. *Russian Radars on the Battlefield and in Defense of State Borders,* Military Parade, 1998. [Online]. Available: http://www.milparade.com/1998/27/060.htm.