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Upgraded ESM for Coast Guard Cutters

Upgraded ESM for Coast Guard Cutters

By Fred Ilsemann

As the Coast Guard's participation in homeland defense gains momentum, the service will need new and more powerful capabilities to fulfill its vital role in helping to ensure U.S. security. A model improvement program for enhancing the capabilities of the Coast Guard's *Hamilton* (WHEC-715)-class cutters is the addition of newly upgraded electronic support measures (ESM) systems to detect a wide range of hostile threats to U.S. citizens, vessels, and property.

Threats to our interests are neither new nor novel. What is relatively new by military standards—and has gained prominence in the past 20 years—is the concept of an unseen and sometimes unknown enemy that cannot be identified with organized governments. In light of today's dangerous and confusing geopolitical situation, the Coast Guard's motto, Semper Paratus, has never been more relevant.

To help guard against such eventualities, sophisticated electronic warfare (EW) systems on board modern Coast Guard cutters must be equipped to provide the earliest possible warning of potential threats so that rapid and effective interdiction actions can be taken. The ESM systems play a key role in this defensive capability by providing passive surveillance of radio frequency (RF) signals, 24 hours a day in all weather. The $9.65-million contract for production of AN/WLR-1H(V)7 countermeasure receiving set modification kits recently was awarded to replace existing (V)5 systems on board Coast Guard WHEC-class cutters. The first of the new upgrades is scheduled for installation on six of the high-endurance cutters. These systems will support the Coast Guard's strategic roles of national defense and maritime security by increasing the cutters' maritime domain awareness. They represent the latest technology in maritime electronic surveillance applications.

The (V)7 upgrade is a "maintenance upgrade" because it retains (with some modifications) the cutter's AN/AS-4122A antenna and replaces other components with advanced processors, fiber optic communications, state-of-the-art frequency-measurement receiver systems, and a new tuner. To maximize system sensitivity, all RF equipment is integrated with the antenna assembly. A single composite cable incorporates fiber optic and copper conductors to transmit data and control signals from the antenna to a control display unit that is situated in the combat information centers on cutters. The function of the upgraded systems is to identify RF emitters—for example, radar and communications links—as individual aircraft or vessels; then track and document them in milliseconds to provide real-time data that greatly improves situational awareness.

Countermeasure Receiving Set Modifications

Key technological features of the ESM modification kits are:

- ➤ Sensitivity: detection of low-powered signals at a distance
- ➤ Probability of intercept: interception of simultaneous signals distributed in frequency, range, and bearing
- ➤ Automatic processing: correlation of raw data into emitter tracks without operator intervention
- ➤ Network connectivity: sharing data results with other assets, on and off board

It is important to distinguish between sensitivity and probability of intercept (POI) because the effects related to these characteristics often are confused in the field. The POI refers to the statistical ability of the system to intercept an RF signal that is above the detection threshold; it takes into account such factors as frequency sweep time, antenna positioning, and external blanking. (Blanking is the technique used to disable an EW receiver whenever an onboard radar is transmitting to avoid damage or interference to the receiver resulting from the high RF power levels induced by the onboard radar.) Sensitivity defines the minimum input power required for detection, assuming the system is configured to intercept the signal of interest—i.e., it is tuned to the correct frequency, the antenna is pointed at the emitter, and there is no blanking. When a system fails to intercept a signal in the field, it may not be insufficient sensitivity (as often is asserted), but rather that the system configuration has degraded the POI to prevent detection. For example, if a system using an external blanker

U.S. COAST GUARD/INSET: WIDE BAND SYSTEMS

The Coast Guard's ability to detect a wide range of threats to U.S. citizens, vessels, and property will be enhanced considerably by the AN/WLR-1H(V)7 countermeasure receiving set modification kits being installed in high-endurance cutters—such as the Gallatin (WHEC-721) shown here.

receives a signal from an off-board radar at precisely the same time that an onboard radar is transmitting, then the off-board signal is not received— owing to the disable command from the blanker issued in response to the onboard radar—although it may be above the detection level of the EW system.

System Sensitivity

This is defined as the minimum input power required to detect a signal. The lower the power requirement, the more sensitive the system. More system sensitivity translates into greater detection ranges for emitters and improved situational awareness. Generally, the ability to locate the RF receivers as close to the antenna as possible improves system sensitivity because it is possible to eliminate interconnecting cables (coaxial and wave guide) that can introduce dramatic reductions in signal level, which worsen as cable runs get longer. In addition, narrow band receivers can be used effectively to achieve a reduction in the integrated noise floor, making signals of interest easier to detect. To achieve sensitivity improvements using these techniques, a system's receivers have to be packaged in space and power-efficient assemblies that are "ruggedized" for use in harsh environments. Further, the system must be able to operate in the presence of severe electromagnetic interference (EMI) caused by a ship's own radars.

The receivers used in the WLR-1H(V)7 provide a wide and narrow band in parallel, and they are installed in the antenna assembly. They are packaged in environmentally qualified assemblies and produce a digital pulse descriptor word for every RF event they intercept. Digital data includes frequency, pulse width, time of arrival, RF amplitude, and a variety of flags such as frequency modulation on pulse, phase modulation on pulse, and identification of the signal as a pulse event or a continuous wave event. This digital data is transmitted to the system's central processor using fiber-optic lines that are immune to the effects of EMI. The use of a patented coherent threshold technique provides consistent detection and resistance to false alarms across frequency ranges.

Probability of Intercept

Of equal importance to system sensitivity is the probability of intercept (POI). It is the system's ability to intercept multiple signals at different frequencies, different ranges, and different bearings, where 100% POI translates to seeing all signals occurring above the system sensitivity (detection threshold) all the time. Wide bandwidth receivers with high-pulse throughput are a requirement for achieving 100% POI. In today's RF environment—involving multiple commercial, military and personal wireless activity— the capacity to intercept and process all these signals is essential to maintaining situational awareness.

One of the core technologies in the WLR-1H(V)7 system is a wide bandwidth (2 to 18 gigahertz [GHz]) instantaneous frequency measurement receiver. This receiver technology can intercept signals instantaneously between 2 and 18 GHz at a rate of more than four million pulses per second. When used with an omnidirectional antenna or high-speed (300 revolutions per minute or higher) direction-finding antenna, intercepts from all bearings are possible. By using the patented multipath blanking technique, false returns from sea-surface reflections are eliminated, thereby maximizing effectiveness of the high-pulse throughput. Built-in protection from RF component damage owing to high RF power levels caused by onboard radars, and the capability to process and identify onboard radars, removes the need for an external blanking system.

Automatic Processing

A priority for advanced ESM systems is to provide automated processing capabilities to translate each of the individual pulse reports into an emitter track that describes the source of the emissions completely. Processing must handle today's complex emitter profiles and still be able to reconfigure rapidly to meet the new threats of tomorrow. Two important features supporting these goals are the processor hardware and the software operating systems.

The ability to reconfigure rapidly requires that the latest technologies, such as field programmable gate arrays (FPGAs) and commercially available single board computers (SBCs), be integrated with ESM systems. These devices and commercial software operating systems prevail in the AN/WLR-1H(V)7 system architecture. The receiver interfaces resident at the operator workstation are controlled by FPGAs and use software configurable designs that can be modified and reloaded without changing the hardware components of the system—although it significantly changes system operation. The SBCs with dual Intel Pentium III® processors can be upgraded with a single board change to keep pace with advanced processor technology. The (V)7's use of familiar Windows® desktops for ESM applications provides a significant reduction in the learning curves of new operators, and MS Office® tools for data collection and emitter database management can turn any desktop PC into a potential support station for post-mission analysis and emitter database updates.

Network Connectivity

While a complete tactical picture of the electronic environment can be achieved locally by a single ESM system, network connectivity is defined as interfaces that allow data to be distributed to other systems and assets, thus providing maritime domain awareness to many stations and craft. Integration with other systems— especially those that support specific emitter identification (SEI)—is critical to successful electronic surveillance.

The AN/WLR-1H(V)7 is supplied with hardware and software interfaces to support local and off-board area networks, shipboard navigation, EW training systems, and support for SEI processing. The SEI support is of particular importance to the Coast Guard's role in port defense and interdiction. By establishing a network connection to an SEI processor, such as the AN/UYX-4 developed by the Naval Research Laboratory, the receivers and antenna of the WLR-1H(V)7 can be controlled to support SEI data collection and the processed track information can be passed back to the WLR-1H(V)7 to supplement its tactical emitter track. Meanwhile, off-board network support permits other U.S. units to view the solution as it is being developed locally.

Conclusions

Based on the latest assumptions in political and military arenas, the need for cutting-edge electronic support measures is vital to U.S. maritime security. The AN/WLR-1H(V)7 underscores the importance of electronic surveillance in homeland defense by providing the earliest possible warning of terrorist threats. It is clear that the sophisticated technology used in this excellent improvement program will be of considerable assistance to the Coast Guard as it adjusts to meet rapidly expanding maritime mission requirements.

Mr. Ilsemann is general manager of the Defense Systems Division at Wide Band Systems, Incorporated, in Newtown, Pennsylvania.

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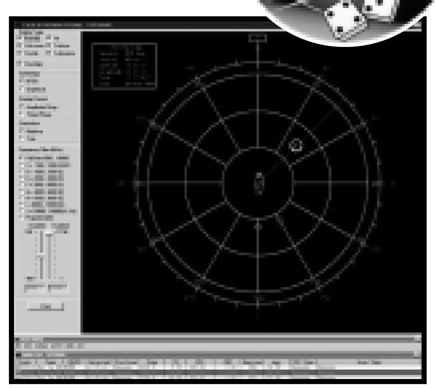

The ***Wide Band AN/WLR-1H(V)7*** system provides an indigenous ESM capability for the U.S. Navy's CV/CVN class and Coast Guard's WHEC class vessels. The system provides ***real-time intercept, processing, direction finding, and evaluation of RF signal emitters*** from 0.5-18 GHz using both automatic and manual analysis techniques.

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