

**TELEMETRY SYSTEMS DESIGN
TO SUPPORT THE
AUSTRALIAN DEFENSE FORCE
AT THE
EAST AUSTRALIA (JERVIS BAY RANGE)
AND OTHER
LAND OR OPEN OCEAN EXERCISE LOCATIONS**

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ABSTRACT

The Royal Australian Navy (RAN) Sonar and Ranges Group (S&RG) office has a requirement to provide a dual weapon capable Mobile Missile Telemetry Range (MMTR) and data analysis system to upgrade their Jervis Bay Range telemetry ground station for supporting at-sea testing of air and surface launched guided weapon, decoy, and target systems. This paper describes the design and development of the MMTR and data analysis system used to support the Jervis Bay Range and the acquisition strategy used to procure the system. Unique design features of the MMTR system include a dual use packaging scheme which permits the system to be transported to any suitable land based location or deployed as two independent shipboard telemetry receiving systems. In addition, the paper describes antenna, receiver, recording, matrix switching, processing, display, and communication subsystem components used within the MMTR system.

KEY WORDS AND ACRONYMS

Key Words: Integrated ground and portable telemetry system design.

BACKGROUND

The Australian Defense Force (ADF) through the Royal Australian Navy (RAN) has an on-going requirement to provide telemetry data collection and analysis of surface and air-launched missile firings conducted on the Jervis Bay Range. In 1969, RAN requested Naval Warfare Assessment Station (NWS) build and install a Very High Frequency (VHF) telemetry ground station at Jervis Bay. RAN requested the Jervis Bay telemetry ground station design be based on the architecture used at the United States Navy Atlantic Fleet Weapons Training Facility tactical training range. In 1979, NWS upgraded the Jervis Bay telemetry ground station to include Ultra High Frequency (UHF) and Pulse Amplitude Modulation (PAM) capabilities. RAN has also received Flight analysis training and support from NWS since 1969.

During RIMPAC 96, RAN representatives observed telemetry system equipment operation while at the Pacific Missile Range Facility (PMRF) Makaha Range telemetry ground station. The telemetry system they observed was designed by NWS to support data processing, display, and analysis during United States Navy (USN) Fleet exercises conducted on the PMRF range. RAN inquired how these capabilities could be provided for their Jervis Bay range, which led to investigative discussions with NWS on how they could be implemented.

REQUIREMENTS

In addition to supporting exercises involving telemetered missiles, decoys, and targets on the East and Western Australian exercise areas, the ADF has an emerging requirement to support exercises at various land based and open ocean locations. RAN developed technical specifications for a MMTR system to support these requirements. The MMTR system would be designed to support both land and portable shipboard requirements using the same integral hardware and software. MMTR subsystem requirements are defined in Table 1.

SYSTEM DESIGN

The MMTR system is designed to receive, record, and analyze multiple streams of telemetry data from existing and planned missiles in the Australian Defense Force (ADF) arsenal. The MMTR contains two identical sections, called Mobile Telemetry Reception and Analysis Systems (MTRAS), which are designed to operate together or independently. When operating together, the MTRAS systems compose the MMTR. Figure 1 is a system block diagram of one MTRAS. In the MMTR configuration, the two MTRAS systems operate under control of a single Supervisory and Control Computer System and a patch panel allows signal routing between the two systems.

Table 1 Subsystem Name and Definition

Subsystem Name and Number of Units	Definition
Antenna and Controller (2)	Automatically tracks the telemetry radio signal from a transmitter in a missile or other object.
Receiver (4)	Receives both right hand circularly polarized and left hand circularly polarized telemetry signals and combines them for improved signal to noise ratio (SNR).
Recorder (2)	Simultaneously records in digital format all voice, telemetry and control data.
Decommutation (2)	Processes and digitizes missile and target telemetry data formats.
Timing (2)	Generates, translates, and distributes the required timing signals to other subsystems.
Communication (A second unit is kept packed in transit cases for use with an MTRAS configuration)	Provides voice communications on military channels between telemetry station operators and other exercise participants.
Display (2)	Interacts with the Decommutation Subsystem to provide hard copy display on missile functions.
Output	Does not exist as a physical subsystem. Manages the distribution of time tagged digital telemetry data from the Decommutation Subsystem to external systems and functions as part of the Communication Subsystem.
Supervisory and Control (1)	Allows remote set up of selected equipment and configuration parameters.
Telemetry Operations and Transportation Containers (2)	Containers that are specifically designed to be transportable: (1) an operations container and (2) a storage container.

To meet requirements for deploying the system at various land and shipboard locations, two transportable containers are used, one for the MMTR system, a second for ancillary communication and support equipment including a flight termination system. The MMTR equipment is installed in a Telemetry Operations & Transportation Container (TOTC), shown in Figure 2. The ancillary communication and support equipment is installed in a Storage Container (STORC). The TOTC and STORC are mounted in a truck and trailer configuration, which is shown in Figure 3, which enables easy transportation to operational sites. The complete MMTR system is designed to operate as a self sufficient, standalone entity, and includes the capability to generate its own electrical power, provide an air-conditioned operating environment, and to assemble and disassemble antenna and other large subsystem hardware via a hydraulic crane.

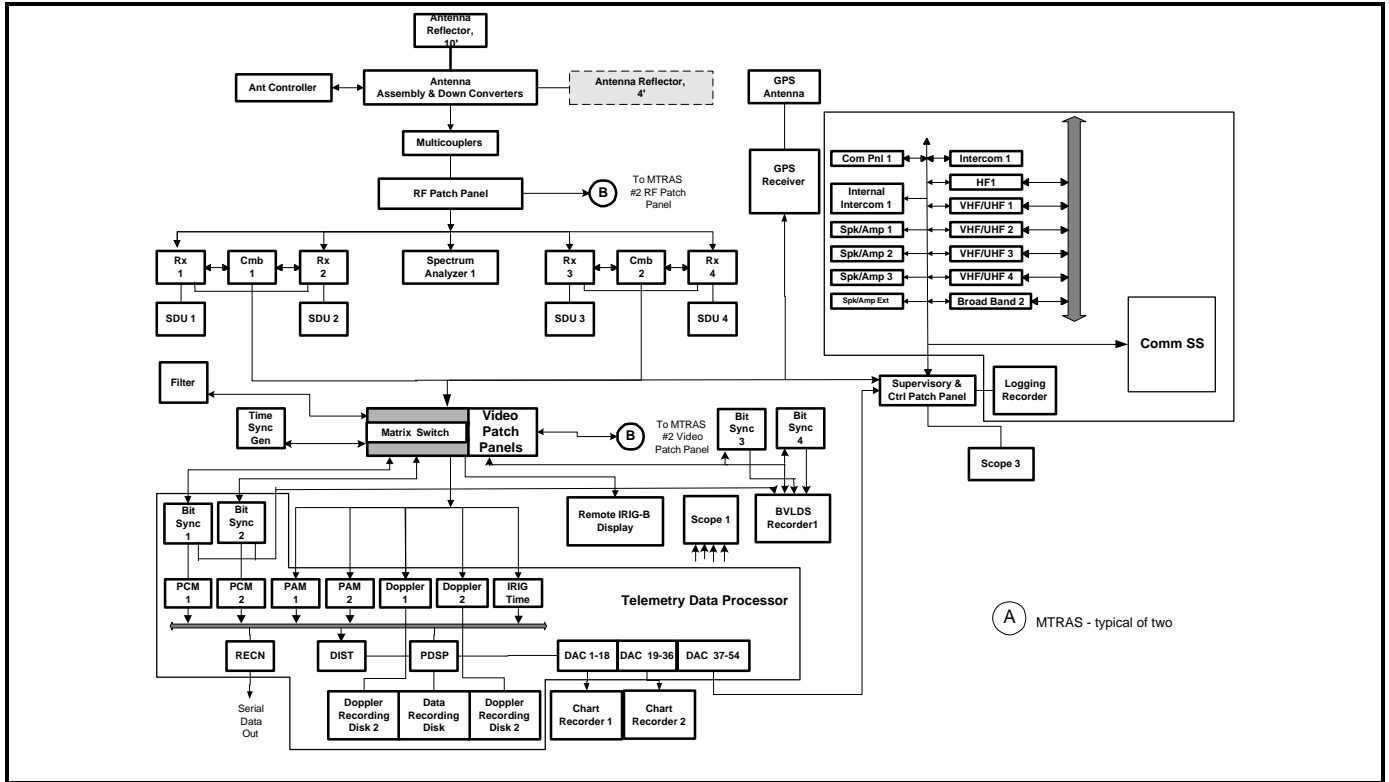


Figure 1 MTRAS Block Diagram

Within the TOTC, a special rack-mounting scheme was designed to allow the sharing of MMTR equipment based on its deployment at either land or shipboard locations. After reviewing various industry approaches, the rack mounting approach available from Hardigg, Inc. was selected for the MMTR system. Hardigg frames are freestanding and allow multiple 19-inch rack mountable equipment to be installed within them. Equipment racks are configured with rails specifically designed to accommodate Hardigg frames. Multiple Hardigg frames can be installed within the equipment racks, depending on their vertical size. The use of Hardigg frames allows MMTR telemetry subsystem equipment to be grouped by functionality, weight, power consumption, or other criteria. The frames are removed from the racks and installed in portable cases without the necessity to disassemble the contained equipment. A second set of cable harnesses designed for portable use allows rapid changeover from the rack configuration to the portable configuration. The MMTR rack layouts within the TOTC and in separate portable shipboard system configurations are shown figures 4 and 5, respectively.

HARDWARE DESIGN

Commercial-off-the-shelf (COTS) hardware was used exclusively throughout the MMTR system. Wherever possible, subsystem vendors were selected based on proven performance within existing Navy tactical training range telemetry ground and portable systems. Key subsystem hardware within the MMTR system are identified as follows:



Figure 2 Telemetry Operations & Transportation Container

- Two parabolic reflectors are provided with each tracking antenna. Four and ten foot reflectors are used for ground and shipboard based applications, respectively. Eight low noise amplifiers and four dual band down converters are used to provide redundancy and improve isolation between the lower/upper L/S bands.
- Wide band telemetry receivers and combiners configured to support PCM/FM modulation
- Dual 32x32 matrix switches allow rapid reconfiguration to receive, record, and playback telemetry signals. Patch panels allow manual operation in the event matrix switches fail during an exercise.
- Remote control of all subsystem hardware is provided using a Windows based software package provided by Sparta Technical Services Company, which was augmented by Acroamatics Corporation to provide support for all MMTR subsystems. Specific setup commands for all hardware may be created, edited, saved, and retrieved based on specific user and exercise requirements.
- The communication subsystem supports high-speed INMARSAT, HF/VHF/UHF radio communications, landline phone, cellular phone, ISDN, and LAN connections for workstation, decommutation, and other network based MMTR hardware. A master console provides operation of all communication system hardware from a single location.
- The decommutation system (an Acroamatics Model 2220V Telemetry Data Processor) supports the digitizing, digital recording, and playback of PAM, PCM, and video Doppler telemetry data.

The system supports the processing of asynchronous subframes, variable word lengths, packetized telemetry, and other unique formatting requirements.



Figure 3 Communication Subsystem and Storage Container

ACQUISITION STRATEGY

In response to a request for tender from the Australian Defense Acquisition Organization, Acroamatics Corporation and NWAS teamed to design, procure, integrate, test, and install the MMTR system. This Government and industry team was made possible based on Under Secretary of Defense guidance regarding the use of Government facilities to promote research, development, and transfer of technology from the military to the commercial sector. Acroamatics Corporation served as the prime contractor, acquisition agent, and provided the decommutation subsystem hardware. NWAS provided system/subsystem design, system integration, installation, integrated logistics support, and system documentation.

PROJECT STATUS

A Preliminary Design Review of the MMTR system was conducted in September 1998. In February 1999, a Critical Design Review was completed. Factory acceptance testing of available system components was conducted in December 1999. The system was packaged for shipment to Australia in January 2000. Subsystem hardware was installed within the TOTC at the RAN Range Assessment Unit (RANRAU) at Jervis Bay during the months of April and May 2000. Full trials for the system are scheduled to occur across July and August in line with existing RAN operational activities.



Figure 4 MMTR TOTC Rack Layout

CONCLUSION

The MMTR system was designed to support telemetry data collection, processing, and display during ground and shipboard deployments within a self contained transportable configuration. The system incorporates proven telemetry hardware subsystems which will support current and future ADF missile exercises conducted on-range, at sea, or at various land based locations. The system was developed in concert with recent United States Department of Defense policy changes, which encourage increased partnership with industry. Prime contractor responsibilities, which traditionally were performed by a Government agency, were capably performed by industry for the MMTR system. The Government and contractor team, which consisted of NWS, Acroamatics Corporation, and other commercial subcontractors worked extremely well together to design, build, and successfully install the MMTR system.



Figure 5 MMTR Portable Shipboard System Rack Layout

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