

TRANSPORTABLE RANGE AUGMENTATION AND CONTROL SYSTEMS FOR MULTIPLE SHOT ENGAGEMENTS

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ABSTRACT

The Ballistic Missile Defense Organization (BMDO) is developing new Theater Missile Defense (TMD) weapon systems to defend against the rapidly expanding ballistic missile threat. The tactical ballistic missile threats include systems with range capabilities greater than 1000 kilometers. The development and testing of systems such as the Patriot Advanced Capability 3 (PAC-3), the Theater High Altitude Area Defense (THAAD), Navy Area Defense, and the System Integration Tests (SIT) to address the interoperability of this family of systems, will require the development of the Transportable Range Augmentation and Control System for Multiple Shot Engagements (TRACS - MSE). Congress has mandated that these systems be tested in multiple simultaneous engagements. These systems will be tested at several ranges to meet all the developmental and operational testers' needs. Potential range locations include White Sands Missile Range (WSMR), Kwajalein Missile Range (KMR), the Pacific Missile Range Facility (PMRF) and the Gulf Range at Eglin Air Force Base. Due to the long distances separating the target launch site and the interceptor site, the TRACS - MSE will be required at multiple sites for each range used. To be cost effective, transportable systems should be developed to augment existing capabilities. Advances in Global Positioning System (GPS) technology and high data rate receivers make telemetry based solutions attractive. This article will address the requirements for range safety, for Time, Space, Position Information (TSPI) collection and processing requirements to support a TRACS - MSE capability.

KEYWORDS

Ballistic Missile Defense, Missile Defense, Multiple Shot Engagements, Range Instrumentation, Range Safety, Time-Space-Position-Information, Theater Ballistic Missile Defense

INTRODUCTION

The BMDO is developing a family of new TMD weapon systems to defend against the rapidly expanding ballistic missile threat. The tactical ballistic missile threat includes systems with range capabilities greater than 1000 km. The development of systems such as the PAC-3, Theater High Altitude Area Defense (THAAD), Navy Area Defense, and eventually CORPS SAM and Boost Phase Intercept programs, along with SITs to address the interoperability of this family will require the development of the TRACS - MSE.

BODY

The current Theater Missile Defense test program is shown in Figure 1 . The flight test program for the PAC-3, THAAD, Navy Area Defense, and TMD System Tests are depicted. The PATRIOT program successfully completed PATRIOT Multimode Missile and Extended Range Interceptor testing at WSMR . The PATRIOT Engineering, Manufacturing, and Development (EMD) phase will start in 1997 and will be conducted at WSMR with short and medium range targets launched from the Firing-In-Extension (FIX) Site and Fort Wingate, respectively . The Eglin-Gulf Range is being evaluated for the long range tests required for the PATRIOT EMD test program.

The THAAD Demonstration and Validation (DemVal) test program will be initiated at WSMR this year . Following DemVal testing, THAAD will conduct User Operational Effectiveness System (UOES) Characterization Tests (UCT) and EMD tests at KMR . Wake Island has been selected as the site for medium range target launches for THAAD tests . Launch facilities to support dual target launches are currently under construction at Wake Island . KMR outer islands are being considered for short range target launches . A study will be conducted to determine the best approach for long range target launches.

The Navy Area Defense program will conduct risk reduction and development flight tests at WSMR . The PMRF is being considered as the site for Navy Area Defense Development and Operational Testing (DT/OT) . The TMD SITs will begin in 1996 to address the interoperability of the TMD Family of Systems with Battle Management, Command, Control, and Communications (BM/C³). A typical SIT scenario, which will involve multiple shot engagements (MSEs), is shown in Figure 2.

The Central Test and Evaluation Investment Program (CTEIP) administered by the Under Secretary of Defense for Acquisition and Technology, Test Facilities and Resources (OUSD (A&T) TFR), and the BMDO have initiated programs to assure adequate instrumentation will be available at these locations to support single target engagements. MSEs, however, will require augmentation of the range support systems such as range safety and data collection instrumentation, and launch sites and launch support facilities. The BMDO's needs for MSE instrumentation, rather than continuing as a stand-alone project was combined with a programmed CTEIP project entitled the Transportable Range Augmentation and Control System (TRACS) . The combined TRACS-MSE project has been funded over the next five or more years to develop a highly mobile instrumentation suite which can be used to solve the short term instrumentation problems for all programs involving ballistic missile defense . The TRACS-MSE will concentrate on satisfying the BMDO's MSE test instrumentation requirements during the FY96-98 time frame.

The TRACS-MSE is visualized as a five-part development effort to do the following:

- a. Augment the Mobile Range Safety System (MRSS) . The MRSS is currently being developed to provide Missile Flight Safety support for a single target launch from Wake Island or other remote locations . The augmented MRSS will support a second, concurrent, target launch from the same location.
- b. Develop additional Command Destruct systems, and upgrade real-time data processing and display systems to support the intercept end of the flight corridor.
- c. Develop additional, mobile wide-band telemetry receiving and processing capability. to augment existing equipment in the field.
- d. Develop or modify airborne platforms to perform the stand-alone safety function for a single target launch, to serve as a backup range safety and signal relay system, and to support launch of a third target if necessary.
- e. Further TRACS-MSE development to support other required targets.

The target launch portion of the augmented MRSS, consisting of the Flight Safety Launch support system will provide range safety officer displays of position, impact

prediction, etc., based on S-band telemetry from dual redundant target inertial navigational systems (INS). In addition, the system will have the ability to receive and process GPS-derived TSPI information translated from L-band to S-band and down-linked with the telemetry data, as soon as the required, miniaturized, digital GPS Translators and GPS Translator Processor equipment become available. The latter are currently being developed by the GPS Range Applications Joint Program Office (RAJPO). All target vehicles and most interceptors will be equipped with GPS systems, providing valuable data for precision miss distance computations during post-flight evaluation. A block diagram of the MRSS is shown in Figure 3.

The target launch portion of TRACS - MSE will be configured for deployment on-board an ocean surveillance ship as risk mitigation against target plume attenuation of S-band telemetry and UHF Command Destruct signals. Due to metallic aluminum particulates in the target plume, high UHF and S-band plume attenuation was anticipated during the target boost stages. S-band telemetry signal strengths were measured during the first HERA target launch on April 24, 1995 to assess the degree of plume attenuation. The results, shown in Figure 4, indicate less S-band plume attenuation during second stage boost than was anticipated.

A schematic of the proposed instrumentation ship, before modification with L-Band and S-Band antennas, is shown in Figure 5. All ship-mounted range safety equipment would be modular to allow easy removal from the ship and relocation in host vans and trailers to allow land based operation when required.

Most Ranges are not equipped to handle the Theater Ballistic Missile (TBM) multiple-interceptor launch scenario. The interceptor launch portion of TRACS - MSE will provide additional mobile Command Destruct Systems to satisfy the additional demands placed by multiple interceptor launches. These units will be designed to operate in either stand-alone mode with independent control and display capability or to operate as an integrated component of the existing range architecture. All TRACS - MSE instrumentation will apply available Common Range Architecture standards.

A third component of TRACS - MSE will entail state-of-the-art, mobile, wide band telemetry receiver systems. The telemetry systems will be developed to handle the large number of telemetry streams associated with complex SITs and MSEs. The interceptor telemetry data streams will include wideband infrared focal plane array, GPS receiver/translator, inertial navigation system and health/status data. The target telemetry data will include GPS receiver/translator, inertial navigation system, RF

miss distance indicator (MDI), damage attack indicator (DAI), and target health/status data. Figure 6 provides a telemetry system block diagram . The upper bounds for telemetry bandwidth requirements are summarized in Table 1 below:

Table 1: Interceptor and Target Telemetry Bandwidth

Vehicle	Telemetry Stream	Bandwidth (MHz)
Interceptor	Inertial Navigation System	2.0
	Focal Plane Array	Up to 10.0
	GPS Receiver/Translator	Up to 4.0
	Health and Status	0.1
Target	DAI Fiber Optic Mesh	6.0
	Inertial Navigation System	2.0
	GPS Receiver/Translator	Up to 4.0
	RF MDI	1.0
	Health and Status	0.1

The final portion of TRACS - MSE that will support ballistic missile launches will upgrade the range safety capabilities of two RP-3A aircraft . The design and modification work will be executed by the Naval Air Warfare Center, Naval Air Station Point Mugu with direction from U.S. Army Space and Strategic Defense Command. The two aircraft will be equipped to perform a stand-alone flight safety function. Aircraft modifications will include telemetry receivers, command destruct systems, and appropriate display and control systems . These aircraft will fly to provide back-up range safety to ship and shore-based range safety systems and range safety coverage for target launches that can not be covered by the augmented MRSS . The RP-3A aircraft will be essential to support SITs involving launch of more than two ballistic targets.

CONCLUSION

The BMDO and OSD will jointly fund the development of TRACS - MSE to first meet critical test instrumentation requirements for testing ballistic missile interceptors

in multiple shot engagements . The TRACS - MSE will provide a capability to control dual target launch from a launch area and a third target launch from a geographically separated area . It will also provide telemetry receiving and recording system to collect target and interceptor data during multiple shot engagements.

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NOMENCLATURE

BMC ³	Battle Management/Command, Control, and Communications
BMDO	Ballistic Missile Defense Organization
CTEIP	Central Test and Evaluation Investment Program

CORPS SAM	Corps-level Surface-To-Air Missile Defense
DAI	Damage Attack Indicator
DemVal	Demonstration and Validation phase of development
dB	Decibels
DT	Development Testing
EMD	Engineering and Manufacturing Development phase of development
GPS	Global Positioning System
HERA	A threat-representative, 1200 kilometer range, tactical ballistic target missile
INS	Inertial Navigation System
KMR	Kwajalein Missile Range, Marshall islands
MDI	Miss Distance Indicator
MRSS	Mobile Range Safety System
MRTFB	Major Range and Test Facility Base
MSE	Multiple Shot Engagement
NAWCWD	Naval Air Warfare Center Weapons Division
OT	Operational Testing
OUSD(A&T) TFR	Office of the Under Secretary of Defense for Acquisition and Technology, Test
PAC-3	PATRIOT Advanced Capability 3
PMRF	Pacific Missile Range Facility
RAJPO	Range Applications Joint Program Office
RF	Radio Frequency
SIT	System Integration Test
TBM	Theater Ballistic Missile
TCMP	TMD Critical Measurements Program
THAAD	Theater High Altitude Area Defense
TMD	Theater Missile Defense
TSPI	Time-Space-Position-Information
TRACS	Transportable Range Augmentation and Control System
TRACS - MSE	TRACS for MSEs
UCT	UOES Characterization Test
UHF	Ultra High Frequency
UOES	User Operational Effectiveness System
USAKA	U.S Army Kwajalein Atoll
USASSDC	U.S. Army Space and Strategic Defense Command
WSMR	White Sands Missile Range, New Mexico