LOW COST SUBMINIATURE TELEMETRY SPREAD SPECTRUM TECHNOLOGY DEMONSTRATION/VALIDATION

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ABSTRACT

Eglin Air Force Base (AFB) plans to demonstrate subminiature telemetry (SMT) spread spectrum technology, via an upgraded prototype SMT system, to validate its cost-effectiveness for both Department of Defense (DoD) and commercial use. The goal is to develop new and/or modify current SMT instrumentation using existing production methods to provide increased capabilities at lower costs and reduced size. The transmitter is to require less than 2 cubic inches of space and have a cost goal of $500/unit "in quantity." The cost goal of a ground-based, 24-channel capable ground receiver is $4000/unit "in quantity". The SMT project as well as its schedule, flight and ground demonstrations, validation criteria and goals, and various benefits are discussed.

INTRODUCTION

A capability is needed to obtain telemetry (TM) data from all guided and/or fuzed conventional weapons during all phases of flight testing. Current TM instrumentation systems are costly, bulky, require extensive modification to aircraft and/or munitions, and are limited to single data stream operation. Off-the-shelf systems cannot be installed into these weapon systems in a rapid, cost-effective manner; custom systems must be designed and built for each application. Multiple TM requirements can only be met by using a separate TM system for each TM stream; often the cost is prohibitive. Test range schedules and costs are also impacted by the need for multiple frequency band allocations.

SMT instrumentation can provide a cost-effective solution to meet multiple TM requirements. While traditional TM systems are capable of receiving/relaying multiple types of data on one TM stream, SMT instrumentation provides a new rapidly installable and limited capability to transmit a subset of the traditional multiple types of data via spread spectrum with the ability to demodulate up to 24 different upper S-Band TM frequencies with no interference from or with traditional TM systems. A mixture of analog, digital, and discrete types of data can be transmitted and received. Also, this new instrumentation can provide extremely small, very low cost, and severe-environment proof TM capabilities for any test application.

An SMT system uses miniaturized TM units configured with four to 12 integrated circuit chips (weapon complexity dependent) enabling real-time data to be gathered from submunition and larger sized test items. An SMT unit can be used internally to test a smart weapon or externally to monitor an aircraft/munition. Internally, the SMT unit is easily configurable and can be integrated in a custom high density package or directly into the weapon's circuit card. Externally, the SMT unit is a self-contained, easily installed unit which can be reused, depending upon the actual test scenario.

PROJECT DESCRIPTION

The Central Test and Evaluation Investment Program (CTEIP), Test Technology Development and Demonstration (TTD&D) has funded this project ($900,000), emphasizing broad test applications and dual use capabilities. This project will complement a $3.2M Wright Laboratory Armament Directorate (WL/MN) 6.3 SMT research and development program; both are with Harris Corporation.

In this Demonstration/Validation (DEM/VAL) project, the SMT unit, called an Integrated Telemetry Package (ITP), will be used externally. Data will be collected from the test item, digitized by the ITP, and transmitted to a prototype ground Receiver/Demodulator Unit (RDU) for slant ranges up to 9 kilometers (Km) or to an Airborne Receiver Demodulator Unit (ARDU) for subsequent retransmission to the RDU for slant ranges over 9 Km.

This Air Force Development Test Center (AFDTC) project builds on prior WL/MN SMT technology development programs which provided baseline SMT instrumentation. This effort will modify existing SMT designs and develop new SMT instrumentation to provide increased capabilities for expanded military and commercial use. The design of current ITPs, each with a complete data acquisition interface and with a spread spectrum mode capable transmission system, will be modified to increase transmission power to 1/4 watt and to have a remote on/off capability. The existing WL/MN SMT ARDU is an airborne qualified 12-channel capable unit populated with four cards. The RDU will be designed as a rack mounted, ground-based version of the ARDU with 12 channels capable of receiving and demodulating up to 12 simultaneous transmissions in the upper S-band (multi-user spread spectrum operation). The project will then incorporate the redesigns/modifications into prototypes for DEM/VAL by the 46th Test Wing (46 TW); Harris Corporation will build six to 12 ITPs, one 12-channel RDU, one custom-designed breakout box, and one handheld remote on/off control switching device. In 1996, system capabilities will be validated via ground and flight tests conducted by the 46 TW at Eglin AFB, Florida. Also, a cost reduction study will be accomplished and used to design a low cost 24-channel RDU. Figure 1 depicts the SMT project schedule.

	FY 95				FY 96			
ACTIVITY	1	2	3	4	1	2	3	4
Contract Award - Harris Corporation		x						
T-2 Modification								
GI Pod Modification		x	---	x				
Aircraft Modification				x	---	x		
MK-82 Modification					x	x		
Design/Build (1) 12-Channel RDU		x	---	---	x			
Design/Build (6-12) 1/4 Watt ITPs		x	---	---	---	x		
Ground Demonstration						x	x	
Flight Demonstration						x	x	
Cost Reduction Study/Design 24-Channel RDU			x	---	---	---	---	x
Reports							x	x

Figure 1: SMT Spread Spectrum Technology DEM/VAL Schedule

DEM/VAL RESPONSIBILITIES

WL/MN will: complete the General Instrumentation (GI) Pod modification, temporarily loan the ARDU for use in the GI Pod for the flight demonstration, ensure that all ITPs can interface/link to an omnidirectional antenna, and ensure that all ITPs have an uplink capability (remote on/off).

46 TW will: schedule, modify and/or provide resources, and conduct the ground/flight tests; assist WL/MN and Harris Corporation develop ITP and RDU users manuals; acquire ground and flight test data; assist in evaluating system performance adequacy; and prepare a Test Report.

VALIDATION CRITERIA

The SMT system (ITPs, WL/MN's ARDU, and 12-channel RDU) flight/ground performance must meet these criteria to validate its adequacy for range use:

1. Demonstrate spread spectrum operation of the system and its components
2. Not exceed the form, fit, and function limits of current equivalent TM systems
3. Demonstrate compatibility and interoperability with existing range systems
4. Meet or better the data link operations and characteristics of current systems

VALIDATION GOALS

The following goals apply for validation of the SMT units for range use:

1. Meets specifications based upon contractor in-house testing and WL/MN laboratory tests.
2. Demonstrates RDU data reception and demodulation from six to 12 ITPs simultaneously, with no degraded data; demonstrates spread spectrum multiple transmission and reception of data in both airborne and ground scenarios.
3. Demonstrates compatibility and interoperability with range airborne transmitter(s) and ground receivers.
4. Demonstrates data link characteristics: on/off control, omnidirectional antenna interface, ITP transmit range of 9 Km, and acceptable data dropout rate.

FLIGHT/GROUND DEMONSTRATIONS

Performance shall be determined through contractor provided data, ground tests, and flight tests. Final proof of concept will be demonstrated via representative test scenarios.

The flight demonstration will use two 1/4 watt ITPs each mounted on an F-16's wingtips to transmit accelerometer data to the ARDU in the GI Pod carried on a chase aircraft. Also, during the mission a MK-82 bomb, modified with a 1/4 watt ITP interfaced to an omni antenna (both tail section mounted), will be released and also transmit data (before, during, and after separation) to both the chase aircraft pod and the ground-based RDU. All data will be retransmitted from the GI Pod to a ground station and monitored in real-time. The SMT transmitted/received data will be compared to data transmitted/received in parallel by existing TM system(s) to verify data fidelity.

The ground demonstration will show that data transmitted from six to 12 ITPs (mounted on tanks, trucks, and other available vehicles) can be simultaneously received and demodulated by the RDU; transmitted data will be vehicle dependent.

PRODUCIBILITY/AFFORDABILITY

The AFDTC project objective is to develop new and/or modify current SMT instrumentation using existing production methods to provide increased capabilities at lower costs and reduced size. The ITP is to require less than 2 cubic inches of space and have a cost goal of $500/unit "in quantity." A feasibility study, or market survey, will also identify components that will lower the RDU unit cost, while providing required performance. The cost goal of a ground-based, 24-channel capable RDU is $4000/unit "in quantity." However, high volume production is also required to realize these cost goals. [Note: the 12-channel RDU is not considered a production representative configuration; hence, no cost goal was defined for it.]

SUPPORTABILITY

Supportability of AFDTC unique applications will be addressed only. This project will not purchase maintenance support for either the RDU or ITPs. Harris Corporation will deliver a custom-designed breakout box to the 46 TW for use in performing preflight checkout and troubleshooting of the SMT system. However, any special RDU or ITP support equipment required shall be identified with supplier information and costs provided.

COMMERCIAL/DUAL USE

Spread spectrum technology will be capable of supporting virtually all future smart weapons systems. The prototype SMT units will be utilized by the 46 TW for tailored test support applications. Some SMT hardware configurations, including these prototypes, have been put into the National Stock Supply System. The small size, potential low-cost, and multiple access waveform designed into the SMT system should support a dual-use market. The recently developed ITP represents a major step in achieving a small, affordable TM transmitter. However, its only existing compatible receiver for multiple access applications is the ARDU, which was designed and built in small quantities for a specific aircraft GI pod application. The

ARDU is too expensive ($240,000) for ground range sites or for commercial applications. The proposed RDU is a ground-based, commercially designed, low-cost version of the ARDU. Such a low-cost receiver should greatly increase the possible dual use applications of SMT technology.

Potential consumer markets include automobile transponding devices, such as toll booth systems or on-board navigation systems, remote sensing for pipelines and oil/gas well systems, earthquake monitoring, hospital systems for computer and patient monitoring, and factory remote data collection.

CONCLUSION

The planned SMT DEM/VAL program will enable validation of the performance of the RDU and the IPTs to effectively meet DoD/Eglin Test Range requirements. Approaching or achieving their respective cost goals will also make them more desirable for DoD and commercial use.

REFERENCES

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