ARCHIVED REPORT

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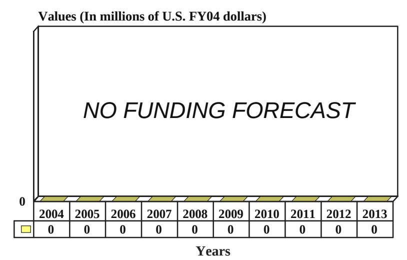
AMSTE - Archived 8/2005

Outlook

- Final AMSTE completed in October 2003 with Northrop Grumman scoring direct hit
- U.S. Navy considering AMSTE technology
- Northrop Grumman requesting for permission to sell AMSTE technology on the international market
- Barring any changes, this report will be archived in the near future

Forecast Funding Levels
2004 - 2013



Orientation

Description: The Affordable Moving Surface Target Engagement (AMSTE) program conducts research and development on affordable technologies for tracking and engaging moving surface targets, such as small boats and tactical ballistic missile transporters.

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Status: In development.

Total Produced: Experimental prototypes are being developed by Northrop Grumman.

Application: AMSTE is being designed to work with multiple intelligence, reconnaissance, and attack platforms. The goal is for AMSTE to provide guidance to a multitude of low-cost weapons from stand-off positions in all weather conditions.

Price Range: The cost of making a weapon AMSTE capable is estimated to be US$5,000 to US$13,000. To add basic AMSTE capabilities to an aircraft would cost roughly US$1 million.

Technical Data

Design Features. The objective of the Affordable Moving Surface Target Engagement (AMSTE) program is to combine the input from various sensors, in order to provide fire control systems with up-to-date data for accurate guidance of inexpensive armaments against moving surface targets. Current systems, which demand either sophisticated target-seeking systems, human designators, or area-effective munitions, are expensive and risky, and can produce unwanted collateral damage.

Because this is a developmental program that permits competing companies to employ a variety of existing technologies, it is not possible to give specific design features of the AMSTE. However, the key characteristics outlined in the AMSTE Program Research and Development Announcement (PRDA) call for all-weather capabilities; rapid, high-confidence targeting; and precision engagement.

To achieve an all-weather engagement capability, AMSTE would require a radar solution that fuses ground moving target indication (GMTI) and synthetic aperture radar (SAR) modes. These netted GMTI/SAR sensors will provide constantly updated precision fire control data for inexpensive, non-smart weapons. Northrop Grumman, for example, has used the Joint Surveillance Target Attack Radar System's precision GMTI coupled with the Joint Strike Fighter GMTI radar in a flight test of its AMSTE system.

Equipment to be utilized in AMSTE will include recently developed apparatus such as GMTI and Global Positioning System/Inertial Navigation System (GPS/INS). No new weapons or platforms are being requested for the AMSTE program. Various platforms, ranging from the Global Hawk unmanned air vehicle to satellites, are envisioned as integral parts of AMSTE's netted sensor system.

Variants/Upgrades

Since AMSTE is still in development, no variants exist.

Program Review

During the 1999 conflict in Kosovo, the Serbian Army frustrated NATO forces by constantly moving their defense assets, often within a convoy mixed with civilian vehicles and personnel. This situation accentuated the need for a system to precisely track and target moving surface vehicles. Because a vehicle can accelerate and stop at a moment's notice, moving targets pose a significant challenge to current weapon systems.

In an effort to investigate the possibilities of an affordable moving surface target engagement system, in June 1999 the U.S. Air Force Research Laboratory issued eight contracts totaling more than US$22.5 million. Various companies were awarded contracts to conduct feasibility studies, and to develop and evaluate technologies required for the AMSTE. This first phase of the AMSTE program explored technologies to network ground moving target indication sensors for accurate fire control data to track and direct inexpensive munitions against moving targets. At the end of the 15-month feasibility studies, it was concluded that obtaining the high accuracy required for precision fire control is possible.

The second phase of AMSTE began in fall 2000. This phase included a series of experiments to explore and develop technologies capable of providing affordable tracking and target acquisition of surface vehicles.

Two contracts with a total value of more than US$23.3 million were issued in December 2000 to Raytheon and Northrop Grumman, for further development and integration of technologies in support of AMSTE experiments.

On May 10, 2001, Northrop Grumman successfully completed the first set of system-to-system flight tests of AMSTE at Eglin Air Force Base, Florida. During the experiment, a Joint Surveillance Target Attack Radar System precision ground moving target indicator (GMTI) coupled with a Joint Strike Fighter GMTI radar was mounted on a BAC I-II testbed aircraft. These systems were able to gather precision GMTI engagement quality track data in real time.

The data collected from this test were used to validate algorithms and system-of-system design. These improvements were incorporated in tests performed by Northrop Grumman in August 2001 at Eglin Air Force Base, where a low-cost weapon launched from an F-16 was successfully guided to destroy a moving target. The weapon, a Mk 84 bomb fitted with a special tail kit developed by Lockheed Martin, was able to make a direct hit on a vehicle moving at approximately 20 miles per hour.

A couple of weeks earlier Raytheon also carried out a demonstration of its AMSTE prototype. Fusing the radar data from a Lockheed Martin U-2 carrying Raytheon's upgraded ASARS-2A radar, and the Sensor Emulation Platform (a modified A-3 jet carrying the radar currently used on Global Hawk), Raytheon was able to deliver an AGM-65 Maverick missile to engage and destroy a moving wheeled vehicle traveling at about 20 miles per hour. Both the Raytheon and Northrop Grumman teams utilized critical precision tracking and data fusion technology provided by Orincon Corporation International.

By the autumn of 2001, the Defense Advanced Research Projects Agency decided on a single contractor for AMSTE. Northrop Grumman was awarded a US$22.9 million contract in November 2001 for the second phase of AMSTE development.

As Northrop Grumman wrapped up the second phase of the AMSTE program in September 2002, the AMSTE network scored a direct hit on a moving target. During the test, two Joint Direct Attack Munitions (JDAMs) and one Joint Stand-Off Weapon (JSOW) were dropped. The two JDAMs were fired from an F-14D flying at 20,000 feet, six miles away, at two vehicles in a five-vehicle convoy. Both weapons landed within the effective destruction range. Later, an F/A-18D released the JSOW from 30,000 feet and 35 miles away to record a direct hit on a moving M60 tank.

A Link 16 terminal was used to guide the JSOW to its target. The JDAMs, on the other hand, were fitted with a production tail kit modified with a Raytheon anti-jam UHF data link. During both tests, precision real-time targeting information was provided by an E-8C Joint Surveillance Target Attack Radar System (JSTARS) and a fourth-generation AESA F-35 prototype radar flown in a BAC 1-11 testbed.

A total of five weapons have been dropped during the first two years of the program. Two weapons have recorded direct hits, two landed within 5 to 6 meters of their targets, and the fifth missed by 8 meters. All were well within the DARPA specified range and would have destroyed or severely damaged their targets if they were equipped with explosive warheads.

A contract for the third phase of the AMSTE program was awarded in November 2002. During this phase, more complex targeting scenarios were performed. Erratic vehicle movement was introduced, and targets were placed behind vegetation and terrain features for varying lengths of time to demonstrate the radar's ability to reacquire a target when it emerges from cover. Work for this contract was completed in October 2003.

Funding

U.S. FUNDING

	FY00		FY01		FY02		FY03(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
Sensor & Guidance Technology PE#0603762E Project SGT-04	-	81.5	-	73.9	-	106.8	-	121.0

	FY04(Req)		FY05(Req)		FY06(Req)		FY07(Req)	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
Sensor & Guidance Technology PE#0603762E Project SGT-04	-	105.5	-	90.4	-	90.2	-	90.9

All US$ are in millions.

Note: Specific outlays under this Program Element (PE) for AMSTE in 2001, 2002, and 2003 are US$35.376, US$40.962, and US$28.09 million, respectively. Funding for AMSTE ended in fiscal year 2003.

Recent Contracts

Contractor	Award (US$ millions)	Date/Description
Northrop Grumman	12.2	Dec 2000 – Air Force Research Laboratory contract awarded for development and integration of technologies in support of AMSTE experiments to be performed at Nellis Air Force Base. Work completed by the end of 2001.

Contractor	Award (US$ millions)	Date/Description
Raytheon	11.2	Dec 2000 – Air Force Research Laboratory contract awarded for development and integration of technologies in support of AMSTE experiments to be performed at Eglin Air Force Base. Work completed by the end of 2001.
Northrop Grumman	22.9	Nov 2001 – Air Force Research Laboratory contract for second phase of AMSTE program. Contract work completed November 2002.
Northrop Grumman	14.1	Nov 2002 – A cost-plus fixed-fee contract modification to provide for continuation of the development of long-term track maintenance capabilities to develop and demonstrate real-time battle management and command, control, and communications (BMC^3), and to complete the development of the Affordable Moving Surface Target Engagement (AMSTE) II System architecture in order to perform an end-to-end demonstration of an AMSTE precision engagement system. Work completed by October 2003. The Air Force Research Laboratory is the contracting agency (F30602-02-C-0001/P00007).

Timetable

Month	Year	Major Development
Jun	1999	Eight contracts for feasibility studies, development, and evaluation of AMSTE awarded by Air Force Research Laboratory
Dec	2000	Contracts issued to Raytheon and Northrop Grumman for further development and evaluation of AMSTE
May	2001	Northrop Grumman successfully completed first set of system-to-system flight tests of AMSTE at Eglin Air Force Base
Dec	2001	Northrop Grumman chosen as single contractor for AMSTE
Nov	2002	Second phase of AMSTE development completed
Oct	2003	Final phase of AMSTE testing completed

Worldwide Distribution

AMSTE is a **U.S.**-only program. Once its development is completed, the AMSTE architecture will likely be shared with close allies.

Forecast Rationale

On July 24, 2003, Northrop Grumman conducted the first AMSTE system test utilizing only a single Ground Moving Target Indicator (GMTI) radar source and a Joint Attack Munition (JDAM). Dropping a 2,000-pound bomb from an F-16 six miles away at 20,000 feet, the AMSTE system was able to engage a truck traveling at 23 mph. The weapon, fitted with a datalink, struck within three meters of the target, well inside the lethal zone of a live JDAM. The test demonstrated that such a mission can be successfully carried out when data from only one radar system is available.

Northrop Grumman ran the final and most complicated AMSTE test on October 7, 2003, at Eglin Air Force Base, Florida. During a three-hour scenario 18 military target vehicles were maneuvered to test an improved AMSTE tracking system. During the test, targets were acquired and tracked for up to 40 minutes. An F-16 dropped a modified 2,000-pound JDAM equipped with a low-cost datalink; using real-time information from a JSTARS aircraft, the JDAM was able to score a direct hit on a remotely controlled M-60, which was moving in a column of traffic traveling at 18 mph.

Out of the eight tests conducted by Northrop Grumman, AMSTE recorded three direct hits and struck within the original goal of 10 meters for the remainder of the tests. After three years of study AMSTE has proven an effective method of identifying, tracking and engaging moving targets from stand-off distances under all weather conditions. Despite this successful completion of AMSTE testing, there has not been a commitment by any of the U.S. armed forces to this system. The U.S. Navy is the only branch which has taken some actions towards incorporating AMSTE. Currently, the U.S. Navy is evaluating the priority of funding for this capability as part of its fiscal year 2006 budget.

While waiting for the U.S. armed forces to make commitments to AMSTE, Northrop Grumman is petitioning permission to market AMSTE to foreign governments. Reportedly, AMSTE technology will be advanced under an Office of the Secretary of Defense program known as Horizontal Fusion. Northrop Grumman is said to have received a US$5.5 million contract to support this program.

Although AMSTE is mentioned in the fiscal year 2005 DARPA budget, there is no specific funding allocated to this program. With Northrop Grumman's AMSTE contract with DARPA completed and the absence of funding in current U.S. budget documentation, this report will be archived in the near future. This does not indicate that AMSTE technology will be set aside. The success of the program will likely lead to the integration of AMSTE technology into future target acquisition equipment and weapon systems. Whether the technology will be considered as a whole or remain under the nomenclature of AMSTE remains to be seen.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR FUNDING (US$ in millions)

				High Confidence Level			Good Confidence Level			Speculative		
Designation	**System**	**Thru 03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**Total 04-13**
AMSTE	Prior Prod'n:	119.591	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000