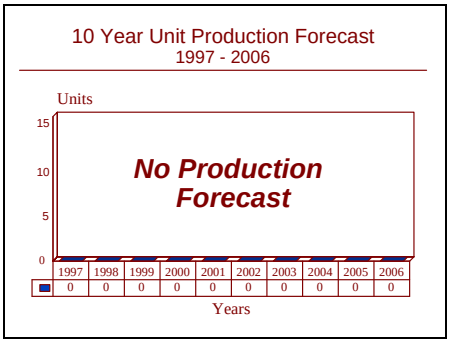
# Multi-Sensor Target Recognition System - Archived 3/98

## Outlook

- DARPA refocused its Warbreaker program with various elements transitioned to other programs
- MUSTRS project terminated due to lack of progress with the Synthetic Aperture Radar sensor and service customer sponsorship
- US completed partial test and evaluation of MUSTRS technology using a helicopter testbed prior to its cancellation




## Orientation

Description. Advanced sensor and guidance system development effort.

Sponsor. The US Department of Defense through the Defense Advanced Research Projects Agency (DARPA), Arlington, Virginia, USA, in cooperation with the various armed services.

Contractors. Hughes Missile Systems Company, Tucson, Arizona (formerly General Dynamics Corporation, Convair Division, San Diego, California), USA, is the prime contractor for the MUSTRS (formerly Thirsty Saber) program.

Major Subcontracts. Martin Marietta Electronics, Information & Missiles Group, Orlando, Florida, USA, will provide the MUSTRS (Thirsty Saber) sensor package. Martin Marietta has merged with Lockheed to form the Lockheed Martin Corporation.

Status. Program terminated. The MUSTRS was in development as a near-term demonstration effort prior to its conclusion. Flight demonstrations were commenced in late 1993. Hughes (formerly General Dynamics) was conducting these test flights to determine how well the system can find and identify mobile targets.

Total Produced. No specific weapon system production was associated with the MUSTRS program, since its potential carriage platform options were varied. Lockheed Martin planned to complete construction of the first prototype sensor package by the end of 1992. This unit was to be delivered to Hughes and integrated with an aircraft pod. The second sensor package was to be completed by mid-1993.

Application. This system was expected to locate, identify and engage mobile ballistic missile launching platforms, and then direct aircraft/missiles to this area. This technology had applications to manned and unmanned airborne systems, including such platforms as the F-15, fast low-flying UAVs and cruise missiles.

Price Range. No specific per-unit price could be determined, although MUSTRS (Thirsty Saber) was expected to be very expensive.

# Technical Data

Design Features. The MUSTRS (Thirsty Saber) sensor package was to detect ground targets using either millimeter wave radar, infrared sensors or both simultaneously. The millimeter wave radar allowed target detection in all weather conditions, while the infrared sensor could locate targets passively through the radiant energy naturally emitted by all objects. The targets were to be rapidly identified using a special onboard computer developed by Lockheed Martin and known as the Geometric Arithmetic Parallel Processor (GAPP). Sources stated that Lockheed Martin's new computer was capable of performing 75 billion calculations per second. The MUSTRS (Thirsty Saber) was not being designed to fit on any specific platform. Texas Instruments and Alliant were developing a new computer that had been described as a "Cray in a soup can." This advanced computer, known as the Aladdin Weapon Processor, was designed to be versatile, fast and specially designated for modular application to numerous weapons for target acquisition, recognition and guidance. It was also being adapted by the US Air Force for aircraft applications.

# Variants/Upgrades

No specific information was provided concerning additional variants or planned upgrades for the MUSTRS system.

# Program Review

Background. For a number of years, the United States has been experimenting with different ways to detect and engage moving ground-based weapon systems, such a mobile ballistic missile launchers similar to the SS-1 Scud. The Defense Advanced Research Projects Agency's (DARPA) Thirsty Saber program, later known as the Multi-Sensor Target Recognition System (MUSTRS), was one of the research efforts. MUSTRS (Thirsty Saber) was a highly classified DARPA effort through the late 1980s, later becoming part of the Warbreaker program. Programs such as MUSTRS were given new priority due to the experience gained during Operation Desert Storm.

Warbreaker. Warbreaker, which is also known as the Critical Mobile Target program, was created after Operation Desert Storm and was led by DARPA. This initiative grew out of the lessons learned when it became apparent that existing reconnaissance assets had difficulty tracking Iraqi tactical surface-to-surface Scud missile launchers. Warbreaker sought to dramatically improve target detection, the swiftness of mission planning and preparation, and the precision of target locating. Specifically, Warbreaker aimed to foster systems that would enable US forces to find targets as small as one square meter in an area of 10,000 square kilometers, to plan an attack mission within 10 minutes, and to maintain broad situational awareness over an area of one million square kilometers.

The goal of Warbreaker was to develop technologies in the areas of automated area search reduction, target location projection, tracking and attack assessment, adaptive operational planning, automated target recognition and surveillance, and targeting technologies. The program could have eventually lead to the creation a fully integrated, end-to-end system capable of targeting and neutralizing time-critical targets within enemy strike cycle times. However, Warbreaker itself was not a hardware acquisition program, but could have lead to service procurement of new sensors, C3I and weapons platforms to carry out its mission. The program's technology challenges were multifaceted; the three areas of primary thrust for Warbreaker were:

- Surveillance and Targeting Technology Effort was to develop and integrate technologies and systems yielding wide area and focused surveillance, target detection and recognition, and precision target acquisition capabilities. Technologies being investigated included advanced 3-D and polarimetric synthetic aperture radar, multispectral electro-optical/infrared, foliage penetration technologies, internetted unattended ground sensors and robust automatic target detection and recognition algorithms.

- The Intelligence and Planning Effort was to develop technologies and systems to provide a continuous update of enemy force status and allow a commander to nominate targets of interest rapidly. Efforts were under way to develop algorithms and software to automate intelligence processing and data correlation, strike planning, decision aids, and terrain data generation, and to support distributed dynamic databases enabling theater-wide sharing of information.

- The System Engineering and Evaluation Effort was to develop the Warbreaker system architecture, integrate all

Warbreaker elements, and evaluate system performance. This effort used simulation, system engineering tools, and the communications infrastructure necessary to conduct rapid prototyping for concept and architecture evaluation.

The Intelligence and Planning component of Warbreaker comprised: Intelligence Correlation (IC), Multiple Access Intelligence and Nomination System (MAINS), Local Attack Controller (LAC), Terrain and Feature Generation (TFG), Internetted Unattended Ground Sensors (IUGS), and TOPSIGHT.

Candidates for critical components for Warbreaker were undergoing technology demonstrations throughout 1994. During 1995 and 1996, these components were to be developed and demonstrated, with an integrated system demonstration to follow in 1997 and 1998. An end-to-end demonstration of all system elements were to take place around 1998-1999.

MUSTRS (Thirsty Saber). This program had as its aim the development of technology to seek out, detect and destroy relocatable targets. The effort was a spin-off of DARPA's smart weapons technology program, which had been experimenting with ways of programming systems in order to more closely imitate human thought patterns. MUSTRS was seen as critical to the first tier of the planned US theater missile defense network, which would strike ballistic missile targets during pre-launch, boost and ascent phases.

As part of MUSTRS (Thirsty Saber), intelligence sensor suites were be placed on unmanned aerial vehicles to test its abilities. Relocatable targets represented a particular challenge to the United States military, since existing weapon systems used fixed target coordinates. However, sources said that the real challenge of this program would be testing the software in order to assure that the system takes into account various other aspects of any engagement (such as fuel usage and levels, and understanding what threats have been identified).

The Pentagon had only recently begun to declassify certain parts of the program. General Dynamics Convair Division (now part of Hughes), San Diego, California, was the prime contractor on the project (system integrator and was working on in-flight mission replanning software), with Martin Marietta and Texas Instruments competing for a major subcontract. Martin Marietta and Texas Instruments were to provide multi-sensor automatic target recognition system. Texas Instruments was using an infrared and laser radar, while Martin Marietta was to offer a millimeter wave radar. A subcontractor selection was based on size, weight, power and performance of the prototypes. Martin Marietta was awarded a contract for this segment of the program in 1992.

Technology demonstrations were under way, with the program past its halfway point (overall this is a 29-month effort). Test and evaluation of the MUSTRS were scheduled to be completed during FY95. However, the program was terminated in 1996 due to a lack of progress with the synthetic aperture radar sensor and service customer sponsorship. An initial operational capability could have occurred around 2000, if the program had proceeded into full-scale development.

# Funding

Funding for the Warbreaker and MUSTRS efforts was located under the Experimental Evaluation of Major Innovative Technologies, PE#0603226E Project EE-40 Critical Mobile Targets; and Air Defense/Precision Strike Technology, PE#0603238A Project D177 Joint Air/Land/Sea Precision Strike Demonstration (JPSD). Project EE-40 reflected the project/program element consolidation and realignment within DARPA. The associated FY91, FY92 and FY93 funding for this project were accomplished in Program Element 0603227E Project RT-01 and Project EE-30 (PE#0603226E), and were shown for continuity purposes. Also, some $4.4 million for the continuation of the effort was contained within the US Office of the Secretary of Defense PE#0603737D Balanced Technology Initiative line. Project D177 Joint Air/Land/Sea Precision Strike Demonstration (JPSD) was a restructure from PE#0603772A Project D289. To achieve its goals of countering mobile missiles, DARPA said that it would require some $50 million to $100 million annually.

US FUNDING

| | FY94 | | FY95 | | FY96 | | FY97 (Req) | |
|---|---|---|---|---|---|---|---|---|
| | QTY | AMT | QTY | AMT | QTY | AMT | QTY | AMT |
| RDT&E | | | | | | | | |
| Proj - 1 | - | 117.4 | - | 109.4 | - | 110.9 | - | - |
| Proj - 2 | - | 10.0 | - | 31.3 | - | 33.2 | - | 32.1 |

All $ are in millions.
Proj - 1 Project EE-40 Critical Mobile Target.
Proj - 2 Project D177 Joint Air/Land/Sea Precision Strike Demonstration.

## Recent Contracts

In October 1994, Raytheon and PRC won the development contract for a high-speed intelligence correlation system as part of the Warbreaker program. Each company participated in the Phase 1 portion of this effort, with a downselection to a single contractor (Raytheon) for Phase 2 occurring in February 1995. The program includes the development of a software/hardware suite capable of correlating up to 240,000 multi-source intelligence messages per day. This capability will enable Warbreaker to locate and identify critical mobile targets.

In September 1993, SAIC Engineering Systems Group, San Diego, California, was awarded $18.4 million contract for Critical Mobile Target program support. Contract Number N66001-93-D-0116. On January 3, 1992, General Dynamics Corporation, San Diego, California, was awarded a $3 million increment as part of a $47.3 million cost-plus contract for Thirsty Saber Phase IIB. This contract award was worth $27.1 million. Contract work was to be performed in Orlando, Florida, and San Diego, California, and completed by April 30, 1994. Contract Number MDA972-90-C-0042 P00022.

At the same time, Martin Marietta received a Thirsty Saber subcontract as part of this overall DARPA award to General Dynamics. No specifics were announced concerning this subcontract, although Martin Marietta's share of this $27.1 million award is believed to be two-thirds. The total contract value was announced as $20.8 million for a 29-month program. Martin Marietta was to provide two prototype sensor systems, which were delivered to General Dynamics in 1993.

## Timetable

| | | |
|---|---|---|
| | 1980s | US Air Force works on Synthetic Aperture Radars |
| | 1988-89 | Thirsty Saber program revealed |
| Jan | 1992 | Thirsty Saber subcontract awarded to Martin Marietta |
| | 1992 | Thirsty Saber becomes MUSTRS |
| Mid | 1990s[(a)] | Demonstrations of technology (Warbreaker/MUSTRS) |
| | 1996 | MUSTRS program terminated |

[(a)] estimates

## Worldwide Distribution

The MUSTRS (Thirsty Saber) system development moved ahead, but it was not expected to be exported by the United States. This would be due to the sensitive nature of the technology involved in its development and the need to maintain its security.

User Country(s). The United States was expected to be the initial operator of the MUSTRS (Thirsty Saber) system. With the termination of the program, no system is expected to be deployed.

## Forecast Rationale

The United States has concluded the Multi-Sensor Target Recognition System (MUSTRS) portion of the War-breaker program. This was due to a lack of progress with the synethetic aperture radar sensor and service customer sponsorship. Certain promising aspects of the Warbreaker program have been transitioned to other development efforts for further study.

Work on more capable target detection and acquisition systems is continuing and could eventually produce a unit for installation in an advanced cruise missile or unmanned air vehicle. However, the United States is facing defense budget shortfalls which could easily delay the introduction of the next generation of cruise missiles, while curtailing the production of existing systems.

## Ten-Year Outlook

No production forecast has been provided for MUSTRS since the aim of these programs was to develop technology and not a specific weapon system.

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