

Utilization of a Low Cost Interceptor (LCI) for Cost Effective Air Defense against Low Tech Threats

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Several studies and reports over the past ten years have discussed the need for a low cost interceptor for use in air defense against low tech air breathing threats. The Low Cost Interceptor (LCI) program that Miltec Missiles and Space Company has managed for the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command's (USASMDC/ARSTRAT) Office of Technical Integration and Interoperability since April 2001 was implemented to address that need. The LCI program has developed several interceptor concepts and designs and has tested many of the components and subsystems that will go into the interceptor. This paper discusses some of those subsystems and benefits that LCI has realized to date.

I. Introduction

In March 1998, the United States General Accounting Office (GAO) published a report for the Chairman, Subcommittee on Military Research and Development, Committee on Armed Services, House of Representatives, entitled "Low Cost Cruise Missile Defense – Progress Made but Significant Challenges Remain." One of the findings of this report included the following:

"The technical challenges identified by the senior level officials include developing mechanisms to enhance warfighters' ability to fight jointly and a capability to intercept cruise missiles outside the view of weapon system operators, improving sensors' abilities to detect and track low observable (stealthy) cruise missiles, fielding interoperable systems, **and developing low-cost defense systems to counter attacks by large numbers of unsophisticated cruise missiles.**"⁴

A DARPA Special Projects Office (SPO) program, Low Cost Cruise Missile Defense (LCCMD), had already begun looking at these technical challenges, focusing primarily on developing a low cost seeker. In late 2000, Miltec Corporation submitted a proposal to USASMDC/ARSTRAT in response to a Broad Area Announcement (BAA). The proposal, entitled Low Cost Interceptor (LCI) / Multi-Service Extended Range Low Cost Interceptor (MERLIN), proposed that Miltec, as the missile system integrator, develop a low cost, adjunct and complementary

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⁴ GAO Report, Cruise Missile Defense, GAO/NSIAD-99-68, March 1999, p 3.

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missile that would be used within the existing Air and Missile Defense architecture against low-cost, low-tech air breathing threats.

With escalating costs for the PAC-3 and AMRAAM missiles, Congress provided limited funds, earmarked specifically for the development of a low cost missile interceptor, and in April of 2001, USASMD/ARSTRAT awarded a contract to Miltec for the development of a low cost interceptor. The goal of the development effort is to demonstrate the feasibility of integrating existing missile technology and components into an interceptor and make it fully capable of killing certain air-breathing threats at extended ranges, before entering the defended area.

II. Program Overview

Miltec, working with the Air Defense Center at Fort Bliss, USASMD/ARSTRAT and several System Engineering Technical Assistance (SETA) contractors, began examining requirements and conducting studies and analyses that would support a System Requirements Review (SRR). A July 2001 memorandum from the Directorate of Combat Developments, US Army Air Defense Artillery School at Fort Bliss, supporting the research and development for reducing the costs of kinetic interceptors, stated:

“In addition to ballistic missiles and cruise missiles, we also see proliferation of far less sophisticated, though no less dangerous targets. These targets include unmanned aerial vehicles, decoys, and relatively simple cruise missiles, potentially carrying weapons of mass destruction. We would like to engage these targets using an interceptor that costs far less than those designed for the more difficult targets. This would result in significant munitions inventory cost savings and allow preservation of the higher cost, more capable interceptors for the tough targets. This lower cost interceptor would ideally have application to other Army and Joint mission areas.”⁵

The Air and Missile Defense Battle Lab at Fort Bliss provided a memorandum that linked the need for LCI to the Mission Need Statement for Theater Air and Missile Defense and concluded:

“that there is a compelling mission need for a capability to counter other than high performance threat systems with a interceptor that can be provided in sufficient quantities and lower cost than present AMD interceptors. The intent of this new capability is not meant to replace existing system or systems but rather augment those systems by reducing the cost per intercept ration, as a result of the anticipated lower cost of the LCI.”⁶

In addition to the memorandums, the US Army Defense Artillery School provided draft Concept of Operations and Desired Operational Capabilities documents that drove the technical performance requirements and the design of the interceptor. This development could give the battlefield commander the option of using lower cost interceptors against low cost threats, and thus save the more capable interceptors for the high-end threats.

III. Threat Set

The emerging threat set is a relatively low cost airborne vehicle or cruise missile with less capability than a sophisticated cruise missile, but just as lethal. Low cost makes it affordable for rouge nations to obtain large quantities and use them against military installations and unsuspecting civilian population centers. The threat set consists of relatively unsophisticated airborne vehicles, such as first generation cruise missiles, unmanned air vehicles, and fixed and rotary wing aircraft that have been equipped with simple navigation aids for autonomous delivery of conventional or biological weapons. The following threat types and cases make up 80 to 90 percent of the full threat spectrum and include:

- Reworked/retrofitted anti-ship cruise missiles
- Retrofitted drone type aircraft
- Retrofitted manned aircraft and kit planes
- Patrolling UAVs and UAVs equipped with ordinance

⁵ US Army Air Defense Artillery School Memorandum, Subject: Low Cost Interceptor, July 2001, p1.

⁶ US Army Air and Missile Defense Battle Lab Memorandum, Subject: Statement of Mission Need for LCI, 30 July 2001, p1.

Table 1 shows the general characteristics of these different threat types.

Table 1 General Threat Type Characteristics

Type	Description	Range (km)	Cruise Velocity (SL Mach)	Altitude (Min/Max) (m)	Max Maneuver Capability (g's)	RCS (m ²)	Dimensions Length/Span (m)
A	Anti-ship cruise missile adapted for land attack role	100 – 800	0.5 – 0.9	50 / 300	5	0.1 – 1.0	~7-8 / 3-3
B	Drone aircraft adapted for land attack role	100 – 2000	0.5 – 0.9	50 / 2000	3	0.1 – 2.0	2-4 / 2-4
C	Propeller aircraft or drone adapted for land attack role	100 – 2000	0.1 – 0.3	100 / 2000	3	0.1 – 4.0	~7-8 / 7-8 (Prop) or ~2-4 / 2-4
D	UAV surveillance aircraft	100 -1000	0.1 – 0.3	100 / 10,000	3	0.1 – 1.0	~2-4 / 2-4

The threat cases for which the LCI might encounter include a wide spectrum of potential flight characteristics and attack profiles. Six cases have been defined to describe direct and maneuvering attacks. Weather and day/night cases are derivative of case II. Figure 1 shows an example cross range plan of a defended area. The anticipated intercept region is between 100km and 200km. Assuming Round Earth, an elevated sensor 4.6km above ground level can see the horizon at about 300km. The detection range using an elevated sensor is greater than 500km.⁷

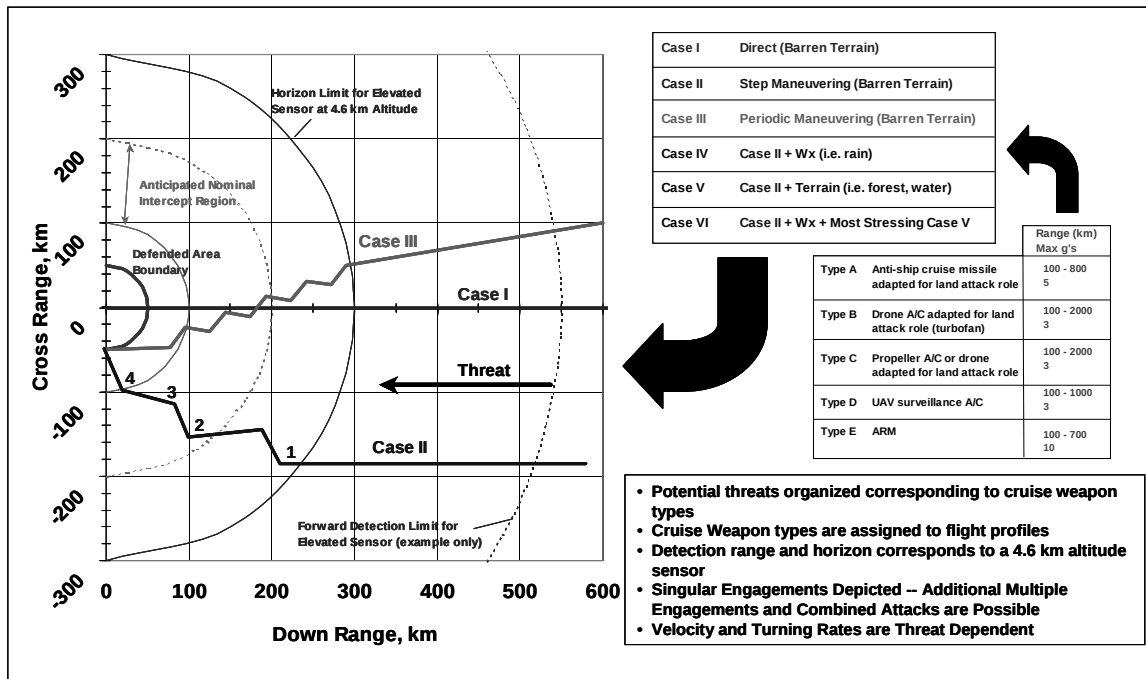


Figure 1. Example Defended Area Plan

IV. Low Cost Interceptor Development and Design

The development of the LCI has been an iterative and multi-level process that has traded cost, requirements and performance. A system requirements review (SRR) and system and subsystem preliminary design reviews (PDR) in 2002, led to the initial design shown in Figure 2. A key requirement for the missile was the ability to engage targets at ranges in excess of 100 km. Major subcontractors supporting Miltec on this effort included Northrop Grumman Electronics Division (responsible for the seeker), Aerojet Corporation (responsible for the propulsion system) and MPC Products (responsible for the control actuation system). Miltec is responsible for the air frame and avionics, as

⁷ Mission, Threat and Environmental Summary for the Low Cost Cruise Missile Defense / Low Cost Interceptor Program, pp 3 -8.

well as integration, assembly and testing. Off the shelf components and existing technologies are incorporated into the design as a cost saving measure whenever possible. Throughout the program, we've traded costs against performance to maintain the low cost aspect of the interceptor. Efforts in this early phase included a control actuation system prototype, static fire testing of the solid rocket motor, wind tunnel testing, and the development and testing of avionics testbed.

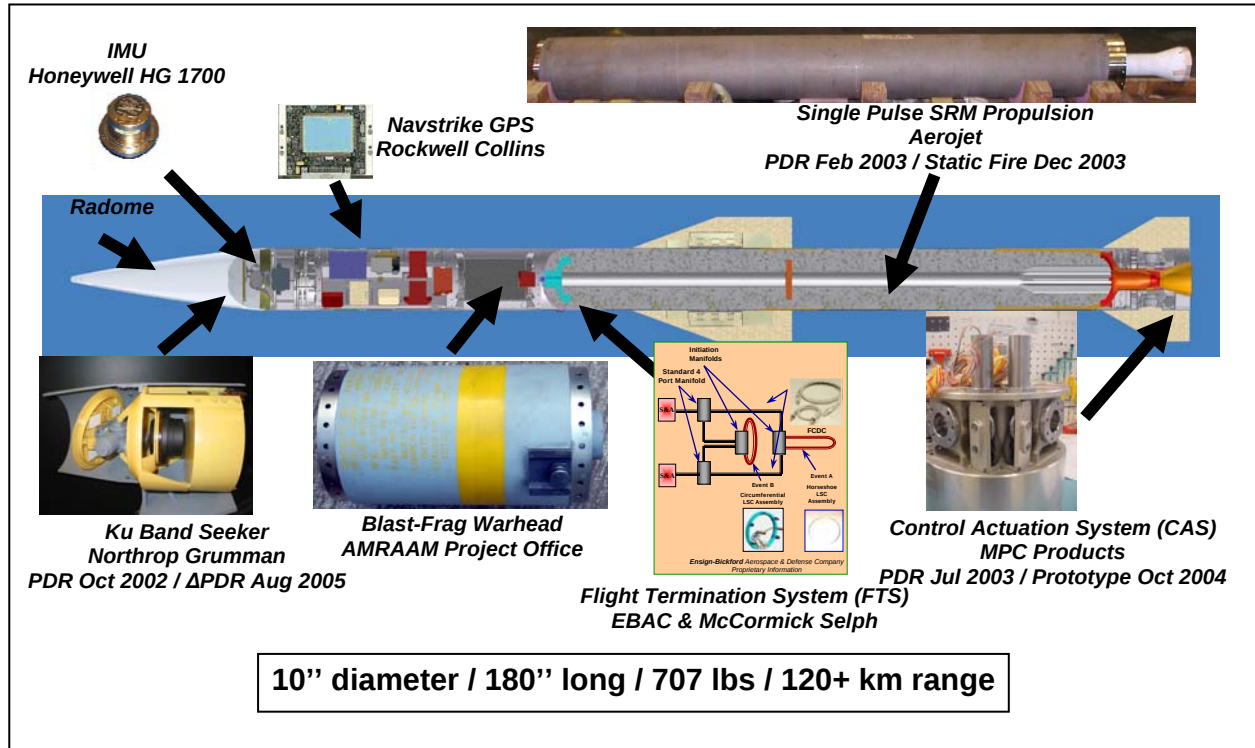


Figure 2. LCI 10" Design and Development Status

In August of 2004, USASMDC/ARSTRAT awarded a follow-on contract to the initial BAA, which included a basic and two optional tasks within the contract:

- Basic - Conduct of a Short Hot Launch (SHOTL) Flight Test at Redstone Arsenal
- Option 1 - Conduct of a Critical Design Review (CDR)
- Option 2 - Conduct of a Controlled Vehicle Flight Test

Preparation for the SHOTL Test began in September of 2004, with a scheduled launch in August of 2005 – a period of less than one year. Miltec received a HAWK Launcher as Government Furnished Equipment and developed a design that would replace one of the launcher sections with a rail. A surrogate propulsion unit was selected which replicated the initial launch environment, but facilitated the missile staying within the confined range fans of Redstone Technical Test Center (RTTC) Test Area 1. Components for a Ground Test Unit (GTU) and Flight Test Unit (FTU) were procured and using Miltec and RTTC facilities, the two units were integrated, assembled and ground tested. On 3 August 2005, the SHOTL test was successfully conducted, and achieved the primary tests objectives of:



- Measuring Induced Missile Tip-off Rates and Launch Data
- Validating the LCI Launcher Design and Mechanical Interface to the Missile
- Establishing and Practicing Miltec IA&T, Range and Launch Procedures
- Demonstrating Program Maturity

In March 2005, while preparations for the SHOTL Flight Test were progressing, Miltec received contractual direction to modify the design of the LCI so that the missile would be capable of launching within the Surfaced Launched Advanced Medium Range Air-to-Air Missile (SLAMRAAM) architecture. This contractual change, directed by the Commanding General of USASMDC/ARSTRAT, resulted from AMRAAM escalating costs and failure to meet the objective range of the SLAMRAAM requirements. Miltec was directed to take the 10" missile design, capitalize on efforts to date, and redesign the missile to a 7" configuration that fit within the volume and weight constraints of AMRAAM. The resultant design, shown in Figure 3, is currently undergoing subsystem and component tests.

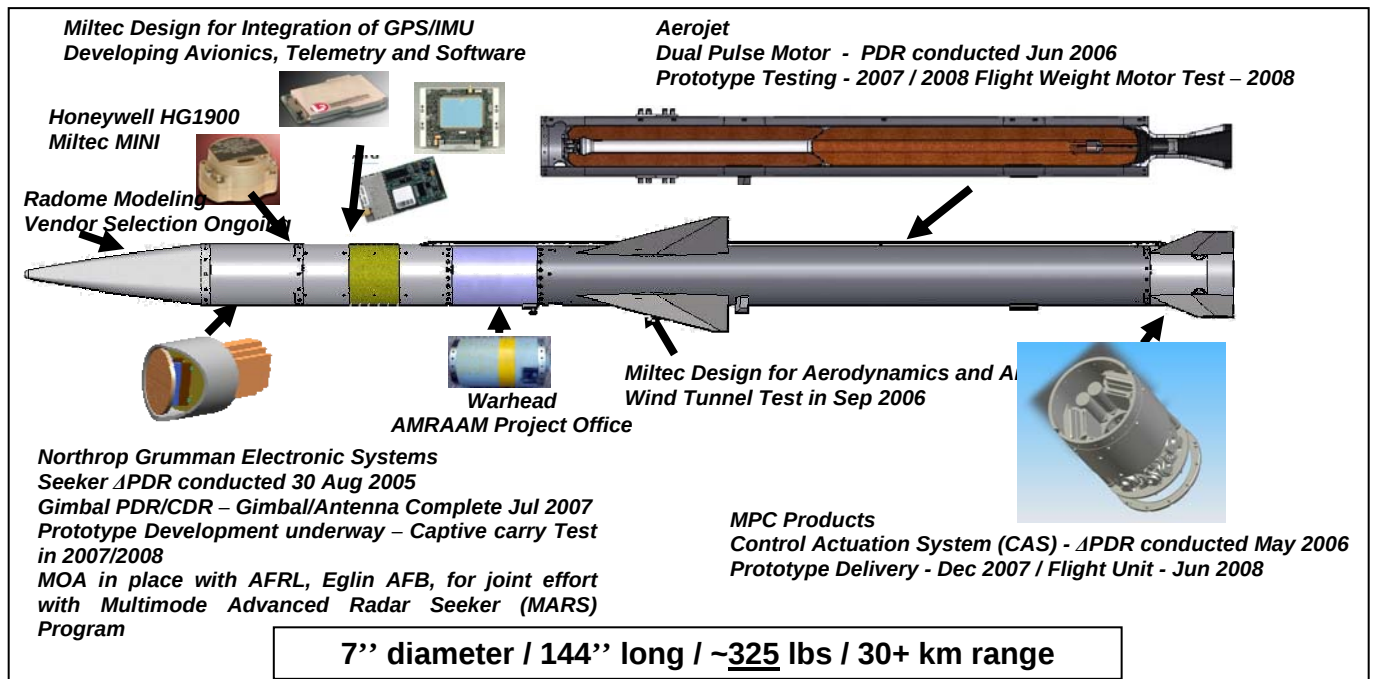


Figure 3 LCI 7" Design and Development Status

One key outcome of efforts to date has been the Memorandum of Agreement (MOA) between USASMDC/ARSTRAT and the Air Force Research Laboratory (AFRL) at Eglin Air Force Base for joint development efforts between LCI and the AFRL's Multimode Advanced Radar Seeker (MARS) Program. The MARS program is using the gimbal and antenna assembly developed and tested under LCI for a 2009 scheduled captive carry flight test (Figure 4). LCI is leveraging from this effort through the MARS procurement of the electronics backend assembly and modifications to the aircraft and flight schedules. Both of these programs have benefitted from the internal research and development (IRAD) funded Northrop Grumman efforts in the Common Miniature Ku/Ka (CMK) program. The seeker is KU band, and the antenna is electronically steered for elevation and mechanically controlled for azimuth.

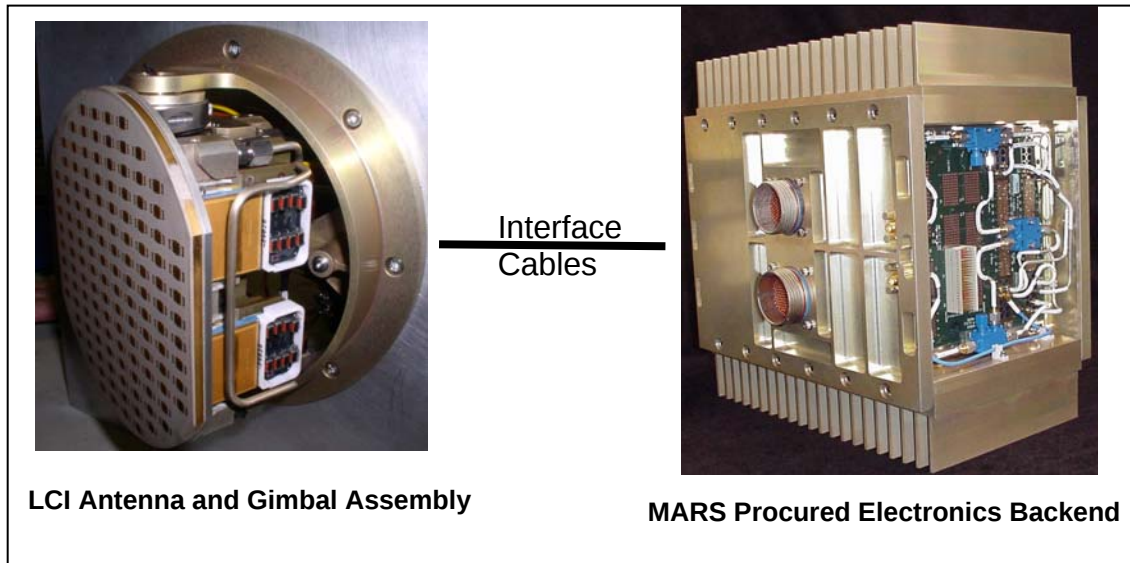


Figure 4. Joint Efforts between the LCI and MARS Programs

The 7" design missile has a dual pulse solid rocket motor, with a first pulse that boosts the interceptor to cruise velocity and a second pulse that produces the necessary endgame velocity and acceleration necessary to defeat the threat. LCI also has an innovative clamshell design for the control actuation system (CAS), designed by MPC Products, that allows the CAS to be installed or removed from the interceptor without interference from the rocket motor blast tube.

The program has separate contractor and government cost analysis teams. These teams monitor the efforts, update cost estimating relationships and vendor provided quotes and analyses, and update the cost models on a continuous basis to ensure LCI remains a cost effective missile. There have been several independent reviews of the cost model and LCI remains a viable and, as importantly, affordable missile.

With successful completion of the propulsion system in 2009, the program is on schedule to conduct a controlled vehicle flight test in 2010.

V. Conclusion

The LCI will have the ability to intercept relatively unsophisticated cruise missiles, unmanned aerial vehicles, remotely piloted vehicles, drones/decoys, and fixed and rotary wing aircraft, all of which are capable of carrying conventional and weapons of mass destruction warheads. It thus enhances the capability of current and future Air and Missile Defense (AMD) systems to counter the air threat, and provides the AMD commander with another option for the air defense battle. Use of LCI against these unsophisticated threats provides significant munitions cost savings (cost per round, as well as cost per kill), and allows preservation of higher cost, more capable interceptors for more stressing threats.

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¹US States Government and Accounting Office, "Cruise Missile Defense – Progress Made but Significant Challenges Remain, GAO/NSIAD-99-68, 31 March 1999.

²Brombery, Howard, Colonel, USA, US Army Air Defense Artillery School Memorandum, Subject: Low Cost Interceptor, July 2001.

³Bell, Hugh M. III, LTC, USA, US Army Air and Missile Defense Battle Lab Memorandum, Subject: Statement of Mission Need for LCI, 30 July 2001.

⁴Space and Missile Defense Command, "Mission, Threat and Environmental Summary for the Low Cost Cruise Missile Defense, Low Cost Interceptor Program, June 2001.