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THE DEPARTMENT OF DEFENSE

THE BALANCED TECHNOLOGY INITIATIVE: ANNUAL REPORT TO CONGRESS

VOLUME II

BTI PROJECT STATUS REPORTS

BASED UPON

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The Balanced Technology Initiative (BTI) is a program started by the 99th Congress to enable the DoD to correct gaps in U.S. conventional warfighting capabilities. The BTI program seeks quantum jumps in capabilities, not evolutionary improvements, and strives to realize these jumps by applying advanced technolgy.

This is an edited version of the BTI Project Status Reports which were provided to Congress as part of the annual report. In the past year, the program has achieved several noteworthy milestones and successes.

The report summarizes the operational utility, technical approach, progress to date, and planned activities for 17 BTI projects. The projects fall under the broad categories of: Advanced Armament, Target Acquisition, Battle Management- C3I, Smart Weapons, and High Power Microwaves.

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BTI PROJECT STATUS REPORTS

This version of Volume II to the BTI Annual Report to Congress has been edited for dissemination to industry. Volume II provides summary status reports of selected BTI projects. "For Official Use Only," proprietary, and funding information contained in the original report have been deleted.

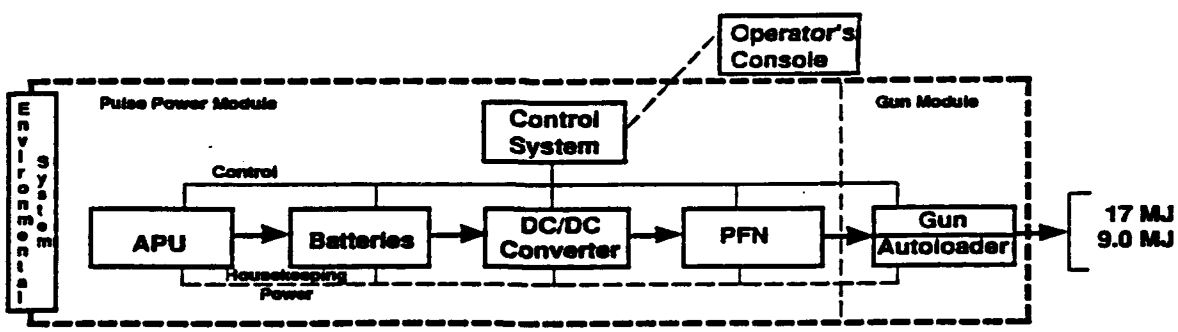
ET GUN PULSE POWER MODULE

BTI POWER MODULE DEMONSTRATION

BTI support to the Army Electric Gun Program has focused primarily on the development of the pulse power module (PPM) to generate, store, and transfer the electrical pulse to the weapon. The product of this phase of the current effort, which will be completed in mid 1992, will be a pulse power module test bed that will enable electric gun testing to move from the laboratory to the field in an operational range environment. The PPM is designed to be a completely self contained, transportable, environment independent system that can be used at a variety of test sites.

The approach taken by the Service's electric gun projects is to maximize the performance of conventional gun tube technology through the development of a propulsion system to increase the energy at the muzzle. This translates into increased velocity and projectile kinetic energy. The goal of the Army ET Gun project is to improve the range of battlefield gun systems and enhance lethality.

PULSE POWER MODULE CONCEPT

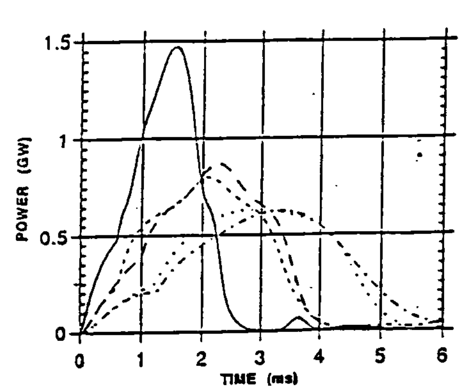


The BTI PPM employs an auxiliary power unit to charge the storage batteries and power the environmental system, control system, and diagnostics. Bi-polar lead acid batteries (twenty 5-megajoule units) deliver 100 megajoules of energy at 400 volts DC through the DC/DC converter to the pulse forming network. The DC/DC converter increases the 400 volts DC power from the batteries to 16,000 volts DC at 1.2 megawatts peak power. The stored energy is released to the gun through a pulse forming network comprised of capacitors, inductors, and interconnections developed especially for this application. The modular design of the PPM has been developed to provide a platform to demonstrate new pulse power components in a systems environment. The battery modules, converter system, pulse forming network components such as capacitors, switches, or inductors can be replaced on an as-available basis to support existing and planned development.

TECHNICAL APPROACH

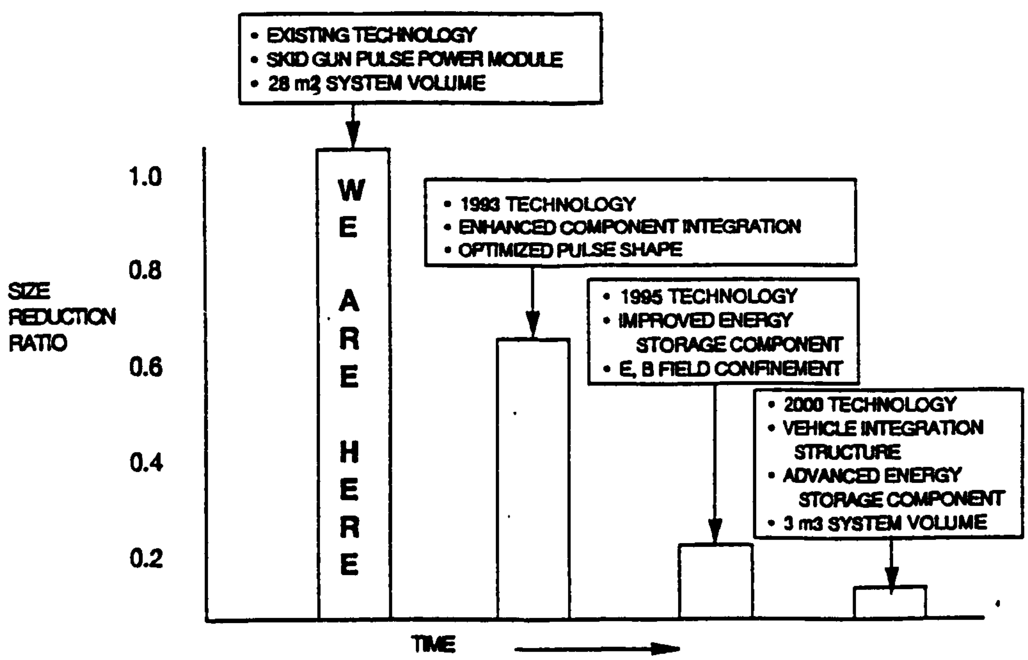
The modular design of the pulse power module allows for the insertion of next generation components as they become available. The PPM provides flexibility in shaping the power pulse to suit the requirements of a wide variety of electric guns. Pulse shaping in achieved by varying switch timing and capacitor voltage and by changing inductors. The PPM provides a unique testbed for powering electrothermal-chemical guns with a variety of pulse shapes, energies, and repetition rates.

Pulse Shape Flexibility



The forecast for PPM technology indicates continued improvement in volumetric efficiency. One fourth of the existing configuration PPM developed under this project will provide sufficient power for the Navy 60mm CIWS application of the ET gun. But future Army applications to combat vehicles demand an order of magnitude reduction in size if the current technology is taken as the baseline. The Army has a component and component technology program to achieve the desired volumetric efficient designs.

Pulse Power Technology Forecast



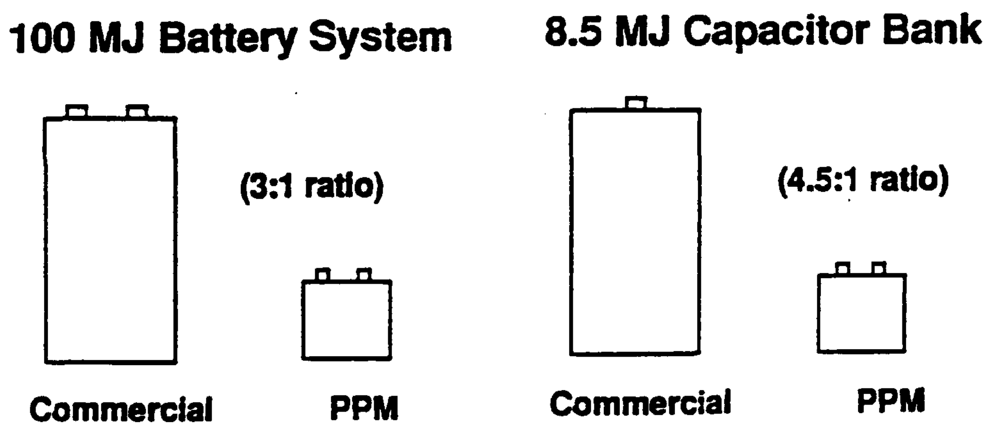
DEVELOPMENT STATUS

The first phase of the BTI Army PPM project is nearing completion. The design required the development of new components and extending the state-of-the-art in existing components. The improvements in component technologies has resulted in significant size reductions in comparison to commercially available components. Notable size and weight reductions have been achieved in battery and capacitor systems.

PPM Component Development

PPM Component	Available at Contract Award	Developed Under PPM Contract
Capacitors	0.3 kJ/kg	1.5 kJ/kg
Inductors	150 kA peak	250 kA peak
PFN Cables	Single Pulse capability	Multiple pulse capability
DC/DC Converter	N/A	12 kW/kg 10 MW/m3
Battery	25 kJ/kg, 0.2 kW/kg	40 kJ/kg, 0.5 kW/kg
Battery Coax Cables	N/A	200A, 1 kV
Battery Junction Box	N/A	3500 A DC switching

Size Reduction Achievements



TRANSITION PLAN

No FY 1992 or FY 1993 BTI funds have been allocated to the PPM project. Development and final testing of the PPM is being completed using Army FY 1992 funds. As part of the initial tests, the PPM will demonstrate single and multiple electrical pulses to a resistive load. Pulse shape flexibility and repeatability will also be demonstrated.

Once the capability of the PPM has been demonstrated and the BTI project goals achieved, the Army and the Navy plan to use the PPM for a variety of projects. The PPM will be used to fire a 60mm electrothermal-chemical (ETC) gun to test the Navy ET cartridge at the Ballistics Research Laboratory (BRL). FMC, the PPM development contractor, will use it at BRL to support their follow-on 60mm ETC tests. BRL will use the PPM to test alternate ETC propellants and to validate their computer models and diagnostics. The Navy also intends to use the PPM to power the 60mm ET gun integrated with the close-in weapon system mount and fire control system for a series of field tests. The PPM can be used on any remote test range because it is a fully self contained, transportable power module.

Program Management

The Army ET Gun Pulse Power Module project was managed for BTI by the Electric Armaments Program Office, ARDEC, Picatinny Arsenal, NJ.

BTI Project Director	Mr. Charles Hansult BTIO Alexandria, VA 22311 (703)998-7720	FMC Program Manager	Mr. Ron Ricci FMC Naval Systems Division Minneapolis, MN (612)572-4774

Current as of February 21, 1992

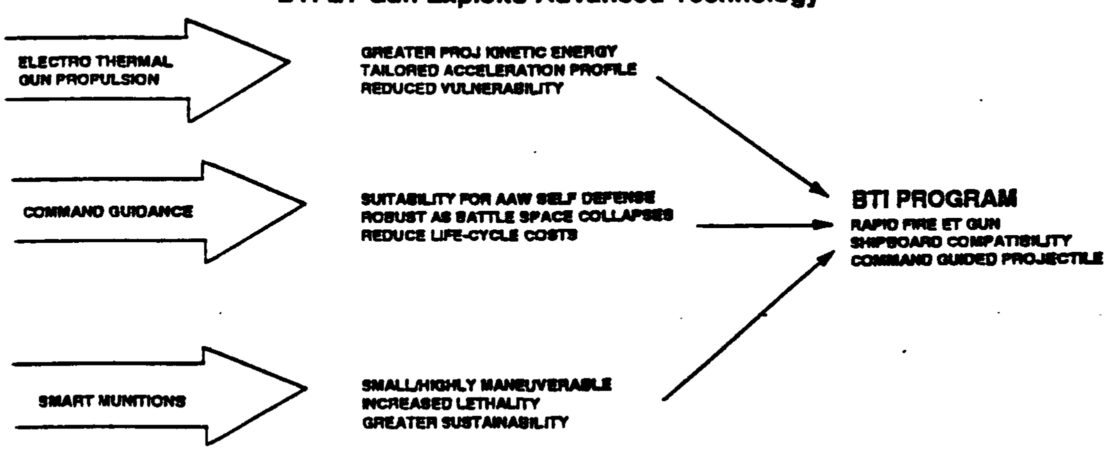
ELECTROTHERMAL GUN DEMONSTRATION

DEFENSE AGAINST THE SEA SKIMMER THREAT

The Navy's surface ship self defense capabilities are highly stressed by supersonic, highly maneuverable, sea skimming cruise missiles that will soon be readily available to third world countries. Future threats demand improvements in surface ship anti-air warfare system detection, control, engagement, and lethality.

Upgrading existing systems to counter the threat is necessary and desirable, but new approaches and technologies are also needed. The Balanced Technology Initiative (BTI) Electrothermal Gun Project is applying advanced technologies to demonstrate a potential solution to this requirement. Electrothermal propulsion technology, coupled with advanced command guidance and smart munitions technologies, should enable small caliber weapons to defeat the anti-ship cruise missile threat. They also have potential for the near term improvement of 76mm and 5-inch gun systems. Used in 5-inch and larger caliber guns, electrothermal propellant technology can enhance the performance and effectiveness of these weapons in the strike, anti-ship missile defense, anti-surface ship, and anti-tactical ballistic missile mission areas.

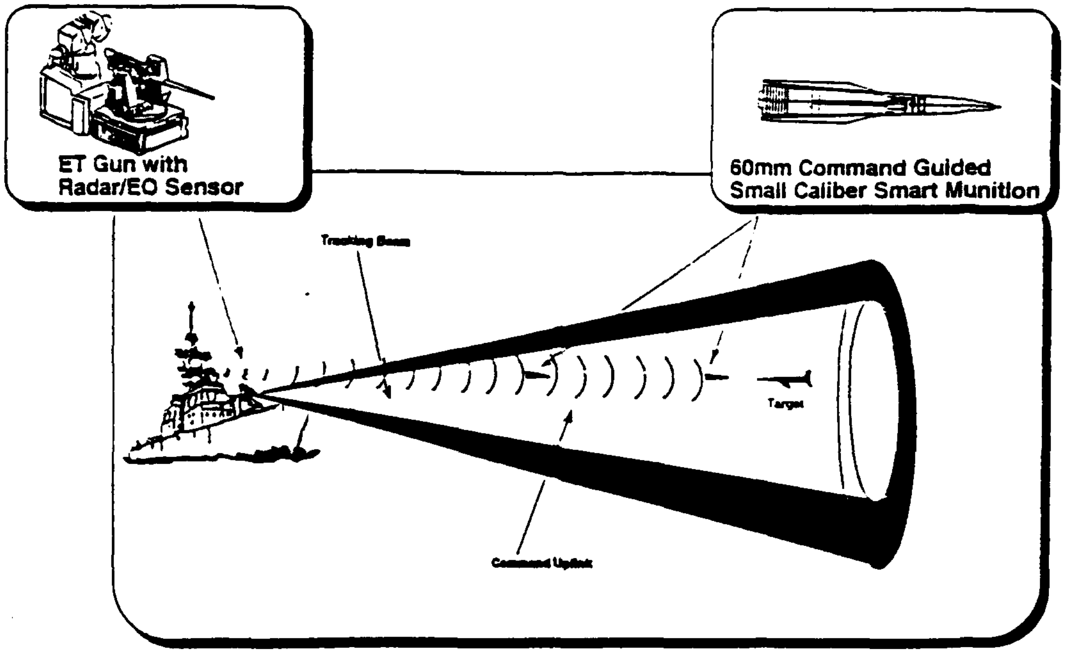
BTI ET Gun Exploits Advanced Technology



SYSTEMS CONCEPT

The Navy ET Gun concept employs an electrothermal gun and small caliber, command guided smart munitions. A target tracking radar or an electro-optic sensor will provide target data to a fire control system, which in turn will generate projectile guidance commands as well as gun pointing and firing commands. Guidance commands will be transmitted to the small caliber smart munitions via a communications link.

ET Gun Systems Concept



Steering commands are encoded by the communications link and transmitted in the K-band of the RF spectrum. The smart munition receives, decodes, and responds to these commands. The projectile design considers both thermal characteristics and radar cross section to provide compatibility with electro-optical and radar tracker systems.

TECHNICAL APPROACH

This project is taking the systems approach and builds upon available components and technology. Hardware development is matched with analytical studies for design definition, gun system effectiveness in the anti-ship missile defense role, and ship integration. The principle development efforts involve the design and test of an electrothermal cartridge, a 60mm gun/autoloader, and a small caliber guided projectile. This 60mm gun system is being used to provide proof-of-principle and permit evaluation of the gun/cartridge/projectile interfaces. Each of the two contractors selected will develop a suitable energetic, combustible, exothermic propellant and design an internal plasma generating and injecting device to ignite the propellant.

Hardware Development

- **Electrothermal cartridge**
- **60mm gun mount and autoloader**
- **Command guided projectile**
- **TASD Radar / Electro optical system**

The object is to control propellant

combustion through control of the shape and magnitude of the electrical firing pulse. The gun, cartridge, autoloader and control assembly, and the command guided projectile will be integrated with an existing Close-in Weapon System (CIWS) gun mount to study the technology issues associated with weaponization of the electrothermal gun concept. An existing electro-optical tracking system and a commercially leased power supply complete the demonstration package. A radar being demonstrated under a separate BTI project, Target Acquisition for Ship Defense (TASD), will be added to the system when it becomes available.

The analytical aspects of the project address requirements for surface ship defense in the context of the evolving threat and the resulting weapons system requirements. These studies address relevant parameters including caliber, rate of fire, lethality, kinematic performance, velocities, threat detection range, tracker accuracy, reaction time, and kill assessment.

Another study will model, design, and scale alternative pulse power configurations that could be integrated with existing surface ship main power systems. This analysis will determine power distribution layouts, identify critical component technologies, investigate alternate power generation concepts, and examine the impact of weight and volume changes on ship space and stability.

Other study efforts assess systems effectiveness and the technologies needed to integrate the pulse power system for the ET gun with existing ship power plants. Integration of the major systems components and subsequent progressive testing will be conducted at facilities of the Naval Surface Warfare Center in Dahlgren, Virginia.

A proof-of-principle demonstration is scheduled in December, 1993, using the 60mm gun, a fire control system and communications data link, and a hit-to-kill guided projectile. This demonstration will engage a subsonic maneuvering target in a live fire test.

DEVELOPMENT STATUS

The Navy ET Gun project began with the ship integration studies in FY 1991. Significant progress has been made in the development of the electrothermal propelling charge and in the design and fabrication of the gun and the autoloader. Development of the command guided projectile is also underway. Development contracts for the electrothermal cartridge were awarded to General Dynamics Land Systems Division and to FMC Corporation. The first phase has been completed, cartridge designs and materials have been evaluated, and results have been analyzed. Cartridge development and

ET Cartridge Objectives

Develop 60mm rapid fire ET cartridge

- Projectile mass 2.5-3.5 kg
- Muzzle velocity 1.2-1.4 km/sec
- Peak acceleration 30,000 g @ 1.2 km/sec; 40,000 g @ 1.4 km/sec
- Muzzle energy 2.5 MJ max
- Elec energy input 2 MJ / 10 KV max

Interface with ET Gun and enable high fire rate operation

ET Cartridge Accomplishments

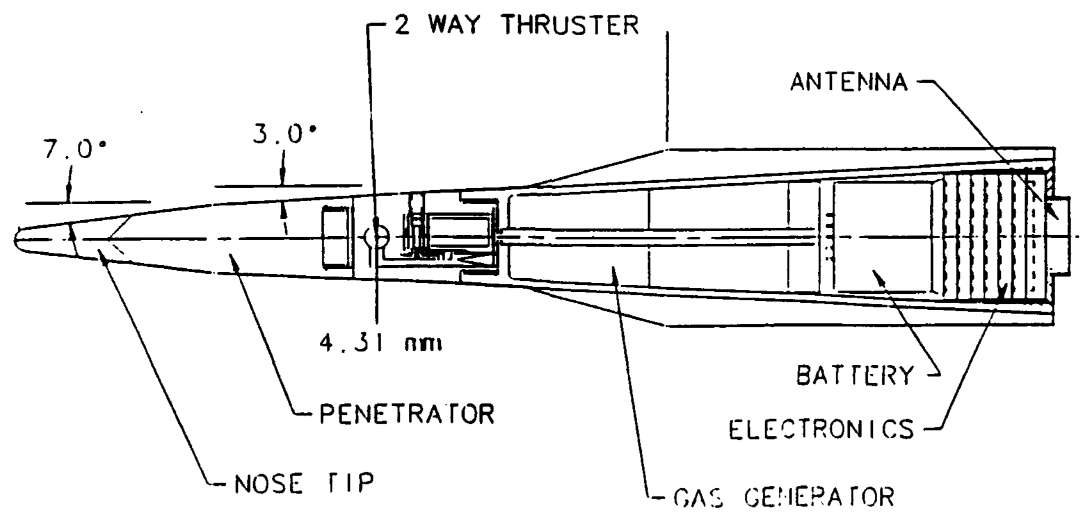
- Approximately 100 test firings
- Higher propellant kinetic energy demonstrated
- Burn rate, pressure, and temperature controlled through pulse power modulation
- Muzzle velocity repeatability demonstrated within projectile acceleration limits
- Muzzle energy varied by altering propellant composition and firing pulse amplitude

engineering improvement are continuing with the objective of optimizing the propellant formula, injector designs, and cartridge performance.

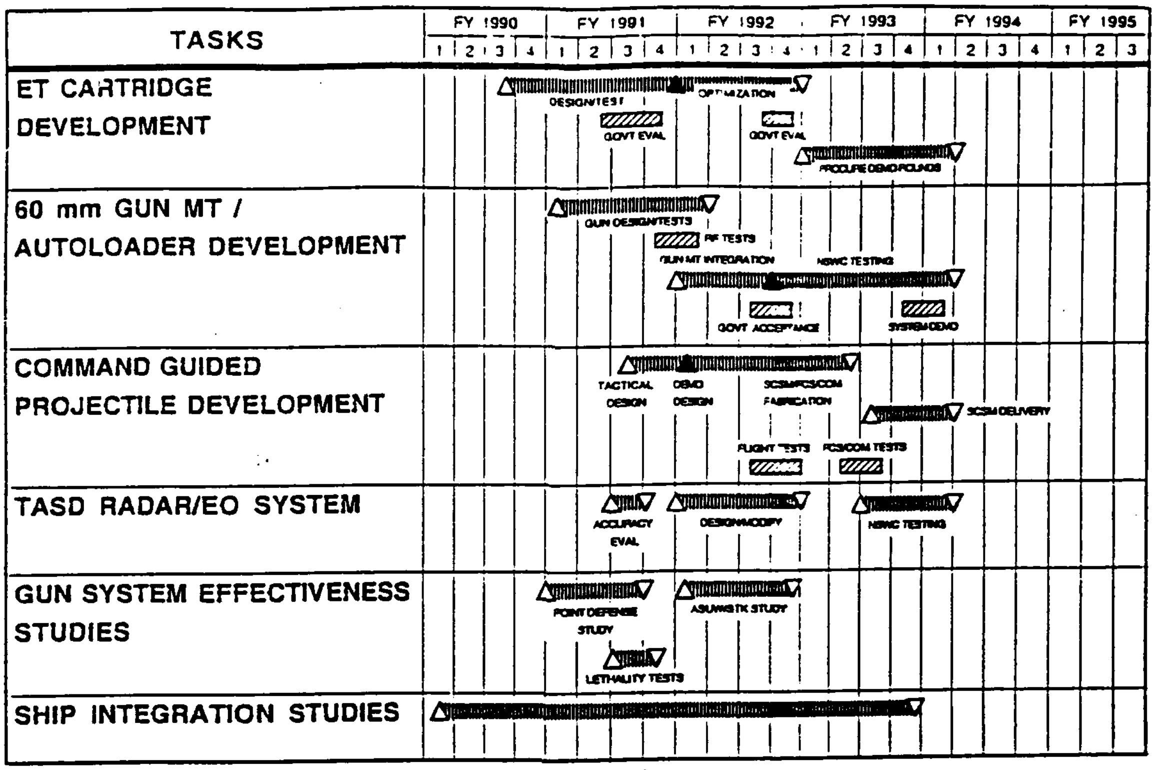
The 60mm gun designed by FMC has been built and is being tested. The rapid fire gun includes an autoloader and control system and is capable of firing a 10 round burst. Gun, autoloader, and control system integration is complete. The autoloader has been tested to 190 rounds per minute. The goal is 240. Both conventional and electrothermal cartridges can be fired using interchangeable breech blocks. After the initial rapid fire tests with electrothermal cartridges, the gun and autoloader will be mated with the CIWS Phalanx gun mount. System integration, testing, and the final demonstration will be performed at Dahlgren.

Key to the Navy ET Gun concept is the command guided 60mm tactical projectile. The General Electric Re-Entry Systems Department was awarded a contract for projectile studies and analyses, an initial projectile design, a related fire control system and a communications link to provide steering commands from the fire control system to the projectile. Design studies which considered several terminal seeker concepts, as well as both hit-to-kill and fragmentation projectiles, have been completed. Following these studies, General Electric has completed a design and is fabricating the projectiles, fire control system, and communications link that will be used in the system demonstration.

Small Caliber Smart Munition 60mm Projectile



ET Gun Demonstration Schedule



TRANSITION PLAN

If successful, this BTI project will provide the Navy with a candidate system to satisfy its need for a rapid fire, highly accurate weapon system to counter low cross section antiship missiles. Active transition opportunities include future research and development for improvements to the close-in weapon system (CIWS), an advanced technology demonstration of guided projectiles in FY 1994 as part of a DDR&E thrust area, a joint Defense Nuclear Agency / US Navy 5-inch electrothermal chemical gun program, and the DDG-51 FLT IIA block upgrade.

Program Management

The Navy ET Gun project is managed for BTI by NAVSEA, Arlington, VA. Technical direction is provided by the Naval Surface Warfare Center, Dahlgren, VA.

BTI Project Director	Mr. Charles Hansult BTIO Alexandria, VA (703)998-7720	Navy Program Manager	CDR Craig Dampier NAVSEA 06KR12 Arlington, VA (703)602-4921

INTEGRATION OF TASD

A separate BTI project, Target Acquisition for Ship Defense (TASD), was initiated to overcome the limitations of conventional ship-board self defense radar systems to provide fire control for the engagement of high-speed, very low altitude, low signature, maneuvering antiship missiles. This project is now complete, and the radar will be integrated with the fire control for the ET gun.

TASD uses a dual band (Ku and W) radar to detect and track the incoming missile. Initial tracking is accomplished in the Ku band with hand off to the narrow beam W band millimeter wave radar. This provides the resolution and angular accuracy needed to operate very close to the horizon. TASD will track both the incoming missile and the outgoing projectiles. When the target comes within firing range, the dual band radar will provide angular track accuracies on the order of 0.1 milliradians at three nautical miles.

Current as of February 11, 1992

ENHANCED KINETIC ENERGY MUNITION

X-ROD IMPROVES EFFECTIVENESS OF ARMOR

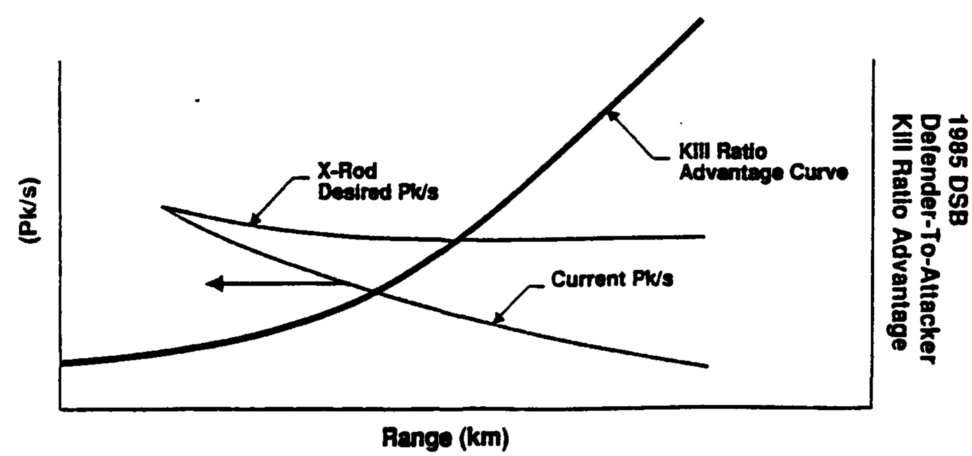
The Balanced Technology Initiative (BTI) X-ROD project objective is to develop guided, boosted 120mm kinetic energy projectiles that can defeat enemy armor at long range. The proposed new munitions will provide fielded tanks with:

- Extended lethal range
- Improved probability of hit using guided projectiles
- Improved probability of kill given a hit from inflight boost and long rod penetrator
- Capability against helicopters

In 1985 the Defense Science Board conducted a study of U.S. armor-antiarmor capabilities. One of the conclusions was that firing accurately at greater range increases the defender to attacker kill ratio advantage. This is supported by Army Material Systems Analysis Activity studies.

This payoff is clearly indicated in the figure. The probability of kill given a shot decreases with range for current tank ammunition, but the curve is almost flat for the guided X-ROD projectile. This translates to a significant improvement in the defender-to-attacker kill ratio at longer engagement ranges.

Performance vs. Payoff



FIRING FIRST AT GREATER RANGE INCREASES THE DEFENDER-TO-ATTACKER ADVANTAGE RATIO

SYSTEMS CONCEPT

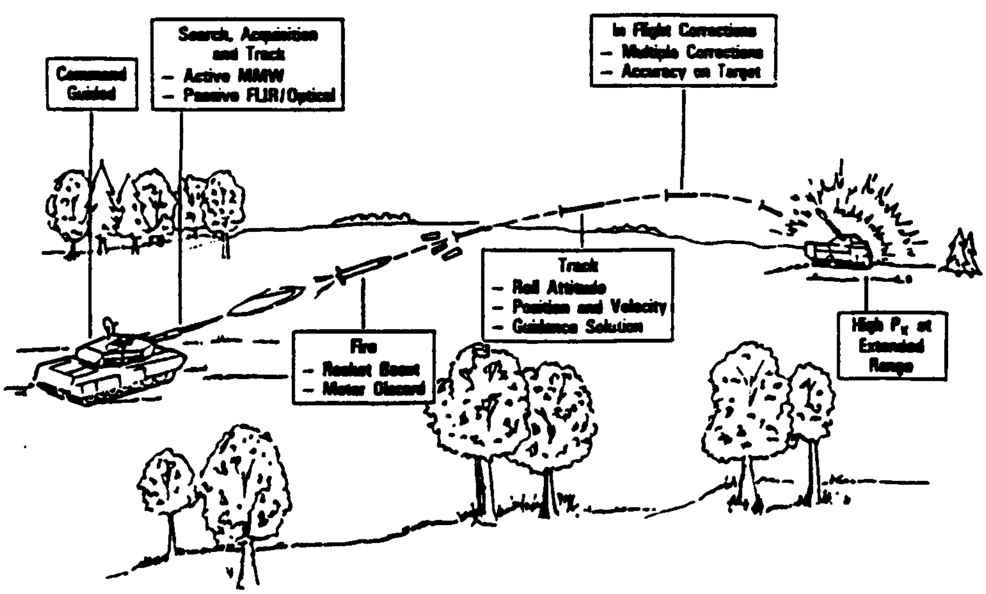
Two distinct X-ROD projectile concepts are being developed in the BTI project. The AAI Corporation in Maryland is developing a command guided projectile that uses the MTAS millimeter wave radar to generate course correction commands. The commands are transmitted to a control unit mounted on the aft end of a high velocity long rod penetrator.

Hercules Defense Electronic Systems Company in West Virginia has chosen a fire-and-forget concept. The Hercules version uses a high velocity rocket boosted projectile that contains a long rod penetrator. An on-board millimeter wave seeker provides self contained target acquisition and terminal guidance.

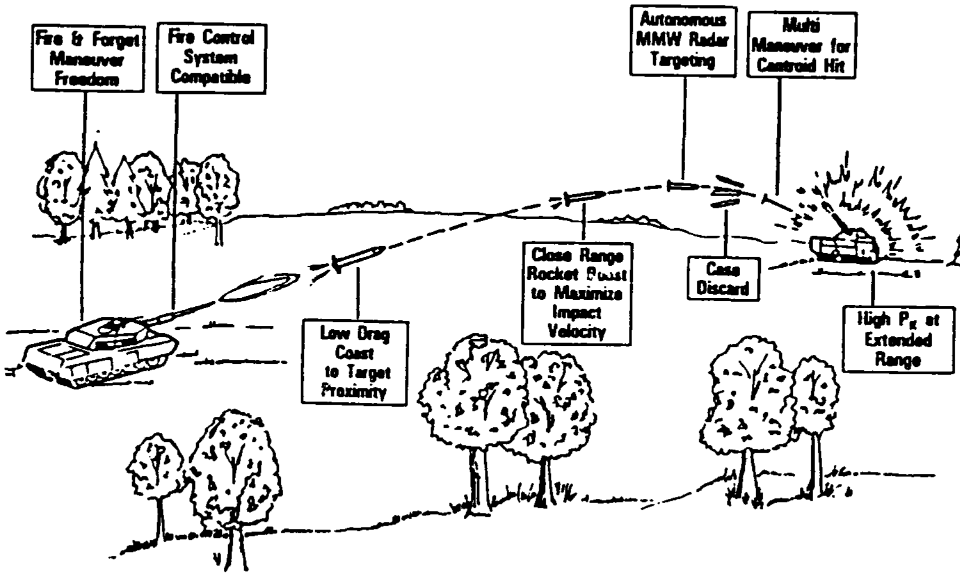
As depicted in the figures, the two approaches are similar in their operational concepts and differ principally in implementation. The AAI command guided projectile requires target acquisition and tracking by the MTAS radar prior to firing. Rocket boost is provided immediately after the projectile is fired. The rocket motor is discarded when the motor burns out. Guidance commands are relayed to the missile throughout the flight to the target. The fire control system is committed to the engagement from launch to impact, but the time of flight is short -- on the order of 2-3 seconds maximum. This approach requires modifications to the MTAS radar being developed for the future tank.

The Hercules concept requires no radar or other modifications to the tank and is compatible with the existing fire control system. All the flight guidance components are carried on the projectile. Rocket boost is provided as the projectile nears the target, maximizing the velocity at impact. Since the weapon is autonomous, the tank is free to maneuver immediately after firing.

Command Guided Projectile System



Autonomous Projectile System



TECHNICAL APPROACH

The alternative technical approaches offer different advantages and pose different risks. The AAI command guided projectile system is potentially the least costly because the complex guidance electronics remain on the tank. Expected lethality is high due to the high impact velocity afforded by the rocket boost-coast flight profile and the advanced long rod penetrator employed. A modified MTAS radar will provide the long range fire control capability required.

The disadvantages of the command guided technical solution center on the expected performance of the MMW radar. At present, there is still considerable uncertainty that multipath problems can be resolved sufficiently to reduce projectile/target tracking errors to acceptable levels. The effects of the separation of the expended rocket motor case on ballistic accuracy is also a risk area.

The autonomous projectile avoids the need for a tracking radar on the tank and allows maneuver immediately after firing. Rocket boost and motor case discard occur late in the trajectory, which maximizes velocity at impact and minimizes the perturbation of the ballistic flight path. However, the millimeter wave guidance and control is considered high risk. The cost and complexity of this round is higher than the command guided round because the flight guidance electronics package is more complex and is expended as part of the projectile. Target acquisition and fire control is dependent on existing systems, which may not meet the requirements of long range engagements.

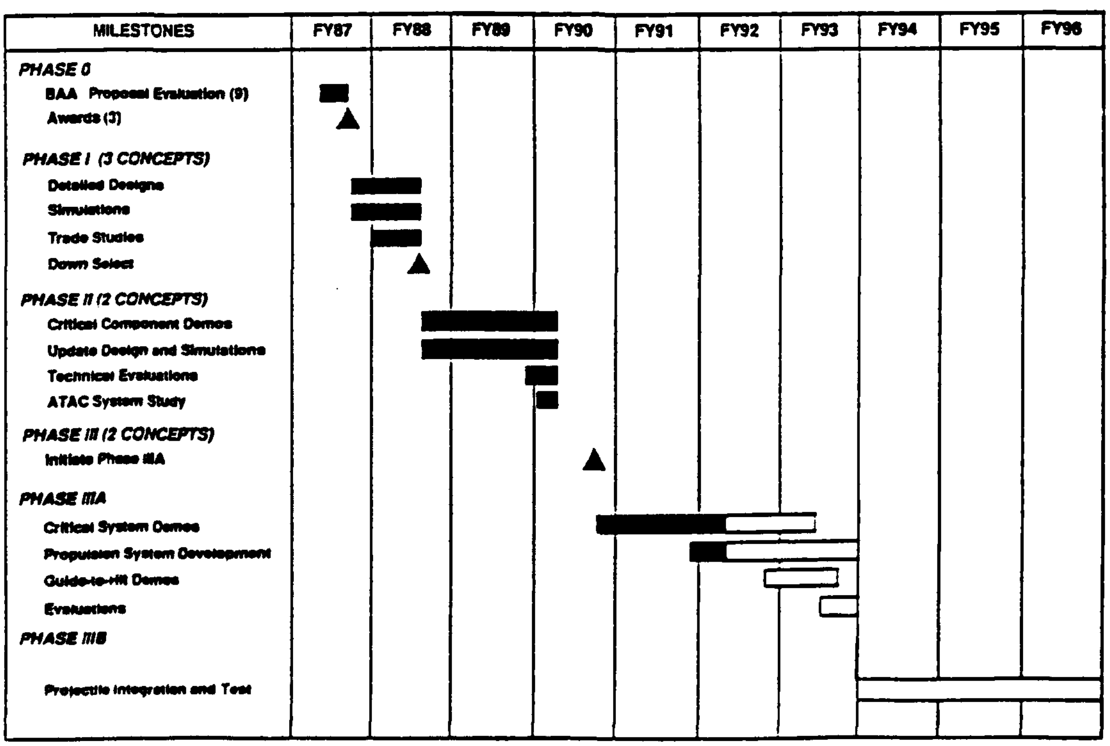
DEVELOPMENT STATUS

The X-ROD project is presently in Phase IIIA of a three phase effort leading to engineering and manufacturing development in FY 1995. In the first phase, which began in September 1987, three contracts were awarded for detailed designs, simulations, and trade studies of concept alternatives. Two of the three concepts were chosen to continue into Phase II.

During Phase II,critical components were demonstrated and the designs and simulations were updated. Technical evaluations and an ATAC system study were completed. AAI demonstrated the feasibility of their rocket motor case separation design. Separation was achieved with no major perturbation of the projectile trajectory. Radar static track of the projectile was demonstrated over short ranges. A breadboard design of the transponder carried in the projectile control unit was fabricated and tested. A six-degree-of-freedom simulation of the partial system was completed. Models were based on test results, and performance and sensitivities were predicted.

Hercules built and tested a breadboard MMW seeker in Phase II. A form, fit, and function MMW transceiver was fabricated, and critical MMW components were tested for their ability to withstand high gun-launch accelerations. Seeker algorithms were developed, and static and spin tests performed. A six-degree-of-freedom simulation of the total system was completed. Both contractors completed structural and propulsion system designs and analyses and performed wind tunnel tests.

Phase III began in June 1990. Because of uncertainties remaining after the completion of Phase II, the decision was made to restructure Phase III into two subphases. Phase IIIA is a 30-month system characterization, projectile demonstration, and



propulsion system development phase. During this phase both contractors will conduct projectile and guidance system characterization tests, initiate propulsion system development, and conduct guide-to-hit experiments. This phase will demonstrate guide-to-hit performance and resolve critical structural and propulsion issues for both system concepts.

Phase IIIB is scheduled to start in July 1993 and last 24 months. One or both contractors will perform propulsion, guidance, projectile subsystem integration and conduct guided and boosted all-up round flight demonstrations.

Phase III Technical Issues

AAI Command Guided

- Target/Projectile tracking accuracy
  Multipath & clutter errors
- Guidance and control
  No inertial feedback
  Aeroelastic effects
- Guidance module packaging
  Electronics packaging
  Divert thrusters miniaturization
- Upgrade of MTAS fire control

Hercules Fire and Forget

- Seeker performance in a real environment
  Acquisition and tracking algorithms
- Radome and conformal antenna development
- Electronics "g" hardening
- Guidance and control functions
  Guide-to-hit, maneuver timing

Both

- Penetration performance
  Rocket motor case effects
  Case separation disturbances
- Structures/propulsion, launch, ignition, boost
- Close-in lethality
- Countermeasures
- Target acquisition

TRANSITION PLAN

If the development of X-ROD continues successfully, BTI plans to transition the project to the Army pending a decision and a downselect in the fourth quarter of FY 1993. In accordance with Congres sional direction, the Director, BTI, plans to conclude a Memorandum of Agreement with the Army for continuation beyond the FY 1993 BTI effort. However, current Army budget projections do not include funding for X-ROD due to higher priority programs, making promulgation of an MOA uncertain at this time. Transition to the Army following the current phase is highly dependent on the future of the Army tank program. User acceptance of radar on the Main Battle Tank will determine support for the command guided approach.

Program Management

Overall program management for X-ROD is provided by DARPA Land Systems Office. Technical management is provided by ARDEC, Picatinny Arsenal, NJ.

BTI Project Director	Mr. Charles C. Hansult BTIO Alexandria, VA (703)998-7720	DARPA Program Manager	Dr. Peter Kemmey DARPA/LSO Arlington, VA (703)696-2347

DEVELOPMENT PLANNING

The 30-month Phase IIIA effort is intended to show the viability of the X-ROD concept and performance. Guidance system accuracy and in-flight performance will be demonstrated in the guide-to-hit experiments. The original intent was to fund both AAI and Hercules through Phase IIIA and then select one approach for continuation in Phase IIIB. However, technical uncertainties engendered by radar performance in a multipath environment could result in an early downselection in Phase IIIA. In that event, the project will be restructured to use the available resources most efficiently. Since the BTI funding for X-ROD was explicitly allocated by Congressional language, any restructuring will require approval of the appropriate Congressional Committees.

Current as of 18 February 1992

Short Range Anti-Tank Weapon

Project Description

The objective of this project is to develop, fabricate, and demonstrate a lightweight, proliferable, short range anti-tank weapon (SRAW) that will defeat future enemy tanks. The challenge is to incorporate advanced guidance and control, soft launch, and a lethal warhead into a small, light weight, low cost system.

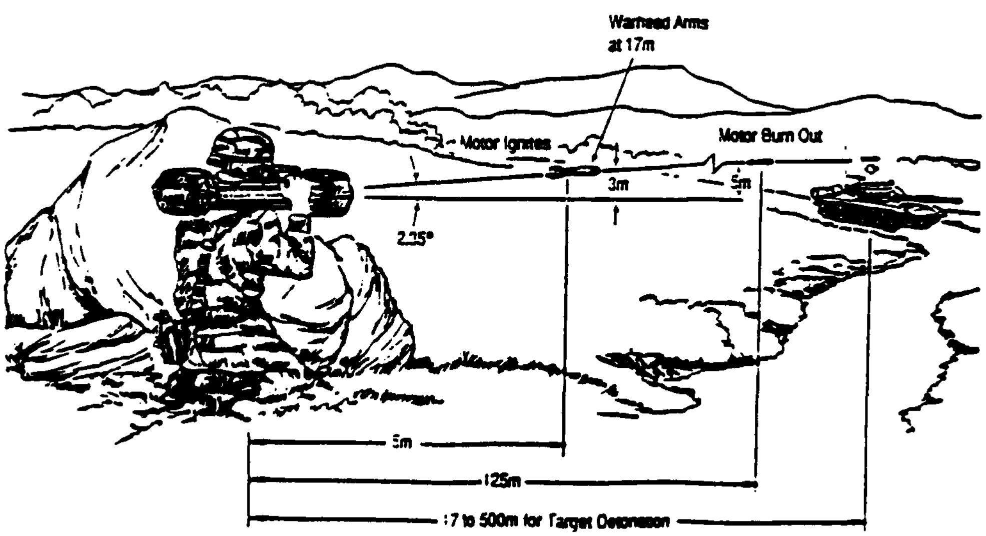
Operational Concept

The operational concept of SRAW employs a trajectory/flight control system and a downward firing EFP warhead to achieve accurate over-the-top kill of the target. Attacking the target's lightly armored top area increases the probability of kill. The short time of flight improves accuracy against moving targets. Soft launch and delayed motor ignition five meters from the launcher enable SRAW to be fired from inside bunkers and buildings and permit military operations in urban terrain capability. Gunner survivability is enhanced by the SRAW point/shoot, low firing signature, and fire and forget capabilities.

Required Operational Capability

- Fire and forget
- High probability of hit
- 20 pound system weight
- Fire from enclosures
- 17 - 500 meter range
- Disposable
- Family of rounds

Operational Concept



User Evaluation of SRAW Launcher at Camp Pendleton

Advantages of the SRAW Concept

- **Shoot-Down Top Attack Kill Mechanism**
- Warhead proven against SRAW targets
- Independent of attack aspect
- Can defeat targets in defilade

- **Dual Optical/Magnetic Fuze**
- Fuze proven in Dem/Val testing
- Demonstrated countermeasures immunity
- Integrated electronic safe and arm device

- **Soft Launch**
- Fully survivable system
- Fire from enclosure/MOUT capability
- Low launch signature

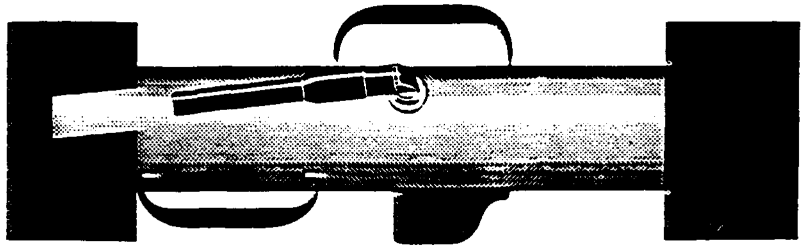
- **Directional Guidance System**
- Ease in aiming
- Simple guidance and control electronics proven in Dem/Val testing
- Fire and forget
- Achieves accuracy requirements at desired ranges

- **Wooden Round**
- No maintenance required

CRITICAL COMPONENTS TO BE DEMONSTRATED IN PHASE II

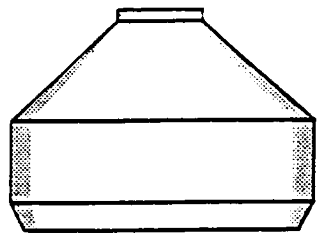
Launcher

- Structure Proven in Test
- Simple Reliable Telescopic Sight
- Fire Through End Caps
- Point and Shoot System



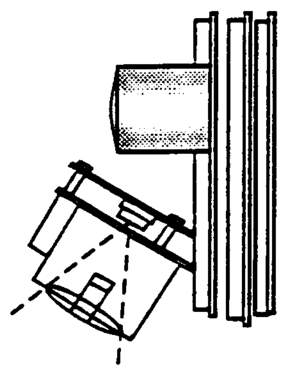
Shoot-Down Top Attack EFP Warhead

- Proven Lethal Against Range Targets
- Adapted From Proven Design
- All Aspect Kill
- Effective Against Targets in Defilade



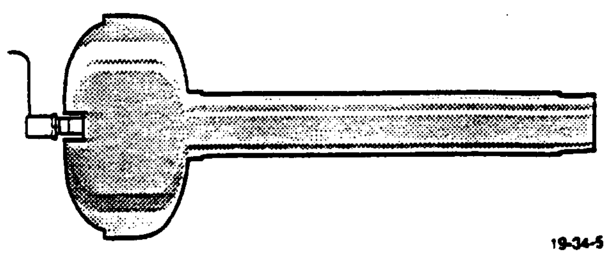
Electronic System With G&C Sensors and Integrated Optical/Magnetic Fuze and S&A

- Optical/Magnetic Fuze Adapted From Proven Design
- Fully Electronic S&A Integrated Into Fuze System
- Quartz Rate Sensors Provide Low Cost Performance
- Integrated Electronic Systems Allow Full Check-Out Before Installation Into Missile



Unitized Launch/ Flight Motor

- Proven in Environmental and Flight Testing
- Low Cost and Schedule Risk
- Minimum Launch Signature



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BTI Project Status

System Characteristics

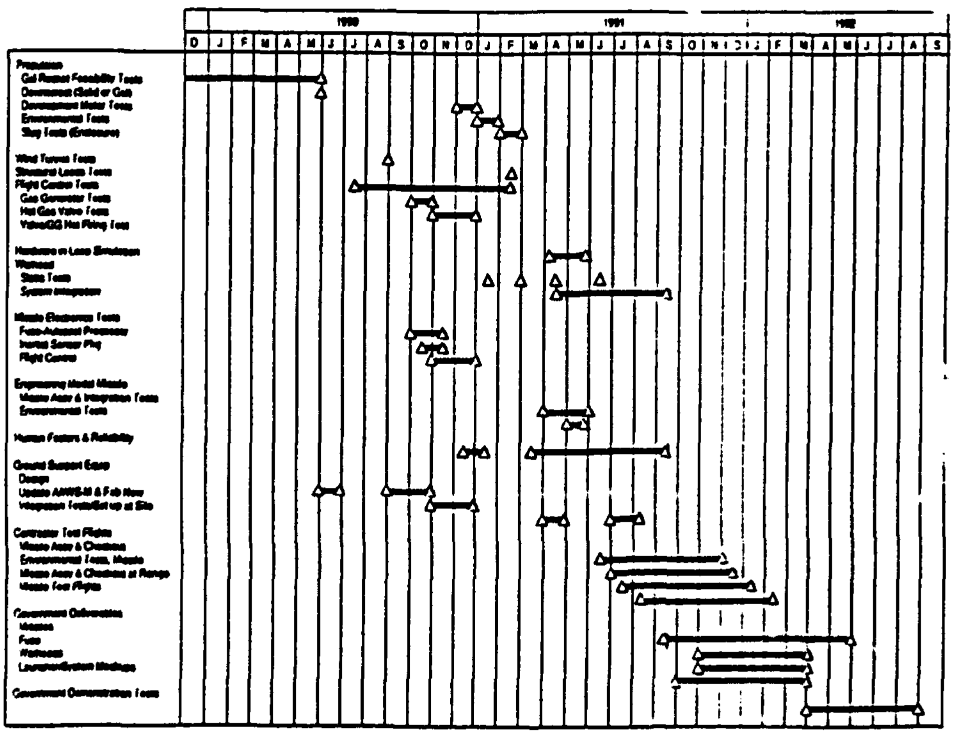
Guidance:	Directional autopilot
Warhead:	EFP/Top attack
Size:	140mm diameter 859mm length
Weight:	19 pounds
Velocity:	Launch: 34.8 m/s Maximum: 301.9 m/s
Time of Flight:	2.25 sec to 500 m
Dispersion:	1.5 milliradians
Launch Noise:	173 dB (enclosure)

Management

Project Direction	Jim McDonald, BTI 1901 N. Beauregard St. Suite 380 Alexandria, VA 22311 Tel: (703)998-7720
Contractor	Lewis R. Loth LORAL Aeronutronic (714)720-4795

Cost:

- **Low development costs**
- **Achievable $3,900 unit production cost**



Project Schedule

TECHNICAL APPROACH

The technical approach to SRAW is to integrate proven component hardware into a system that satisfies the operational requirements. Previous development of the AAWS-M warhead and continuing development of the TOW-2B warhead have contributed greatly to the SRAW warhead design. The directional autopilot automatically adjusts for variations in the firing conditions and makes the system simple to operate. This approach retains a capability for direct attack, if desired. Although the technical risk associated with the SRAW hardware components is considered low, the project is structured to reduce these risks further.

Autopilot Features

- Control of trajectory height above target for optimum top attack effectiveness
- Crosswind correction
- Adjustment for uphill and downhill firing conditions
- Compensation for initial roll angles
- Compensation for temperature effects on rocket motor performance

RISK REDUCTION

System Component	Risk Evaluation	Basis of Risk Evaluation	Risk Mitigation Plans
Warhead	Low	Demonstrated performance in AAWS-M and OATS tests	Additional testing in Phase II
Active Fuze	Low	Demonstrated fuzing and counter-measures performance in AAWS-M tests	Continued algorithm optimization
Propulsion	Low	Motors adapted and soft launch demonstrated from AAWS-M	Early static tests
Flight control	Low	JRC system flight tested on Stinger Alternate	More tests in Phase II
Missile Airframe	Low	Conventional structure, Conventional aerodynamics	Structural loads tests Wind tunnel tests
Guidance	Low-to-medium	Performance validated by 6-DOF simulations	Hardware-in-the-loop simulations
Launcher	Low	Mock -up fabricated for human factors engineering evaluation	User evaluation by Marine gunners

TEST RESULTS

The first five test firings of SRAW were conducted between August 29, 1991, and November 27, 1991, at the Naval Weapons Center, China Lake, California. Every test has been a complete success meeting all test objectives. Firings have been against both stationary and moving targets at ranges up to 500 meters. Telemetry data confirmed all flight characteristics were nominal including normal target detection device function. Direct hits were obtained in all tests fired against a target. The first test flight including a warhead is scheduled to occur in February 1992.

TRANSITION PLAN

The BTI project will produce and test pre-EMD prototype weapon systems. Following successful completion, the project will transition to the Marine Corps for further development. Marine Corps funding is in place to begin Engineering and Manufacturing Development in FY 1993. The SRAW project is managed for BTI by the Marine Corps Systems Command, Quantico, VA.

Current as of December 17, 1991

ANTI HELICOPTER MINES

MINE WARFARE IN THE THIRD DIMENSION

The military utility of mine warfare has been demonstrated countless times in numerous conflicts since the Civil War. The doctrine governing the employment of antiarmor and antipersonnel mines has proven successful in combat. Now technology is making it possible to extend the military utility of mine warfare to the third dimension through the advent of the smart anti-helicopter mine.

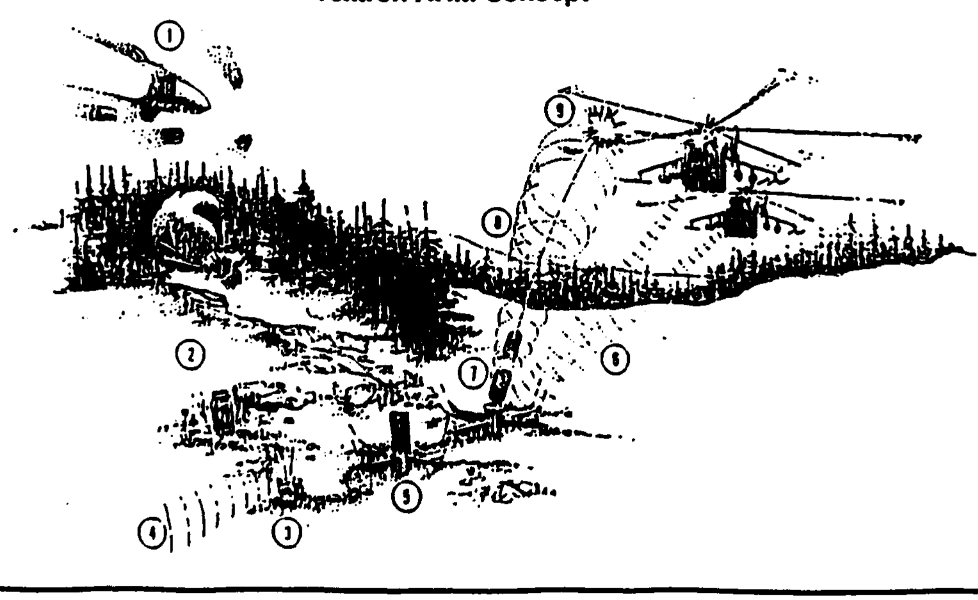
The BTI Anti-helicopter Mine Project (AHM) is the ongoing phase of the Advanced Mines Project managed for BTI by the DARPA Land Systems Office. Previously, the project demonstrated two-way radio remote control of wide area mines.

The two-way controllers are small, low cost, low power encrypted radio control units which will allow mines to receive on and off commands, pass target detection information back to an intelligence network, and permit mine-to-mine communication for attack coordination and improved control. The brassboard phase of development and testing of the mine control system was completed in FY 1991, and the results were transitioned to the Army Program Manager for Mines, Countermine, and Demolitions for further development and eventual insertion into the Army antiarmor Wide Area Mine program.

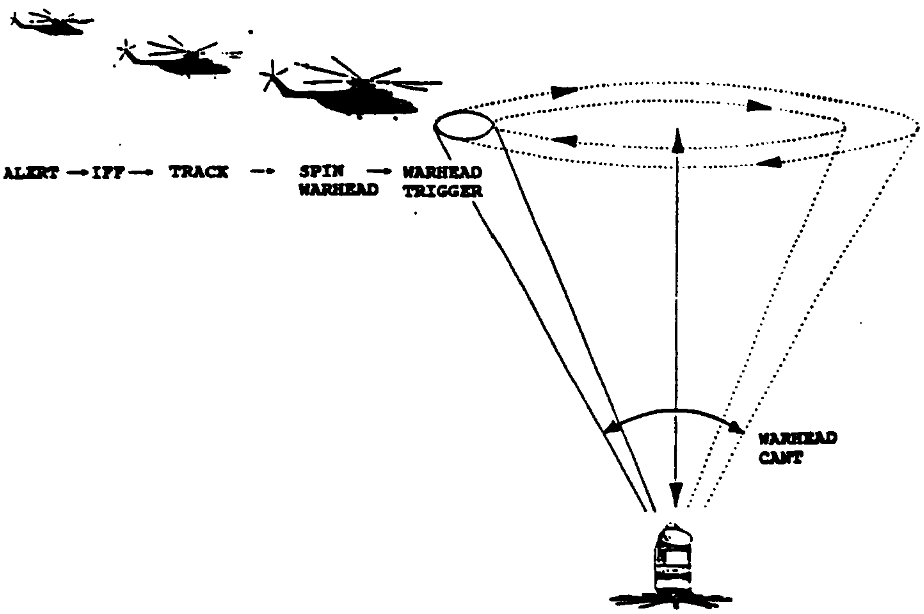
AHM SYSTEM CONCEPT

The purpose of the AHM system is to deny nap-of-the-earth flight and pop-up tactics to attack helicopters, thus eliminating their principal survival mechanism in an air defense missile environment. Selectively deployed, the AHM will be capable of engaging low flying helicopters at altitudes up to a few hundred meters over

Textron AHM Concept



Ferranti AHM Concept



a large engagement area. They can be used to erect a lethal screen to defend an approach path and to deny enemy flight operations over ground areas such as forward area resupply points or airfields. The mines remain passive until airborne helicopters enter their zone of authority. Sensors detect, locate, and identify approaching helicopters by their acoustic signature.

Because the AHMs will be controllable using the two-way radio control system developed earlier, the mines can be turned on and off as required to permit friendly operations and can be recovered and redeployed as needed. This communications capability can be used to provide intelligence and early warning information about the presence of enemy helicopters. Intelligence collection is a matter of secondary interest. This capability is considered a by-product and will not be achieved at the cost of extensive modification of the mine.

AHM Employment Concepts
• Deny the use of airfields and FARPs in enemy territory
• Deny the use of landing zones in friendly territory
• Deny the use of covering terrain and present obstacles to use of approach corridors
• Provide intelligence and early warning of enemy helicopter activity
• Provide flank security to friendly maneuver and aviation forces
• Attrit and disrupt enemy forces
• Deceive the enemy concerning friendly intentions

TECHNICAL APPROACH

The major technical issue is determining the optimal trade between altitude/radius of engagement, IFF capability, operation in forest and cities, and cost. Operational and administrative issues include the definition of the most appropriate user proponents and their requirements for the employment of the system. This is being addressed through various Army Training and Doctrine Command elements.

Two different technical approaches are under investigation in the form-fit-and function phase of the AHM development. Textron Defense Systems is developing a variant of their Wide Area Mine (WAM) system. Ferranti International has devised a direct fire system. Both technical approaches must satisfy common system functional requirements and share common basic properties.

AHM System Functions

• Mission	Identify friend and foe Kill enemy helicopters entering zone of authority
• Safe & Arm	Autonomous Remotely controlled Report status to C2 Visual indication Arm/disarm
• Communications	Command & control Safe & arm Built-in go/no-go test and indication RS232 link to MLRS
• Self righting on slopes up to 30 degrees	
• Self defense	Low detectability Anti-tamper without self destruct Programmable self-destruct/disarm

System Properties

- Wooden Round, WAM commonality
- Size: Cylinder 7-in dia, 15-in long
- Weight: Less than 40 pounds
- Production reliability: 98%
- Operational probability: 80%
- Control probability: 99+%
- Software: ADA or well structured ADA PDL
- Shelf life: 10 yrs (20 preferred) with 99% success
- Active life: 15 days (30 preferred)
- Dud safe: After 4 hrs (1 hr preferred) with 99% confidence
- Emplacement time: 1 minute by hand

DEVELOPMENT STATUS

The 26-month second phase of the AHM development began in September 1991. The purpose of this phase is to demonstrate the form, fit, and function of two competing AHM concepts.

Seven contractors participated in the original concept definition efforts to define optimal system concepts. System effectiveness was analyzed for a variety of threats, scenarios, and conditions. This phase was followed by separately contracted brassboard and prototype development. The efforts will culminate in competitive testing at Sandia National Laboratory.

The brassboard/prototype solicitation resulted in the selection of three contractors: Textron, Ferranti, and Texas Instruments. Contracts were awarded in June 1989. Preliminary testing of the contractor brassboard systems in the Fall and Winter of 1990-91 led to the selection of Textron and Ferranti for the competitive prototype phase.

Plans for a competitive test and evaluation will be completed by June 1992. One critical measure of effectiveness will be the capability of the AHM to reliably distinguish friend from foe. The systems will also be evaluated on acoustic tracking accuracy, aim miss vector, false alarm rate, and warhead parameters.

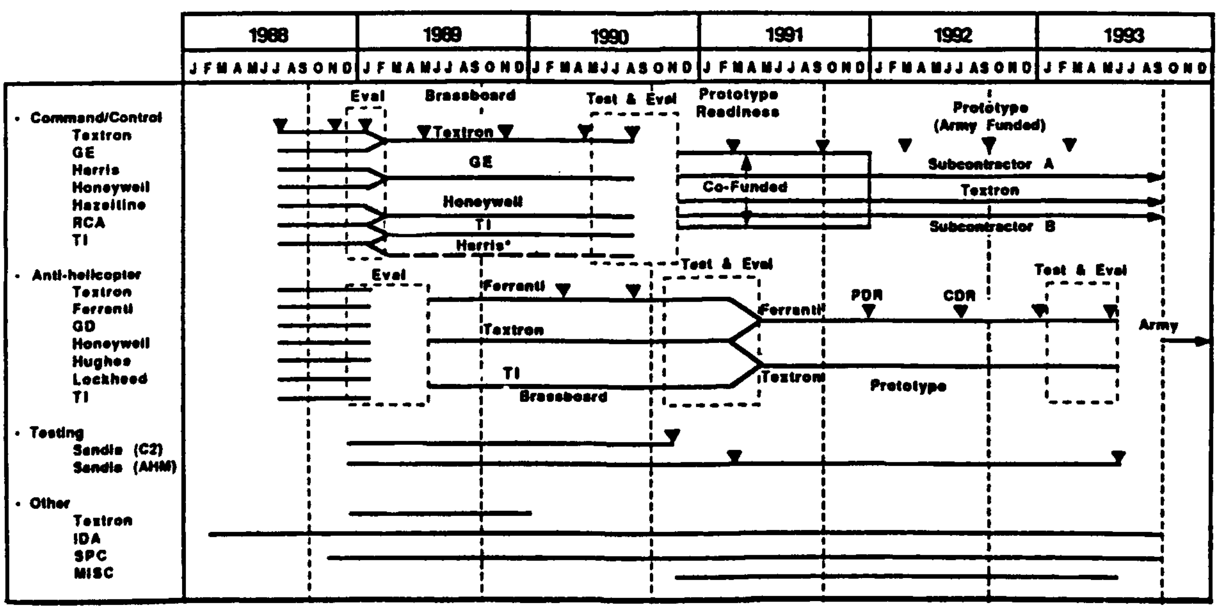
Program Management

BTI Project Director	Mr. Charles C. Hansult BTI Alexandria VA (703)998-7720
Textron Program Manager	Mr. E.J. Mikilitus Textron Defense Systems (508)657-2348
Ferranti Program Manager	Mr. Dave Miller Ferranti International Plc Manchester, UK 011-44-61-681-2071

Mission analyses, requirements definition, technology assessment, effectiveness quantification, system concept definition, subsystem fabrication, and test planning are complete. Several high leverage technologies applicable to this program have been identified.

Both concepts are designed to cost $10,000 or less in production.

Advanced Mines Project Schedule



TRANSITION PLAN

The AHM project is managed for BTI by the DARPA Land Systems Office. Technical assistance is provided by ARDEC, Picatinny Arsenal, NJ. AHM is scheduled to transition to the Army in FY 1994. In compliance with the desires of DDR&E, plans are being prepared to transition direction of the AHM project from BTI to DARPA sometime during FY 1992. FY 1993 funds will be allocated to DARPA as soon as they are received. DARPA/LSO will be responsible for requesting FY 1994 funds, if required.

EFFECT OF FY 1992 BUDGET ACTIONS

The Advanced Mine Project, including the Anti Helicopter Mine, was identified as a Congressional Special Interest item in the FY 1992 Defense Appropriation. Consequently, funding for AHM is adequate in FY 1992.

Current as of March 10, 1992

ALADDIN WEAPON SYSTEM DATA PROCESSOR

SYSTEM DESCRIPTION

The objective of the Aladdin project is to develop a powerful, easily programmable, modular, versatile processor in a compact physical size. Aladdin is not a weapon system; it is a computer made possible by emerging technology. The Aladdin processor potentially can become a component of a myriad of smart weapons systems. More and more modern weapons demand on-board, real-time data processing. Currently, new computers are developed for each specific application. Because of its small size, capacity, and modularity, the Aladdin processor can be easily adapted to diverse advanced smart munitions and tactical platforms resulting in considerable cost savings.

REQUIREMENT

Potential smart weapons applications are presently limited by computer power. Aladdin will enable applications currently inaccessible due to processor size or lack of processor capability.

- Aladdin will perform image processing for 128 x 128 focal plane array and the real time operation of associated automatic target recognition, target tracking, and aimpoint selection algorithms.
- Contractors will deliver a total of five integrated processors and a programming environment.

Potential Applications

- UAV
- LH
- Autonomous vehicles – Air, ground, sea
- Cruise missiles, torpedoes, mines, submarines
- F-14, F-15, F-16, B-2 Mid-life updates
- Ground and space based interceptors
- Multi-sensor – Airborne, ground based, shipboard
- IRST
- RADAR
- ESM and ECM

OPERATIONAL CONCEPT

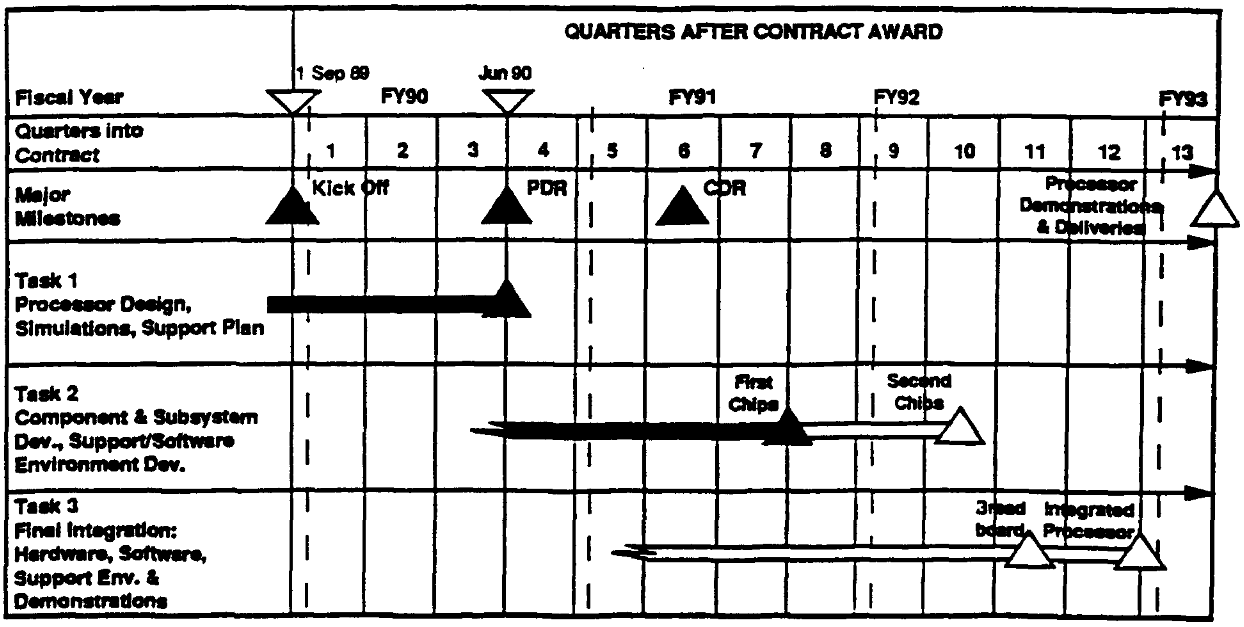
The combination of high throughput, minimized volume, and modularity will permit applications currently inaccessible due to processor size or lack of processing capability. Aladdin will reduce weight, increase on-board processing capability, and enable new capabilities on tactical platforms. Modularity will allow the same architecture and development environment to support numerous missions and applications. Application of Aladdin's attributes to selected systems and missions will improve performance, robustness of operations, and battlefield capabilities.

System Characteristics

• High throughput:	500 MIPS 1 GFlops
• Small volume:	Fit within 4.5-inch diameter by 6-inch long cylinder
• Modular:	Support variety of missions and applications
• Easy to program:	Support high order language (Ada and Image Algebra) software on standard workstations, emphasis on support and tools

Aladdin Management

BTI Project Director	Ms Carolyn Nash BTIO Arlington, VA 22311 (703)998-7720
Contractors	Alliant Techsystems Hopkins, MN
	Texas Instruments Plano, TX



Aladdin Specifications

Requirement	SOW	Alliant Techsystems (proprietary)	Texas Instruments (proprietary)
Design	Modular/ Reconfigurable		
Size	4-in diameter 6-in long		
Throughput	1 GFlops 1 GOps 500 MIPS Nonsimultaneous peak		
Memory	4 Megabytes		
Operation/Cooling	5-10 minutes uncooled; continuous cooled		
Software support	Required		
Modularity	Required		
Demonstration	Minimum: 128x128 focal plane array, ATR algorithm		
G acceleration	Axial Lateral Peak: 100 100 Sustained:50 20		

Note: This page contained proprietary information which has been deleted.

TRANSITION PLAN

To stimulate interest in Aladdin and foster the identification of applications, potential users participate in technical reviews of the project. The transition plan provides for the evaluation of delivered prototypes by interested government agencies. The Air Force Wright Research and Development Center separately has funded activities to support the incorporation of Aladdin in avionics applications.

The Army is considering Aladdin for the Advanced Air Defense Electro-Optical Sensor program and for the proposed Close Combat Tactical Trainer. The U.S. Marine Corps has a potential application in the AN/TPS-59 ground-based air defense radar. The defense electronics industry is considering Aladdin for a variety of applications such as wideband high resolution direction finding, ambiguity function processing, cyclic signal processing, and pro-forma signal processing. One of two competing contractors in the DARPA Thirsty Saber program based his design on the Aladdin processor.

The BTI program is unable to provide the full funding required to complete Aladdin in FY 1992 as planned. Remaining BTI FY 1991 funds, frozen when the FY 1992 appropriation was cut back, will be augmented by DARPA and Army funds to complete the project. The disruption in funding will extend the project into FY 1993.

Aladdin is managed for BTI by DARPA, with technical support provided by the U.S. Army CECOM Night Vision and Electro Optic Division, Ft. Belvoir, VA.

Current as of February 19, 1992

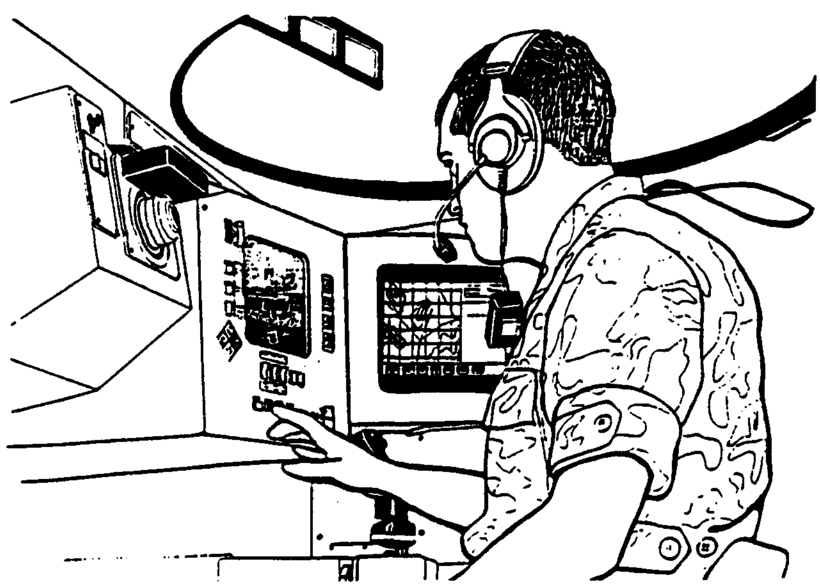
COMBAT VEHICLE COMMAND & CONTROL

US/GERMAN TECHNOLOGY DEMONSTRATION

Despite the sophistication of many of today's weapons systems, the ground combat vehicle commander is still restricted to command and control tools developed for use in a slower paced combat environment. Paper maps, acetate overlays, and a grease pencil are still used to keep track of enemy and friendly forces. Information is transmitted via voice radio requiring interpretation and analysis at each command level. The process is time consuming and prone to error.

The BTI Combat Vehicle Command and Control project (CVC2) is a joint effort between the Department of the Army and the German Federal Ministry of Defense (FMOD) to demonstrate technology for a semiautomatic, integrated, interoperable lower echelon command, control, and communications (C3) system for ground combat vehicles. The program is managed by the U.S. Army Tank-Automotive Command with elements of the program executed by The U.S. Army Communications Command, Army Research Institute, and Armor School at Fort Knox. Developed for US and German main battle tanks, the CVC2 system will display near real-time tactical data-linked map information showing the dispositions and logistics of friendly and enemy forces alike. Armor-specific tactical data messages will be transmitted among CVC2 terminals over the SINCGARS combat radio network.

Experience in Desert Storm stressed the dependency of complex tactical operations on joint C3I interoperability. This is critical for battalion and below battlefield forces near the edge of the battle. Sharing a picture of the battlefield showing friendly and enemy locations can reduce fratricide. CVC2 will significantly enhance battlefield integration and allow the synchronization of maneuver force elements from the individual vehicle level up to and including the battalion level.



SYSTEMS CONCEPT

The CVC2 concept provides a tactical situation display for the commander in all vehicles. This display provides map information, enemy and friendly vehicle locations, and tactical operations graphic overlays. The commander gets a "bird's eye" view of the battlefield tailored to his area of interest. In addition, CVC2 provides for the easy preparation and distribution of standard combat reports by digital data burst.

The CVC2 concept also facilitates further automation of ground combat vehicle cockpits. Networking at the individual vehicle, platoon, company, and battalion echelons allows for embedded command and control of the ground combat maneuver force.

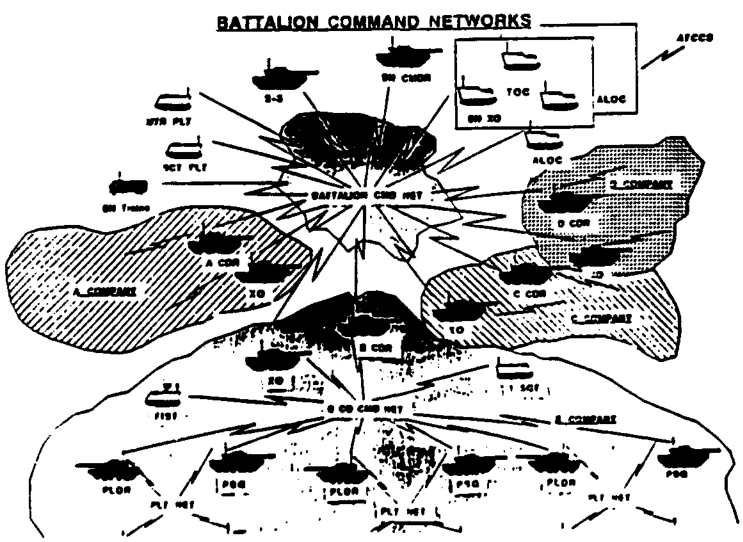
The CVC2 project is designing, building, testing, and evaluating an integrated voice and data multifunction lower echelon C3 system that interconnects with the higher echelon maneuver control system. The effort includes the development of a new family of protocols, user friendly graphics oriented messages, and a common survivable database. The system will visually display information needed for primary combat functions: intelligence data from battlefield sensors, command and control information, position location and navigation, logistics data, diagnostics and prognostics, and embedded training. The CVC2 effort includes a semi-automated command and control system for armor vehicles from battalion down to the individual platoon vehicle. In addition, the CVC2 project also provides a battalion interface between lower echelon CVC2 messages and the higher echelon Maneuver Control System.

CVC2 Operational Benefits

Real time battlefield awareness
- Coordinated search areas
- Sharing of information
- Threat warning
- Map data (topology & situation)

Accurate distribution of firepower
- Target assignment
- Fire support

Increased combat effectiveness
Interoperability within the US Army
Interoperability with NATO allies
Enables the tactical commander to operate inside opponents reaction time



TECHNICAL APPROACH

CVC2 functionality is provided in either a modified M1A2 tank or by a stand alone laptop computer. A militarized Lightweight Computer Unit has been developed to supply digital C3 information to other vehicles on the battlefield which do not have an integrated CVC2 system but which require CVC2 functionality. A new communications protocol is being developed by CECOM to provide reliable, efficient digital data communication between all CVC2 nodes. A Mobile Base Station has been developed to demonstrate the CVC2 concept. Constructed in a trailer, the base station provides a platform to coordinate and evaluate the command and control functions during field demonstrations. It provides a simulated interface between the maneuver control system and the battalion tactical operations center staff elements.

DEVELOPMENT STATUS

The CVC2 proof of concept has been validated through simulation experiments conducted using the SIMNET-D facility at Fort Knox, Kentucky. These experiments examined the command and control effectiveness of a CVC2 system within a battalion command framework. Testing conducted by the Army Research Institute compared units at the platoon and company level, with and without CVC2, and incorporating the Tactical Operations Center. Results show a marked improvement in combat effectiveness.

The system will be previewed at the Fort Knox Armor Conference in May 1992. A full system check out is planned at TACOM in July 1992. The system will be shipped to Germany for joint demonstrations at Baumholder, Germany. The joint demonstrations will consist of technical evaluations followed by VIP demonstrations in the Fall of 1992. Both France and the United Kingdom have expressed an interest in the joint demonstrations and are considering CVC2 for vehicles currently being developed.

Program management for CVC2 is provided by the U.S. Army Tank and Automotive Command, Warren, MI.

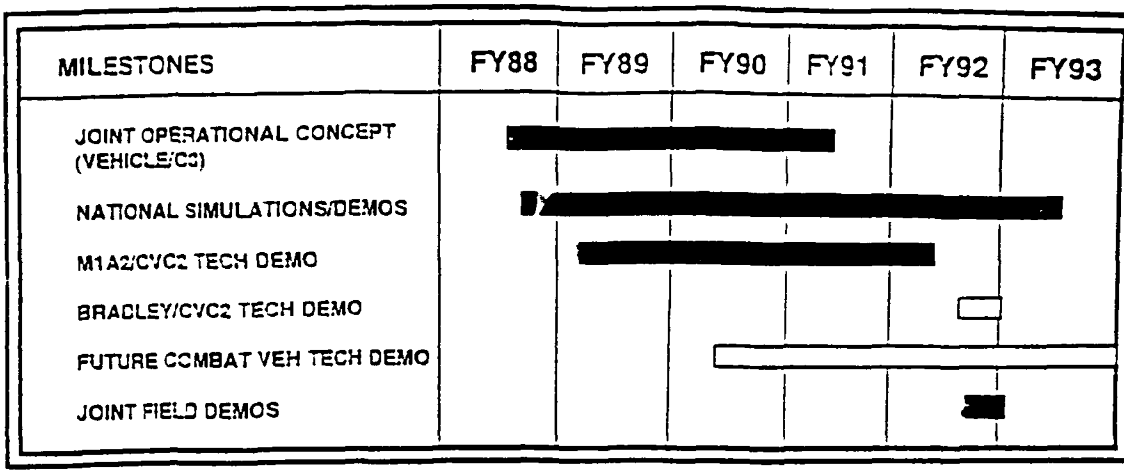
CVC2 Benefits Shown by Simulation

Number of kills:	30 % increase
Mission completion:	42 % less time
Mission planning:	60 % less time
Spot reports:	59 % more accurate
Fuel consumption:	35 % reduction

Program Management

BTI Project Director	Ms. Carol Nash Alexandria, VA 22311 (703)998-7720
Program Director	Mr. Donald S. Sarna US Army TACOM AMSTA-RV Warren, MI 48397-5000 (313)574-6160

Program Schedule



TRANSITION PLAN

Expansion of the CVC2 concept across the force to the next generation of ground vehicles under development in the Armored Systems Modernization (ASM) program can be achieved through software additions to the basic standard vehicle electronics architecture, which will be common to all ASM variants.

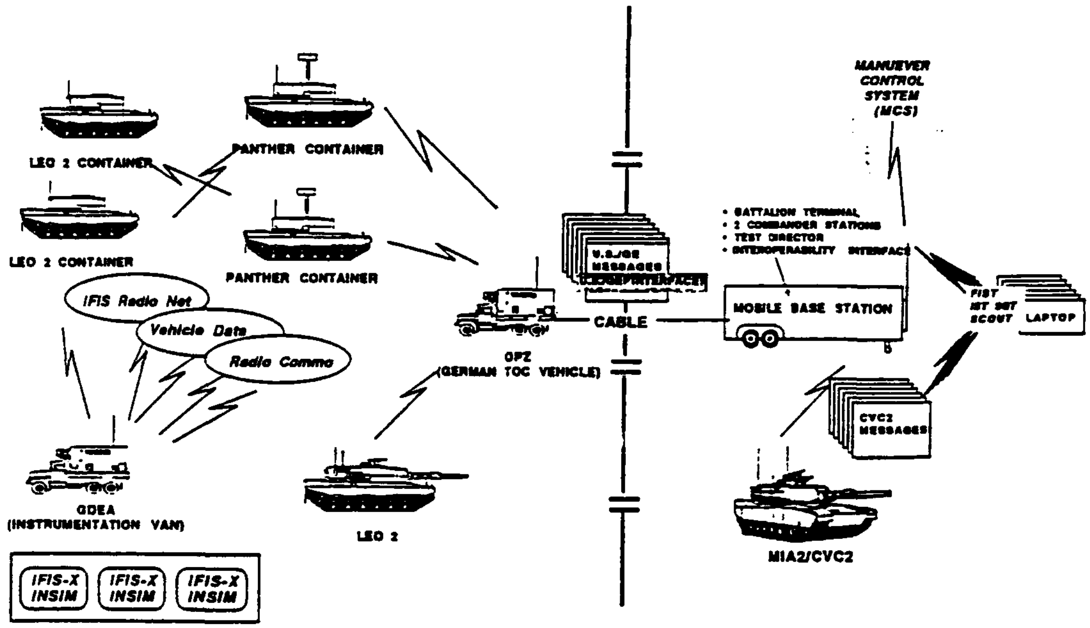
There are several options for transitioning CVC2 from a demonstration project to the field. The system is designed for the M1A2 tank and can be implemented at different levels, depending on future plans for tank product improvement. The options range from software updates to the intervehicular information system currently implemented in the M1A2 to full hardware and software CVC2 implementation. Hardware changes include replacing the monochrome tactical display with a color display, addition of a mass memory device for a digital data map, and electronic module changes to the commander's integrated display to enhance its capability.

A NATO Army Armaments Group has requested CVC2 interoperability standards be established. These would become the basis for a NATO battle management system and could lead to the implementation of CVC2 throughout NATO.

EFFECT OF FY 1992 BUDGET ACTIONS

Severe restrictions on the FY 1992 budget forced a reassessment of all the BTI projects. FY 1992 is the final funding year for the BTI portion of the CVC2 project. Of the $6,900,000 required for the project in FY 1992, BTI is able to fund only $1,400,000. The Army has provided funds for FY 1992 and FY 1993 to complete the program. Actual transition of CVC2 to fielded systems is dependent on plans for the platforms, which are currently uncertain.

BAUMHOLDER JOINT DEMO ASSETS

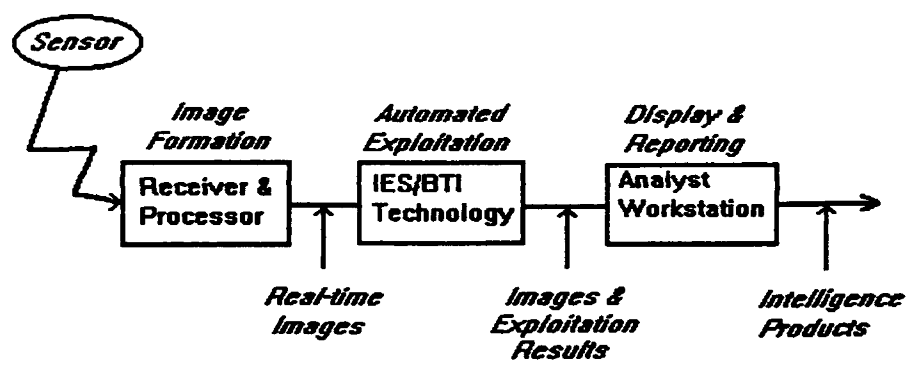


Current as of March 19, 1992

IMAGERY EXPLOITATION SYSTEM

SYSTEM DESCRIPTION

The BTI Imagery Exploitation System (IES/BTI) project applies advanced hardware and software technologies to the critical problem of tactical combat situation analysis. The objective is to demonstrate automated, real-time, first phase image exploitation that quickly detects, recognizes, locates, monitors, and tracks any enemy forces that appear in low resolution/broad area coverage synthetic aperture radar, or infrared sensor data. The IES/BTI advanced algorithms and hardware achieve a substantial increase in speed, accuracy, and volume of sensor data processed in an operational setting that supports considerably improved battlefield management. The goal is to reduce the time to develop an intelligence assessment of the forces in a 10 by 10 nautical mile area to 5 minutes with an accuracy of 90 percent. Recent improvements in off-the-shelf hardware will enable IES/BTI processing rates to approach 1-2 minutes.



IES System Concept

SYSTEM CONCEPT

The IES/BTI concept improves the performance of current methods of exploiting tactical intelligence information. The concept addresses major shortcomings in the exploitation of collected tactical intelligence information. The volume of synthetic aperture radar and infrared sensor data exceeds our current capability to exploit the information effectively. Real-time assessment of sensor imagery is critical to the defeat of cover, concealment, and deception and to the continuous tracking of enemy forces. IES/BTI automates the real-time analyses of multisensor images that are currently performed by image, order-of-battle, and intelligence analysts. The system performs an initial screening of large amounts of image data, permitting the analysts to concentrate on high priority areas and detailed evaluations of objects of interest. During peacetime, IES/BTI will facilitate indications and warning assessments and the treaty verification process. During wartime, the IES/BTI mission will expand to provide real-time input for situation assessments, target development and acquisition, maneuver support, and the defeat of concealment and deception techniques.

IES/BTI Missions

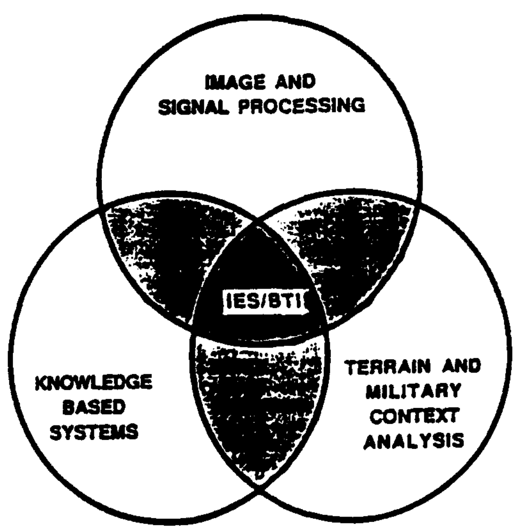
- Support U.S. Army Corps Commander's tactical analysis of the battlefield
- Monitor and verify enemy military activity, capability, and treaty compliance
- Maintain and support a capability to respond to aggression should conflicts arise

TECHNICAL APPROACH

Automated image exploitation using only image processing techniques independent of other supporting information is extremely difficult. High false alarm rates are experienced using synthetic aperture radar and infrared sensor data.

The BTI insertion of advanced technology overlays knowledge-based systems technology in conjunction with terrain, weather, and military context data to the image and signals intelligence. Image and signal processing are accomplished using an open, scalable, parallel computing architecture that maximizes the use of commercial off-the-shelf software such as the Unix operating system and C-based language. Artificial intelligence knowledge-based reasoning is used for detection, classification, terrain analysis, and correlation of collateral information.

Advanced Technology Insertion



This robust process removes the false alarms and increases confidence in the validity of true detections. Terrain and military context data are applied in a generic design that supports Defense Mapping Agency standard products. Terrain and military doctrine incorporated into IES/BTI is reviewed and approved by the Army Intelligence Agency.

The modular architecture of the IES/BTI software is an important feature which enables changes to be made in processing modules associated with sensor input, theater of operation parameters, and topographic data types without disturbing the operation of the remainder of the system. Imagery processing is affected in only one module. If automated target recognition capability is required, one other module may need modification.

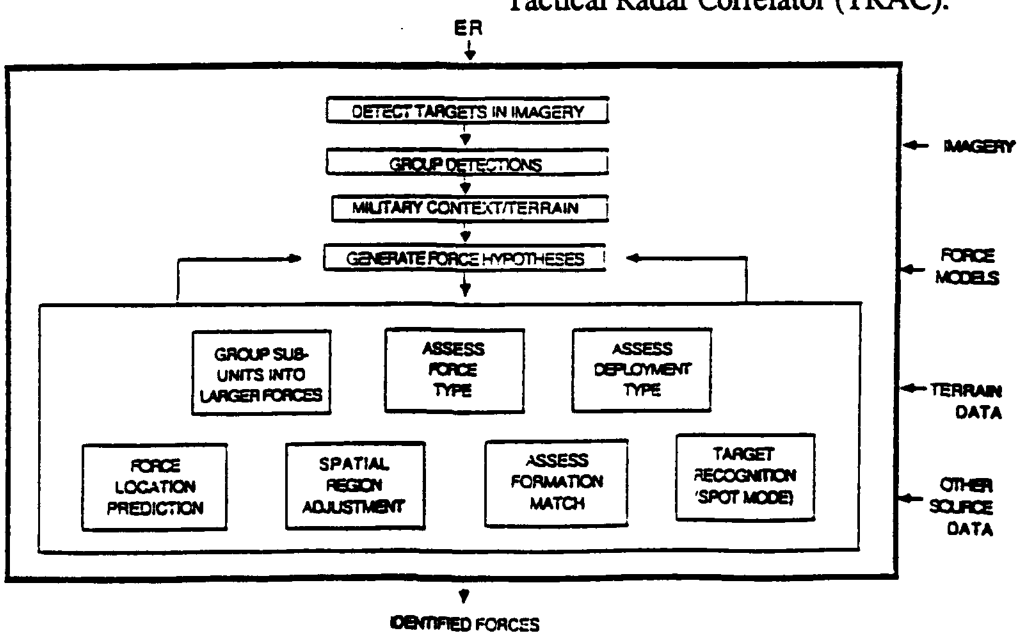
DEVELOPMENT STATUS

A laboratory demonstration of IES/BTI capability was conducted successfully during September 1990. Second echelon Soviet units deployed in a 10 nautical mile square area were identified and located in less than 15 minutes with an accuracy of 75 percent. A similar capability was demonstrated in a Southwest Asian environment during February 1991. This performance satisfied the system requirements for speed, throughput, and accuracy that were levied at this stage of development.

During late December 1990, the Commander-in-Chief for U.S. Forces Central Command requested IES technology for use in Operation Desert Shield/Storm. Due to the brevity of the conflict, IES was not able to participate; however, a Southwest Asia scenario and an additional sensor were added to the IES capabilities. The performance of this configuration was 75 percent accuracy with processing speed of 13 minutes for the 10x10 nautical mile area which satisfied system performance requirements. The IES/BTI project has been identified by the OSD DDR&E Science and Technolgy Precision Strike thrust area panel as a critical technology to provide a capability of near-real-time exploitation of low-resolution SAR imagery. The completion of the entire IES/BTI program is crucial to a precision strike requirement for a fully functional automated exploitation technology.

Feature extraction algorithms have been built and integrated. A new classification/recognition algorithm for ground order-of-battle and follow-on force attack targets has shown 90 percent probability of detection with only 10 percent probability of false alarms in analyzing ASARS data.

IES will provide near real-time exploitation capability to Precision Strike and Global Surveillance. Other fielding options under consideration include the Joint Services Imagery Processing System (JSIPS), the Imagery Processing and Dissemination System (IPDS), the JSTARS Ground Station Module, and the Army Tactical Radar Correlator (TRAC).



IES Processing Concept

	Program Management
BTI Project Director	Mr. James McDonald BTIO Alexandria, VA 22311 (703)756-8972

TRANSITION PLAN

Contractors

- SAIC
  Tucson, AZ
- Advanced Decision Systems
  Mt. View, CA
- MRJ, Inc.
  Oakton, VA
- Pacific Sierra Research Corporation
  Arlington, VA
- Thinking Machines Corporation
  Chevy Chase, MD
- Los Alamos National Laboratory
  Los Alamos, NM

IES/BTI has been managed by the U.S. Army Topographic Engineering Center, Ft. Belvoir, VA. The transition plan calls for IES/BTI to transition to the U.S. Army. Project direction will transfer to DARPA in FY 1992. Initially, IES/BTI would support the OSD DDR&E S&T Thrust Area. In the classic indications and early warning (IEW) scenario, IES/BTI would support the Corps Commanoer's IEW needs for target development, target acquisition, and tactical analysis of the battlefield situation. A prototype system has been deployed to the U.S. Army Intelligence Center School for user testing and feedback. IES/BTI should be incorporated with the TRAC/IPDS architecture at Corps. The concept also has the utility to support Air Force and Marine requirements.

Current as of October 25, 1991

ARTIFICIAL INTELLIGENCE MODULE

HAWKEYE: AN EYE ON THE ENEMY

Soon after the U.S. Army deployed to Southwest Asia under Operation Desert Shield, a powerful system for machine processing of intelligence data was delivered to the theater. This system, the Artificial Intelligence Module Test Bed (HAWKEYE), was used extensively in the Persian Gulf by the U.S. Army 7th Corps, 5th Corps, and five separate divisions and regiments.

HAWKEYE gave the field units the additional analytical tools and automated processing capability needed to generate timely information on the battlefield situation. HAWKEYE proved its value to the field commanders and battlefield analysts by performing successfully during Operation Desert Storm and during prior use by units in Germany.

SYSTEMS CONCEPT

HAWKEYE supports the battlefield commander by improving the timeliness and accuracy of intelligence reports. Combined with advanced computer hardware, the system allows the analyst to rapidly process reports from all sources, determine the location and status of high value targets, estimate the enemy's near term capability, and generate intelligence collection tasking. The system performs automated military situation assessments and generates reports and maps more quickly and comprehensively than any other developmental or fielded system.

TECHNICAL APPROACH

Artificial intelligence and other advanced data processing hardware and software are used to process intelligence inputs and stored data.

The HAWKEYE design is based on an open architecture and is intended to operate on a variety of hardware platforms. This approach enables the system to take advantage of advancements in off-the-shelf software and hardware technology and to be responsive to the operational needs of the users. The open architecture design complies with recognized standards and is extremely flexible. These characteristics made it possible for the software engineers and the field soldiers to establish a close, continuous working level partnership during the development process.

Cooperation resulted in a cycle of field unit trials and feedback followed by modifications and improvements based on user input. This evolutionary approach saved time, energy, and money. It allowed the developers to capture good ideas from the field and improve their understanding of the operational requirements. The users received a better capability more quickly. As a result, they developed an appreciation for the testbed and for the potential of this application of artificial intelligence. In operation, the AIM system accepts and processes digital messages sent over communications nets. The AIM computers generate signals intelligence messages, which are entered into a data base where they can be conveniently used by intelligence analysts.

DEVELOPMENT STATUS

The AIM test bed is a Balanced Technology Initiative (BTI) project that was begun in 1989. The project is managed for BTI by the U.S. Army Intelligence Center and Fort Huachuca. Software was developed by these organizations with support from Mystech Associates, Incorporated. The hardware was fabricated by the Army Materiel Command Harry Diamond Laboratory.

In January 1990 the initial truck-based prototype was put into service with the 7th Corps Tactical Control and Analysis Element in Stuttgart, Germany. In April, a second system comprised of commercial hardware went into operation with the 5th Corps in Frankfurt. Both systems were used in support of daily intelligence operations and USAREUR and CENTAG command post exercises. Later in the year, four additional test beds were deployed to other units in 7th Corps.

During a typical command post exercise, the AIM test bed received and processed over 356,000 individual digital messages over a simulated communications net. More than 18,000 items were then entered into the intelligence data base.

In November 1990, when the 7th Corps deployed to the Persian Gulf region, the corps commander directed that the HAWKEYE test beds deploy as intelligence and early warning assets as well.

During the period 3 January to 15 February 1991, 19 HAWKEYE systems were in operation with units in Operation Desert Storm. Their capability to improve the quality and timeliness of intelligence products was successfully demonstrated. Prior to the attack on the Republican Guards, HAWKEYE was used to reduce the target development effort from 48 hours to 12 hours. The system was also credited for the success achieved in destroying Iraqi command and control nodes.

Utility of HAWKEYE

- Improve the timeliness and accuracy of intelligence reports
- Rapidly process reports from all sources
- Determine location and status of high value targets
- Estimate enemy's near term capability
- Generate intelligence collection tasking, reports, and maps

Program Management	
BTI Project Director	Dr. Judith Daly DARPA/ASTO Tel: (703)696-2374 Fax: (703)696-2206

TRANSITION PLAN

The BTI HAWKEYE project effort has been completed. Program management was provided by the U.S. Army Intelligence Center, Ft. Hauchuaca, AZ. Project direction has transitioned to the Army. The intent is to transition HAWKEYE capability to the Army All Source Analysis System (ASAS) and other DOD information processing programs. The system will be used at the Army Intelligence School and Center. HAWKEYE use will continue in the units that retained the capability after Operation Desert Storm. Severe restrictions on the FY 1992 BTI budget forced BTI to reassess its participation in the project. Army funding is being provided in FY 1992 to facilitate the transition.

Current as of January 29 1992

SPEAKEASY

ADVANCED TECHNOLOGY TACTICAL RADIO

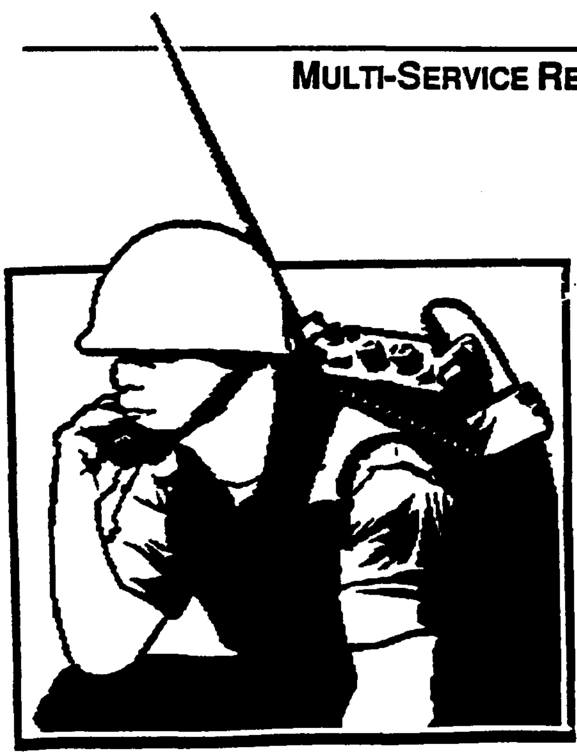
CONCEPT AND OBJECTIVES

Speakeasy is a joint service program to develop a multi-platform, multi-band digital communications architecture that exploits and integrates advanced technologies to provide reliable, interoperable voice and data interchange for a wide range of existing and planned tactical radio systems. Greatly reduced life cycle costs are expected from the modular digital processing architecture. This cost advantage arises from reduced training, maintenance and management costs, reduced major modification costs through programmability, reduced number of inventory radios, and common "spares" inventory. Achievement of common software and hardware module design and development is crucial to successful low cost implementation of the Speakeasy concept.

Speakeasy Development Objectives

- Open and programmable processing architecture
- Allied / Multi-Service interoperability
- Backward compatible with fielded systems
- Less complex creation, integration, and testing of future waveforms
- Multilevel security
- Advanced low probability of intercept capability
- Human factors engineering / Manprint

MULTI-SERVICE REQUIREMENTS DRIVE DESIGN



The Speakeasy system design is driven by future DoD communications needs as expressed in multi-service requirements documents. The design is also taking advantage of lessons learned in Operation Desert Storm which highlight the requirement for interoperable, multi-frequency, multi-platform communications that provide resistance to interference and interception. U.S. forces experienced difficulty communicating between services and with allied forces during the conflict because of different tactical radio frequencies and waveforms, susceptibility to mutual interference, and countermeasures.

Speakeasy Requirements

- USAF 21st Century Tactical Air Command and Control
- US Army Battlefield Information System 2015
- US Navy Copernicus Communications Support System
- Future requirements from Joint Communications Support Elements and Marines

The modular Speakeasy design addresses this incompatibility through a common multi-band digital radio signal and data processing architecture with various waveform options and menu-driven reconfigurability. The same suite of modules will be used for all platforms. The adaptability needed to provide physically dispersed and functionally distributed command and control networks is inherent in Speakeasy functional modularity.

Initially, waveform compatibility will be provided for HF, VHF, UHF C-band, and X-band communications equipment such as SINCGARS, GPS, PLRS, EPLRS, JTIDS, Link 11, and others. Provisions will be made for later incorporation of SHF SATCOM, MILSTAR, and Navy UHF SATCOM into the Speakeasy architecture.

WAVEFORM COMPATIBILITY

HF	VHF	UHF	L-BAND	C-BAND	X-BAND	NEW/ PROGRAMMABLE
HF Modem	SINCGARS	Have Quick I	JTIDS	TRC-170	TSC-94A	Advanced LPI
Paper Bounce	MSRT	Have Quick II				Generic Spread Spectrum
HF ALE	FUGER-A/ VHF	Have Quick IIA				Generic Narrowband
STAJ	PR4G	Saturn				

DESIGN AND DEVELOPMENT APPROACH

A single piece of equipment for multiband operation with one or more multiband antenna types is being designed around a core modular communications processing architecture. This "open" dual bus architecture builds on joint Service avionics concepts, software developed for the YF-22/23 Advanced Tactical Fighter, and Integrated Communications Navigation Identification Avionics programs. More than 25,000 lines of Speakeasy's Ada code is being adopted from these other programs. Reuse of completed and documented radio waveform software substantially reduces the time and cost to design appropriate modules and demonstrate a prototype Speakeasy advanced development model.

The latest communications component and subsystem hardware and software will be incorporated into the Speakeasy modular design. Speakeasy architecture is "open" in the same sense as the IBM personal computer executive software. Hardware and software modules can be replaced to change functionality and to accommodate advances in processing technologies. Greater dedicated functionality can be obtained by paralleling modules or scaling up for faster processing to meet unusual communication demands.

Speakeasy development will proceed in two phases. A prime contract for Phase I was awarded to Hazeltine Corporation, Greenlawn, NY, in August 1990. A subcontract to develop a majority of Speakeasy software was awarded to TRW, Inc., Military Electronics and Avionics Division.

This first phase effort is focused on design and fabrication of various radio subsystems that include the digital signal processing module, radio frequency (RF) subsystems and a multiband antenna subsystem. Selected advanced technology components will be fabricated and evaluated for potential insertion into an advanced development model (ADM) prototype. The Speakeasy ADM prototype radio will be fabricated and evaluated in the Phase I development effort. The ADM will demonstrate the baseline capability of simultaneous communications with different fielded radio and data link equipment.

Miniaturization of selected Speakeasy hardware subsystems, necessary for implementation of a manpack version, will also be demonstrated. Many of the technologies being evaluated in Phase I are supported by BTI.

BTI CONTRIBUTION TO SPEAKEASY DEVELOPMENT

The DoD Balanced Technology Initiative (BTI) is participating in Speakeasy first phase development by enabling design of an advanced, miniaturized ADM architecture and supporting design studies for a number of key Speakeasy modules and components intended to implement a miniaturized architecture. Successful demonstration of this higher risk advanced architecture in the first phase will significantly accelerate Phase II development and enable fabrication of full capability Speakeasy manpack communications equipment.

Speakeasy Technologies

- Wafer scale integrated microprocessors
- Advanced Fast Fourier Transform designs
- Acoustic Charge Transport Devices
- Direct Digital Synthesizers
- Reduced size RF architectures
- Multiband antenna designs
- Advanced battery concepts

The RF front end development will be completed during Phase II and advanced technologies, successfully miniaturized and demonstrated during Phase I, will be integrated into the ADM. The RF conversion module design will be finalized and custom ASIC design of Speakeasy hardware will be accomplished. FSED specifications will be produced as a result of Phase II effort. The ADM delivered at the end of Phase II will be a miniaturized prototype version of Phase I hardware configured to support test and evaluation in the user environment.

BTI ADVANCED TECHNOLOGY INITIATIVES

Project	Description	Contractor
RF Conversion Module	Investigation of low temperature cofired ceramic packaging technology to integrate digital, analog, RF components, and four miniaturized band-independent transmit/receive chains	Hughes
Advanced Fast Fourier Transform Module	Investigate the feasibility of using new high-speed FFT processing modules while meeting the low risk implementation requirements of the program	IBM and TRW
Direct Digital Synthesizer	Investigate the application of a state-of-the-art direct digital synthesizer using combined modulation and carrier generation	SCITEQ Electronics, Inc
Advanced Wafer Scale Digital Signal Processor	Investigate the benefits of using ADSP modules to meet the performance requirements of the Speakeasy radio	TRW and Texas Instruments
Software Rehost Port to Advanced Development Model	Investigate the issues involved in rehosting the Speakeasy software to the new ADSPs	TRW
Co-Site Interference Analysis	Investigate utility of computer simulations with measured and calculated parameters for the Speakeasy radio to evaluate receiver performance in the presence of multiple collocated transmitters. The design will simulate the breadboard and will validate models for evaluation	ViaSat, Inc

TECHNICAL APPROACH

The Speakeasy concept is based on a highly advanced microprocessor that relies on software for signal processing. The system will be compatible with 15 currently fielded radios, spanning HF through X-band and comprising skywave, line-of-sight, tropospheric scatter, and satellite communications media. Speakeasy will be able to communicate simultaneously with any four of these radios.

Speakeasy stores much of the software in memory as parametric functional modules. The modules can be accessed via menu to reconfigure the radio, and specific waveforms are processed by specifying parametric values. The parametric composition drastically reduces the cost and time required to add new waveforms.

Waveforms are generated by a direct digital synthesizer and converted to analog form at the proper carrier frequency by the RF conversion module. The same module converts received waveforms to digital form and, with few exceptions, delivers the product to the digital signal processor. The exceptions are relatively wideband waveforms that need special purpose digital preprocessing for operations too fast for the processor. The advanced anti-jam/low probability of intercept waveform designed expressly for improved interference and intercept resistance is a notable example.

The preprocessor also benefits existing waveforms by adaptively suppressing non-Gaussian wideband and multiple narrowband interference and by combating fading propagation via adaptive channel matching/equalization.

A terminal control function incorporates a variety of techniques to overcome interference from collocated radios. This function also enhances the man/machine interface, aids the operator in the selection of radio waveforms and modes, and automatically reconfigures the radio in accordance with the selections. Reconfiguration is achieved by selecting the appropriate set of modules to match the performance of one or more of the fielded systems.

LIFE-CYCLE COST IMPLICATIONS

Cost Benefits

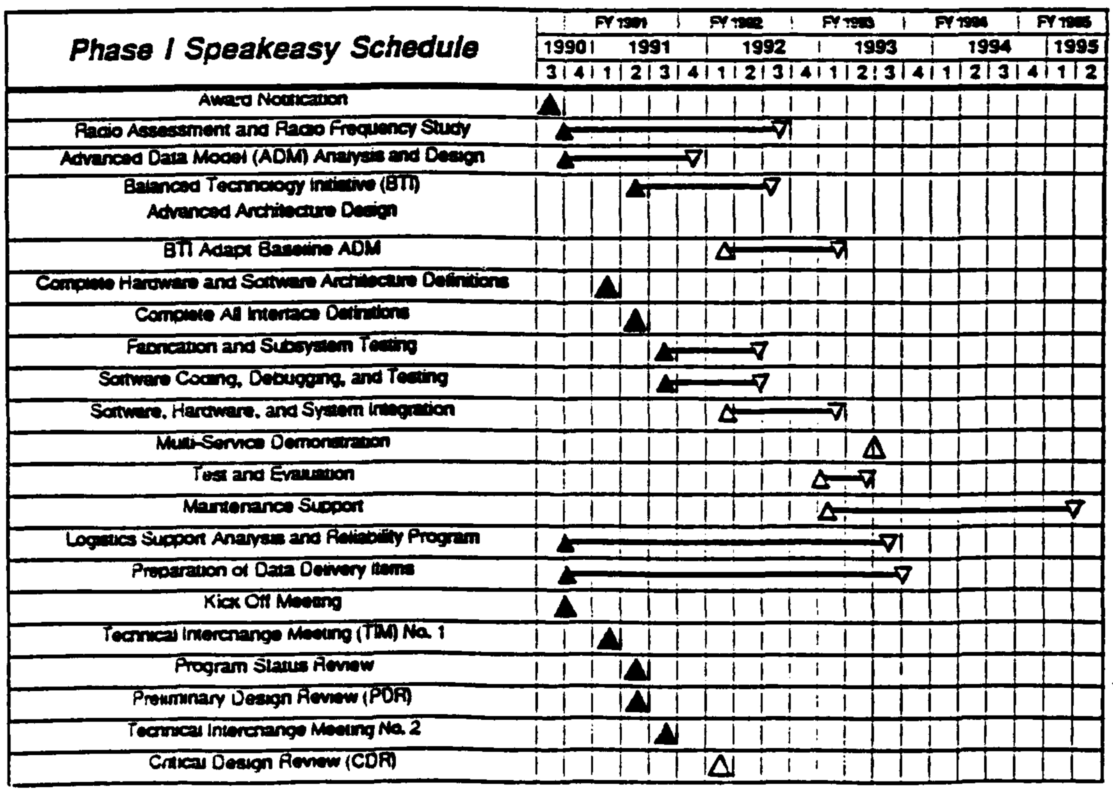
- Hardware and software commonality
- Ease of modification through parametric composition of software
- Simplified maintenance concept
- Extensive use of built-in test, self healing capability
- Consolidation of training, maintenance, and management costs

Each different configuration of a Speakeasy radio is constructed by selecting the appropriate set of modules from a library of standardized modules. Parametric composition of the software drastically reduces the time required to add new waveforms. Support costs are further reduced by the use of extensive built-in testing, together with self healing made possible by reconfigurability and programmability. These features extend the average time between critical failures and reduce the number of maintenance levels to two. If Speakeasy were to eventually replace all the radios with which it is compatible, dramatic savings would result from the consolidation of multiple training, maintenance, and management costs of the different systems.

SCHEDULE

Phase I of the Speakeasy program began in August 1990 and will run through mid-FY 1993. Phase I will focus on the design and fabrication of various subsystems of the radio, including the digital signal processor module, RF subsystems, and a multiband antenna subsystem. The advanced development models developed in Phase I will demonstrate the feasibility of a programmable multi-waveform capability and the miniaturization of various subsystems. A multi-Service demonstration at the end of Phase I will display the capability of the advanced development models to communicate simultaneously with various fielded equipment.

Phase II will begin with a new competition in FY 1993 and end in mid-FY 1995. The advanced technologies evaluated during Phase I will be integrated into the system, and the RF front end development will be completed. Additional miniaturization of all aspects of the system will be accomplished. The advanced development model delivered at the end of Phase II will be a miniaturized version of the Phase I hardware. It will be configured to support testing and evaluation in the user's environment. Specifications for limited production will also be completed in Phase II.



Project Schedule

TRANSITION PLAN

Speakeasy is a tri-Service development program. The project is managed for BTI by the Air Force Rome Laboratory, Griffis AFB, NY. BTI participation in

Management

BTI Project Manager

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the early advanced development model phase has accelerated the application of emerging technologies and supported the early evaluation and insertion of advanced technologies. BTI funding will allow full scale engineering development to begin as early as 1997. The initial operational capability will be accelerated accordingly to the year 2000. The services will realize the improvements offered by Speakeasy -- joint/combined interoperability, enhanced survivability, and drastically reduced costs for tactical battlefield communications -- much sooner due to BTI participation. Direction of the project will transition from BTI to the Air Force following the demonstration of the advanced development model in September 1992.

The current and planned funding for Speakeasy development through Phase I and Phase II show the transition from BTI to the Services.

Current as of February 5, 1992

DIRECTED INFRARED COUNTERMEASURE SYSTEM PROTOTYPE DEVELOPMENT

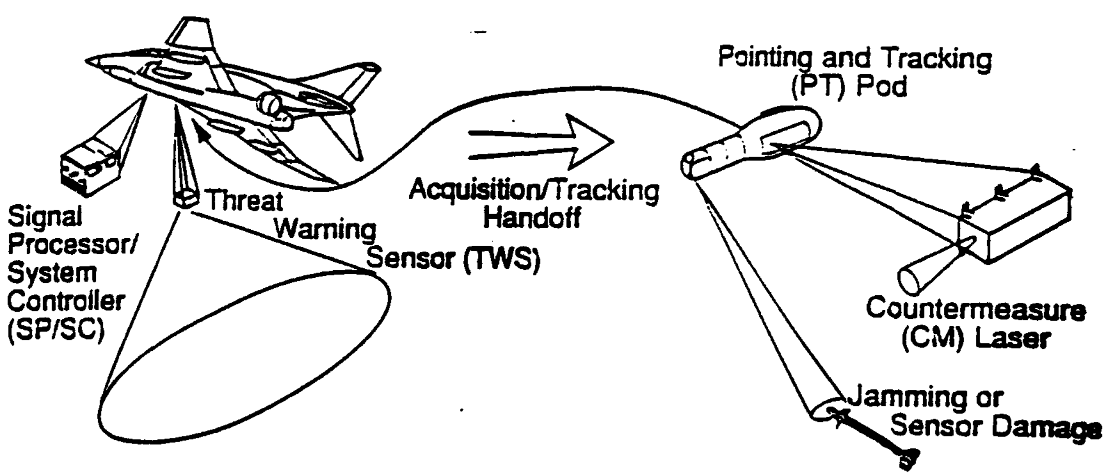
IR-GUIDED MISSILES A SERIOUS THREAT TO AIRCRAFT

Advances in infrared seeker technology have greatly increased the extent of the threat to U.S. tactical attack, helicopter, and transport aircraft posed by IR-guided surface-to-air and air-to-air missiles. Flare rejection and jam-resistant tracking techniques are more sophisticated and increasingly more effective against existing IR countermeasures. IR-guided weapons are now readily available throughout the world and threaten the survivability of U.S. tactical aircraft in any future conflict.

Precision guided air-to-surface standoff weapons reduce the exposure of attack aircraft to terminal air defenses in the target area, but they do not eliminate the threat of airborne and ground based point and area defenses. Recognition of a need to counter IR-guided weapons led to the Balanced technology Initiative (BTI) project to develop and demonstrate directional, multiple wavelength, active source infrared countermeasures.

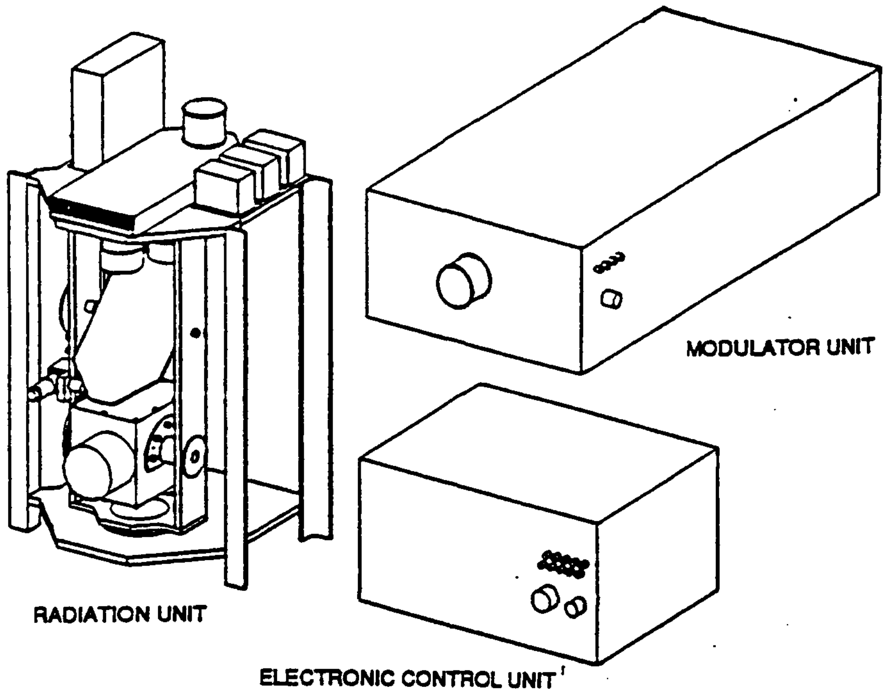
In 1989, BTI initiated a tri-Service project to develop a Directed Infrared Countermeasure (DIRCM) prototype. The objective of the project is to demonstrate directional, active source jamming systems configured for helicopters, attack aircraft, and transport aircraft. The typical flight regimes and volume and weight limitations of these classes of aircraft are sufficiently different to require different configuration DIRCM systems. The principal of the technology involved is common to each of the three approaches.

The BTI DIRCM project is essentially three separate but related projects with varying degrees of technical risk and potential payoff. The transport aircraft ver-



Attack Aircraft DIRCM System Concept

sion of DIRCM began as a quick reaction program to obtain a limited capability quickly with low risk using off-the-shelf hardware. The helicopter version also has limited objectives, but size and weight constraints imposed by helicopter platforms mitigate against a quick fix adaptation of existing hardware components. The attack aircraft version of DIRCM is a higher risk, high technology approach to counter the current and projected threat capability.



Helicopter DIRCM Components

OPERATIONAL CONCEPT

The basic DIRCM operational concept is illustrated in the design for attack type aircraft, which employs an active directional laser as the countermeasure source. The system has four major elements:

- High resolution missile warning system
- High speed digital signal and data processor
- Precision pointing and tracking subsystem
- Active countermeasure source

Initially, the missile warning system (MWS) sensor detects the incoming missile and provides angular location data to the precision tracker. The tracker establishes and maintains a high accuracy track to point the countermeasure source. Then the countermeasure device defeats the incoming missile and perhaps damages the seeker.

The helicopter version of DIRCM differs slightly from the attack version. The four basic elements are packaged in three relatively small units. The MWS and the countermeasure sources are mounted together on a common frame in the radiation unit and function with a common pointing mirror. The IR jamming energy is supplied by multiple flash lamps. The jamming wave forms are generated by the modulation unit. The transport version of DIRCM also uses a multiple flash lamp source. The MWS and the pointing and tracking functions are provided by a modified version of an existing countermeasure pod.

TECHNICAL APPROACH

The DIRCM prototype development focuses on the application of existing or near-term technologies. The helicopter version uses existing components reconfigured to be compatible with the space, power, and weight limitations of helicopter platforms. Stringent form factor and operational limitations forced a complete redesign and further development of MWS, countermeasure source components, and software for the attack version. Modification of existing pointing and tracking components provides the required accuracy.

Advanced technology is being inserted into selected hardware and software components of all three DIRCM versions. Functional system integration is being accomplished through a digital processing architecture design tailored for each application. Key capabilities being demonstrated in the BTI DIRCM project include:

- Threat missile acquisition at appropriate range for countermeasures
- High resolution threat missile tracking
- Precision beam pointing
- High intensity jamming
- Near real time automated operation.

The principal design issues addressed and resolved for each of the three DIRCM applications were high resolution, moderately long range acquisition, and low false alarm rate missile detection at wavelengths where most IR-guided missiles operate. Sufficiently accurate pointing and tracking hardware was readily available.

Non-linear processes are used to generate the required infrared wavelengths. The attack aircraft type DIRCM uses a solid state laser as the countermeasure source. This laser operates at near room temperature and has the power, size, and efficiency required for a jammer on attack-type aircraft. An additional benefit of the BTI technical approach is that this laser can be used in laser range finder and laser designator applications.

The missile warning sensor and the active sources in the helicopter version are mounted together on a common frame and function with a common pointing mirror in the radiation unit. The active source is provided by three flash lamps driven by an appropriate jamming wave form generated in the modulation unit.

An existing MWS and countermeasure pod have been modified to provide DIRCM capability for the transport version. This application also uses multiple flash lamps as the active countermeasure source.

DEVELOPMENT STATUS

The principal design issues in the BTI DIRCM project are being resolved. A sensor using a staring focal plane array to obtain longer detection range with a low false alarm rate has been demonstrated. Computer simulations have verified the performance of a generic countermeasure modulation scheme against a variety of threat missile types. A low power feasibility demonstration of the laser source for the attack version DIRCM was accomplished in February 1992.

Development and testing of the transport and helicopter versions of DIRCM are essentially complete. Expedited testing of the transport version is in progress using modified off-the-shelf components and simulated IR missile threats. The prime contractor, LORAL Electro-Optical Systems Division, modified an Air Force missile warning receiver and a Navy countermeasure pod, integrated these using a digital software architecture, and achieved an enhanced jammer-to-signal noise ratio to effectively counter current IR missile threats. Initial laboratory testing of the transport version has been successful. The countermeasure source modulation effectiveness was evaluated at the Air Force Electronic Warfare Evaluation Simulator facility.

Operational tests of the DIRCM hardware are very difficult to accomplish. Safety considerations preclude firing live IR-guided missiles against aircraft platforms carrying the DIRCM. Alternative test methodologies are being devised to evaluate the systems performance.

The DIRCM has been installed on a transport aircraft. Flight tests are being conducted using a captive threat seeker mounted on a rocket sled at Holloman Air Force Base.

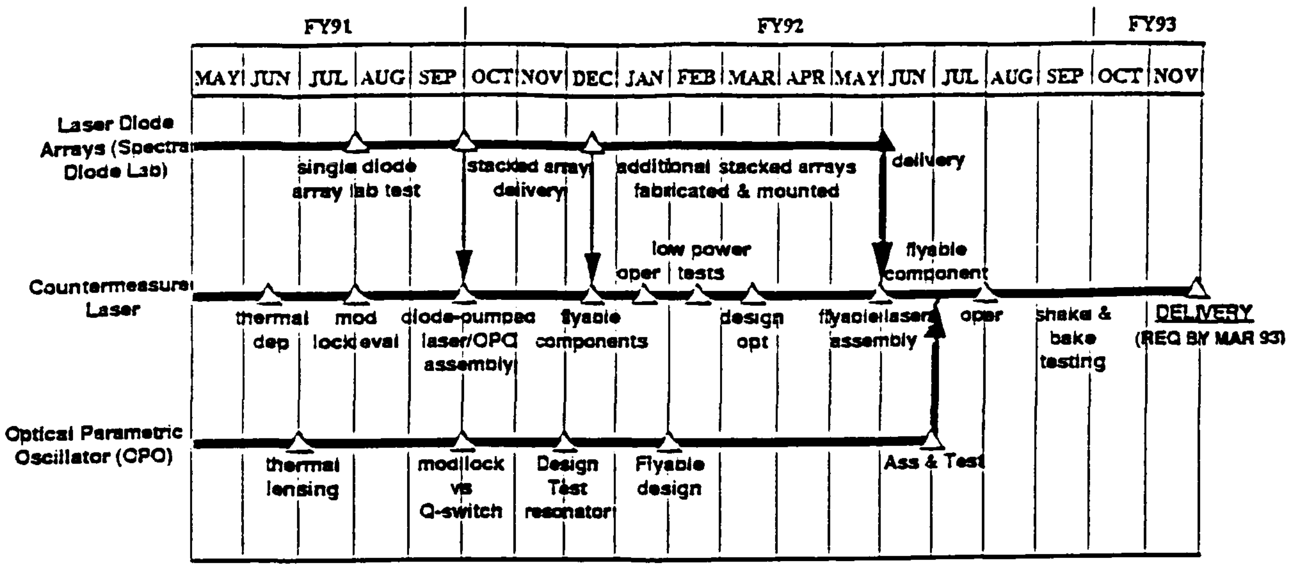
The prime contractor for the helicopter DIRCM hardware, Northrup Corporation, and the subcontractor for the MWS, Westinghouse Corporation, delivered hardware to the government for field tests in July 1991. Using a DIRCM mounted on a cable car at the Sandia Corporation Cable Car Test Facility, the following operational capabilities have been demonstrated:

- Significantly higher jammer-to-signal ratios were generated than is possible with current omni-directional countermeasure devices
- The MWS achieved precise location and tracking of the threat
- Accurate pointing of the countermeasure source was achieved using information provided by the MWS

The test plan included live missile firings at the DIRCM mounted in the cable car. However, range safety concerns deferred the tests pending range modifications and improvements.

The attack aircraft DIRCM design was originally based upon a reconfiguration of the pointing and tracking hardware and the laser source in the Air Force LANTIRN pod. The MWS was to be mounted internal to the aircraft itself. Both industry and the Naval Research Laboratory are working to develop the major hardware components. NRL is developing the laser countermeasure element and integrating the major components into a flight-worthy system.

DIRCM Laser Development Schedule



The form factor of the completed laser design meets the constraints of the Air Force LANTIRN pod. The design incorporates multiple heads in a single cavity. An alternative laser design that has less rigorous form factor constraints is under development in a parallel effort and will be suitable for testing in a larger aircraft.

The attack version MWS has been successfully tested by Rockwell International Missile System Division in Duluth, Georgia. The MWS will be delivered to NRL for acceptance tests. The MWS staring focal plane array provides two-color imagery to effectively discriminate the threat from background and battlefield clutter.

System software and passive tracker algorithms being developed by Martin-Marietta Electronic Systems Division for their geometric array parallel processor (GAPP) have been delivered to NRL. Final acceptance tests were scheduled for January 1992. Investigation of an alternative laser configuration suitable for large aircraft is complete, and another existing pointing and tracking system was selected for modification. Unfortunately, severe restrictions on the FY 1992 BTI budget preclude further work on the integration of attack version DIRCM hardware and software components.

In summary, the helicopter DIRCM prototype system capability has been demonstrated. The transport DIRCM demonstration will soon be complete. Demonstration of the attack aircraft DIRCM component capabilities, except for the countermeasure laser, has been terminated due to the reduction of the FY 1992 budget. Full power operation of the countermeasure source is still scheduled.

TRANSITION PLAN

The DIRCM project is managed for BTI by the Naval Research Laboratory, Washington, DC. The transition of the Helicopter DIRCM to the U.S. Army CECOM Advanced Technology DIRCM development program has been accomplished incrementally as the design, fabrication, and test results have become available. The parameters achieved in the helicopter and attack aircraft DIRCM projects satisfy Advanced Technology IRCM objectives.

Transition of the transport DIRCM prototype hardware and software is pending depending on the results of flight tests and countermeasure effectiveness evaluations. Follow-on engineering development may incorporate a higher power multiple frequency laser source, such as the laser developed by NRL.

Program Management

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Attack DIRCM Program Manager	Dr. Raymond Patten NRL Code 6530 Washington, DC (202)767-3049

EFFECT OF FY 1992 BUDGET ACTIONS

Severe restrictions on the FY 1992 BTI budget forced a reassessment of all the DIRCM projects. Demonstration of the attack aircraft DIRCM prototype system cannot be accomplished with currently available funding. Some of the major elements, such as the MWS and system software, are being transitioned into the Navy integrated electronic warfare system (IEWS) advanced IR jammer program as these components are successfully demonstrated. The feasibility of a solid-state, mid-IR wave length, prototype laser countermeasure source will be demonstrated during May 1992. Transition of the full power, multiple-laser countermeasure source into the IEWS depends upon funding from other sources and continued development.

SOLID STATE LASER COST REDUCTION

The utility of solid state lasers has been limited by the high cost of diode arrays used to pump the solid state lasers. This BTI project will result in a fielded system only if the cost of laser diodes is significantly reduced through volume production. The BTI project was structured to include a demonstration of cost reduction feasibility.

Before the start of the BTI and tri-service cost reduction activity, diode arrays used in a generic countermeasure laser that puts out one joule per pulse cost approximately $1.5 million. Now the same diode array can be manufactured for only $150,000 -- a tenfold reduction. In larger quantities, the cost may be as low as of $15,000. Costs have dropped from about $100 per watt to less than $10 per watt and could drop to $1 per watt at high production rates. The diode pumping of lasers is an enabling technology that will soon be much more affordable thanks to this portion of the infrared countermeasures project.

Current as of February 3, 1992

MULTI-MISSION SEEKER DEMONSTRATION

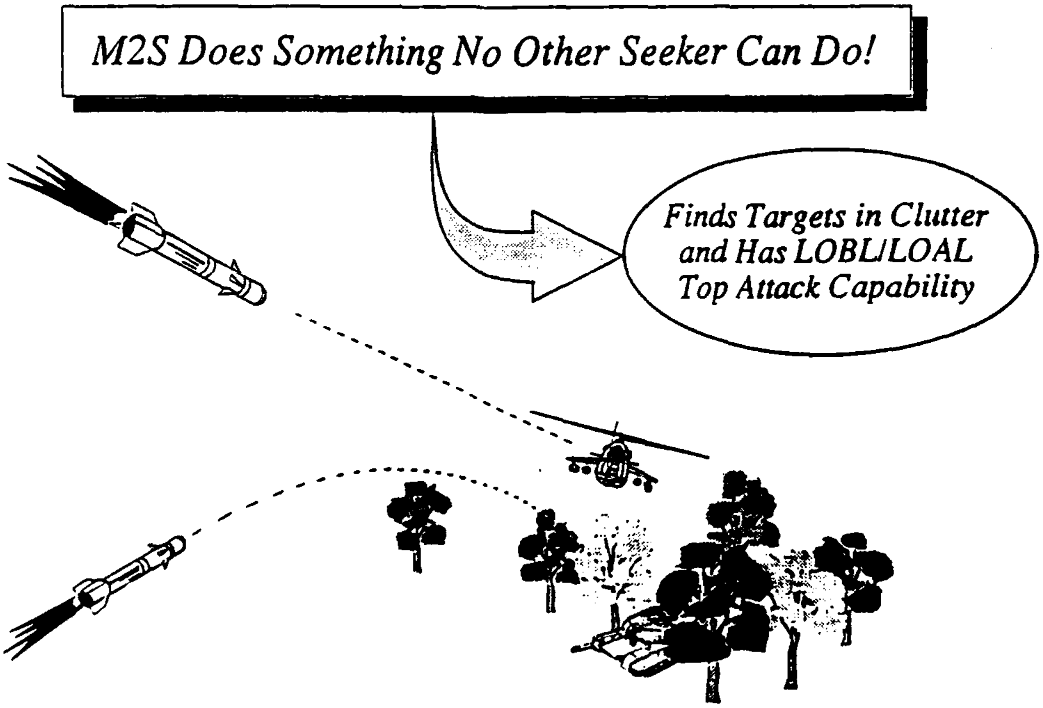
SYSTEM DESCRIPTION

What is MMS?

- An advanced missile seeker matched to a multi user missile design
- A unique sensor designed for clutter rejection and target discrimination
- An opportunity to reduce logistics support costs through multi-user, multi-mission capability

The Multi-Mission Seeker project will develop and demonstrate an advanced infrared seeker for Tri-Service application to missile systems required to acquire, classify, identify, track, and terminally guide on targets. The concept incorporates advanced infrared imaging techniques and a unique processing approach to provide lock-on-before-launch, lock-on-after-launch, and target reacquisition capabilities. The combination of different techniques in a single seeker design makes it possible to engage ground targets, helicopters, and fixed wing aircraft at long range in heavy clutter and the presence of countermeasures. Improved target discrimination and positive identification capabilities will reduce the probability of fratricide. The concept can be applied to the upgrade of existing systems and will support improved capabilities in future weapon systems.

MMS CONCEPT

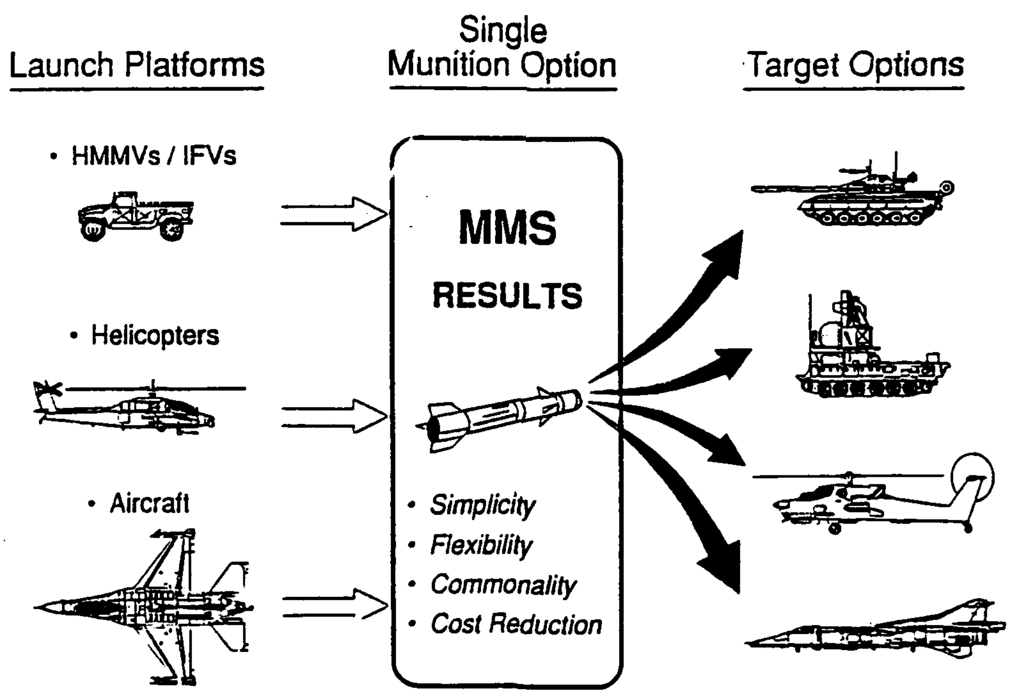


REQUIREMENT

Potential Applications

- Close air support munitions
- Crew served and vehicle mounted ground-to-ground munitions
- Attack and armed reconnaissance helicopter munitions
- TACAWS
- JAWS
- Stinger upgrades
- Theater missile defense

Present weapons systems, both in the field and under development, are designed for specific missions and targets. This limits the broader utility of the weapons, increases their costs, and results in hardware that cannot readily be adopted to other missions and systems. Missiles that can be launched from either surface or airborne platforms against both ground and airborne targets will reduce the need for dedicated weapons, increase responsiveness to unexpected targets and targets of opportunity, and enhance overall battlefield effectiveness. A common seeker for multiple applications will reduce costs through commonality in logistics support.



Launch and Target Options

OPERATIONAL UTILITY

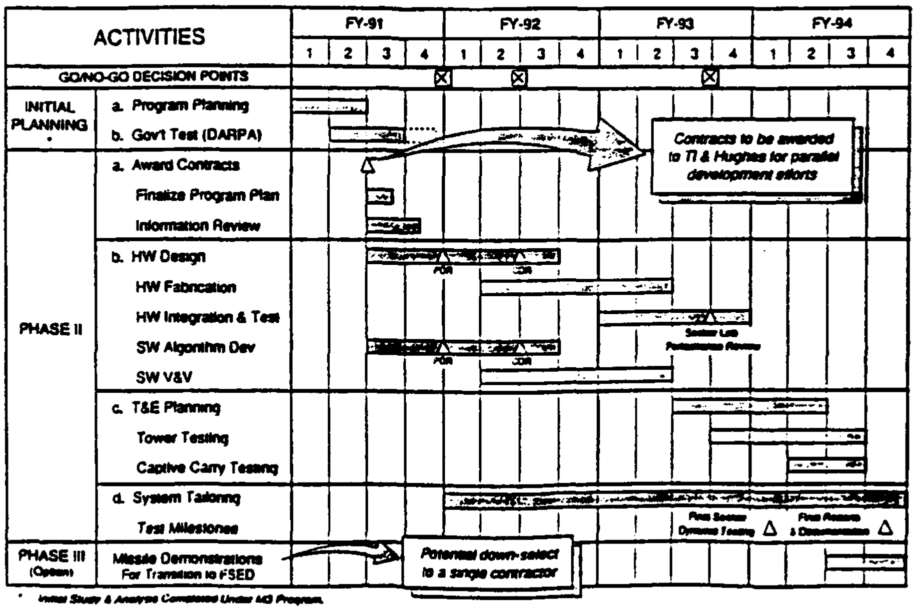
Project Demonstration Objectives

- Target discrimination in clutter and adverse environments
- Extended operational ranges
- Lock-on-after-launch, lock-on-before-launch, and target reacquisition
- Automated target identification and IFF
- Solution for countermeasure deficiencies

The application of the Multi-Mission Seeker concept to selected battlefield systems will greatly improve performance, robustness of operation, and combat utility and versatility. The concept will support new capabilities and provide target acquisiton, reacquisition, and discrimination in heavy clutter environments to an extent currently unavailable. The seeker has potential for employment against a wide array of ground and aerial targets.

TECHNICAL APPROACH

The primary mode of operation will be to apply special processing techniques to the infrared signal. The seeker senses and integrates two unique target aspects. When this cannot be done, the seeker will revert to basic infrared guidance. The special processing capability permits acquisiton and engagement of certain targets in clutter at standoff ranges greatly in excess of current capability. The project takes advantage of recent imaging technology developments, such as infrared focal plane array technology, large throughput compact digital signal processing hardware, and specialized algorithms. Modularity will permit multi-mission, multi-user applications.



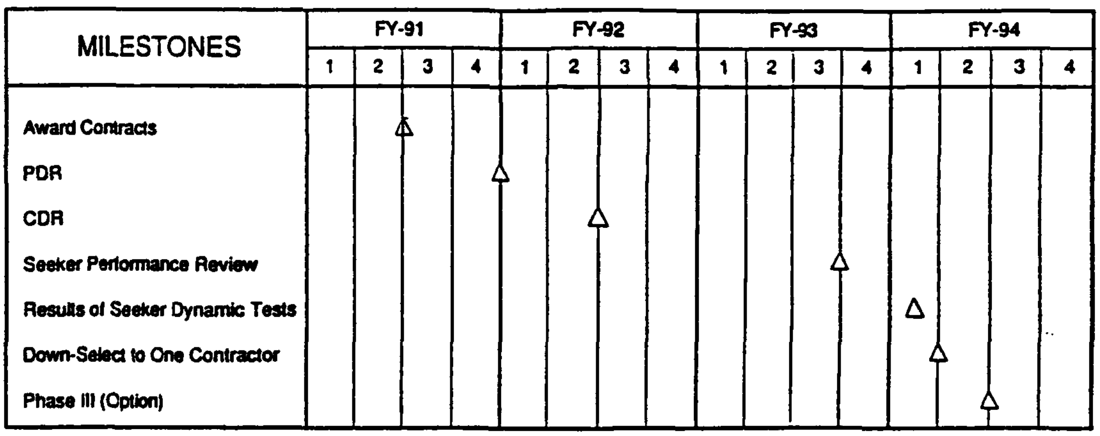
Project Schedule

TRANSITION PLAN

MMS MANAGEMENT

Project Manager:	Ms. Teresa Puretz BTIO Alexandria, VA 22311 (703)998-7720
Competitive Contractors:	Texas Instruments Dallas, TX Hughes Aircraft Corp. Canoga Park, CA

The Army, Marine Corps, and the Air Force have an interest in the Multi-Mission Seeker project. Project management has been provided by the U.S. Army Missile Command, Redstone Arsenal, AL. The seeker and associated technologies will be transitioned to user applications as they are identified. The MMS is expected to enter full scale development for selected applications at the end of FY 1994. The project office is coordinating with potential users in each of the Services as well as with other interested government agencies. Project responsibility for MMS will be assumed by DARPA following a critical design review in September 1992.



Current as of October 25, 1991

MILLIMETER WAVE SEEKER DEMONSTRATION

MMW RADAR FOR STANDOFF ATTACK

The objective of the BTI millimeter wave (MMW) seeker demonstration project was to provide the Air Force with a day/night, adverse weather, autonomous, lock-on-after-launch weapon for standoff delivery against fixed and mobile air defense units, moving and massed armor, and other mobile battlefield and second echelon targets. To meet this challenge, the project developed and integrated seekers on AGM-65 Maverick airframes and completed a series of captive carry and free flight tests against mobile target arrays. The results show that MMW radar can provide the desired capability.

The seeker can meet other requirements as well. A potential use is in response to a need revealed by Operation Desert Storm. Air Force evaluation of that operation led to a priority requirement for an all-weather direct attack weapon suitable for attacking high value fixed targets and achieving a hard kill against air defense radars.

Congress approved an extension to the BTI project that will be used to address these near term applications. The follow-on efforts will assess the applicability of the MMW seeker to the Joint Direct Attack Munition (JDAM) terminal guidance requirement. The project also will continue development of robust algorithms to find and destroy the radars of enemy air defenses.

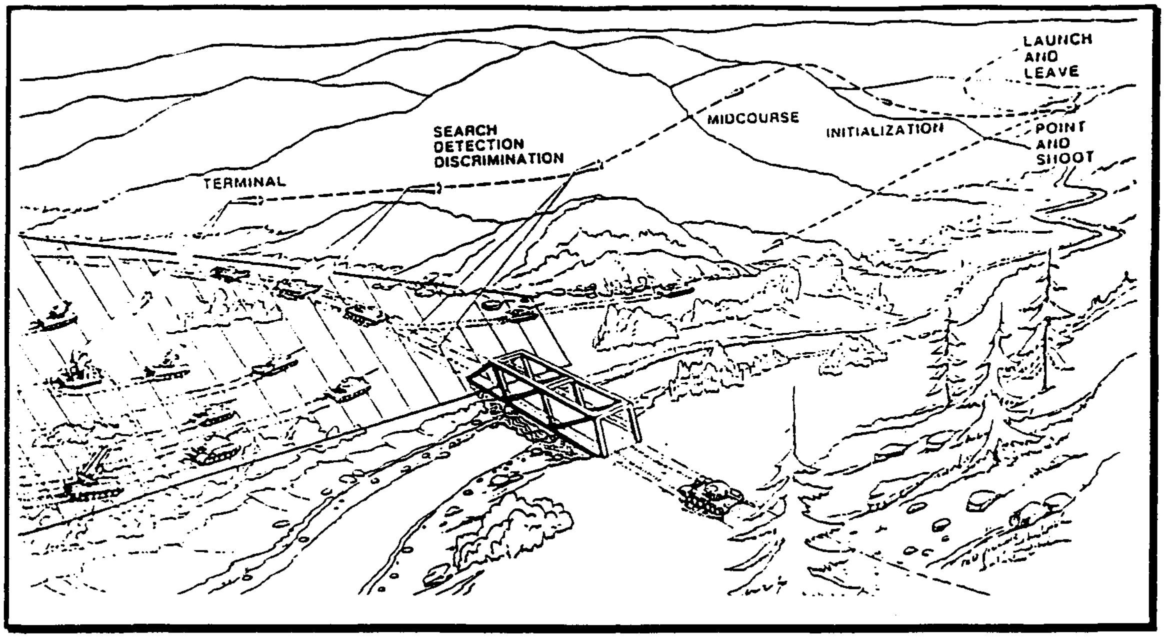
OPERATIONAL CONCEPT

This technology demonstration project evolved from weaponization trade studies for the Tactical Air Force Statement of Need 317-87. The statement of need required that the weapon be used on current tactical aircraft with no hardware or software modifications to either the aircraft or the launcher. In addition, the project was to consider only upgrades to existing or in development weapons to keep development and life cycle costs to a minimum. These ground rules coupled with the operational requirements meant that the most effective approach was to integrate a MMW seeker on the Maverick missile airframe for the demonstration.

TAF Requirements

- Autonomous lock-on after launch
- Multiple launches/kills per pass
- Adverse weather and night capability
- Low altitude launch
- Standoff
- Multi-role/Multi-platform

The concept of operations calls for a tactical aircraft to fly to a point out of visual contact with the target, launch its missiles without first having to acquire the targets, and without having to reattack. The missiles would fly to the target area, search, detect, acquire, and attack the targets without further human intervention.



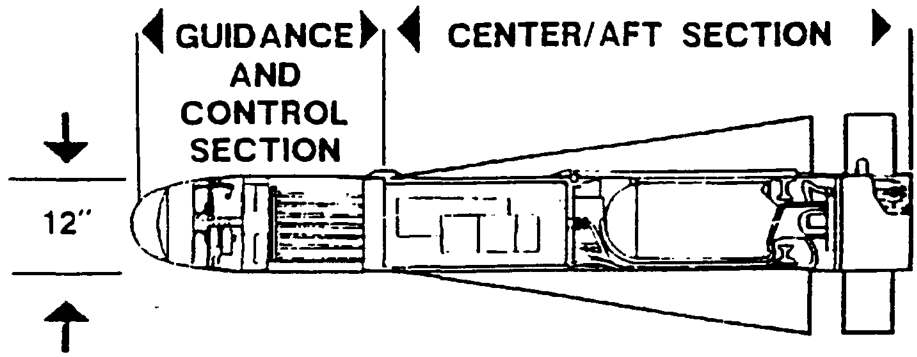
Launches are permitted as low as 200 feet above the ground at standoff ranges near the maximum flight range of the missile. A direct attack mode is also provided to allow the pilot a point and shoot option. This option retains the same lock-on-after-launch feature, and the seeker guides to the first target that appears in the field of view. Other features of the missile include cockpit selectable modes of operation such as type of target to be attacked and which target in an array is to be attacked. Pilot workload is minimized as all parameters may be preset before takeoff or enroute to the selected launch point. The pilot merely arms the weapon and fires as he approaches the launch point.

TECHNICAL APPROACH

The approach to providing a weapon meeting the statement of need was to transform existing MMW seeker hardware and brassboard electronics into flight worthy demonstration hardware, electronics and instrumentation; package it into the Maverick guidance and control section and warhead section; run the seeker radar and all processing algorithms in real time in captive flight tests to evaluate performance at missile speed; and validate, through hardware-in-the-loop simulations, seeker aided midcourse, target detection, target track and terminal guidance to impact.

The ultimate goal was to demonstrate the capability of Millimeter Wave Maverick to perform all functions of an autonomous, lock-on-after-launch missile including guidance to a direct hit on a representative target. The MMW guidance and control section is designed to accept data from the aircraft via a MIL-STD-1553 digital data bus as a growth option. This will allow targeting information and inertial guidance parameters to be passed from the aircraft to the missile. This growth option will greatly enhance the launch envelop of aircraft so equipped.

MMW MAVERICK MISSILE



DEVELOPMENT STATUS

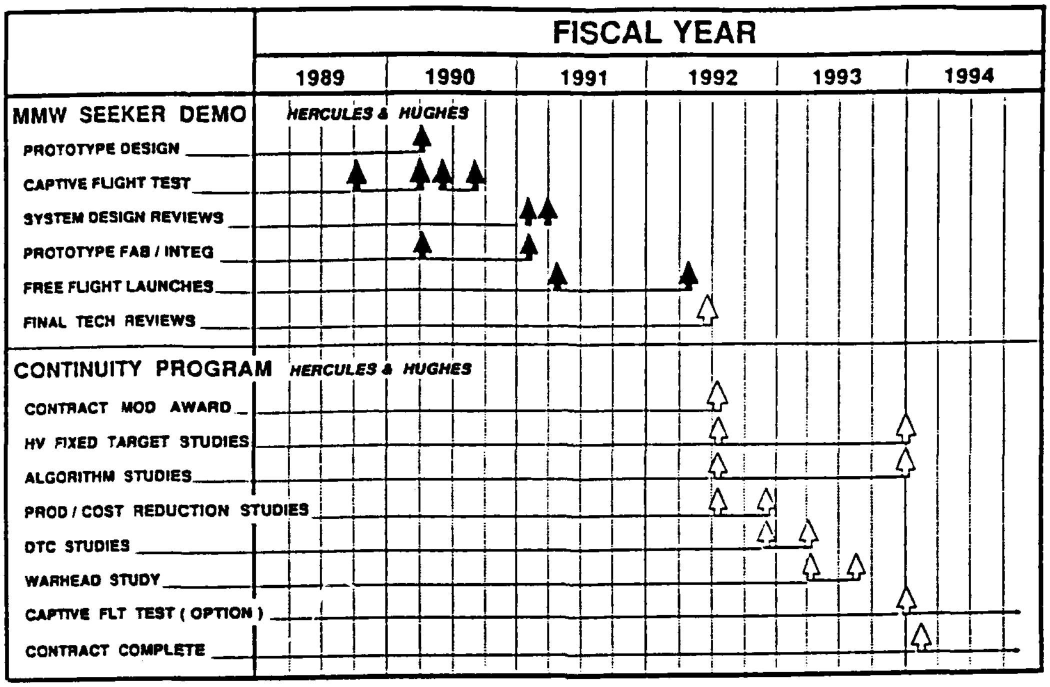
Parallel contracts were awarded to Hughes Aircraft Company Missile Systems Division and to Hercules Defense Electronics System for development, integration, and test of MMW seeker guidance units for the Maverick Missile. Each contractor followed a different approach to the design of the seeker and developed the signal processing, detection, discrimination, and tracker algorithms to meet the requirements for an autonomous weapon.

Although the weaponization requirements were the same for each contractor, their hardware and software are significantly different. The Hercules seeker is a Ka-band frequency modulated continuous wave radar, while the Hughes seeker is a W-band pulsed radar.

Program Management	
BTI Project Director	Bob Hoh BTIO Alexandria, VA (703)998-7720

Both concepts proved to be technically feasible. Seekers were fabricated and flown in a series of low speed captive flights over numerous mobile force targets, both U.S. and Soviet, under varied environmental background conditions. The data was analyzed and the software was refined to increase robustness. Design changes were incorporated and the seekers were integrated into complete guidance units with all signal processing and algorithms running in real time. Integration of the guidance units with Maverick center and aft sections was completed and closed loop guidance was analyzed and validated through hardware-in-the-loop testing.

All-up MMW Maverick missiles were fully instrumented. The warhead section was used to house the instrumentation,



telemetry package, and C-band radar tracking beacon. The missiles were integrated with and captively flown on F-16A/B aircraft over a variety of tactical target arrays on an instrumented test range at Eglin AFB, Florida. Missile data was telemetered to a ground receiving station, and critical parameters were displayed in real time at a central control facility. Analysis of the captive carry data and the hardware in the loop simulations provided a high confidence that the missiles were ready for live fire testing.

Two missiles from each contractor were successfully launched and demonstrated the capability of the MMW seeker to provide autonomous guidance to the Maverick missile. The seekers performed missile initialization after launch, seeker aided midcourse guidance, search of the target area, detected, selected, tracked, and terminally guided to kill both air defense radars and other tactical targets. Two of the missiles (one from each contractor) guided to direct hits and inflicted massive damage even without a warhead. The other two missiles impacted within inches of the target and well within the lethal range of the Maverick warhead.

TRANSITION PLAN

The BTI MMW Seeker Demonstration project will be completed in FY 1992. The project has been managed for BTI by the Aeronautical Systems Division Air-to-Surface Systems Program Office at Eglin AFB, FL. This demonstration project was conducted as a risk reduction for an intended follow-on engineering and manufacturing development or product improvement program. Continuation efforts will be conducted by the Air Force and will focus on high value fixed target guidance algorithms and will broaden the seeker's capabilities against air defense radars. Successful completion will provide a reduced risk approach to meeting the technical challenges associated with adverse weather terminal guidance for JDAM, the Joint Standoff Weapon, and other candidate systems for employment against massed armor, air defenses, and high value fixed targets. The technology should be available to transition to the services for these requirements by FY 1994. Project management responsibility will transition from BTI to the Air Force following a preliminary technical review in August 1992.

Current as of March 23, 1992

Low Cost Anti Armor Submunition

System Description

The objective of the BTI low cost anti armor submunition project (LOCAAS) is to develop, integrate, and demonstrate prototypes of low cost advanced submunition concepts having multi-service and multi target applicability. The technologies involved include submunition sensor, target detection and acquisition, target classification, tracking, maneuvering devices, lethal mechanisms, and fuzing. Combinations of these technologies will enable the development of submunition concepts and prototypes with a significant increase in cost effectiveness over current submunitions. Both hit-to-kill and shoot-to-kill submunition concepts are being developed.

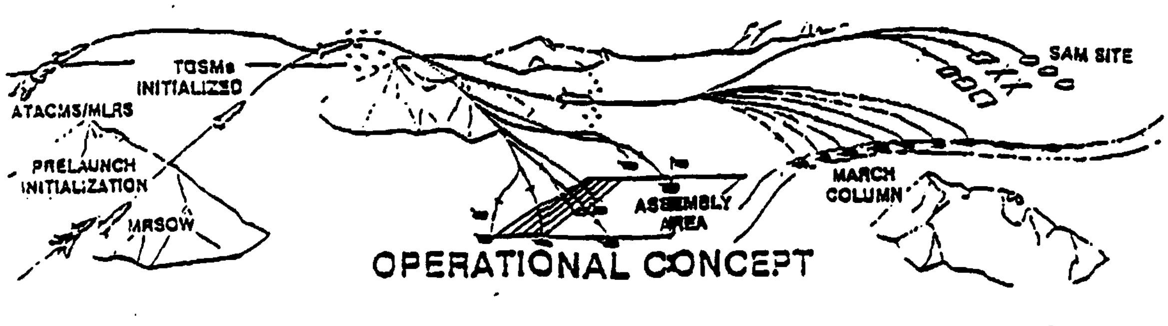
The BTI LOCAAS project focuses on cost per kill. Emphasis is placed on lethality and design-to-production-unit-cost. The objective is to demonstrate the desired performance with a system that will cost less than $15,000 per submunition.

Requirement

LOCAAS addresses several approved operational requirements for systems to attack armor, surface-to-air and surface-to-surface missile launchers. This target set is categorized as Critical Mobile Targets (CMT). The combined requirements of the Army Tactical Missile System Block II Required Operational Capabilities statement and the Air Force Wide Area Antiarmor Munition General Operating Requirement result in a joint target set composed of moving and stationary armored vehicle formations and other high value targets.

Potential Carriers

- **Army TACMS**
- **Army MLRS**
- **Air Force MRSOW**



OPERATIONAL CONCEPT

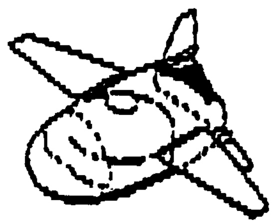
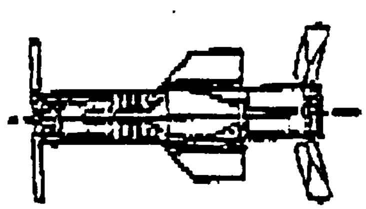
The operational concept of LOCAAS is illustrated in the preceeding figure. Low cost, highly effective submunitions are dispersed in the target area by munitions carriers that were initialized prior to launch. The submunitions search the area within their programmed footprint, guide to the targets, and execute a top attack against the least protected parts. Lethality is provided by either a shaped charge warhead or an explosivly launched projectile. Adaptability with Army TACMS, MLRS, and the Air Force Medium Range Standoff Weapon is a contractual part of the LOCAAS project.

TECHNICAL APPROACH

The basic technical issues are related to: "How to achieve CMT lethality at low cost?" Design-to-unit-prodection-cost technologies are being used to meet the cost goals.

There are two competing technical approaches to satisfying the LOCAAS requirements. The LTV concept uses a laser radar seeker which is highly resistant to countermeasures, a highly maneuverable airframe, and a shoot-to-kill explosively formed projectile warhead. Martin Marietta's design is based on the more traditional terminally guided submunition airframe. Martin uses a millimeter wave seeker with a steerable antenna and mature guidance and control algorithms. The warhead is a hit-to-kill shaped charge. The target classification features and aimpoint selection offer the potential for very high kill probability. The algorithms virtually eliminate the possibility of false targets.

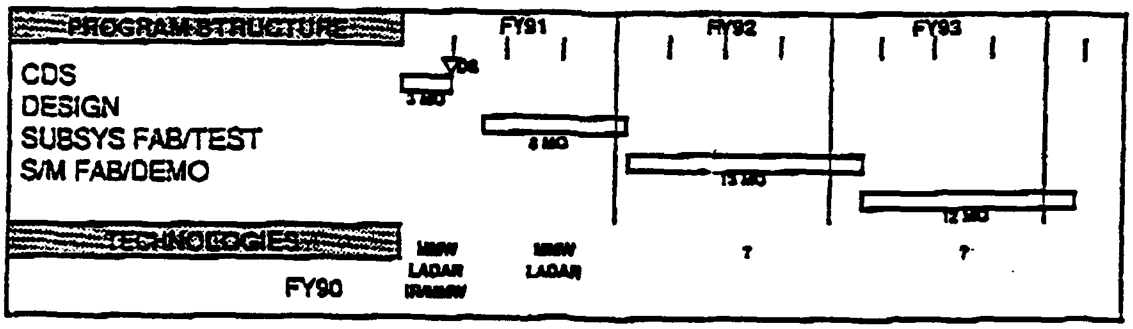
Competitive Concepts

	LTV	MMC
		
Seeker	LADAR Counter-measure robustness	MMW Steerable antenna Mature G&C algorithm
Airframe	Innovative, highly maneuverable	Traditional, TGSM variant
Warhead	EFP	Shaped charge

DEVELOPMENT STATUS

Accomplishments to date include completion of the concept definition statements, design of the submunitions, and the government and independent cost analyses. Brassboard seeker hardware has been tested from tower and in captive carry flight tests.

In FY 1992, development will focus on a down-scoped seeker-only demonstration to include tower testing and captive flight testing. This will enable the seeker technology to compete in the seeker preplanned product improvement development for the Army Brilliant Antitank (BAT) system and the Air Force/Navy Joint Direct Attack Munition (JDAM) program. In FY 1993 we plan to demonstrate the seeker in the submunition design. These program changes were the result of the overall funding constraints placed on BTI in FY 1992.



Project Schedule

TRANSITION PLAN

The intent of the LOCAAS project was to demonstrate prototype multiple application, multiple target submunitions. The most promising concepts or component technologies from the project will be competitive candidates for JDAM, to meet currently unfunded requirements such as a smart submunition for the MLRS, and as part of a pre-planned product improvement (P3I) of the seeker for another antiarmor submunition.

Transition of LOCAAS could occur as early as FY 1994. The project has been jointly managed for BTI by the U.S. Army Missile Command, Redstone Arsenal, AL, and the Air Force Wright Laboratories, Eglin AFB, FL.

Entry into EMD would be compatible with the schedules of the candidate carrier vehicles. The Army Tactical Missile System and the Multiple Launch Rocket System are currently functional and would require integration only.

The technologies, components, and subsystems evolving from the LOCAAS project have a variety of potential defense uses. Systems concepts based on LOCAAS are currently being considered.

Management	
Program Director	Teresa Puretz BTIO Alexandria, VA 22311 (703)998-7720
Contractors	LTV Dallas, TX Martin Marietta Corp Orlando, FL

Current as of December 20, 1991

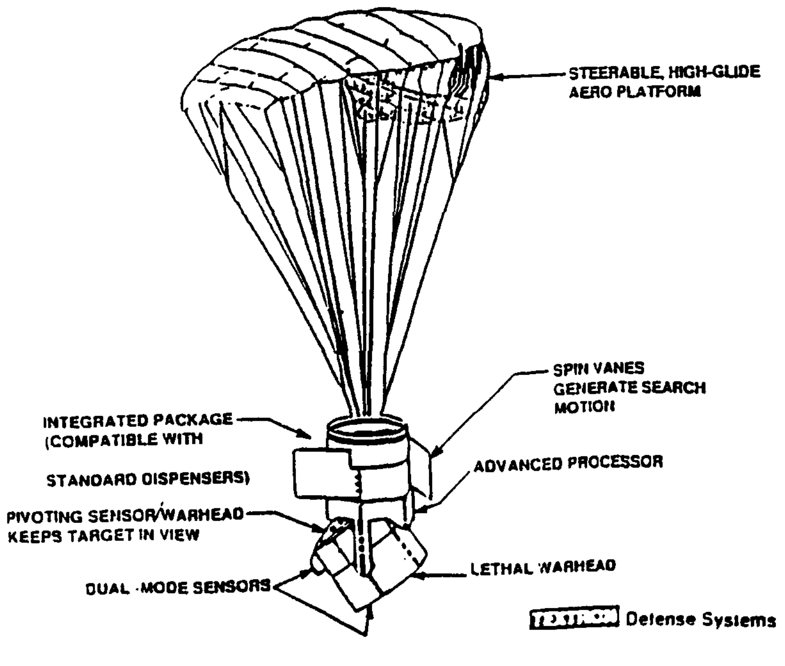
DAMOCLES
AUTONOMOUS INTELLIGENT SUBMUNITION

SYSTEM DESCRIPTION

The Damocles Autonomous Intelligent Submunition (AIS) is a smart submunition that has been designed specifically to provide the greatest effectiveness against mobile launchers for surface-to-surface missiles such as SCUDS. This target was the primary reason for the Damocles system concept, choice of sensors and algorithms for finding the target, and warhead. Damocles will also operate against mobile command posts, stationary and mobile air defense units, and arrays of light armor tactical vehicles. The submunition will be deliverable by current and emerging weapons platforms including the Autonomous Air Vehicle, the Army Tactical Missile System, the Army Multiple Launch Rocket System, and the Air Force Medium Range Stand-off Weapon and Tactical Munition Dispenser.

System Features

- Unique 4:1 glide ratio ram air parachute
- Efficient spin-vane driven scanning
- High resolution active MMW and Passive LWIR sensors
- Robust target detection, classification, and engagement algorithms
- State-of-the-art digital signal processor with parallel, multiple microprocessor architecture.
- Closed-loop platform maneuvering control system
- Novel, single-axis variable-elevation sensor/warhead aiming mechanism
- Effective 7.5 inch tantalum multiple explosively formed penetrator warhead.



REQUIREMENT

Damocles supports AirLand Operations Doctrines. The concept overcomes several munitions deficiencies identified in U.S. Army Battlefield Development Plans including munitions lethality, system range, and target acquisition.

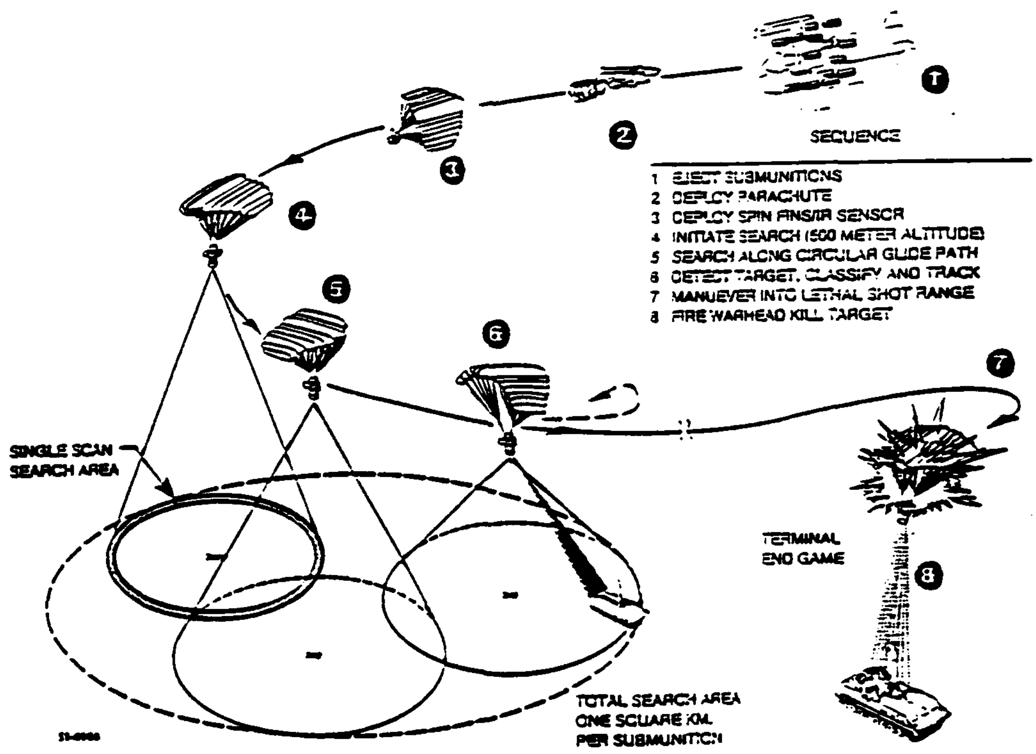
Current autonomous munitions are limited in their ability to detect partially obscured targets. The scenario is technically very challenging. The surface-to-surface missile launchers, components of the air defense missile units, and support elements that comprise the target set are typically deployed in small groups over a large area. Visibility can be limited by darkness, adverse weather, smoke, dust, and other obscurants. Targets can be camouflaged, positioned in defilade, partially occluded, and protected by active and passive countermeasures. The munitions must be able to perform a broad area search, acquire and classify the target, and destroy it under all conditions of the modern battlefield.

Damocles Satisfies Army Needs for Deep Battle Attack of SSM and SAM Sites

Army Needs	Damocles Attributes
Dispense from multiple carriers	Compatible with ATACMS, MLRS, Lance, MRSOW, TMD
Provide high productivity	Multiple kills per launch
Recover from target location and delivery errors	One million square meters footprint
Attack and kill hard to find SSM/SAM targets and command posts	Moving -- Maneuverable airframe, tilting warhead/sensor
	Stationary -- High resolution sensors, advanced signal processing
	Obscured -- Steep look-down angle, multi-aspect search
Operate in all weather	Dual sensor, less than 600 meters standoff
Low false alarm rate, countermeasures resistant	Dual sensors, multiple looks
Fire and forget	Totally autonomous operation
Low cost	Design to unit production cost $15,000

OPERATIONAL CONCEPT

Damocles places sensors and a warhead on a rotating, maneuvering platform coupled to a high-glide parachute. The platform provides a search footprint in excess of one square kilometer to compensate for both target location and carrier delivery errors. The steep look-down aspect, relatively slow rate of descent, robust dual mode sensor, and fuzed data signal processing overcome the limitations of current systems and increase the probability of target detection and identification. During the terminal phase, the sensor examines the target in multiple scans from different aspects. The processor improves classification and false target rejection performance and controls the terminal maneuvers and submunition aim point. Lethality is provided by a tantalum explosively formed penetrator aimed and fired at short range and steep target entry angles, increasing the probability of kill.



Damocles AIS searches for, detects, classifies, and tracks the target and maneuvers to take the best shot

System Specifications

• Length:	368 mm	• Acquisition Range:	577 meters
• Diameter:	191 mm	• Lethal range:	200 meters
• Weight:	20.5 kilograms	• Sensor Suite:	Passive IR, 8-10.5 µ Active MMW radar, 35 GHz
• Search Area:	1,000,000 square meters	• False alarm probability:	Less that 1 per square kilometer
• Search altitude:	500 meters to 50 meters	• Detection probability:	Greater than 0.9
• Scan rate:	3Hz, Passive drag fins	• Kill probability:	Greater than 0.7
• Over scan ratio:	6:1 (nominal)	• DTUPC estimate:	$15,000 per submunition
• Engagement geometry:	360 degrees about heading	• Cost per kill:	Less than $100,000 for 100,000 units

PROJECT PLAN

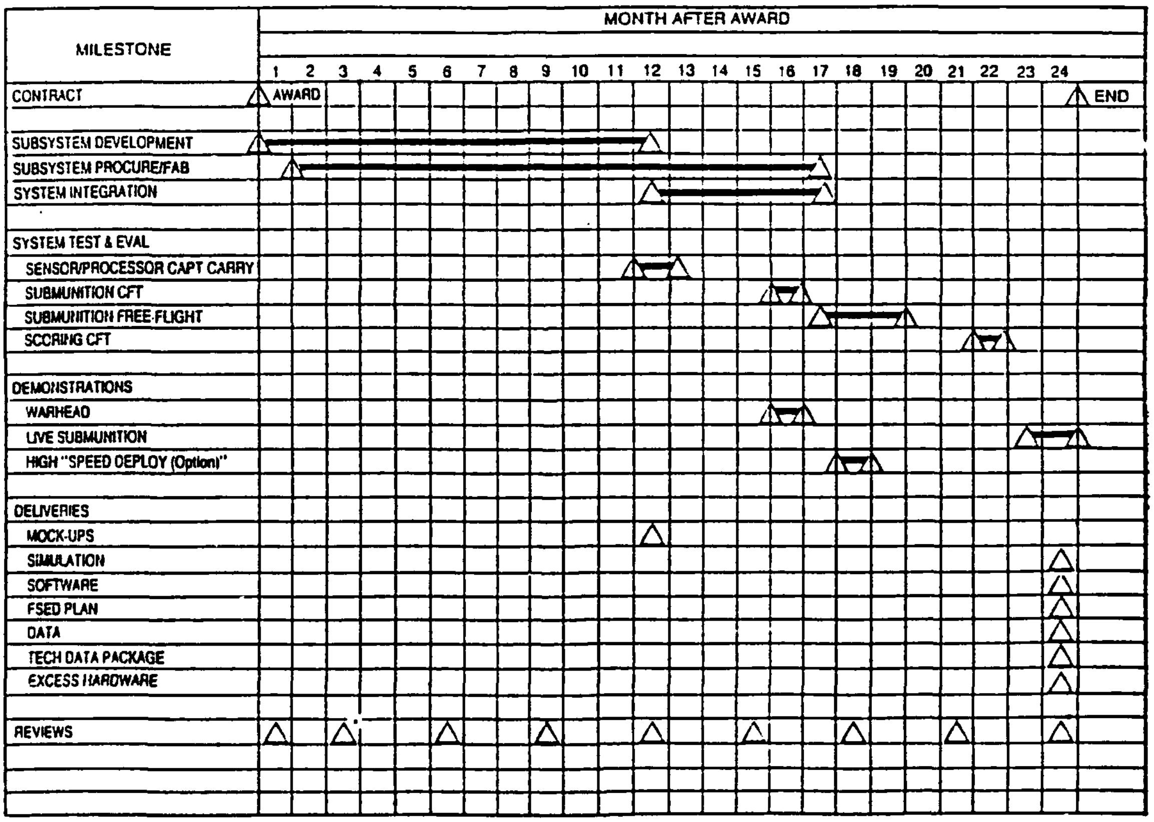
The Damocles AIS project is a continuation of previous subsystem development efforts for the prototype IR sensor, millimeter wave sensor, signal and control processor, and aeromechanical subsystems. The current effort is structured to form-factor the subsystems, integrate them into a fully autonomous submunition, and demonstrate performance in live fire tests against realistic targets. The 24-month project will be conducted in four phases.

During Phase 1, the subsystems developed previously will be repackaged to fit the AIS demonstration test articles. The reconfigured warhead will be tested, evaluated, and redesigned as required to retain demonstrated performance. A production ready safe and arm device will be incorporated. Phase 1 includes the fabrication of sufficient subsystems to support the engineering evaluation and live fire tests to be conducted in subsequent phases.

During Phase 2, the submunitions will be assembled and tested at progressively higher levels of integration. Completed submunitions will be subjected to baseline performance tests, workmanship environmental screening, and acceptance tests prior to release for system evaluation and demonstration testing.

Engineering evaluation tests will be conducted in Phase 3. They will begin with captive flight evaluation of the sensors and data collection to support evaluation of the targeting algorithms. Captive carry tests of the integrated submunition will be conducted to verify performance in a variety of operational environments. Free flight tests of an inert AIS will verify the closed loop performance of the target engagement functions including detection, steering, and aim point control. The final tests will verify end-to-end function under the same conditions as the live fire demonstration to be performed in Phase 4.

The Phase 4 live fire demonstrations will complete the Damocles AIS project. The tests will include launching a submuntion with a live warhead over a test area The AIS will search, detect, classify, and fire at representative targets. Warhead lethality will be demonstrated with a series of static fire tests to characterize p.:netration and behind armor effects. A high speed deployment system will be developed and tested to demonstrate deceleration of the AIS from typical platform dispense velocities to parachute opening speed.



*GOVERNMENT DECISION ON WHETHER OR NOT TO PROCEED

Damocles AIS Master Milestone Schedule

TRANSITION PLAN

The BTI funding plan for the Damocles project is shown below. Concept development and subsystem development were funded by BTI and DARPA and constitute the basis for the current AIS proof-of-principle phase of the development. Upon completion, the project will transition to the Army. The US Army Field Artillery School is the designated User Agency for Damocles AIS. The Artillery School submitted a Memorandum of Support for the project to ARDEC, the development agency, in July 1991.

A Memorandum of Agreement between the Army and BTIO agrees to evaluate the Damocles AIS in the Joint Precision Strike simulations if the Damocles project is successful.

Project Management

Program management support for DAMOCLES is provided for BTI by DARPA, Arlington, VA

BTI Point of Contact	Teresa Puretz	BTI 1901 N. Beauregard Suite 380 Alexandria, VA 22311	Tel: (703)998-7720 Fax: (703)998-6035

Current as of January 27, 1992

Low Cost Uncooled Sensor Project

What is LOCUSP?

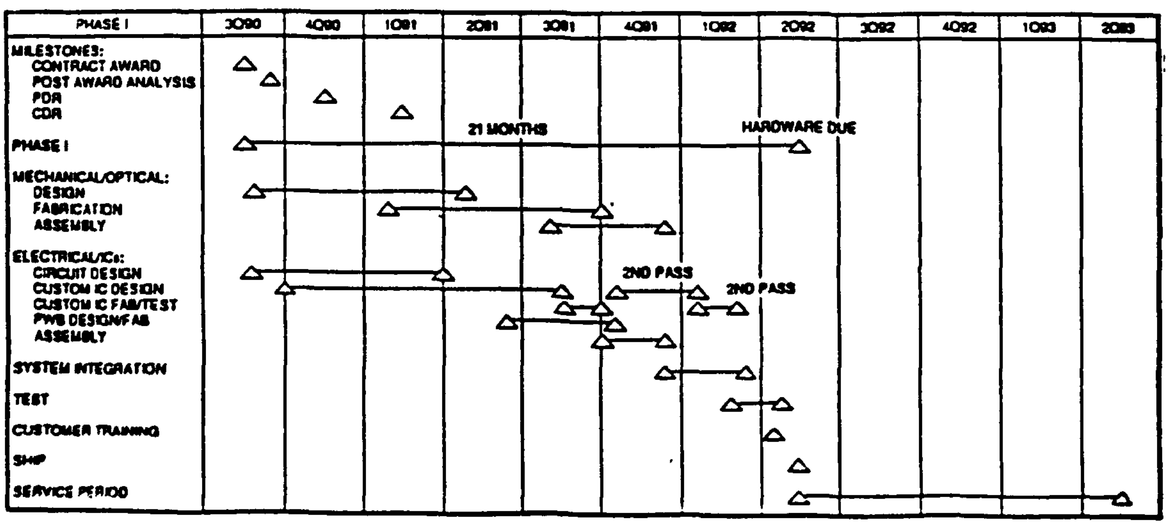
The Low Cost Uncooled Sensor Project (LOCUSP) began as a joint DARPA/ Army investigation of infrared detector materials that function at significantly higher temperatures than photoconductive or photoelectric materials such as mercury-cadmium-telluride (MCT). A number of thermally sensitive ferroelectric materials, such as strontium-barium-titanate, and bolometric materials, such as vanadium oxide, have demonstrated uncooled infrared detector sensitivity suitable for low and medium performance IR sensor applications. LOCUSP has been referred to in other BTIO reports as the Uncooled Focal Plane Array project.

The first uncooled IR sensor to demonstrate performance comparable to cooled IR detector equipment was the Short Range Thermal Sight developed by the Army Night Vision Laboratory in 1986. Subsequently, the Balanced Technology Initiative office joined with DARPA and the Army to increase sensitivity by 50 percent, reduce the size of individual detector elements by one-third, and increase the number of detectors in the array by a factor of eight.

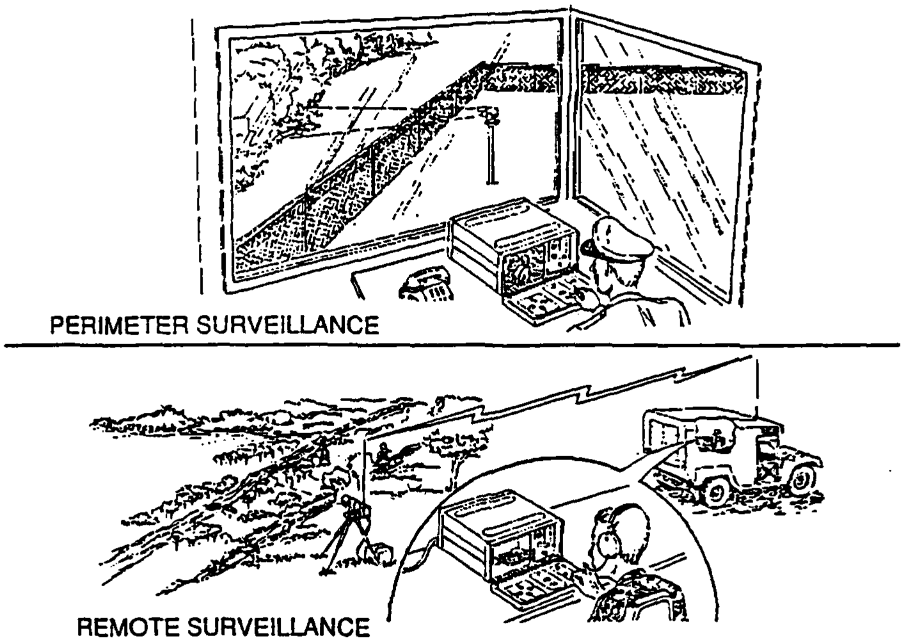
The BTI project includes the fabrication of two prototype applications of the LOCUSP technology: a rifle sight (similar to the Short Range Thermal Sight developed earlier) and a remotely operated perimeter surveillance sensor. The BTI project is attempting to solve three key technical problems:

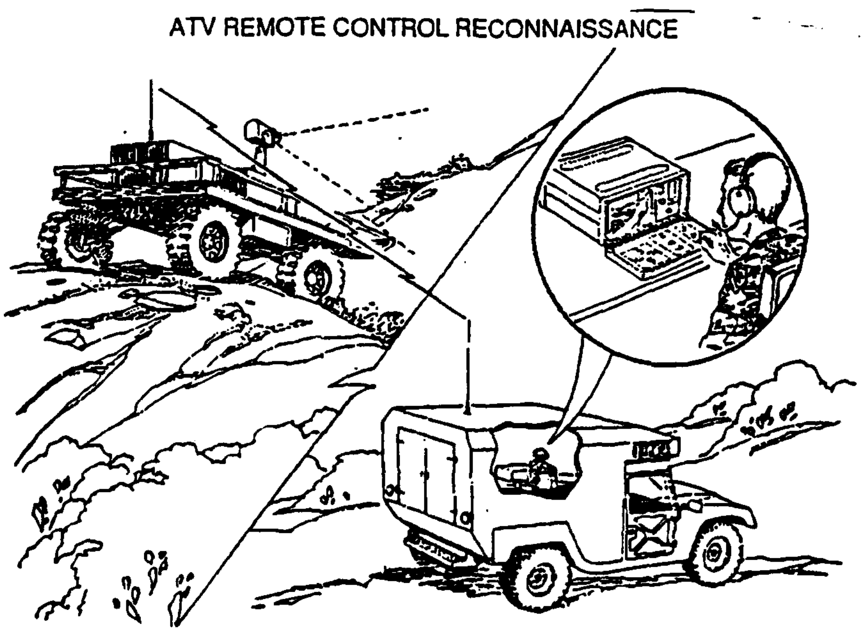
- How to achieve the sensitivity needed for medium range applications using uncooled materials.
- How to reproducibly make large detector arrays with uniform response and few dead elements.
- How to develop small, low cost, low power electronics packages that will work in an operational environment.

LOCUSP Schedule



Surveillance System Operational Concepts



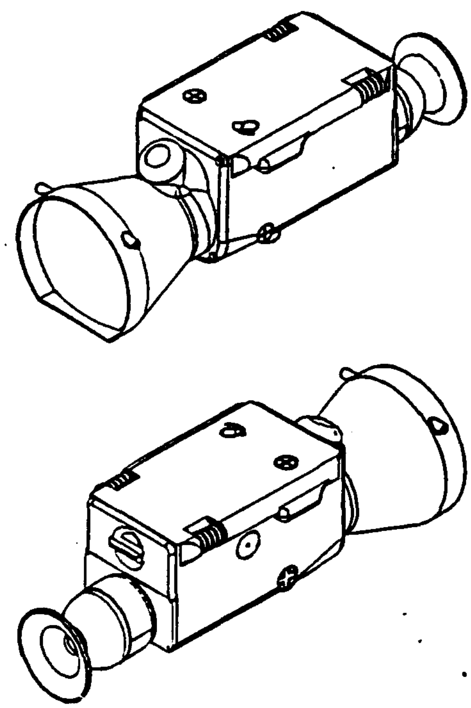


Project Goals

So far the project has explored two different technical approaches to uncooled focal plane arrays. The project plans to demonstrate and compare the performance of both for individual weapon sights and short range area surveillance devices. Medium range capability will be demonstrated by man-in-the-loop and autonomous munitions seekers and sensors. Current performance is adequate for the short range applications, but higher performance will be required to meet the medium range objectives. The BTI project will deliver rifle sights and surveillance systems designed to operate under ambient temperature conditions as high as 130 degrees F. Operation at 140 degrees F is possible with some performance degradation and increased power consumption. The first units will be delivered in 1992. Preliminary estimates indicate costs on the order of $7,000 per unit for an acquisition of 1,000 units or more.

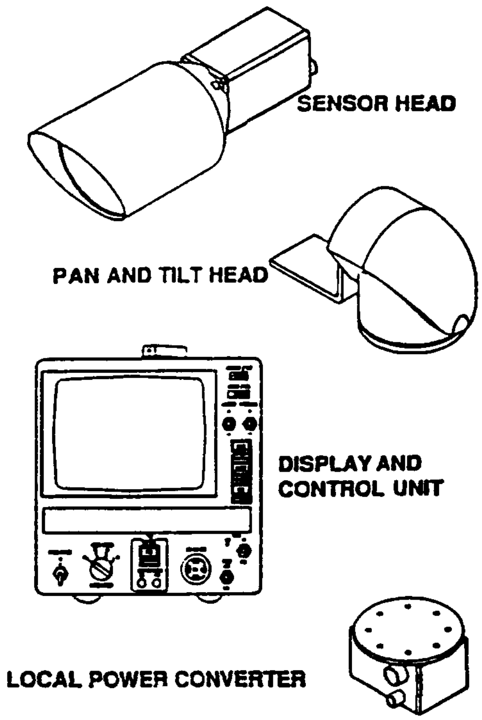
Medium-Range Thermal Sight Requirements

Range	50 percent probability of detection of a man at 1000 meters
Compatibility	With M16, M203, M4, M249, M60
Weight	Less than 4 pounds
Size (inches)	4 high, 4 wide, 13 long
Operating time	More than 10 hours at 25 degrees C
Mean time before failure	More than 1,000 hours
Start-up time	Less than 10 seconds
Noise equivalent temperature difference	Less than 0.2 degrees C
Instantaneous field of view	Less than 0.5 milliradians
Total field of view	7 degrees by 9 degrees
Eye relief	More than 30 millimeters
Exit pupil	More than 10 millimeters
Diopter adjustment	+ 2 to - 6
Magnification	3x - 4x



Surveillance System Requirements

Range (narrow field of view)	50 percent probability of detection of a man at 1,500 meters
Weight	System: Less than 88 lbs Sensor: Less than 13 lbs
Power	System: Less than 100 watts Sensor: Less than 20 watts
Start-up time	System: Less than 15 sec Sensor: Less than 15 sec
Voltage	100/120 VAC 50/60 Hz or 24-28 VDC
Mean time before failure	More than 4,000 hours
Sensor field of view	Instantaneous: 0.33 mr Wide: More than 9x15 deg Narrow: More than 3x5 deg
Noise equivalent temperature difference	less than 0.2 deg C



MILITARY UTILITY OF INFRARED DETECTOR TECHNOLOGY

One lesson learned during Operation Desert Storm was the major advantage of continuous day and night operations. American high technology systems such as night vision goggles, infrared targeting systems, low-light-level television cameras, and other devices enabled men and weapons systems to see and operate at night and under restricted visibility conditions. In the future, sensors based upon LOCUSP technology will provide a lightweight (less than four pounds), long wavelength (8-12 microns) infrared imaging sensor capability independent of light level and insensitive to smoke. The technology will provide the individual soldier with infrared imaging weapons sights and surveillance devices for increased physical security.

Prototype Applications

- Medium Range Thermal Imaging Sight
- Infrared Security Sensor
- Infrared Missile Seeker Sensor
- Infrared Autonomous Munition Seeker Sensor

The development of uncooled infrared sensors, particularly focal plane array devices, provides a breakthrough in capability. Staring focal plane arrays further reduce complexity by eliminating the need for mechanically operated scanning systems. The elimination of cryogenics reduces power requirements, saves weight, and improves reliability and availability. The uncooled detector technology will permit the development of moderate performance imagers that could be acquired in sufficient numbers to make a difference. Lightweight systems that will operate for more than 10 hours on battery packs are feasible.

IMPORTANCE OF LOCUSP TECHNOLOGY

High performance advanced systems require cryogenic cooling of the detector material to obtain the sensitivity and reduce systems noise so that low contrast targets can be detected at long range. The Stinger, Chaparral, and Sidewinder antiair missiles use heat-seeking guidance systems based on cooled infrared detector technology. Infrared images generated by the targeting device on the F-117 Stealth Fighter were seen on television sets all over the world. The cost and complexity of cryogenic cooling is prohibitive for many medium and short range sensor applications. Elimination of the cooling requirement while providing adequate performance for selected applications, will change the picture entirely. The military applications for readily available, reliable low-cost infrared detectors are limited only by the imagination. Surveillance systems, vehicle driving viewers, weapons sights, and guidance systems for unmanned land and aerial vehicles are but a few ways these devices can be used. Systems taking advantage of this technology would proliferate with the availability of infrared detectors that do not demand cryogenic cooling. These devices find many applications in all branches of the Service.

Advantages of UCFPA Technology

Reduced:

- Size
- Weight
- Power
- Cost

LOCUSP MANAGEMENT

Program management of the LOCUSP project is provided for BTI by the U.S. Army CECOM Night Vision and Electro Optic Division, Ft. Belvoir, VA.

BTI Project Director	Stan Dereska	BTIO Alexandria, VA 22311	Tel: (703)998-7720 Fax: (703)998-6035
Contractor Program Managers	Tom Broyles	Texas Instruments Dallas, TX 75265	Tel: (214)995-2880 Fax: (214)995-2231
	Mike Gallo	Alliant Techsystems Minneapolis, MN 55343	Tel: (612)939-2538 Fax:(612)939-3044

Potential Applications

Manportable Systems	Seekers
• Weapons sights	• Low cost seeker
• Handheld viewers	• Dual mode seeker
• Helmet mounted sights	• Terminally guided submunition
• Fire fighting	• Autonomous mine sensor
Vehicle Systems	**Fixed Surveillance Systems**
• Low cost driver's aid	• Base Security
• Unmanned aerial vehicles	• Perimeter surveillance
• Robot vision	• Waterside security
• Navigation	• Remote sentry

TRANSITION PLAN

There are a myriad of potential applications for the uncooled focal plane array technology that is being demonstrated through the BTI LOCUSP project. The Air Force, the Navy, and the Immigration and Naturalization Service all plan to purchase additional prototype systems for evaluation. The USAF Electronic Security Center will procure eight perimeter security systems. The Naval Weapons Support Center will buy a Stinger Night Sight for the Marine Corps, and the INS will obtain six driving aid concept demonstrator systems for the Border Patrol. Other potential applications for uncooled FLIR systems are listed in the box. The project will transition to DARPA following the demonstration of prototypes scheduled in September 1992.

Current as of April 15, 1992

ULTRA WIDEBAND / HIGH POWER MICROWAVE TECHNOLOGY

INVESTIGATION OF MILITARY UTILITY

This BTI project was initiated in FY 1990 in response to expressions of Congressional interest in the potential military utility of ultra wideband (UWB) high power microwave (HPM) technology. A joint effort was started between BTI and the Services with two major objectives.

- Investigate UWB radar phenomenology, compare the performance of UWB and conventional radar system designs for the same applications, and, if warranted, develop prototype systems to demonstrate advanced capabilities.
- Establish the susceptibility of important classes of U.S. and foreign electronic systems to UWB/HPM radiation and demonstrate defensive and offensive system prototypes.

Applied to radar systems, UWB short pulse microwaves have the potential for superior performance in applications such as short range air defense and antiship missile defense. Offensively, directed radiation of very high power microwave impulses may have utility as a countermeasure to enemy communications, sensors, and electronically guided weapons. Conversely, U.S. and allied systems may be susceptible to interference from enemy sources of HPM.

TECHNICAL APPROACH

UWB Radar System Concepts

The phenomenology, design techniques, and potential military applications of UWB (impulse or monocycle) technology are less well understood than conventional wideband pulse radar. UWB radar systems have extremely fine range resolution which can enhance detection of stealthy and camouflaged targets. Substantial performance improvements are expected in foliage penetration, target recognition, and land mine detection.

The quantitative evaluation of the military utility of UWB/HPM technology is hampered by the lack of established design rules, the limited availability of high power impulse generation and transmission components, and an inadequate database of system oriented laboratory and field experimental results. The BTI approach to correct these deficiencies is through comprehensive technology assessments that include theoretical analyses, phenomenological experiments, component development, and system point design studies. Laboratory and field measurements are attempting to quantify:

- Foliage penetration and land mine detection capabilities
- Antiship missile detection and tracking performance
- Time domain signal processing and target identification techniques

AD-A259 239 THE BALANCED TECHNOLOGY INITIATIVE: ANNUAL REPORT TO CONGRESS VOLUME 2 BTI PROJECTS STATUS REPORTS(U) OFFICE OF THE UNDER SECRETARY OF DEFENSE RESEARCH AND ENGINEERING WASHINGTON J R TRANSUE ET AL. 2/2

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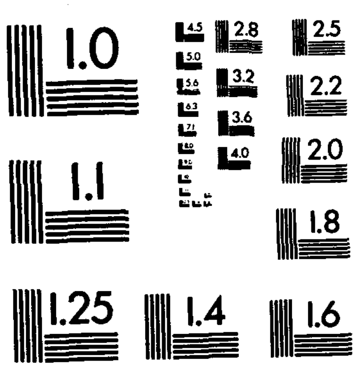
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UWB radar time domain designs can be significantly different, and perhaps simpler, than conventional radar frequency domain designs. However, UWB radars must process signals at sub-nanosecond intervals to achieve superior performance in clutter and for object identification. This project includes the design of UWB radar transmitter and receiver components for specific applications.

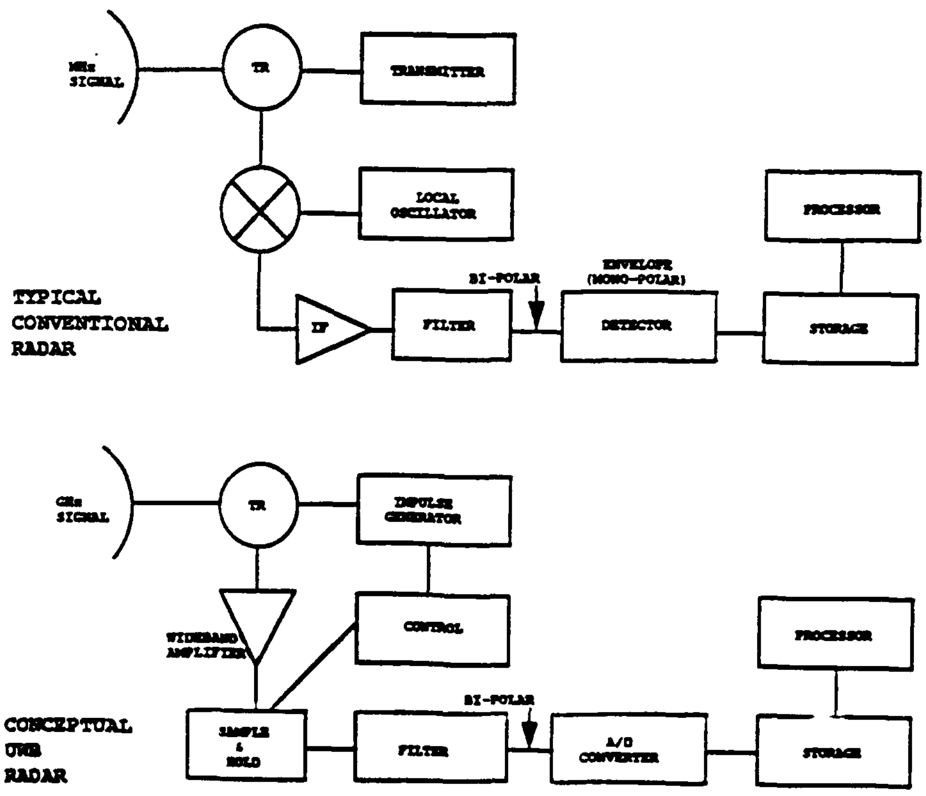
UWB/HPM Countermeasure Concepts

Another major thrust of the BTI UWB/HPM project was an assessment of the susceptibility of selected classes of U.S. and foreign electronic systems to UWB/HPM radiation. This task was pursued in association with the DOD High Power Microwave susceptibility program. If systems were determined to be susceptible, hardening techniques were developed in the laboratory and validated. Effects measurements were conducted on missiles, radars, fuzes, and radio communications.

Radiation Source Development

Field testing and validation requires an adaptable source of UWB/HPM radiation. BTI and the Air Force are jointly developing a transportable radiation source testbed. Based on a successful laboratory demonstration of the concept using available components, Kaman Sciences Corporation and Sandia National Laboratory are developing a high power laser activated semiconductor switch (LASS) in conjunction with the Air Force Phillips Laboratory. Performance characteristics of the mobile testbed can be varied over a wide range to examine the effects of UWB/HPM radiation on field systems.

Conventional Vs UWB Radar Concepts



DEVELOPMENT STATUS

Management Approach

The BTI office has provided direction to a tri-service technology development team. DARPA has responsibility for the UWB radar, and the Air Force Phillips Laboratory has responsibility for the HPM susceptibility assessment tasks and radiation source development.

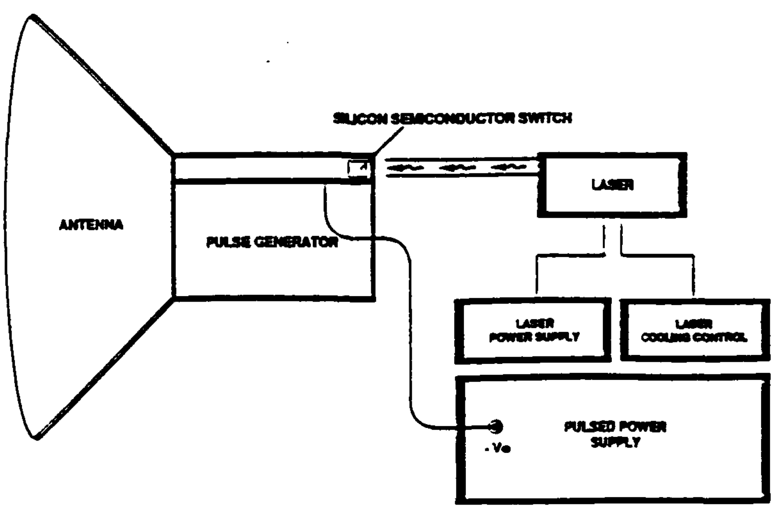
Program Management	
BTI Project Director	Mr. Stanley P. Dereska Arlington, VA 22311 (703)998-7720

Accomplishments and Transition to the Services

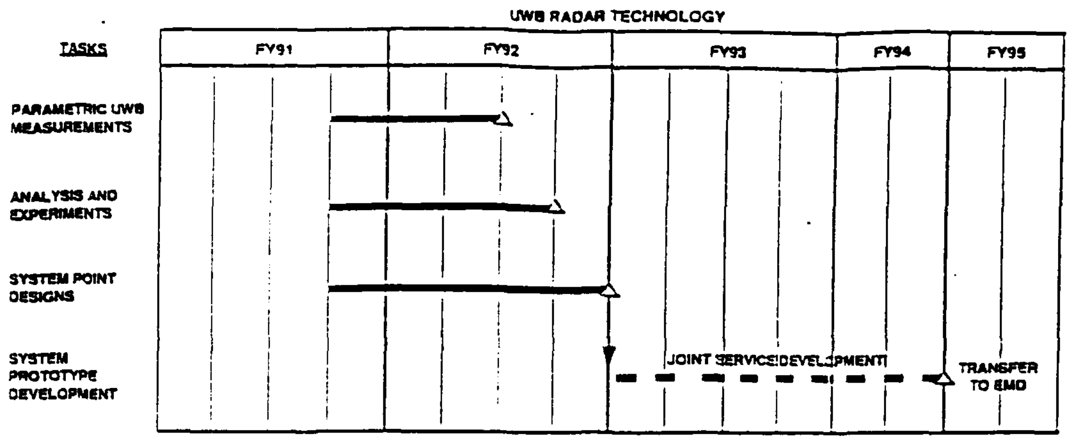
Both the UWB radar utility assessment task and the HPM susceptibility task have been terminated due to a severely restricted BTI budget in FY 1992. Analytical studies and laboratory and field experiments related to design of UWB radar systems are being completed. The results of analyses, experiments, and system point design studies are being provided to DOD and industry development agencies. Results to date indicate that UWB radar can provide a significant new capability for detecting targets hidden by foliage and a missile detection capability for ship defense.

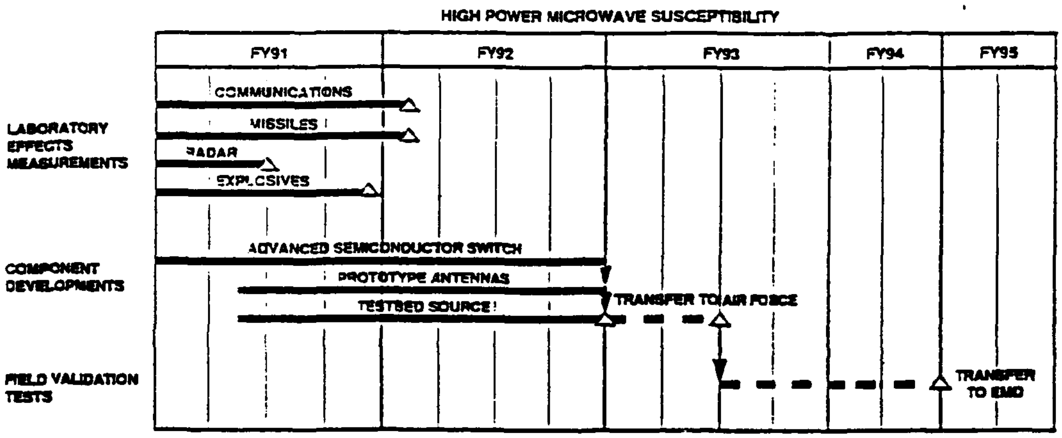
Measurements of the effects of HPM radiation on selected missile, radar, communications, and fuze systems have been completed. Reports on the susceptibility of these systems are being provided to the Services. The fabrication and field tests of the testbed source will be completed mostly with Air Force funds.

UWB/HPM Testbed Source



BTI Project Status





Effect of FY 1992 Budget Actions

Severe restrictions on the FY 1992 BTI budget forced a reassessment of all the BTI projects. The FY 1992 allocation for UWB radar development was reduced from $10,900,000 originally planned to $1,500,000. The FY 1993 and 1994 funding lines were increased accordingly.

Current as of February 24, 1992