# Ballistic Missile Defense Technology Master Plan (TMP)




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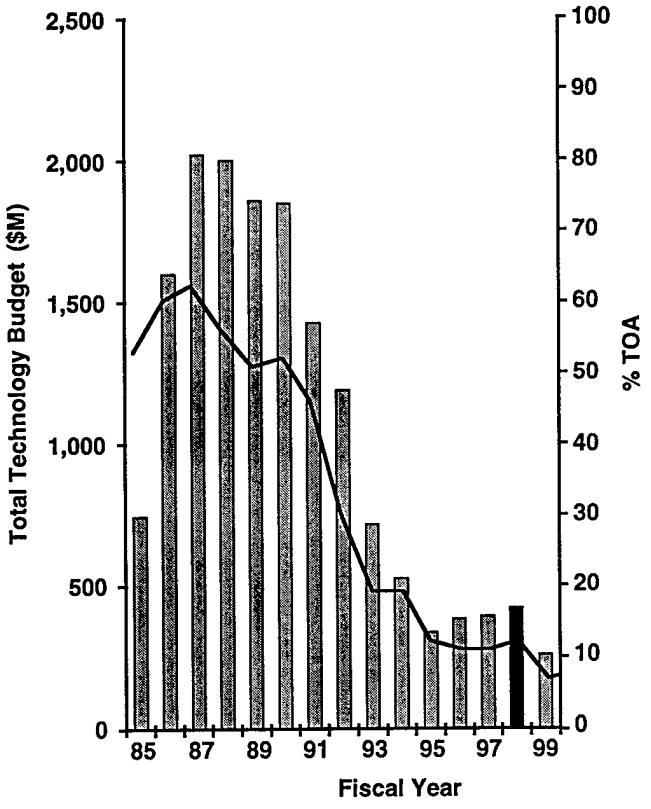
# BMDO TECHNOLOGY FUNDING




- SDI Focus In Past Years Was On Research, Development And Demonstration Of Fundamental Technologies
- The Shift In Program Focus To The Development And Fielding Of National And Theater Defenses Resulted In Limited Resources For Continued Technology Development
- Reduction In Resources From ≈ 60% To 7% TOA Presents Us With Both A Challenge And An Opportunity

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# RATIONALE FOR TECHNOLOGY MASTER PLAN

- End Decline In BMDO's Technology Budget
  - Threatened Ability To Keep Pace With Threat
  - 7% TOA In FY 99 With Demands For Further Reductions
  - Maximize Funding Leverage By Using Service And Other Agencies' Technology Programs Wherever Possible
- Document How BMDO Technology Supports Its Major Defense Acquisition Programs (MDAPs)
- Improve Missile Defense Community Participation In BMDO Technology Program

# 1997 TMP CONTENTS

- Missile Defense Architectures
  - TMD, NMD, Cruise Missile
- BMD Drivers
  - Threat, MDAP Support, Resource Constraints
- Military Needs
  - Weapon System Effectiveness, Utility, Availability
- Technology Needs
  - Interceptor, Surveillance, BM/$C^4$I, Directed Energy
- Technology Solutions
  - Technology Area Plans And Road Maps For Each Technology Needs Area
- Investment Strategy
  - Funding For Each Program By Year In Accordance With Director's Guidance

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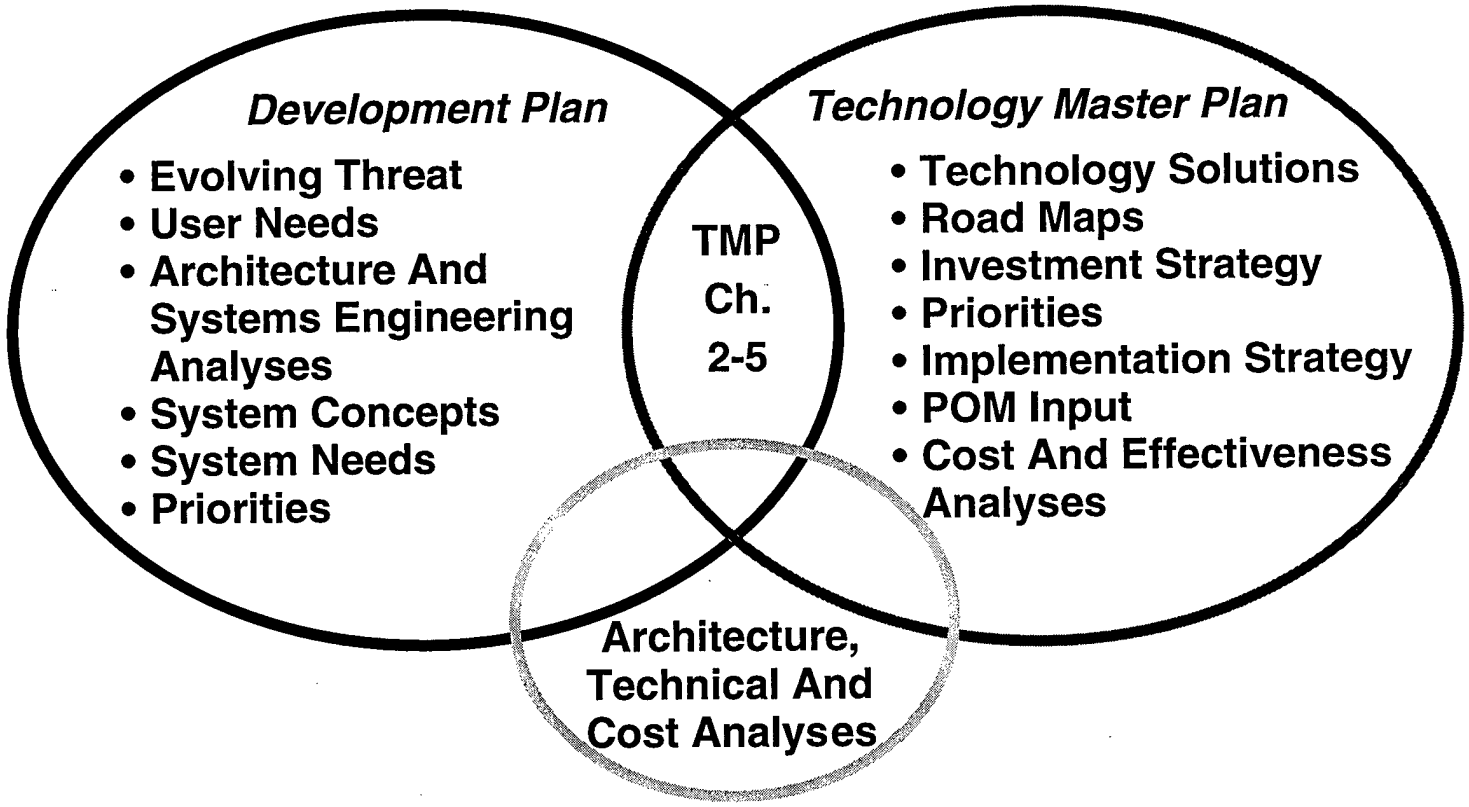
# BMDO PLANNING FOR TECHNOLOGY INVESTMENT

***The Development Planning Process Provides BMDO's System Needs For Technology And Basis For Investment***




**The Technology Master Plan Defines BMDO's Investment And Approach To Obtaining The "Needed" Technology**

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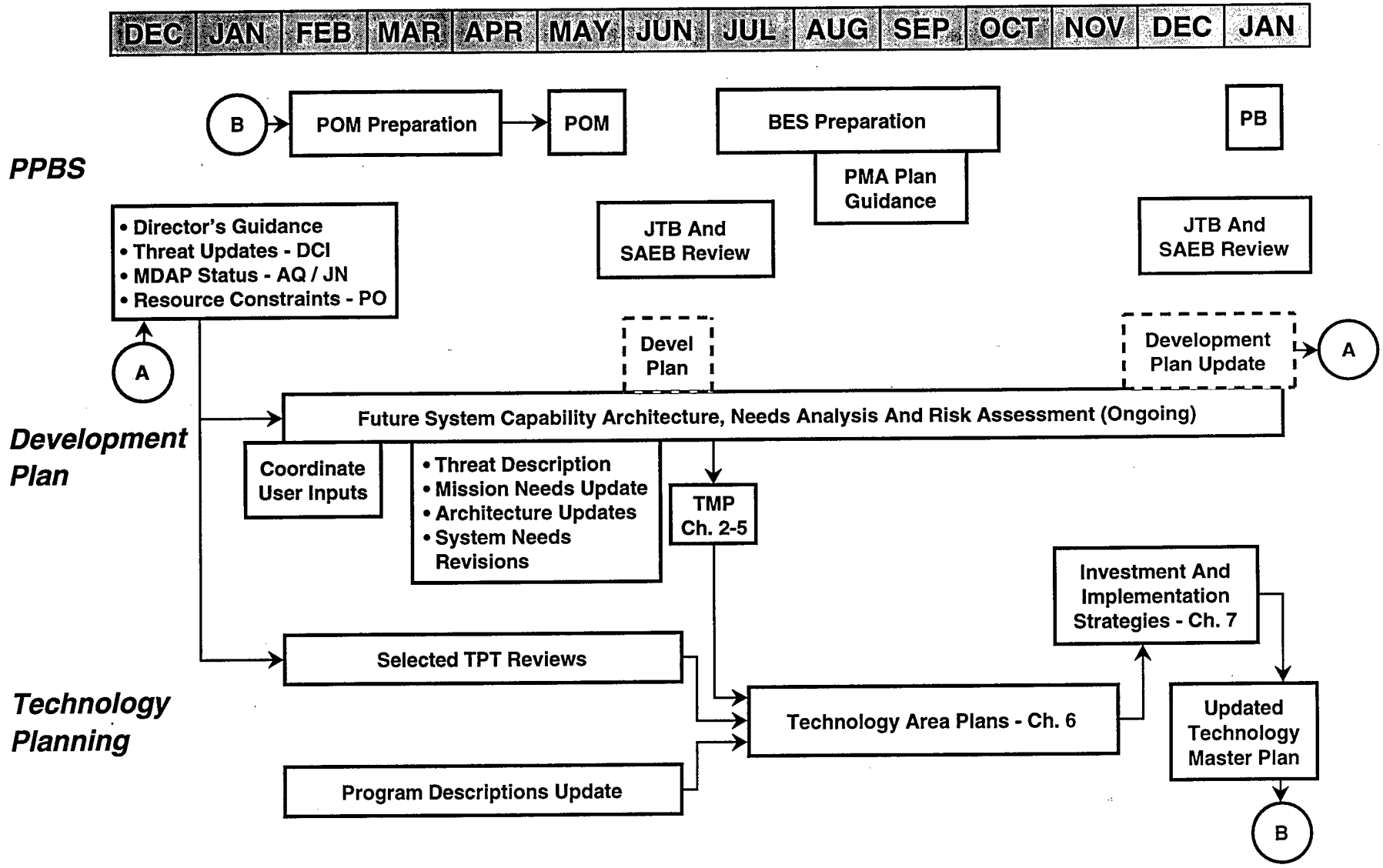
# ANNUAL TMP PROCESS

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# TECHNOLOGY PLANNING TEAMS (TPT)

- TPT Areas
  - Interceptors
  - Surveillance
  - BM/C$^4$I*
  - Directed Energy*
- Responsibilities
  - Identify Programs That Meet Technology Needs
  - Develop Technology Area Plans
  - Tailor Or Leverage Existing Programs Where Possible, Otherwise Recommend New Starts
  - Produce Technology Road Maps
  - Prioritize Technology Programs

* Formed 1998

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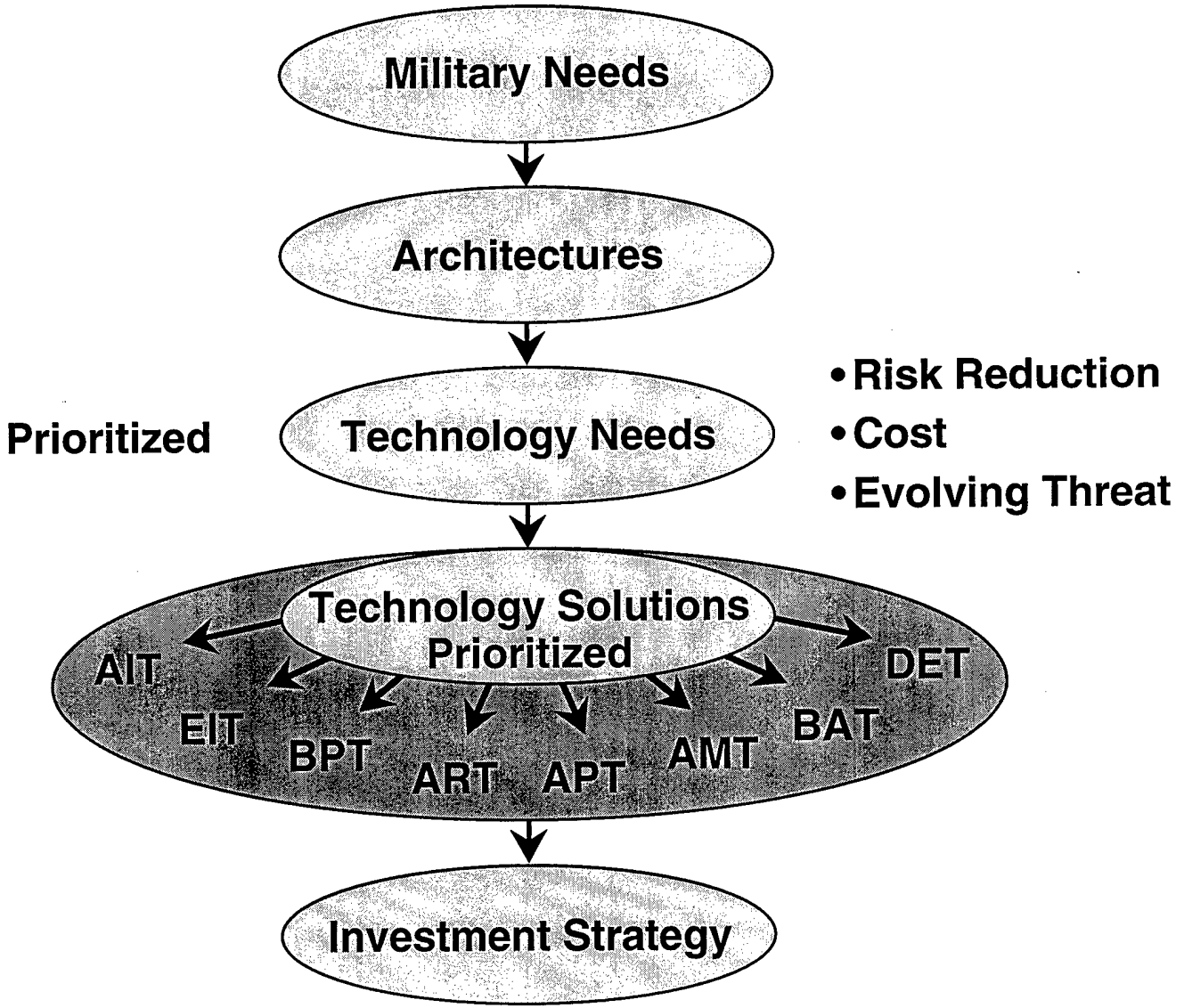
# TMP TECHNOLOGY AREAS

- Atmospheric Interceptor Technology (AIT)
- Exoatmospheric Interceptor Technology (EIT)
- Boost Phase Intercept (BPI)
- Advanced Radar Technology (ART)
- Advanced Passive Technology (APT)
- Advanced Mission Technology (AMT)
- BM/C$^4$I Advanced Technology (BAT)
- Directed Energy Technology (DET)

# 1998 TMP FORMAT

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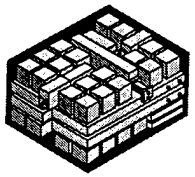
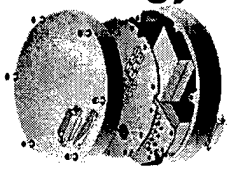
# INTERCEPTOR INTEGRATED TECHNOLOGY PROGRAMS

## *Atmospheric Interceptor Technology*

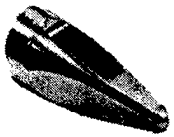
Shroud



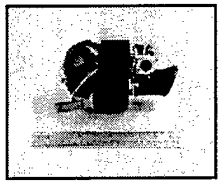
Ka-band Transmitter



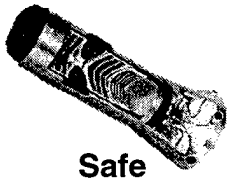
Advanced GNC Avionics



Cooled Window



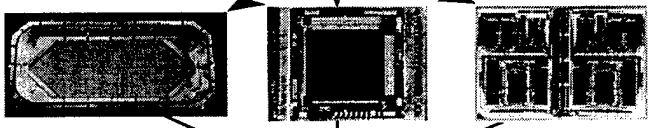
Strap Down IR Seeker



Safe DACS

## *Exoatmospheric Interceptor Technology*

**Component Development**

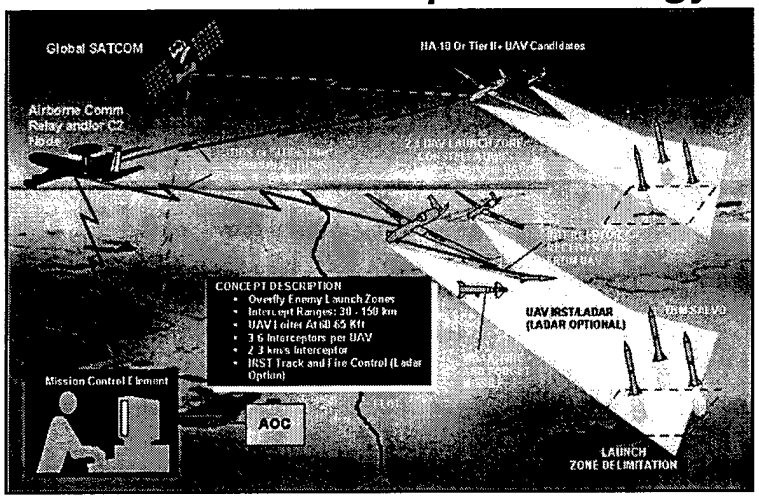


**Ground Testing**

*Laboratory* *AMOR* *ISTEF* *Others*

**Flight Testing**

## *Boost Phase Intercept Technology*




- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured Interceptor Technology Programs
- Interceptor Technologies Are Better Tied To MDAP Needs
- New Technologies Will
  - Respond To Evolving Threat
  - Enhance Current MDAP Performance
  - Improve Affordability / Reliability

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# INTERCEPTOR FOCUS AREAS

- Atmospheric Interceptor Technology (AIT)
  - Advanced Lower Tier Interceptor Technology
  - Endoatmospheric Seekers, Windows, Interceptor Agility, Safe DACS, Optimal Guidance, Estimation Of Target Maneuvers
- Exoatmospheric Interceptor Technology (EIT)
  - Advanced Technologies For NMD And TMD Upper Tier
  - Multicolor Focal Plane Arrays, Laser Radar, Advanced Processors, Algorithms
- Boost Phase Intercept (BPI)
  - Target State Estimation Sensors And Algorithms, Missile Plume To Hard Body Handover

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# AIT TECHNOLOGY CROSSWALK

| TMP Identified Needs | | | | | | AIT Technology Solutions Satisfy TMP Identified Needs For The MDAPs | Potential Users | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Discrimination | Interceptor Agility | Seeker Accuracy | Affordability / Producibility | Information Technology | Other Support (Lethality, M&S) | AIT Technology Solutions | PAC-3 | Navy Area | MEADS | THAAD |
| | | | | X | | Advanced GNC Processors* | X | X | X | X |
| X | | | | | | Dual Mode IR / RF Seekers | X | X | X | |
| X | | X | X | | | Strap Down Seeker With Image Motion Stabilization | X | X | X | |
| X | | X | | X | | Solid-state Ka-Band RF Seeker | X | X | X | |
| | X | | | | X | High Thrust Nontoxic DACS | X | X | X | |
| | X | | | | X | Controllable, TVC Axial Propulsion | X | X | X | |
| | | | | X | | Advanced GNC Algorithms | X | X | X | X |
| | | | | | X | Lightweight Composite Structures (Comparable Cost / Risk) | X | X | X | |
| X | | X | X | | | Advanced Windows | | X | X | X |
| | | X | | | X | Aim Point Selection Algorithms | X | X | | X |
| | | | X | | | Flight Software Development Methodology | X | | X | X |
| | | | X | | | Advanced Nonthermal Battery* | X | X | X | X |

* May Also Apply To Upper Tier Programs

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# EIT TECHNOLOGY CROSSWALK

| TMP Identified Needs | | | | | | EIT Technology Solutions Satisfy TMP Identified Needs For The MDAPs | Potential Users | | |
|---|---|---|---|---|---|---|---|---|---|
| Discrimination | Interceptor Agility | Seeker Accuracy | Affordability / Producibility | Information Technology | Other Support (Lethality, M&S) | *EIT Technology Solutions* | GBI | NTW | THAAD |
| X | | | X | | | 2-color LWIR FPA (3-4-color Desirable) | X | X | X |
| X | | X | | | | Imaging Laser Radar | X | X | |
| X | | | X | | X | Large Format Array Producibility And Operability | X | X | X |
| X | | X | X | | | ROIC / On-FPA Processing* | X | X | |
| X | | X | | | | TOM Correlation | X | X | X |
| X | | X | | | X | Fusion Algorithms | X | X | |
| X | | X | | | | Multitarget Tracking Algorithms | X | X | X |
| | X | X | | | | Aim Point Selection Algorithms | | X | X |
| X | | | | X | | High Performance, Lightweight Processor* | X | X | |
| | | | X | X | | Small 20 / 44 GHz UL / DL Transceiver* | X | X | |
| | | | X | | X | Beyond LOS Cooperative Engagement | X | | |
| | | | X | | | High Efficiency, Long Shelf Life Batteries | X | X | X |
| | | X | | | | All Reflective Optics | | X | |
| | | | X | | X | Lightweight Structures – Cost And Risk Comparison To Aluminum | X | X | X |
| | | | | | X | Lethality – Code Validation And Data Collect* | X | X | X |
| | | | | | X | Lethality – Kill Enhancers* | | X | X |
| | | | | | X | Radiation Hardening Of Advanced Components | X | X | X |

*May Also Apply To Lower Tier Programs

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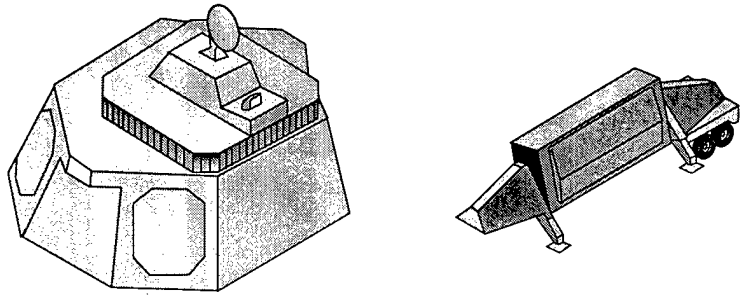
# BIT INTERCEPTOR TECHNOLOGY CROSSWALK

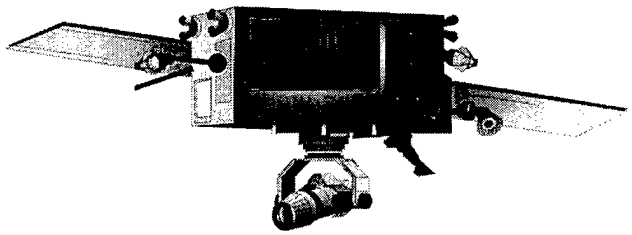
| TMP Identified Needs | | | | | | BIT Interceptor Technology Solutions Address TMP Identified Needs For UAV BPI Hedge Capability With Contributions To MDAP Upgrades | Potential Users | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Countercountermeasures | Interceptor Agility | Seeker Accuracy | Affordability / Producibility | Information Technology | Other Support (Lethality, M&S) | BIT Technology Solutions | UAV BPI | Air Superiority Missile | Lower Tier MDAPs | Upper Tier MDAPs |
| | X | | | | | Maneuverable, Thrust-on-demand Boosters | X | X | X | X |
| | X | | X | | | Nontoxic, High Mass Fraction Liquid DACS | X | X | | X |
| | X | | | | | High Mass Fraction Axial Stage Booster | X | X | X | X |
| X | | X | X | | | Lightweight, Low-cost Visible KKV Seeker | X | | | |
| X | | X | | | | Dual Mode Seeker With Active Ranging (LADAR / RF) | X | X | X | |
| | X | X | | X | | Advanced BPI GNC Algorithms (Commit Through Endgame) | X | X | | |
| X | | X | | X | | Plume-to-hardbody Handover Algorithms | X | X | | |
| X | | X | | X | | Boost Phase Aim Point Selection Algorithms | X | X | | |
| | | X | | X | | PIP Generation Algorithms | X | X | | |
| | X | | | | | Advanced Thermal Materials (Structure / Windows) | X | X | X | |
| | X | | | | | All Aspect Commit Interceptor - Aircraft Integration | X | X | | |
| | | | | X | | Lightweight IFTU Communications Subsystem | X | X | X | X |
| | | | | | X | End-to-end Design Tools, HWIL Test Beds | X | X | | |

# SURVEILLANCE INTEGRATED TECHNOLOGY PROGRAMS

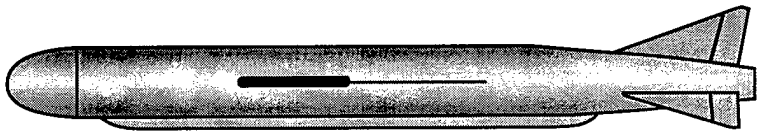
## *Advanced Radar Technology (ART)*



## *Advanced Passive Technology (APT)*



## *Advanced Mission Technology (AMT)*



- **The BMDO Technology Master Plan (TMP) Is The Foundation For Surveillance Technology Programs**
- **Surveillance Technologies Are Directly Tied To MDAP Needs**
- **Technology Efforts Will**
  - ***Meet* Current MDAP Requirements**
  - **Respond To Evolving Threat**
  - **Improve Affordability / Reliability**

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# SURVEILLANCE FOCUS AREAS

- Advanced Radar Technology (ART)
  - Increased Power Aperture And Beam Agility, Enhanced Waveform Design
  - Low Cost T / R Modules, Improved Processors, Advanced Algorithms
- Advanced Passive Technology (APT)
  - Advanced Components For Satellite Surveillance, Acquisition, Track, Discrimination, Kill Assessment (SATDKA)
  - Improved FPA Uniformity, Longer Wavelengths, Optics Cleaning, Cryocoolers, Radiation Hardened Electronics
- Advanced Mission Technology (AMT)
  - SATDKA Functions For Cruise Missile Threat

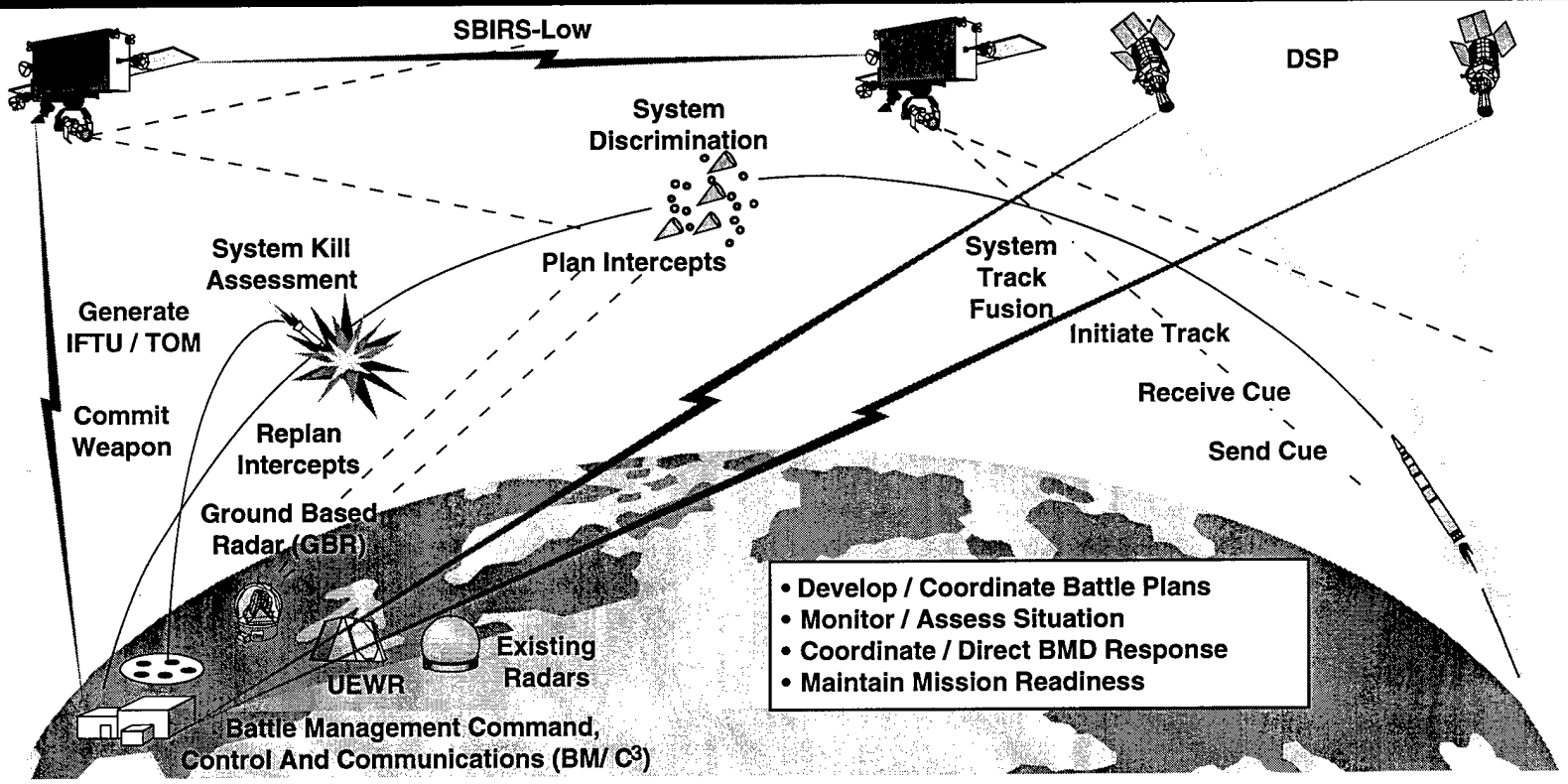
# ART TECHNOLOGY CROSSWALK

| TMP Identified Needs | | | | | | ART Technology Solutions Satisfy TMP Identified Needs For The MDAPs | Potential Users | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surveillance | Acquisition | Track | Discrimination | Kill Assessment | Affordability / Producibility | ***ART Technologies*** | THAAD | NTW | Navy Area | NMD GBR |
| X | X | X | X | X | | Transmitter / Waveform Generator | X | X | X | X |
| X | X | X | X | X | X | Antenna | X | X | X | X |
| X | X | X | X | X | | Threat / Environment | X | X | X | X |
| X | X | X | X | X | X | Receiver / Signal Processor | X | X | X | X |
| X | X | X | X | X | | Controller / Data Processor | X | X | X | X |
| X | X | X | | | X | Electromechanical Support | X | X | X | X |
| X | X | X | X | X | X | Advanced T / R Modules | X | | | X |

# APT TECHNOLOGY CROSSWALK

| TMP Identified Needs | | | | | | APT Technology Solutions Satisfy TMP Identified Needs For The MDAPs | Potential Users | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surveillance | Acquisition | Track | Discrimination | Kill Assessment | Affordability / Producibility | ***APT Technologies*** | THAAD | NMD SBIRS | Navy Area | NTW |
| X | X | X | X | X | X | MCT Single- And Mulitiple-color Focal Plane Arrays | X | X | X | X |
| X | X | X | X | X | X | 10 Through 100 Kelvin Long-life Cryocoolers | | X | | |
| X | X | X | X | | X | MSX Data Reduction | X | X | | |
| X | X | X | X | X | X | Radiation Hardened Electronic Devices | X | X | X | X |
| X | X | X | X | X | X | Fault Tolerant Processors | X | X | X | X |
| X | X | X | X | X | X | Thermal Integration | | X | | |
| X | X | X | X | X | X | Si Single- And Multiple-color Focal Plane Arrays | X | X | X | X |
| X | X | X | X | | | Radiation Hardened Filters And Baffles | X | X | X | X |
| X | X | X | X | X | X | Radiation Hardened Optics And Structures | X | X | X | X |
| X | X | X | | | X | Power Conversion And Handling | X | X | | |

# BM/C$^4$I ADVANCED TECHNOLOGY (BAT)




**Defense Against Strategic Ballistic Missiles**

- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured BM/C$^4$I Technology Programs
- BM/C$^4$I Technologies Are Tied To MDAP Needs
- New Technologies Will
  - Improve Battle Management In Response To An Evolving NMD / TAMD Threat
  - Enhance Current MDAP Performance And Improve Affordability / Reliability
  - Address Advanced Mission Threat Battle Management

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# BM/C$^4$I FOCUS

- BM/C$^4$I Advanced Technology (BAT)
  - Use Open Systems Standards, Leverage Communications Infrastructure
  - Battle Management Technology, Situation Awareness, Kill Assessment, Evaluation Tools

# BM/C$^4$I TECHNOLOGY CROSSWALK

| TMP Identified Needs | | | | | BM/C$^4$I Technology Solutions Satisfy TMP Identified Needs For The MDAPs | Potential Users | |
|---|---|---|---|---|---|---|---|
| Comms infrastructure | Battle Management | Situation Awareness | Kill Assessment | Evaluation Tools | | NMD | FoS |
| X | | | | | GPS / IFTU Broadcast | X | X |
| X | X | | X | | Miniaturized Wideband SATCOM | X | X |
| X | X | | X | | Passive Millimeter Radiometry | X | X |
| X | | | | | Intelligent Bandwidth Imaging | | X |
| | X | | X | | Wideband Cloud Imaging | X | X |
| | | | X | | Impact Signature Collection / Research | X | X |
| | | X | | | Cooperative Engagement Capability Range Extension | | X |
| | X | X | | | Multiple Sensor Fusion | X | X |
| | X | X | | | UEWR / XBR Fusion | X | |
| | | X | | | Distributed UHF Propagation Environment | X | |
| | X | | | | Distributed Tracking | X | |
| | X | X | X | | UHF Doppler Discrimination | X | |
| | | | | X | Surveillance Test Bed Network Models | | X |
| | | | | X | Adaptive Planning | X | X |

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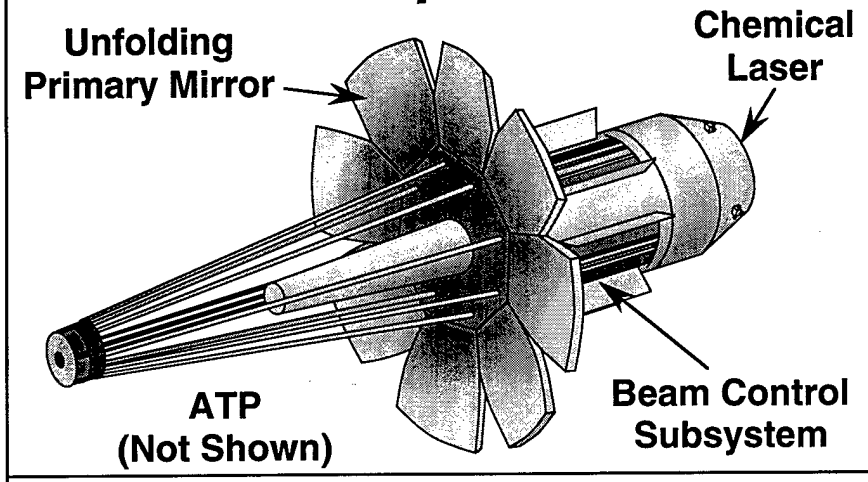
# SPACE BASED LASER (SBL) SYSTEM

## Notional Space Vehicle




## Mission

- Continuous, Global Coverage, Boost Phase Intercept For NMD And TMD
- Space Control
- Other Futuristic Applications

## Development Issues

### Operational System

- Policy / Treaty
- Cost
- Launch Vehicle (Size / Weight)
- Integration Into NMD / TMD
- Alternative System Concepts
- Advanced Technology

### Readiness Demonstrator (RD)

- POM Funding / Schedule
- Traceability To Operational System
- Spacecraft Integration
- Maturity Of Technology (Risk)
- Test Site

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# DIRECTED ENERGY FOCUS

- Directed Energy Technology (DET)
  - Integrated Technology For Space Based Laser Readiness Demonstrator
  - Precision Pointing, Wave Front Sensing Adaptive Optics, Advanced Beam Generation

# IMPLEMENTATION STRATEGY

- Based On Director's Guidance To Allocate 10% (Minimum) – 12% (Goal) Of BMDO Total Obligational Authority To Technology Development
  - Includes Set Asides (e.g., SBL Readiness Demonstrator, SBIR)
- Consistent With Technology Priorities
  - Solution Or Mitigation Of A Critical Challenge
  - Cost Reduction
  - Multiple Potential Applications
  - Breakthrough Technologies

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# THE WAY AHEAD

- TMP Updated Annually To Keep Technology Program Current With Threat, Mission And MDAP Changes
  - 1997 TMP Is Complete. 1998 TMP Is In Work
- 1998 Changes
  - Added Two New TPTs (BM/C$^4$I And DET)
  - Include MANTEC
  - Include Industry Programs
  - Include Allied Programs
  - Improve TMP Readability
- Engineering Analysis Team Formed
  - Derive Technology Needs
  - Quantify Performance And Cost Benefits Of Technology Solutions

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# SUMMARY

- BMDO TMP Is The Vehicle For Implementing Director's Guidance For Technology
  - Maintain U.S. Technical Superiority In Missile Defense
  - Relate BMDO Technology To MDAP Needs And Operational Capabilities
  - Allocate A Goal Of 12% Of TOA, But Not Less Than 10% For BMDO Technology Program
  - Maximize Participation Of Missile Defense Community In BMDO Technology Program

# 1997 TMP TAXONOMIES

- Interceptors
  - Discrimination, Agility, Accuracy, Information Technology, Affordability And Other Supporting Technologies
- Surveillance
  - Surveillance, Acquisition, Track, Discrimination, Kill Assessment, Affordability, Other Supporting Technologies
- BM/$C^4$I
  - Communications, Battle Management, Situation Awareness, Kill Assessment, And Evaluation Tools
- Directed Energy
  - Space Based Laser Readiness Demonstrator