Ballistic Missile Defense Technology Master Plan (TMP)

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Dr. Walter R. Dyer, BMDO/TO
And
Col Susan A. Vance, USAF, BMDO/TOS
Ballistic Missile Defense Organization
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
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
• 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^4I, 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
The Development Planning Process Provides BMDO's System Needs For Technology And Basis For Investment

**Development Plan**
- Evolving Threat
- User Needs
- Architecture And Systems Engineering Analyses
- System Concepts
- System Needs
- Priorities

**Technology Master Plan**
- Technology Solutions
- Road Maps
- Investment Strategy
- Priorities
- Implementation Strategy
- POM Input
- Cost And Effectiveness Analyses

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

Architecture, Technical And Cost Analyses
TECHNOLOGY PLANNING TEAMS (TPT)

• TPT Areas
  - Interceptors
  - Surveillance
  - BM/C⁴I*
  - 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
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^4I Advanced Technology (BAT)
- Directed Energy Technology (DET)
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
    - ISEF
    - 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
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
<table>
<thead>
<tr>
<th>Potential Users</th>
<th>THAAD</th>
<th>MEADS</th>
<th>Navy Area</th>
<th>PAC-3</th>
</tr>
</thead>
</table>

* May Also Apply To Upper Tier Programs
# EIT Technology Crosswalk

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

*May Also Apply To Lower Tier Programs*
<table>
<thead>
<tr>
<th>Potential Users</th>
<th>Upper Tier MDA's</th>
<th>Lower Tier MDA's</th>
<th>Air Superiority Missile</th>
<th>UAV BPI</th>
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<tbody>
<tr>
<td>Maneuverable, Thrust-on-demand Boosters</td>
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<tr>
<td>Nontoxic, High Mass Fraction Liquid DACS</td>
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<tr>
<td>High Mass Fraction Axial Stage Booster</td>
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<td>X</td>
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<td>X</td>
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<tr>
<td>Lightweight, Low-cost Visible Seeker</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Dual Mode Seeker with Advanced Ranging (LADAR / RF)</td>
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<td>X</td>
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<tr>
<td>Advanced BPI GNC Algorithms (Commit Through Endgame)</td>
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<tr>
<td>Plume-to-hardbody Handover Algorithms</td>
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<td>X</td>
<td>X</td>
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<tr>
<td>Boost Phase/Point Selection Algorithms</td>
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<td>X</td>
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</tr>
<tr>
<td>PIP Generation Algorithms</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Advanced Thermal Materials (Structure / Windows)</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>All-Aspect Commit Interceptor - Aircraft Integration</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Lightweight IFIU Communications Subsystem</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Weighted End-to-end Design Tools, HWIL Test Beds</td>
<td>X</td>
<td>X</td>
<td>X</td>
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</tr>
</tbody>
</table>

BIT Interceptor Technology Solutions

Address TMP Identified Needs For UAV BPI Hedge Capability With Contributions To MDAP Upgrades

Other Support

Information Technology

Affordability / Productability

Seeker Accuracy

Interceptor Agility

Countermeasures

(lethality, MAS)
<table>
<thead>
<tr>
<th>Surveillance Integrated Technology Programs</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Advanced Radar Technology (ART)</th>
<th>Advanced Passive Technology (APT)</th>
</tr>
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<tbody>
<tr>
<td><img src="image" alt="Advanced Radar Technology" /></td>
<td><img src="image" alt="Advanced Passive Technology" /></td>
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</tbody>
</table>

| Advanced Mission Technology (AMT) |  |
|-----------------------------------|  |
| ![Advanced Mission Technology](image) |  |

- 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
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

#### ART Technology Solutions Satisfy TMP Identified Needs For The MDAPs

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<td></td>
<td>THAAD</td>
</tr>
<tr>
<td>Surveillance</td>
<td>X</td>
</tr>
<tr>
<td>Acquisition</td>
<td>X</td>
</tr>
<tr>
<td>Track</td>
<td>X</td>
</tr>
<tr>
<td>Discrimination</td>
<td>X</td>
</tr>
<tr>
<td>Kill Assessment</td>
<td>X</td>
</tr>
<tr>
<td>Affordability/</td>
<td>X</td>
</tr>
<tr>
<td>Productivity</td>
<td>X</td>
</tr>
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</table>

**ART Technologies**

- Transmitter / Waveform Generator
- Antenna
- Threat / Environment
- Receiver / Signal Processor
- Controller / Data Processor
- Electromechanical Support
- Advanced T / R Modules
# APT TECHNOLOGY CROSSWALK

## APT Technology Solutions Satisfy TMP Identified Needs For The MDAPs

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<td>X</td>
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<td>X</td>
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<tr>
<td>Kill Assessment</td>
<td>X</td>
</tr>
<tr>
<td>Affordability / Productivity</td>
<td>X</td>
</tr>
</tbody>
</table>

**APT Technologies**

- MCT Single- And Multiple-color Focal Plane Arrays
- 10 Through 100 Kelvin Long-life Cryocoolers
- MSX Data Reduction
- Radiation Hardened Electronic Devices
- Fault Tolerant Processors
- Thermal Integration
- Si Single- And Multiple-color Focal Plane Arrays
- Radiation Hardened Filters And Baffles
- Radiation Hardened Optics And Structures
- Power Conversion And Handling
Defense Against Strategic Ballistic Missiles

- The BMDO Technology Master Plan (TMP) Is The Foundation For Restructured BM/C⁴I Technology Programs
- BM/C⁴I 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
• BM/C⁴I FOCUS

- BM/C⁴I Advanced Technology (BAT)
  - Use Open Systems Standards, Leverage Communications Infrastructure
  - Battle Management Technology, Situation Awareness, Kill Assessment, Evaluation Tools
# BM/C⁴I Technology Crosswalk

## TMP Identified Needs

<table>
<thead>
<tr>
<th>Comms Infrastructure</th>
<th>Battle Management</th>
<th>Situation Awareness</th>
<th>Kill Assessment</th>
<th>Evaluation Tools</th>
<th>Potential Users</th>
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</thead>
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<tr>
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<td></td>
<td>NMD</td>
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<td></td>
<td></td>
<td>FoS</td>
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</tbody>
</table>

### BM/C⁴I Technology Solutions Satisfy TMP Identified Needs For The MDAPs

- GPS / IFTU Broadcast
- Miniatrized Wideband SATCOM
- Passive Millimeter Radiometry
- Intelligent Bandwidth Imaging
- Wideband Cloud Imaging
- Impact Signature Collection / Research
- Cooperative Engagement Capability Range Extension
- Multiple Sensor Fusion
- UEWR / XBR Fusion
- Distributed UHF Propagation Environment
- Distributed Tracking
- UHF Doppler Discrimination
- Surveillance Test Bed Network Models
- Adaptive Planning

<table>
<thead>
<tr>
<th>NMD</th>
<th>FoS</th>
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<tbody>
<tr>
<td>X</td>
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</tbody>
</table>
# SPACE BASED LASER (SBL) SYSTEM

## Notional Space Vehicle

- Unfolding Primary Mirror
- Chemical Laser
- ATP (Not Shown)
- Beam Control Subsystem

## 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
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
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/C4I 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
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/C⁴I
  - Communications, Battle Management, Situation Awareness, Kill Assessment, And Evaluation Tools

- Directed Energy
  - Space Based Laser Readiness Demonstrator

mj-82690 / 051298