AEGIS BALLISTIC MISSILE DEFENSE

Status, Integration and Interoperability

6 May 2008

Agenda

- Aegis BMD Overview
- BMD Theater Chain of Command
- Force and Unit Level Planning
- Maritime BMD Operating Principles

Integrated Ballistic Missile Defense System

Aegis BMD

Sensors


Defense Support Program


Space Tracking and Surveillance System



Sea-Based Radars


Forward-Based Radar With Adjunct Sensor


Midcourse X-Band Radar


Early Warning Radar

Boost Defense Segment | **Midcourse Defense Segment** | **Terminal Defense Segment**


Airborne Laser


Kinetic Energy Interceptor


Aegis Ballistic Missile Defense / Standard Missile-3


Multiple Kill Vehicle


Ground-Based Midcourse Defense


Terminal High Altitude Area Defense


Sea-Based Terminal


Patriot Advanced Capability-3

Command, Control, Battle Management & Communications

NMCC USSTRATCOM USNORTHCOM USPACOM EUCOM CENTCOM

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 5.0, 3/14/07

Current and Future Aegis BMD Capability

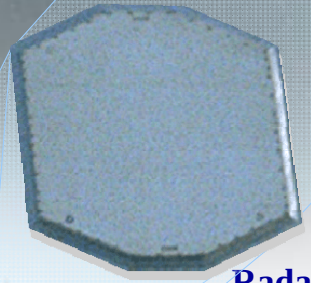
Aegis BMD

Launch on Remote (Aegis BMD) 2006
Launch on Remote (BMD Sensors) 2010
Engage on Remote 2015

Link 16

Aegis Ballistic Missile Defense Signal Processor (BSP) Upgrade 2010

Open Architecture 2012



Radar System AN/SPY-1

SM-3

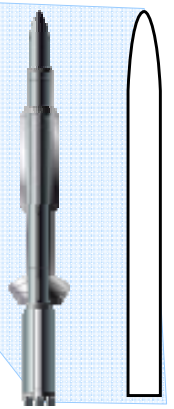
Blk I / IA / IB 2004/2006/2010

Blk IIA 2015+

Vertical Launching System Mark 41

SM-2 **TBD**

Sea-Based Terminal



Blk IV 2009 Near Term **2015 Far Term**

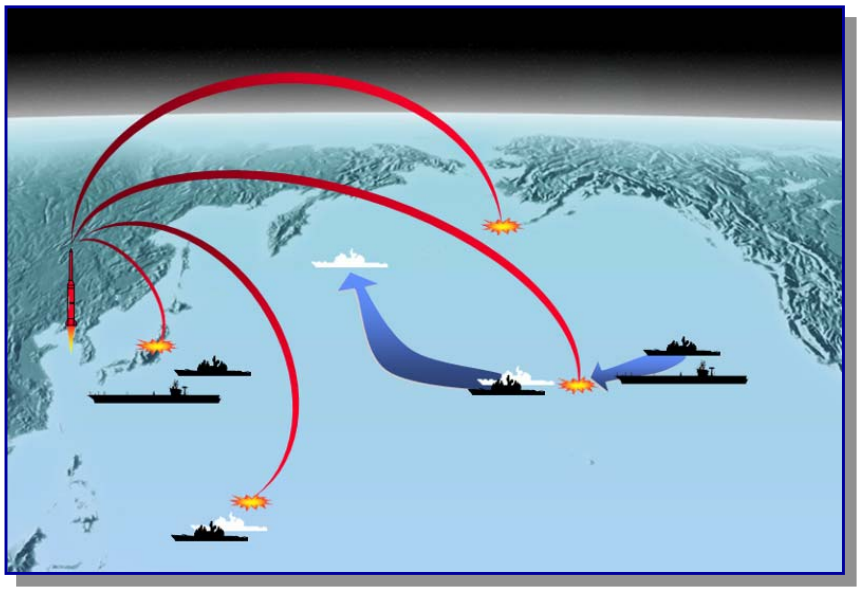
Program of Record Quantities Thru 2013	
	3
	15
	147
	2

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 3.0, 2/9/07

Aegis BMD Contribution to the BMDS

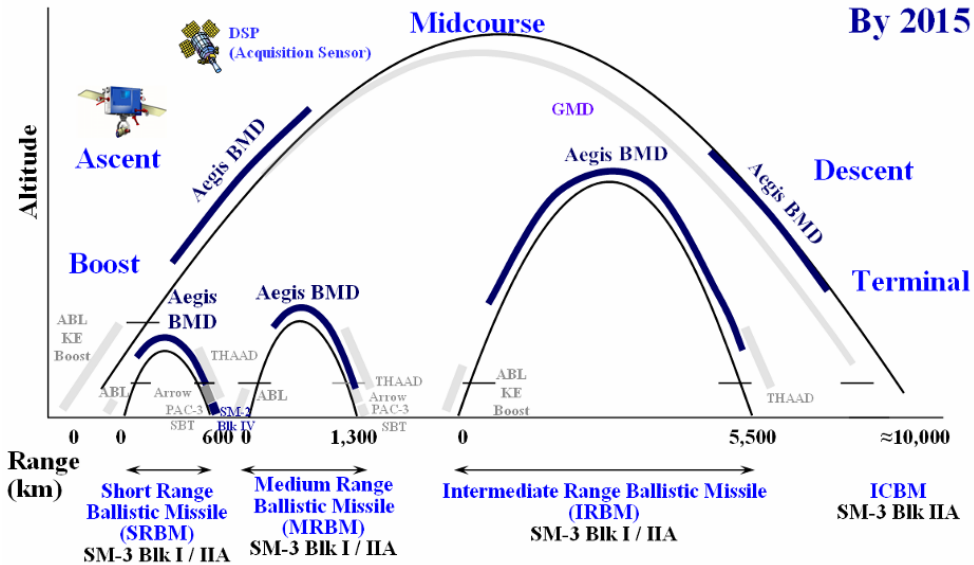
Aegis BMD

Flexible Forward Defense vs. Ballistic Missile Threats



- Autonomous Operations in International Waters Moves Ballistic Missile Defense Forward From U.S.
- Counter-Ballistic Missile Strike, Forward Presence, and Multi-Mission Capabilities
- Surge Capability Scalable by Force Level and Geographical Considerations

- **Engagement:**



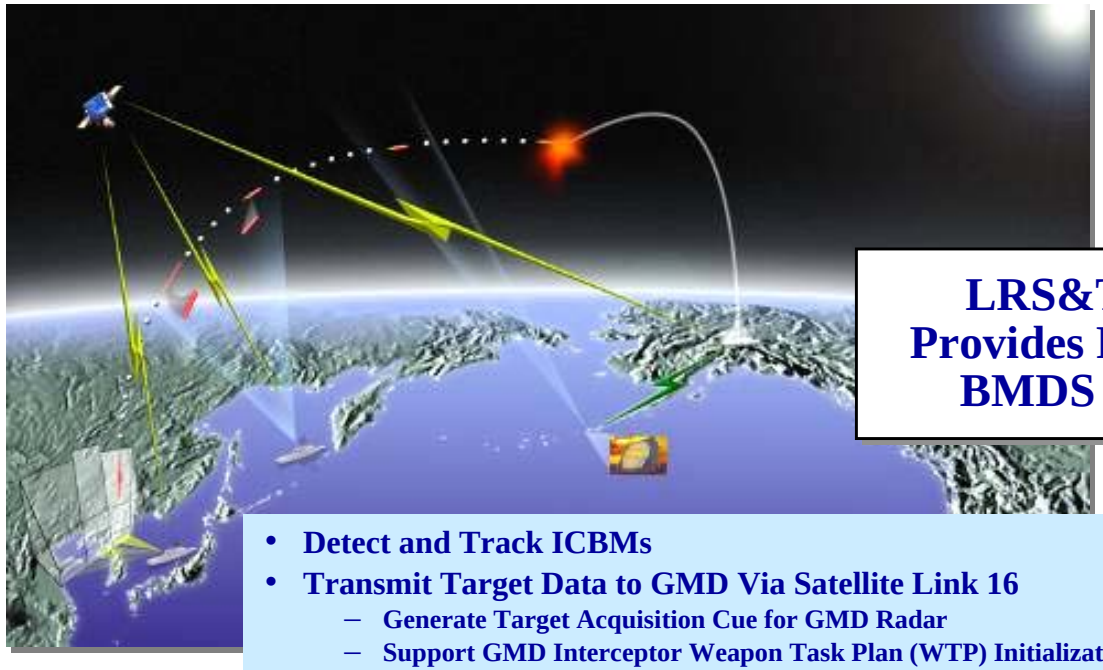
- **Long Range Surveillance & Track (LRS&T)**
  - **Fire Control Quality Track Data for Other BMDS Elements**

Global Presence

Aegis BMD Block 1.0 & 2.0 (Nee Block 04)

Aegis BMD

- ✓ **Limited Defense Operations (LDO)**
- ✓ **Long Range Surveillance & Track (LRS&T)**
  - ✓ Sept 04
    - Destroyers "On Alert"
  - ✓ Aegis BMD 3.0E
- ✓ **Engagement**
  - ✓ Preliminary Capability Spring 05
    - Cruiser
    - Aegis BMD 3.0
    - SM-3 BLK I
  - ✓ Block 04 Capability Spring 06
    - Cruiser
    - Destroyer (End CY 06)
    - Aegis BMD 3.6
    - SM-3 BLK IA



LRS&T Capability Provides Forward Based BMDS Surveillance

- Detect and Track ICBMs
- Transmit Target Data to GMD Via Satellite Link 16
  - Generate Target Acquisition Cue for GMD Radar
  - Support GMD Interceptor Weapon Task Plan (WTP) Initialization

Engagement Capability Defeats SRBMs, MRBMs, & Some IRBMs

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 5.0, 1/18/07

Block 2.0 3.6 System Performance

Aegis BMD

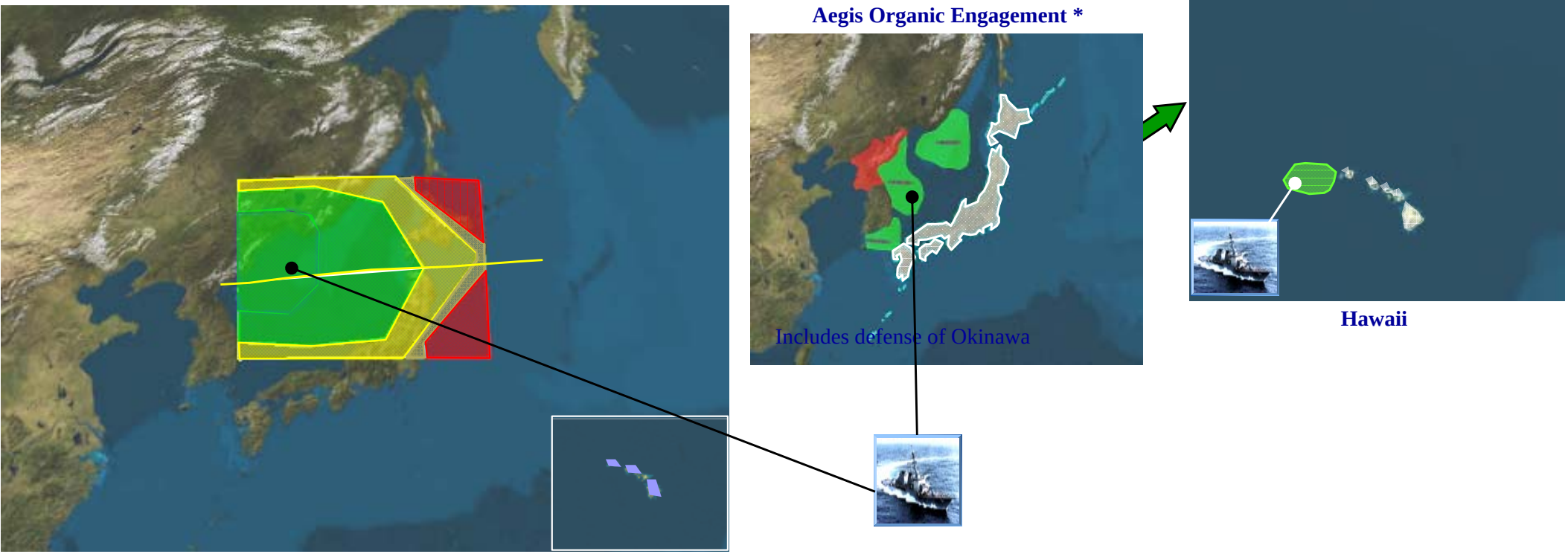
Long Range Surveillance and Tracking

Engagement

GMD Engage on Aegis

Aegis Organic Engagement *

Launch on TADIL



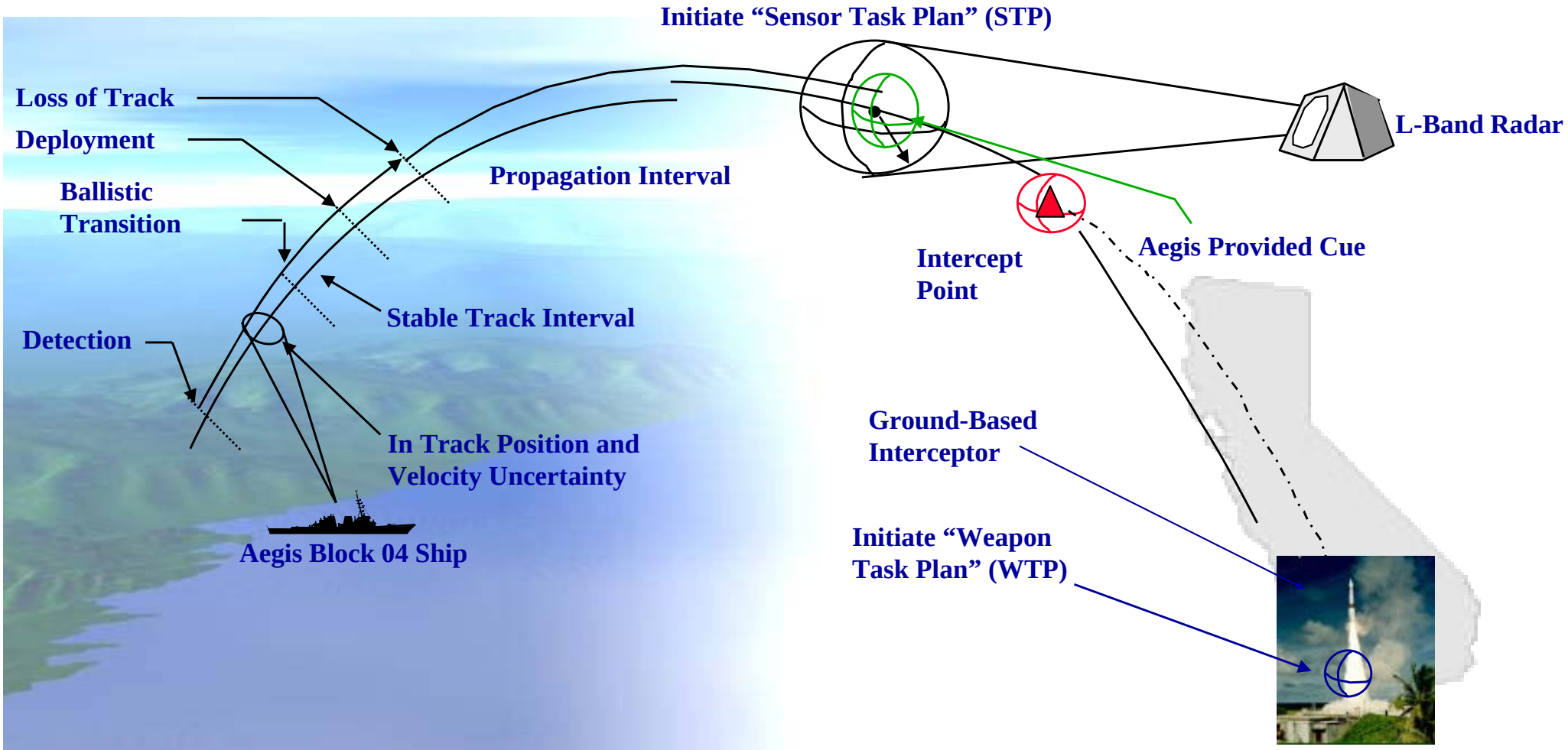
Ship Locations Simultaneously Support All Three Operational Missions

*** Block 2.0 Threat Set**

AEGIS BMD BLOCK 2.0 CAPABILITY

Long Range Surveillance Operations

Aegis BMD



AEGIS DATA PASSED TO GMD VIA SATELLITE LINK 16

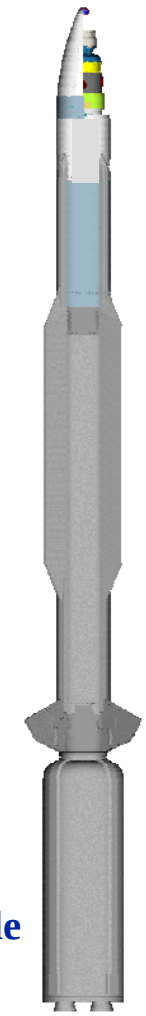
Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 5.0, 2/9//07

Aegis BMD SM-3 Evolution

Spiral Development with Incremental Capability Improvements

Aegis BMD

SM-3 Blk IA	SM-3 Blk IB	SM-3 Blk II	SM-3 Blk IIA
• Blk IA Kinetic Warhead (KW) – 1-Color Seeker – Pulsed Divert/Attitude Control System (DACS)	• Blk IB KW – 2-Color Seeker – All-Reflective Optics – Advanced Signal Processor – Throttleable Divert/Attitude Control System (TDACS)	• 21” Nosecone Japan Cooperative Research (JCR) • Blk IB KW	•21” Nosecone JCR •Large Diameter KW – Adv Discrim Seeker – High Divert DACS
• 13.5” Propulsion – 2nd & 3rd Stage	• 13.5” Propulsion – 2nd & 3rd Stage	• 21” Propulsion – 2nd & 3rd Stage	• 21” Propulsion – 2nd & 3rd Stage
• MK 72 Booster • MK 41 Vertical Launch System (VLS) Compatible	• MK 72 Booster • MK 41 VLS	•MK 72 Booster •MK 41 VLS Compatible Light Weight (LW) Canister	•MK 72 Booster •MK 41 VLS LW Canister

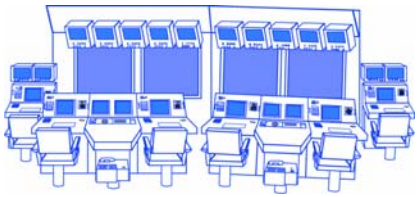


(Part of IIA Development; Not Planned to be a Fielded Capability)

Final Block 2004 Configuration
- Aegis BMD 3.6 Engage / LRS&T Ships-

Rev: 3.0, 8/9/05

Aegis BMD



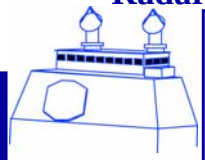
Aegis Display System Mark 2
- ✓ BMD 3.6 Computer Program

Command & Decision System Mark 2


- ✓ BMD 3.6 Computer Program
- C&D Adjunct Computer
- Joint Tactical Terminal
- ✓ Integrated Mission Planner

Weapon Control System Mark 8

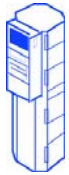

- ✓ BMD 3.6 Computer Program
- ✓ SM-3 Blk IA Sustain Mode or Pulse DACS
- ✓ SM-3 Launch on TADIL
- SM-2 AAW

Radar System AN/SPY-1


- ✓ BMD 3.6 Computer Program
- Programmable Energy Sig Pro Mods
- ✓ Integrated Satellite System Calibration Computer

Fire Control System Mark 99


- Supports SM-2 Engagements

Aegis Combat Training System Mark 50


- ✓ Upgraded to Support BMD Training

Missile Downlink System (T&E, CG Only)

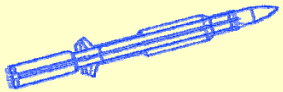

- Receives KW Downlink
- Supports Kill Assessment

Operational Readiness Test System Mark 7

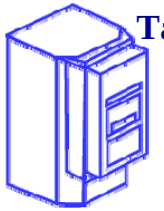

- ✓ Upgraded to Monitor SPY BMD Functions

Vertical Launching System Mark 41


- VLS – GPS Integration
- ✓ Upgraded Computer Program
- ✓ Supports any Missile – any cell
- ✓ SM-3, SM-2 (all variants), VLA, TLAM

Standard Missile-3


- ✓ SM-3 Blk I Sustain Mode DACS
- ✓ SM-3 Blk IA Sustain Mode or Pulse DACS

Tactical Data Links


- ✓ CDLMS v3.4
- ✓ Upgrade to Support JRE

Delta to 5.3.8

✓ = Changes from 3.0

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 1, 02/14/08

Ship Deliveries
- As of February 08 -

Aegis BMD

Engagement and Long Range Surveillance & Track (Aegis BMD 3.6)


USS PORT ROYAL (CG 73)


USS SHILOH (CG 67)


USS LAKE ERIE (CG 70)


USS DECATUR (DDG 73)


USS RAMAGE (DDG 61)


USS CURTIS WILBUR (DDG 54)


USS JOHN S. McCAIN (DDG 56)


USS STETHEM (DDG 63)


USS FITZGERALD (DDG 62)


USS RUSSELL (DDG 59)


USS MILIUS (DDG 69)


USS O'KANE (DDG 77)

Long Range Surveillance & Track (Aegis BMD 3.6)


USS JOHN PAUL JONES (DDG 53)


USS PAUL HAMILTON (DDG 60)


USS BENFOLD (DDG 65)


USS HOPPER (DDG 70)


USS HIGGINS (DDG 76)

Upgrade Installation in Progress

Aegis BMD Accomplishments to Date

Aegis BMD

LRS&T

First ICBM Tracking: 19 Sep 02

Homeland Defense

Joint Cooperative Research

Sea Based Terminal

20 Feb 08
Intercept of Satellite

17 Dec 07
JFTM 1

- First Launch on Remote Operation
- First Firing from Japanese Destroyer

6 Nov 07
FTM 13

- Engage Dual SRBMs

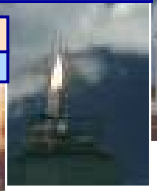
22 Jun 07
FTM 12

26 Apr 07
FTM 11 Event 4

- Simultaneous BMD/AAW Engagements
- Auto-BMD
- Pulse DACS

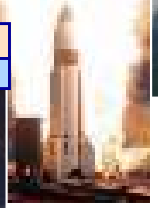
7 Dec 06
FTM 11

22 Jun 06
FTM 10



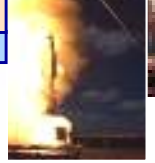
- SM-3 BLK IA
- Aegis 3.6
- First Coalition Test

17 Nov 05
FTM 04-2(FM-8)



- Separating Warhead

24 Feb 05
FTM 04-1(FM-7)

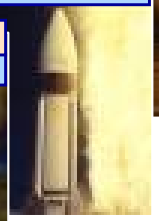


- No Notice Firing

11 Dec 03
FM-6

- Descent Phase With Aim Point Adjust

17 Jun 03
FM-5



21 Nov 02
FM-4

- Ascent Phase Intercept

13 Jun 02
FM-3

25 Jan 02
FM-2

- First Intercept

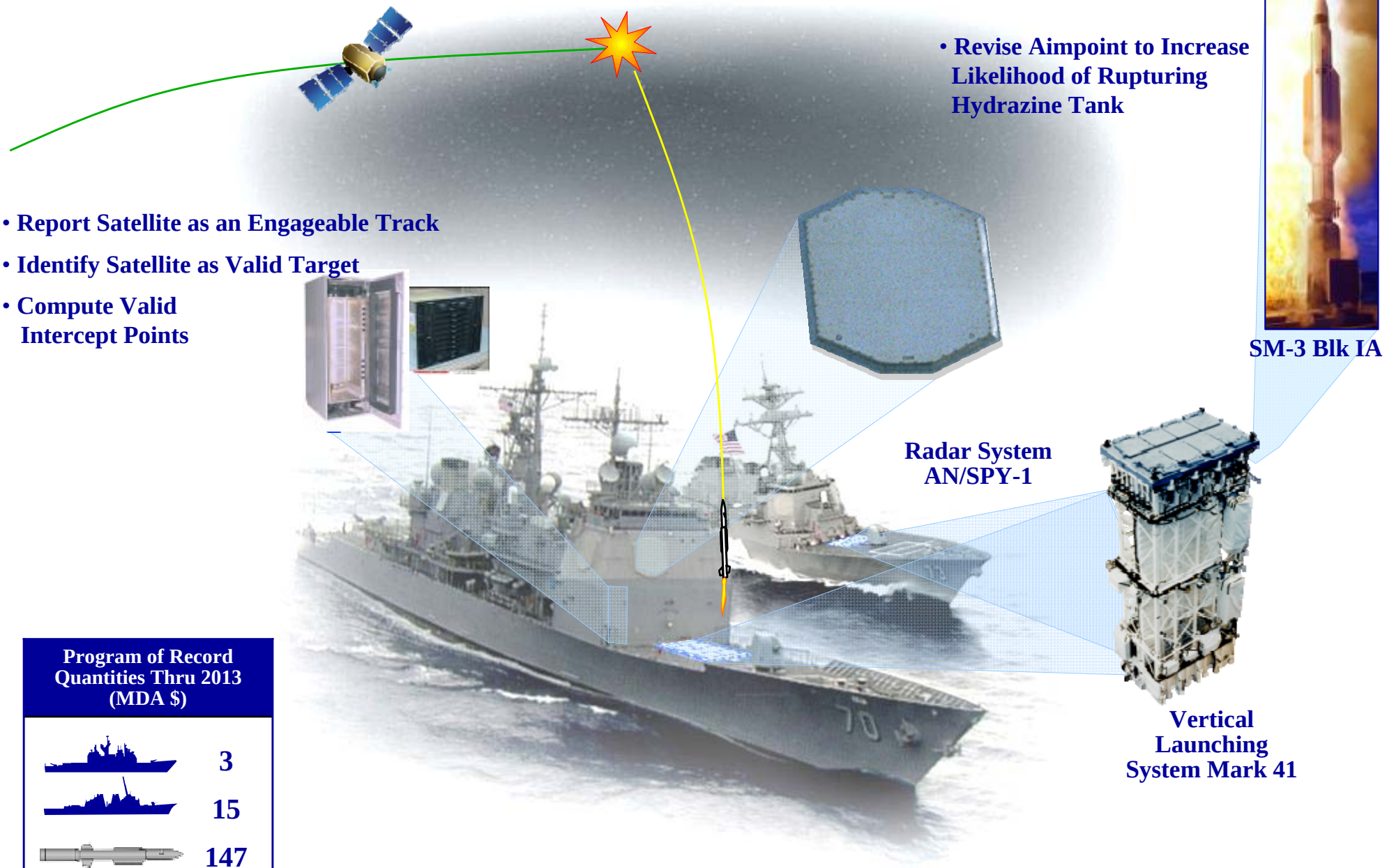
Future Testing

- FTM-14 (6/08): Engage SRBM Threat (Terminal Defense)
- FTM-15 (3/09): Engage IRBM (Launch on TADIL)
- FTM-16 (9/10): SM-3 Block IB Engage MRBM

12 for 14 in SM-3 Midcourse Intercepts Including Japanese Intercept
1 for 1 in SM-2 Block IV Terminal Intercepts
1 for 1 in Real World Events

Modifications To Aegis Ballistic Missile Defense System To Accomplish Mission

Aegis BMD



- Report Satellite as an Engageable Track
- Identify Satellite as Valid Target
- Compute Valid Intercept Points

- Revise Aimpoint to Increase Likelihood of Rupturing Hydrazine Tank

SM-3 Blk IA

Radar System AN/SPY-1

Vertical Launching System Mark 41

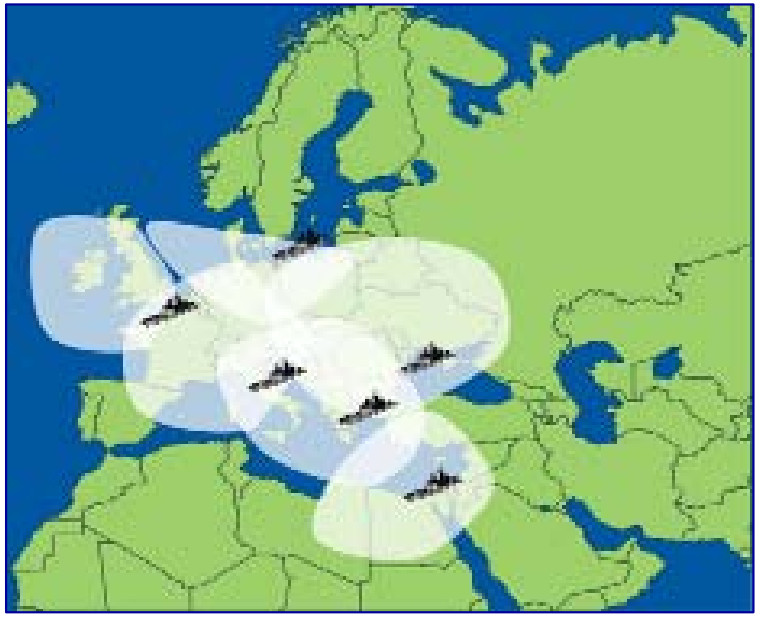
Program of Record Quantities Thru 2013 (MDA $)	
	3
	15
	147

Sensors and Missile Improvements With Increased Integration With BMDS

Aegis BMD

Near-Term

Tactical Capability



Aegis BMD 4.0E/4.0/4.0.1

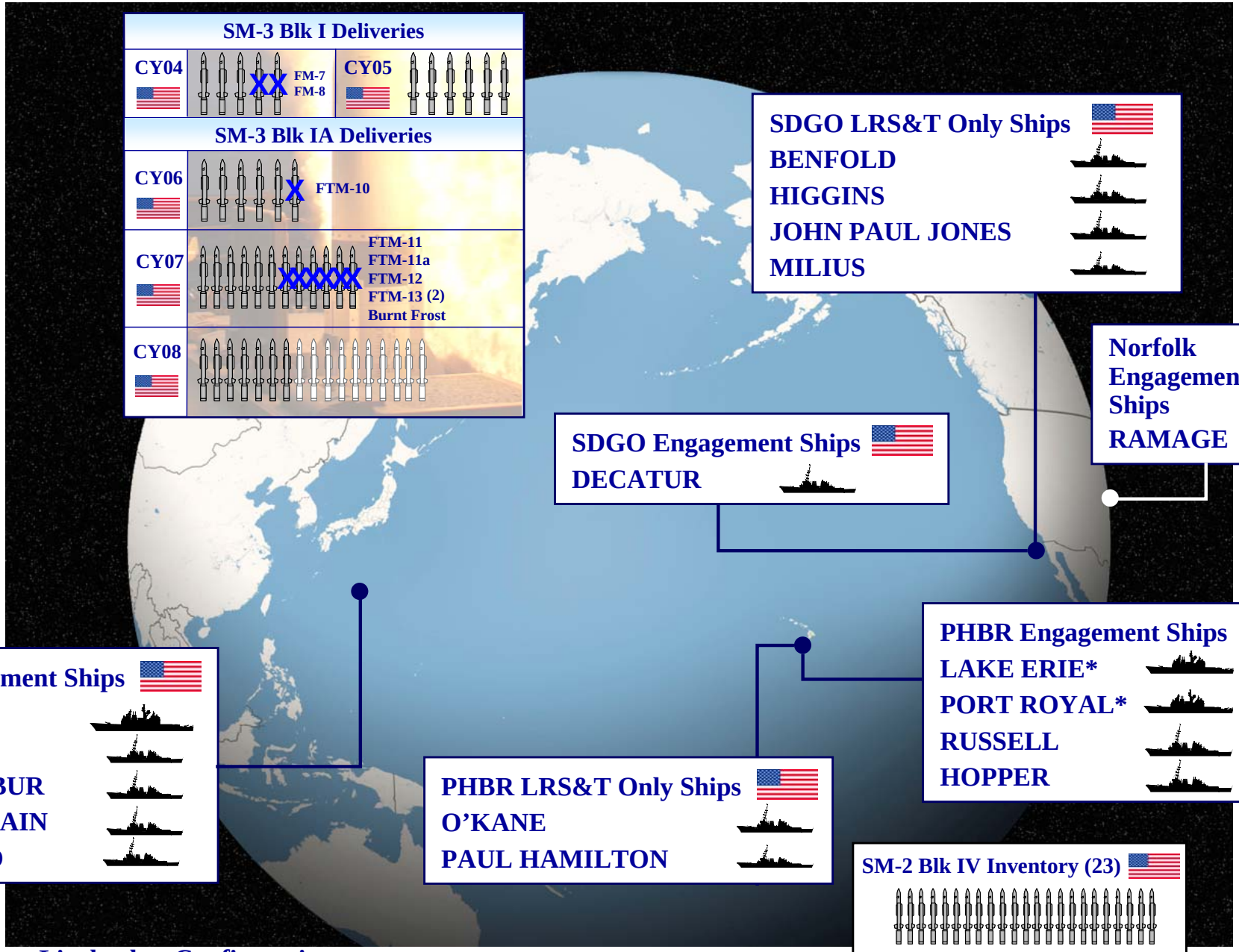
- **Enhanced Use & Support of BMDS ESGs**
- **Enhanced SRBM, MRBM & Limited IRBM Defense**

- **AN / SPY-1 Radar with Aegis BMD Signal Processor (BSP)**
- **SM-3 Block IB Missile with Improved IR Sensitivity & Discrimination**
- **Launch on Remote with BMDS Sensor Cueing**
- **Tactically Certified Weapons System Capability (2010 / Aegis BMD 4.0.1)**

AEGIS BMD UNDERLAY SUPPORTS "3rd SITE"

The U.S. Aegis BMD Fleet Today

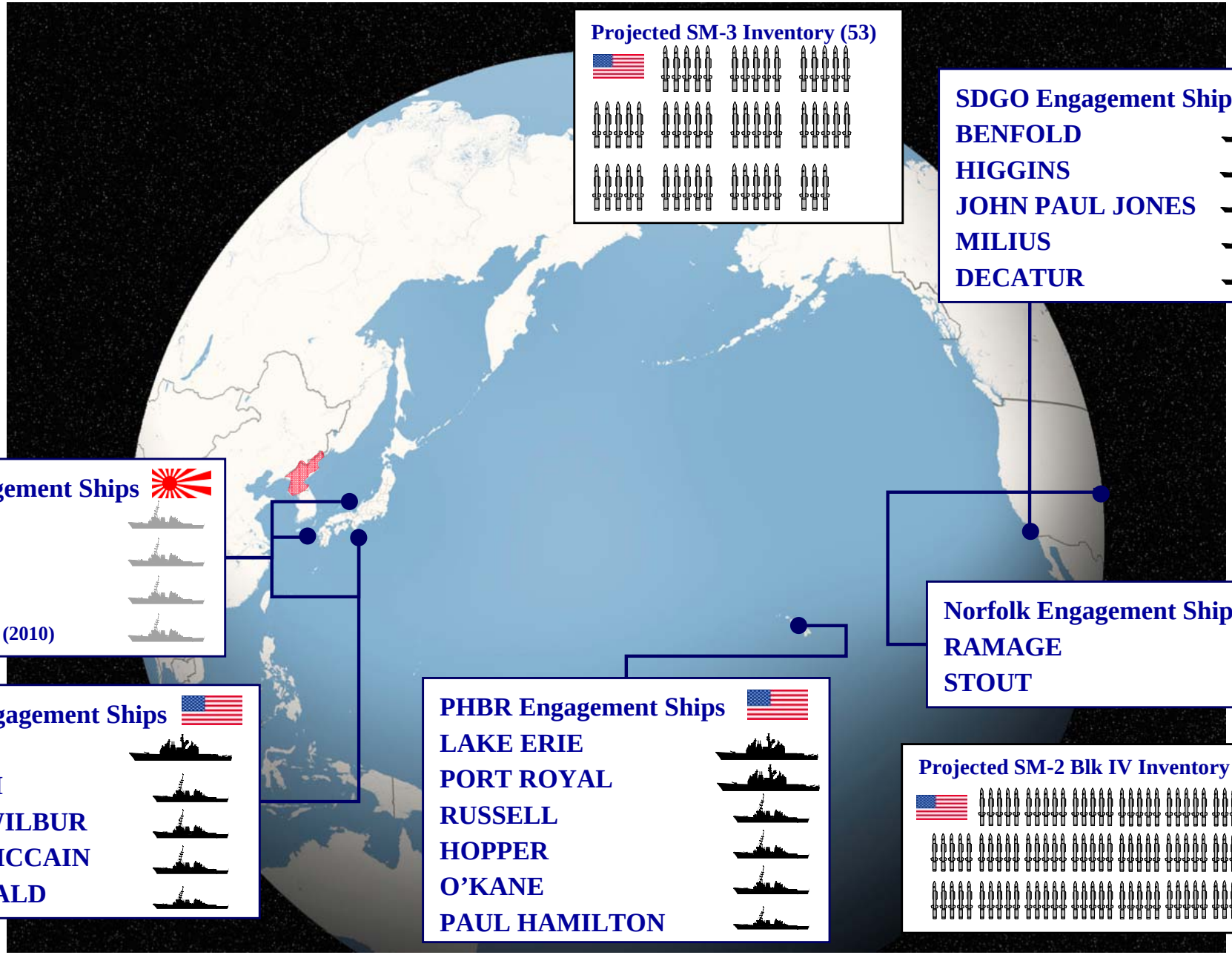
Aegis BMD



*Aegis BMD 3.6 or Linebacker Configurations

The Aegis BMD Fleet – End of CY 2009

Aegis BMD



Projected SM-3 Inventory (53)

SDGO Engagement Ships
- BENFOLD
- HIGGINS
- JOHN PAUL JONES
- MILIUS
- DECATUR

JMSDF Engagement Ships
- KONGO
- CHOKAI
- MYOKO
- KIRASHIMA (2010)

Norfolk Engagement Ships
- RAMAGE
- STOUT

YOKO Engagement Ships
- SHILOH
- STETHEM
- CURTIS WILBUR
- JOHN S. MCCAIN
- FITZGERALD

PHBR Engagement Ships
- LAKE ERIE
- PORT ROYAL
- RUSSELL
- HOPPER
- O'KANE
- PAUL HAMILTON

Projected SM-2 Blk IV Inventory (100)

R-Doc Ref: N/A

Near Term Sea-Based Terminal Defense

Aegis BMD

SM-2
Block IV

- Fuze Modifications
- Auto Pilot Modifications

- **Near Term Objective: Early Capability to Defeat Ballistic Missiles in the Terminal Phase**
  - Modify 100 SM-2 Block IV missiles to attain BMD Capability
  - Modify Aegis BMD 3.6 Baseline for Terminal Capability with SM-2 Block IV
  - Eighteen Ships, installations commence in FY08
  - Est. Cost Share (FY06-09): Navy: $22M, MDA: $108M

	FY06 & 07	FY08	FY09	FY10	FY11	FY12	FY13
R&D $M	57.5	71.5	19.9	3.1	1.2	0	0
	(17)	(39)	(39)	(5)			
CUM	(17)	(56) (1)	(95) (5) (1)	(100) (11) (1)	(100) (15) (3)		

Far Term Sea-Based Terminal Defense

Aegis BMD

Potential Alternatives

SM-6

PAC-3 MSE

- Hit to Kill & Enhanced HTK
- Expanded Battlespace
- Highly Agile
- Dual Use AAW & BMD

- **Far Term Objective: Expanded Capability to defeat Ballistic Missiles in the Terminal Phase**
  - **MDA/Navy Supported Approach**
  - **Potential Acquisition Approach: Directed Competition for New Missile**
  - **Certified Tactical Capability Integrated in Aegis Modernization Program / Open Architecture**
  - **First Delivered Capability in 2015**

	FY08	FY09	FY10	FY11	FY12	FY13
PB09 $M	13	39	50	45	164	177

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 5.0, 2/9//07

Aegis BMD SM-3 Evolution

Spiral Development with Incremental Capability Improvements

Aegis BMD

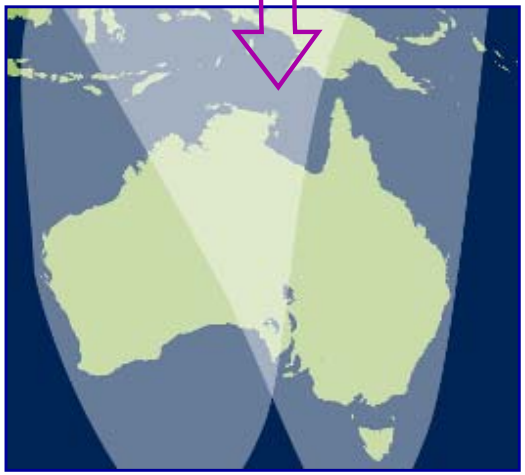
SM-3 Blk IA	SM-3 Blk IB	SM-3 Blk II	SM-3 Blk IIA
• Blk IA Kinetic Warhead (KW) – 1-Color Seeker – Pulsed Divert/Attitude Control System (DACS)	• Blk IB KW – 2-Color Seeker – All-Reflective Optics – Advanced Signal Processor – Throttleable Divert/Attitude Control System (TDACS)	• 21" Nosecone Japan Cooperative Research (JCR) • Blk IB KW	•21" Nosecone JCR •Large Diameter KW – Adv Discrim Seeker – High Divert DACS
• 13.5" Propulsion – 2nd & 3rd Stage	• 13.5" Propulsion – 2nd & 3rd Stage	• 21" Propulsion – 2nd & 3rd Stage	• 21" Propulsion – 2nd & 3rd Stage
• MK 72 Booster • MK 41 Vertical Launch System (VLS) Compatible	• MK 72 Booster • MK 41 VLS	•MK 72 Booster •MK 41 VLS Compatible Light Weight (LW) Canister	•MK 72 Booster •MK 41 VLS LW Canister

(Part of IIA Development; Not Planned to be a Fielded Capability)

Aegis BMD Block IIA "SM-3 Cooperative Development Program"

Aegis BMD

- MDA/D Provided Direction to Incorporate IIA Development Into Aegis BMD in 22 Dec 05 Program Guidance Letter
- The 21" SM-3 Blk IIA Combined with BMDS Remote Sensor Data Provides:
  - Increased Defended Area
  - Increased Probability of Kill Against a Broader Threat Set
  - Reduces Force Structure Requirements
  - Improves Operational Flexibility
- PB07 Program Assumes Japan Work Share at ~50%
  - Cost Estimate $2.1B ($1B – Japan Estimated Contribution)
- SM-3 Block IIA Delivery End of 2015

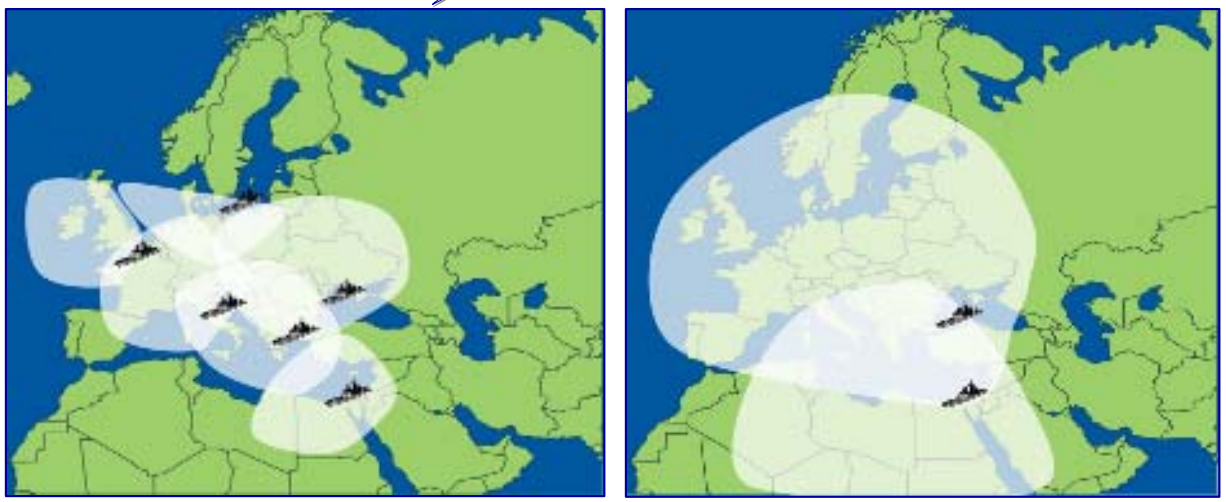


ms-107684 / 083005

Greater Missile Reach Increases Defended Area

Aegis BMD

SM-3 Block IB → SM-3 Block IIA



Aegis BMD 5.0/5.1/5.2

- Enhanced Use & Support of BMDS ESGs
- SRBM, MRBM & Enhanced IRBM Defense & Limited ICBM Defense

- Supports 3rd Site
  - Forward Layer of Defense Ascent Phase
  - Underlay
  - Additional Depth of Fire
  - Interoperable Component of BMDS Including GMD and THAAD

WORLDWIDE MOBILE CAPABILITY

Approved for Public Release 08-MDA-3231 (5 Feb 08)
Rev: 3.5, 6/18/07

Sea-Based Ballistic Missile Defense State of Play

Aegis BMD

United Kingdom (UK):

- MDA Framework MOU
  - RDT&E Annex
- US / UK Type 45 BMD Capability Study completed

Netherlands:

- LCF Frigates (3) SMART-L (L-Band) APAR, MK 41 VLS
- Completed successful tracking of TTV during FTM-11 (Dec 06)
- Looking at potential for SM-3 integration

Japan:

- Upgrading 4 KONGO DDGs to BMD 3.6
- First Engagement Capable Ally in Dec 07
- Largest BMD Co-Development - SM-3 Blk IIA Co-Development – Flight Test in 2014/15
- Discussions on SM-3 Joint Maintenance Facility in Japan
- Radar (JUSRR) and Open Architecture (BMDOAR) Co-Research Annexes

Spain:

- 4 Aegis (F-100) Ships: SPY-1D (S-Band), MK 41 VLS (B/L 3.4.8)
- 2 Aegis Ships (B/L 7.1)
- F-104 participating in FTM-12 to detect and track ballistic missile

Germany:

- F 124 Frigates (3)
  - SMART-L (L-Band) & APAR
  - MK 41 VLS
- Plan to implement LRS&T capability
- MOU for LNO in Aegis BMD

South Korea:

- 3 Aegis Ships Under Construction
- KDX-III Destroyers
  - B/L 7.1 COTS (C/R-2)
- Expressed Interest in Sea Based Terminal

NATO ALTBMD Requirements:

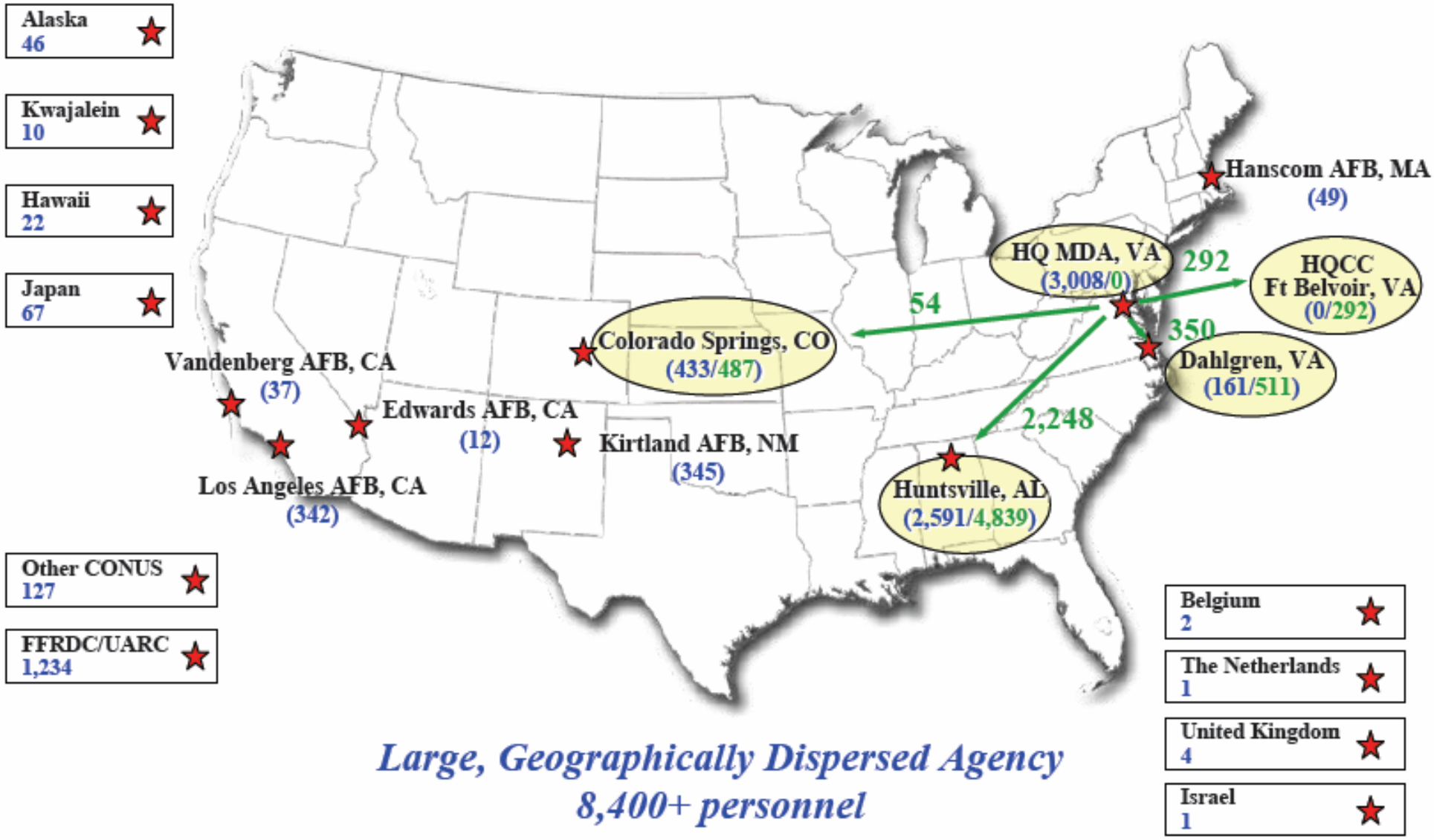
- Integration Test Bed
- Aegis BMD providing sensor support to initial lower tier efforts

Australia:

- 3 Aegis Ship Procurement (DDG 101-103)
  - B/L 7.1 OA
- MDA Framework MOU
  - 07 July 2004

Missile Defense Agency: Funded Workforce (BRAC Impact: 2006 / 2012)

Aegis BMD



Large, Geographically Dispersed Agency
8,400+ personnel

Major Field Activity / Contracting Activity

Aegis BMD

Canoga Park, CA
Boeing
Kinetic Warhead Assembly

Corona, CA
NSWC Corona
Operational & Test Analysis

Port Hueneme, CA
NSWCPHD
Live Fire Test Support, Fleet Logistics, Fleet Operations

Tempe, AZ
Honeywell
Inertial Nav Units for SM-3 & Other Components

Tucson, AZ
Raytheon
SM-3 Missile Dev. Upper Stage Assembly

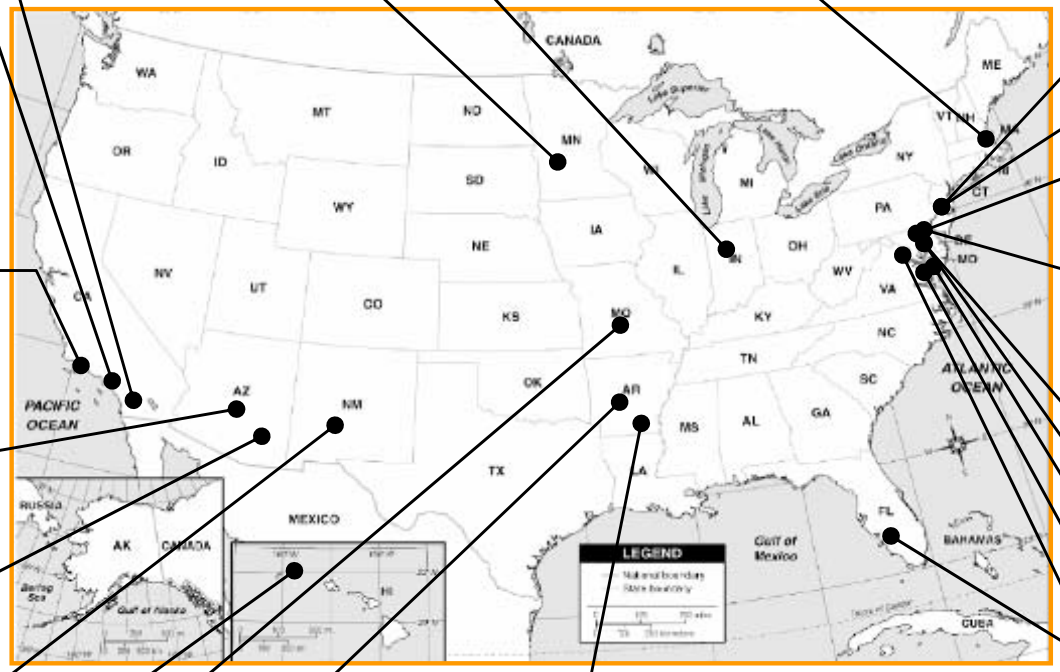
White Sands, NM
WSMR
T&E CONUS Support

Barking Sands, Kauai
PMRF
Live Fire Test Shore Support

Minneapolis, MN
BAE/UDLP
VLS Canister Construction

Crane, IN
NSWC Crane
Ship Support & Liaison

Boston, MA
MIT/LL
Trade Studies & Analysis



Joplin, MO
Eagle Picher
SM-3 Microelectrics Including Batteries

Camden, AR
Raytheon
SM-3 Assembly

Camden, AR
Aerojet
MK72 / MK19

Clearwater, FL
LM
Defense Computer Systems, Navigation & Guidance Systems, Radar & Sonar Systems, Electro Optics

Arlington, VA
GDIT
Program Office Support

Moorestown, NJ
CSC
Combat System Software Development

Moorestown, NJ
LM/MS2
Combat System Engr. Agent, Weapon System Development

Elkton, MD
ATK
TSRM /SDACS Development

Laurel, MD
APL
Technical Direction Agent for the Program Office

Baltimore, MD
LM/MS2
VLS Engr. Development & Support

Indian Head, MD
NSWC Indian Head
EXCOM Support

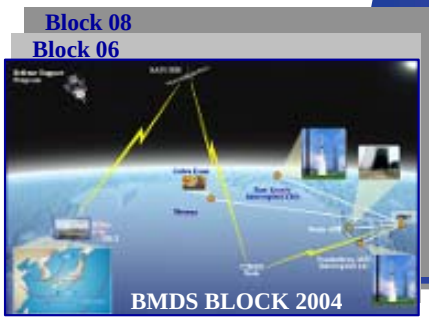
Wallops Island, VA
SCSC
Weapon Systems Checkout & Certification

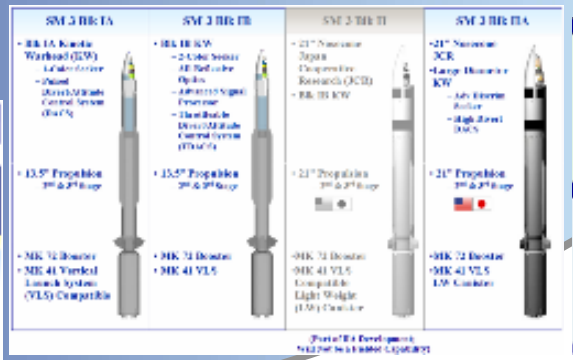
Dahlgren, VA
NSWCDD AB
Lifetime Support Engr. Agent & Certifying Authority Program Office

Summary

Aegis BMD

- **Aegis BMD is at Sea Today**
  - **Aegis BMD Warships Conducting Missile Defense Patrol Operations**
  - **Aegis BMD 3.6 Certified Aug 06**
  - **Delivery of SM-3 Blk IA Missiles Underway**
- **Aegis BMD Will Become More Capable Through Block Upgrades**
  - **Able to Engage Increasingly Longer Range and More Sophisticated Ballistic Missiles**
  - **Add a Terminal Capability in 2009**
- **Japan is Our First Ally to Pursue Aegis BMD and SM-3 Missiles**
  - **Japan and the United States Cooperatively Develop 21-Inch Diameter SM-3, the SM-3 Block IIA**
- **Interest in Maritime Ballistic Missile Defense is Growing in a Number of European and Pacific Rim Nations**





"AEGIS BMD - WE DELIVER"

Where Is the...

Aegis BMD

…Missile Defense Fleet?

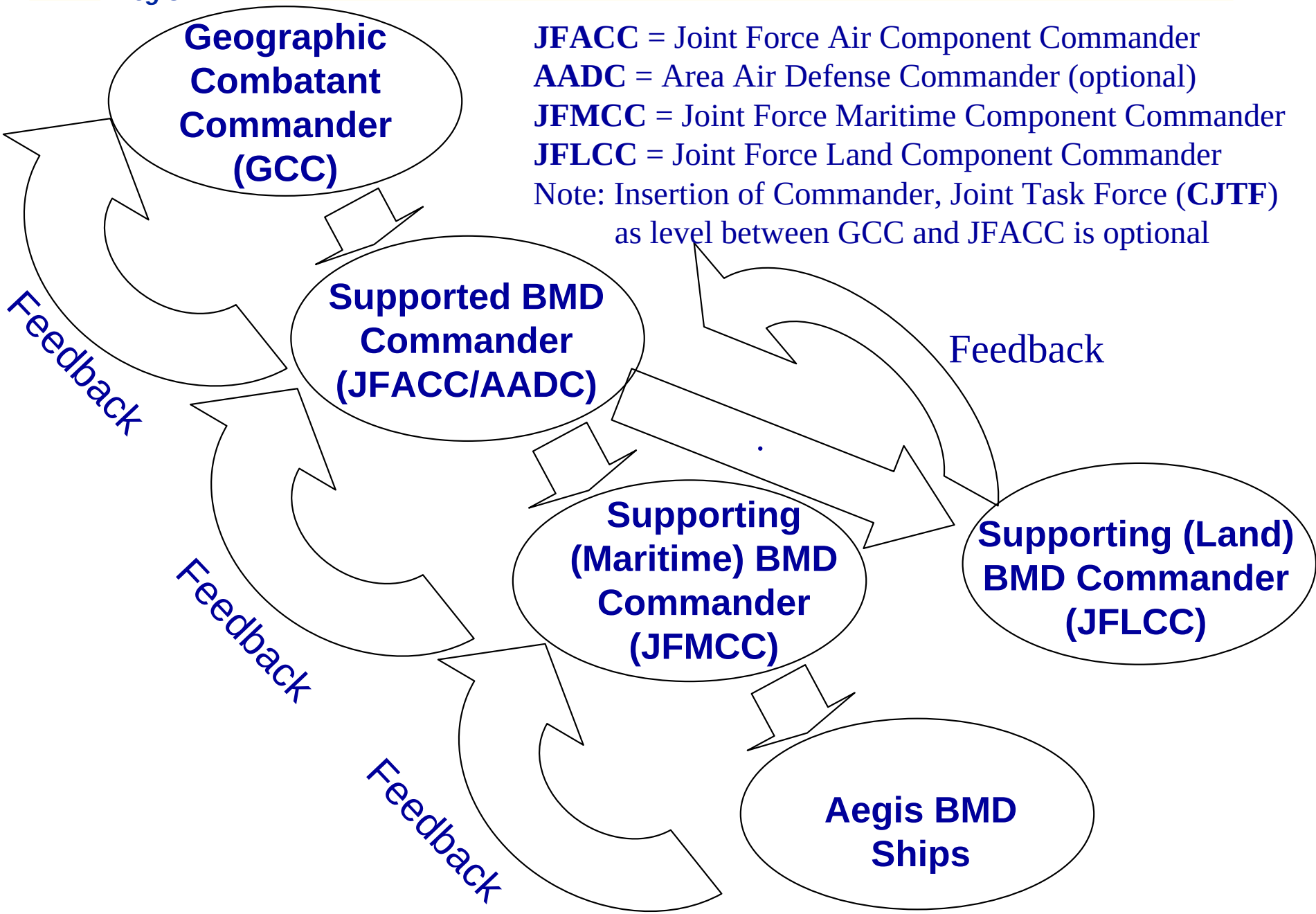
Agenda

- BMD Theater Chain of Command
- Force and Unit Level Planning
- Maritime BMD Operating Principles

BMD Theater Chain of Command

Aegis BMD

JFACC = Joint Force Air Component Commander
AADC = Area Air Defense Commander (optional)
JFMCC = Joint Force Maritime Component Commander
JFLCC = Joint Force Land Component Commander
Note: Insertion of Commander, Joint Task Force (**CJTF**) as level between GCC and JFACC is optional



Force and Unit Level Planning

- **Force Planning**
  - **Process of Allocating Multiple Assets Against a Particular Threat**
    - **Integrated Air and Missile Defense for Theater Missile Defense**
  - **Conducted by Operational Staffs, e.g.**
    - **Supporting Navy Commander (e.g. JFMCC)**
    - **Supported BMD Commander (e.g. AADC)**
  - **Output is Series of Orders or Directives to Subordinate Units**

- **Unit Planning**
  - **Assigned Specific Mission by Higher Authority**
  - **Report Compliance or Non-Compliance to Higher Authority**
  - **Process Supports Taking Assigned Tasking from Force Planning Output, Properly Positioning the Unit, and Configuring Weapons Systems**

Planning Outputs

Echelons	Planning Outputs
Geographic Combatant Commander (GCC) (Force Level)	• Mission Objectives • Rules of Engagement • Measures of Success • Apportionment Guidance
Commander, Joint Task Force (CJTF) (Force Level)	• Prioritized Defended Asset List (PDAL) • Other Guidance as Delegated by GCC
Joint Force Air Component Commander (JFACC)/Area Air Defense Commander (AADC) (Force Level)	• Translate GCC Guidance Into Specific BMD Mission Orders • Allocate BMD Tasks Between Supporting Component Commanders IAW HHQ Directives • Coordinate Multiple Planning Processes with Interactions of Multiple Component Commanders
Joint Force Maritime Component Commander (JFMCC) (Force Level)	• Determine Ships Required to Meet Tasking • Determine Operating Areas and BMD Patrol Areas • Produce an Integrated Force Laydown that Maximizes Utility of Aegis BMD Ships in Particular Scenario • Develop Requisite Support Plans •WILCO/CANTCO with HHQ Tasking
Aegis BMD Ship (Unit Level)	• Detailed Ship Operating Area • Radar Settings / Doctrine • WILCO/CANTCO with HHQ Tasking

Higher Echelon BMD C2 Principles

- **Command-by-Negation Provides Mechanism for Higher Echelons to Control Aegis BMD Operations**
  - **Command-by-Negation is Almost Always a Voice Order**
- **Centralized Planning Provides for Unity of Effort and Coordination of all Available Forces**
- **Deliberate, Crisis Action, and Dynamic Replanning and Analysis of Plans are Required for Effective BMD**

Maritime BMD C2 Operating Principles

Aegis BMD

- **Navy Commanders Support Joint Commander While Accomplishing Other Maritime Objectives (e.g. Air Defense) and Supporting Unique Requirements of Ship Operating at Sea**

- **Decentralized Execution is Essential to Minimize Reaction Time and to Cope with Uncertainty, Disorder, & Fluidity of Combat**
  - **Engagements Based on Pre-Defined Rule of Engagement (ROE) Provide a Clear Basis for Decision Making**
  - **The Most Accurate Tactical Information is Held at the Unit Level, in this Case the Firing Unit**
  - **Moving Engagement Decision Making to a C2 Node Remote from the Firing Unit Introduces Latency, Reduces Knowledge, Increases System Complexity, and Decreases System Reliability**
  - **Minimizing the Length of the Engagement Control Loop Minimizes Reaction Time and Maximizes Decision Time**

Tactical Control of Aegis BMD Ships

- **Tactical Control (TACON) is Command Authority Over Assigned or Attached Forces Usually Limited to the Detailed Direction and Control of Movements or Maneuvers Necessary to Accomplish Assigned Missions or Tasks**
- **The JFMCC or Fleet Commander Normally Exercises TACON of Missile Defense Ships Directly or Delegates TACON to a Subordinate Navy Commander**
- **A Navy Commander Should Retain TACON for Safety of Navigation and to Ensure that Ship's Movement is Coordinated with Supporting Logistic and Force Defense Operations**