PRECISION STRIKE ASSOCIATION

Precision Strike Technology Symposium (PSTS-09)

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"*Improving Precision Weapons to Win the War on Terror*"

27 – 29 October 2009
Laurel, MD

Due to the classifed nature of this symposium, very few presentations were approved for distribution.

Agenda

TUESDAY 27 OCTOBER 2009

NAVY WEAPONS DEVELOPMENT & NET WORK ENABLED WEAPONS: Rear Admiral William E. Shannon, III, USN—PEO for Unmanned Aviation and Strike Weapons (PEO (U&W))

KEYNOTE —*BUILDING THE FUTURE FORCE:* Lieutenant General Duane D. Thiessen, USMC—Deputy Commandant for Programs and Resources, USMC

WEDNESDAY 28 OCTOBER 2009

GPS EPHEMERIS & IONOSPHERIC CORRECTION SHARING SERVICE (GEISS) FOR PRECISION GUIDED MUNITIONS (ALTERNATE ABSTRACT): Dr. Alison Brown—President and CEO of NAVSYS Corporation

Office of the Secretary of Defense:

- **Capitalization on Investment & OSD Concerns**: Keith Sanders—DD Air Warfare, Portfolio Systems Acquisition, OUSD(AT&L)

1605 PEO U&W:

- **Addressing the ASuW Capability Gap—An Acquisition Perspective**: Captain Mat Winter, USN—PMA-201, NAVAIR
- **Network Enabled Weapons & Time Sensitive Strike**: Captain Dave Davison, USN—PMA-280, NAVAIR

THURSDAY 29 OCTOBER 2009

TACTICAL GRENADE EXTENDED RANGE: Ross Sanders—Chief Technical Analyst, MBDA Missile Systems

AGENDA
TUESDAY, 27 OCTOBER

0715 **CHECK-IN / CONTINENTAL BREAKFAST**

0800 **SYMPOSIUM WELCOME:** ***Andy McHugh***—Chairman of the Board

0805 **JHU / APL WELCOME:** ***Dr. Ira Blatstein***—Director of Strategic Planning

0815 **NAVY WEAPONS DEVELOPMENT & NETWORK ENABLED WEAPONS:**
Rear Admiral William E. Shannon, III, USN—PEO for Unmanned Aviation and Strike Weapons (PEO (U&W))

0835 **NATIONAL INTELLIGENCE ISSUES & CHALLENGES:**
Major General John Landry, USA (Ret) —National Intelligence Officer, National Intelligence Council, Office of the Director of National Intelligence

0915 **WEAPON SYSTEM INFORMATION ASSURANCE (IA) THREAT:**
Mark E. Byrkit—Senior Professional Staff Scientist, Air & Missile Defense Dept., JHU/APL

0945 **KEYNOTE—BUILDING THE FUTURE FORCE:**
Lieutenant General Duane D. Thiessen, USMC—Deputy Commandant for Programs and Resources, USMC

1030 **NETWORKING REFRESHMENT BREAK** (sponsored by: Kaman Precision Products)

1045 **DEVELOPING THE JSF TO FIGHT THE WAR ON TERROR:**
Captain John "Snooze" Martins, USN—Director, Air Vehicle, F-35 Lightning II Program

1115 **WARPLAN-WARFIGHTER FORWARDER SPIRAL II (WWF II) JOINT EXPEDITIONARY FORCE EXPERIMENT (JEFX 09-3) ASSESSMENT** (ABSTRACT):
Greg Williams—Senior Professional Staff, JHU/APL

1145 **STRIKE HORIZONTAL INTEGRATION LIMITED OBJECTIVE EXPERIMENT (SHILOE) FOR NET ENABLED WEAPONS** (ABSTRACT):
Randel Langloss— Network Enabled Weapons (NEW) System-of-Systems Engineer, China Lake Naval Air Station, CA

1215 **LUNCHEON—Kossiakoff Center Dining Room** (sponsored by: Lockheed Martin Corp.)

1245 **LUNCHEON ADDRESS—WINNING THE GLOBAL WAR ON TERROR:**
Lieutenant General Thomas G. McInerney, USAF (Ret)—Fox News Military Analyst

1330 **TARGET-CENTRIC WEAPON DESIGN FOR SMALL UAS APPLICATIONS** (ABSTRACT):
Douglas M. Storsved—Chief Systems Engineer, ATK Advanced Weapons Division

1400 **8th AIR FORCE & GLOBAL STRIKE COMMAND'S ROLE IN NATIONAL SECURITY STRATEGY:**
Colonel West Anderson, USAF—Eighth Air Force Chief of Staff, Barksdale AFB

1445 **NETWORKING REFRESHMENT BREAK**

1515 **METHODOLOGIES FOR ASSESSING WEAPONS EFFECTIVENESS IN THE URBAN ENVIRONMENT** (ABSTRACT):
Robert Stevenson—Senior Operations Research Analyst, Systems Planning & Analysis

1545 **PRECISION TARGETING—ENABLER OF PRECISION STRIKE** (ABSTRACT):
Stephen Pearcy—Senior Advisor, USARDEC, Picatinny Arsenal

1615 **TRENDS IN GEOSPATIAL INTELLIGENCE SUPPORTING PRECISION STRIKE:**
John Tuley—National Geospatial-Intelligence Officer for Targeting Issues, National Geospatial-Intelligence Agency (NGA)

1700 **CHALLENGES IN CALCULATING COLLATERAL DAMAGE:**
Lieutenant Colonel Deborah MacKay, USAF—Chief for Targeting Policy, Directorate for Intelligence, The Joint Staff (J2)

1730 **EVENING RECEPTION WITH HEAVY HORS D'OEUVRES** (sponsored by: Honeywell International)

Mark E. Byrkit
Senior Professional Staff Scientist, Air & Missile Defense Dept., JHU/APL

Captain John "Snooze" Martins, USN
Director, Air Vehicle, F-35 Lightning II Program

Colonel West Anderson, USAF
Eighth Air Force Chief of Staff, Barksdale AFB

NOTE:
Unclassified note-taking is permitted.

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Classified notes will be confiscated by security.

AGENDA
WEDNESDAY, 28 OCTOBER

Keith Sanders
DD Air Warfare, Portfolio Systems Acquisition, OUSD(AT&L)

Rear Admiral David "Decoy" Dunaway, USN
Commander, Operational Test and Evaluation Force

Captain Larry "Buck" Burt, USN
OPNAV N880C, Strike Aircraft Plans & Requirements

Lieutenant Colonel Tim Farquhar, USAF
Air-to-Ground Weapons Analyst
Force Application Division (J-8)
The Joint Staff

0700 **CHECK-IN / CONTINENTAL BREAKFAST** (sponsored by: Northrop Grumman)

0730 **THERMOBARIC ADVANCED CONCEPT TECHNOLOGY DEMONSTRATION (ACTD)** (ABSTRACT):
Major Ken Lemire, USA—Program Manager, Thermobaric ACTD, Defense Threat Reduction Agency (DTRA), US Army, Eglin AFB

0800 **A SMALL UNMANNED AIRCRAFT SYSTEM (UAS) FOR ENHANCED SUPPORT OF CAVE DETECTION & DEFEAT** (ABSTRACT):
Peter Thompson—Professional Staff, Test Support Division, DTRA, Albuquerque

0830 **GPS EPHEMERIS & IONOSPHERIC CORRECTION SHARING SERVICE (GEISS) FOR PRECISION GUIDED MUNITIONS** (ALTERNATE ABSTRACT):
Dr. Alison Brown—President and CEO of NAVSYS Corporation

0900 **KEYNOTE—SCIENCE AND TECHNOLOGY FOR PRECISION STRIKE:**
Alan R. Shaffer—Principal Deputy Director, Defense Research & Engineering, OSD

0945 **NETWORKING REFRESHMENT BREAK** (sponsored by: The Boeing Company

1010 **PRECISION STRIKE IN A JAMMING ENVIRONMENT:**
Elaine Simmons—Director, Tactical Air Forces Division, Cost Assessment & Program Evaluation (CAPE), OSD

1040 **NET ENABLED WEAPONS:**
Wayne Willhite—Chief Engineer, Naval Air Warfare Center, China Lake

1110 **THE FUTURE OF CARRIER & EXPEDITIONARY AVIATION:**
Rear Admiral David "Deke" Philman, USN—OPNAV N88, Director of Air Warfare

1135 **NAVAL STRIKE AIRCRAFT & WEAPONS:**
Captain Larry "Buck" Burt, USN—OPNAV N880C, Strike Aircraft Plans & Requirements

1200 **LUNCHEON**—Kossiakoff Center Dining Room (sponsored by: Raytheon Company)

1230 **RICHARD H. JOHNSON AWARD CEREMONY:**
- Chairman's Remarks
- Presentation of Award for Technical Excellence in the Field of Precision Strike
- Recipient's Remarks

1245 **CAN HIGH-SPEED CRUISE MISSILES MEET PROMPT GLOBAL STRIKE (PGS) NEEDS?** (ABSTRACT):
Roger Gray—Principal Scientist, Naval Surface Warfare Center, Dahlgren Division

1315 **TESTING IN TOMORROW'S JOINT ENVIRONMENT:**
Rear Admiral David "Decoy" Dunaway, USN
Commander, Operational Test and Evaluation Force, Norfolk, VA

1355 **NETWORKING REFRESHMENT BREAK**

AGENDA
WEDNESDAY, 28 OCTOBER

1415 **ANTI-SURFACE WARFARE REQUIREMENTS PANEL:**
Moderator: ***Lieutenant Colonel Tim Farquhar, USAF***
Air-to-Ground Weapons Analyst, Force Application Division (J-8), The Joint Staff

1420 **REQUIREMENTS:**
- **UONS/Capability Gap/Solution/Range Issue:**
  PACOM/PACFLT issues to be covered by OPNAV N880C & OPNAV N864
- **Naval Aviation Perspective:**
  Captain Larry "Buck" Burt, USN—OPNAV N880C, Strike Aircraft Plans & Requirements
- **USAF Perspective:**
  Colonel Mike Fantini, USAF—Division Chief, Combat Force Application Requirements (AF/A5RC)
- **Surface Perspective:**
  Captain Robert Kerno, USN—OPNAV N864, Surface Warfare

1505 **SCIENCE & TECHNOLOGY:**
- **LRASM Goals / Technologies / Rapid Transition Capability:**
  Rob McHenry— Program Manager, Tactical Technology Office, Defense Advanced Research Projects Agency (DARPA)
- **Support to the Warfighter:**
  Joe Doychak—Program Manager, Aerospace Science Research Division, Office of Naval Research

1535 **BREAK**

1545 **OFFICE OF THE SECRETARY OF DEFENSE:**
- **Capitalization on Investment & OSD Concerns:**
  Keith Sanders—DD Air Warfare, Portfolio Systems Acquisition, OUSD(AT&L)

1605 **PEO U&W:**
- **Addressing the ASuW Capability Gap—An Acquisition Perspective:**
  Captain Mat Winter, USN—PMA-201, NAVAIR
- **Network Enabled Weapons & Time Sensitive Strike:**
  Captain Dave Davison, USN—PMA-280, NAVAIR

1640 **STRIKE, LAND ATTACK & AIR DEFENSE (SLAAD):**
- **ASuW Study Group's Interim Findings:**
  John Fox—Manager, Advanced Weapons Programs, The Boeing Company

1700 **ASuW REQUIREMENTS PANEL DISCUSSION—Q&A:**
- **N88 –** ***Captain Larry "Buck" Burt, USN***
- **AF/A5RC –** ***Colonel Mike Fantini, USAF***
- **N864 –** ***Captain Robert Kerno, USN***
- **PEO –** ***Captain Mat Winter, USN***
- **OSD –** ***Keith Sanders***

1730 **ADJOURN FOR THE DAY**

Captain Mat Winter, USN
PMA-201, NAVAIR

Colonel Mike Fantini, USAF
AF/A5RC

Captain Robert Kerno, USN
OPNAV N864

Captain Dave Davison, USN
PMA-280, NAVAIR

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PRECISION STRIKE TECHNOLOGY SYMPOSIUM COMMITTEE

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Col Mike Fantini USAF
COL Lance Moore USA (Ret)
Col Bob Valin USAF
LTC Joe Horab USA
LCDR Scott Wilson USN
Lt Col Tim Farquhar, USAF
LtCol Chuck Kelly USMC (Ret)
LTC Ken Britt USA (Ret)

EXECUTIVE DIRECTOR
Dawn M. Campbell, CMP

AGENDA
THURSDAY, 29 OCTOBER

Jim "Hondo" Geurts
Commander, Joint Acquisition Task Force-Dragon, HQ USSOCOM

Lieutenant Colonel Hampton Hite, USA
Staff Synchronization Officer for Fire Support Command & Control, DCS Army G-8

0700 **CHECK-IN / CONTINENTAL BREAKFAST**

0730 **TACTICAL GRENADE EXTENDED RANGE** (ABSTRACT):
Ross Sanders—Chief Technical Analyst, MBDA Missile Systems

0800 **EXTENDED RANGE MORTAR AMMUNITION** (ABSTRACT):
Dr. Christine Michienzi—Program Manager, Gun Propellant Development, Naval Surface Warfare Center, Indian Head Division

0830 **TECHNOLOGIES FOR DIRECTED ENERGY WEAPONS:**
Dr. Edward A. Duff—Acting Precision Engagement Product Line Leader, Air Force Research Laboratory, Kirtland AFB

0910 **NETWORKING REFRESHMENT BREAK**

0930 **KEYNOTE—FUTURE SOF CAPABILITY NEEDS:**
William M. Shepherd— Senior Advisor, Science & Technology, United States Special Operations Command

1015 **U.S. SPECIAL OPERATIONS PANEL:**
Moderator: *Lieutenant Colonel Hampton Hite, USA*—Staff Synchronization Officer for Fire Support Command & Control, DCS Army G-8

- **USSOCOM Support to OEF/OIF:**
  Senior Master Sergeant Eric Neilsen, USAF—AFSOC Ground Integration Branch, Hurlburt Field, FL
- **Global Special Operations Support:**
  Colonel Mike Adams, USA—SOCOM Director of Current Operations, HQ USSOCOM
- **Precision Munitions and Platforms in Support of Irregular Warfare:**
  Jim "Hondo" Geurts—Commander, Joint Acquisition Task Force – Dragon, HQ USSOCOM
- **Strategic Authorities & Approval Process:**
  Colonel Rich Samuels, USAF—Division Chief for Plans, Policy & Exercises, Office of DD Special Operations & Combating Terrorism (DDSO/CT), The Joint Staff (J-37)

Questions to be addressed by the Panelists include: *How is precision engagement being employed? How is it working? What requirements are needed for improved capability in the GWOT?*

1130 **AC-130U GUNSHIP ENGAGEMENTS IN SUPPORT OF OEF:**
Lieutenant Colonel Mark Clawson, USAF—Assistant Operations Officer, 4th Special Operations Squadron, Hurlburt Field

1200 **BUFFET WORKING LUNCH**—Kossiakoff Center Dining Room
(SOCOM Officials informal interaction with Government & Industry Representatives)

1300 **3RD PARTY TARGETING OF TLAM:**
Commander David "Manny" Ramsey, USN—USSOCOM NSWDG

1320 **PRECISION TACTICAL TARGETING IN OEF AND OIF:**
Michael Wirtz—Digital Precision Strike Suite (DPSS) PM, Naval Air Warfare Center, Weapons Division, China Lake

1400 **CLOSING REMARKS:** *Andy McHugh*

Precision Strike Technology Symposium

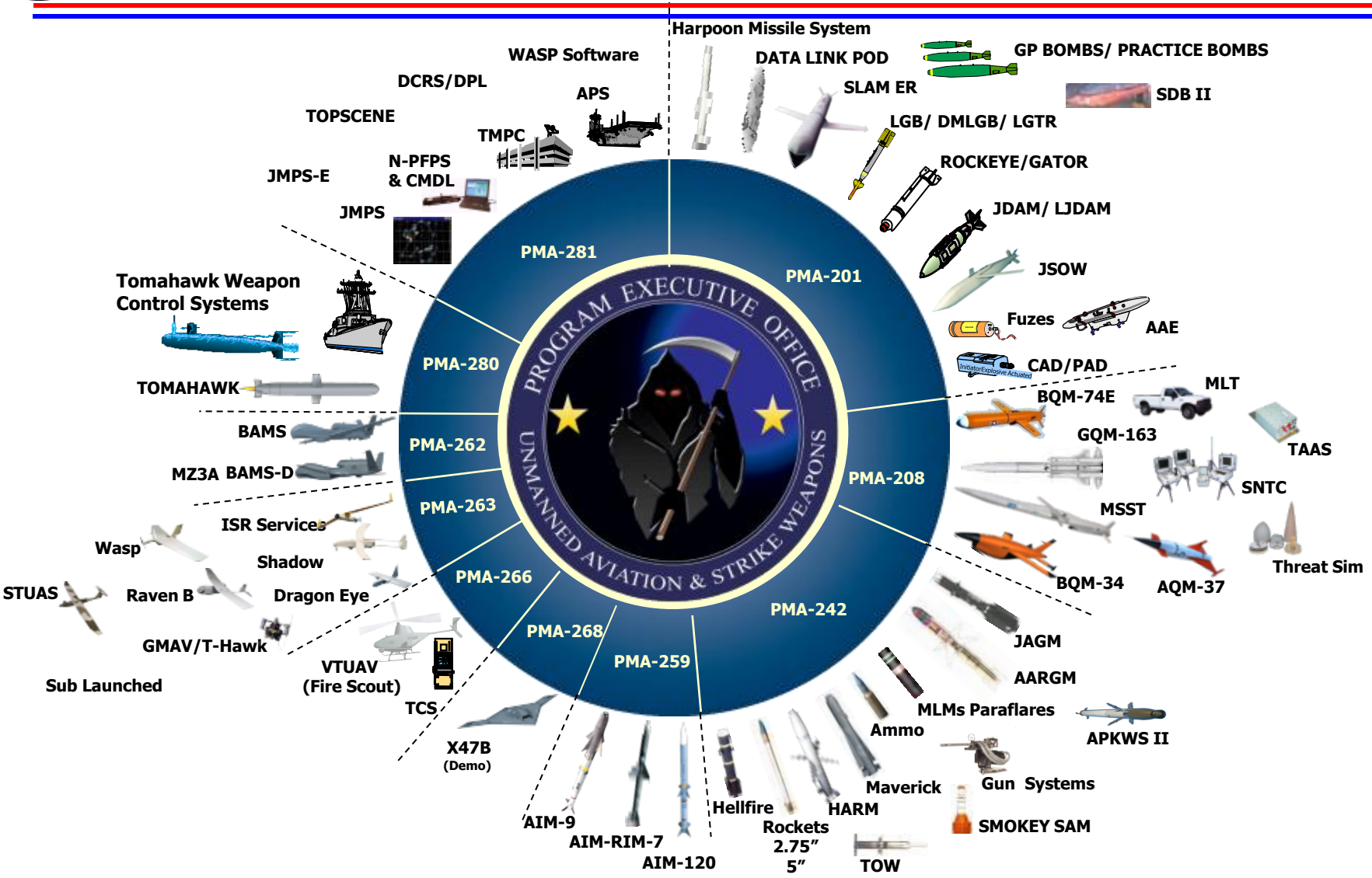
Navy Weapons Development
&
Network Enabled Weapons

October 27, 2009

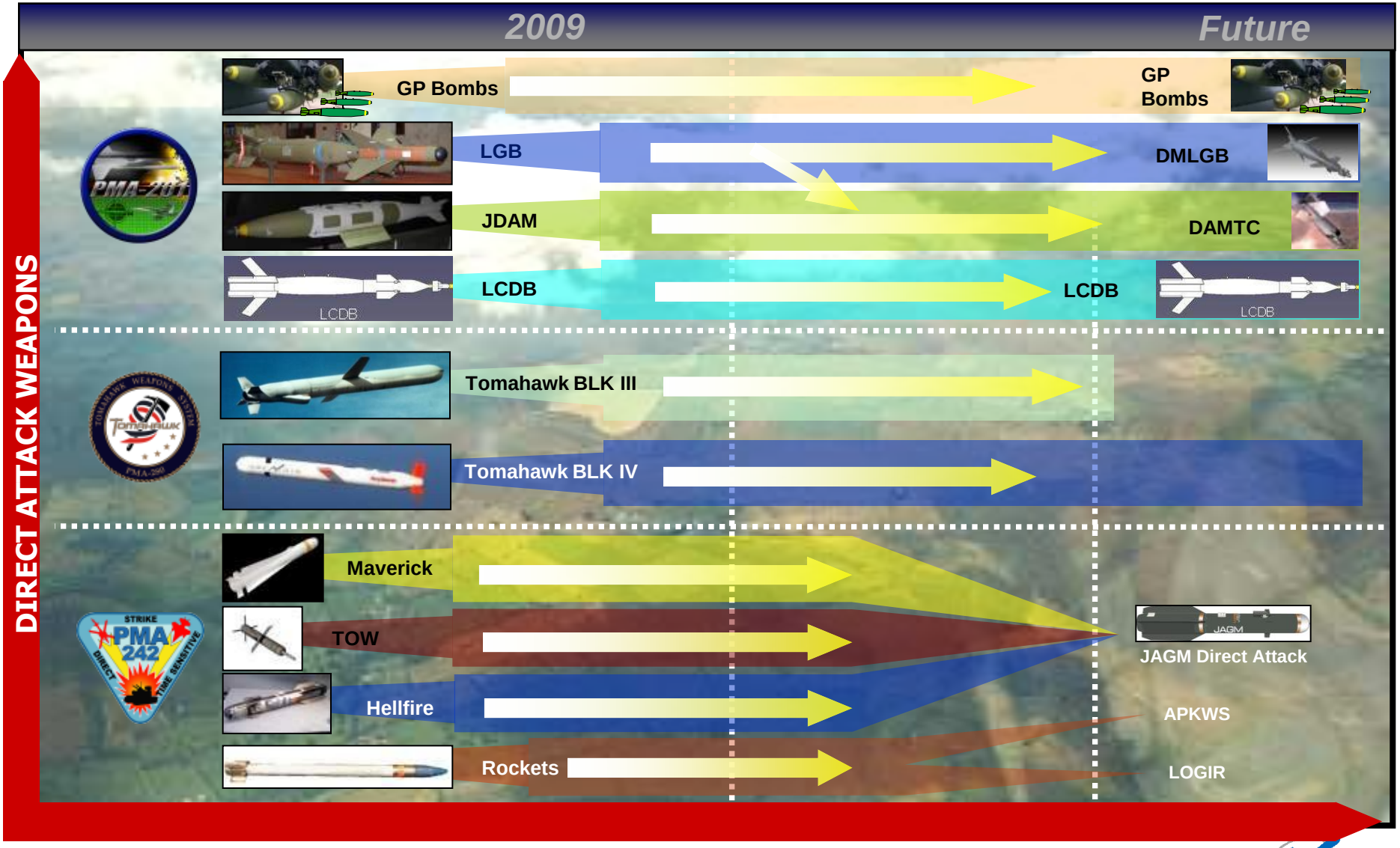
RADM Bill Shannon
Program Executive Officer
Unmanned Aviation and Strike Weapons

NAVAIR

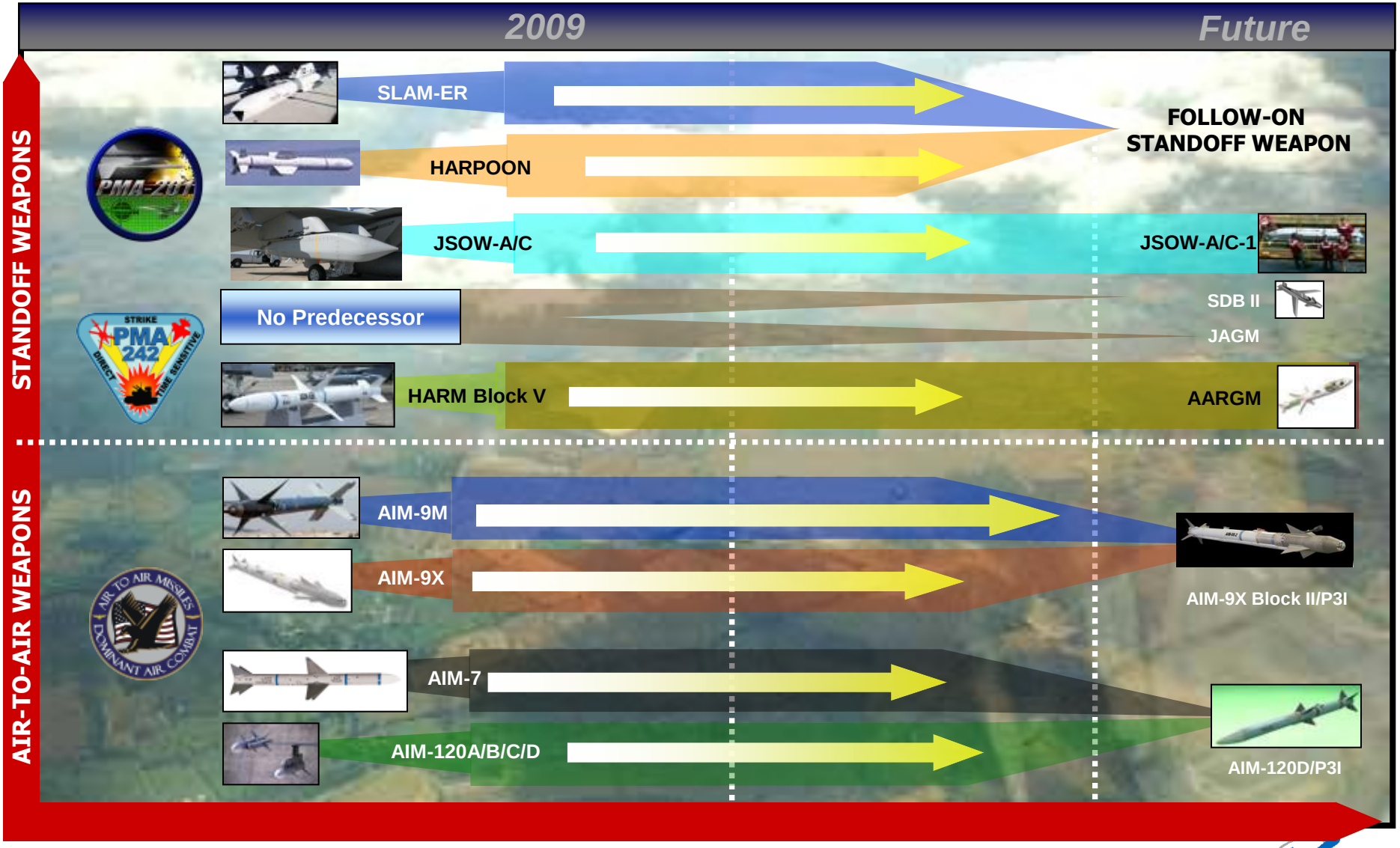
PEO(U&W) Overall Portfolio



Strike Weapons Family of Systems
Direct Attack Weapons



Strike Weapons Family of Systems
Standoff Weapons / Air-to-Air Weapons



Advanced Precision Kill Weapon System II (APKWS II)

Capability

- APKWS is a Semi-Active Laser (SAL) guidance kit added to current 2.75-inch rocket motors and warheads
- Low cost, low collateral damage and minimal integration
- Accurate: 80% within 2 meters of laser spot
- Increased Kills/Sortie: 14 - 38 per sortie
- Status: Mature design, Integrated Test begins November 2009
- Initial Operational Capability 3rd Qtr FY11

Low Cost, High Precision, Low Collateral Damage for Irregular Warfare

Advanced Anti-Radiation Guided Missile (AARGM)

Capabilities

- Counters Advanced IADS
- Greater Lethality
- Addresses ARM countermeasures
- Weapon Impact Assessment

Demonstrated Test Results

- 8 Live Developmental Test Shots
- Multi-mode guidance (ARH, MMW, GPS)
- Advanced Emitter threat detection and ID
- Counter Shutdown Tactics
- Target geo-location
- Netted with off-board targeting (US only)
- Weapon Impact Assessment

Suppression to Destruction of Air Defenses

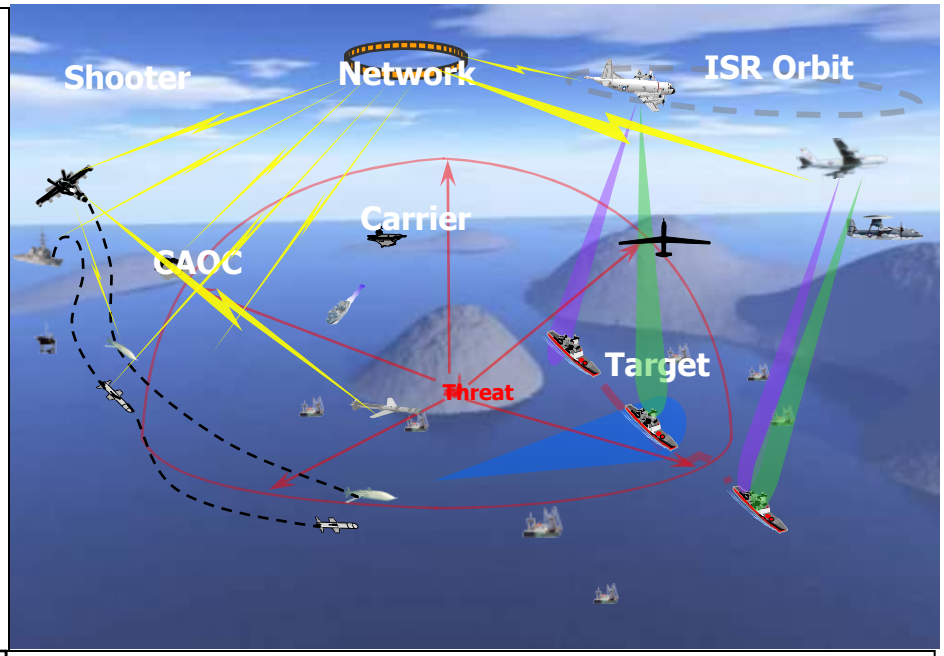
Harpoon Block III

- Block IC out of production
- Block IC continues to provide reliable SUW capability
- Block II FMS in production
- Block III kit upgrade program cancelled
- OPNAV initiating Follow-On SUW AoA

Joint Surface Warfare JCTD

Description:

- **Joint War-fighter has limited capability to engage enemy surface vessels at stand-off ranges in all weather conditions (PACOM sponsor)**
- **Weapon Data-link Network provides linkage and interoperability between USAF and USN ISR platforms via Link-16 to provide in-flight target updates to Joint anti-ship standoff weapons**
- **Proposed Participants**
  - ISR (E-8 JSTARS, P-3 LSRS)
  - Shooter (FA-18)
  - Weapons (H3, JSOW-C-1, SLAM-ER)



Discussion:

- **DUSD (AT&L) program, USN lead w/USAF co-lead**
- **Program began in FY07, runs through FY10**
- **JCTD will deliver first true Net-centric Warfare CONOPS and TTPS**

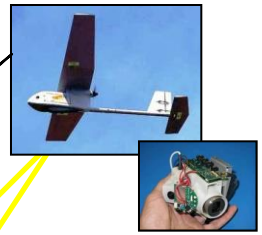
Schedule:

• **Requirements and Software Development**	**FY07**
• **System Integration Testing**	**FY08**
• **Capability Demonstration**	**FY09**
• **Military Utility Assessment**	**FY10**

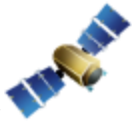
Tactical Real Time Employment Of TACTOM

- Use of UAS Intelligence
- Use of PSS-SOF
- Use of JSPEAR
- Direct Transmission of mission on SIPR

SOF



T/A and FRU will have comms with missile via TSN



JSPEAR MSN on SIPR to TA

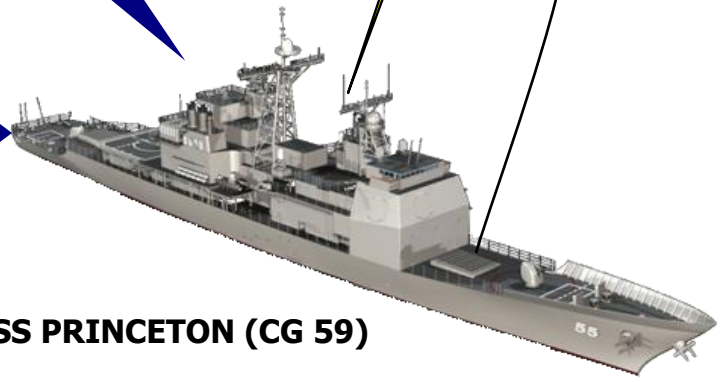
JSPEAR MSN on SIPR to FRU

AUR

Tasking Authority

Sends initial ESP to ship

Electronic Strike Package with preliminary mission via RNI



USS PRINCETON (CG 59)

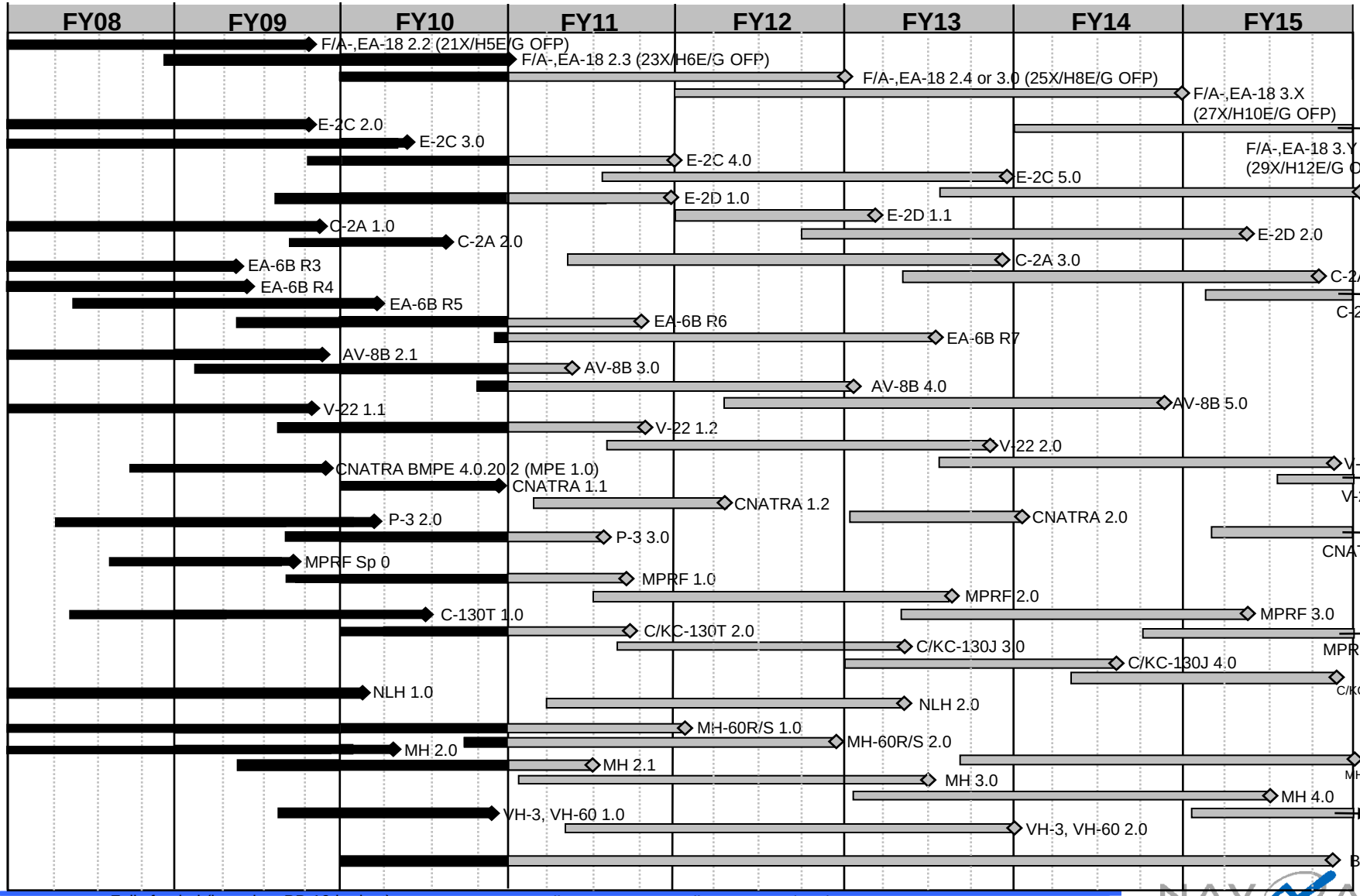
NAVAIR

Mission Planning

Current aircraft using JMPS

FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
F/A-18	MV-22	CNATRA	C-2A	SH-60B	MPRF	MH-60R/S	E-2D	KC-130J	BAMS
E-2C			EA-18G	SH-60F	AH-1Z	KC-130T	H-53K		
AV-8B				HH-60H	UH-1Y				
EA-6B				MH-53E					
S-3				CH-46E					
				CH-53D					
				CH-53E					
				AH-1W					
				UH-1N					
				VH-3					
				VH-60					
				P-3					
				C-130T					

JMPS MPE Development & IOCs



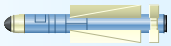
= Fully funded (based on PB-10 budget) =Funding status TBD until PR-11completed

As of 5-18-09

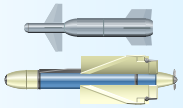
Weapons Revolution

1985 Mission Centric Operations

Rockets
TOW
Maverick



Rockeye
Bombs
LGB
Walleye



Penguin
Sea Skipper
Harpoon

HARM

AIM-9M Sidewinder

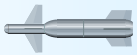
AIM-120 C5/7
Phoenix

Tomahawk

1995

Rockets
TOW
Maverick
Hellfire

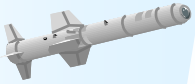
Rockeye
Bombs
LGB



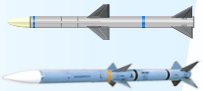
Penguin
Harpoon

HARM

SLAM



Sidewinder
Sparrow
AMRAAM
Phoenix

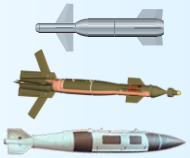


Tomahawk

2005 Network Centric Operations (GPS)

Rockets
TOW
Maverick
Hellfire

Rockeye
Bombs
LGB
EGB
JDAM



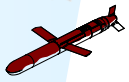
Harpoon

HARM

JSOW-A/C
SLAM-ER

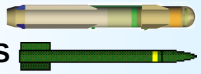
AIM-9X
AMRAAM

TACTOM (WDL)



2015 Enhanced NCO

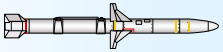
JAGM
APKWS



Rockeye
EGB
JDAM
SDB-II (WDL)

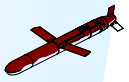
SLAM-ER
JASSM (WDL)

JSOW-A
JSOW-C (WDL)



AARGM

AIM-9X Blk II
AMRAAM

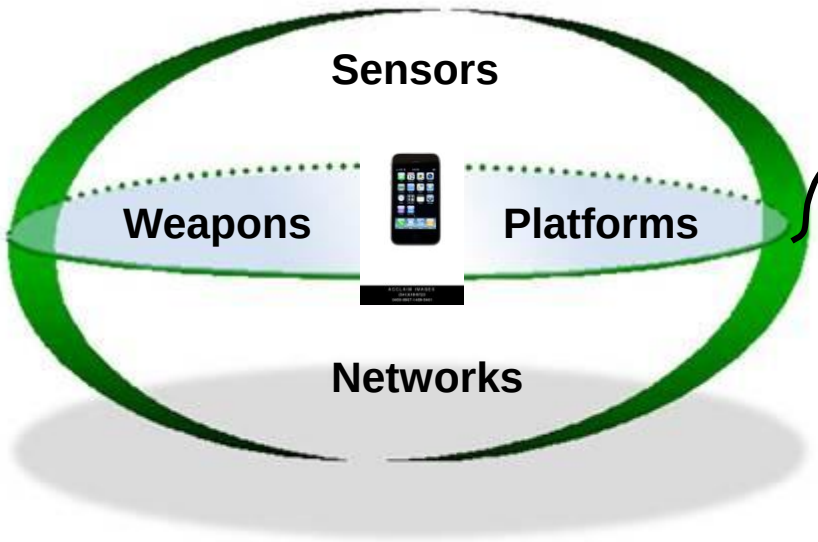


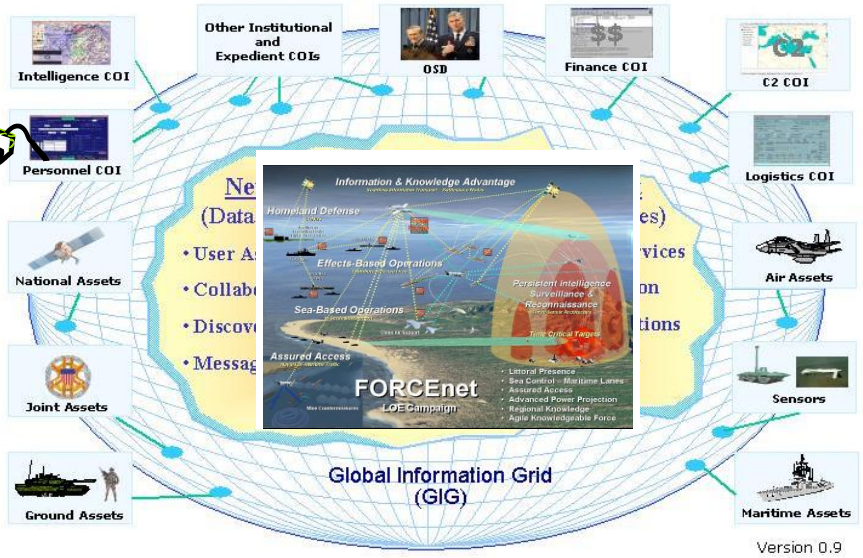
TACTOM (WDL)

The Next Revolution….

Mission Capability Focused: Speed, Agility, & Alignment

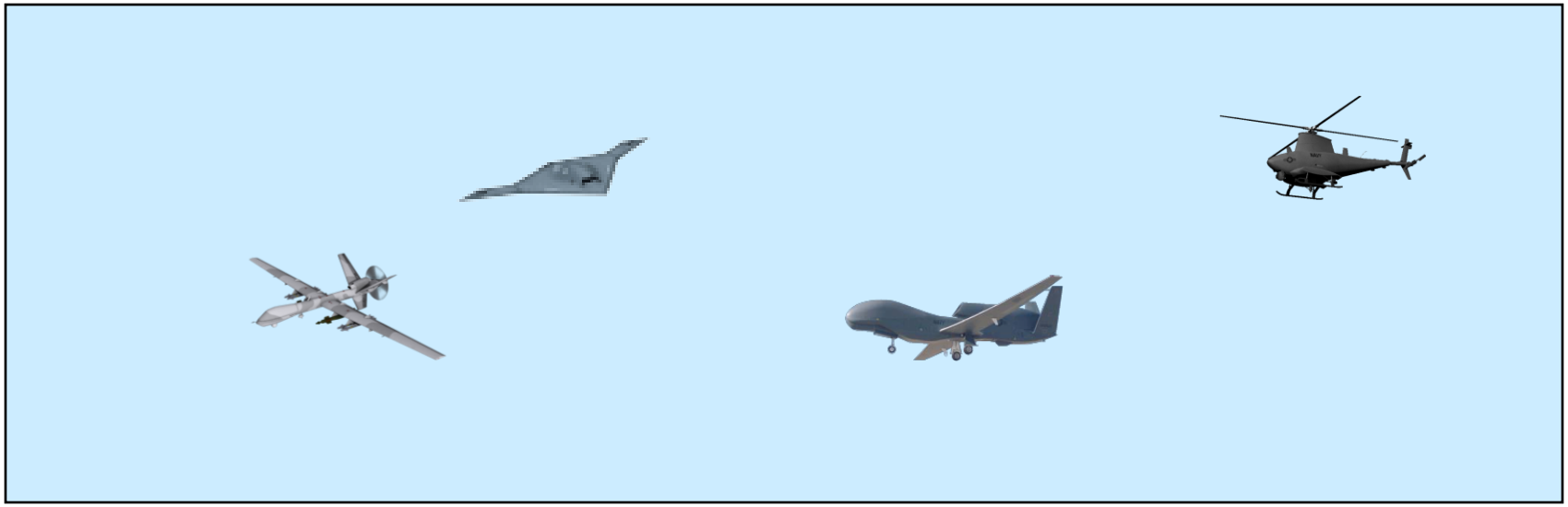
- **We must be networked and interoperable with joint forces (Machine-to-Machine)**
- **We must possess the ability to move tactical war fighting information seamlessly on/off the aircraft and across a networked force**
- **We must manage at the interface**





And the next…

UAV's are destined to become the next evolution of the world's air combat forces. The integration between manned and unmanned systems will be the first step in meeting those future systems, today.



Why?

- **Persistent ISR**
- **Small = Tactical OTH / Big = Strategic**
- **Reduces Footprint**
- **Efficient / More Affordable**

Unintended Consequence:

- **Stressing the Acquisition Process**
- **Easy to get our hands on technology + insatiable fleet thirst = Faster than the current process allows**

GPS Ephemeris & Ionospheric Correction Sharing Service (GEISS) for Precision Guided Munitions

PSTS 09

October 28, 2009

Alison Brown, Bruce Johnson, Joel Schuster, Charles Johnson

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Brian McAbee

Army Excalibur Program
Picatinny Arsenal, NJ
(973) 724-2152

What is the Problem?

- Small precision guided munitions need high accuracy GPS for guidance
- Munitions must be initialized prior to launch to allow rapid GPS acquisition
- GPS guided weapons only use satellites for navigation with pre-loaded NAV data
- Denial of GPS service at launch platform also limits PGM navigation performance

What is the Solution?

- Small Diameter Bomb (SDB)
  - Accuracy improved by use of Precision GPS Ephemeris uplink through Talon NAMATH TCS
  - F-15E platform provides Nav data locally
- GPS-Guided Projectiles
  - GPS Ionospheric & Ephemeris Sharing Service (GEISS) provide ionospheric and ephemeris data for all satellites in view

SDB Solution- ZDGPS

2 SOPS/GPSOC
- Generate differential corrections

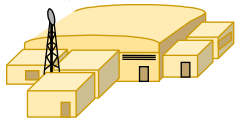
TN TCS

Talon NAMATH Tactical Control Station (TCS)
- Generate ZDGPS J28.2(12) msg
- Publish/Subscribe capability

SIPRNET (primary)

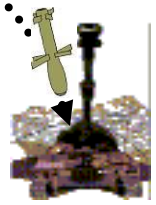
LINK 16

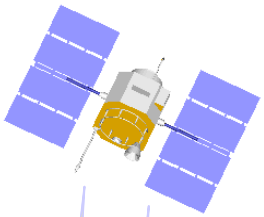
Combat Aircraft
- J28 msg from Data Link
- Push to Weapon



CAOC or C2 node
- Pull Nav Data
- Push to Data Link via JRE per JICO

Weapon
- Apply ZDGPS to GPS Signal
- Result: Precise Strike





Broadcast Nav Message

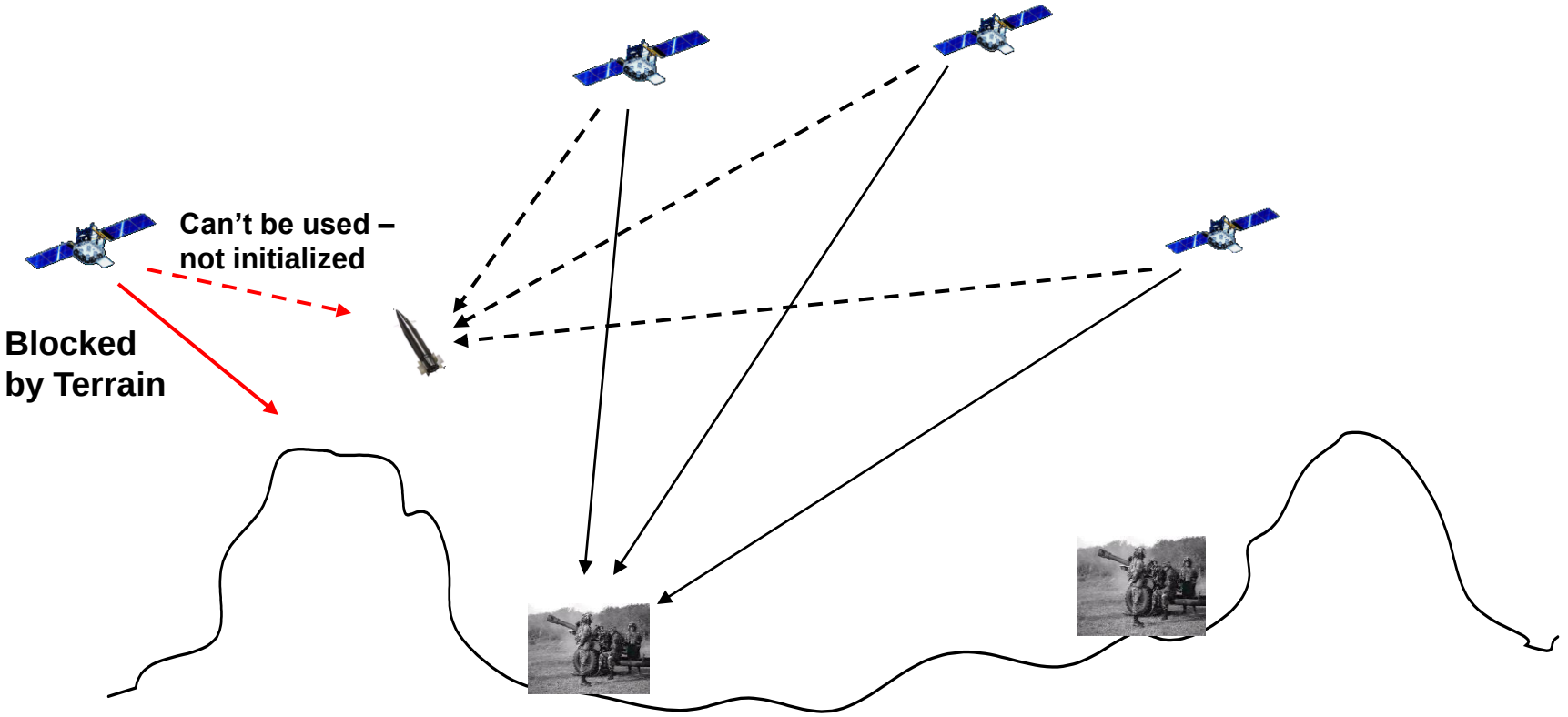
Ranging Data

GPS-Guided Munitions that Could Benefit from GEISS

- Munitions
  - Excalibur
  - M107, M549/A1, M795 (w/ PGK)
- Platforms
  - Paladin, M777A2, Digitized M119

PGM Performance

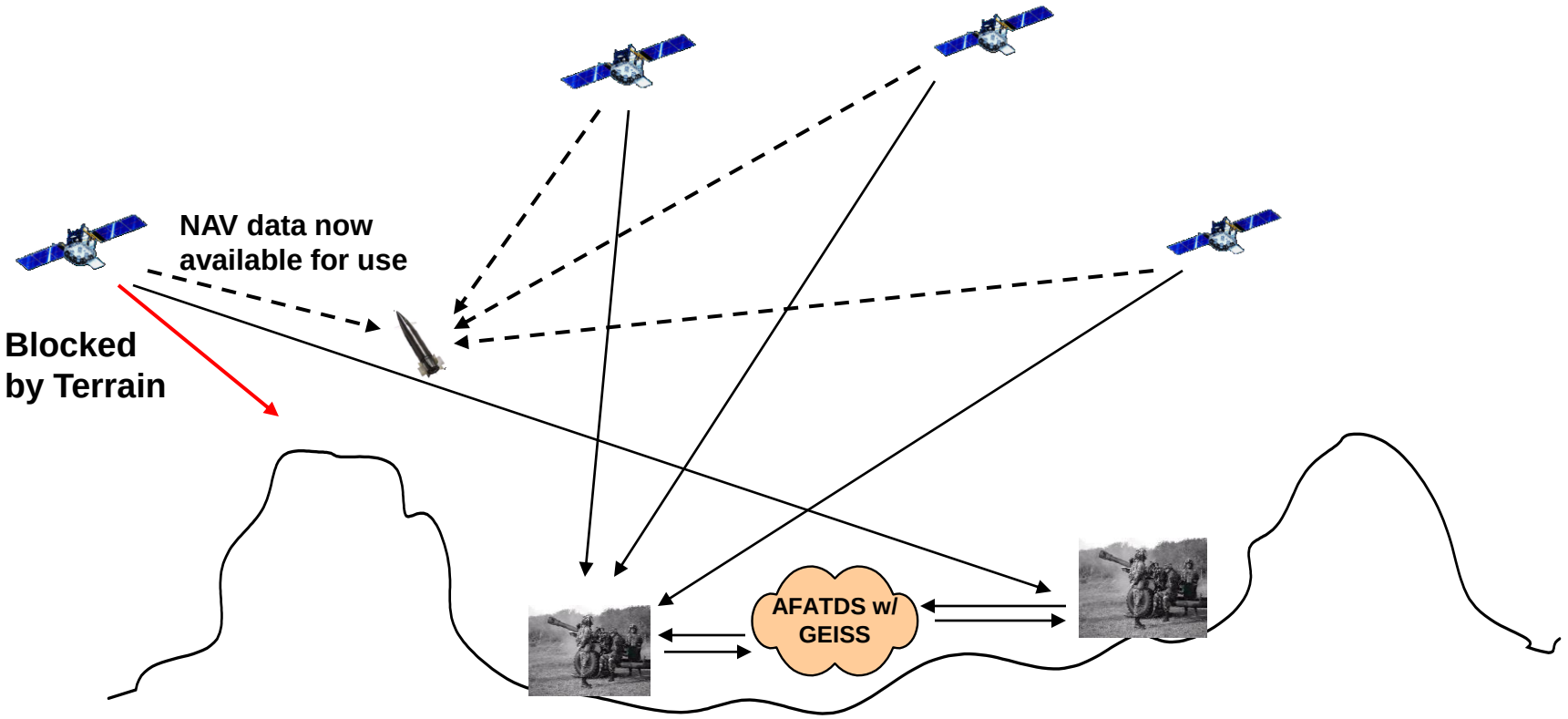
- Currently, munitions are initialized with navigation, ephemeris, and Iono data from each weapon platform (WP) GPS receiver, using only satellites visible to that platform
- In flight, navigation data is only used from "initialized" satellites, reducing accuracy



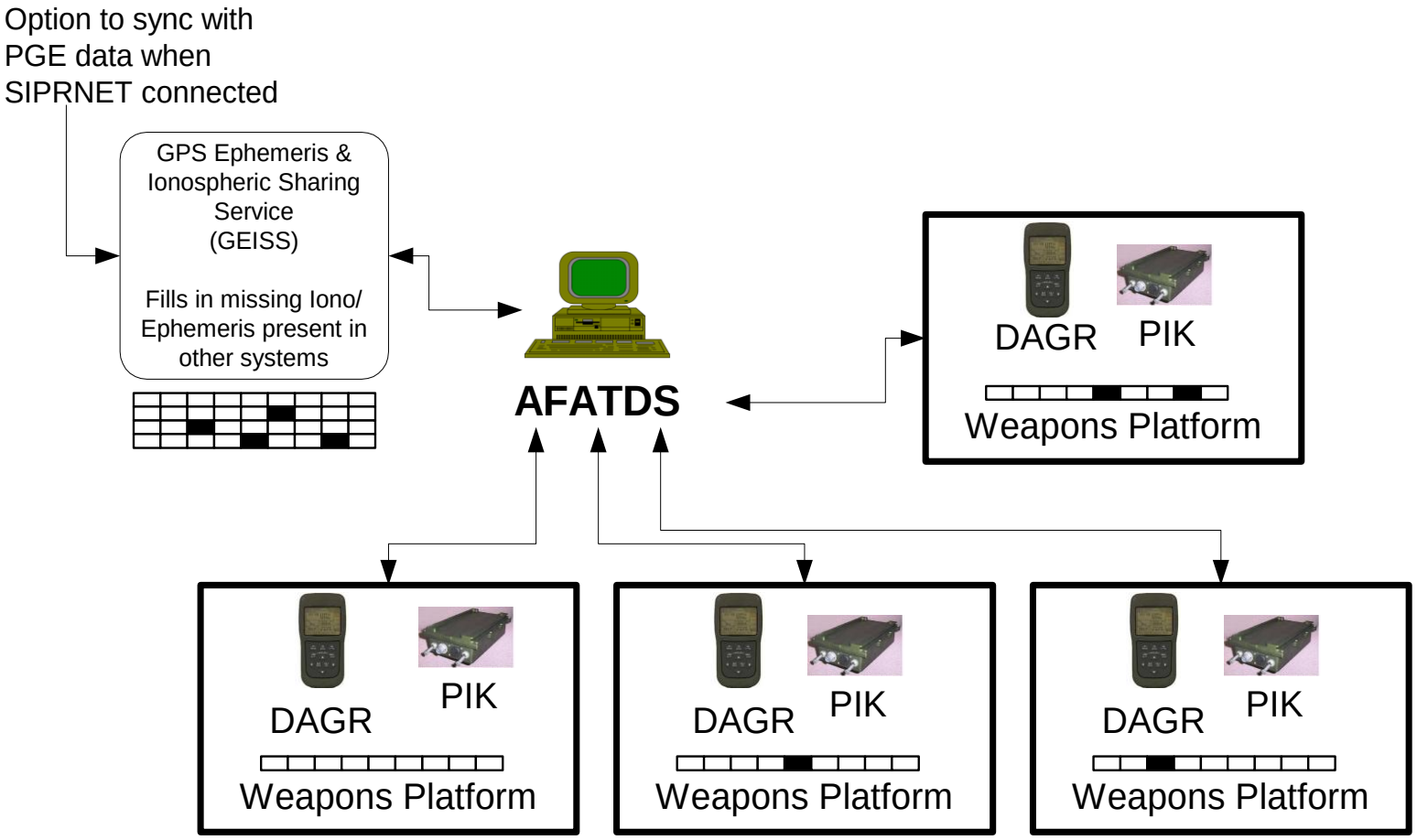
PGM Performance w/ GEISS

navsys CORPORATION

- GEISS "combines" satellite information from each WP GPS receiver and supplies the complete set to each WP through AFATDS for munitions initialization
- This allows even initially blocked satellites to be used in flight when available

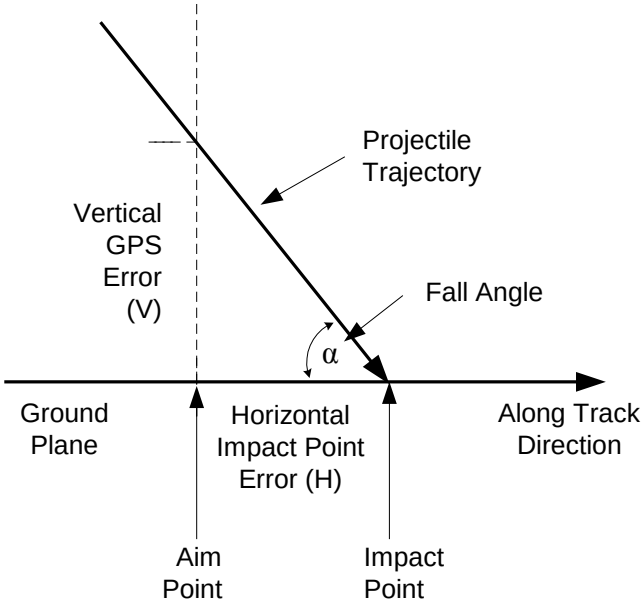


Network Sharing Integration w/ AFATDS



Note: TCM-Cannon personnel will make final determination on all GEISS, AFATDS, and Weapon Platform requirements

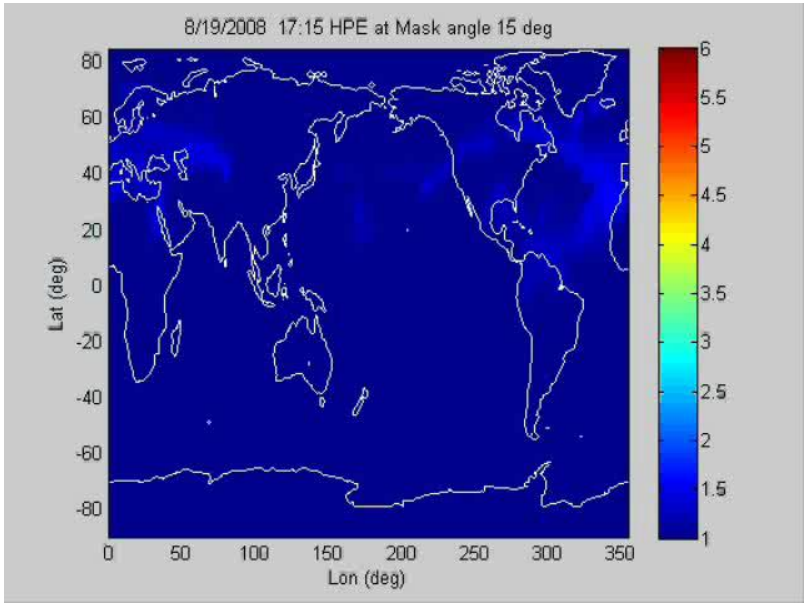
Aim Point Errors

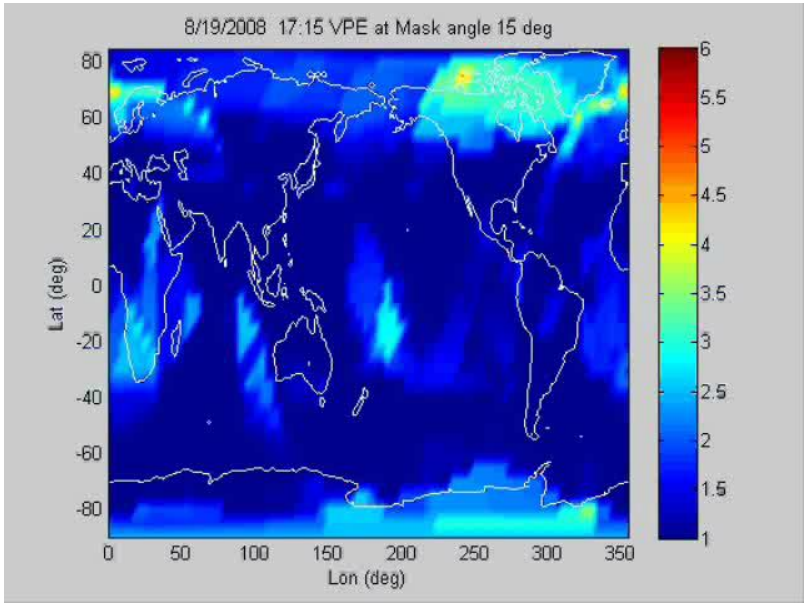


Vertical GPS errors map into along track aim point errors

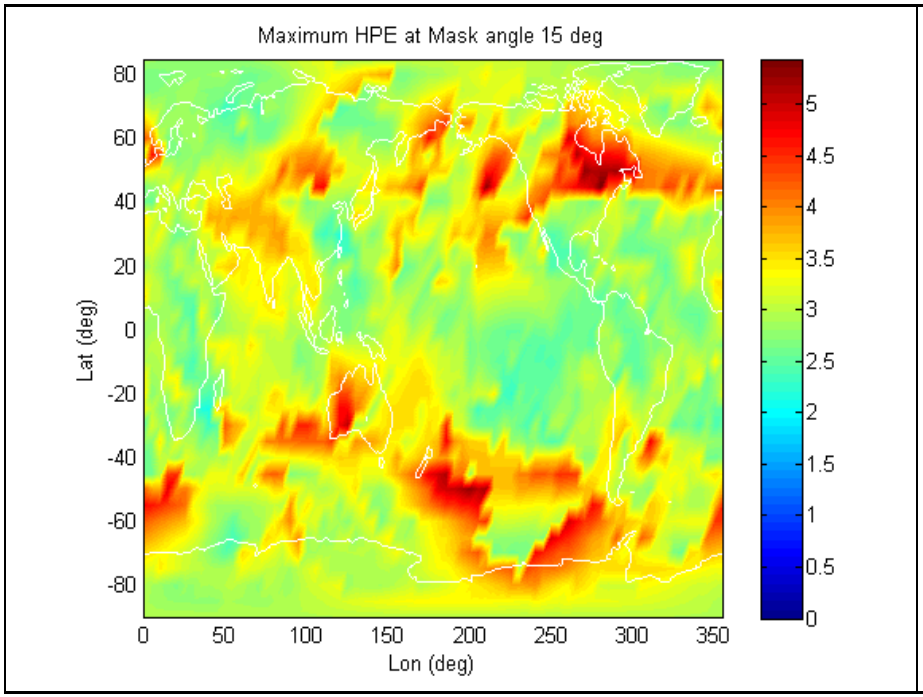
- Horizontal GPS bias errors map into horizontal aim point errors (earth referenced frame)
- Vertical GPS bias errors map into horizontal aim point errors through munition fall angle
  - Result in along track errors

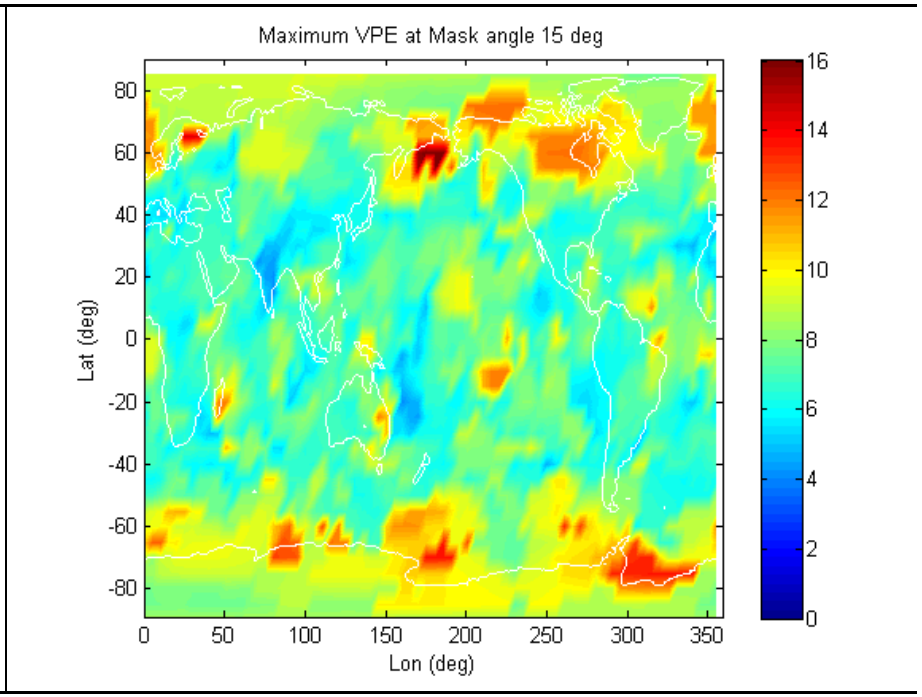
HPE and VPE
Antenna 15 Degree Mask Angle





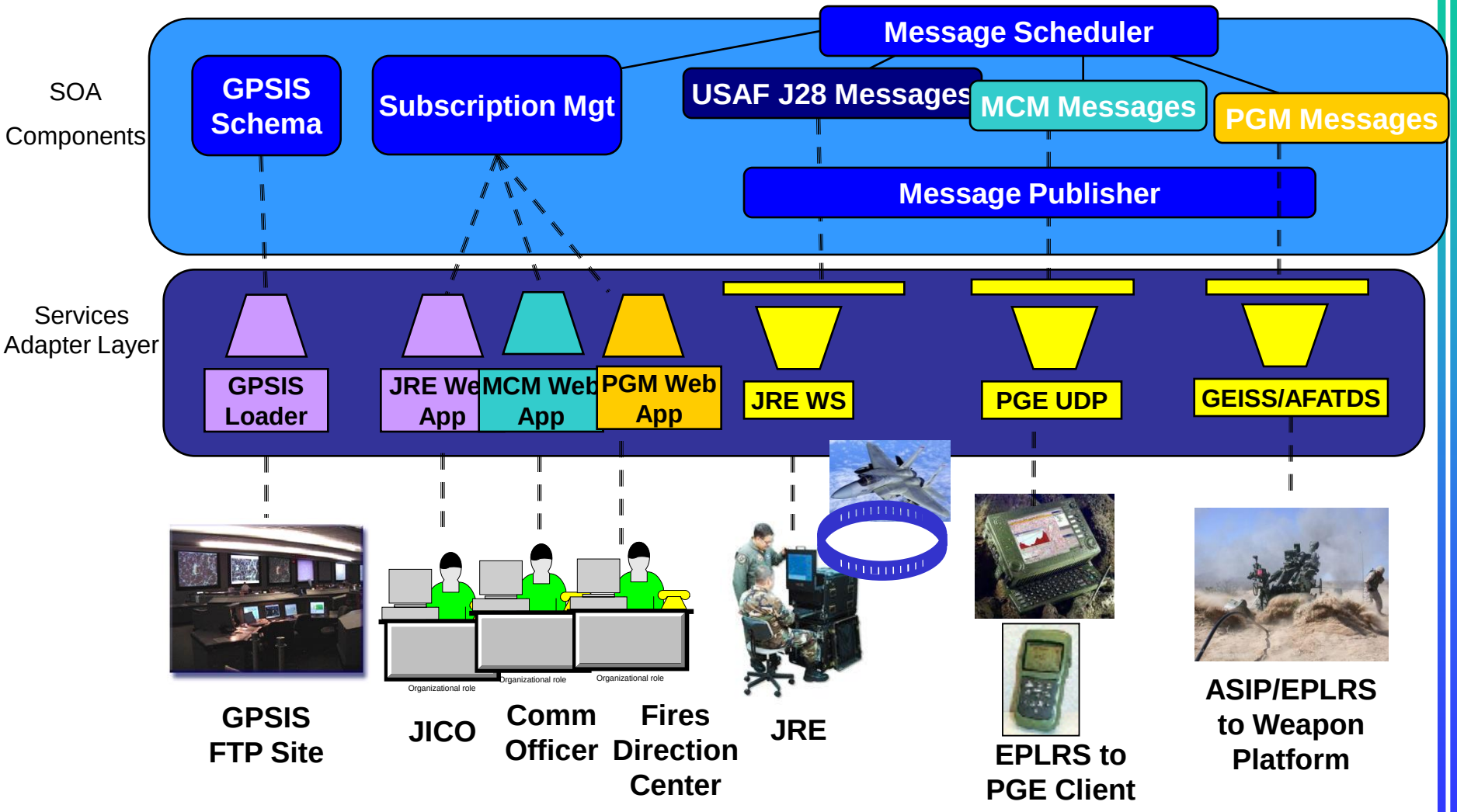
Maximum HPE and VPE Antenna 15 Degree Mask Angle





Note: Different meter error scale on side for HPE vs VPE

GEISS/PGE Integration Option



Scenarios

1. Open Sky (mask angle 5 deg, DAGR default)

   Baghdad 0500Z, 9 Sep 08

   HDOP = 0.71 VDOP= 0.84

2. Far Field Terrain (mask angle 15 deg)

   Baghdad 0500Z, 9 Sep 08

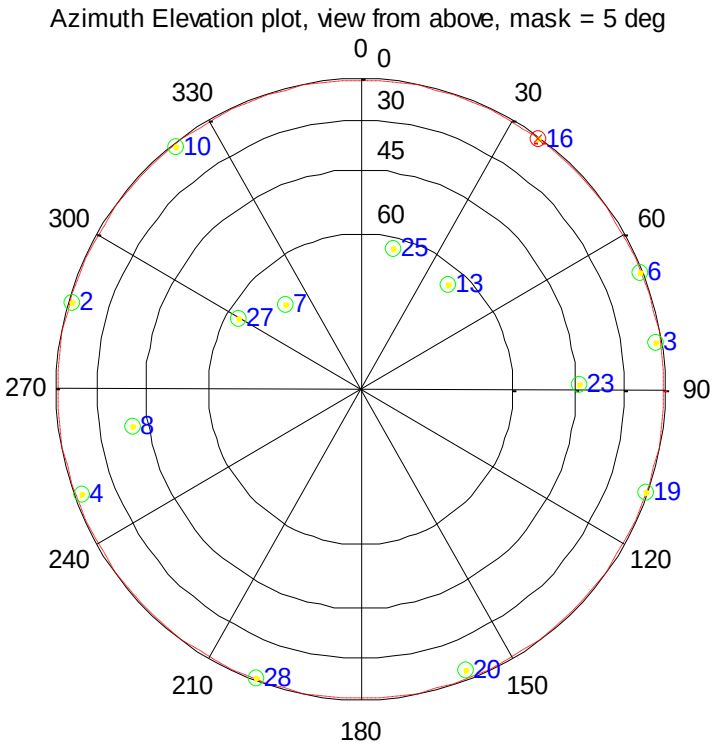
   HDOP = 5.64 VDOP= 9.61 VAPP

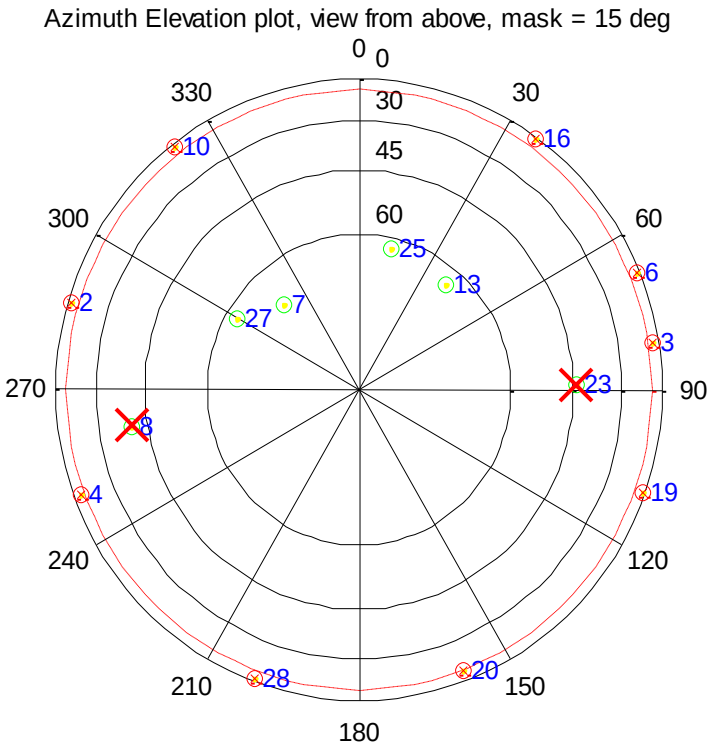
3. Hide Site (mask angle 40 deg) FOM > 1

   Baghdad 0500Z, 9 Sep 08

   HDOP = 0.71 VDOP= 0.84

Scenarios

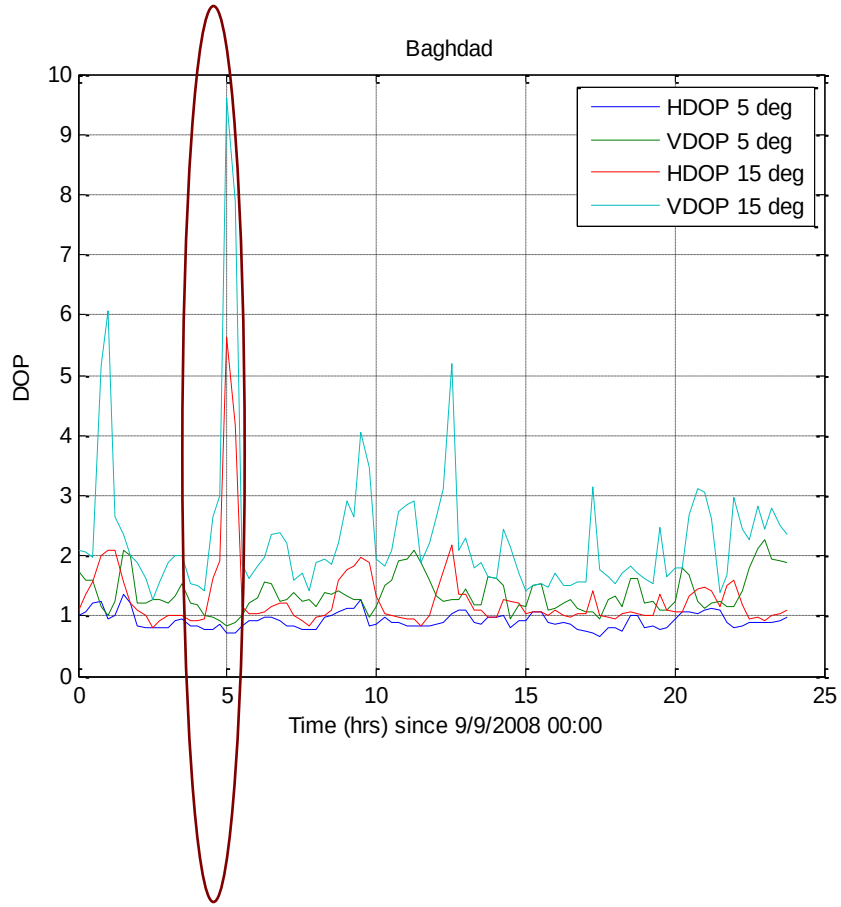




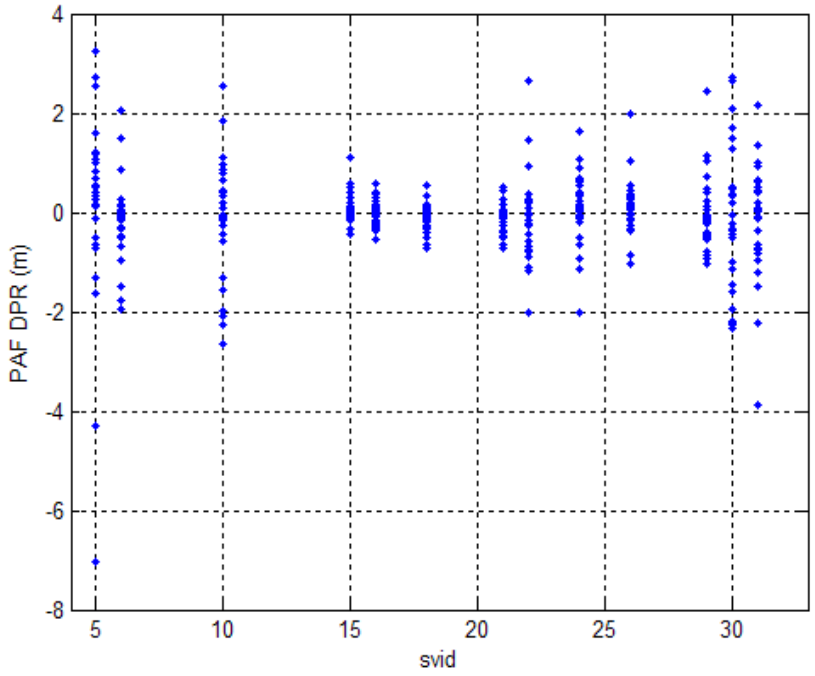
	Mask (degree)				
DOPs	0	5	10	15	20
HDOP	0.65	0.71	1.39	5.64	5.64
VDOP	0.79	0.84	1.72	9.61	9.61
GDOP	1.11	1.20	2.48	13.11	13.11

At mask angles >40 deg, FOM exceeds 1, resulting in no shot

Baghdad Performance Analysis



Time selected

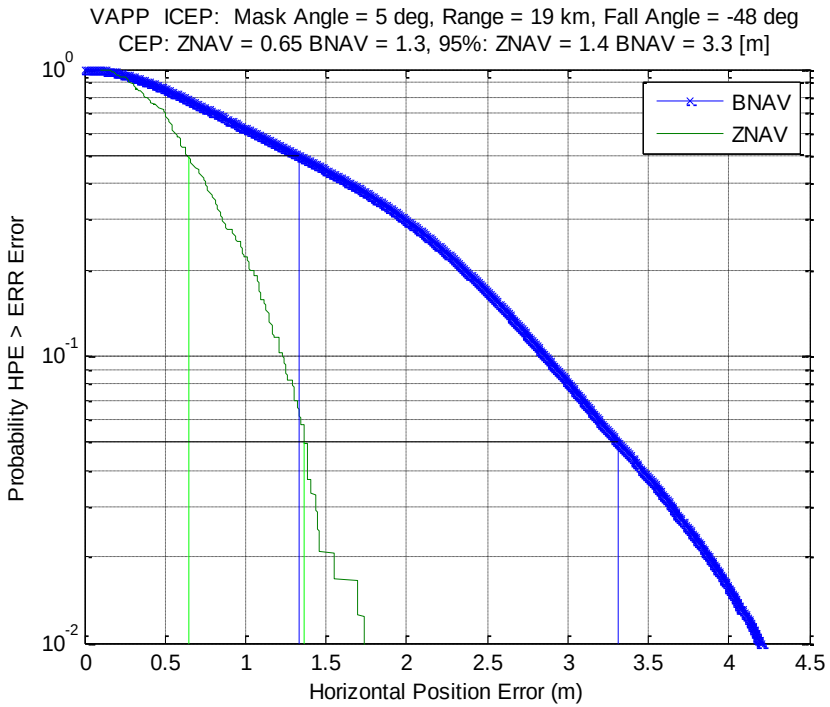


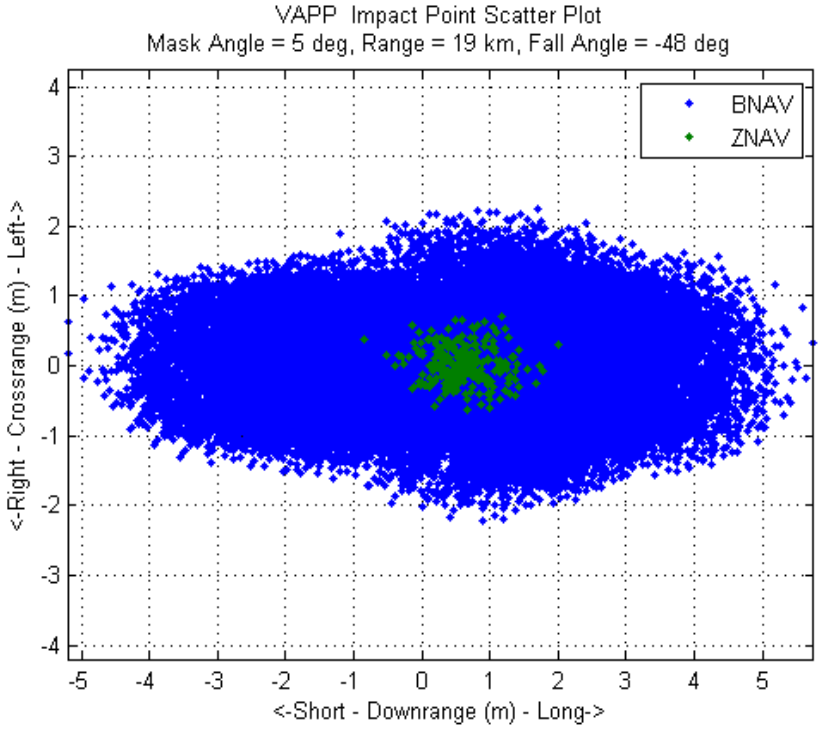
30 Day PAF errors for SVs in view at selected sidereal time

Final VAPP Simulations 5 Bags

navsys CORPORATION

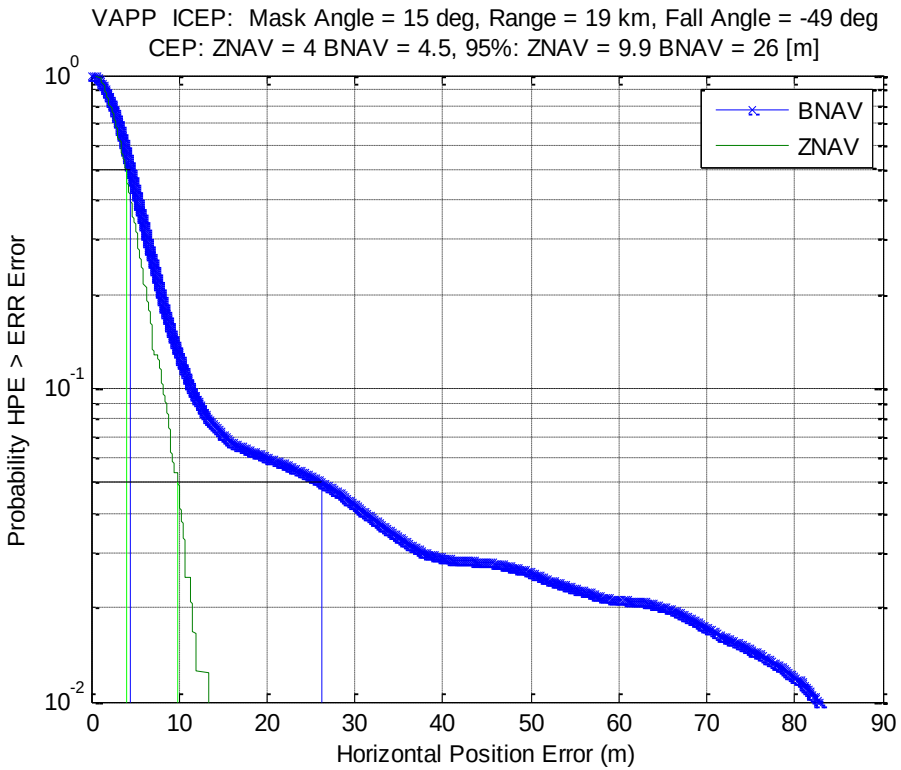
1. Local DAGR Open Sky ICEP & X/Y Plot
5 deg Mask, Baghdad (HDOP=0.71 VDOP=0.84)
Range: 19 km, Fall Angle: 48 deg

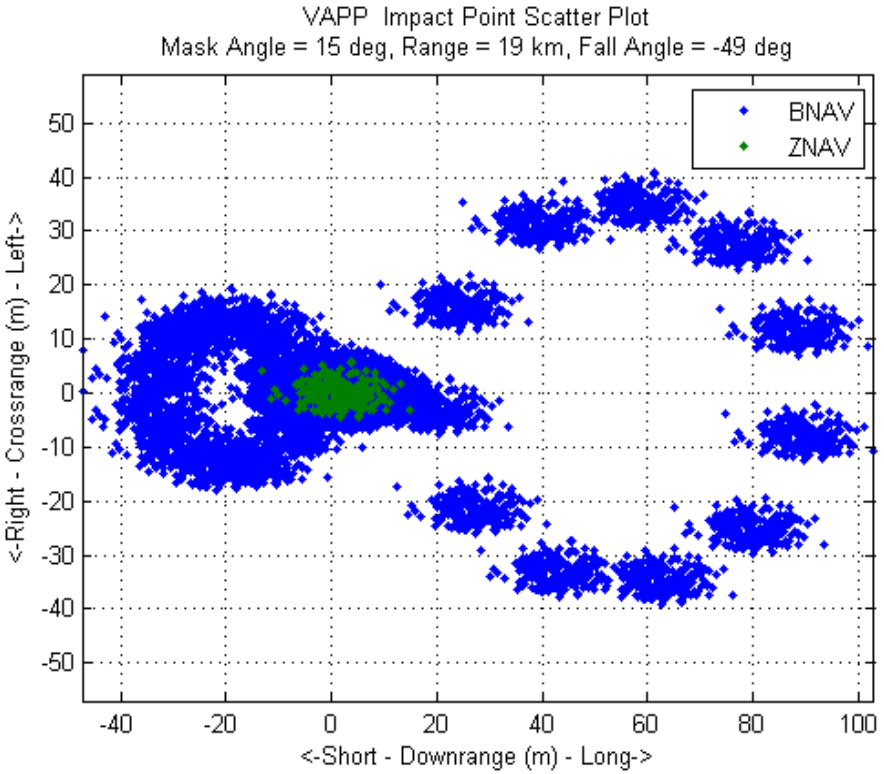




ZNAV CEP =	**0.65m**	**ZNAV 95% =**	**1.4m**
BNAV CEP =	**1.30m**	**BNAV 95% =**	**3.3m**

2. Local DAGR Open Sky ICEP & X/Y Plot
15 deg Mask, Baghdad (HDOP=5.6 VDOP=9.6)
Range: 19 km, Fall Angle: 48 deg





ZNAV CEP = 4.0 m **ZNAV 95% = 9.9 m**

BNAV CEP = 4.5 m **BNAV 95% = 26 m**

3. Mask Angle >40 Deg

- Without GEISS augmentation, FOM >1, no shot
- With GEISS aiding, effective mask angle reduced, allowing precision shot

GEISS Scenarios Summary

Scenario Mask angle	1. Open-Sky 5 deg	2. Far Field Terrain 15 deg	3. Hide Site 40 deg
Local DAGR	OK	Degraded	FOM > 1 No shot
PGE	High Precision	Degraded	FOM > 1 No shot
Iono & Ephemeris N/W Sharing	OK	OK	OK
PGE + Iono Sharing	High Precision	High Precision	High Precision

Conclusion

- GEISS network sharing can enhance number of satellites available for use by GPS-guided projectiles
- USA CECOM sponsoring GEISS research and demos for current and future platforms
- CERDEC/ARDEC providing technical oversight and guidance
- Integration with AFATDS will allow deployment to follow-on Excalibur and PGK projectiles with SW upgrades only

Capitalization on Investment
OSD Concerns

Keith Sanders

Precision Strike Technology Symposium 2009
October 28, 2009

Outline

- ✗ Capitalization on Investment
- ✓ OSD Concerns
  - regarding needed behavioral adjustments to the business of defense acquisition

Administration & Congressional Focus

Weapons System Acquisition Reform Act of 2009

- “to address unreasonable cost and schedule estimates, performance expectations, immature technologies and repeated program changes that have led to explosive cost growth and costly schedule delays” …. Senator McCain

- “limit cost overruns before they spiral out of control
- strengthen oversight and accountability by appointing officials who will ... closely monitor the weapons systems we are purchasing to ensure costs are controlled
- end conflicts of interest in the weapons acquisition process
- enhance competition…” …. President Obama

Limit cost growth of individual programs

Significant Changes

Weapons System Acquisition Reform Act

- Creates new positions with independent reporting authority
  - Director, Cost Assessment & Program Evaluation
    - Higher confidence in cost estimates
  - Director, DT&E and Director, Systems Engineering positions
    - Added discipline to understand risks and mature products in E&MD

- Revises Milestone certification requirements (10 USC 2366a and 2366b)
  - All major programs beyond Milestone B, regardless of maturity

Significant Changes (cont'd)

Department Business Practices

- Renewed emphasis on Fixed Price Type contracts
- Peer Reviews for major source selections
- Independent reviewers to judge readiness for OT
- Increased emphasis on technical maturity within a program phase
  - Risk mitigation
  - Reliability and maintainability

The Means to an End

- Government
  - Better defined requirements and acquisition plans
  - Better defined decision criteria
  - Better cost estimates and program funding

- Industry
  - Proposals with provisions for risks
    - Scope
    - Schedule
    - Cost

The Big Assumptions

- Companies will act responsibly, with expert understanding of the challenges, and propose programs whose schedule and cost anticipate all the appropriate, avoidable risks
- Companies will execute their contracts efficiently and effectively
- Government will act responsibly

The Alternatives?

- Proposals deemed unrealistic
- Source Selection recommendations reversed
- Source Selections reopened
- Programs in limbo awaiting a Milestone decision due to perceived risks, or inability to certify

OSD Concerns

- How long will it take for government and industry behaviors to adjust?
- How do we handle those programs that are already in the midst of source selection but operating with out-of-date expectations?
- How hard will those in denial fall given the scarcity of new program contracting opportunities?

Questions?

Comments?

Rebuttals?

Tactical Grenade-Extended Range (TGER)
A Precision Small Unit Tactical Weapon

Precision Strike Association
October 2009

Presented by Dr Ross Sanders
Chief Technical Analyst
MBDA Missile Systems
ross.sanders@mbda-us.com
818-300-3086

MBDA
MISSILE SYSTEMS

Operational Need

- Small tactical units need a precise, rapid response, extended range weapon for employment at the discretion of the on-site commander
  - Troops deployed in urban environments
  - Fire Team, Squad, Platoon, Company
- Small hand launched, extended range weapon provides a solution
- Potential applications
  - Counter sniper weapon
  - Targets beyond effective small arms range
  - Targets obscured by walls, buildings, or ditches
  - Key positions / targets posing an immediate threat
    - Machine guns, personnel, cars, trucks, tactical vehicles, crew served weapons
  - Destruction of IED weapon
- This requirement is now showing up with SOCOM as LMAMS (Lethal Miniature Aerial Munition System)

Tactical Grenade Extended Range

- Hand Launched, extended range weapon
  - 3 pound fly away weight
  - 1 pound warhead
  - Inflatable wing
  - 24 inch wingspan
  - 2 inch diameter fuselage, 12 inch long
  - Vertical stabilizer 3 inch
  - Dual 40 mm grenade warhead
  - Electronic Safe and Arm Fuze
- Containerized for transport
  - 4 inch diameter by 15 inch long sealed canister
  - 4 pound shipping weight

TGER Vehicle

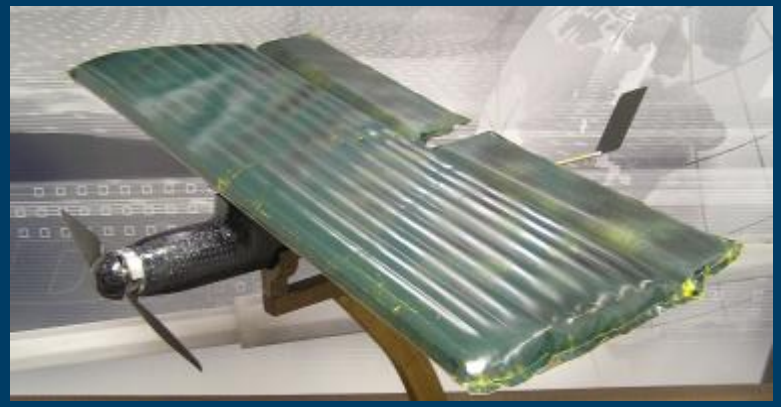
Currently Developed TGER Components

Inflatable Wing

Tiny Guidance Engine

Ground Control

Data Link



TGER Weapon

Motor

GPS

Warhead

MBDA MISSILE SYSTEMS

Company Information

MBDA Incorporated,
Westlake Division

- Westlake Village, California
  - US Arm of MBDA in Europe
- Expertise in guided weapon technology
  - Precision air to ground weapons
  - Weapon control data links
  - Laser guided rockets
  - Small Diameter Bomb wing kit

MBDA MISSILE SYSTEMS

Company Information

Continental Controls and Design

- Huntington Beach, California
  - Active since 1997
  - CCD is a small business

Locust ISR Vehicle

- Expertise in Guidance, Navigation and Control technology
- CCD's mission
  - Design and support innovative, rapid response solutions by employing miniature instruments and UAV autopilot

Company Information

DSE, Inc

- Tampa, Florida
  - Production facility in Gaffney, South Carolina
- Primary Expertise
  - Currently one of two existing prime contractors to U.S. Army for 40mm ammunition
- Major Products
  - 40mm to 155mm munitions
    - 40mm High Velocity Rounds
    - 40mm Low Velocity Rounds

M430 40mm Grenade Round

Company Information

ILC Dover

- Location
  - Fredricka, Delaware

ILC Inflatable UAV Wing

- Primary Expertise
  - Inflatable design and advanced materials development
  - Over 30 years experience in design and manufacture of inflatable UAV wings
  - Provides space suits for space shuttle crews

MBDA MISSILE SYSTEMS

ILC DOVER creating what's next

TGER Development

Background

- TGER History
  - Derivative of Locust ISR vehicle
  - Locust program started in December 2004 by CCD
    - 18 systems delivered to the Army
    - Currently being operationally evaluated at Ft Huachuca
    - Airframe has flown > 750 flights
  - Locust avionics suite integrated into TGER vehicle
    - Camera, GPS, data link, autopilot, flight instruments, ground station
    - Capable of geo-locating points within the video field of view

Locust ISR Vehicle

TGER System Characteristics

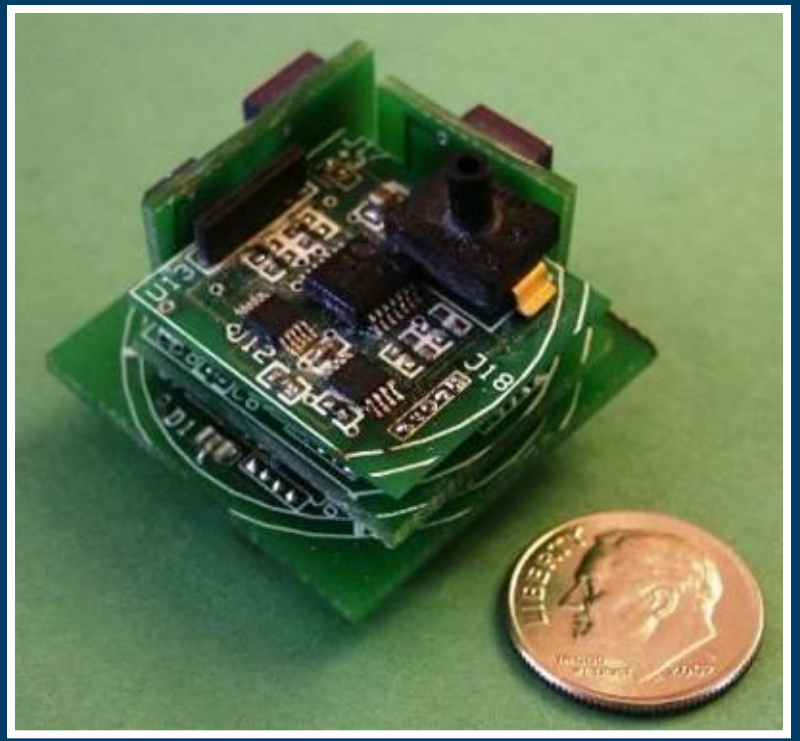
- Autonomous flight
  - Autopilot and inertial instruments fly the vehicle
  - Joystick operation supported but not desired for tactical use
- Flight Performance
  - Electric motor propulsion
  - Speed: 50 mph cruise, 30 mph loiter, 80 mph dive
  - Altitude 20,000 feet MSL capable
  - Typical flyout altitude 400 feet AGL
  - 12 -15 minute flight time
  - 2 mile operational range
- GPS waypoint programmable
  - Enables attack of targets behind buildings and walls
- Two way digital data link
- On-board terminal guidance
  - Man in the loop aim point selection
  - Attacks fixed and moving targets

TGER Concept of Operation

- Pre-Launch
  - Target located by troops on the ground or overhead assets
  - Launch weapon from concealment / defilade
    - Launch at best heading for launch condition
- Post Launch
  - Weapon automatically follows waypoints to the target area
  - Video image down linked to operator
- End game capability
  - Loiter while look over target area
    - Allows attack of targets that are obscured or moved after launch
  - Mission abort
- Terminal guidance
  - Operator selects target aim point on control station touch screen
  - Terminal guidance engages and guides weapon to the target
  - Wave off and target reacquire

Enabling Technologies - TGE

- Tiny Guidance Engine (TGE) provides
  - 3 Axis IMU
    - MEMS rate gyros and accelerometers
  - Magnetometer and pressure sensor
  - GPS Navigation interface
  - Full GPS / INS estimation filter
  - 13 grams, 1 cubic inch
- TGE designed and produced by CCD
- TGE tested for environments
  - Operates from -30° C to +50° C
  - Survives Mil Std 810 Minimum Integrity Vibration for fixed wing aircraft and helicopters
    - 1 hour each axis



Tiny Guidance Engine
(without GPS)

Enabling Technologies - Ground Control Station

- Locust ground control station fully developed and operational
- Hosted on standard laptop
  - Compatible with existing ground stations like Rover
- Ground control station provides
  - Point and click functionality
    - Compatible with DTED and Falcon View map data
  - Waypoints and target location uploaded to weapon
  - Real time video display for target selection
  - Vehicle status
    - Remaining flight time
    - Arming status

TGER Ground Station Display

CONTINENTAL Controls & Design

MBDA MISSILE SYSTEMS

Enabling Technologies – Data Link

- CCD currently completing a Phase II SBIR for upgrading the Locust from analog to digital data link
  - Locust data link is a direct application for use in TGER
- Digital data link
  - Two way data link uses 802.11g communications format (2.4 GHz)
    - Video and status down, operator commands up
  - 1 watt power amplifier in vehicle and ground station
  - Operational range of 2 miles
- Data link antenna
  - Vehicle: 2 inch monopole
  - Ground Station: 6 inch monopole
- CCD proprietary software minimizes contention with other 802.11 users
  - Allows data link use in urban areas

TGER Data Link Card

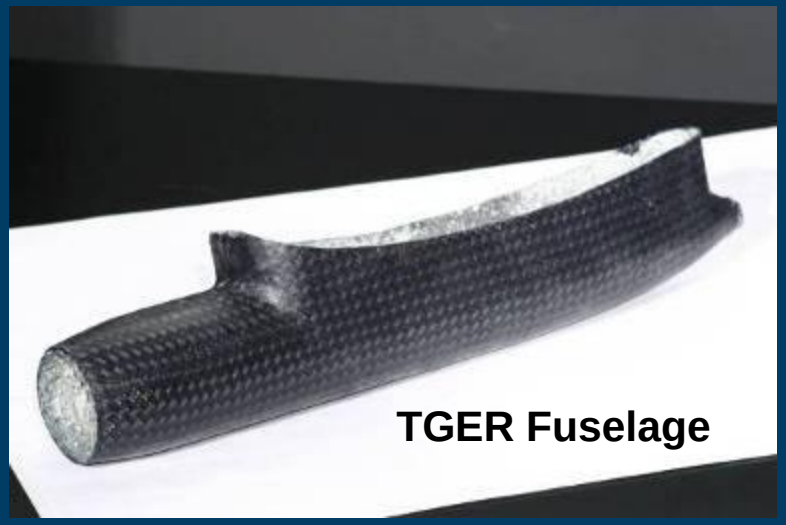
Enabling Technologies – Camera

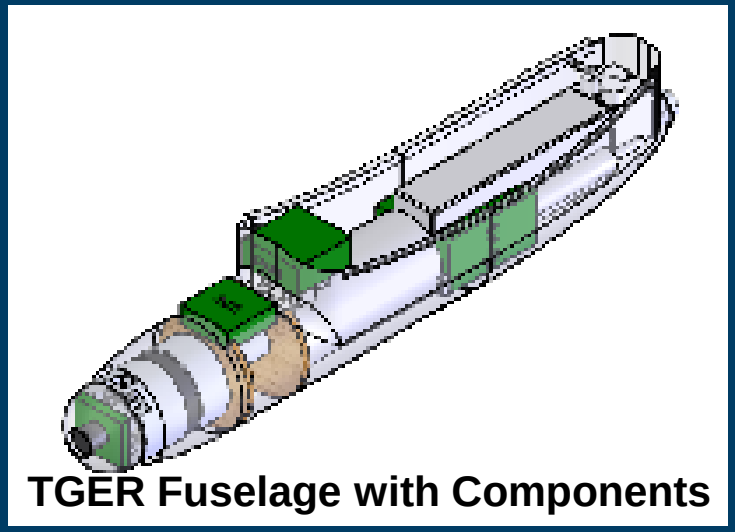
- TGER development uses digital CMOS visible light camera
  - 5 mega pixel resolution
  - Low cost, commercially available
  - Can be upgraded for new technology
- TGER can operate with IR camera for night operation
  - IR useful for detection of obscured human targets
  - Higher cost than visible light camera
- Locust has flown with the DRS E3500S IR camera
  - 3 ounce weight
  - 8-12 µm waveband

DRS E3500S IR Camera

Enabling Technologies - Fuselage

- Second generation TGER fuselage has been designed and fabricated
  - Lightweight, one piece, carbon fiber fuselage
  - Wing bonds directly to fuselage
  - Open top for installation of avionics
- Flight tests
  - Verification flight tests of the TGER vehicle with new wing, motor, and fuselage conducted in mid 2009

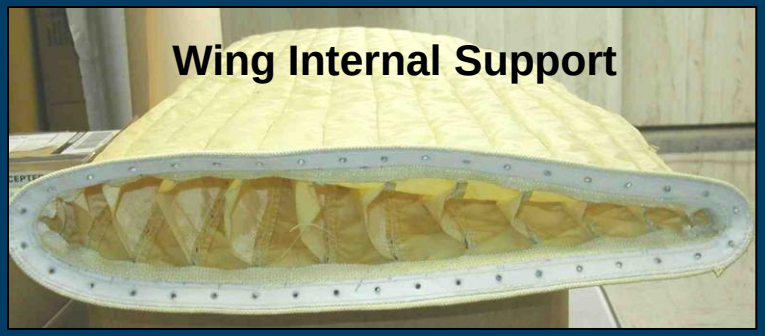

TGER Fuselage

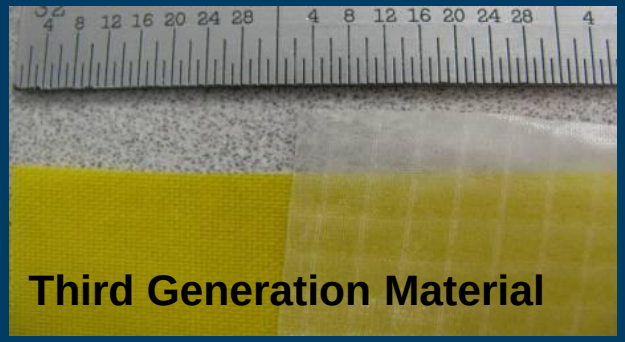

TGER Fuselage with Components

MBDA MISSILE SYSTEMS

Enabling Technologies - Inflatable Wing

- High lift wing provides
  - Variable flight speed
    - High speed ingress to target area
    - Slow loiter for aimpoint selection
    - Dash speed for terminal attack
  - Large payload capacity
    - Carry batteries and warhead
- Fabricated from coated, commercially available sail cloth material
    - Light weight
    - Folds easily for canister storage
    - Translucent material for stealthy operation
- Life vest type CO_2 inflation system
  - Over pressure relief valve for operation at different altitudes





MBDA MISSILE SYSTEMS

ILC DOVER creating what's next

Enabling Technologies - Inflatable Wing

- TGER launch video with first generation inflatable wing

Click Video to Play

Terminal Guidance Mode

- TGER avionics and flight algorithms support GPS only terminal attack

GPS Only Attack Video

Click Video to Play

MBDA MISSILE SYSTEMS

Terminal Guidance Mode

- TGER uses Man-in-the-Loop Corrected Impact Point GPS Terminal Guidance (referred to as Nudge Guidance)
  - Vehicle uses GPS coordinates of selected target to initiate terminal attack
  - Projected impact point displayed on the ground station video screen
    - System errors cause impact point to drift off the target
  - Operator touches desired impact point on the video screen
    - New input corrects errors in the target coordinates
  - Successive inputs allow the system to auto correct errors and to track moving targets
- Integration and flight tests of Nudge Guidance are currently being conducted
  - Nudge Guidance is working
  - Conducting further tests to accommodate user requirements and feedback

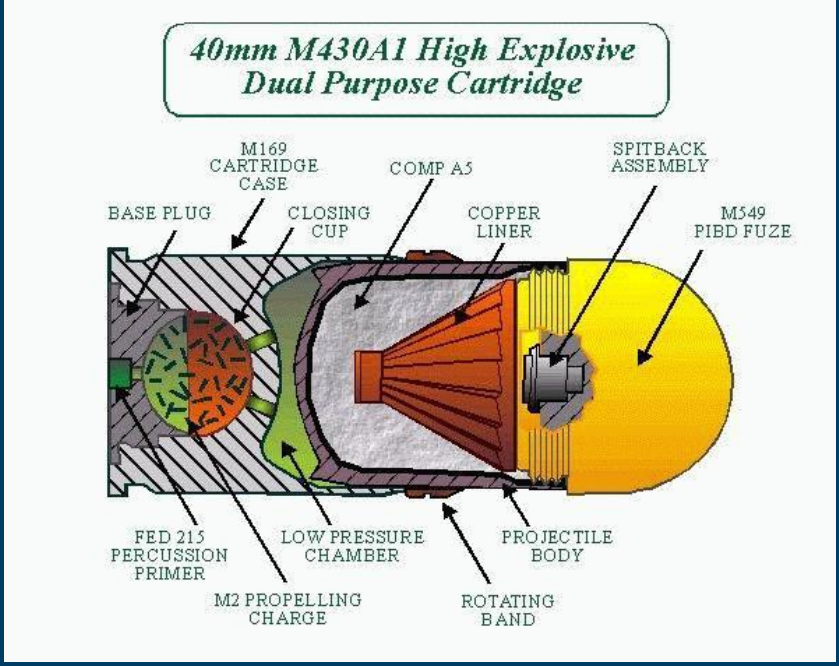
Terminal Guidance Mode

- Features of Nudge Guidance
  - Takes advantage of the high quality human tracking ability
  - Avoids loss of track associated with auto trackers when operating in
    - High clutter regions
    - Urban environments
  - Enables terminal attack on targets that an auto tracker can not lock on to
    - Targets under foliage
    - Individual person in a moving group
    - Selected point on a large featureless region
  - Remains operational in a GPS denied environment
    - TGER vehicle capable of inertially guided flight using INS and magnetometer without GPS
    - TGER can fly heading hold to the target area

Warhead

- Warhead concept based on existing M430 40mm grenade round
  - High Explosive – Dual Purpose impact rounds
  - Designed to penetrate 2” of steel armor
  - Inflict personnel casualties, 5 meter effective radius
  - DSE’s M430 production rate for first quarter 09 > 650,000

M430A1 – 40mm HEDP

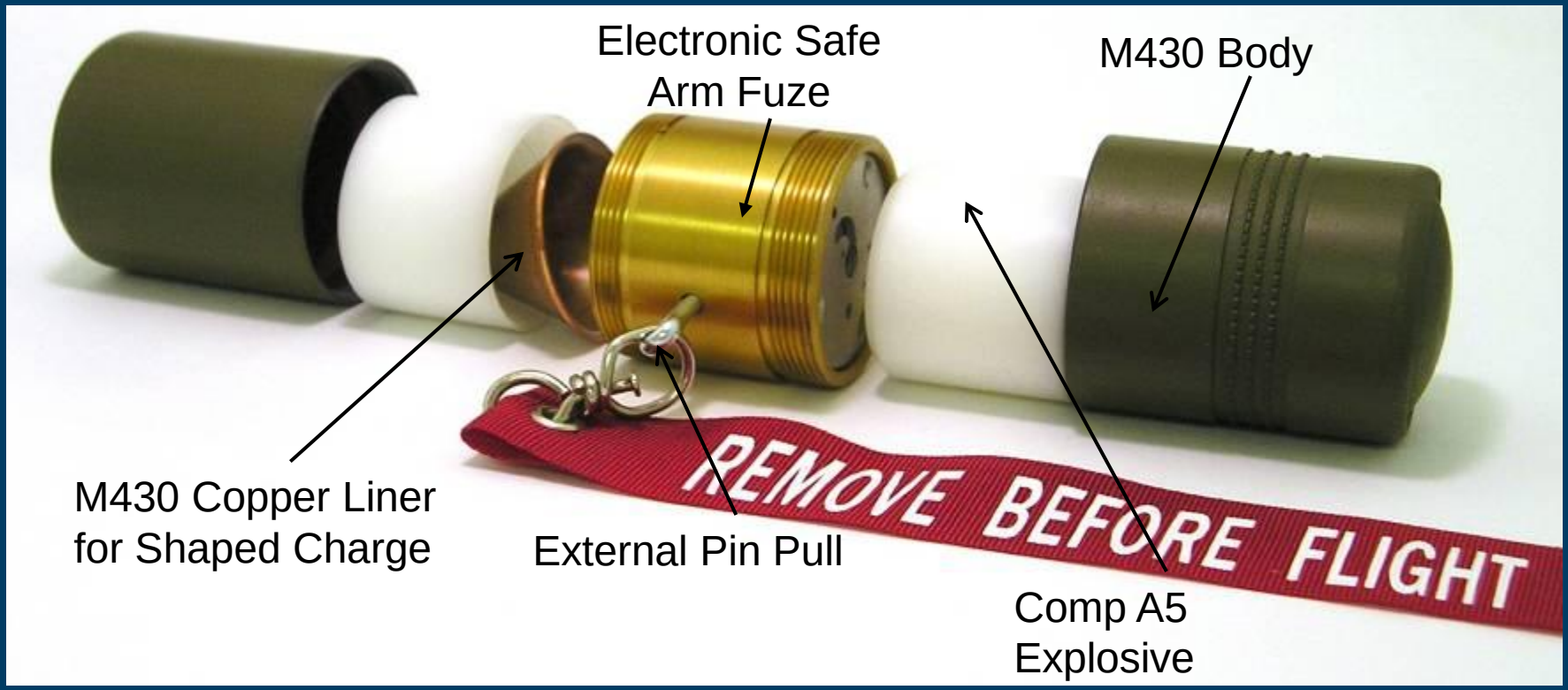


MBDA MISSILE SYSTEMS

DSE, INC.

Warhead

- Shaped Charge/Frag Configuration



Warhead

- Design and test of a lethal payload is ongoing
  - Dual purpose anti-personnel, light armor penetrating
- Single, double, and triple configurations of M430 bodies
  - Armor Penetrating
  - Fragmentation
- Seven 40 mm configurations tested at DSE's facility in Gaffney, SC
- Arena tests at Redstone Arsenal to determine effectiveness
  - Conducted September 2009
  - Four configurations
    - 2 Fragmentation/Shaped Charge
    - 1 Fragmentation/Fragmentation
    - 1 Fragmentation/Fragmentation/Fragmentation
- Test data currently being analyzed by Redstone
  - Test report expected before the end of the year

Warhead

DSE Warhead Test Set Up at Gaffney, SC

Click Video to Play

DSE, INC.

MBDA MISSILE SYSTEMS

Warhead

- Warhead arena test setup at Redstone Arsenal

Warhead

- Side view of warhead placement inside arena

Warhead

- Top view of warhead placement inside the arena

Warhead

- Witness panels after warhead detonation

Warhead

- Witness panels after warhead detonation

Safe and Arm Fuze

- Since TGER is a hand deployed weapon special safety concerns are applicable
- The desire is to use an ESAF (Electronic Safe and Arm Fuze) for TGER
- Two options available for ESAF
  - Picatinny Arsenal has a TRL 4 ESAF designed for lethal UAVs
  - TRL 9 ESAF is available from a commercial company
- Multiple arming environments will be utilized to fully arm the warhead
  - Relying on the Army to drive the final ESAF operation
    - Manual, external pin pull
    - Safety environments available
      - Distance from launch site
      - Altitude above ground
      - Velocity
    - Final arming step will be operator selection of target on the video screen

Development Program

Proposed TGER Development Program

Quick Reaction Program

- Development is focused on a Quick Reaction Program
  - MBDA – System integrator
  - CCD – Avionics and guidance
  - DSE – Warhead
  - ILC Dover – Inflatable wings
- Program can deliver 40 Quick Reaction weapons within 6 months
  - Weapons will be end to end flight worthy
    - Ground station
    - Warhead
    - Safe and Arm Fuze
    - Nudge Guidance

Contact Information

- Program

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  Chief Technical Analyst

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Precision Strike Technology Symposium

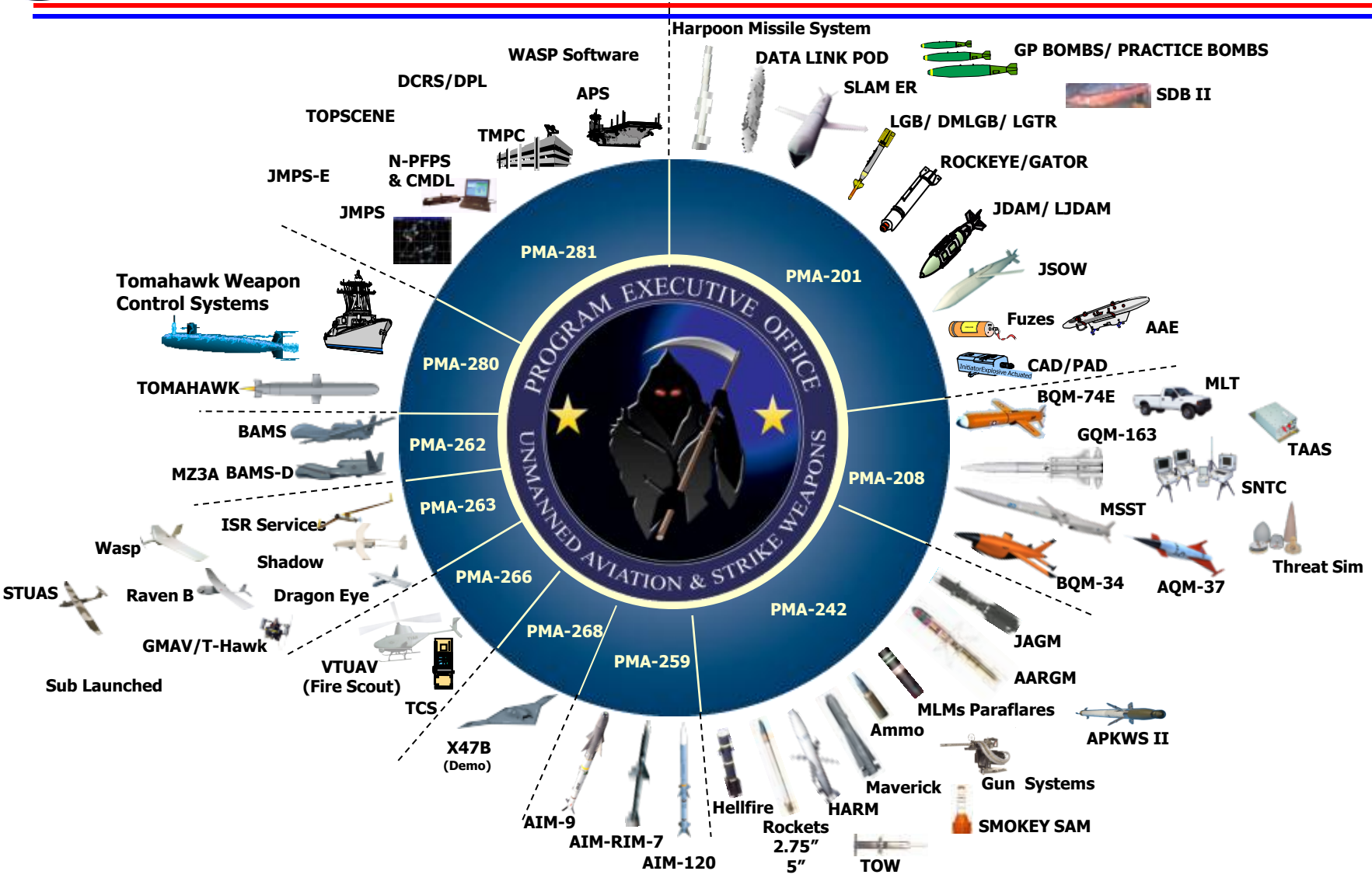
Navy Weapons Development
&
Network Enabled Weapons

October 27, 2009

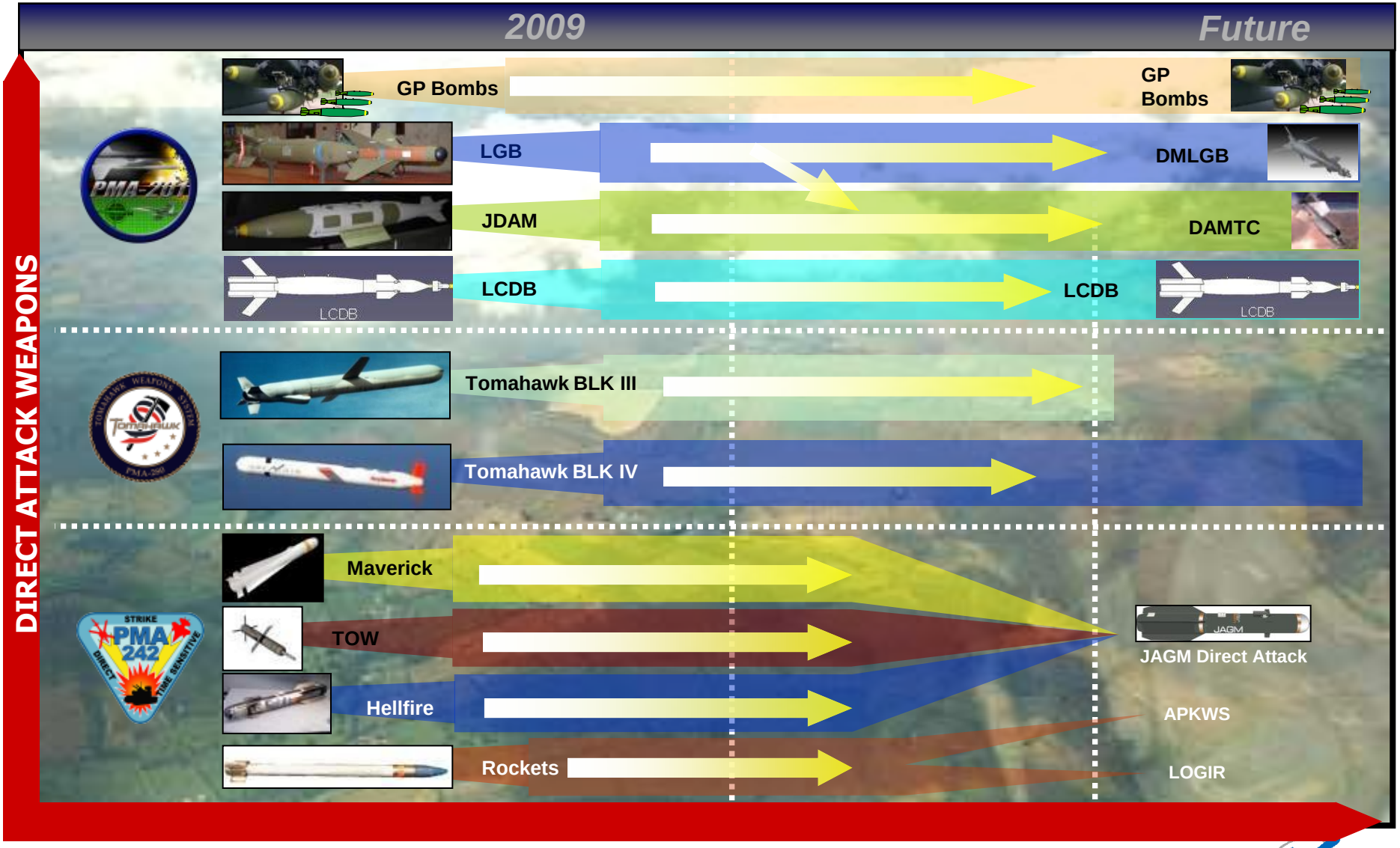
RADM Bill Shannon
Program Executive Officer
Unmanned Aviation and Strike Weapons

NAVAIR

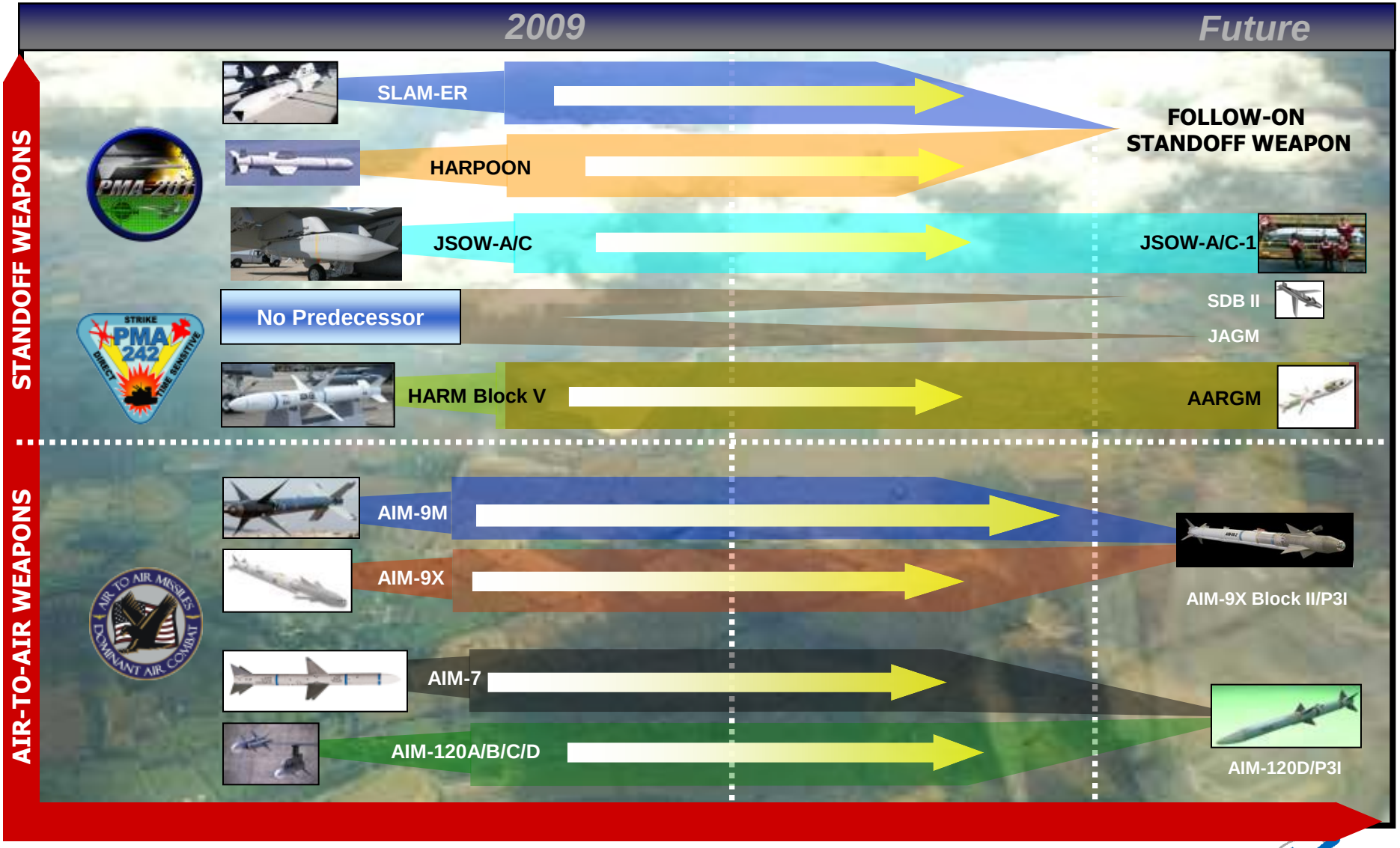
PEO(U&W) Overall Portfolio



Strike Weapons Family of Systems
Direct Attack Weapons



Strike Weapons Family of Systems
Standoff Weapons / Air-to-Air Weapons



Advanced Precision Kill Weapon System II (APKWS II)

Capability

- APKWS is a Semi-Active Laser (SAL) guidance kit added to current 2.75-inch rocket motors and warheads
- Low cost, low collateral damage and minimal integration
- Accurate: 80% within 2 meters of laser spot
- Increased Kills/Sortie: 14 - 38 per sortie
- Status: Mature design, Integrated Test begins November 2009
- Initial Operational Capability 3rd Qtr FY11

Low Cost, High Precision, Low Collateral Damage for Irregular Warfare

Advanced Anti-Radiation Guided Missile (AARGM)

Capabilities

- Counters Advanced IADS
- Greater Lethality
- Addresses ARM countermeasures
- Weapon Impact Assessment

Demonstrated Test Results

- 8 Live Developmental Test Shots
- Multi-mode guidance (ARH, MMW, GPS)
- Advanced Emitter threat detection and ID
- Counter Shutdown Tactics
- Target geo-location
- Netted with off-board targeting (US only)
- Weapon Impact Assessment

Suppression to Destruction of Air Defenses

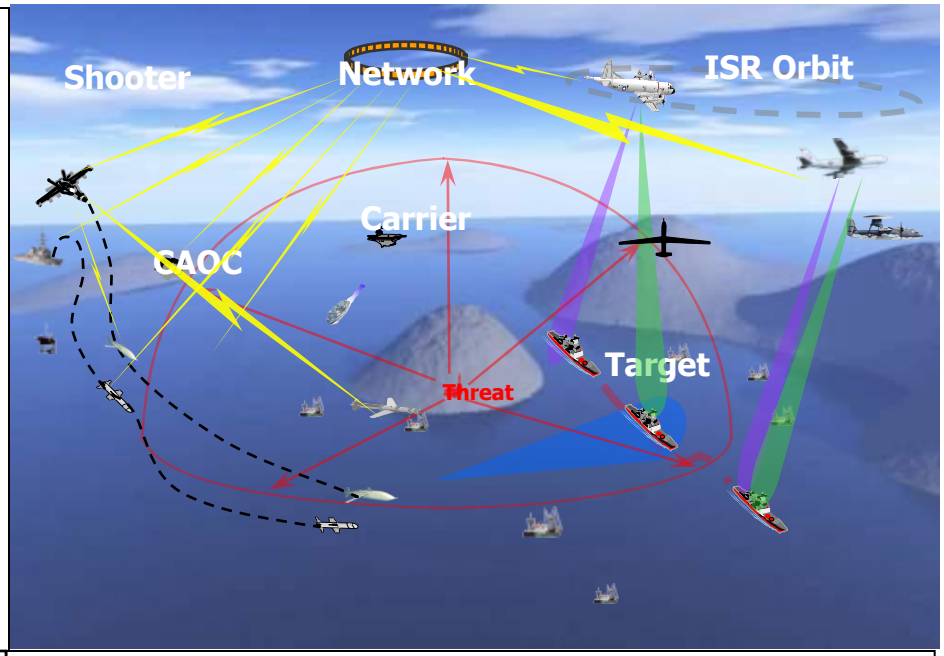
Harpoon Block III

- Block IC out of production
- Block IC continues to provide reliable SUW capability
- Block II FMS in production
- Block III kit upgrade program cancelled
- OPNAV initiating Follow-On SUW AoA

Joint Surface Warfare JCTD

Description:

- **Joint War-fighter has limited capability to engage enemy surface vessels at stand-off ranges in all weather conditions (PACOM sponsor)**
- **Weapon Data-link Network provides linkage and interoperability between USAF and USN ISR platforms via Link-16 to provide in-flight target updates to Joint anti-ship standoff weapons**
- **Proposed Participants**
  - ISR (E-8 JSTARS, P-3 LSRS)
  - Shooter (FA-18)
  - Weapons (H3, JSOW-C-1, SLAM-ER)



Discussion:

- **DUSD (AT&L) program, USN lead w/USAF co-lead**
- **Program began in FY07, runs through FY10**
- **JCTD will deliver first true Net-centric Warfare CONOPS and TTPS**

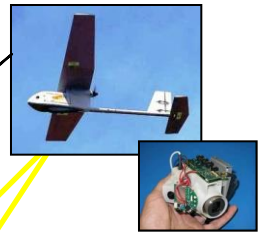
Schedule:

• **Requirements and Software Development**	**FY07**
• **System Integration Testing**	**FY08**
• **Capability Demonstration**	**FY09**
• **Military Utility Assessment**	**FY10**

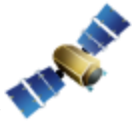
Tactical Real Time Employment Of TACTOM

- Use of UAS Intelligence
- Use of PSS-SOF
- Use of JSPEAR
- Direct Transmission of mission on SIPR

SOF



T/A and FRU will have comms with missile via TSN



JSPEAR MSN on SIPR to TA

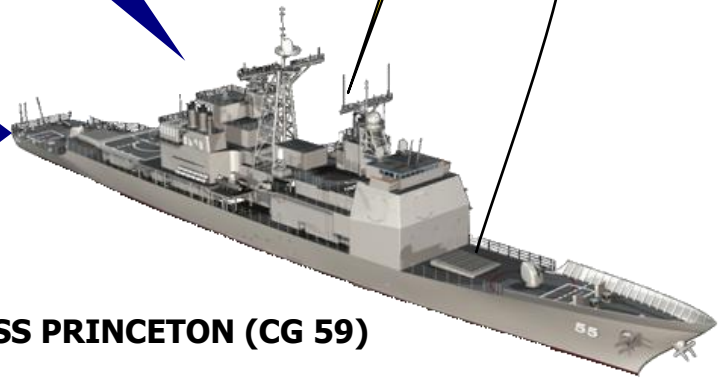
JSPEAR MSN on SIPR to FRU

AUR

Tasking Authority

Sends initial ESP to ship

Electronic Strike Package with preliminary mission via RNI



USS PRINCETON (CG 59)

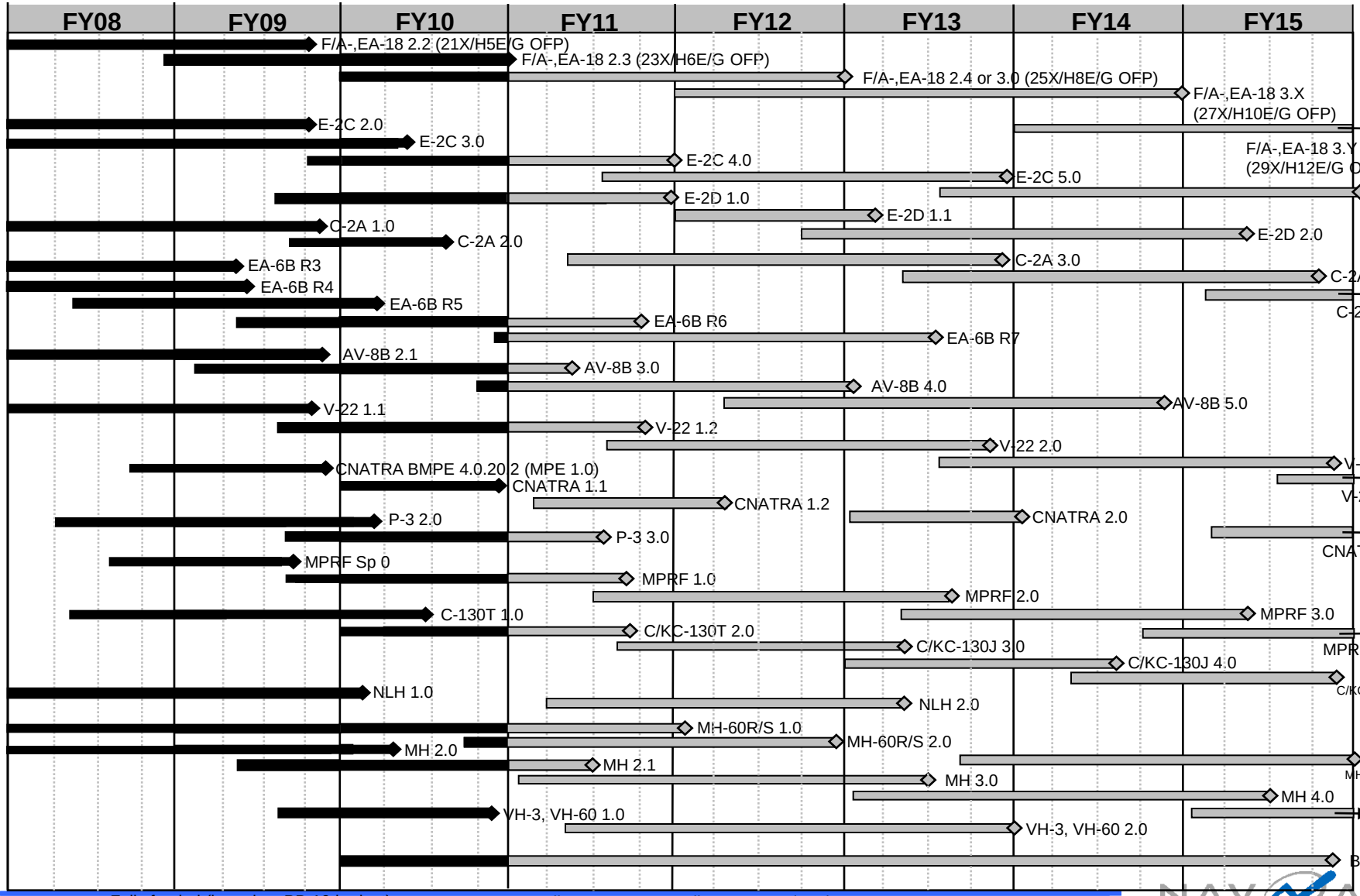
NAVAIR

Mission Planning

Current aircraft using JMPS

FY06	FY07	FY08	FY09	FY10	FY11	FY12	FY13	FY14	FY15
F/A-18	MV-22	CNATRA	C-2A	SH-60B	MPRF	MH-60R/S	E-2D	KC-130J	BAMS
E-2C			EA-18G	SH-60F	AH-1Z	KC-130T	H-53K		
AV-8B				HH-60H	UH-1Y				
EA-6B				MH-53E					
S-3				CH-46E					
				CH-53D					
				CH-53E					
				AH-1W					
				UH-1N					
				VH-3					
				VH-60					
				P-3					
				C-130T					

JMPS MPE Development & IOCs



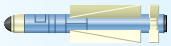
= Fully funded (based on PB-10 budget) =Funding status TBD until PR-11completed

As of 5-18-09

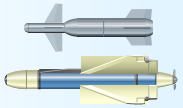
Weapons Revolution

1985 Mission Centric Operations

Rockets
TOW
Maverick



Rockeye
Bombs
LGB
Walleye



Penguin
Sea Skipper
Harpoon

HARM

AIM-9M Sidewinder

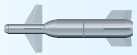
AIM-120 C5/7
Phoenix

Tomahawk

1995

Rockets
TOW
Maverick
Hellfire

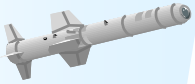
Rockeye
Bombs
LGB



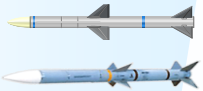
Penguin
Harpoon

HARM

SLAM



Sidewinder
Sparrow
AMRAAM
Phoenix

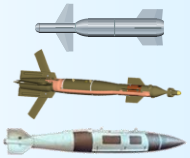


Tomahawk

2005 Network Centric Operations (GPS)

Rockets
TOW
Maverick
Hellfire

Rockeye
Bombs
LGB
EGB
JDAM



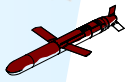
Harpoon

HARM

JSOW-A/C
SLAM-ER

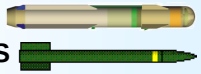
AIM-9X
AMRAAM

TACTOM (WDL)



2015 Enhanced NCO

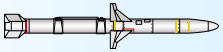
JAGM
APKWS



Rockeye
EGB
JDAM
SDB-II (WDL)

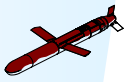
SLAM-ER
JASSM (WDL)

JSOW-A
JSOW-C (WDL)



AARGM

AIM-9X Blk II
AMRAAM

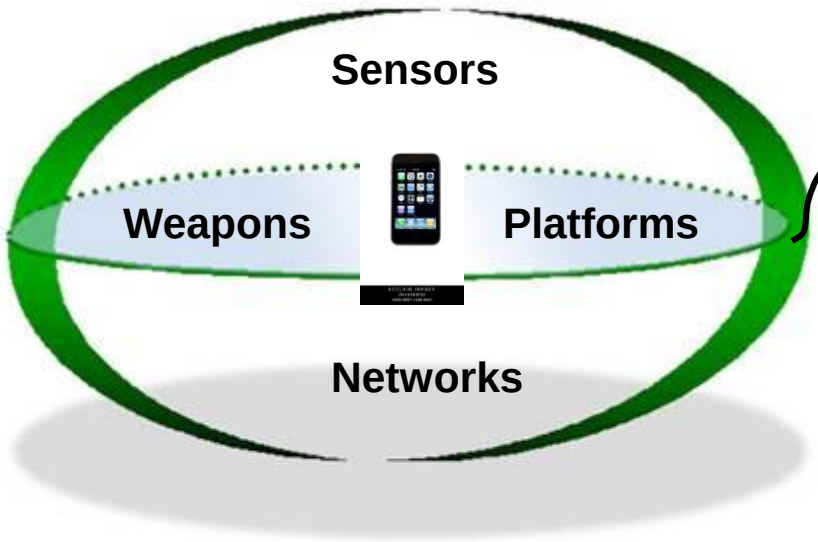


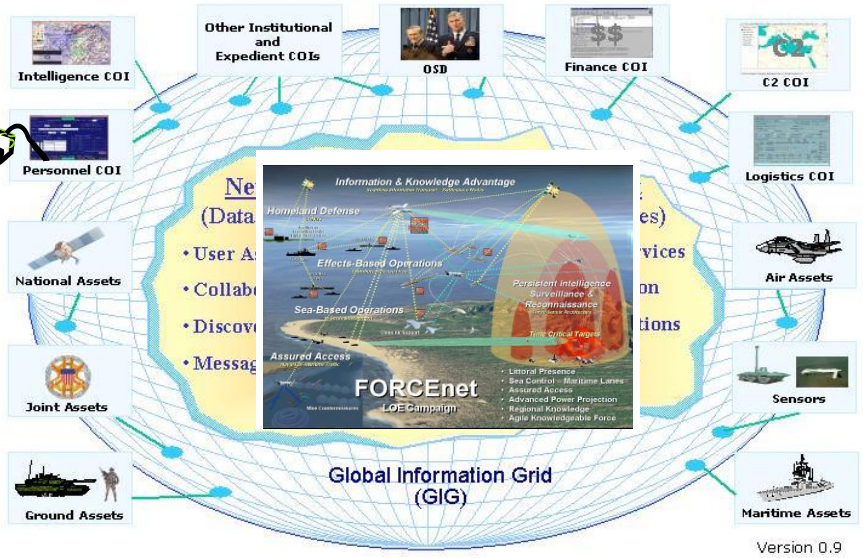
TACTOM (WDL)

The Next Revolution….

Mission Capability Focused: Speed, Agility, & Alignment

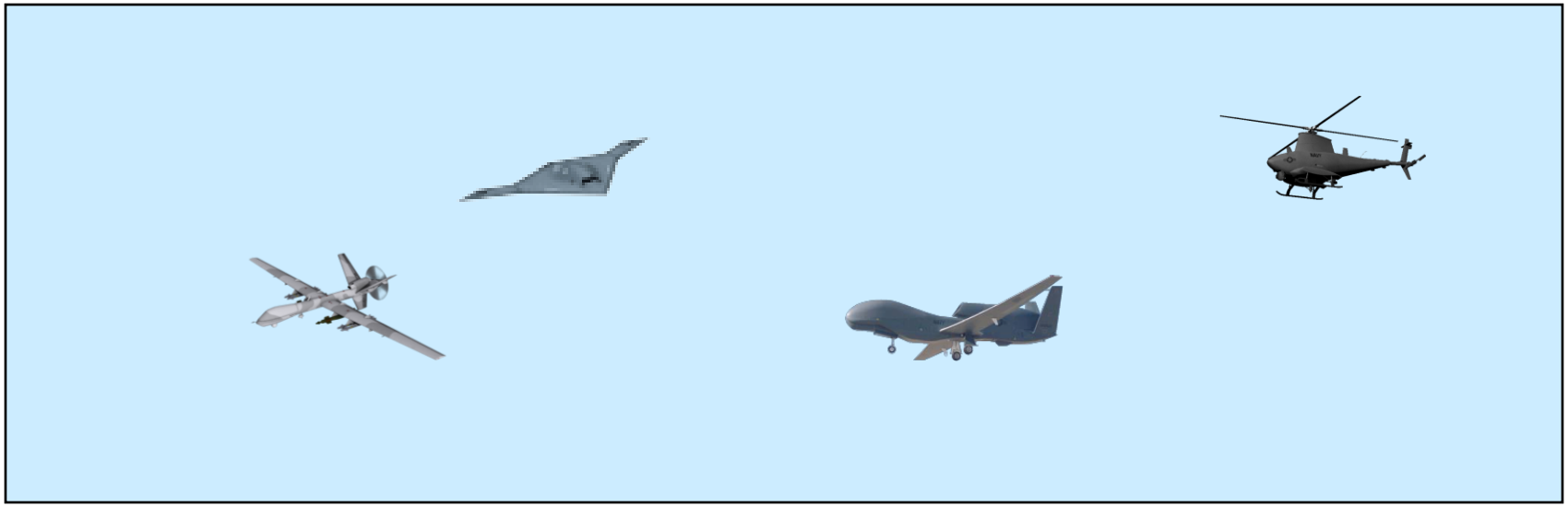
- **We must be networked and interoperable with joint forces (Machine-to-Machine)**
- **We must possess the ability to move tactical war fighting information seamlessly on/off the aircraft and across a networked force**
- **We must manage at the interface**





And the next…

UAV's are destined to become the next evolution of the world's air combat forces. The integration between manned and unmanned systems will be the first step in meeting those future systems, today.



Why?

- **Persistent ISR**
- **Small = Tactical OTH / Big = Strategic**
- **Reduces Footprint**
- **Efficient / More Affordable**

Unintended Consequence:

- **Stressing the Acquisition Process**
- **Easy to get our hands on technology + insatiable fleet thirst = Faster than the current process allows**

PSA
Precision Strike Technology Symposium

LtGen Duane Thiessen
Deputy Commandant
Programs and Resources

A Balanced Strategy

Reprogramming the Pentagon for a New Age

"The defining principle of the Pentagon's new National Defense Strategy is balance. The United States cannot expect to eliminate national security risks through higher defense budgets, to do everything and buy everything. The Department of Defense must set priorities and consider inescapable tradeoffs and opportunity costs."

Robert M. Gates, SecDef

Foreign Affairs, Jan/Feb 09

CMC Priorities

- Achieve victory in the “Long War”
- Right-size the Marine Corps
- Resetting for today while modernizing for tomorrow
- Improve quality of life for Marines and families

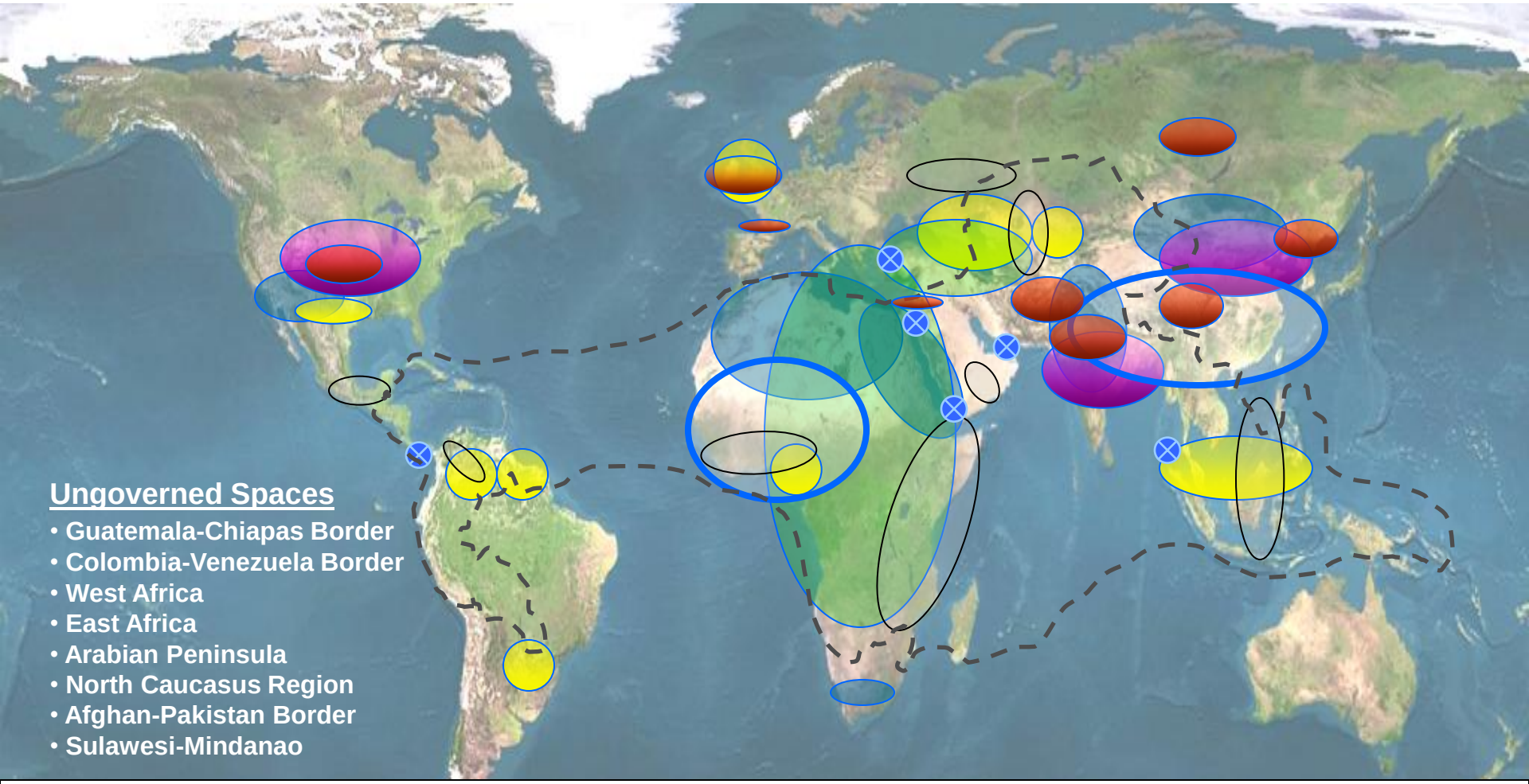
Strategy Objectives for 2025

- Focus on the Individual Marine
- Improve Training and Education for Fog, Friction, and Uncertainty
- Expand Persistent Forward Presence and Engagement
- Posture for Hybrid Threats in Complex Environments
- Reinforce Naval Relationships

- Ensure Amphibious Force Levels Meet Strategic Requirements
- Create Joint Seabasing Capabilities
- Lead Joint/ Multinational Operations & Enable Interagency Activities
- Maintain a Ready & Sustainable Reserve
- Build/Deploy Multicapable MAGTFs

A national imperative - Strengthening the MAGTF for employment across the ROMO

Sources of Stress, Instability, & Conflict



Adapting to Current and Future Battlefields

Wars Amongst the People

- Networked Terrorists, Criminals, & Insurgents
- Emerging Global Powers
- Increasing Interdependence
- "Haves" vs "Have Nots"
- Anti-West attitudes
- Identity/ Faith-based movements

Hybrid Threat Capabilities

- Terrorism/Crime
- Significant Drug Regions
- Ungoverned Spaces
- Nuclear Armed States
- Anti-access Weapons

Access challenges…
Largely in the Littorals

Complex Terrain

- Urbanization
- Famine and Disease
- Increased Resource Competition
- Climate Change
- High Earthquake Risk Areas

Information Environment

HYBRID THREATS *"militias, insurgent groups, other nonstate actors, and developing world militaries are increasingly acquiring more technology, lethality, and sophistication… Sec Gates*

Precision Strike:
Improving the Kill Chain

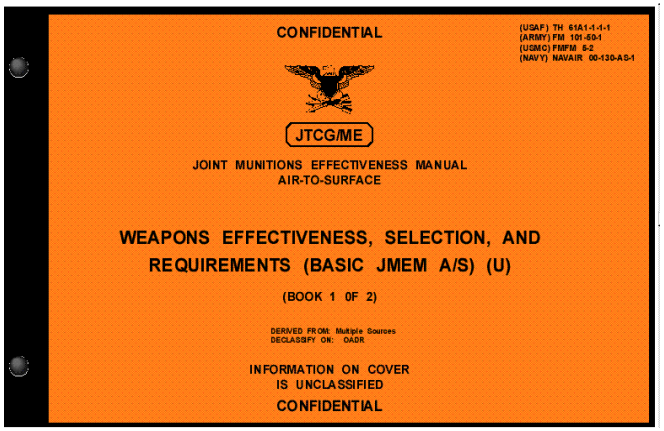
FIND FIX TRACK TARGET ENGAGE ASSESS

Key enablers:

- **Command, Control, & Communication**
- **Situational Awareness**
- **Precision Targeting**
- **Standoff**
- **Response Time**
- **Precision Lethality**

Precision: A Warhead on a Forehead

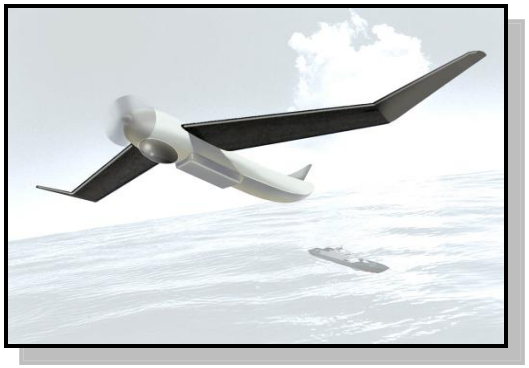
JMEMs



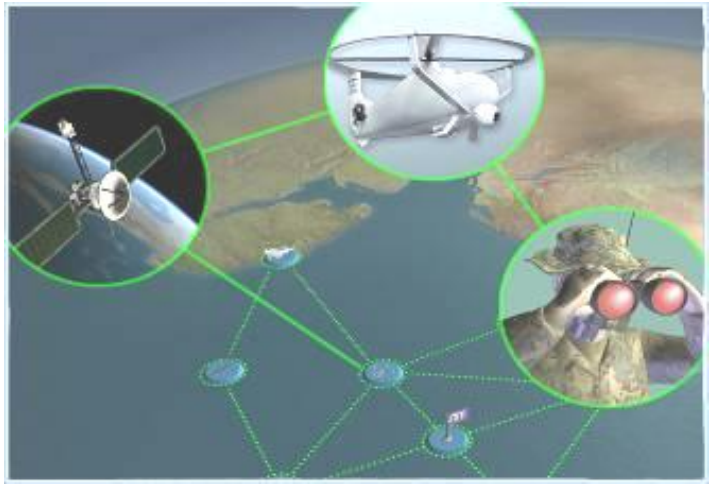
- **Introduced 1967**
  - **Slide rule and stubby pencil**
  - **Many voluminous books of data**
  - **Manual methodologies**
    - **Single guided weapon: 20 minutes**
    - **Stick of unguided weapons: 1.5 hours**
    - **Stick of cluster weapons: 3.0 – 5.0 hours**
  - **No ability to perform weaponeering against complex targets**

Today's model for precision strike

Improving the kill chain: Finding the target



- We can't hit what we can't find
  - 24/7 ISR is a must
- Many tools available for ISR
  - UAS
  - Fixed sensors
  - Satellite
- Communication is vital
  - Rapid/accurate dissemination
  - Common network



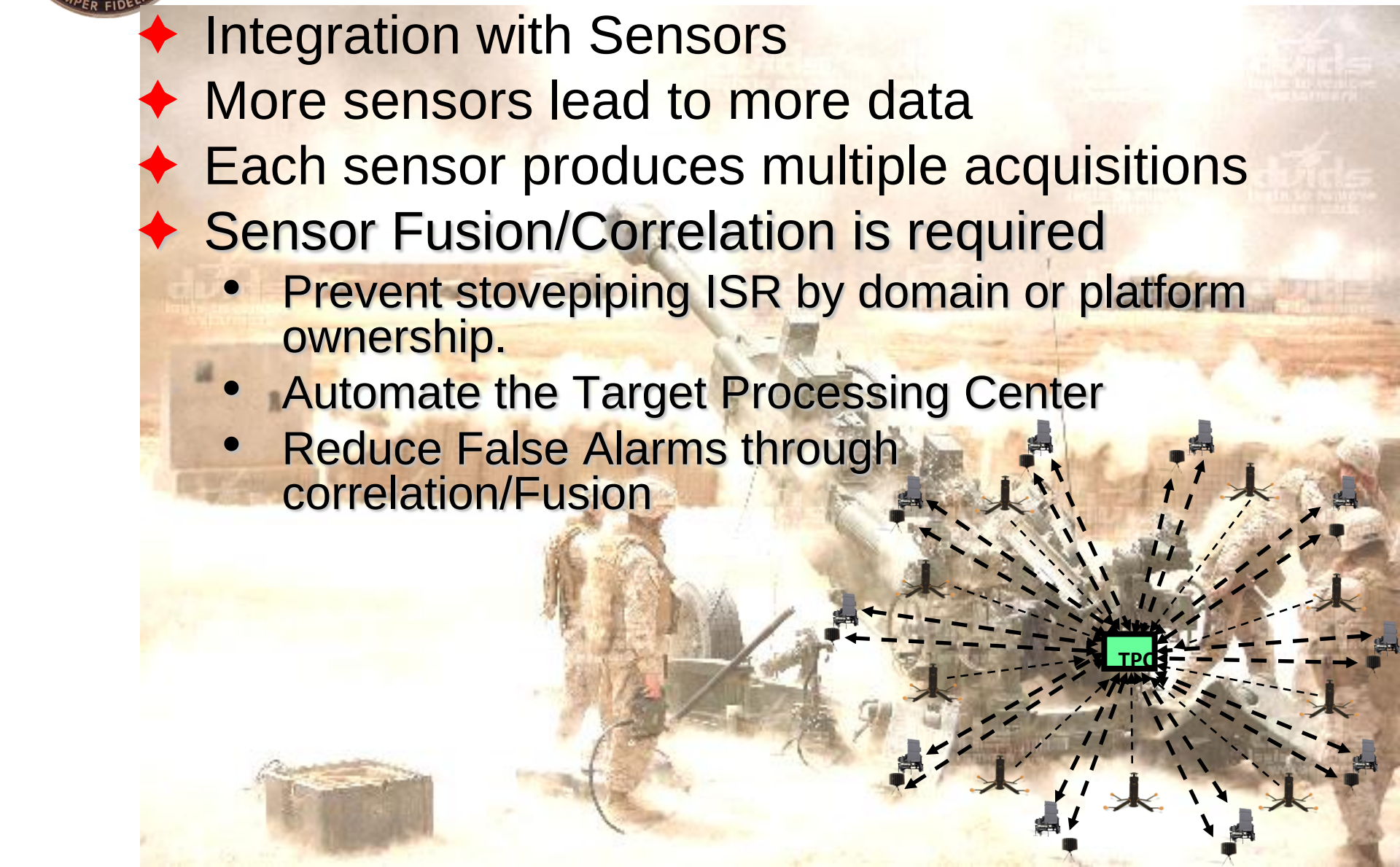
Improving the kill chain: Fix/Track the target

Requirement:

- Coordinate locking
  - GPS location within 1m
- Auto Target Hand-off System
- Prolific ISR assets
  - Satellite / fixed sensors
  - TF ODIN / C-12
  - UAS
  - Observer on the ground

Improving the kill chain: Targeting

- Integration with Sensors
- More sensors lead to more data
- Each sensor produces multiple acquisitions
- Sensor Fusion/Correlation is required
  - Prevent stovepiping ISR by domain or platform ownership.
  - Automate the Target Processing Center
  - Reduce False Alarms through correlation/Fusion

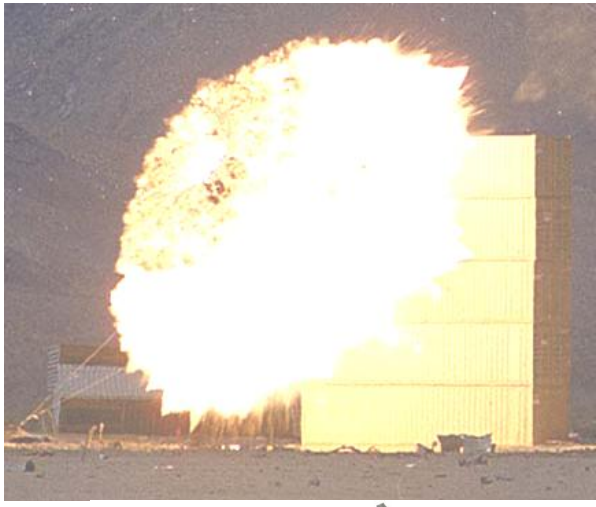


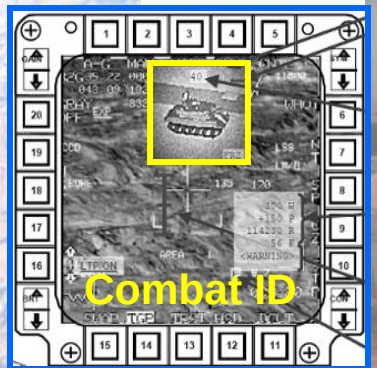
Improving the kill chain: Engage the target

- Response time reduction
  - Accomplish within minutes
  - Vital for unplanned Troops In Contact missions
  - Targets of opportunity
- Need to continue movement into digital age
  - Strikes still called over voice nets using “nonintegrated” GPS, LRF, map and compass
  - Different delivery platforms require coordinates in different formats

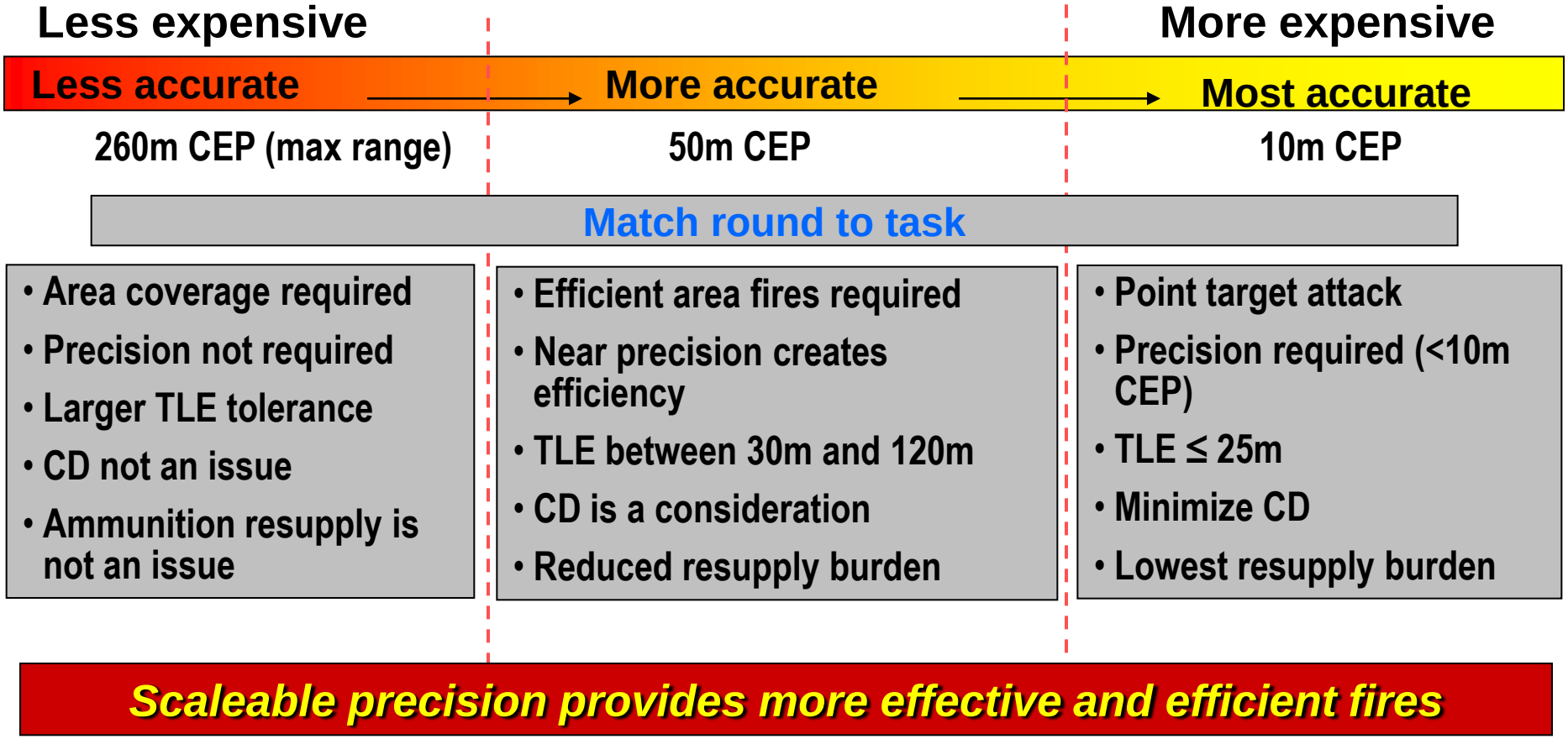
Improving the kill chain: Engage the target

- Close-medium range
  - Hellfire / Rockets / Mortars / Sniper
  - Artillery
- Longer range
  - JSOW / JDAM / AARGM / JASSM
- Scalable effects

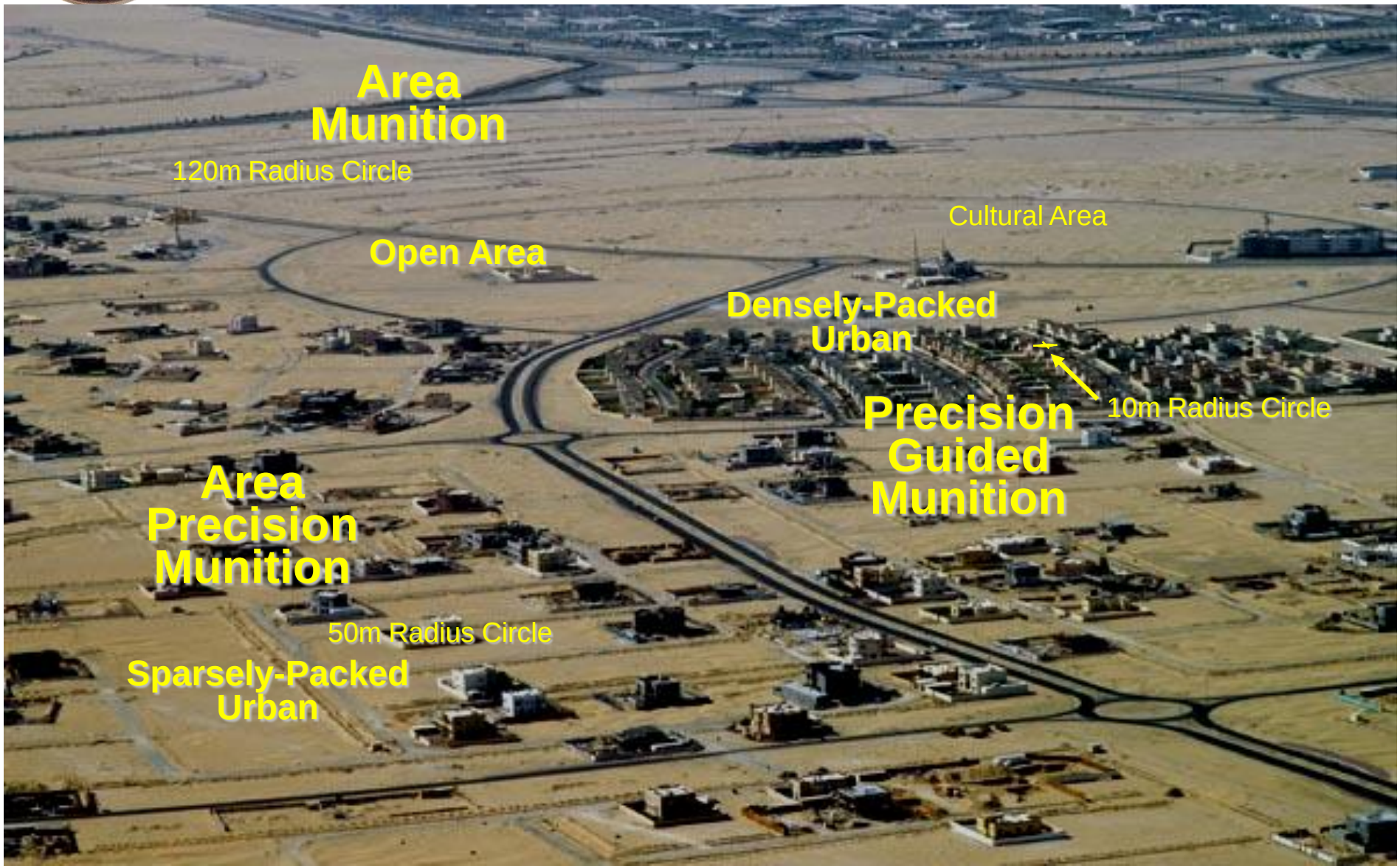




Engagement Considerations



What Level of Precision is Needed?

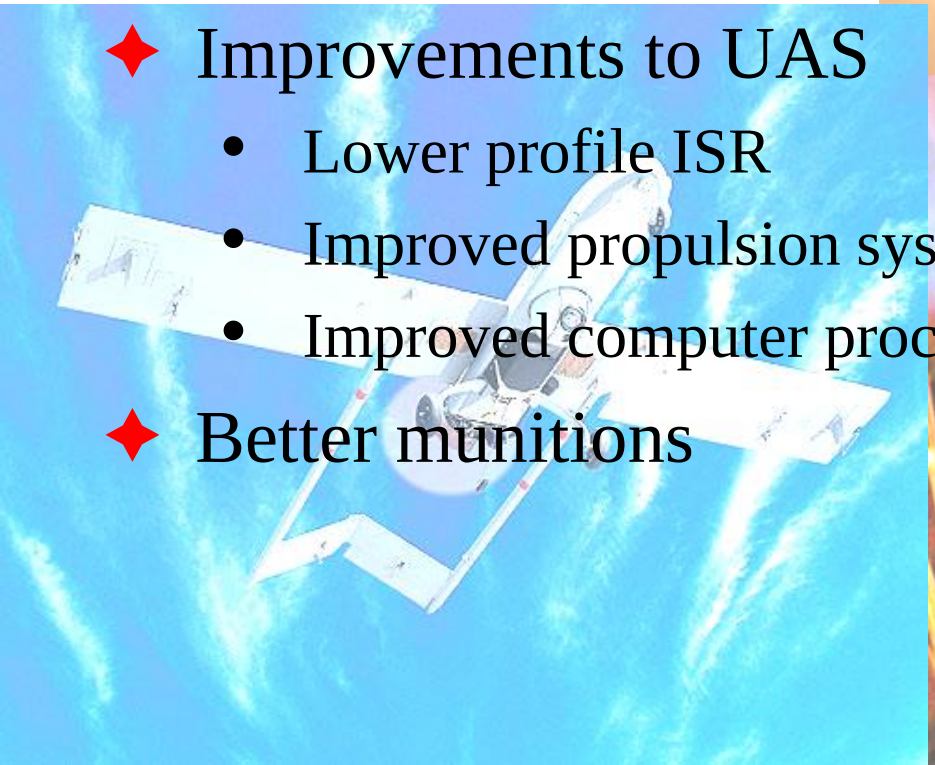


Improving the kill chain: Assess the damage

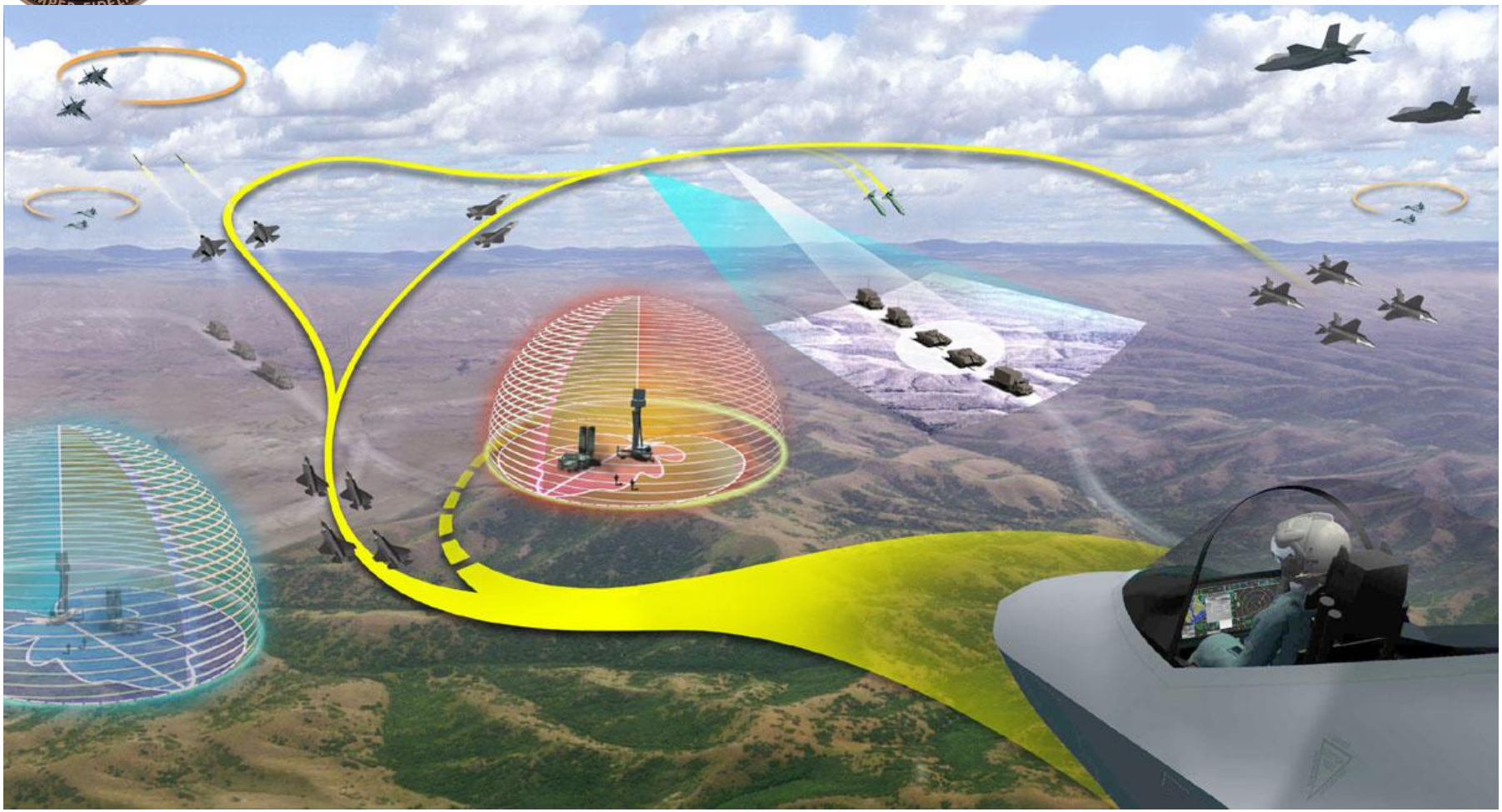
- Information and communication are vital
  - Eyes/sensors on target for BDA
  - Data relayed instantly to analyst for assessment
  - Re-attack or start cycle over
  - Common data-base for timely/accurate assessments

Near future for the long term

- Information Systems improvements
  - Networks
  - Digital communications
  - Web-based data
- Improvements to UAS
  - Lower profile ISR
  - Improved propulsion systems
  - Improved computer processing
- Better munitions



JSF - Single multi-mission adaptable platform



Multi-capable for the MAGTF


Душанбе
Dushanbe
Кӯлоб
Kulyab
Tajikistan
Madud
Mary
Bayramaly
Qargin
Кӯрғонтеппа
Kurgan-Tyube
Feyzabad
Khanabad
Patukh
Andkhoy
Aqcheh
Mazar-e Sharif
Qonduz
Taloqan
Kholm
Yangi Aregh
Eshkashem
Hoper
Baghlan
Aybak
Pol-e Khomri
Dowshi
Khinjan
Barfak
Almar
Belcheragh
Bala Morghab
Darreh-ye Bum
Qaleh-ye Now
Bamian
Charikar
Kabol
Asmar
Chilas
Gilgit
Skardu
Mashhad
Neyshābūr
Torbat Heydariyeh
Eslam Qaleh
Tirpul
Herat
Karokh
Ghurian
Chesht-e Sharif
Masjed Negar
Chaghcharan
Panjab
Jalez
Ghazni
Adraskan
Afghanistan
Abbottābād
Srinagar
Jammu a Kashmi
Islāmābād
Mirpur
Baghran
Mogor
Robat-e Khoshk Aveh
Birjand
Sorkh Ab
Farah
Sangin
Qalat
Gujrat
Jammu City
Sargodha
Gujranwala
Sialkot
Lash-e Joveyn
Gereshk
Lashkar
Kandahar
Senjaray
Takhteh
Bhakkar
Lahore
Amritsar
Jalandhar
Zabol
Kang
Spin Buldak
Jhang
Firozpur
Ludhia
Alimardan
Khan-e Bagat
Quetta
Loralai
Sinjawi
Badra
Multān
Okāra
Panjeke
Punjab
Kamal Khan
Rudbar
Khwaja Ali Sehyaka
Pakistan
Bathinda
Bahāwalpur
Chishtiān
Sirsa
Bam
Salar Ziarat
Kundi
Nuttal
Sui
Zāhir Pīr
Khānpur
Kashmor
Haryana
Bikaner
Gajner
Sādiqābād
Lārkāna
Sukkur
Sikar
Irānshahr
Panjgur
Nangreja
Bahawalpur
Jaipur
Rajasthan

Questions?

Tomahawk Asymmetric & Time Sensitive Strike

Presented to:
19th Annual Precision Strike Technology Symposium
28 October 2009
Presented by Mike Thumm

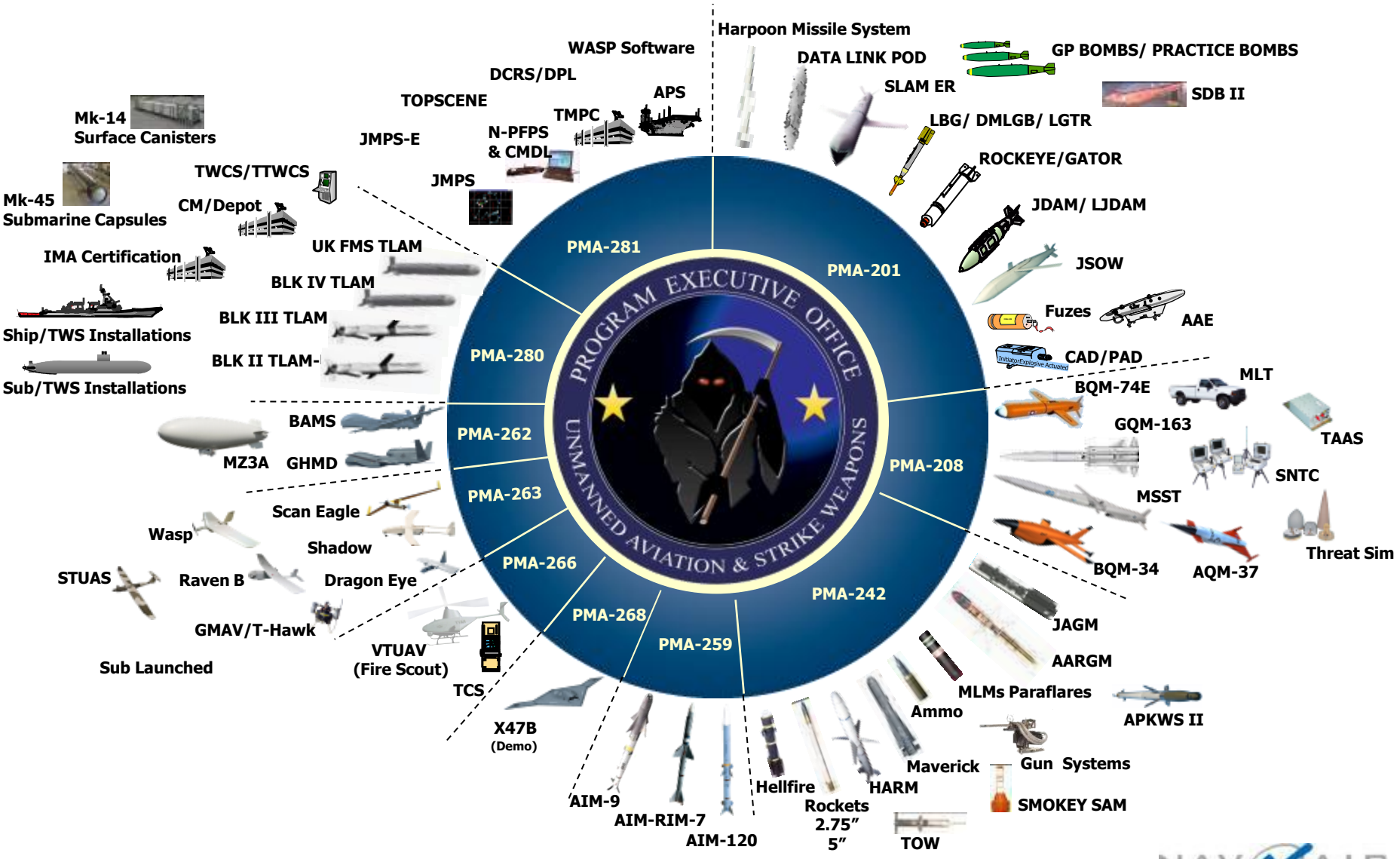
BLK II
BLK III
BLK IV

SHIPS **SUBS** **TAs**

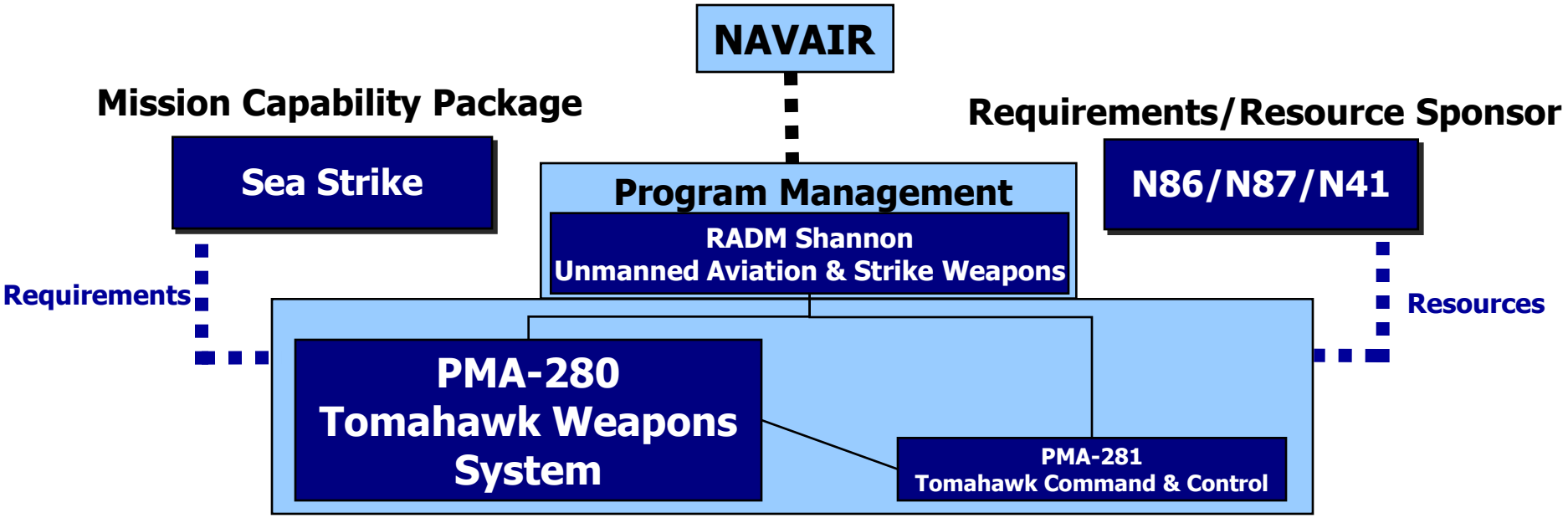
ATWCS **TTWCS** **TC2S**

CAPT Dave Davison
PMA-280
david.d.davison@navy.mil

PEO(U&W) Products



TWS Team Organization



Engineering & Logistics Support

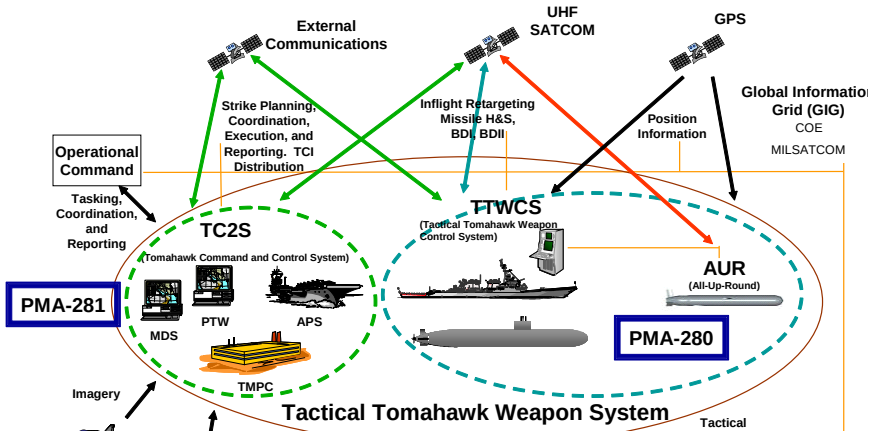
- NAVAIR: Pax River/China Lake/Pt Mugu
- NAVSEA: Newport/Dahlgren/Corona/ Port Hueneme/Indian Head

Development & Production

- Raytheon (All-Up-Round)
- Lockheed Martin (Weapon Control Sys)
- Boeing (TMPC/APS)
- BAE (DIWS)
- COMGLOBAL (MDS/TSN)
- SAIC (SE&I, IV&V, MVS)
- JHU APL (TDA)

PMA-280 Overview

TWS Critical Interfaces



Development/Production Programs

Tomahawk BLK IV AUR Program (ACAT IC)

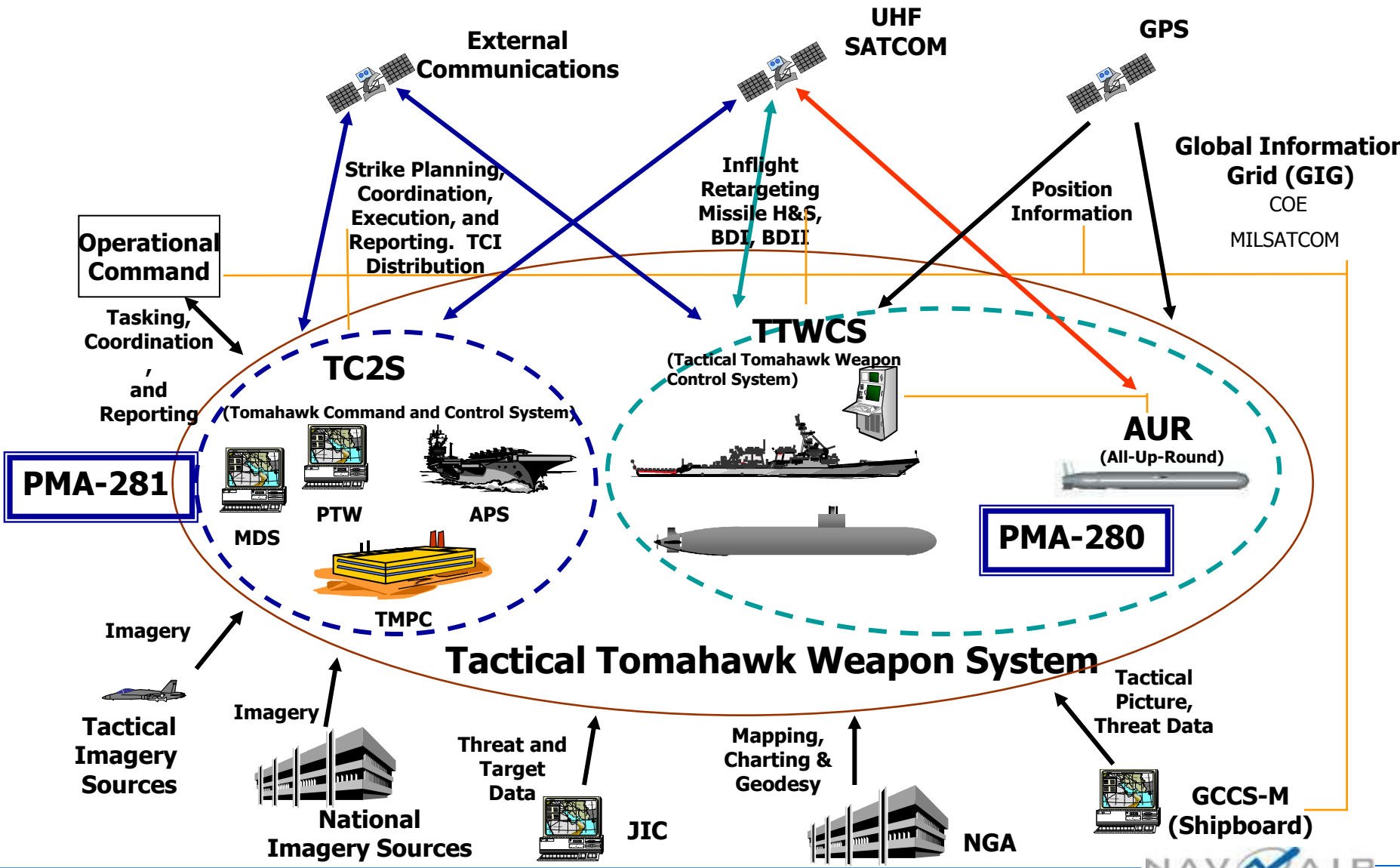
Major Milestones	Date
FY04-08 MY Contract-1945 Missiles	Aug 04
CLS Contract Award	Apr 10
FY09 MY Contract-207 Missiles	Mar 09
FY10 Production Option Exercise- 196 Missiles	Jan 10
FY11-15 MY Contract Award-196 Missiles	Jan 11

TTWCS Program (non-ACAT)

Next Major Milestone	Date
Version 5.4.1 Increment 2 PDR	Oct 09
Version 5.4.1 Increment 2 CDR	Mar 10
Version 5.4.1 Increment 3 SRR	Sep 10
Version 5.4.0 Fleet Release	Mar 11

- **Enhance the Kill Chain**
- **Horizontal Integration**
- **Near Real Time / Re-targetable**
- **Agile**
- **Enterprise vs. Network**
- **Long Range Unmanned Precision Strike**
- **Prompt Strike on Critical Targets**

Tactical Tomahawk Weapon System Overview



USN/UK Tomahawk Shooters

SURFACE

TICONDEROGA (CG)
22 Platforms
• VLS

ARLEIGH BURKE (DDG)
54 Platforms
• VLS

SUBMARINE

LOS ANGELES 688
47 Platforms
• CLS/TTL

SEAWOLF
2 Platforms
• TTL Only

SSGN
4 Platforms
• CLS (MAC)

VIRGINIA Class
5 Platforms
• CLS/TTL

UK

TRAFALGAR
7 Platforms
• TTL Only

- Remote Shooters
- Minimal Infrastructure / Interruption to Deployed Forces
- Fire and Forget
- No Tanker Support Needed
- Mobile and Concealed With Minimal Footprint

Concept of Employment

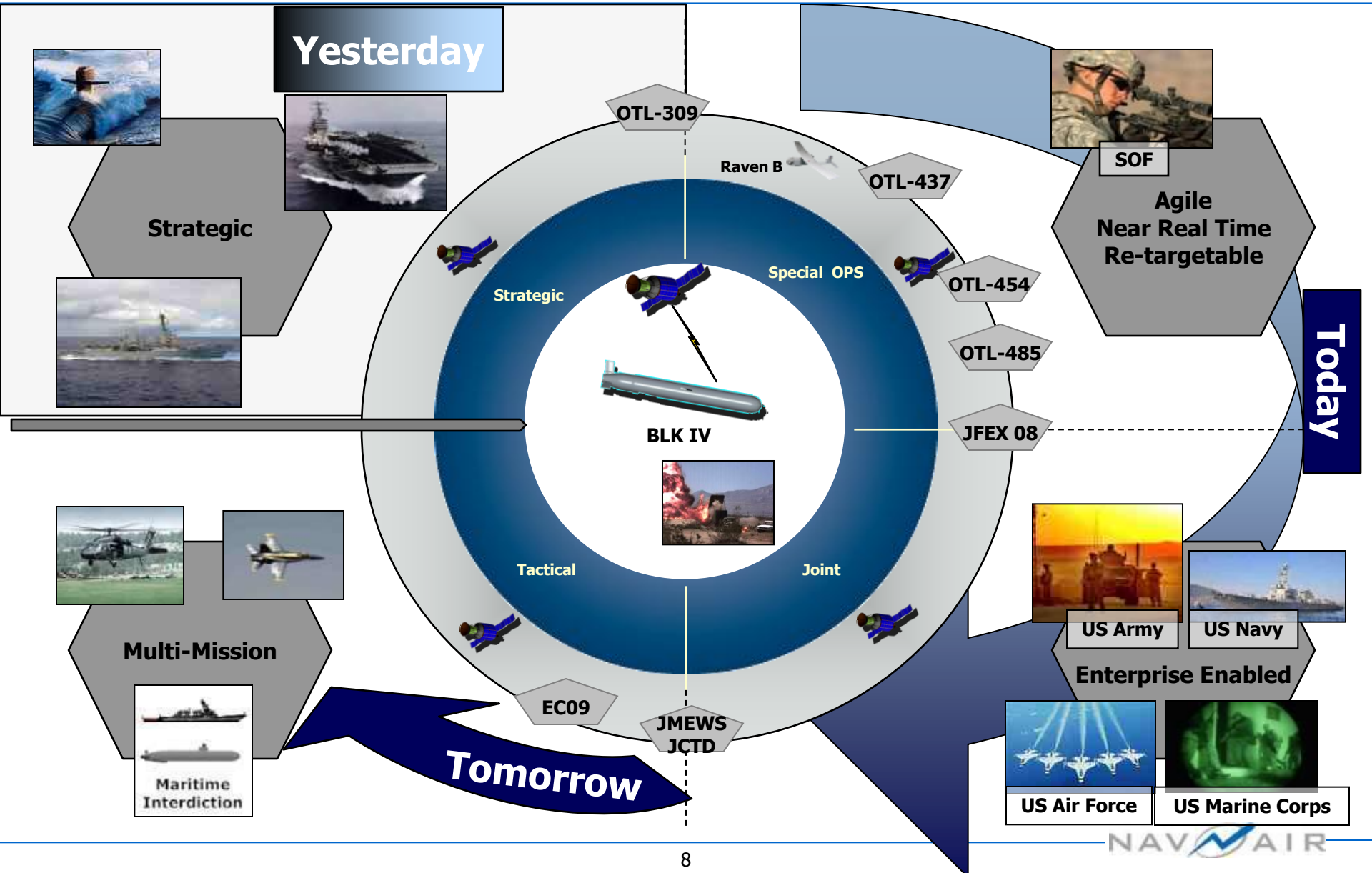
Strategic
- Long Term
- Strategic Targets
- OPLANS
- CMSA Support
- Non-time sensitive / Deliberate Planning

Tactical
- High Value Targets
- Planned at Fleet or Firing Units (FRU)
- Flexible Targeting in Flight
- BDII
- Time sensitive / Tactical Mission Support

Non – Traditional/Asymmetric Warfare
- Al Qaeda Targets / Overseas Contingency Ops
- Near Real Time Targeting

  Ability to plan with JSPEARS in the Field
- Loiters
- Communicates / Network
- Flexible Targeting in Flight
- Third Party Targeting

Horizontal Integration
Expanding Role of TACTOM



Special Forces Re-Targeting of a BLK IV Tactical Tomahawk

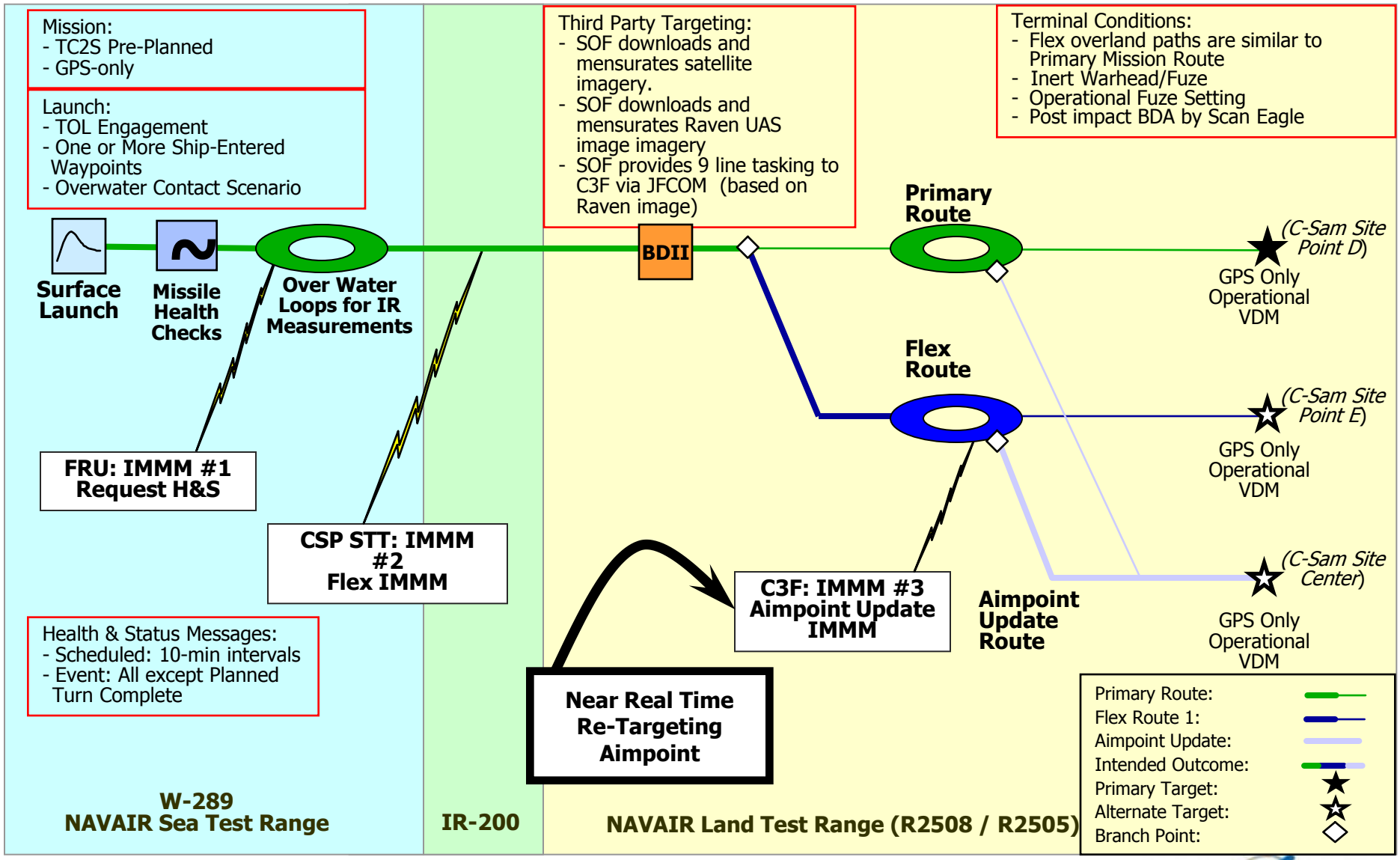
Tomahawk/Special Forces Near Real-Time Targeting, Tech Demo

- Demonstrated ability to mensurate both commercial satellite and Unmanned Aerial Systems (UAS) imagery in the field
  - Target TLAM BLK IV by generating (Category 1) coordinates using commercial satellite imagery matched to Digital Point Precision Database (DPPDB)
  - Precision Fires Image (PFI)s loaded on Personal Data Assistant (PDA)s for Special Operations Forces (SOF) observer prior to launch
- While BLK IV missile inbound to preplanned primary/secondary targets, SOF personnel sent target coordinates to Commander 3rd Fleet (C3F) via nine-line message
- C3F transmitted Aimpoint Update In-flight Mission Modification Message (IMMM) to BLK IV missile via UHF Tomahawk Strike Network
- Missile prosecuted the SOF Aimpoint
- Post mission Battle Damage Assessment (BDA) collected by Scan Eagle UAS

OTL-473 Validated Multiple Satellite and UAS Sources Capable of Supporting BLK IV Near Real Time Re-Targeting and BDA

OTL-473 Video

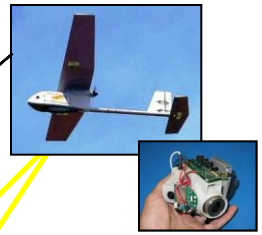
Mission Overview



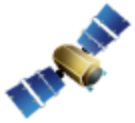
Tactical Real Time Employment Of TACTOM

- Use of UAS Intelligence
- Use of PSS-SOF
- Use of JSPEAR
- Direct Transmission of mission on SIPR

SOF



T/A and FRU will have comms with missile via TSN



JSPEAR MSN on SIPR to TA

JSPEAR MSN on SIPR to FRU

AUR

Tasking Authority

Sends initial ESP to ship

Electronic Strike Package with preliminary mission via RNI

USS PRINCETON (CG 59)

Asymmetric TACTOM Employment

Tomahawk Missile Systems available for Non-Traditional support

- Proven Asymmetric Warfare (Overseas Contingency Operations)
- Ability to support third party targeting
- Only network enabled long range weapon
- Mission flexibility
  - In-flight flexibility for changing real-time targets
  - In-flight health monitoring (IMMM) messaging
  - Battle Damage Imagery
  - Responsiveness to nine line brief/calls for fire tasking

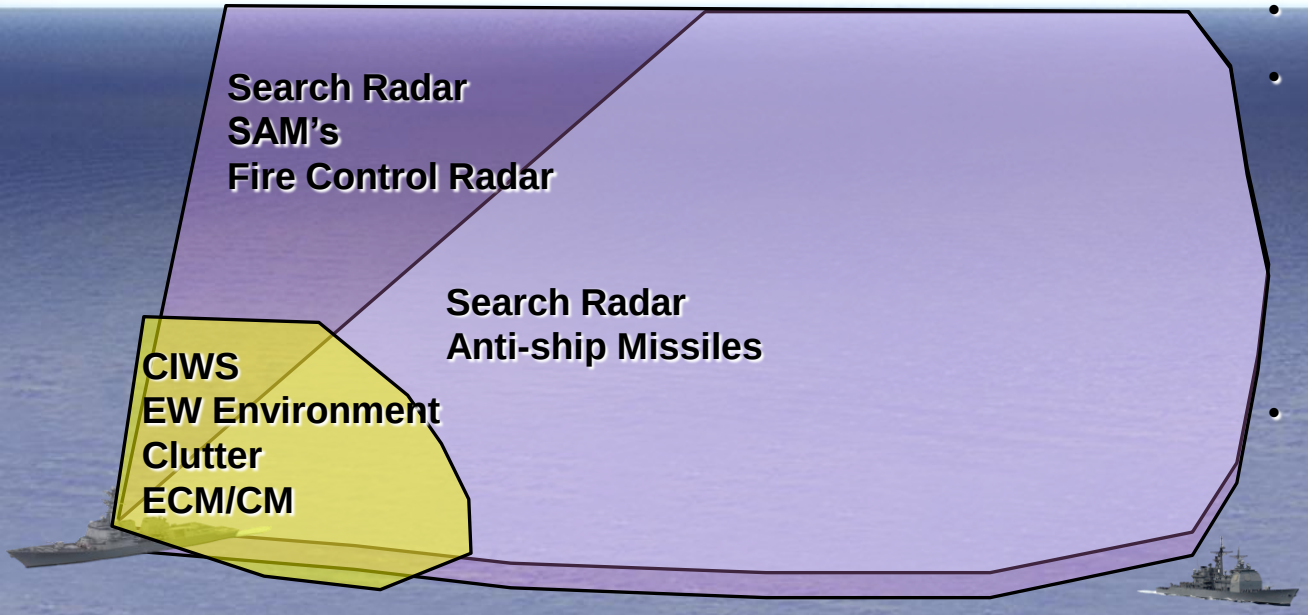
Tomahawk meets the Requirement of Asymmetric Warfare & Training Joint Forces in Calls for Fire

Addressing the ASuW Capability GAP: An Acquisition Perspective

CAPT Mat Winter
PM, Precision Strike Weapons
28 October 2009
mathias.winter@navy.mil

ASuW Capability Gap

The ASuW Problem…

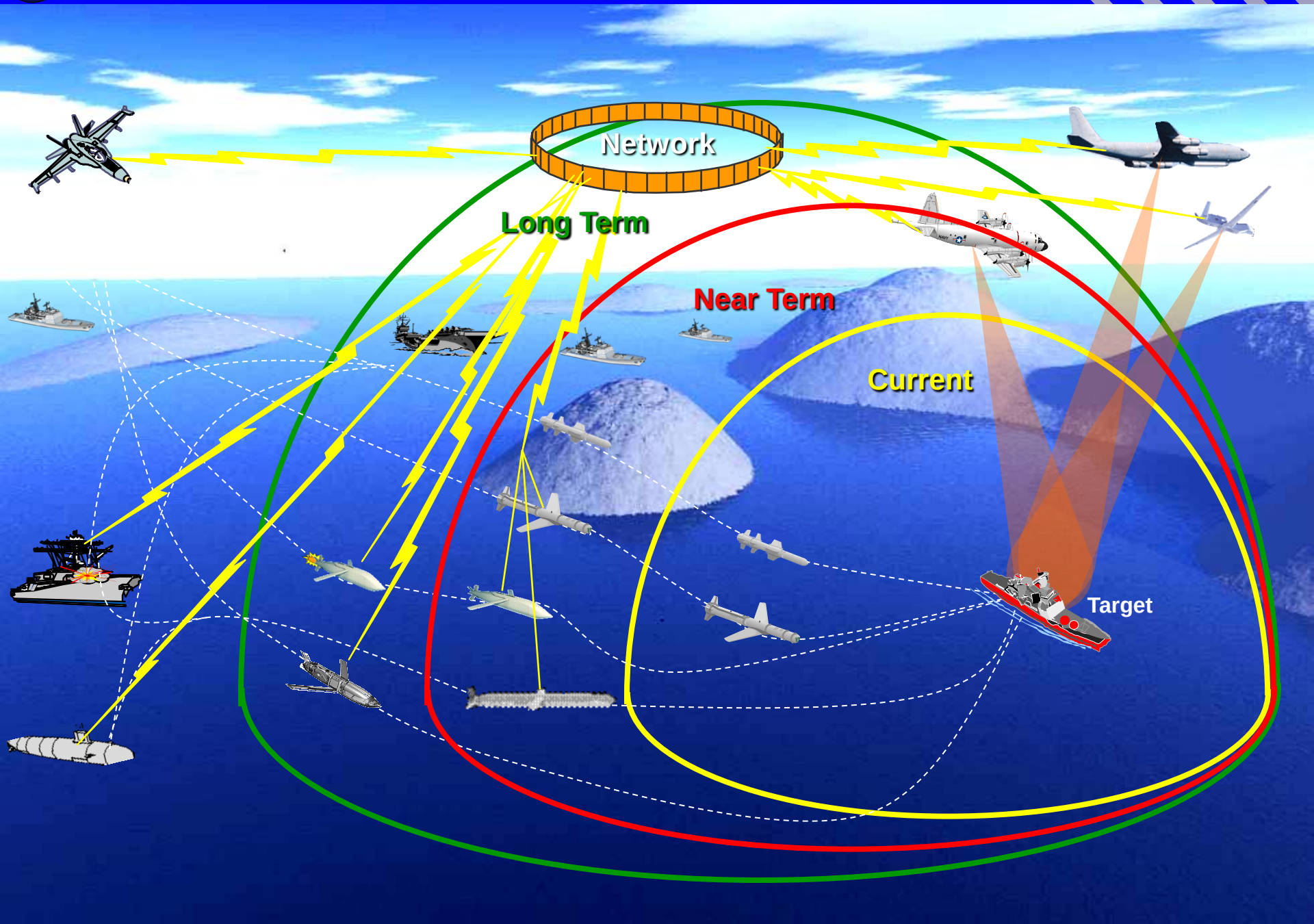


Maneuvers
Civilian Ships
Target Size
Quantity

Required ASuW Weapon Attributes

- *Long Range (> 200 nm)*
- *Survivable*
  - *Stealth/ECM*
  - *Speed*
  - *Maneuver*
  - *Passive*
- *Targeting*
  - *Autonomous Target Classification/Identification*
  - *In flight Updates*
  - *All Weather*
- *Responsive*
- *Lethality – Warhead & Aim Point Selection*
- *Platform Compatibility (VLS, Air)*

Current/Future ASuW Capabilities



ASuW Solution Barriers

- Acquisition timeline pressurizes realistic capability gap solutions
- DoD ASuW requirement not formally approved/validated
- DoD FYDP budget constraints influence material solution options
- Upgrade/modify current capabilities versus pursuing the next generation solution

ASuW Strategic Capability Options (FY12-20)

USN ASuW Capability

2012	2013	2014	2015	2016	2017	2018	2019
FY12	FY13	FY14	FY15	FY16	FY17	FY18	FY19

Upgrades

Air Launched
- Anti-radiation seeker integration
- Surface threat Automatic Target Recognition (ATR)
- Aim Point Selection
- Extended Range – Hi-Lo profile
- ECM

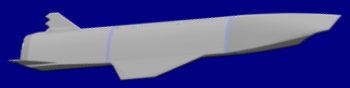
- Upgrade SLAM ER/JASSM/JSOW ER

Address Long-term Threat Maturity

Ship Launched - VLS
- Multi-mode seeker integration
- Surface threat Automatic Target Recognition (ATR)
- Aim Point Selection - Precision Targeting
- ECM

- Upgrade Tomahawk

- Multi-mode seeker integration
- High Speed – Survivability, Improved Responsiveness
- Range >>200 NM
- Robust OTH Datalink – Network enabled (MIDS-JTRS waveform)
- SATCOM
- Surface threat Automatic Target Recognition (ATR)
- Aim Point Selection -Precision Targeting
- ECM



- Next generation ASuW Weapon

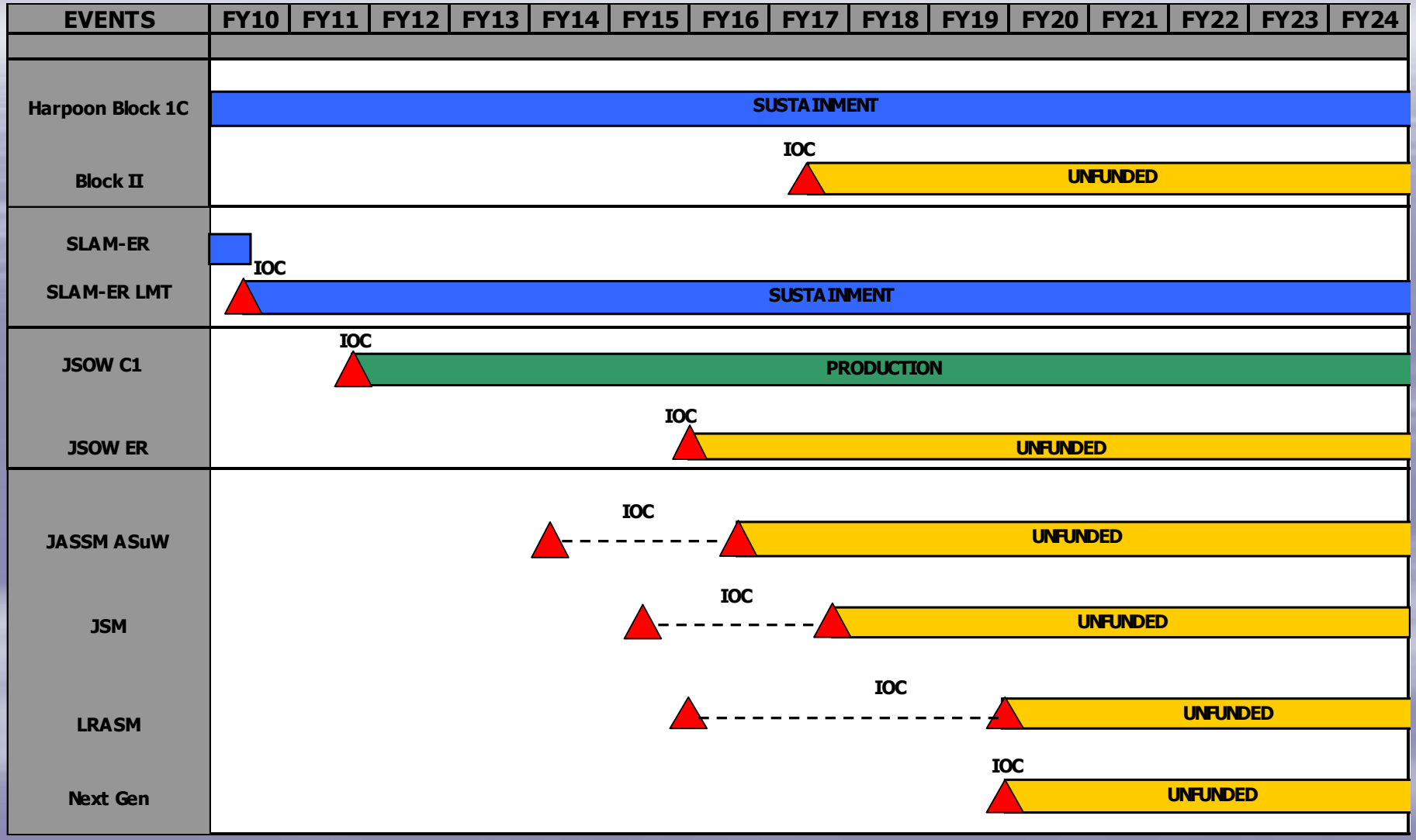
Proposed Technical Solutions

R&D Needs

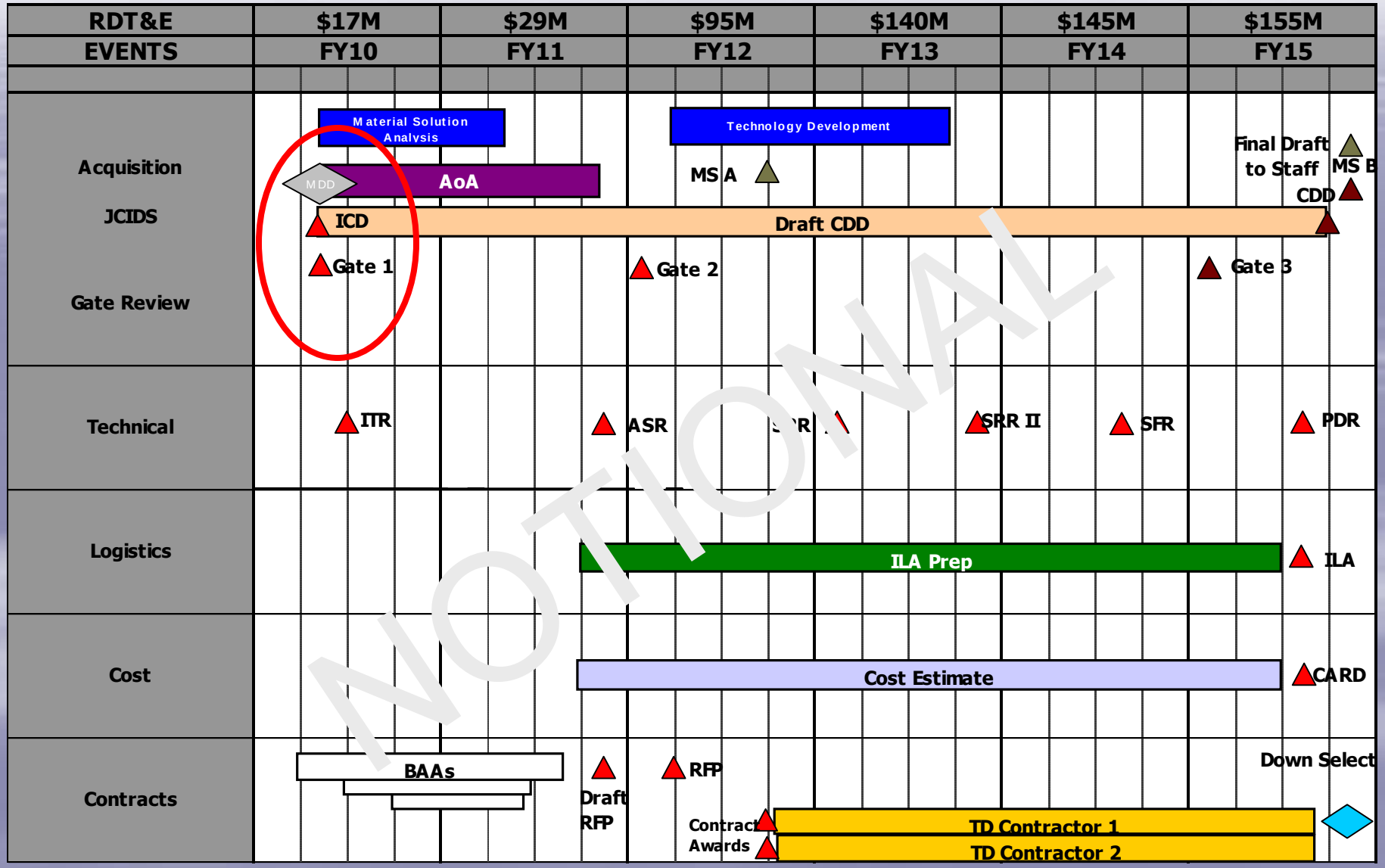
ARH sensor	MIDS-JTRS datalink
ASuW ATR Algorithms	SATCOM datalink
Adv. Multi-mode seeker	Other OTH Datalinks
ECM	
Afford High Speed Propulsion	

Future POM Issues

ASuW Capabilities: Acquisition Reality



Next Generation ASuW Weapon "AoA to MS-B"



Summary

- Multiple ASuW Gap Efforts underway across DoD/Industry
- DoN ASuW AoA critical to scoping/defining requirement
- DoN/Industry cooperation provides best timely solutions
- Leveraging S&T investments key to "right sizing" capability attributes
- Phased ASuW solution with "near term modifications" coupled with "dedicated new investment" for next generation ASuW capability