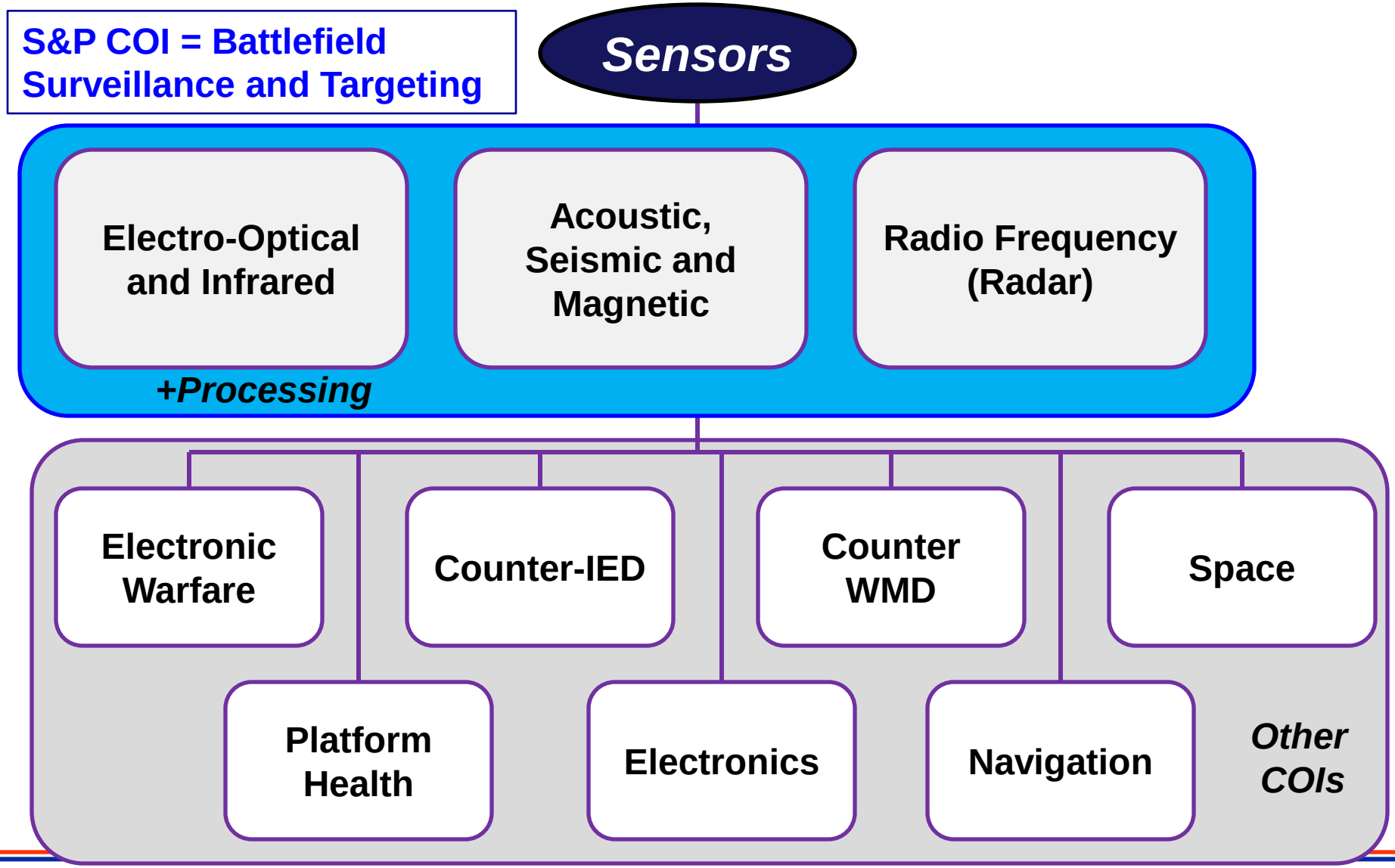
Sensor and Processing COI

Sensors in the DOD

S&P COI = Battlefield Surveillance and Targeting



Why Does the DOD Need To Invest in Sensors S&T?

- **Long range surveillance & targeting largely a military requirement. State-of-the-art capabilities provide US a strategic advantage.**
  - Most of the sensor technology in the COI Is military specific, requiring DOD investment to improve the state-of-the-art, meet new and more demanding requirements
- **Consumer applications mostly very low cost/low performance:**
  - Consumer: Focus on lowest cost and packaging (point solutions). Examples:
    - Back-up sensor (ultrasonic)
    - Driving camera (infrared)

DOD does not invest in CMOS day TV cameras

  - Military: Focus on highest performance at acceptable cost (10-1,000X consumer thresholds)
- **Some high performance commercial sensors are adaptations of military technology, where the commercial business case does not justify extensive commercial S&T investment**
  - Example: cooled FLIRs for scientific and law enforcement applications
- **Some commercial markets do not want to do business with DOD**
- **DOD S&T community needs to maintain awareness and invest in adaptations of non-military sensor technology where possible**
  - Examples: IR driving cameras (industry invested heavily in signal processing)

    Acoustics program focuses on processing of acoustic signals not hardware (microphones)
  - Perform “smart buyer” function for Users and Acquisition community

Common Warfighter Needs Met By Sensors COI

- Survivable Broad Area Persistent Surveillance
- Target Detection, Recognition & ID at Standoff Ranges
- Force/Platform/Sensor Protection
- Target Tracking
- Early Warning
- BDA
- Precision Strike
- Resilient Architectures

Sensor Challenges in the Pacific Pivot

Jungle

FOPEN SAR
LADAR
Hyperspectral
UGS

Megacities

Wide Area
Persistent Surveillance

360º Situational
Awareness

Vehicle ID & tracking

Narrow Maritime Corridors

Sea Mines

Ship Self
Defense
Countermine

A2/AD

Integrated Air
Defense
Long ranges
Anti ship
Missile
Land mines

Ship Self
Defense
Countermine

Peer Threat

Fighters,
Ship, tank,
Crew served weapons
Layered IADS

Advanced FLIR
Long Range Radar
360º SA
MDA
Full Spectrum
Conflict

Challenging Environments

Difficult Targets that Challenge Today's Sensors Capabilities

- Submarines
- Small UAVs
- Mines
- People
- Enemy Sensors
- Low trajectory munitions
- Camouflage
- Underground
- Under Foliage
- Cruise and Ballistic Missiles

Low Contrast, Small, Fleeting Targets Challenge the Limits of Sensor Resolution & Signal-to-Noise – Processing of Signals Key Part of Systems to Detect, ID and Track these Threats

- **All made more difficult to detect in Pacific Pivot scenarios**

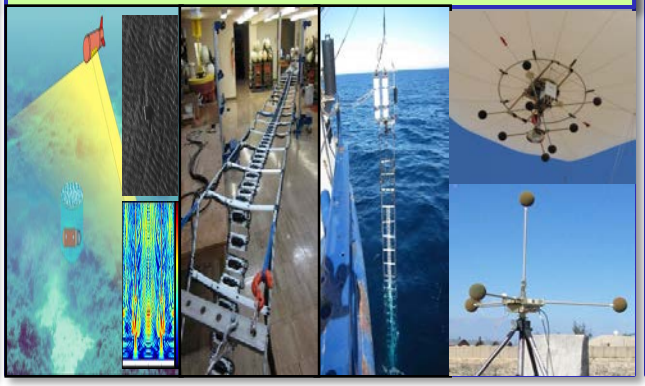
Taxonomy

Sensors and Processing Technology

RF *(non-EW)*

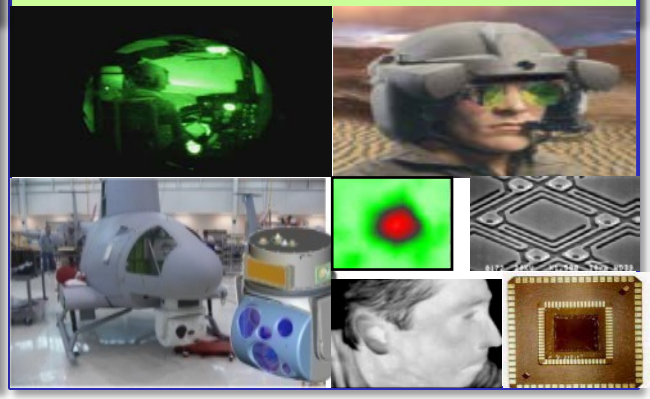
- RF Sensors
  - Active
    - Monostatic Radar
    - MIMO
  - Passive
  - Cooperative
    - Multistatic Radar
  - Non-Cooperative
    - PCL
    - SIGINT

Acoustic, Seismic, Magnetic



- Acoustic
  - Active
  - Passive
- Seismic/Acceleration
  - Ocean
  - Terrestrial
- Magnetic/E-M Field
  - Maritime
  - Terrestrial

Electro-Optics /Infrared

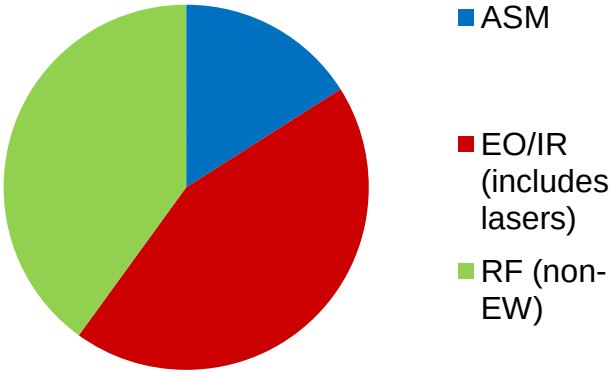


- Imaging
  - Active
  - Passive
- Lasers
  - High Power CW
  - Pulsed
- Displays
  - Direct View
  - Virtual

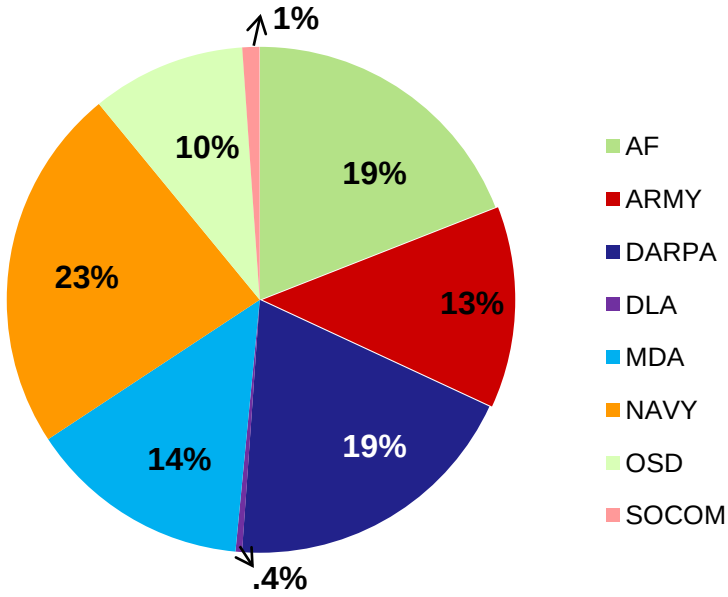
Sensor Processing is an Element of All Areas

Overview of Portfolio

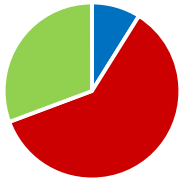
DTA FY15



Total COI Portfolio by Executing Organization

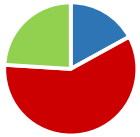


DTA FY14



DTA/EP COI Taxonomy Areas	FY11 EP COI Health Assessment	DTA FY14 Breakout	DTA FY15 Breakout
EO/IR (includes lasers)	$401.9M (59%)	$427.9M (61%)	$242.8 (44%)
RF (non-EW)	$165.8M (24%)	$217.3M (31%)	$223.6 (40%)
ASM	$114.8M (17%)	$61.2M (9%)	$89.8M (16%)
Total	*$682.5M*	*$706.4M*	*$556.3M*

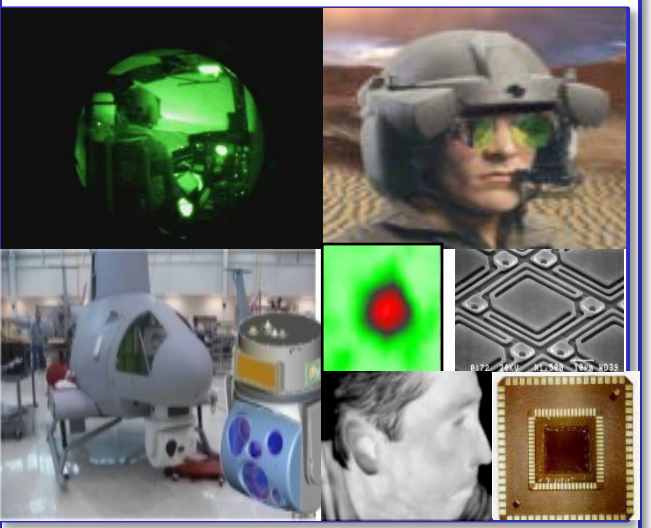
FY11 EP COI



Major S&T Initiatives

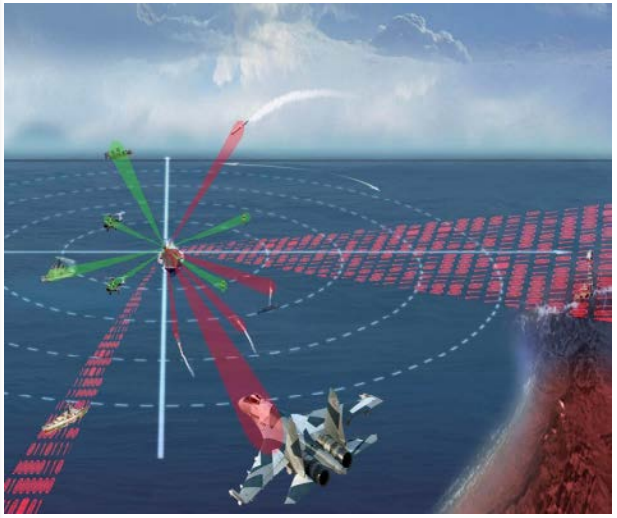
Joint
Air Force
Army
Navy/USMC

EO/IR



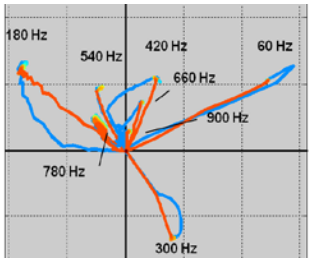
- 360º SA/DVE
  Multi-Function Lasers
- Hyperspectral
  Synthetic Aperture LADAR
- Search & Response System
  Staring Panoramic Imager
- FPAs & DROICs

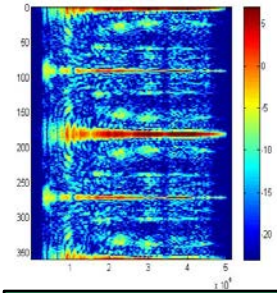
RF



- Expendable RF
- RF Power, Spectrum, Timing & Emission Control, Convergence
- Noise Radar; LPI/LPD
- Long Standoff Sensing
  SAR/GMTI
- Open Architecture RF

ASM

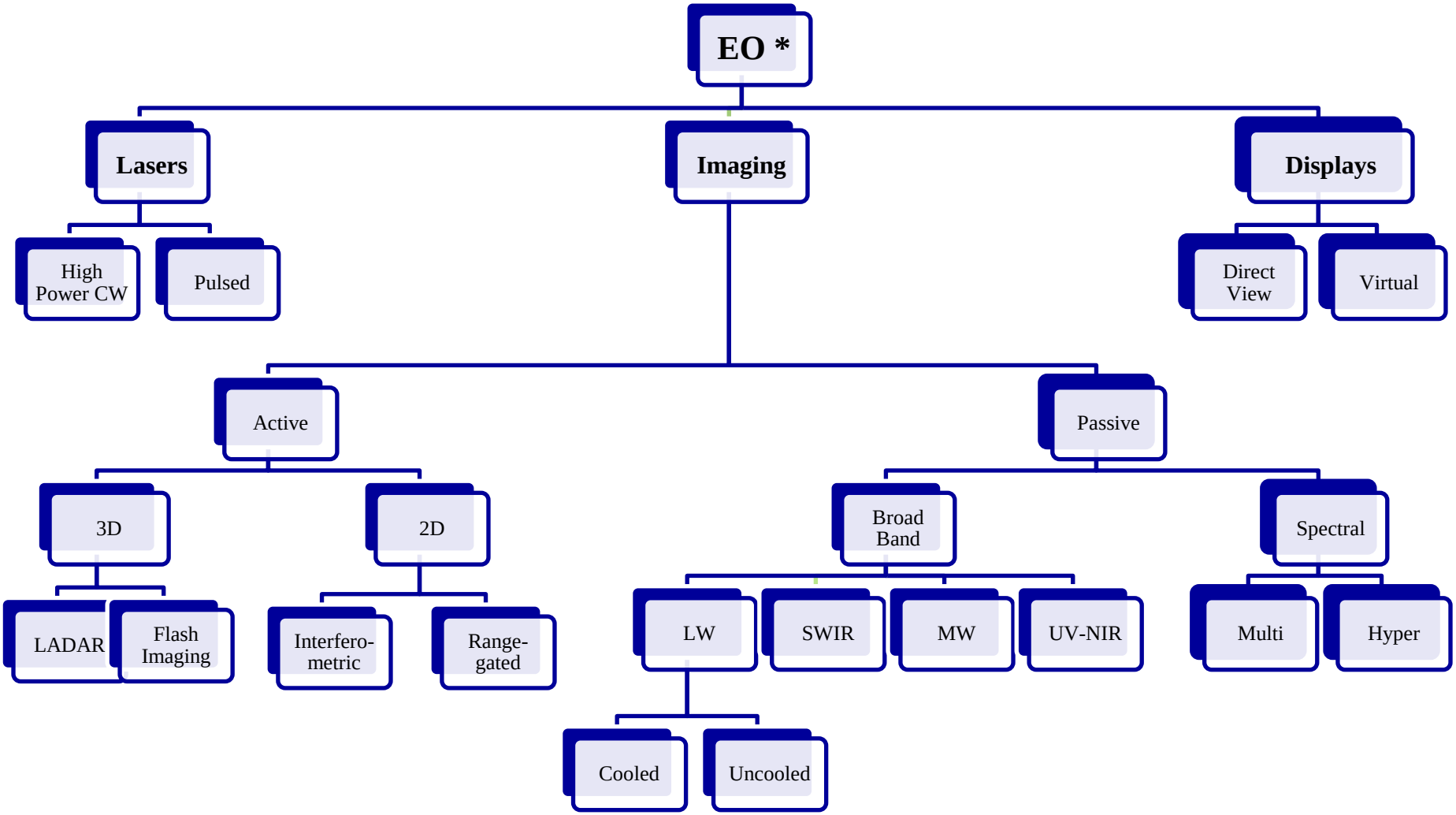




- Power Line Sensing
  Solid State E-M Sensors
- Acoustic Arrays
  UAV/UUV Magnetometer Noise Reduction
  Deep Water Acoustic Sensing

EO/IR

EO/IR Taxonomy



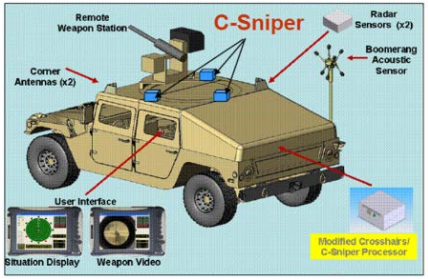
* Processing included

Warfighter Opportunity Areas

(Electro-Optics)

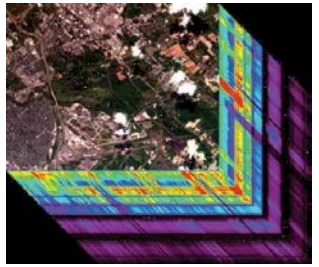
Survivable Broad Area Persistent Surveillance

- Persistent Surveillance in all weather and over all terrain conditions
- Sensors with the resolution and sensitivity required to identify and track threat systems and targeted individuals (patterns of life, hostile intent, etc.)
- Air to ground and ground to ground systems that can operate at survivable altitudes and stand off ranges



Target Detection, Recognition, and ID at Standoff Ranges

- Ability to use active imaging such as LADAR and 3-D when passive systems can not satisfy the operational requirement
- Components and processing required to extend ranges and mitigate the effects of turbulence
- Provide the capability to ID and defeat multimodal decoys and camouflage
- Accurate far target location systems including laser range-finders, azimuth measurement systems, laser designation/marking, spot trackers, and laser pointers

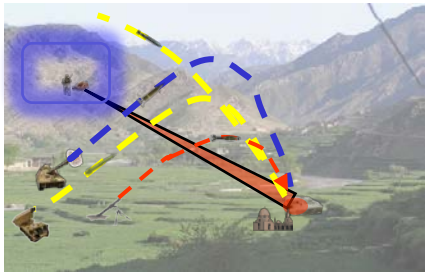


Force, Platform, and Sensor Protection

- Electro-Optic Counter-Countermeasures (EOCCM)/Infrared Countermeasures (IRCM)/ Electro-Optic Counter-Measures (EOCM) to protect friendly forces and negate threat sensors
- Explosives/mine detection with imagers and laser-based techniques
- Pilotage – operations in Degraded Visual Environments
- Multi-target/multi-track for small boat swarm attack

Battle Damage Assessment

- Support and speed kill chain
- Non-literal phenomenology to assess effectiveness of weapons effects



Technical Challenges

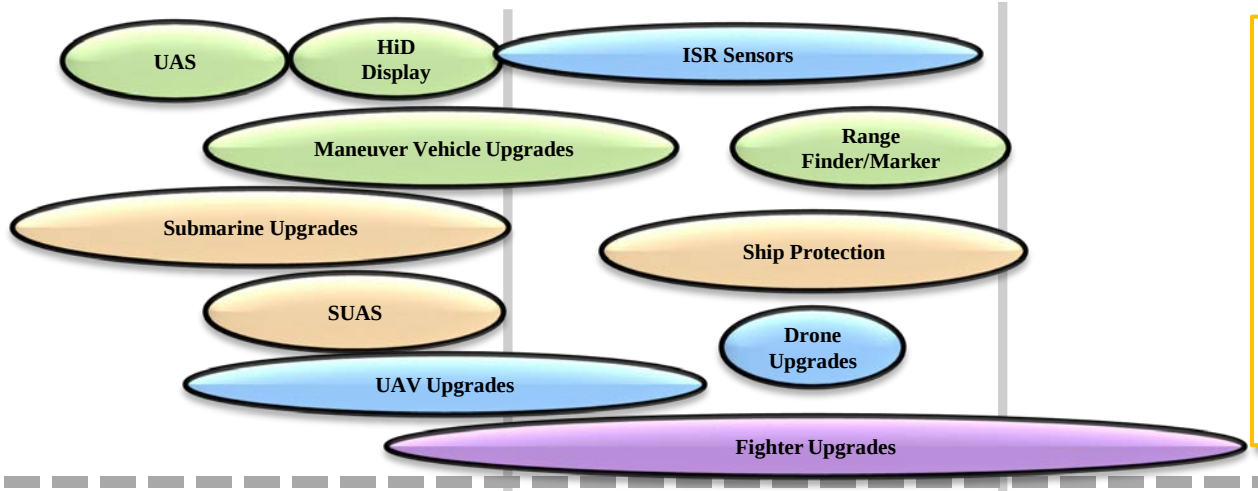
(Electro-Optics)

- **Affordable, large format IR sensors (reduced pitch, alternative substrates, alternative material systems, sensitive across multiple atmospheric windows)**
- **High performance sensors (multi-band, extended cutoff, low noise, reduced pitch, higher operating temps)**
- **High Performance Readout Integrated Circuits (well capacity/gain)**
- **Day/night, color, HD low light cameras and novel low noise pixels enabling HD color imaging**
- **High efficiency multi-band lasers and sources**
- **Multi-function lasers**
- **3D imaging and processing**
- **Light-weight, low volume optics and image formation strategies**
- **Atmospheric Mitigation & Image Formation Algorithms**

Sensor COI Roadmap - EO/IR Sub Group

Near Term | Mid Term | Far Term

Transition Opportunities

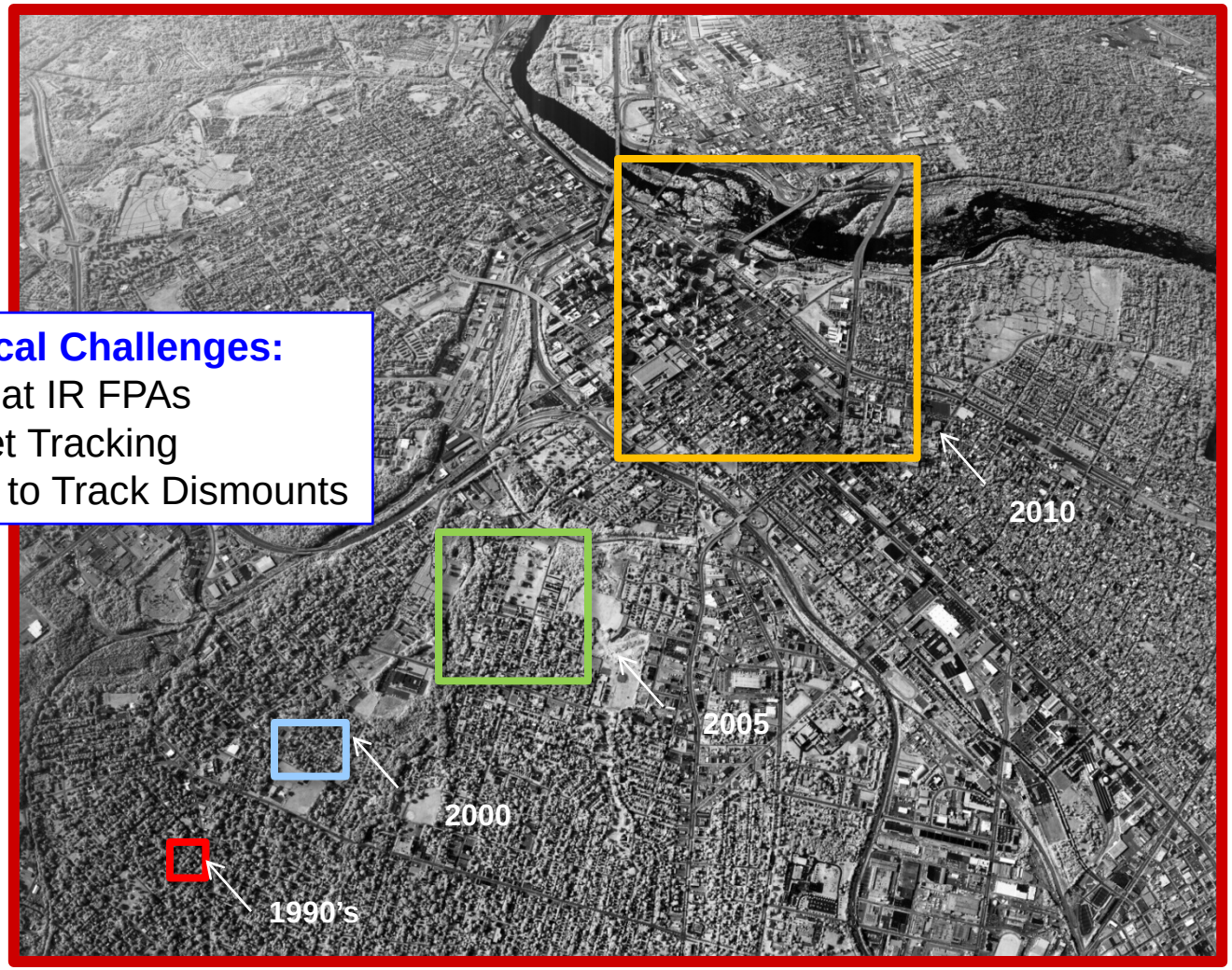


- Green Fill - Army
- Tan Fill - Navy
- Blue Fill – Air Force
- Purple Fill - Joint
- Budgeted Efforts - solid
- Prospective Efforts-dash
- 6.2 Brown Border
- 6.3 Blue Border
- 6.4+ PEO/PM Black Border

S&T Activities

Imaging Sensors		
Passive	LWIR Imaging for Airborne Platform	LWIR & ROICS Upgrades and High resolution with Large FOV for uncooled
Active	Synthetic Aperture LADAR/3D Imaging for ATR /	Large format, low cost, 3D image fusion
Lasers	Multifunction Laser for Marking, LRF, Active Imaging, Combat ID, Wind sensing and 3D Imaging	High efficiency MWIR/LWIR lasers for all weather
Displays	OLED Microdisplays	Wave Guide Displays
EO/IR Processing	Processing for Remote Weapons	Signal process for multimodal sensing

S&T Enabled Capability: Wide Area Day/Night Video Surveillance



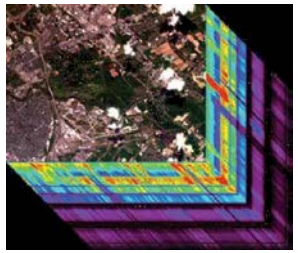
Future: Large Format, High Operating Temperature

Key Technical Challenges:
- Large format IR FPAs
- Multi-Target Tracking
- Resolution to Track Dismounts

DARPA
Air Force
Army
Navy/USMC

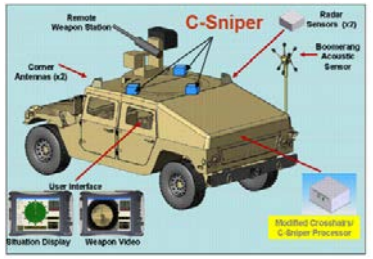
Larger Format IR Focal Plane Arrays Enable Unprecedented Real Time Day/Night Target Detection and Tracking over Wide Areas

EO/IR Opportunities



- **Multiple modalities associated with electromagnetic waves (spectral, polarimetric, temporal…) in addition to conventional spatial information will provide additional information about the targets and hence improved performance under all weather conditions**

- **Extend the static target models for dynamic target models for dynamic target acquisition by employing new modes for development in SAR and EO/IR fusion to improve decision, feature, and signal level fusion to augment ATR fusion of Battle Damage Assessment**



- **Miniaturization of sensors to fit reduced size and weight of new military platforms, especially to ease physical burden for Soldiers and small UAVs**

RF

RF Sensing Taxonomy

S&P COI	Subgroup	RF Radiation		System
Sensors and Processing	RF Sensing	Active		Monostatic Radar
				MIMO
		Passive	Cooperative	Multistatic Radar
			Non-Cooperative	PCL
				SIGINT

NOTE: Multi-static Radar and MIMO both overlap Active RF and Cooperative / Non-Cooperative Passive RF

ACRONYMS: MIMO = Multiple Input Multiple Output

PCL = Passive Coherent Location
SIGINT = Signals Intelligence

Traditional Radar Frequency Selection Factors

Selection Factor	VHF-UHF 150-800 MHz	L & S-Band 1 – 4 GHz	C & X Band 5 – 12 GHz	X & Ku 12 – 18 GHz	Ka & W 35, 95 GHz
Atmosphere & Weather Penetration					
Wall-Ground-Foliage Penetration					
Accuracy for Antenna Size					
Transmit Power Efficiency					
Identification / Discrimination					

Unfortunately, No Single Frequency Fulfills All User Requirements Leads to Radars Operating at Different Frequencies

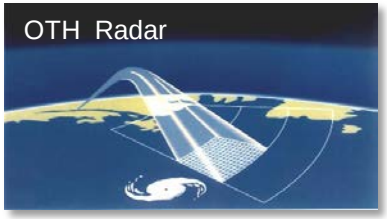
Good Marginal Bad

Warfighter Opportunity Areas

Capability Needs

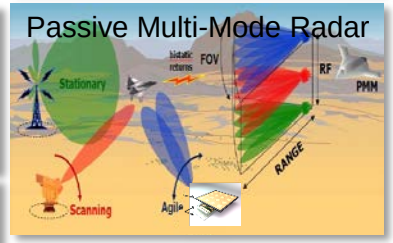
Long Stand-Off Sensing of A2/AD Environments

- Sensing as a Service / Sensing on Demand - What you need when you need it
- Long-range Air-Air, Air-Surface, and Surface-Air sensing in all RF Modes
- Provide integrated C4ISR picture and Battle Management Command & Control to all assets in theater
- Enhanced early warning protection provided by portable, bistatic Over-the-Horizon (OTH) radar
- Cooperative long range RF Illumination for stand-in aircraft using passive radars
- Perform ISR/RSTA mission for tactical superiority



Persistent Stand-In Sensing in Area-Denied Environments

- Counter Rocket, Artillery, and Mortar (C-RAM) radar for improved force protection
- Active and passive RF Sensing in all weather, terrain, and battlefield conditions
- Detect and track critical mobile ground targets and ID patterns of life and utilization
- Low-Cost “Expendable RF” for stand-in GMTI/SAR in area-denied airspace



Detection and Identification of Enemy Combatants

- Airborne detection & tracking of dismounts & vehicles in all weather/ all environs
- Ground-based & airborne detection of Explosive Hazards (landmines, IEDs, bunkers, tunnels, and underground facilities)
- Ground-based & airborne Detect/Track/Classify enemy combatants

Detection of Concealed Targets & Threats

- RF imaging to find static, concealed targets
- Concealed detection, ID explosives, Counter Target / Counter Battery

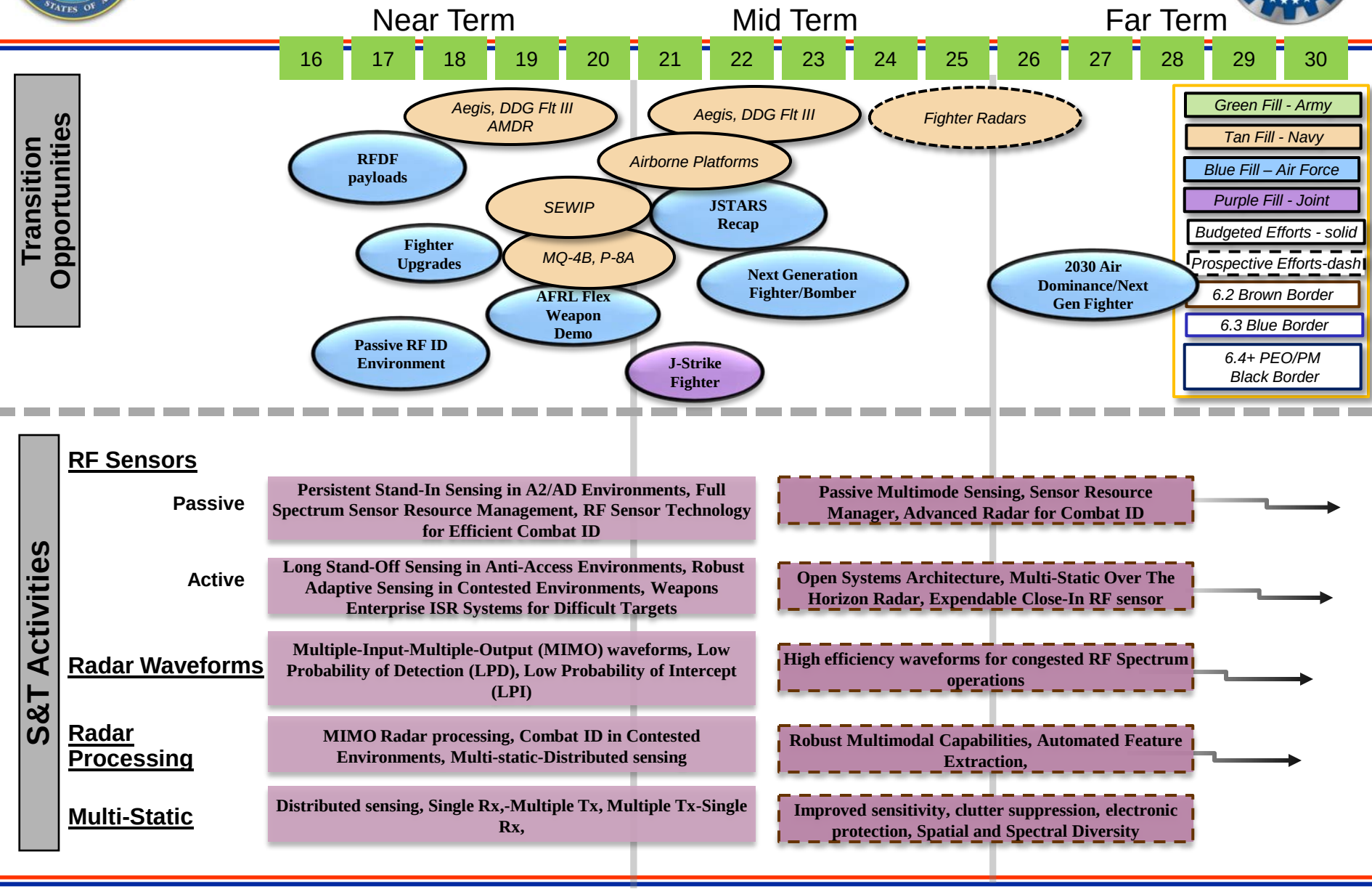
Multi-Platform Integrated Sensor Resource Management (SRM)

- Cross-platform distributed RF Sensing, target cueing, and effects coordination
- Dynamic allocation of RF power, spectrum, processing, multi-sensor data fusion
- Multiple simultaneous cooperative modalities
- Cognitive Radar for mitigating congested and contested spectrum

RF Technical Challenges

- **Long Stand-Off** - Power-aperture, low slant angle, resolution, clutter, obscuration, slow asset repositioning, simultaneous field of view, multi-static radar
- **Persistent Stand-In** - Tx: Novel waveforms and adaptive use of contested sensing spectrum Rx: Passive Multi-Mode (PMM) radar, MIMO, distributed radar processing
- **Open System Arch** - Maximum interoperability, autonomous multifunction RF, multi-platform sensor resource management, simultaneous mode scheduling, maximum use of diversities, simultaneous transmit and receive (STAR) apertures
- **Advanced Components** - High dynamic range, wideband receivers, affordable AESA components for SWAP-constrained payloads (low prime power, high performance), improved power added efficiency, element level-DREX
- **Expendable RF** - Small Loitering ISR Munition (SLIM): software-defined radar/comms, low cost phased arrays, reduced processor-load algorithms
- **Concurrent EP** - Radar/Electronic Protection, operate in spectrally crowded environments

Sensor COI Roadmap - RF Sub Group

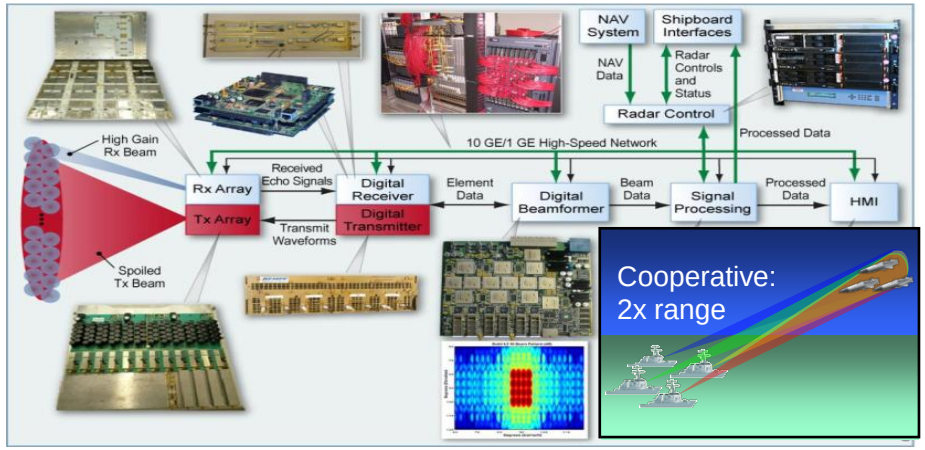


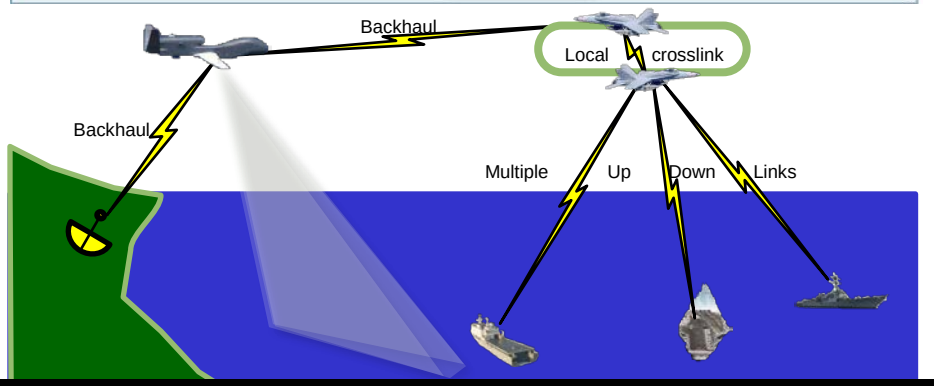
Examples of flagship programs
RF Open System Architectures

Warfighter Impact:
- Capability: Enables new capabilities that cannot be attained with traditional RF systems
- Stovepipes: Prioritize communications, radar, and/or electronic warfare functions you need, when you need them
- Cost: Significant procurement, support, tech insertion, and total ownership cost benefits

Transition Plans:
- Complete: Air and Missile Defense Radar
- FY12: USAF MOSA Back End
- FY21: Surface Enterprise Air Surveillance Radar
- FY25: Future X-Band Radar

S&T Objectives:
- Dynamically selectable RF functions
- Multi-system/multi-platform precision arbitrary RF scheduling, execution, collection, processing, s haring, and reprocessing enable otherwise unobtainable capabilities
- Robust open specifications for effective piecewise acquisition, tech refresh, and obsolescence management



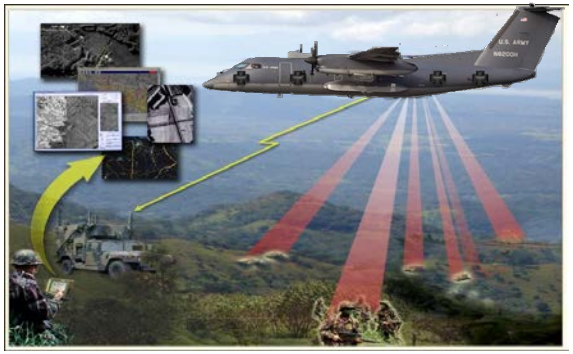


YES: Integrated Prioritized RF Capability. NO: Either Radar System OR Communications Pod.

RF openness at multiple levels enables efficient technology insertion, reuse, repurposing, scalability, prioritization, and integrated distributed RF effects.

Examples of flagship programs
Ground Moving Target Indicator – Foliage Penetrating

Warfighter Impact: A robust penetrating radar capability on a fixed wing aircraft that will image stationary targets and detect, geolocate, and track ground moving targets to defeat an enemy's ability to freely maneuver while concealed by foliage.



Transition Plans:

- FY17 Lessons Learned from Concept Development to:
  - TCM-IS for requirements development of the CCS CCD
  - PM SAI for platform integration development
- FY19 Airborne multi-INT open system architecture
- FY20 GMTI/F Technologies to PM SAI

S&T Objectives:

- Develop an electrically large antenna aperture (DPCA, MIMO) for DCH-8 airframe
- Develop radar resource manager for dynamic frequency and energy management
- Develop an open system architecture for integration of radar on a multi-INT platform
- Develop tools and techniques for automatic target extraction in high clutter environment

Technical Challenges:

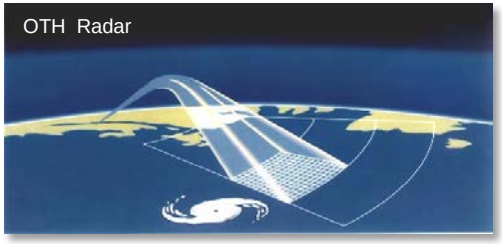
- Large aperture, airframe compatibility
- Size, Weight and Power
- Dynamic Frequency Management
- Small target exploitation
- High clutter environment
- Cost control
- Multi-INT aircraft open system architecture

Key Performers:

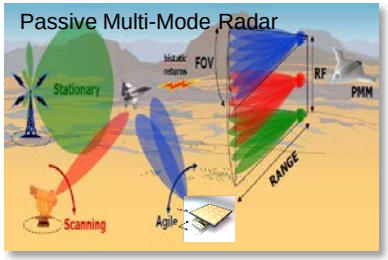
- CERDEC Intelligence & Information Warfare Directorate
- Army Research Lab
- PM Sensors-Aerial Intelligence

RF Opportunities

- **Long Stand-Off Sensing of A2/AD Environments**
- **Persistent Stand-In Sensing in Area-Denied Environments**
- **Detection and Identification of Enemy Combatants**
- **Detection of Concealed Targets & Threats**
- **Multi-Platform Integrated Sensor Resource Management (SRM)**



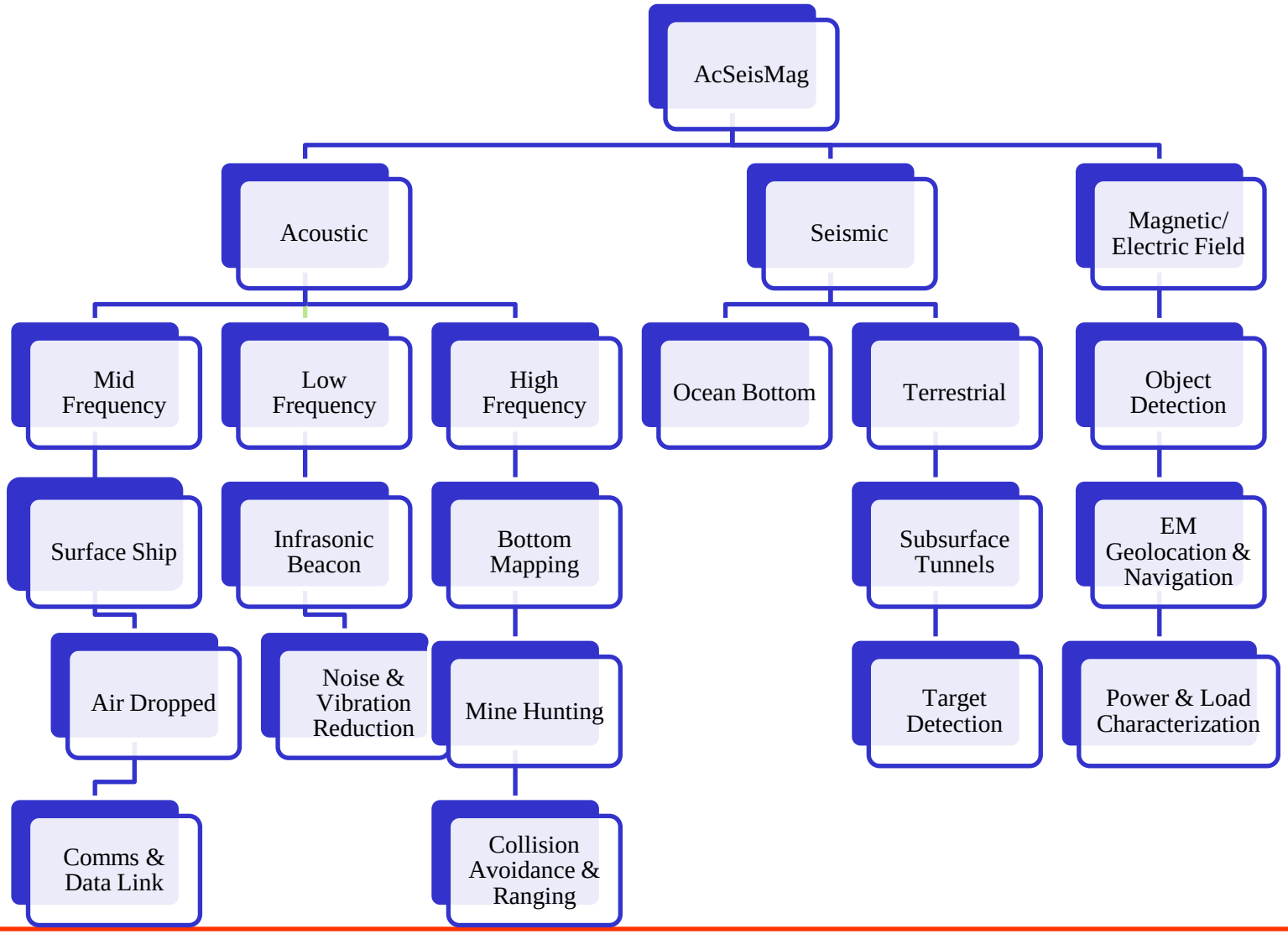

Multi-Platform Sensor Resource Management



Acoustic, Seismic and Magnetic

Application Taxonomy

Acoustic Seismic and Magnetic/E-Field

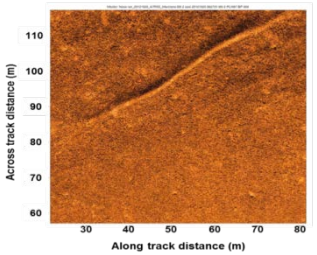


Warfighter Opportunity Areas

(Acoustics & Seismic)

Broad Area Persistent Surveillance

- Ensure access to the global ocean and littoral reaches and hold strategic and tactical targets at risk.
- Off-board sensing, cooperative vehicle autonomy, increased endurance, autonomous classification, data exfiltration, and networking in unmanned systems
- Unattended ground system (UGS) for Forward Operating Bases (FOB) and border surveillance
- Multifunctional algorithms for diverse threat situational awareness & ISR



Counter Enemy Use of Sensors and Weapons

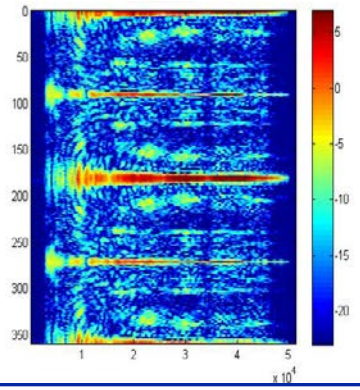
- Sonar interception that provides warning well in advance of detection
- Automatic classification that supports effective countermeasure employment
- Acoustic detection & localization of mortars, rockets & gunfire
- Counter-Unmanned Aerial Systems (C-UAS) to detect, locate, and cue imaging or threat neutralization technologies

Detection of Proud, Buried and Volume Mines

- Rapid detection of mines
- Operations from a distance, keeping ships and sailors out mine fields
- Much longer ranges and much higher area coverage rates

Detect and Track Targets

- Detect, classify, localize and track threat submarines
- Active and passive sonar automation technologies for operator workload reduction
- Distributed systems for wide area search and surveillance
- Very long-range infrasonic detection of events and targets of interest
- Multiple-array tracking of ground & air vehicles, gunshots, mortars, rockets
- Robust classification algorithms
- Non-emitting vehicle and weapons detection and tracking



Detect and Locate Underground and Surface Activity

- Detect, locate & assess activity associated with tunnels & UGFs
- Mine & IED detection
- High propagation speed
- Synergistic with atmospheric acoustics & infrasound
- Fusion of atmospheric acoustics with seismic to estimate range target

Warfighter Opportunity Areas

(Magnetics & Electric-Fields)

Magnetic Anomaly Detection (MAD) for ASW Targets

- MAD from additional platforms.

Buried Mine Identification

- Reduce false alarms
- Increase PD/PC in complex MCM environments to avoid missing mines during clearance
- Reduce MCM operator workload
- Site surveys for buried UXO

Surveillance

- Unattended Ground Sensors (UGS)
- Persistent surveillance to cue ASW assets

Magnetic Stealth for the Fleet

- Cost effectively reduce susceptibility to mines and ASW

E- and B- field phenomena may be passively exploited as a signal of opportunity

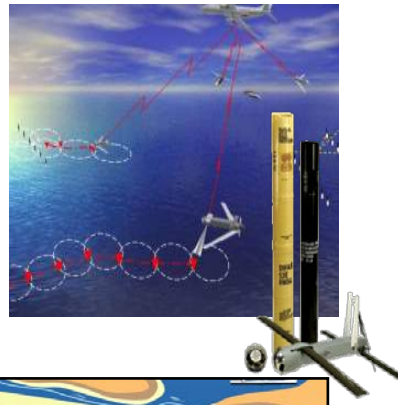
- Moving object event counting, localization, and electrostatic signature classification
- E- & B- signals for Assured PNT and Direction Finding
- Physiological Monitoring
- Energy harvesting for self-powered continuous sensors
- Low frequency digital & analogue communications

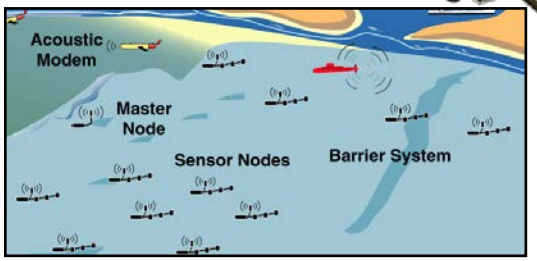
Unique active sensing possibilities

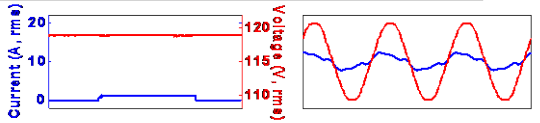
- Magnetic induction
- Mutual capacitance
- Underground anomaly detection through soil impedance measurements

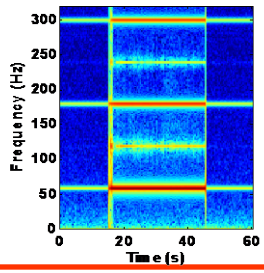
Low Cost, High Sensitivity Sensors that Consume Little Power

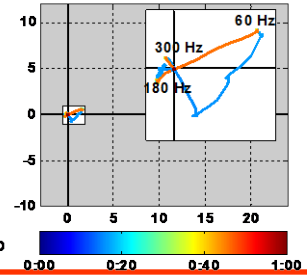
- MEMS Flux concentrator
- Energy efficient receiver wakeup

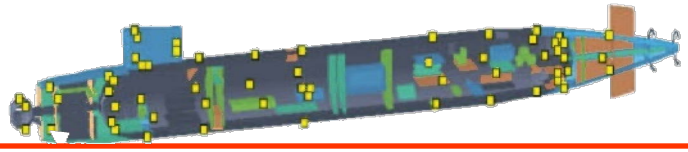












Technical Challenges
(Acoustics & Seismic)

Ocean Acoustics

- High performance two dimensional passive arrays that exploit elevation and azimuthal variations in the noise field
- Small low power sonar and acoustic interceptors that detect acoustic threats
- Deep water acoustic sensors that exploit low noise environments.
- Long range synthetic aperture sonars (SAS) that discriminate targets
- Compact sonar array technologies and signal processing algorithms to provide and fuse structural acoustic signatures with high resolution imagery.

Air Acoustics

- Detection of low SNR targets for ASW passive sonar systems
- Robust signal classification in complex environments and after extended propagation ranges
- Technologies to replace larger arrays with small-aperture microphone arrays or particle velocity sensors

Seismic

- Ground conditions are unknown & asymmetric due to geology variability
- Significant clutter near urban areas
- Shallow seismic susceptible to airborne acoustics
- Timely access to data from ocean bottom seismometers in tactically and strategically relevant environments

Technical Challenges
(Magnetics & Electric-Field)

- **Low SWAP-C magnetometers**
  - Magnetometers on unmanned platforms
  - Low cost magnetometers for wide area coverage
- **Noise reduction to utilize magnetometer performance**
  - Platform integration
  - Environmental noise
- **Area with virtually zero industry investment making DoD laboratories the only technology source**
  - Few collaborators, minimal literature base, limited sensor selections
  - Low-TRL levels
  - Limited university research: need more national infrastructure
- **Signal processing challenges**
  - Clutter significant (EMI from platforms, power lines, etc)
- **Transducer and sensor designs**
  - Significant and unfavorable physics tradeoffs between cost, SWaP, and transducer sensitivity
  - Cost of low quantity production
  - Sensitivity: dipole signal decreases as $1/r^3$
- **Platform integration**
  - Conductor materials (metals) are shields or flux concentrators
  - Communications between sensors & between sensor & Hub

Sensor COI Roadmap - ASM Sub Group

Near Term | Mid Term | Far Term

16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Transition Opportunities

- NEST
- P8
- Army: BAIS
- PSS-T
- Gunfire detection POR
- LCS
- SURTASS and FSS
- IWS5A APB
- Virginia Class SSN
- Ohio Replacement SSBN

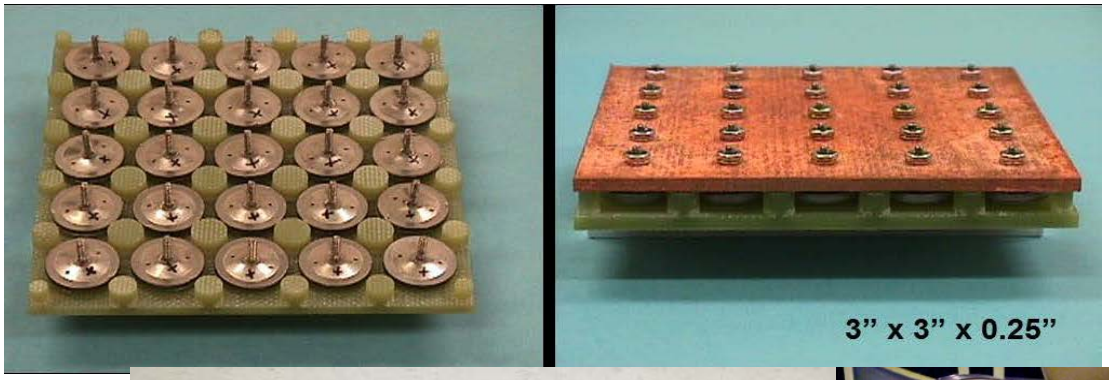
Green Fill - Army
Tan Fill - Navy
Blue Fill – Air Force
Purple Fill - Joint
Budgeted Efforts - solid
Prospective Efforts-dash
6.2 Brown Border
6.3 Blue Border
6.7 Black Border

S&T Activities

Acoustic Sensors

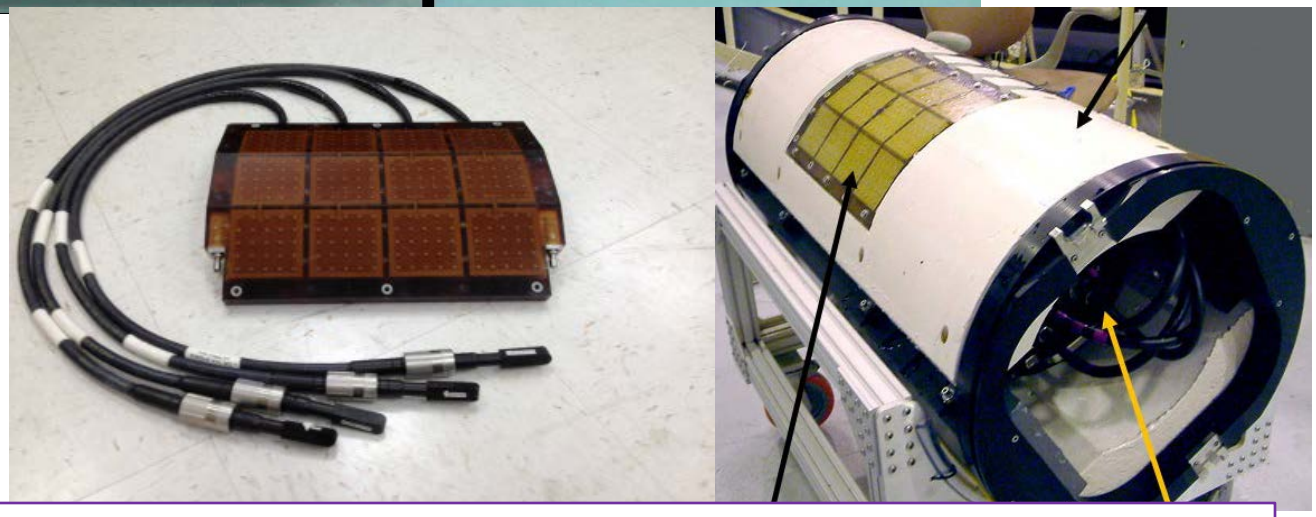
Passive	Vector Sensors; large multi-dimensional arrays; deep water sensing; gunshot detection; persistent infrasonic sensors	Detection accuracy in urban & complex channels; improved sensing arrays for submarines
Active	Advanced broadband source and receiver array technologies ; AUV based mine hunting; fusing of structural and image signatures	Single-pass mine hunting capability for buried mines in very shallow water (VSW).
Magnetics	Chip Scale Atomic Magnetometer ,; UAV Noise Mitigation; UUV Noise Mitigation; Vector Magnetometers	Advanced Clutter Reduction; MQ-8C & MH-60R Noise Mitigation; Vector Magnetometer
Seismic	Laser vibrometry & shearography; Multimodal sensors; Identify noise sources and mitigate	Couple seismic/acoustic sensors to cue other modalities for increased performance
Electric Field	3 modality power line sensor for ISR and microgrid; 1/f noise reduction MEMS flux concentrator; Ground sensors	Signal processing and algorithms for predicting fault conditions

S&T Enabled Capability: Low-Frequency Broad Band Acoustic Projectors



Innovative projector requires less power to generate acoustic energy over the spectrum of interest

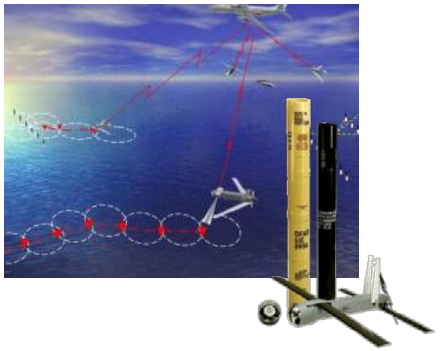
Capable of delivering a significant acoustic output over an extended frequency range.



One projector covers entire frequency band with excellent directivity characteristics. The innovative projector that utilizes new materials can show improvement in acoustic source levels as compared to identical units made from legacy ceramics.

ASM Opportunities

- Broad Area Persistent Surveillance
- Detection of Proud, Buried and Volume Mines
- Detect and Track Targets
- Detect and Locate Underground and Surface Activity
- Magnetic Anomaly Detection (MAD) for ASW Targets
- Buried Mine Identification
- Surveillance
- Magnetic Stealth for the Fleet
- E- and B- field phenomena exploited as a signal of opportunity
- Unique active sensing possibilities
- Low Cost, High Sensitivity Sensors that Consume Little Power



Summary & Closing

MSS:
An invaluable information exchange that encourages Reliance

- **MSS presently serves as the only classified/limited distribution, US-only, ITAR restricted forum for communication within the US Military Sensing Community**
  - 1900 attendees/year (56% contractor, 34% DoD, 10% other government)
  - Classified proceedings are published for all conferences
    - Serve as a historical record of US Military Sensing Technology vital to US defense beginning in the 1950s
    - Papers are provided at no cost to the US military sensing community (with appropriate clearance and NTK)
    - Conferences are composed only of high quality, refereed technical papers - NO marginal content.
    - Papers are highly valuable input to the DTIC library – often cited as key references
    - Reduces duplication of military sensing research.
  - Close cost scrutiny has assured total MSS conference expenses remain modest and meetings remain cost effective.
  - Programmatic Harmonization Can Be Added to MSS
  - Planning the migration of MSS meeting administration to a DoD hosted MSS website later this year.
  - Targeting the website to be a part of the DTIC Techpedia but the final location is not finalized.

Conference Moratorium had major negative impact on MSS. Momentum re-established in CY14.

Active/IRCM

Tri-Service Radar

Parallel (EO/IR)

BAMS

National + Sensor Data Fusion

Gap assessment (EO/IR)

- Assessment of Priority Gaps
  - Many IR imaging applications require wide area, fine resolution, fast frame rate and high dynamic range operation which, in turn, stresses state-of-the-art image readout technology, bandwidth available with RF links and sensor SWaP
  - Development of Digital ROICs (D-ROICs) has the highest potential for providing leap-ahead technology for EO/IR sensing capability with high frame rates, wider dynamic range and increased on-chip signal processing
  - Success in this area will have operational benefits for: Wide Area Motion Imagery/Persistent Surveillance, DVE penetration, Fast scanning for FOB protection and IRST
- Recommendations to close gaps
  - Army has programmed out-year S&T dollars to partially address the gap
  - ManTech investment will be required to provide affordability
  - Potential resource leveraging with DARPA or MDA
- Opportunities to leverage non-DOD investments:
  - Some IR&D exists from FPA vendors, but not enough to produce affordable parts and unlikely that they will sell to other FPA competitors
  - Foundries have shown willingness to invest in process capability with business case motivation

D-ROICS Will Enhance Multiple War Fighting Capabilities And Maximize Performance Of Existing And Emerging FPAs

Gap assessment (EO/IR)

- Assessment of Priority Gaps
  - With the development of advanced night vision equipment we conquered darkness (Own the Night), but world-wide proliferation of night vision technology has decreased operational superiority of our warfighters. The next step will be to “Own the Atmosphere” mitigating effects of deleterious atmospheric conditions (turbulence, clouds, haze, fog, rain, snow, dust, smoke) on long range high resolution sensing.
  - Recent Army efforts on degraded visual environment pilotage (dust) have demonstrated promising results.
  - Broad Area Maritime Surveillance capability is severely impacted by presence of cloud cover and marine haze/fog.
- Recommendations to close gaps
  - Initiate 6.1 and 6.2 research activities in exploring diversity sensing (time, spectrum, polarization) combined with multi-frame image processing and enhancements to achieve desired operational capability.
- Opportunities to leverage non-DOD investments:
  - Biomedical imaging community has parallel interest in deep tissue imaging via non-ionizing radiation. Imaging through inhomogeneous and complex media is also a foundational challenge for President’s BRAIN initiative.

Explore Advanced Sensors And Processing Techniques To Provide Warfighters Enhanced Capabilities When Operating In Degraded Visual Environments

Gap assessment (RF)

- Assessment of Priority Gaps
  - Dynamic flexibility to support the most urgent tactical needs of the moment will come from multifunction within each system, which will require a reasonable degree of openness
  - Development of a cooperative networked radar will have the effect of improving search coverage, detection range and resolution without increasing individual platform Aperture, Power, Processing.
  - Even with the open systems work being done by the services, there is a need for an effective standards body to achieve meaningful interoperability at the RF and systems level
- Recommendations to close gaps
  - Develop Government-owned, hardware-independent Open Systems Architecture to support increased competition, broaden vendor base, improved tech insertion and decreased Life Cycle Cost
  - Leverage on-going service lab research efforts to demonstrate that fully utilizing multiple platform resources in a collaborative manner with a Sensor Resource Manager (SRM) we can schedule, execute, receive, process, share, and reprocess those same resources for a significant improvement in performance
  - Potential resource leveraging with DARPA Program addressing open systems
- Opportunities to leverage non-DOD investments:
  - DOD is the primary investor in closing the stated gaps.

Open RF System Architecture Will Add Significant Operational Capability And Improve The Material Development Process Providing The Systems

Gap assessment (Acoustics)

- Assessment of Priority Gaps
  - U.S. Navy ships utilize active sonar systems to detect, classify, and track adversarial submarines. Other Navy assets utilize active sonar systems to detect and classify mines.
  - Many of the mine detection systems that are in use or under development are operated from Unmanned Undersea Vehicles (UUVs) that have limited energy storage capacity.
  - All types of active sonar systems, and particularly the UUV based ones, can be greatly enhanced by the development of high-power, high-efficiency, low-cost, low-weight/volume transduction materials.
  - Sensing in complex urban environments requires small aperture arrays, vector sensing and noise mitigation approaches for systems on moving Soldiers, ground vehicles, and on airborne platforms.
- Recommendations to close gap
  - Research on innovative materials and device structures is being pursued to enhance the performance of the electro-mechanical transducers used by the Department of Navy to generate, detect and suppress undersea sound waves.
  - The present Office of Naval Research program has two thrusts. The first aims to devise and validate first-principles quantum-mechanical methods to evaluate the properties of materials with structural phase transitions; this will enable the exploration of the properties of new materials systems in advance of their synthesis. The second focuses on new piezoelectric single crystals; efforts underway aim to produce and characterize these piezocrystals and to design/fabricate innovative transducers from them for Navy sonar systems
  - Complete development and transition ceramics into a transducer to replace the costly slotted cylinder projector currently in use.
  - Pursue advanced signal processing and novel sensor approaches to robustly separate and localize low-SNR acoustic target signatures embedded within motion-induced flow-noise, wind and platform vibrations.

A New Acoustic Source Array Is Needed With A Larger Bandwidth And A Reduced Cost

Conclusion

- The Sensor COI will continue to act as OSD's principal Reliance tool for technical and programmatic de-confliction and coordination of efforts under the purview of the Sensors COI
- The COI stands ready to work with industry to share gaps, technical challenges, and technical directions (subject to the limitations of the FAR, disclosure policy, and other DoD directives)
- The COI membership will also seek to identify key Contractor IRAD efforts and leverage them to the maximum extent possible across the department.