



# Sensor and Processing COI

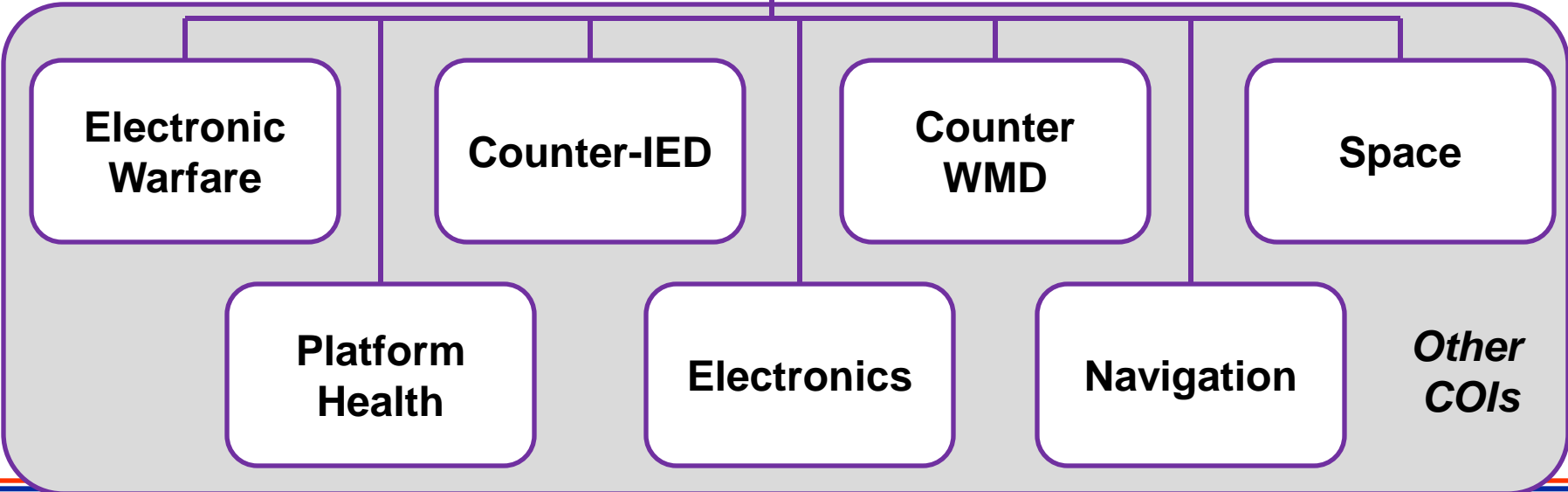
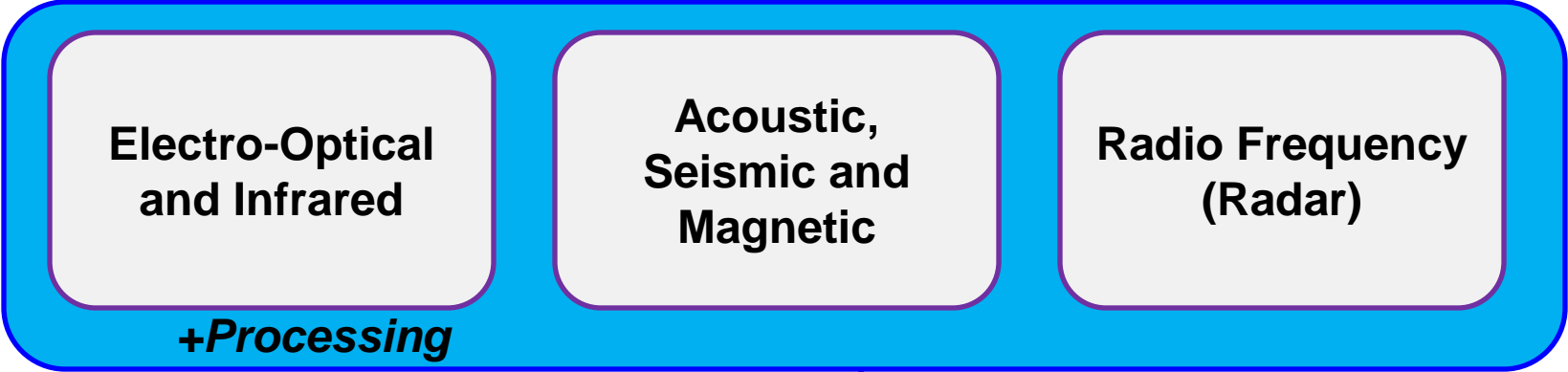


# Sensors in the DOD



**S&P COI = Battlefield Surveillance and Targeting**

## *Sensors*





# 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) 
    - Military: Focus on highest performance at acceptable cost (10-1,000X consumer thresholds)
- DOD does not invest in CMOS day TV cameras
- 
- **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  
  
360° 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  
360° 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



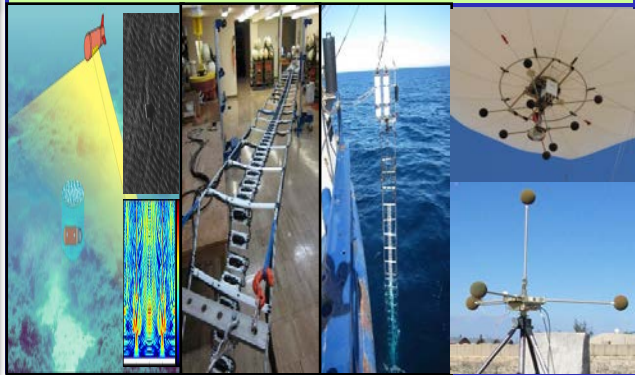
# Taxonomy

## Sensors and Processing Technology

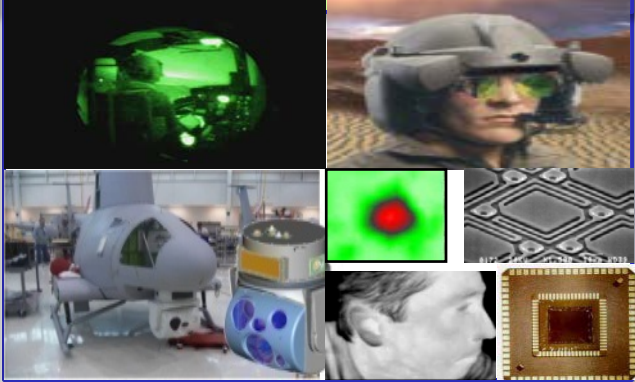
### RF (non-EW)



### Acoustic, Seismic, Magnetic



### Electro-Optics /Infrared



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

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

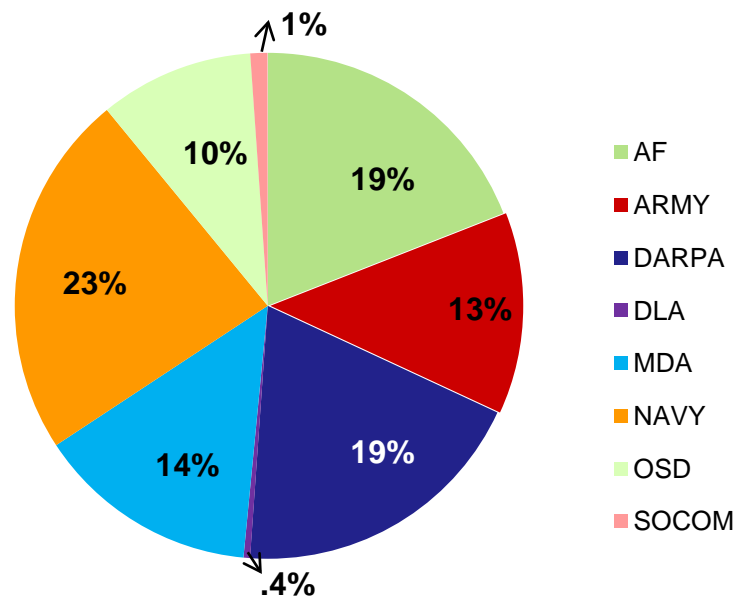
- Imaging
  - Active
  - Passive
- Lasers
  - High Power CW
  - Pulsed
- Displays
  - Direct View
  - Virtual

**Sensor Processing is an Element of All Areas**

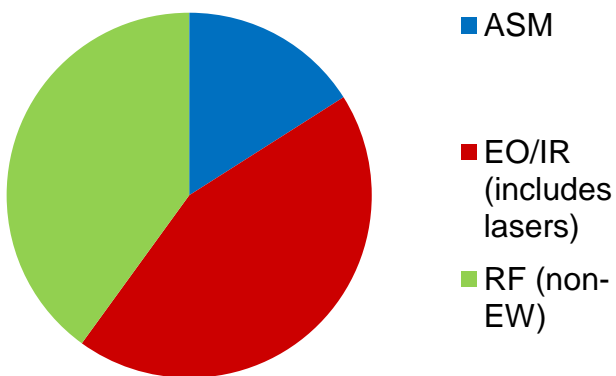


# Overview of Portfolio

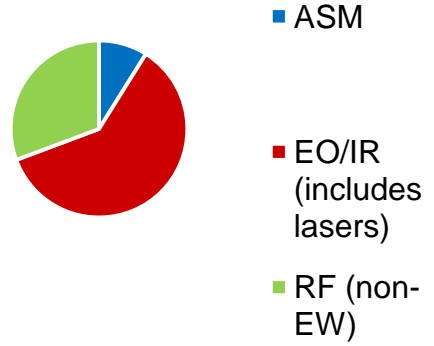
Total COI Portfolio by Executing Organization



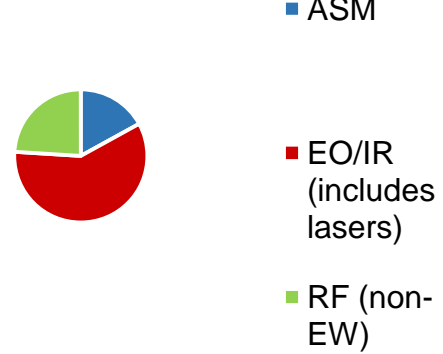
DTA FY15



DTA FY14



FY11 EP COI



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%)
<b>Total</b>	<b>\$682.5M</b>	<b>\$706.4M</b>	<b>\$556.3M</b>



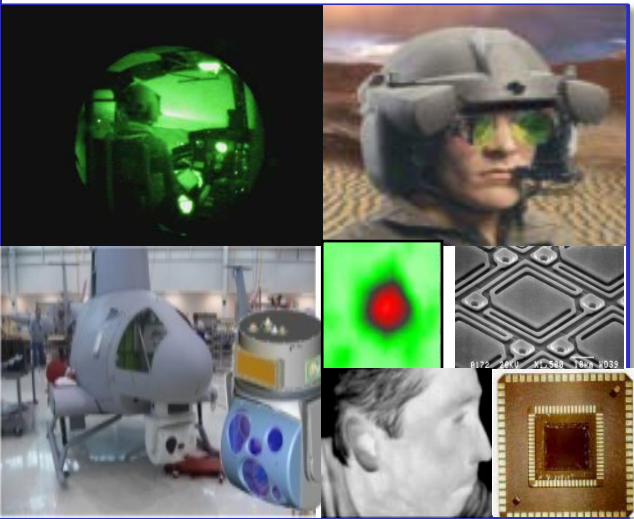


# Major S&T Initiatives

Joint
Air Force
Army
Navy/USMC

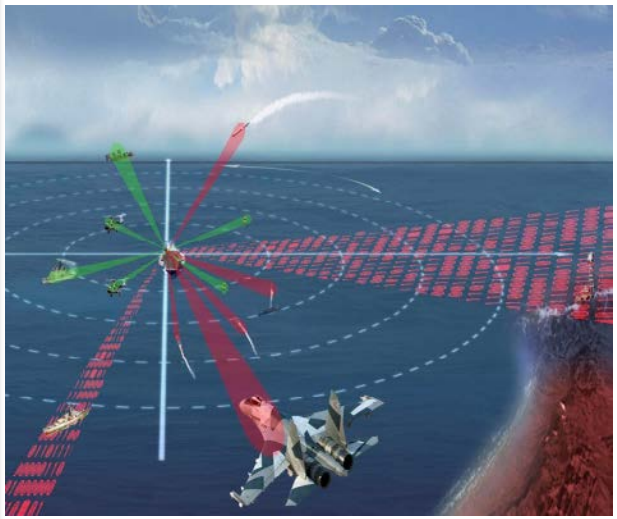


## EO/IR



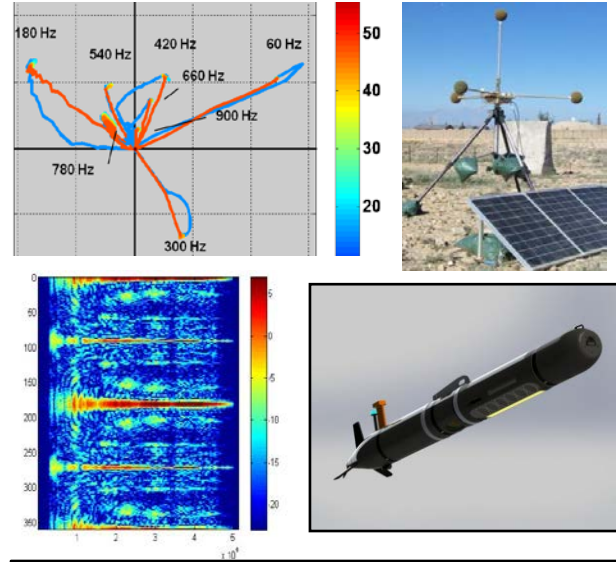
- 360° SA/DVE
- Multi-Function Lasers
- Hyperspectral
- Synthetic Aperture LADAR
- Search & Response System
- Staring Panoramic Imager
- FPA's & DROICs

## RF



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

## ASM



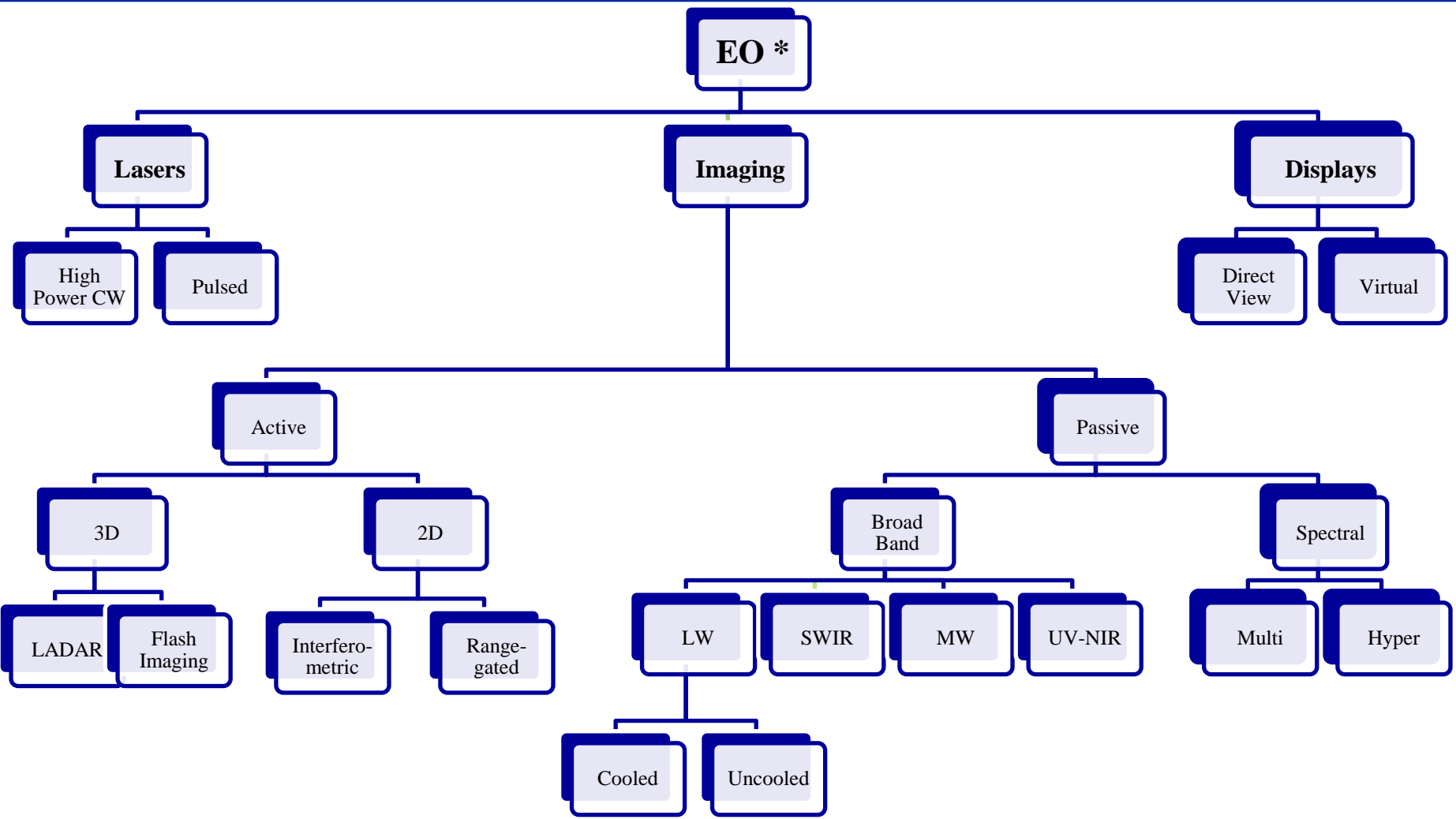
- Power Line Sensing
- Solid State E-M Sensors
- Acoustic Arrays
- UAV/UUV Magnetometer Noise Reduction
- Deep Water Acoustic Sensing



# EO/IR



# EO/IR Taxonomy



\* Processing included



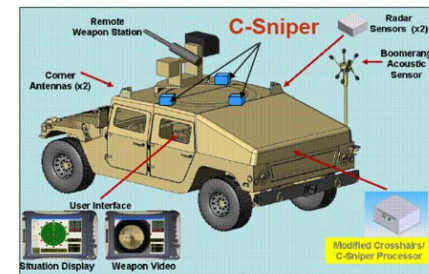
# Warfighter Opportunity Areas

## (Electro-Optics)



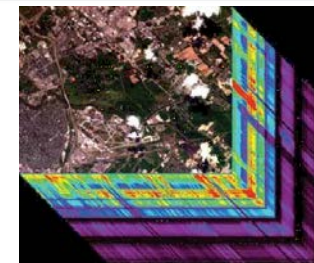
### Survivable Broad Area Persistent Surveillance

- 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



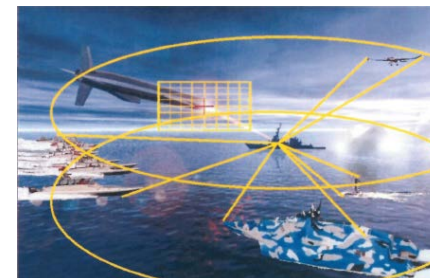
### Target Detection, Recognition, and ID at Standoff Ranges

- 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



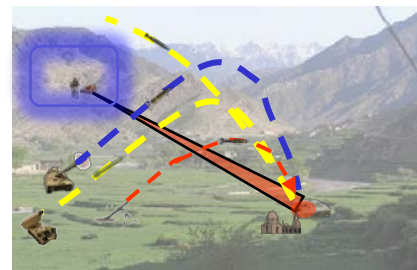
### Force, Platform, and Sensor Protection

- 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

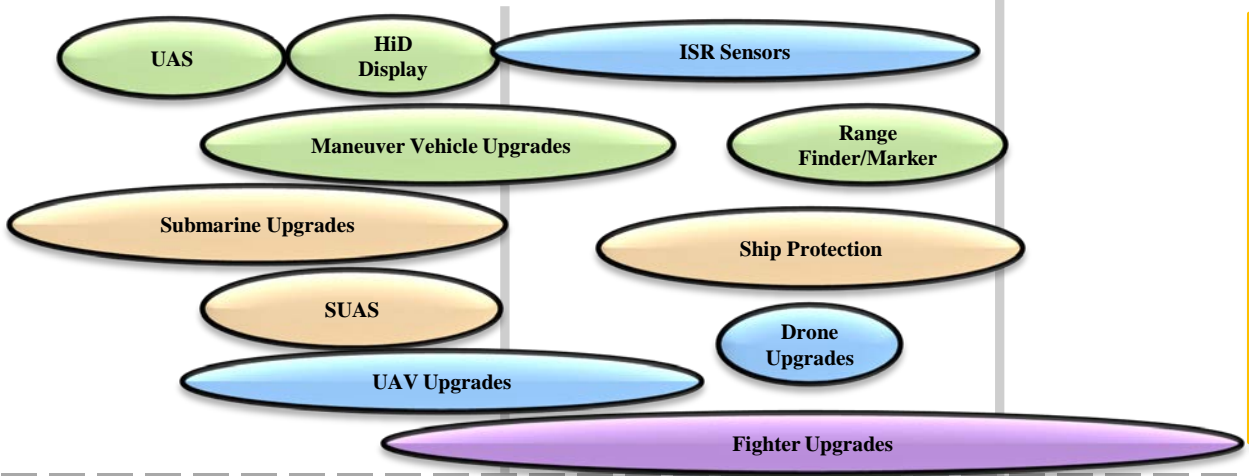


Near Term

Mid Term

Far Term

Transition Opportunities



Green Fill - Army
Tan Fill - Navy
Blue Fill - Air Force
Purple Fill - Joint
Budgeted Efforts - solid
Prospective Efforts - dashed
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**

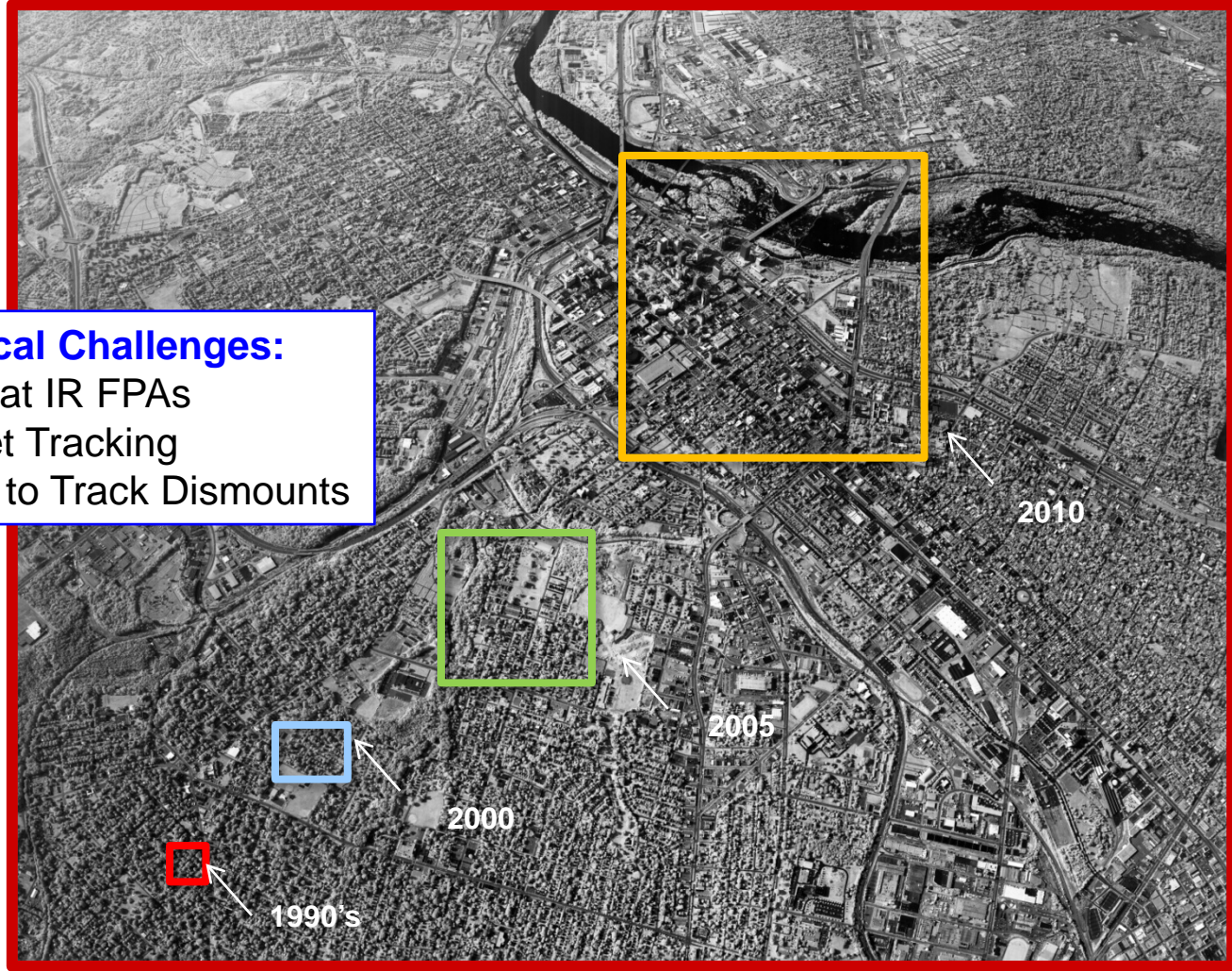
OLED Microdisplays | Wave Guide Displays

**EO/IR Processing**

Processing for Remote Weapons | Signal process for multimodal sensing



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



**Key Technical Challenges:**

- Large format IR FPAs
- Multi-Target Tracking
- Resolution to Track Dismounts

Future: Large Format, High Operating Temperature

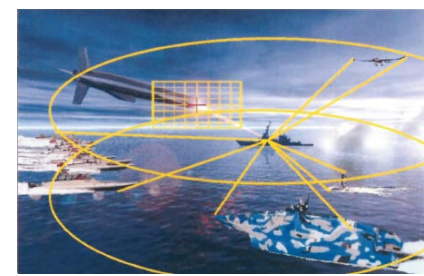
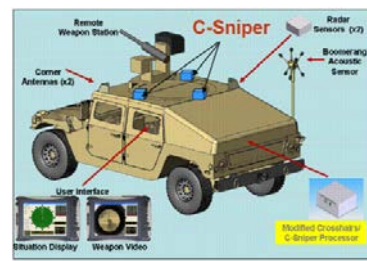
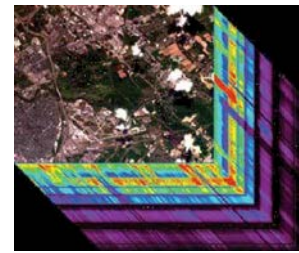
DARPA
Air Force
Army
Navy/USMC

**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	Good	Good	Marginal	Marginal	Marginal
Wall-Ground-Foliage Penetration	Good	Marginal	Bad	Bad	Bad
Accuracy for Antenna Size	Bad	Marginal	Good	Good	Good
Transmit Power Efficiency	Good	Marginal	Marginal	Marginal	Bad
Identification / Discrimination	Marginal	Marginal	Good	Good	Good

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

Good

Marginal

Bad

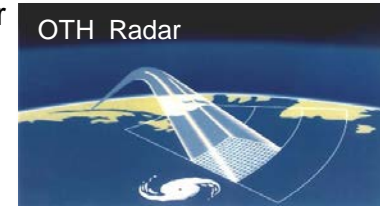


# Warfighter Opportunity Areas Capability Needs



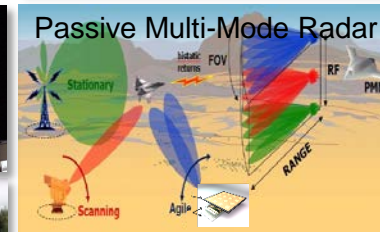
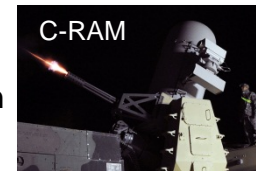
## Long Stand-Off Sensing of A2/AD Environments

- 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



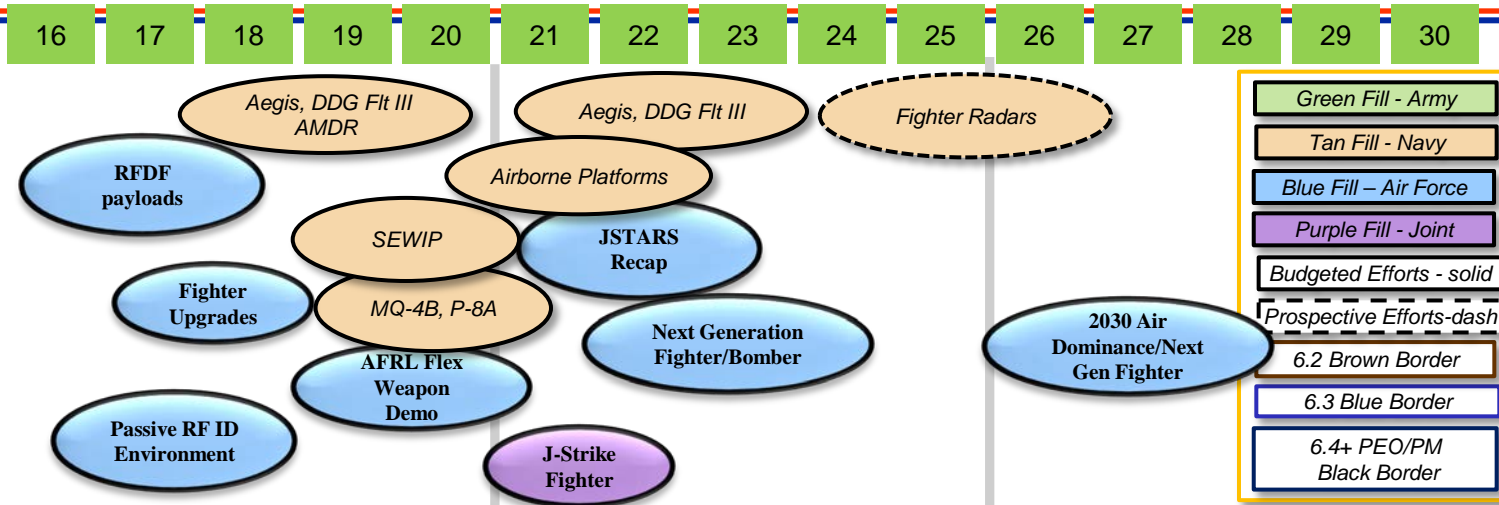
# Sensor COI Roadmap - RF Sub Group



Near Term

Mid Term

Far Term



Transition Opportunities



S&T Activities

RF Sensors

Passive

Persistent Stand-In Sensing in A2/AD Environments, Full Spectrum Sensor Resource Management, RF Sensor Technology for Efficient Combat ID

Passive Multimode Sensing, Sensor Resource Manager, Advanced Radar for Combat ID

Active

Long Stand-Off Sensing in Anti-Access Environments, Robust Adaptive Sensing in Contested Environments, Weapons Enterprise ISR Systems for Difficult Targets

Open Systems Architecture, Multi-Static Over The Horizon Radar, Expendable Close-In RF sensor

Radar Waveforms

Multiple-Input-Multiple-Output (MIMO) waveforms, Low Probability of Detection (LPD), Low Probability of Intercept (LPI)

High efficiency waveforms for congested RF Spectrum operations

Radar Processing

MIMO Radar processing, Combat ID in Contested Environments, Multi-static-Distributed sensing

Robust Multimodal Capabilities, Automated Feature Extraction,

Multi-Static

Distributed sensing, Single Rx,-Multiple Tx, Multiple Tx-Single Rx,

Improved sensitivity, clutter suppression, electronic protection, Spatial and Spectral Diversity



# Examples of flagship programs RF Open System Architectures

## Warfighter Impact:

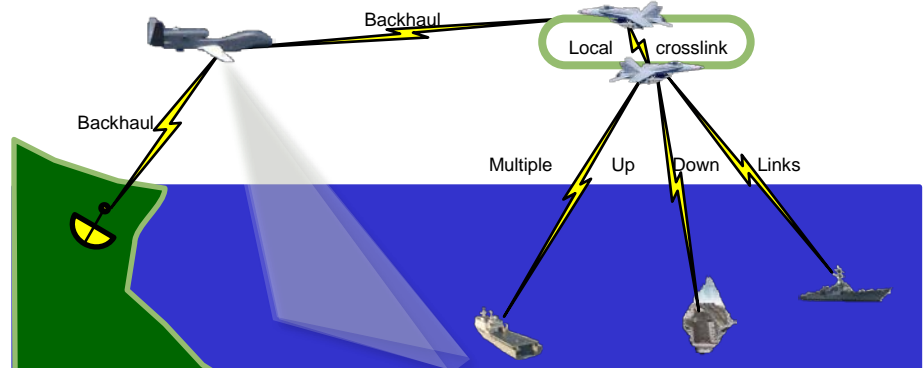
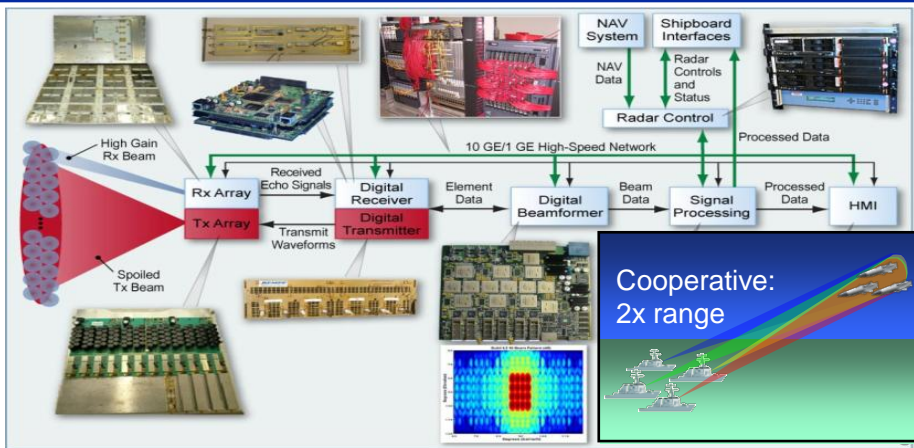
- Capability: Enables new capabilities that cannot be attained with traditional RF systems
- Stovepipes: Prioritize communications, radar, and/or electronic warfare functions you need, when you need them
- Cost: Significant procurement, support, tech

## 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, sharing, 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:

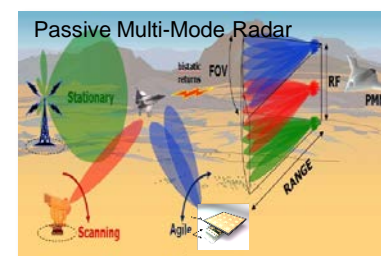
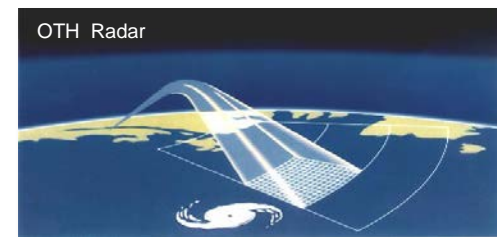
- CERDEC Intelligence & Information Warfare Directorate
- Army Research Lab
- PM Sensors-Aerial Intelligence





# 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)



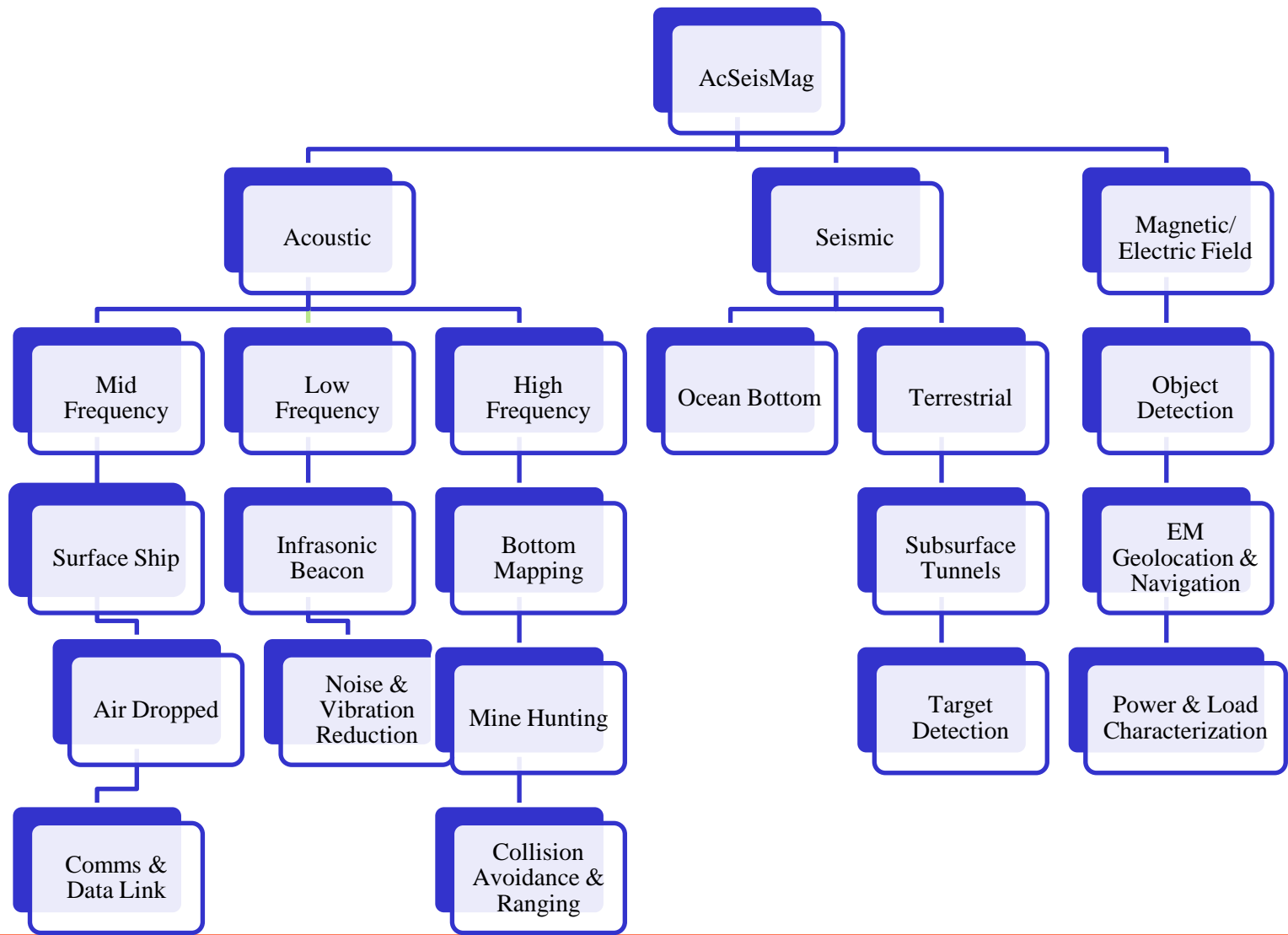


# Acoustic, Seismic and Magnetic



# Application Taxonomy

## Acoustic Seismic and Magnetic/E-Field





# Warfighter Opportunity Areas



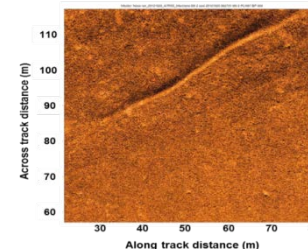
## (Acoustics & Seismic)

### 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

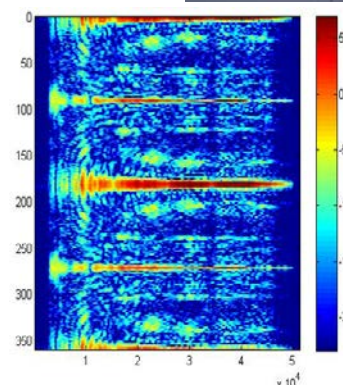
### Detect and Track Targets

- 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

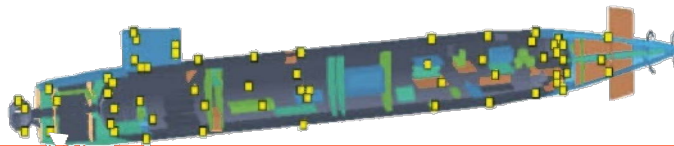
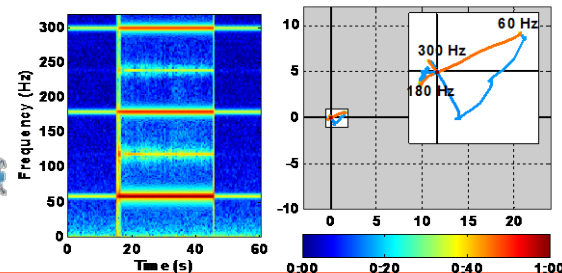
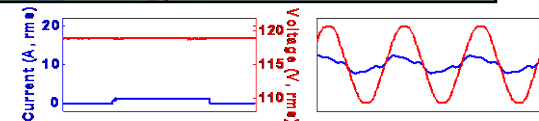
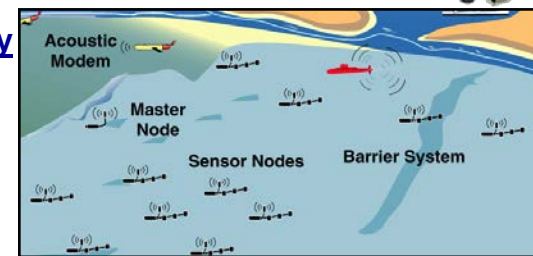
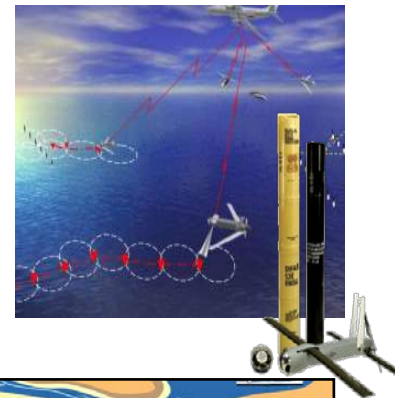
- Moving object event counting, localization, and electrostatic signature classification
- E- & B- signals for Assured PNT and Direction Finding
- Physiological Monitoring
- Energy harvesting for self-powered continuous sensors
- Low frequency digital & analogue communications

## 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



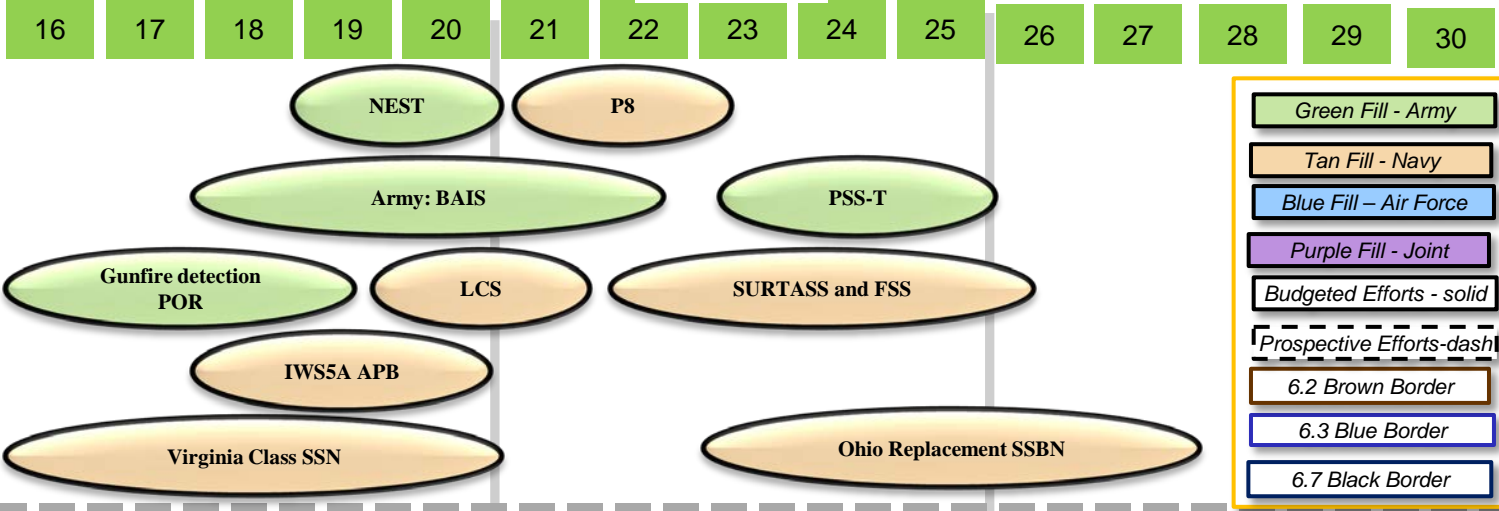
# Sensor COI Roadmap - ASM Sub Group



Near Term

Mid Term

Far Term



Transition Opportunities

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**

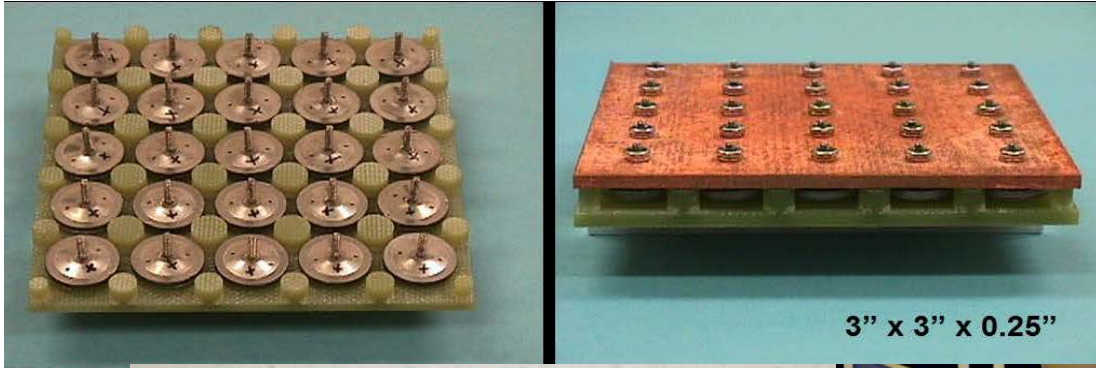
3 modality power line sensor for ISR and microgrid; 1/f noise reduction MEMS flux concentrator; Ground sensors

Signal processing and algorithms for predicting fault conditions





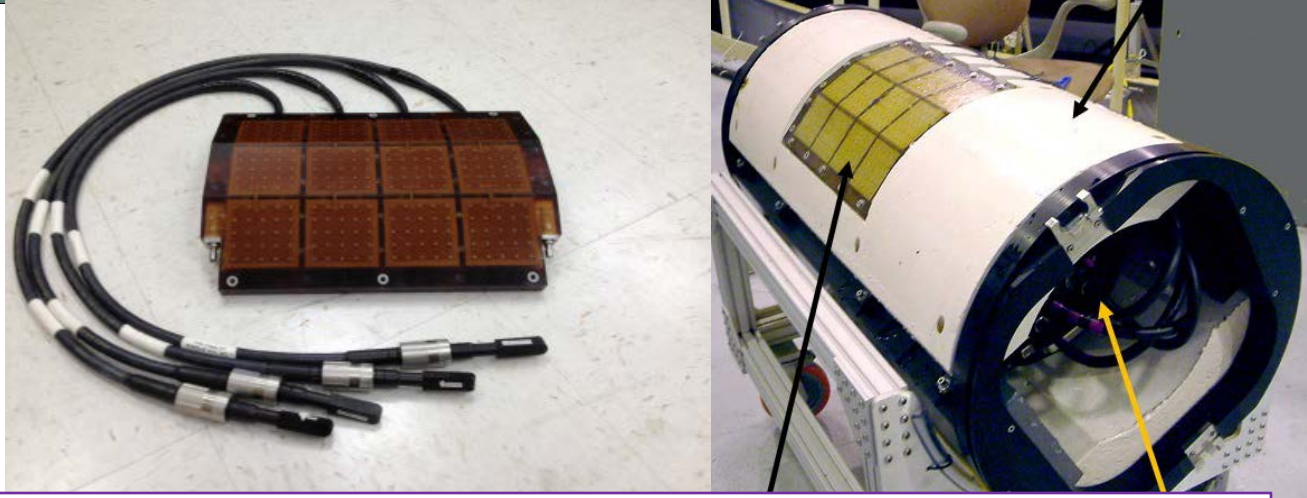
# S&T Enabled Capability: Low-Frequency Broad Band Acoustic Projectors



3" x 3" x 0.25"

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.



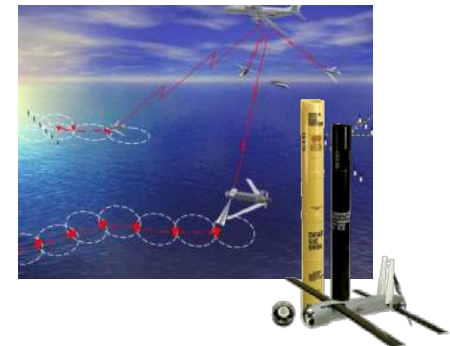
One projector covers entire frequency band with excellent directivity characteristics. The innovative projector that utilizes new materials can show improvement in acoustic source levels as compared to identical units made from legacy ceramics.



# 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.

**Active/IRCM**

**Tri-Service Radar**

**Parallel (EO/IR)**

**BAMS**

**National + Sensor Data Fusion**

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



# 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 andIRST
- **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.**