Sensor and Processing COI

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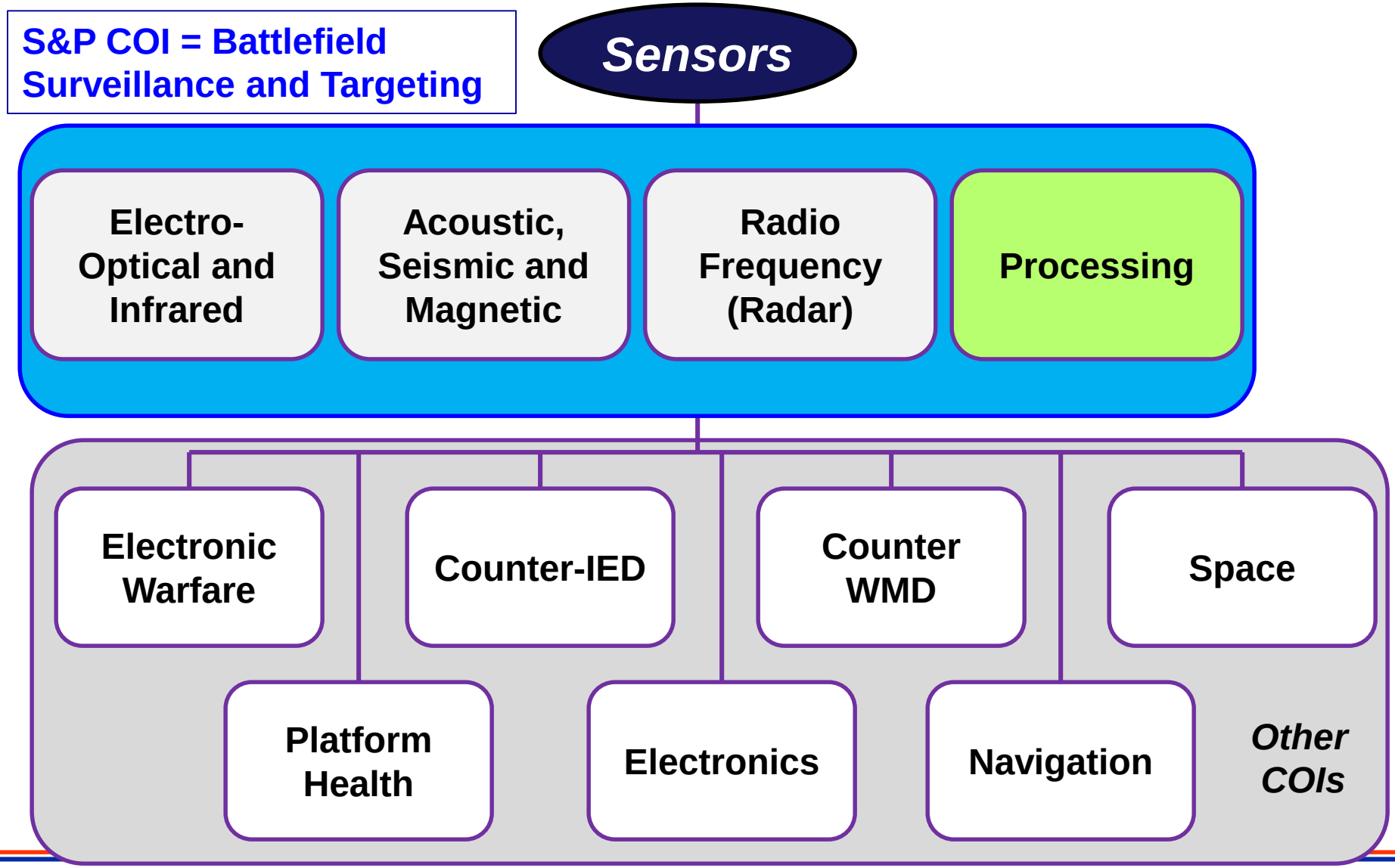
Sensors in the DOD

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

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 with additional emphasis on near peer competitor**

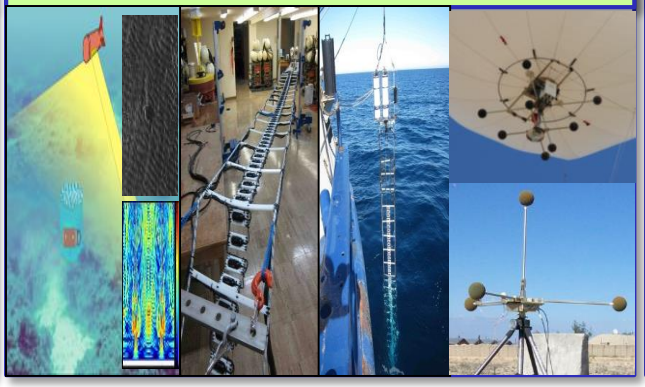
Taxonomy

Sensors and Processing Technology

RF *(non-EW)*

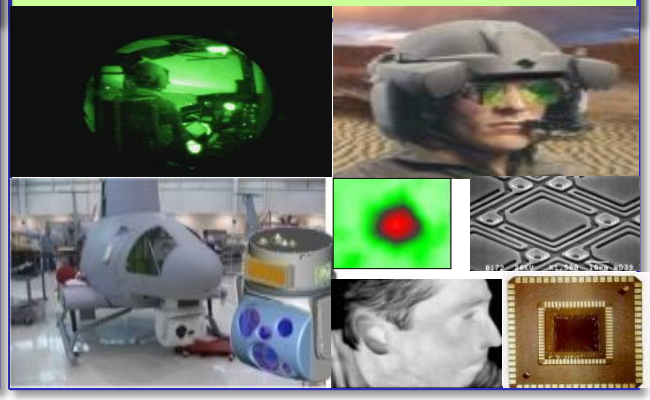
- RF Sensors
  - Active
    - Monostatic Radar
    - MIMO
  - Passive
  - Cooperative
    - Multistatic Radar
  - Non-Cooperative
    - PCL
    - SIGINT

Acoustic, Seismic, Magnetic



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

Electro-Optics /Infrared

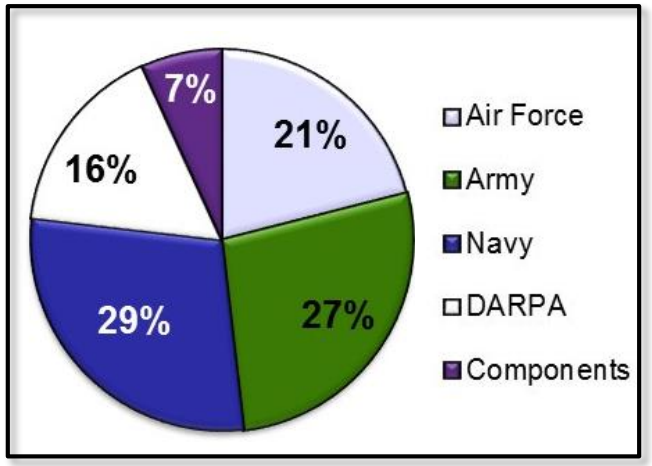


- Imaging
  - Active
  - Passive
- Lasers
  - High Power CW
  - Pulsed
- Displays
  - Direct View
  - Virtual

Sensor Processing Taxonomy Being Worked

Resource Trends

Sub-Group	PB 17	PB 16	Delta	PB 15
EO/IR	214,528	192,281	22,247	242,792
RF	143,358	193,261	(49,903)	223,240
ASM	83,633	87,281	(3,648)	82,807
General	0	16,566	(16,566)	7,311
Total	**441,519**	**489,389**	**(47,870)**	**556,149**



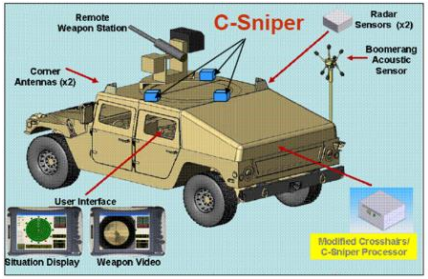
- **No major changes to service efforts**
- **Deltas resulted from OSD changes and program binning**

Warfighter Opportunity Areas

(Electro-Optics)

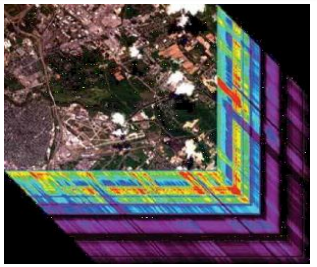
Survivable Broad Area Persistent Surveillance

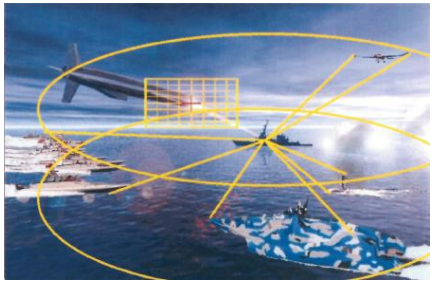
- Persistent Surveillance in all weather and over all terrain conditions
- Sensors with the resolution and sensitivity required to identify and track threat systems and targeted individuals (patterns of life, hostile intent, etc.)
- Air to ground and ground to ground systems that can operate at survivable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



Target Detection, Recognition, and ID at Standoff Ranges

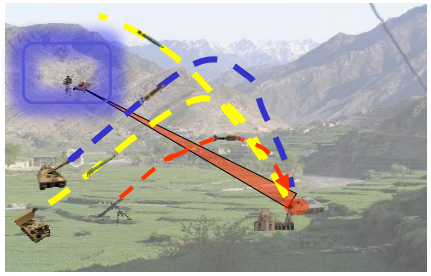
- Ability to use active imaging such as LADAR and 3-D when passive systems can not satisfy the operational requirement
- Components and processing required to extend ranges and mitigate the effects of turbulence
- Provide the capability to ID and defeat multimodal decoys and camouflage
- Accurate far 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

EO/IR Technical Challenges

- **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**

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

ASM Technical Challenges

Ocean Acoustics

- High performance two dimensional passive arrays that exploit az/el 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

Magnetics

- Low SWAP-C magnetometers
- Magnetometers on unmanned platforms
- Low cost magnetometers for wide area coverage

The Military Sensing Symposium (MSS)

- **MSS presently serves as the only classified/limited distribution, US-only, ITAR restricted forum for communication within the US Military Sensing Community**
  - 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.

An invaluable information exchange that facilitates government and industry technical interaction

Active/IRCM

Tri-Service Radar

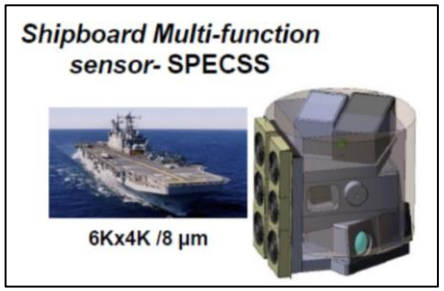
Parallel (EO/IR)

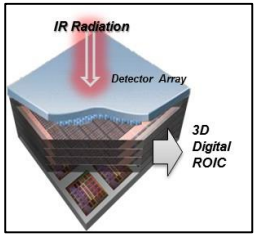
BAMS

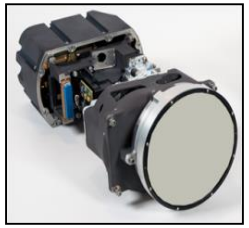
National + Sensor Data Fusion

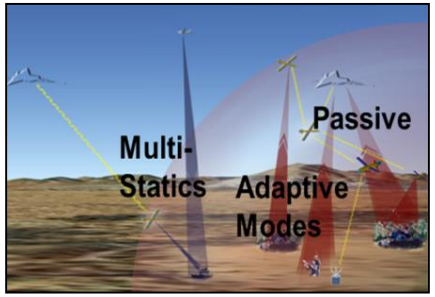
Cross Service Collaboration Efforts

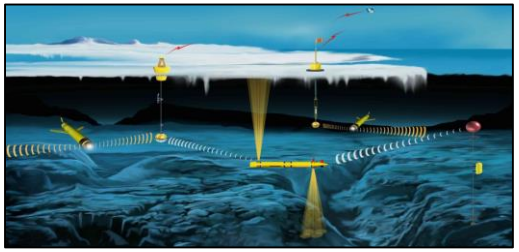
- **EO/IR**
  - Degraded Visual Environments (DVE) – Fusing RF and EO multispectral technology by collaboration
  - Digital Readout Integrated Circuits (DROICs) – Developing real-time multi-function processing capabilities of DROICs. Applications include IR search and track, threat detection, 360 SA and pilotage/DVE
  - III-V Focal Plane Arrays (FPAs) – Tri-Services collaboration on development of an affordable large format FPA at higher operating temperatures (HOT)
- **RF**
  - Target Detection in Concealed Environments (Foliage and Ground Penetration); combining RF and Ladar yielding significant ID capability
  - Multi-Mission/Multi-Function (M2/MF) RF Sensing HW/SW for improved capability and survivability against advanced jammers and IADS
  - Multi-Intelligence Sensor Processing, Exploitation and Processing (Multi-Int PED) for detect, track, and ID of mobile targets and enhanced intel capabilities through national to tactical tipping and exploitation.
  - Anti-Access/Area-Denial (A2/AD)Common Open Standards
- **ASM**
  - UUV based acoustic sensing efforts











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.**