National Center for Secure and Resilient Maritime Commerce and Coastal Environments (CSR)

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- **CSTARS/U of Miami**: Satellite Based Maritime Monitoring of High Seas and Sea Lanes; Detection, Classification and Tracking of Vessels in Near-Real Time
- **Rutgers University**: HF RADAR and Gliders
- **University of Puerto Rico, Mayaguez**: HF RADAR
- **Stevens Institute of Technology**: High-Resolution Multi-Sensor Surveillance of Estuaries and Harbors

<table>
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<th>Present Capabilities and Research Areas of CSR Partners</th>
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<td><strong>Space-Based to Fine-Scale Maritime Sensing Systems</strong></td>
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<td>Integrated Supply Chain Management, Coastal Hazards Management, Systems Engineering</td>
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<td>Information Fusion, Hostile Intent Assessment, Optimization</td>
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<td>Reduced Latency in Response</td>
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<td>Resilienity Analysis, Strategic Planning, Design of Resilient Extended Enterprises</td>
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<td>Analysis of Security Measures, including Technical, Legal, Organizational, Political, and Policy Issues, Economic Benefits of Security Measures</td>
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<td>Assessment of Policy and Regulatory Impacts from Local to Global Scale</td>
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A Satellite Data Reception and Analysis Facility for Environmental Monitoring and Time Sensitive Tactical Applications in the Southeastern US, Gulf of Mexico, Caribbean Basin and Equatorial Atlantic

Sponsors: Office of Naval Research (DoD) and NASA

Former U.S. Naval Observatory Alternate Time Tracking Station
CSTARS Current and Future Satellite Reception Capabilities

Current Agreements:
- RADARSAT-1 (microwave SAR)
- ERS-2 (microwave SAR)
- SPOT 2/4 (hi-res electro-optical visible)
- ENVISAT-ASAR (microwave SAR)
- ENVISAT-MERIS (med-res electro-optical visible)
- MODIS-TERRA/AQUA (med-res electro-optical visible)
- SPOT-5 (very hi-res electro-optical visible)
- QuickBird-2 (Demo) (very hi-res electro-optical visible)

Future and Planned Agreements:
- RADARSAT-2 (very hi-res microwave SAR)
- TerraSAR-X (very hi-res microwave SAR)
- ALOS/PALSAR (hi-res optical & microwave SAR)
- FormoSat 2 (very hi-res electro-optical visible)
- SarLupe (very hi-res microwave SAR)
- CosmoSkyMed (very hi-res microwave SAR)
ENVISAT ASAR (30 m). Typical details of container ship signature are visible showing smoke stack and bridge (back), forward half presumably containers at this resolution. Note ship was on maiden voyage, so don’t know exact loading of vessel at time.
ENVISAT ASAR (30 m). Note uniformity of backscatter, little distinguishing signatures at this resolution.
New SARs with Higher Resolution
TerraSAR-X Stripmap: 4 September 2007

TerraSAR-X (X-Band, 3 m).
Now lots of details visible. Resolution approaching EO sensors. Bridge (back), rows of containers easily detected at this resolution. Note don’t know exact loading of vessel at time.
New SARs with Higher Resolution

TerraSAR-X Stripmap: 4 September 2007

TerraSAR-X (X-Band, 3 m). Again lots of details visible. Resolution approaching EO sensors. Signature quite different from container type vessels. Bridge (corner reflector in back), different types of structure, possibly cranes, piping.
OceanView™

- Multi-satellite sensor
- Multi-frequency
- Queuing of short and long-term targets
- Ship analysis (size, type, heading and speed)
- Ship prediction of future location
- Environmental conditions (i.e. sea state, winds and currents)
- Projection of target advance (i.e. next sat obs)
- Optimized target identification
- Wake analysis
- Java-based display, accessible over internet
- OTH Gold report
- Jointly developed by CSTARS & Vexcel

Likely ships (including ships in rivers)

Unlikely ships
Rutgers University - Coastal Ocean Observation Lab
Operations & Data Fusion Center

CODAR Network
L-Band & X-Band Satellite Systems
Field Communications
3-D Nowcasts & Forecasts
Glider Fleet

Coastal Observation and Prediction Sponsors:
Optimizing HF Radar for SAR using USCG Surface Drifters

Art Allen
U.S. Coast Guard

Scott Glenn
Rutgers University

and the Mid-Atlantic Regional Coastal Ocean Observing System
Emerging National HF Radar Network
Rutgers – East Coast NOAA Hub
Scripps – West Coast NOAA Hub

National HF Radar Network: 96 Sites from 22 Institutions

USCG Drifter Deployments For Search And Rescue
The CaRA Example

AIS Vessel Traffic in the Mona Passage

Planned HF Radar Sites In Puerto Rico
HF Radar for Over-the-Horizon Vessel Detection & Tracking

Rutgers Coastal Ocean Observation Lab
Rutgers Computational Biomedicine Imaging and Modeling Center
CODAR Ocean Sensors

Dual use from the same Radar network—Currents (SAR) & Ships (MDA)
Distributed network is robust to countermeasures
Multi-static operations further increases coverage
Bragg Peaks from a Moving Transmitter (4.66 MHz)
Bragg Peaks from a Moving Transmitter (4.66 MHz)
Vessel Detection and Tracking

Legend

Data
- OVELEADIES BACKSCATTER
- SANDY HOOK BACKSCATTER
- LOVELADIES/SANDY HOOK BISTATIC

Tracks
- OLEANDER GPS
- CODAR SHIP TRACKER

Symbols
- Shipping lanes

Scale
- 10 (km)
SeaTow 25

Tracker solution is based on data from Brant Beach from 1511.15 to 1524.03.
Maritime Security Laboratory (MSL)

Laboratory features:
- Real-time command & control
- Systems-level experiments & integration
- Relevant environments and scenarios
Maritime Security Laboratory (MSL)

Four High-Resolution High-Speed Visible-Infrared Cameras
Four Night Images in New York Harbor
Object Cast Overboard – MWIR – August 28, 2007
Maritime Security Laboratory (MSL)

Automated Target Detection and Tracking
Maritime Security Laboratory (MSL)

Geo-referenced vessel tracks based on Field of View measurements
Combined underwater acoustic and surface video tracking
Questions?