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All-Domain Sensor Network Orchestration from Seabed-to-Space

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Monterey, California: Naval Postgraduate School

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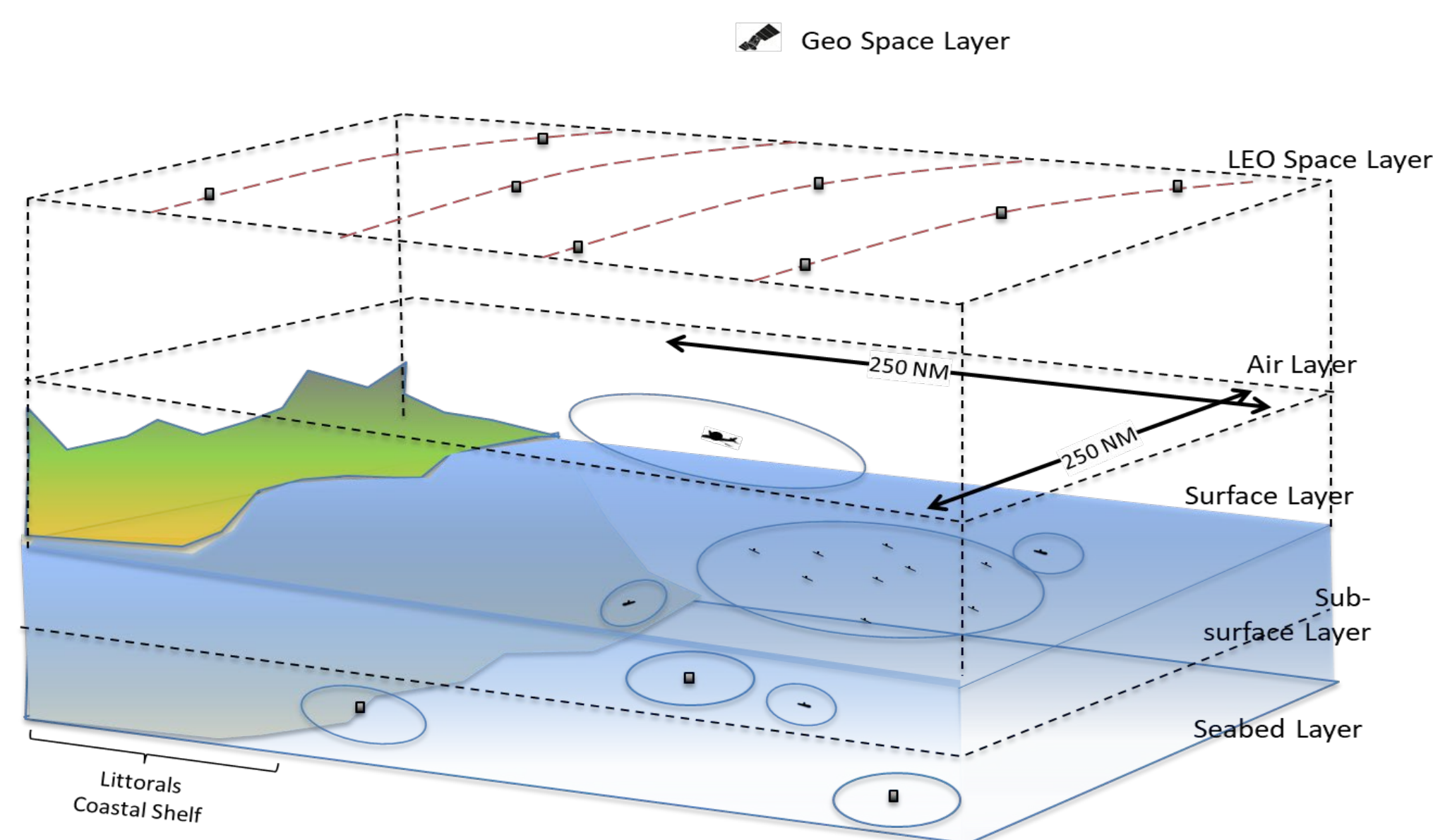
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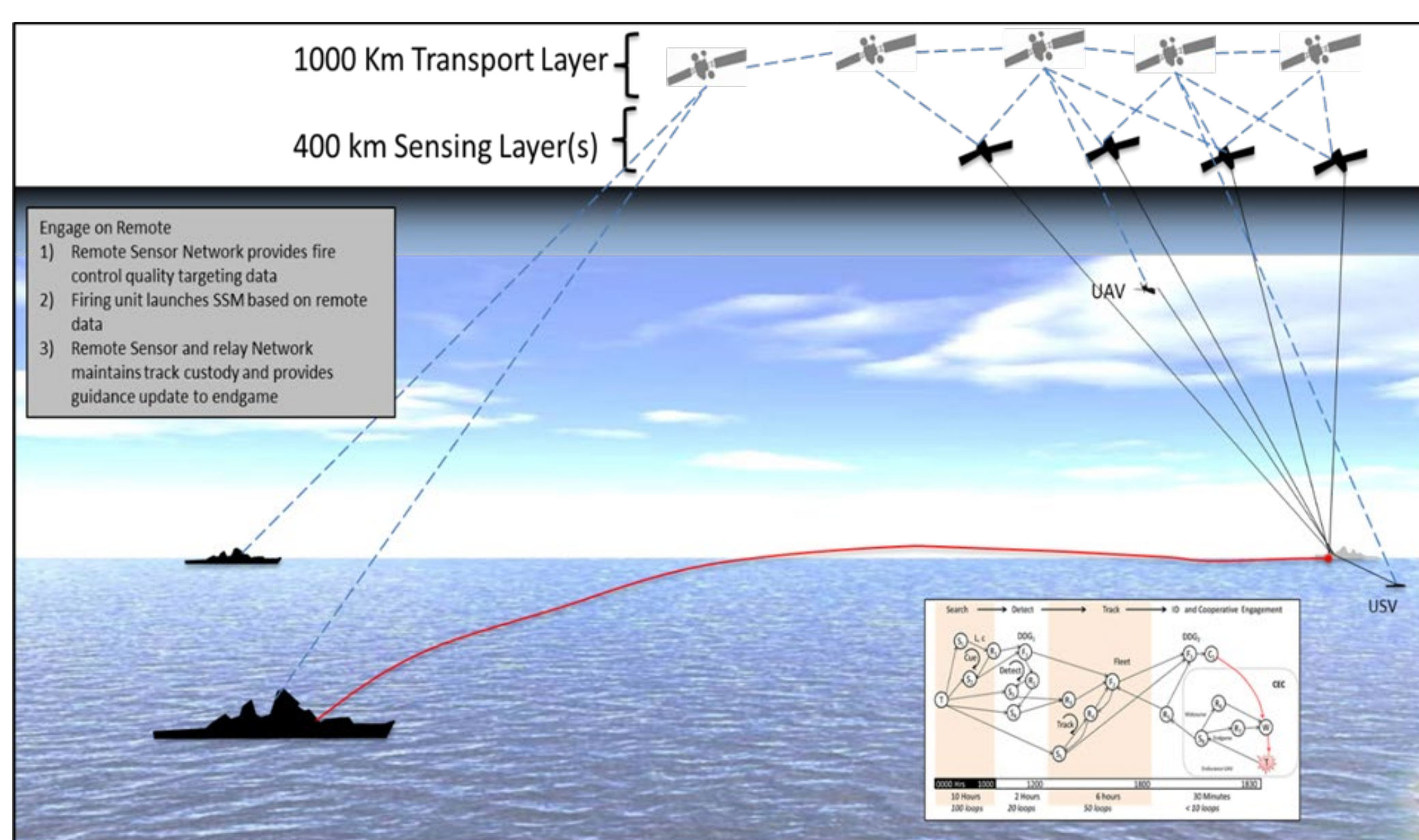
Background and Objective

The networking, integration, and orchestration of ISR sensors from the seabed, subsurface, surface, air, and space will enable Distributed Maritime Operations (DMO) and distributed lethality of the fleet. This study:

- Evaluates the complexity, operation and feasibility of orchestrating these sensors
- Models the complex dynamics required to detect-ID-track and engage long-range targets



Seabed-to-Space sensing and networking enables Distributed maritime Operations (DMO)



Conceptual Engagement with Space-Based or unmanned vehicle sensing and relay

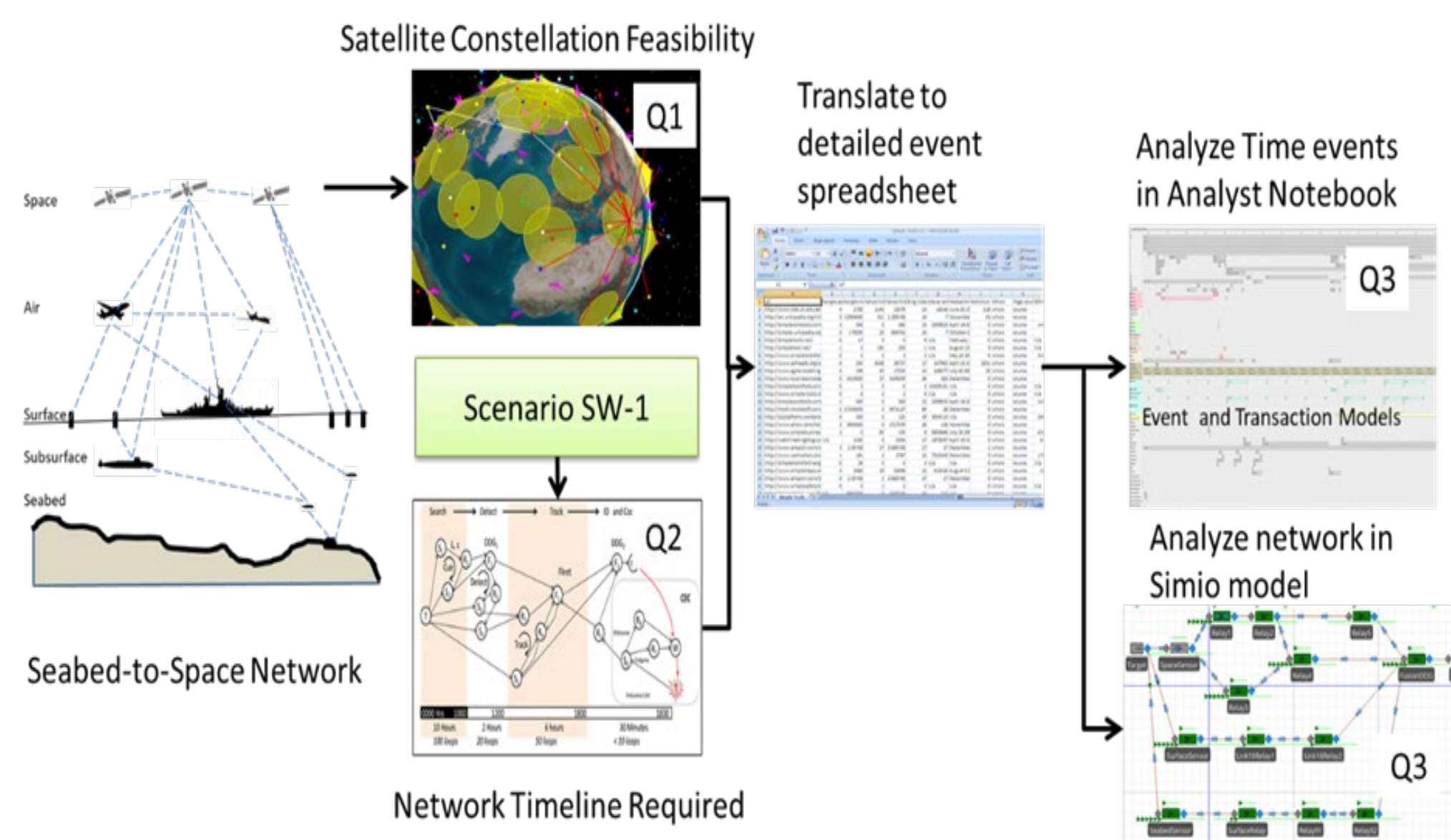
Study Method

Evaluate the orchestration of sensors for ISR:

- **Seabed-to-Space Sensors** – Analyze the value of widely distributed organic sensors on manned and unmanned platforms *and the contribution of each*. Study low-bandwidth autonomous underwater vehicles and stationary seabed sensors, as well as high-revisit space sensors (EO-IR-Radar-RF).
- **Data Networks** – Analyze the available network from sensor to fusion nodes to weapon systems, particularly the *availability of sensors, ability to orchestrate sensing collection at critical times to support fire control*.
- **Fusion Nodes** – Analyze the network structure and placement of nodes *to combine data and orchestrate dynamic collection*.
- **Closed-Loop Operation** – Analyze the potential for adaptive closed-loop operations from a sensor to a fused picture of target dynamics, to prediction of *the necessary ISR dynamics to support DMO targeting*.

Analysis and Results

- Performed a conceptual and numerical analysis of a selected Surface Warfare (SW-1) scenario that applies sensors from seabed to space
- Modeled the Space Development Agency transport layer (Relay) and space EO and SAR Sensing
- Modeled the end-to-end 24-hour timeline and network transactions
- Evaluated scenario operations, latencies, sequencing for feasibility



Evaluation considers sensor and relay network constellations in a DMO long-range engagement scenario

Major Findings

- ✓ Conceptual coordination of Seabed-to-Space sensors via space relay will enable effective DMO distribution and over-the-horizon operations
- ✓ Orchestration of the diverse sensors from seabed-to-space to perform coordinated fires with space constellations (both sensing and relay) is complex but feasible
- ✓ A constellation (similar to DoD SDA) as modeled, or larger, will provide coverage, but may require local UAV, USV support for terminal engagement
- ✓ Network Transaction process is complex but feasible; Redundancy exists in sensor and network to assure availability
- ✓ We can address the Admiral's fundamental questions with supporting first-order quantitative data