Closing the Maritime Awareness Gap

Real-Time Satellite Surveillance for Maritime Defense and Coastal Security

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INTRODUCTION

Maritime defense and coastal security depend on maintaining awareness across vast and strategically important waters [source]. Yet despite extensive investment in AIS, radar, aircraft, uncrewed systems and satellites, the operational picture remains incomplete.

Maritime forces do not primarily lack sensors. They lack a persistent, independently observed and operationally timely layer that converts wide-area detection into prioritized information for existing command systems and response assets.

Real-time satellite surveillance offers a new approach to provide this missing layer. By combining coordinated satellite fleets, onboard edge-AI processing, rapid communications and integration with existing maritime systems, it can turn orbital observations into trusted alerts that help operators reduce search areas, prioritize contacts and cue the appropriate crewed or uncrewed asset.

This white paper examines why maritime domain awareness remains incomplete, defines real-time satellite surveillance, explains how it can integrate with existing Intelligence, Surveillance and Reconnaissance and operational workflows, and considers its future role in maritime defense and coastal security.

> **"The value of maritime surveillance lies not in how much is observed, but in whether relevant activity can be identified and acted upon in time.**

PART I

Why maritime domain awareness remains incomplete

A Maritime Jurisdictions and Surveillance Responsibilities

Maritime surveillance spans several legal and geographic zones. A state's territorial sea generally extends up to 12 nautical miles from its coast, where it exercises sovereignty subject to navigational rights such as innocent passage. Beyond this, its Exclusive Economic Zone (EEZ) can extend up to 200 nautical miles, giving the state sovereign rights over fisheries, offshore energy and other marine resources.

The scale of these areas creates a significant surveillance challenge. The U.S. EEZ exceeds four million square miles, larger than the land area of all 50 states combined [source], as shown in the Figure below.

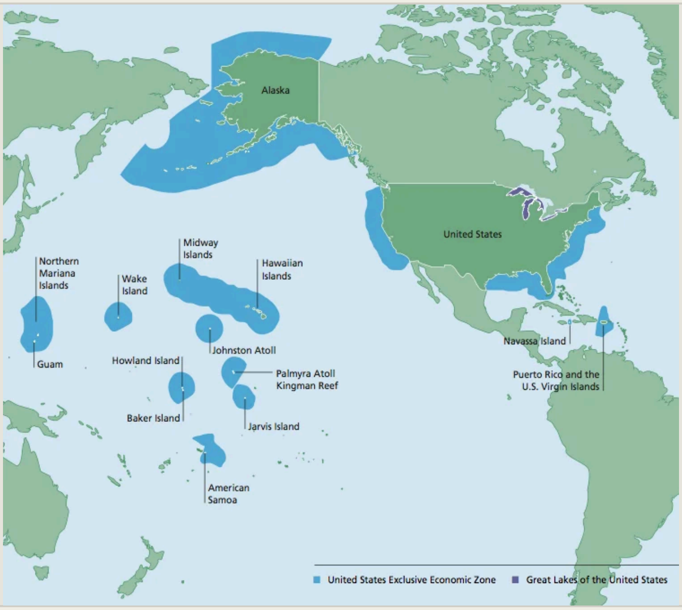

FIG. 01 — The U.S. EEZ is larger than the combined land area of all 50 states.

B The Current Maritime Awareness Architecture and Its Limitations

Monitoring these waters is both a security and an economic responsibility. Beyond national EEZs lie the high seas, where naval and maritime-security forces still require awareness of activity affecting sea lines of communication, military operations, international trade and regional stability. Maritime surveillance must therefore extend from the coastline into the wider ocean, where threats and disruptions may develop before reaching national waters, critical infrastructure or deployed forces.

Modern maritime domain awareness combines AIS, coastal and shipborne radar, patrol aircraft, UAVs, uncrewed systems, satellites and enterprise MDA platforms. Together, these sources provide valuable awareness, but not a complete or continuously verified picture.

AIS is widely used because it provides frequent vessel identity and movement data. However, it is a cooperative system designed for navigation and collision avoidance, not independent surveillance. Vessels may disable it, transmit misleading information or operate without it, while technical failures and reception gaps can also create missing signals [source].

Authorities must therefore distinguish between the cooperative picture, where vessels report themselves to be, and the observed picture produced by independent sensors.

Those sensors also have limitations. Coastal and shipborne radars provide local coverage, while aircraft and uncrewed systems offer wider search and closer identification but remain constrained by range, endurance and availability. Satellites extend surveillance into remote waters, yet most existing services still depend on collecting, downlinking and analysing imagery before useful information reaches an operator.

Enterprise MDA platforms such as SeaVision can correlate these sources and maintain vessel tracks, but they cannot compensate for observations that are missing, delayed or unverified [source]. The remaining strategic gap is a persistent, non-cooperative, wide-area detection layer capable of delivering trusted information quickly enough to direct existing assets.

C Defense and Strategic Security Gaps

The limitations of maritime domain awareness become most visible in contested waters, strategic chokepoints and around critical infrastructure.

Strategic passages such as the Strait of Hormuz and the Bab-el-Mandeb concentrate commercial and military traffic within narrow operating areas. However, the surveillance requirement extends well beyond the chokepoint itself, as threats may emerge from wider approaches where AIS interference, spoofing or deliberate non-transmission can reduce the reliability of the declared maritime picture.

Europe's Baltic Sea illustrates a related challenge. Following damage to undersea energy and communications links, NATO launched Baltic Sentry in January 2025 to strengthen the protection of critical infrastructure. The activity combines frigates, maritime patrol aircraft, naval drones and national surveillance assets [source]. This demonstrates the need for independently observed, wide-area information capable of identifying suspicious activity before it reaches deployed forces, critical shipping routes or protected infrastructure.

D Coastal Security, Law Enforcement and Economic Sovereignty

Surveillance gaps also affect the ability of coastal states to enforce maritime law and protect national resources. In Indonesia, Bakamla must monitor one of the world's largest archipelagic maritime areas with only ten patrol vessels. Its commander has estimated that the agency will require 274 vessels by 2045 and currently relies on cooperation with the navy, police and fisheries authorities [source]. Across monitored South China Sea features, satellite analysis identified a daily average of 241 Chinese maritime-militia vessels in 2025, illustrating the scale of activity that regional authorities must distinguish from routine fishing and commercial traffic [source].

The U.S. Arctic presents a different version of the same problem. The U.S. Government Accountability Office reported that the Coast Guard had been unable to meet all its Arctic commitments because of limited asset availability, insufficient icebreaking capability and constrained infrastructure and logistics in Alaska. The Coast Guard also assessed that it could not assure continuous presence and reliable access across the region with its existing capabilities [source].

In both regions, authorities may possess ships and aircraft capable of investigation or interception but still lack the persistent information required to locate and prioritize relevant activity across vast waters.

> “ **The recognized maritime picture remains constrained by gaps between cooperative reporting, independent observation and operational response.**

PART II

What is real-time satellite surveillance?

A A New Era in Satellite ISR

Real-time satellite surveillance is emerging as a distinct category between conventional Earth-observation imagery and operational maritime ISR. It combines coordinated satellite fleets, onboard processing and rapid communications to detect activity and deliver structured observations within the time available for tasking, investigation or response.

Unlike conventional satellite imagery, which is often collected for later analysis, real-time surveillance is organized around a standing mission. Its outputs may include vessel location, timestamp, confidence and position uncertainty. As observations become more frequent, the system can also contribute to estimates of course, speed and predicted position.

B From Imagery to Operational Information

The defining difference is not simply faster image delivery, but a change in the satellite's role within the wider surveillance architecture. Rather than functioning only as an imagery source, the satellite becomes an active sensing node that generates operational observations and contributes directly to the recognized maritime picture. This helps address the gaps identified in Part I by providing independently observed, wide-area information that can be used to direct existing assets.

C What Makes It Possible

This capability is becoming possible because advances in edge-AI hardware and perception algorithms now allow more processing to take place onboard satellites. Compact, energy-efficient processors can increasingly run computer-vision models capable of detecting vessels and other relevant activity directly from sensor data.

Improvements in model compression, onboard computing and autonomous data handling allow satellites to identify and prioritize useful observations without first transmitting the complete image to the ground. This creates an onboard intelligence layer, an operational "brain" for the satellite, that can convert raw imagery into structured detections, alerts and tracking information. Combined with rapid communications and coordinated satellite fleets, these advances reduce the delay between observation and operational use.

> **“ The value shifts from delivering delayed images to generating real-time operational alerts within the decision window.**

PART III

Integration into existing defense workflows

Real-time satellite surveillance is not intended to operate as a standalone capability. Its value comes from strengthening the sensors, platforms and command systems that defense and coastal-security organisations already use. Integration could take place through two primary pathways: tactical cueing and enterprise-level integration.

A Tactical Tip-and-Cue

A satellite can detect a suspicious vessel across a wide area and generate an observation containing its location, timestamp, confidence and position uncertainty. Where repeated observations are available, it may also provide an estimated course, speed and predicted search area. This information can be passed to a maritime patrol aircraft, UAV, naval vessel, uncrewed surface vessel, coastal radar, electro-optical sensor or another satellite for closer investigation. The orbital detection reduces the area that the tactical asset must search, allowing limited platforms to focus on prioritized contacts.

B Integration into Maritime Command Systems

Satellite-generated detections should enter the MDA, intelligence and common operational picture systems already used by defense operators. Within those systems, an observation can be compared with AIS, radar tracks, radio-frequency detections, intelligence reporting, watchlists and historical vessel activity.

The operator should not need to open a separate imagery portal and manually inspect a complete scene. Instead, the observation should appear as a recognized sensor report containing clear information about its location, time, confidence, uncertainty and source. Together, these pathways create a continuous workflow in which orbital detections are correlated within existing command systems and used to cue the most appropriate asset for confirmation or response.

> “Orbital detections reduce the search area, strengthen the common operating picture and direct existing assets towards priority contacts.

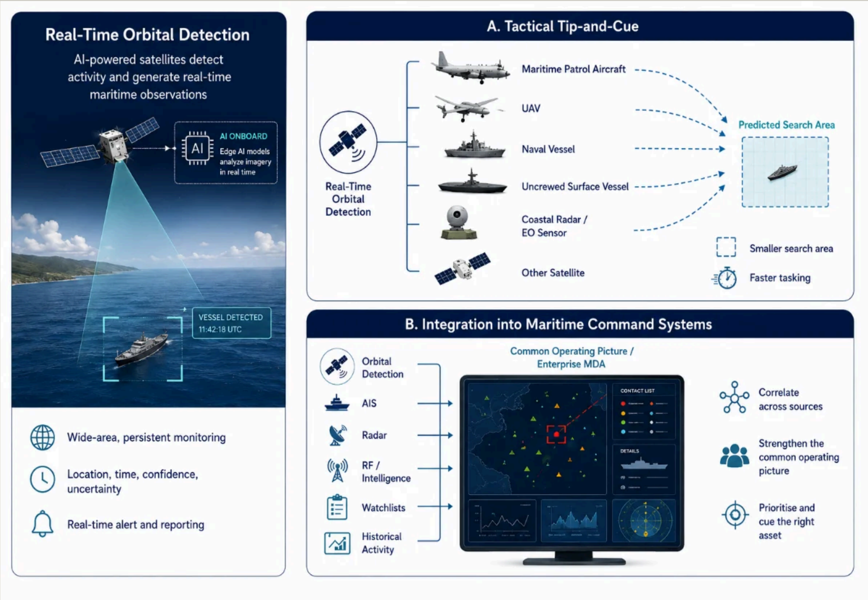

FIG. 02 — Real-time orbital detections can either cue operational assets directly or feed enterprise MDA systems for correlation, prioritisation and integration into the common operating picture.

PART IV

The future of real-time satellite surveillance

Real-time satellite surveillance is unlikely to follow a single commercial or ownership model. Different governments will require different levels of control, investment and operational access.

A Commercially Provided Services

Some governments may purchase detections, vessel tracks or surveillance coverage from commercial providers without owning the satellites. This model can provide faster access and lower upfront costs, but may offer less control over tasking, capacity, data governance and availability during periods of high demand.

B Sovereign Capability

As satellite manufacturing, launch and onboard computing become more accessible, some nations may develop dedicated fleets under national control. Sovereign ownership provides authority over tasking, mission priorities, data processing and access. A nationally controlled fleet can be configured around territorial waters, an EEZ, strategic approaches, critical infrastructure or other priority areas rather than providing global coverage.

C Shared Regional Architectures

Not every nation will require or be able to justify an independently owned fleet. Neighboring states may instead jointly fund and operate a regional architecture focused on shared seas, chokepoints, fishing grounds or trade routes. This model can distribute cost, improve information sharing and provide continuity across maritime boundaries while allowing participating nations to retain control over sensitive data and operational decisions.

D Hybrid Architectures

In practice, many governments may combine nationally controlled satellites with commercial services, allied data and shared regional infrastructure. This approach can provide sovereign control over priority missions while using external capacity to extend coverage or meet temporary operational demand. The appropriate structure will depend on the mission, geography, security requirements and level of national control required.

> **“Future architectures may be sovereign, shared or commercially supported, but they should be configured around the operational priorities of the nations they serve.**

CONCLUSION

Maritime domain awareness remains incomplete because existing systems cannot provide persistent, independently verified information across vast operating areas.

Real-time satellite surveillance closes this gap by converting orbital observations into timely, machine-readable alerts that can be correlated with existing data, reduce search areas and cue the appropriate crewed or uncrewed asset. It strengthens rather than replaces existing ships, aircraft and command systems.

The immediate priority is therefore integration and operational testing: define the alert product, establish latency and confidence requirements, connect it to an existing common operating picture and measure its effect on cueing and asset employment.