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A Maritime Information Exchange Model (MIEM) for Sharing Actionable Intelligence

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Introduction — A Mandate to Share: The 9/11 Commission Report and related Presidential directives have highlighted the need to share information between different government agencies, military services, and international allies. With sponsorship from the Navy and the Office of the Secretary of Defense (OSD), NRL provided the technical leadership for the Comprehensive Maritime Awareness (CMA) Joint Capabilities Technology Demonstration (JCTD) aimed specifically at developing and demonstrating effective means for sharing maritime intelligence to improve interdiction of suspicious or threatening vessels, cargo, and people. To accomplish sharing in an effective manner, we need to enable humans and computers to understand situation intelligence so that they can respond quickly to significant events. As the number of sensors and internetworked systems increase, the data volumes continue to soar, so people will need to rely on the machines to assess and filter more and more of the data. Human attention will need to focus on key events and making important judgments.

The Department of Defense (DoD) plans to improve information sharing by making information assets *understandable* and *accessible*. We term information understandable when it consists of familiar types and values. We consider it accessible when computerized services can obtain it for us. Thus, one goal of the CMA JCTD was to make actionable intelligence about maritime situations understandable and accessible in that way. The key to achieving that goal was to create a set of types and values that could be used to describe beliefs about maritime entities, relations, and events, as well as the evidence for those beliefs. The Maritime Information Exchange Model (MIEM) addresses that need by prescribing how to express such beliefs and evidence.

Conceptual Models of Situations and XML Schemas: The MIEM comprises a *conceptual model* for the entities and relationships needed to describe dynamically evolving maritime situations, consisting of beliefs and evidence. As situations evolve, these beliefs change, and the MIEM provides a way to characterize and capture those changes. Beyond being just a conceptual model, the MIEM consists of actual information encoding models expressed as Extensible Markup Language (XML) schemas. These XML schemas provide a grammar for writing syntactically correct XML-tagged documents that express specific maritime situations. These schemas consist of specified terms for key entities such as vessels, cargo, and people, attributes of these entities, and permissible types of values that can be associated with these attributes. In addition, the MIEM schemas provide types and values for various types of metadata that can qualify or embellish the situation data themselves. These metadata can characterize how strongly something is believed, the evidence for or against that belief, time qualifiers for when the belief is valid, sources of evidence, and restrictions on access, for example.

The MIEM schemas are intended for use by service-oriented architecture (SOA) systems or other schema-aware software applications. The MIEM describes how information should be expressed when it is transferred between two independent systems, namely as XML-tagged text. Each independent system, which can be a source or a consumer of maritime intelligence, may use its own database techniques for maintaining its view of situation data. The MIEM provides a target for producers or consumers, who can translate into and out of the MIEM as appropriate. In the future, systems could choose to use the MIEM as a schema for document or database storage directly, because XML-based storage products are becoming increasingly common. However, that practice goes beyond the immediate purpose and significance of the MIEM.

Levels of Actionable Intelligence: In assessing how intelligence becomes actionable, we identify nine increasing levels of value that information sharing systems need to address. These nine levels are listed and briefly illustrated in Table 1. Where most DoD systems operate at levels 1, 2, or 3, the MIEM can support information sharing at all nine levels, including the exchange of multiyear case files tracking vessels or persons of interest.

The principal features of MIEM comprise ways to describe key domain entities, key secondary concepts, and extensive and universally applicable metadata. MIEM consists of modular XML schemas that can be restricted or extended wherever required to meet the needs of a specific application. The key domain entities include conveyance and vessel, person, crew and passenger, cargo and facilities, and measurements such as time, position, length, and weight. The key secondary concepts address lifecycle issues including states, transitions, voyages and epochs, events, anomalies, and threats. The extensive metadata provide ways to describe source, confidence, alternatives, pedigree, and caveats, as well as ways to distinguish past, present, and predicted future states.

Summary — Sharing Maritime Intelligence: The MIEM provides the foundation for a collaborative approach to sharing and continually improving intelligence. To further the objectives of cross-agency sharing, the Navy has established a partnership with the Department of Homeland Security Enterprise Data Management Office (DHS EDMO) and the program management office for the National Information Exchange Model (NIEM PMO). Under this agreement, the MIEM will become the authoritative information sharing model for maritime data throughout the entire Federal Government.

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TABLE 1 — Levels of Valued Added Information Supported by the MIEM

Level	Type	Example	Value Added
9 (**highest**)	Case files for key entities	Histories, highlights, comprehensive details	Enables in-depth predictive analysis
8	Threats and anomalies	Dangerous undeclared cargo	Increased preemptive threat reduction
7	"Of interest" conditions and watch lists	Suspicious cargo on board	Increased analytical efficiency
6	History, behavior, and future projections	Voyages and predicted courses	Enables basic predictive analysis
5	Multiple alternatives and analysis	Ambiguity, uncertainty	Direct evidence of certainty
4	Degree of belief and pedigree	Evidence, quality	Direct information about quality
3	Fused data and inferred beliefs	Position, crew	Synergistic improvement in situational awareness
2	Caveats and simple metadata	Sensor type, classification	Indirect quality assessment
1 (**lowest**)	Sensor system reports	Automatic Information System (AIS)	Reduced development costs for customers