

# An ontology for Maritime Situational Awareness Heterogeneous Sensor Networks\*

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**Abstract.** The Maritime Situational Awareness Heterogeneous Sensor Network (MSA-HSN) ontology formalises the information aspects the maritime surveillance system that is one of the demonstrative use case of the Interactive Extreme-Scale Analytics and Forecasting (INFORE) project. Here, different situational views offered by a variegated suite of sensors and platforms are fused and combined with big data analytics to achieve situational awareness for maritime security. The ontology integrates prominent ontologies for sensors, measures and quantities, events, and maritime information, and extends them to model provenance, quality of information, qualitative temporal nature of information. The talk will introduce the relevant aspects of the ontology design, to demonstrate the formalisation of the information components of a prototypical information fusion systems, and will exemplify the most interesting modelling patterns, from MSA sensor information, to maritime event detection and forecasting, to the modelling of information quality in fusion systems.

**Keywords:** Ontology · Maritime Situational Awareness · Heterogeneous Sensor Network · Maritime Surveillance · Maritime Security

## 1 Introduction

Situational Awareness (SA), as the understanding of a (possibly complex) situation, is pivotal for decision making. The information needed to achieve SA in a maritime security context is acquired by an heterogeneous sensor network, that may integrate collaborative and non-cooperating systems, terrestrial and remote sensing devices as well as autonomous, or unmanned, vehicles (UxVs). These are

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the information acquisition components of the Maritime SA (MSA) architecture proposed by the maritime use case of the Interactive Extreme-Scale Analytics and Forecasting (INFORE) project. The INFORE software architecture fuses global, regional and local sensor information produced by the Automatic Information System (AIS), radar, multispectral satellite imaging sensors, passive acoustic sensors and thermal cameras, and applies big data analytics to detect and forecast events of interests for different surveillance tasks. The architecture information layer may support SA in a variety of security and safety scenarios, including environmental monitoring (illegal fishing, waste disposal), transportation safety, efficiency of the supply chain and logistics, to mention a few, which require the fusion of information produced by sources of various reliability and quality.

The Maritime Situational Awareness Heterogeneous Sensor Network (MSA-HSN) ontology is designed to annotate and semantically enrich INFORE information, but can model the information aspects of any typical fusion system, where all information is combined to build and keep up to date the situational picture. The quality of information and sources and information provenance are fundamental aspects that the system consider when fusing the data, as well as the temporal aspects and the nature of the information acquired by the system.

MSA-HSN extends and adapts existing information models for sensors and observations, data streams, measures and units, and events, including the renowned Semantic Sensor Network/ Sensor Observation Sampling Actuator (SSN/SOSA) [1], the Ontology units of Measures (OM) [2], the Simple Event Model (SEM) [5], and complies with the Common information Sharing Environment (CISE) data model [3] for maritime events and data modelling.

The talk will introduce and exemplify the relevant aspects of the MSA-HSN ontology design, to demonstrate how to model the information flowing in and out of a typical information fusion systems, and how the modelling supports situation awareness. Examples taken from the INFORE maritime use case will be used to illustrate the most important characteristics of the ontology.

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