# Orbital Debris Ontology, Terminology & Knowledge Modeling

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## ABSTRACT

The looming threat orbital debris poses to assets in orbit demands solutions. As the orbital population grows, so does this hazard, but so does the sea of data. The problem is also an opportunity for interdisciplinary innovation and cooperation. This paper focuses on the data and information management aspect of developing solutions for a sustainable and safe orbital space environment. The corresponding author's in-progress work to develop an orbital debris domain ontology is summarized in order to discuss knowledge modeling for this domain. Methodological approaches of this effort can also contribute to standards efforts and address terminological and policy questions.

Leveraging the growing volumes of orbital debris and space situational awareness (SSA) data will create a more complete picture of the orbital space environment. Part of the solution will be: consistent and correct data interpretation, sharing orbital debris and SSA data in one form or another, terminology development & harmonization, and knowledge or domain modeling. To facilitate this, [Rovetto, 2015/16] discussed ontology development for the orbital debris domain. This paper lists concepts from that paper, and subsequently developed concepts [2-9] (https://purl.org/space-ontology)

Ontology engineering is an interdisciplinary field related to knowledge representation and reasoning in artificial intelligence, semantic technologies and the so-called semantic web. An ontology is effectively a computable and semantically rich terminology that presents a knowledge or domain model for a topic area. Expressions of knowledge or assertions are stored using formally defined term. This knowledge base is reasoned over to yield answers to queries, among other things. Ontologies have been developed in knowledge-based projects across various disciplines, and used for such things as search engines, chatbots, enterprise knowledge graphs, etc. Ontologies support: interoperability, automated reasoning, data sharing and integration, data search and retrieval, and communicating the meaning of data.

The Orbital Debris Ontology (ODO) [1], and related ontologies [Rovetto & Kelso 2016] [Rovetto 2016, 2017], were proposed to help achieve this. ODO, for instance, is intended as a domain ontology that can be used across federated databases, offering an explicitly specified set of concepts describing the orbital debris domain. Its meaning-rich taxonomy will provide a sharable semantics for orbital debris data to, in part, consistently communicate the meaning of data to both humans and machines, and tag data elements in space object catalogs to help afford inference tasks, decision support, knowledge discovery, and information integration. ODO and the SSA ontology (SSAO) [2] is part of the overall Orbital Space Domain Ontology concept, which is conceived as a broader domain reference ontology. It aims to provide a knowledge representation structure of the orbital space environment, a common semantic model, and develop a sharable terminology. Collectively this will provide common meaning for datasets, a high-level taxonomy or classification for orbital space objects, and thus means to characterize space objects. Ongoing efforts have included using visualizations, R, JSON-LD, and contemporary semantic technologies.

Potential applications and interdisciplinary partnerships include web-based platforms, web apps, visualizations, and academia projects. Community input and participation may yield a more widely understood domain model as well as facilitate terminological standards. For example, the proposed conceptual, terminological and ontological analysis may contribute to such efforts as the Space Debris Mitigation Requirements in the International Standards Organization by developing more precise, consistent and coherent terms and definitions. Projects that seek to develop in-house ontologies can use ODO and related ontologies as reference ontologies.

This paper was produced independent of the authors affiliations. Readers are encouraged to contact the corresponding author[(1)] with general interest and potential opportunities to support or realize the described project.