Describing SmallSat Missions with MetaSat

Daina Bouquin[1], Pierros Papadeas[2], Daniel Chivvis,[1] Allie Williams,[1] Vasilis Tsiligiannis,[2] Fredy Damkalis,[2] Katie Frey[1]

[1] Center for Astrophysics | Harvard & Smithsonian, [2] Libre Space Foundation

[meta]sat

Open, collaboratively-developed metadata to support the future of space exploration.
https://schema.space/

MetaSat is Metadata

Space mission metadata is not standardized and various mission outputs are typically disconnected. This situation makes it hard for different teams to share information, collaborate, or advise each other on best practices and lessons learned. The MetaSat team, made up of staff from both the Wolbach Library at the Center for Astrophysics (CfA) and the Libre Space Foundation (LSF), is addressing these issues by creating a metadata vocabulary and example JSON-LD schemas that can be used to describe small satellite missions. This work will help facilitate the ease of sharing information between missions and lower the barrier of entry into the field.

MetaSat has three primary components:

1. MetaSat Vocabulary
2. MetaSat Crosswalks
3. Example MetaSat Schemas

MetaSat Vocabulary

The MetaSat Vocabulary, the core of the MetaSat Project, is a list of unique concepts that describe spacecraft, missions, ground stations, and more. Each concept in the MetaSat Vocabulary has a unique, permanent URI. These URIs, or Uniform Resource Identifiers, act as machine-readable identifiers for each concept. The MetaSat Vocabulary and its URIs can be used to describe missions both in private databases and on the web; since each concept has a unique URI, the vocabulary can be used for linked data applications and schemas that use any format of the RDF data model (e.g., RDF-XML, Turtle, N-Triples).

Examples from the MetaSat Vocabulary

spacecraftPropulsion

Spacecraft Propulsion

https://schema.space/metasat/spacecraftPropulsion MetaSat URI

Description: Method used to accelerate spacecraft (source)

Example: Electric

Synonym(s): None

Element Segments: Space Segment

Element Families: Propulsion

Crosswalked identifiers from other standards

Crosswalk Identifiers

BNCF Thesaurus	https://thes.bncf.firenze.sbn.it/termine.php?id=23918
Elhuyar ZTH	https://zthiztegia.elhuyar.eus/kontzeptua/137647
Freebase	https://tools.wmflabs.org/freebase/m/071w7
Microsoft Academic	https://academic.microsoft.com/v2/detail/165850701
WikiData Item	https://www.wikidata.org/wiki/Q609089
WikiData Property	https://www.wikidata.org/wiki/Property:P1876

samplingRate

Sampling Rate

https://schema.space/metasat/samplingRate

Description: Frequency with which a measurand is sampled (source)

Example: 50 Hz

Synonym(s): Sample Rate, Sampling Frequency, FS

Element Segments: Space Segment, Ground Segment

Element Families: Attitude Control, Communications, Signal Processing

Crosswalk Identifiers

WikiData Item	https://www.wikidata.org/wiki/Q56220712

receivedChannelPowerIndicator

Received Channel Power Indicator

https://schema.space/metasat/receivedChannelPowerIndicator

Description: A measure of the received RF power in the selected channel, measured at the antenna connector (source)

Example: 0-255

Synonym(s): RCPI

Element Segments: Space Segment, Ground Segment

Element Families: Communications, Signal Processing

Vocabulary Examples: Some concepts in the MetaSat vocabulary have many synonyms and can be grouped into multiple "segments" and non-exclusive groupings we are currently calling "families," (e.g., samplingRate) while other concepts may not (e.g., spacecraftPropulsion. Similarly, some elements may be crosswalked to many existing vocabularies and standards while other concepts only exist in MetaSat (e.g., receivedChannelPowerIndicator).

MetaSat Crosswalks

The MetaSat team has prioritized interoperability through our work building metadata crosswalks. A crosswalk is a table of equivalencies for converting metadata from one schema or vocabulary into another.

Our crosswalks, in combination with our decision to develop JSON-LD example schemas will allow MetaSat users to combine different vocabularies into a single document, or convert their documents into other RDF syntaxes without losing any information.

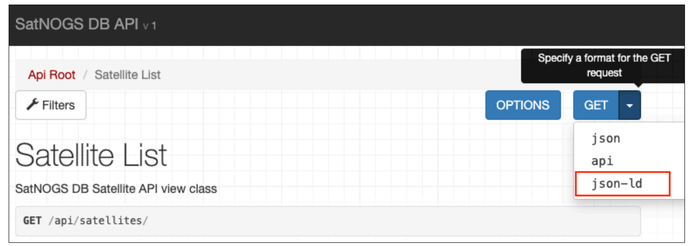
MetaSat Example Schemas (JSON-LD)

We are creating example schemas using the MetaSat vocabulary. Our schemas are written in JSON-LD, a highly flexible form of RDF that is built to be easily human-writable and machine-readable. The examples combine our vocabulary with structure, and give recommendations for how the concepts relate to each other. Example schemas can be found at:
https://gitlab.com/metasat/metasat-schema/-/tree/master/Examples

Implementing MetaSat

The LSF is currently in the early phases of implementing MetaSat on platforms associated with SatNOGS, LSF's global network of open satellite ground stations.

The "SatNOGS Network" stores information about both the ground stations on the network and their observations, while the SatNOGS database ("SatNOGS DB") stores information about active satellites. SatNOGS is one of the earliest adopters of MetaSat and will demonstrate the value of JSON-LD to the SmallSat community.



Future Work

Our hope is that the modular nature of the MetaSat project will allow a high degree of flexibility for our users and that new use cases will guide MetaSat's continuous development. In the near term we plan to pursue the following:

- Live implementation of MetaSat on SatNOGS DB.
- Development of tooling to support expanded adoption of MetaSat by both SmallSat teams and platforms documenting missions — examples of tooling include forms and interfaces to easily generate and validate JSON-LD files.
- Development of educational material, documentation, and other resources to support both novices and people with advanced experience working with metadata.
- Developing example schemas and expanding MetaSat to accommodate new use cases — for example, we are working with NASA's Small Spacecraft Systems Virtual Institute to describe lessons learned from past missions.

Contact Daina Bouquin (daina.bouquin@cfa.harvard.edu)

CENTER FOR ASTROPHYSICS HARVARD & SMITHSONIAN

Libre Space Foundation

ALFRED P. SLOAN FOUNDATION

Funding for MetaSat has been provided by the Alfred P. Sloan Foundation