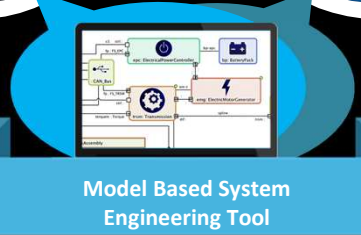
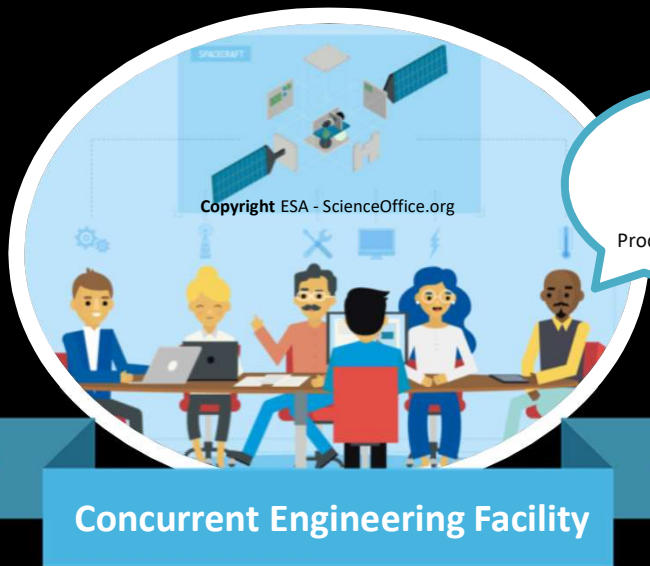


# NLP for Ontology Development: A use case in spacecraft parts domain

Kobkaew Opasjumruskit  
German Aerospace Center (DLR)  
Institute of Data Science

SEMANTiCS 2020, September 7





**OVERVIEW**

Spacecraft from the Science and Technology Hub, ESA's Spacecraft Hub, is a new generation of spacecraft designed to support the European Space Agency's (ESA) mission to explore the Solar System and beyond.

**Operational flexibility, a key requirement**

Spacecraft from the Science and Technology Hub, ESA's Spacecraft Hub, is a new generation of spacecraft designed to support the European Space Agency's (ESA) mission to explore the Solar System and beyond.

**HERITAGE**

ESA's Spacecraft Hub has a long history of successful missions, including the Mars Express, Venus Express, and Rosetta.

**SYSTEM COMPONENTS**

**μSTAR Tracker**

μSTAR Tracker is a small satellite designed to study the Sun's magnetic field and its impact on the solar wind.

Parameter	Value
Mass	10 kg
Power	10 W
Life span	1 year

**SPACE MICRO**

**jenaptronik**

Jenaptronik is a company specializing in the development and production of microelectronics for space applications.

Product	Features
Microcontroller	32-bit ARM Cortex-M4
Memory	512 Kbytes

# #1 ONTOLOGY FOR SPACECRAFT PARTS

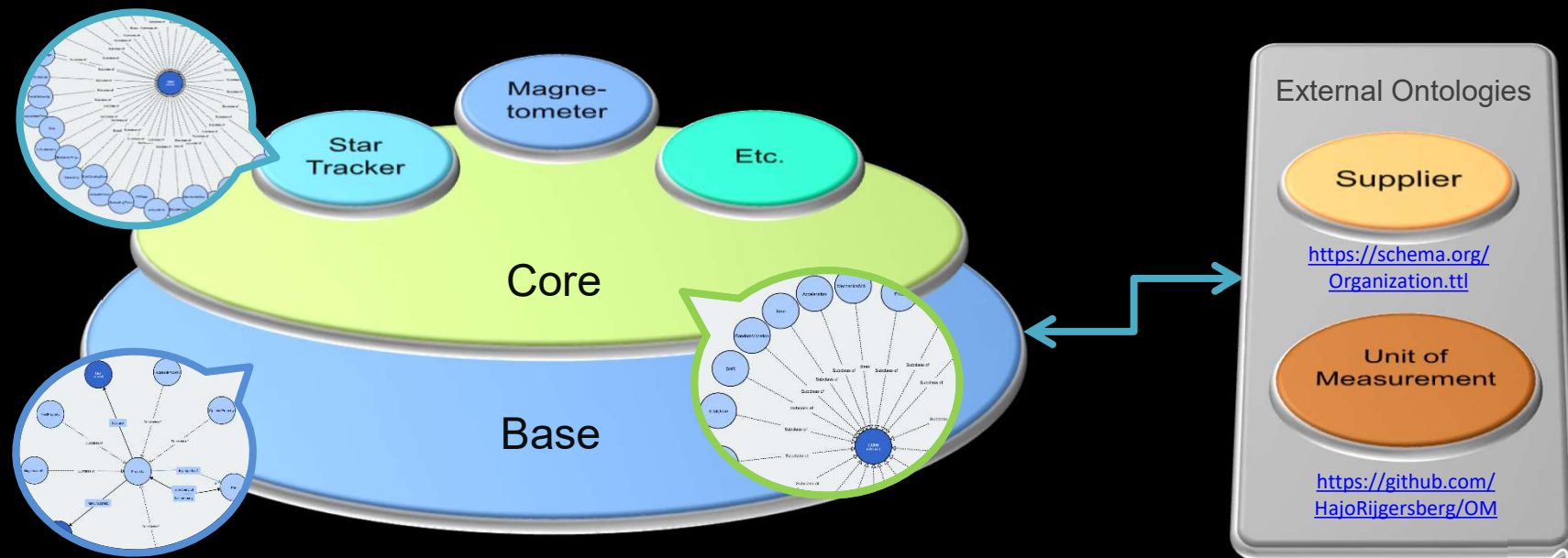


# Ontology: Sources

- Data models developed by DLR's in-house MBSE tool
  - <https://github.com/virtualsatellite>
- Existing product description standards
- Actual product data sheets
- Interview with system engineers and manufacturers
- Current spacecraft parts:
  - <https://zenodo.org/record/3832117>

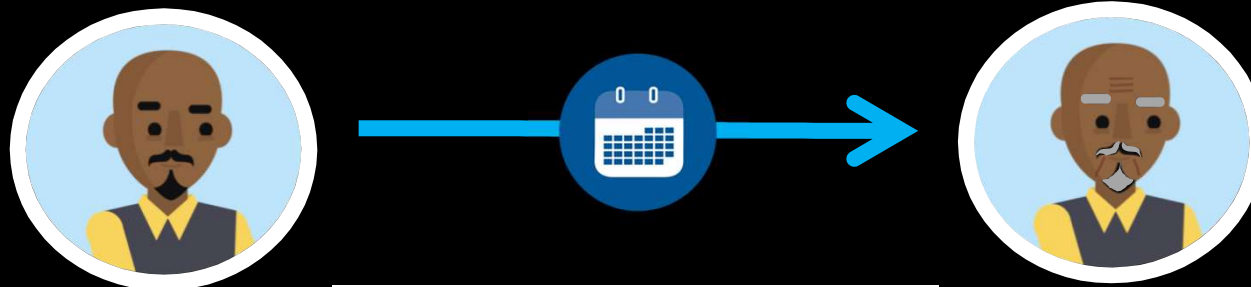


# Ontology: Hierarchical Structure



Spacecraft parts ontologies

# However, as time flies



And ontology should evolve

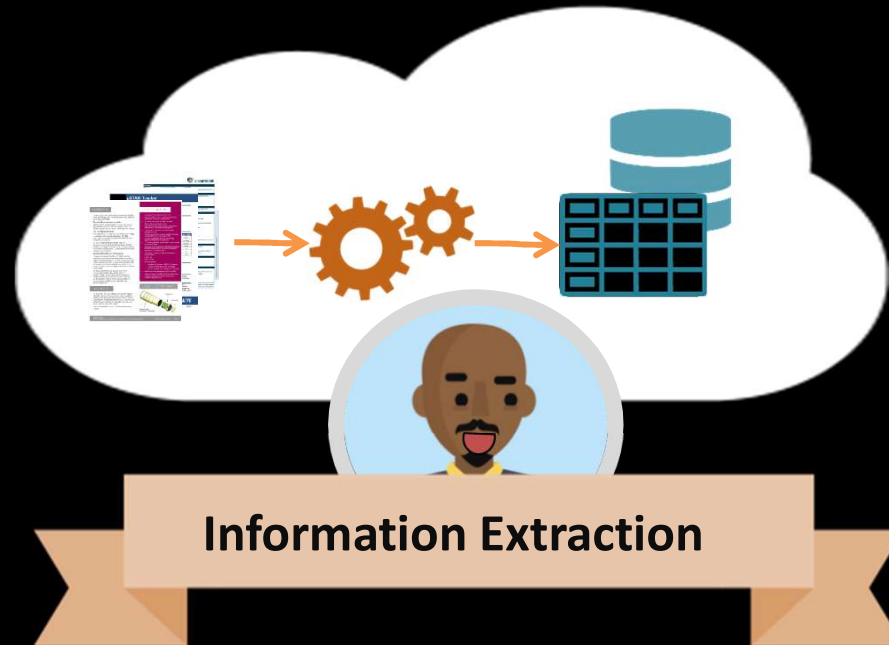
But, how ...





## #2 AUTO-IMPROVEMENT OF ONTOLOGY



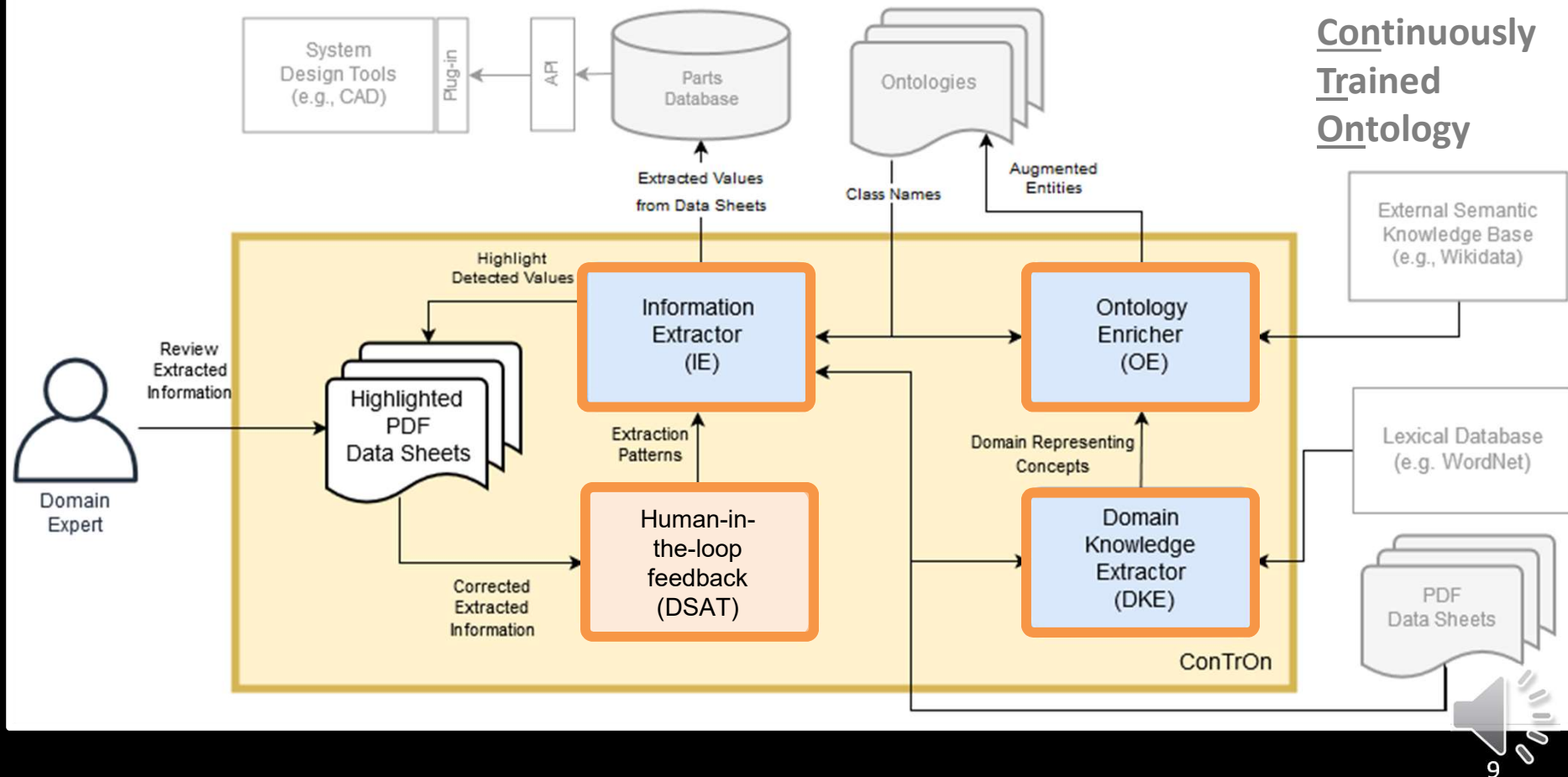


- Natural Language Processing
- Semantic Knowledge





## Continuously Trained Ontology



# Domain Knowledge Extractor



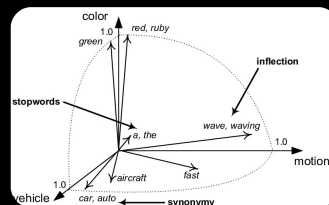
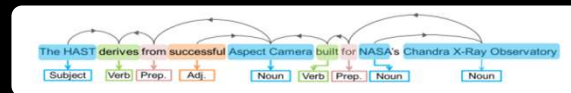
data, power, mm, space, receiver, temperature, mass, thruster, radiation, noise, battery, weight, **magnetic\_field**, reliability, **data\_rate**, payload, telemetry, resolution, thermal, baffle, lifetime, gauss, **data\_rates**, **propulsion\_system**, tracker, solar



- Extract keywords
  - Bag-of-words
  - Tf-idf



Definition, Synonyms, Hypernyms, ...



- Word Disambiguation
  - <https://wordnet.princeton.edu/>
  - Part-of-Speech Tagging
  - Vector Space Model



# Ontology Enricher



Ontology

A battery  
has an attribute  
"Operating  
Temperature"



Semantic  
Knowledge Base

**Operating Temperature (P5066)**  
temperature at which a device operates.  
Use values such as  
"maximum" (Q10578722),  
"minimum" (Q10585806).

- If ambiguous (multiple entities matched),  
compare to domain knowledge keywords
- At this step, only enriching the existing classes



# Information Extractor & DSAT

- Search text based on ontology classes
  - name, label, superclass, same as
- Extract values that come after keywords
- Human-in-the-loop: DSAT (Data Sheets Annotation Tool)

Adcole Maryland Aerospace: MAI-SS-Specification-20180330

contained and features Lost In Space star identification apply power and begin receiving quaternions accurate arcsec at 4 Hz rate. Currently available in either horizontal mounting and with or without baffle.

**Specifications**

Performance Item	Specification
Accuracy (Cross Axis / Boresight)	5.7 arcsec / 27 arcsec
Acquisition Time	130 ms Acq, 105 ms Track (typical)
Max Tracking Rate	>2.0°/sec
Update Rate	4 Hz
Star Catalog	Hipparcos
Lens	0.9in f1.2 BK7 Glass
Sun Exclusion w/wo Baffle	45° / 90°
Operating Temperature	-40 to 80 °C
Weight	170g (282 g w/ housing)
Dimensions wo / w case (mm)	50 x 50 x 47 / 55 x 65 x 70
Baffle Dimensions, Wt.	100 x 90 x 195, 135 gm
DC Voltage	5.0 V
Radiation TID (outside of case)	75 krad
Average power consumption	2.0W LIS, 1.5 W Track
Serial Interface	UART TTL / I2C

**MAI Space Sextant Star Tracker without packaging.**

U.S. Government customers may purchase this product competitive basis as follows: "In accordance with the SBA Policy Decision (c) (2), any procurement by US Government Entities is an SE award that is derived from, extends, or completes efforts made SBIR funding agreements and is authorized under 10 U.S.C. ; 41 U.S.C. 3303(b) with no further competition pursuant to FAR

**Annotation Tool Interface:**

Key: - +  
Value: - +  
Remark: - +

Comment:

Create New Entry

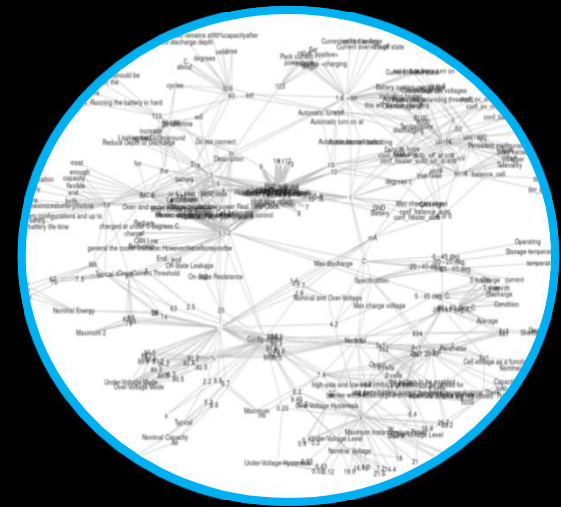
Auto-Detect Search:

	Key	Value	Remark
<input type="checkbox"/>	Dimensions wo / w case (mm)	50 x 50 x 47 / 55 x 65 x 70	
<input type="checkbox"/>	Baffle Dimensions, 135 gm	100 x 90 x 195,	

Save Annotations

# Outlook

- ❑ Apply to other domain: patent, medicine
- ❑ Ontology editing interface on DSAT
- ❑ Knowledge graph from data sheets





kobkaew-opas



kobkaew.opasjumruskit@dlr.de



kobkaewo

Thank you for your attention!



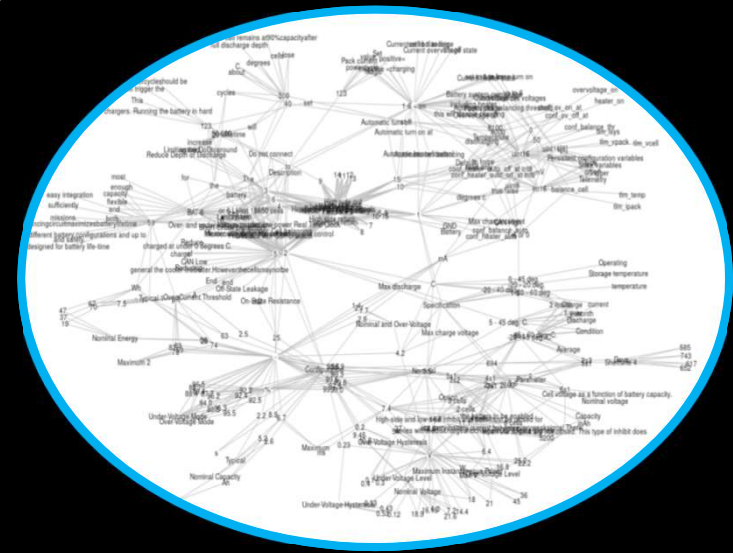
The background of the slide features a dark, semi-transparent overlay on top of technical drawings. On the left, there is a table with multiple rows and columns of text, which appears to be a technical specification or a data table. To the right of the table, there are architectural or engineering drawings, including a plan view of a building or a complex structure with various rooms and corridors. The overall image has a professional, technical feel.

# Agenda

- Scenario
- Ontology for Satellite Design Process
  - NLP for Automatic Improvement of Ontology
- Outlook

# Product Ontology: Further Usages

- Conversion to database schema  
<https://gitlab.com/dlr-dw/ontocode>
- Part data exchange interface
  - Web API
- Knowledge graph
  - Information retrieval



# Existing Tools: Entities Extraction

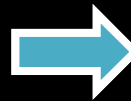
## DBpedia Spotlight



The ASTRO APS has been designed with compact dimensions, low mass, and low power consumption. Since July 2013, the ASTRO APS has been accumulating space heritage operating flawlessly on board of Alphasat.



Jena-Optronik GmbH · Otto-Eppenstein-Straße 3 · 07745 Jena · Germany  
Phone +49 3641 200-110 · Fax +49 3641 200-222  
Email sales@jena-optronik.de · Web www.jena-optronik.com



The Jena-Optronik [ASTRO](#) APS is an Autonomous Star Sensor with the most advanced [radiation hard CMOS](#) Active Pixel Sensor detector technology for long-term missions on Telecom, Science and [Earth](#) Observation satellites. space for success  
The [ASTRO](#) APS has been designed with [compact](#) dimensions, low mass, and low power consumption.  
Since [http://dbpedia.org/resource/American\\_Society\\_for\\_Radiation\\_Oncology](http://dbpedia.org/resource/American_Society_for_Radiation_Oncology) [space heritage](#) operating [flawlessly](#) on board of [Alphasat](#).

Picture Alphasat © ESA

Jena-Optronik GmbH

Phone +49 3641 200-110

Email sales@jena-optronik.de

Size & Mass

Dimensions 154 mm

Mass approx. 2 kg

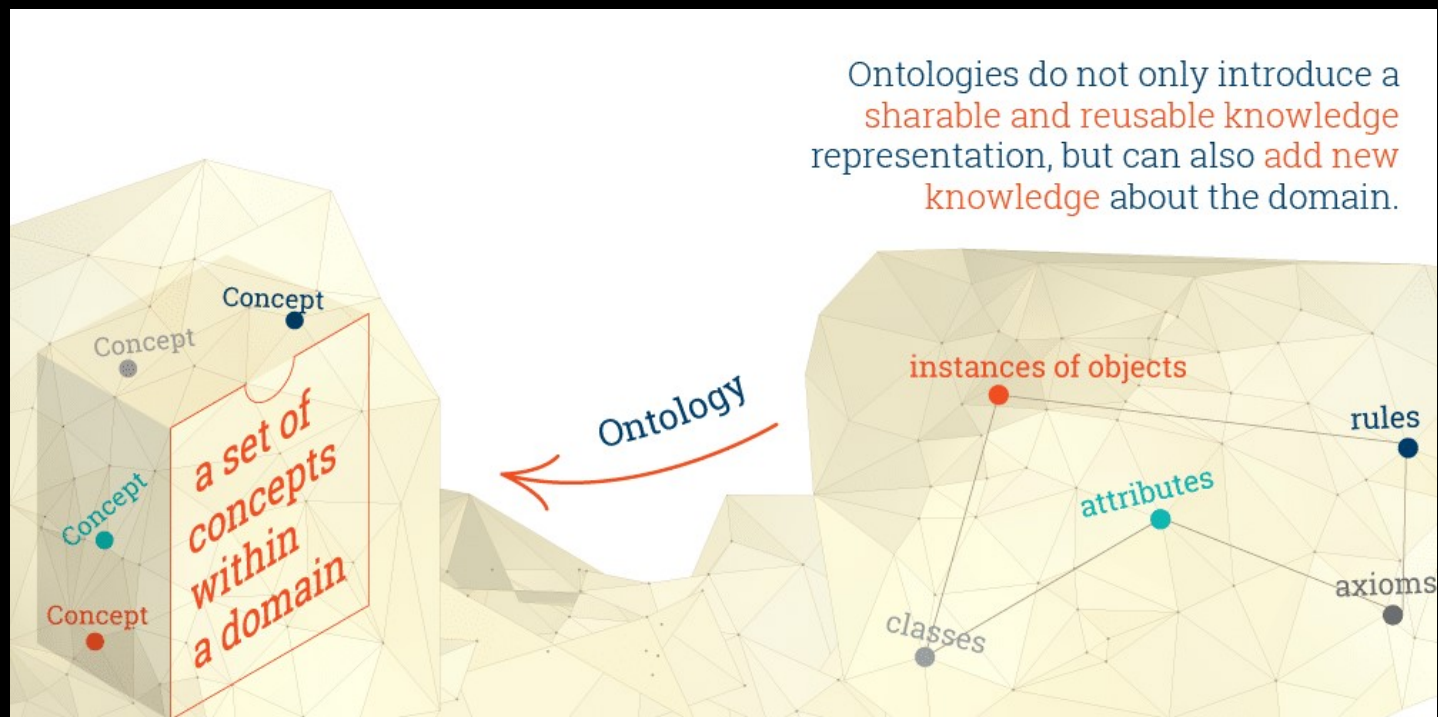
### OPEN CALAIS

ESA Contact Details Company Technology

RELATION CONTACT DETAILS

telephone	+49 3641 200-110
emailaddress	sales@jena-optronik.de
url	www.jena-optronik.com

# Ontology: Concept



<https://www.ontotext.com/knowledgehub/fundamentals/>

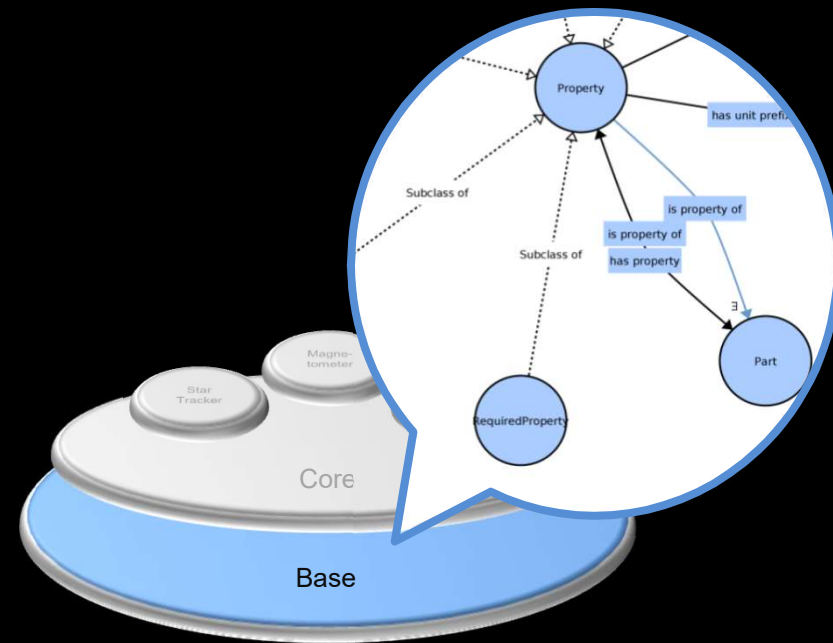
# Semantic Knowledge



<https://www.ontotext.com/knowledgehub/fundamentals/>

# Spacecraft Parts Ontology: Base

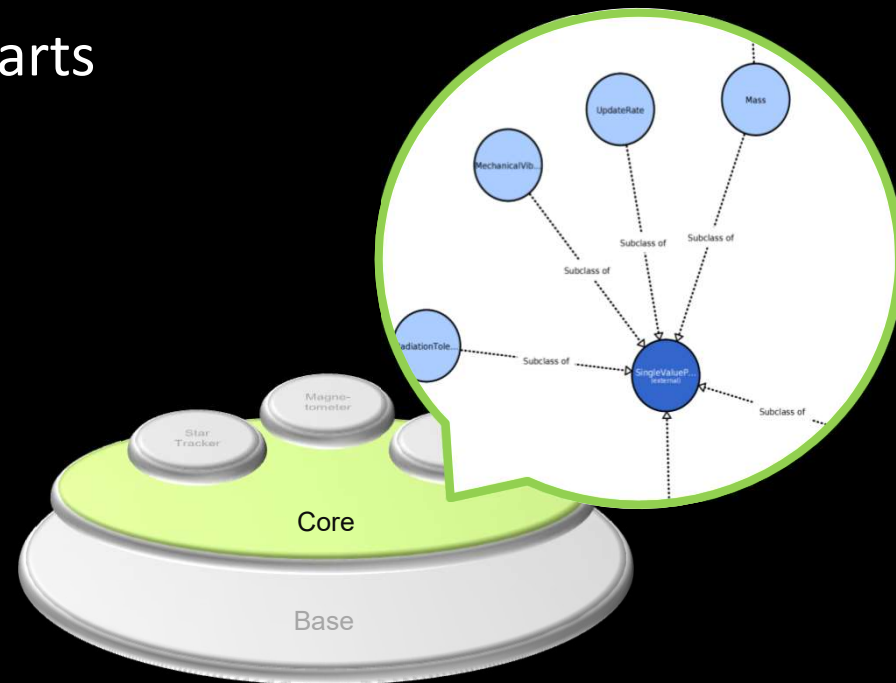
- Primary classes
  - Part (Product)
  - Part's attribute
  - Type of attribute
- Primary properties
  - “is property of”
  - “has property”
  - “has unit”





# Spacecraft Parts Ontology: Core

- Common attributes for all parts
  - Mass
  - Lifetime
  - Operating Temperature
  - Width, Height, Length
- 26 attributes



# Spacecraft Parts Ontology: Star Tracker

- Specific attributes to star trackers
  - Attitude accuracy
  - Field of view
  - SNR
  - Etc.
- 36 Attributes

