Creating Topic Maps Ontologies For Space Experiments

David Damen

david.damen@spaceapplications.com

Space Applications Services, Leuvensesteenweg 325, 1932 Zaventem, Belgium

Tel.: +32 (0)2-721.54.84   www.spaceapplications.com

Introduction

Early in 2009, an FP7 project called ULISSE started with the purpose of:

- improving the return on investment of space experiments through **better valorization, dissemination and exploitation** of the **experiment data**
- creating **opportunities for multidisciplinary** research

In Europe, these space experiments are performed by User Support and Operation Centers (USOCs) each of which specializes in one or more scientific disciplines (see table 1 below).

Scientific discipline	Data provider	Location
Cell Biology	ETH	Switzerland
Fluid Science	MARS	Italy
Fluid Science	E-USOC	Spain
Material Science	MUSC	Germany
Physiology	CADMOS	France
Physiology	DAMEC	Denmark
Plant Physiology	N-USOC	Norway
Solar Physics	B-USOC	Belgium
Space Health & Medicine, Bed Rest studies	MEDES	France
Space Plasma	SRC-PAS	Poland
Technology	Erasmus-USOC	Netherlands

Table 1. Scientific disciplines covered by the data providers

To achieve the goals set forth by ULISSE, the information and data of space experiments will be described in topic maps.

Most data providers, which consist mainly of engineers and scientists, do not have a background in knowledge management. Because Topic Maps technology allows varying degrees of formality and requires less training than other techniques, it was deemed more adequate.

Goals

The first step in authoring topic maps is creating the ontologies that will provide the structure used to represent the domain knowledge.

For ULISSE, this amounts to creating Topic Maps ontologies for space experiments in general and of (relevant parts of) the scientific disciplines of the data providers.

Method

We adapted the ontology creation workflow of [1] into four phases which can be described as follows:

- **Preparation:** Gather relevant documentation and data; explain about Topic Maps.
- **Analysis:** Analyze the available documentation and data; identify typical questions.
- **Draft:** Create the initial Topic Maps ontology by:
  - **Enumerating** relevant terms.
  - **Categorizing** terms into topic types (TT), occurrence types (OT), association types (AT) or instances (I).
  - **Organizing** the categorized terms in an ontology.
- **Refinement:** Fix mistakes, clarify confusion, review the structure, evaluate with typical questions.

A critical first step in this process is setting up Ontology Workshops with each data provider individually.

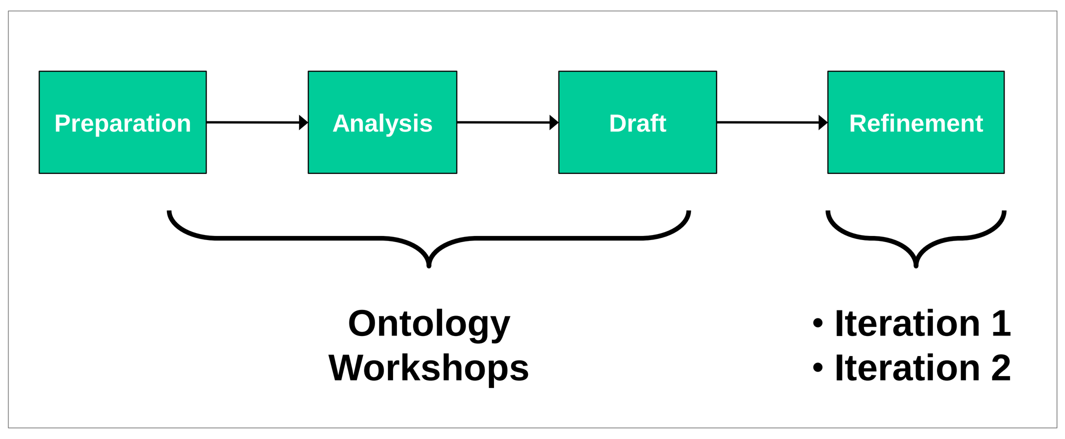

Figure 1: Adapted ontology creation workflow.

The Ontology Workshops bind the prepation, analysis and draft phase together. An Ontology Workshop usually lasts three days and consists of the following agenda:

- **Day 1:** Present Topic Maps; present space experiments and the scientific discipline.
- **Day 2:** Enumerate and categorize words relevant to the space experiments and the scientific discipline.
- **Day 3:** Organize the categorized word list in simple graphs to illustrate the structure of the initial Topic Maps ontology.

During and after the Ontology Workshops, tools that were already known (e.g. Microsoft Excel) or simple to use (e.g. IHMC CMapTools) were enlisted to ease the feedback process. The Graphical Topic Maps (GTM) notation [2] was simplified to facilitate writing down the ontologies.

Results

Using Microsoft Excel allowed for a quick way to enumerate terms and categorize them during the second day of an Ontology Workshop, see Table 2.

Relevant Term	Category	Description
Eckmann number	I	of characteristic number
educational	AT	unary AT: of experiment
electrical conductivity	I	of physical property
electromagnetic force	TT	subtype of body force
engine	TT	AT: "hardware"/"facility" "composed-of" "engine"
environmental temperature	I	of boundary condition
ESA	I	of space agency
evaporation	I	of physical phenomenon
experiment	TT	instances are FASES, … AT: "experiment" "is-performed-in" "exp. Facility". AT: "experiment" "studies" "physical phenomenon"
experiment output	TT	AT: "experiment" "produces" "experiment output"
experiment result	TT	AT: "experiment" "produces" "experiment result"
experiment setup	TT	AT: "experiment" "describes" "experiment setup"

Table 2: Partial fluid science word list

Each word list was then organized, first as a concept map, see Figure 2, and afterwards as a Topic Maps Ontology using a simplified GTM notation in Microsoft Powerpoint.

Common terms among word lists were captured in a *general space experiments* ontology, see Figure 3.

What time is it?

One of the modeling challenges of ULISSE is the representation of time:

- Absolute time: *"An article was published at T1."*
- Relative time: *"All blood pressure measurements for all physiology experiments 10 days post flight."*
- Time intervals: *"An experiment ran from T2 till T3."*

The scoping mechanism of Topic Maps allows for a flexible representation and processing of time.

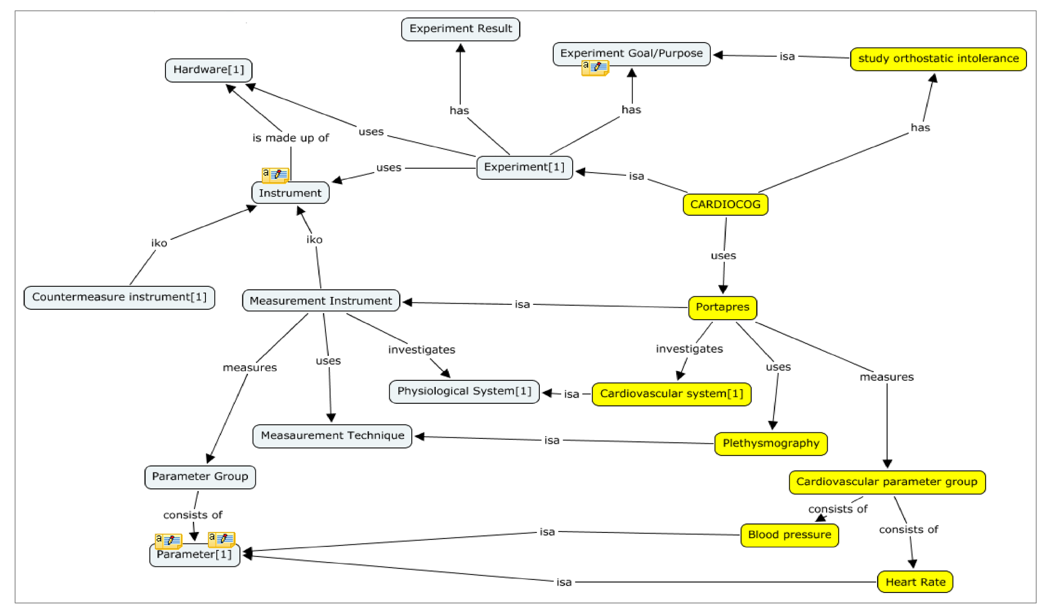

Figure 2: Partial concept map for physiology

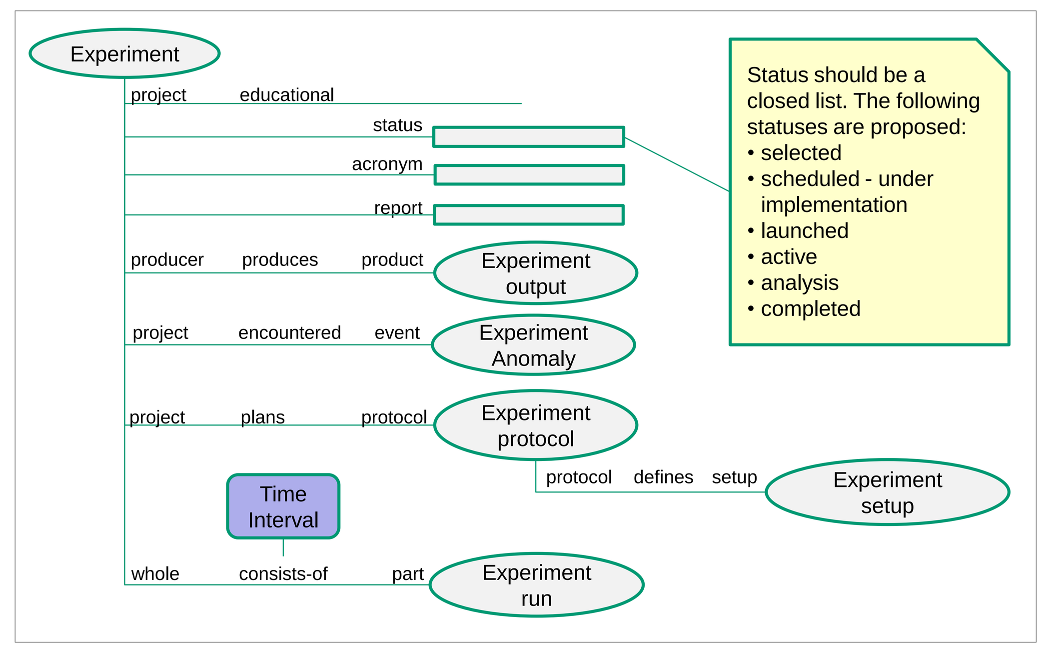

Figure 3: Partial general space experiments ontology

Conclusion

Using tools that the data providers were already experienced with was instrumental in getting feedback during the ontology creation. Using a simplified GTM notation provided everyone with a common language during the refinement iterations.

Future work will develop ScienceCast which will provide a unique access point for heterogeneous data sources scattered around Europe containing scientific data from space experiments. The users will be able to access this data using powerful queries in their own terminology taking advantage of the semantic organization of the information. Domain experts will use ScienceCast to author topic maps about new space experiments. They will be assisted by an ontology wizard that follows the Ontology Workshop approach.

Literature Cited

1. Garshol, L.M.: Towards a Methodology for Developing Topic Maps Ontologies. In: Maicher, L.; Sigel, A.; Garshol, L.M. (eds.) TMRA 2006. LNCS (LNAI), vol. 4438. Springer, Heidelberg (2007)
2. Thomas, H.; Redmann, T.; Pressler, M.; Markscheffel, B.: GTMalpha – Towards a Graphical Notation for Topic Maps, Maicher, L.; Garshol, L. M. (eds.): Subject-centric computing. Fourth International Conference on Topic Maps Research and Applications, TMRA 2008, Leipzig, Germany, October 16-17, 2008, Revised Selected Papers. (Leipziger Beiträge zur Informatik: XII) - ISBN 978-3-941152-05-2

Acknowledgements

This work has received funding from the European Commission through the Seventh Framework Programme (FP/2007-2013) under the Space Theme, under grant agreement № 218815 within the ULISSE Project (USOCs KnowLedge Integration and Dissemination for Space Science Experimentation).