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Geoscience use cases and the design of the ISDC Ontology

Bernd Ritschel (1), Sabine Pfeiffer (2), and Björn Kopischke (3)

(1) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany (rit@gfz-potsdam.de, +49 331 2881703), (2) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany (pfeif@gfz-potsdam.de, +49 331 2881703), (3) Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany (bjoernk@gfz-potsdam.de, +49 331 2881703)

The design process of ontology models as well as the development of appropriate semantic Web based applications also should be use case driven. Of course, further constraints in these processes are technically related and highly depend on personal experiences and resources. This paper demonstrates the impact of practical geoscience objectives related to real data of the Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences (GFZ) and appropriate use cases as well as technical constraints in respect to the matured design of the GFZ Information System and Data Center (ISDC) Ontology.

The research and the understanding of the climate change of the Earth is the high level scope for a group of geoscience use cases which shall be answered and realized by the ISDC ontology. More specific and detailed are the use cases regarding to the research objectives of the Global Geodynamic Project (GGP), wich are based on high-accurate in-situ gravity data measured by a network of superconducting gravimeters around the globe. In order to deal with the use cases (derived from the specific geoscience objectives) the semantics and knowledge in the existing ISDC ontology model had to be extended by new domains (implemented as classes), by new properties and by real individuals. In addition to the present domains *Project*, *Platform*, *Instrument*, *Product Type* and *Institution*, which are now implemented as subclasses of *ISDC*, such important domains as *Geophenomena*, *Keywords* and *Personnel* were introduced to the model. The relationships between the classes are implemented as appropriate properties using specific Ontology Web Language (OWL) features such as inverse and transitive. An ISDC ontology example for an inverse and transitive property related to the classes *Project*, *Platform*, *Instrument*, *Product Type* is the pair consisting of the property *isPartOf* and the inverse property *supplies*. Using these properties, in a broader sense existing relations, such as e.g. an instrument is part of a platform and an instrument is part of a project as well as a platform is part of a project and vice versa a project supplies a platform and a platform supplies an instrument and a project supplies an instrument can be expressed. The content of hundreds of plain text and XML documents of the ISDC repository as well as unstructured knowledge from humans and the Web have been used in order to create the same number of individuals for the ISDC ontology. Even so, only a small part of the ISDC repository and appropriate geoscientific objectives expressed by geophenomena, such as e.g. atmospheric interactions, climate change, core modes, ..., could be taken into account. Some simple use cases, such as e.g. "I am interested in climate change research. Provide all ISDC product types which are related to the geoscience objectives of climate change phenomena." can be directly answered by the ontology. This is realized by the creation of a necessary and sufficient conditioned class combination of a new subclass of *Keywords* which contains all keywords which describe the geophenomenon climate change and a subclass of *Product Type.* A reasoning process using the ISDC ontology and the new class constructs finally computes the appropriate individuals of the *Product Type*. More difficult use cases need the implementation of additional logic within the ontology or outside e.g. using the Semantic Web Rule language, SPARQL or other constructs. The development of the ISDC ontology is not yet finished, but version 1.0 is available at http://isdc.gfz-potsdam.de/ontology/isdc_1.0.owl and is the bases for further developments. The main next steps are the merged use of other appropriate and standardized ontologies, such as e.g. Dublin Core or Friend of a friend, the introduction of a new ISDC domain *Data Product* containing the knowledge of the real data files, and last but not least, the design and the implementation of a semantic Web application in order to offer the data, information and knowledge of the ISDC system in a semantic-based integrated approach.

This paper is based on the research work at GFZ dealing with the design of ontologies and the understanding and usage of semantic Web technologies within the last 2 years as well as on the results of two master thesises finished at the end of 2010 respectively Januar 2011. The main tools for the development of the ISDC ontology model are Cmap Tools Ontology Editor and Protégé version 3.4.4 and 4.1 and Pellet.