A DCAP to promote easy-to-use data for multi-resolution and multi-temporal satellite imagery analysis

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Introduction & Motivations

Satellite images are great!

Satellite images are a valuable source of information. The increasing number of Satellite sensors as well as their diversity produces a huge amount of satellite images.

Satellite images can be used to address multiple environmental issues quickly, repeatedly and in a reliable way:

- Understanding the dynamic of ecosystems
- Urban evolution
- The monitoring of environmental changes
- ...
However ...

Images

- Come from different satellite sensors: Landsat series, SPOT series, PLEIADES...
- Are described using different standards: Standards of the producers, ISO19115, ISO19115-2, O&M...
- Are encoded in different formats: Tiff, GeoTiff, JPG2000...
- The size of satellite image can go from 50 MB (low resolution) to 15 GB (very high resolution)
Introduction & Motivations

Objective

In this context, how to provide accessibility to a variety of expert and non-expert users using the metadata of the different satellite images.

Implementing a *common* tool for discovering satellite images that provides an *open and extensible model* facilitating the sharing and management of distributed images. This model has to cover the needs of *discovery*, *localization*, *processing* and *consulting* satellite images.
GEOSUD context

Acquiring, each year, about 600 images, estimated at a volume of 1 to 2 TB/year for high resolution products and about 12 Tbytes/year for the very high resolution products.
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One size does not fit all

Principles

Application profiles **reuse** metadata standards to respond either to new requirements, or to more specific ones

- Functional requirements
- Domain model
- Description Set Profile
- Usage guidelines
Earth Observation Application Profile: A RDF compliant DSP

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EOAP: Earth Observation Application Profile

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RDF: Resource Description Framework

RDF is a framework for representing resources and metadata. Where the information is structured into a set of subject-predicate-object triples (Hayes, 2004).

RDFS: RDF Schema

RDF Schema is a semantic extension of RDF. It provides data-modelling vocabulary and introduce primitives to determine characteristics of other resources (Brickley, 2004).

DSP: Description Set Profile

DSP is a language that is intended to represent the overall structure of a metadata description set by means of constraints that apply either on resources, properties used or values of those properties (Nilsson, 2008).
EOAP: RDF compliant DSP

Modelling DSP using a three level hierarchy

- M3: RDF / RDFS
- M2: DSP
- M1: EOAP
- M0: Metadata Schema

Universal Modelling Language

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Example : Representing n-ary relation

Associating the class *DescriptionTemplate* with *StatementTemplate*, *Property* and *Constraint*

**Figure** : The association class *StatementTemplate*
EOAP : RDF compliant DSP

Refining the semantics of the DSP model

**Figure**: Simplified DSP diagram qualified with the RDF/RDFS UML profile
EOAP: Earth Observation Application Profile

Figure: Domain model for Earth Observation
Earth Observation Application Profile : A RDF compliant DSP

**EOAP : RDF compliant DSP**

**Figure :** Excerpt of the EOAP model as a DSP profile instantiation
EOAP : RDF compliant DSP

```
<eoap:EarthImage_T
  a     dsp:DescriptionTemplate ;
  dsp:maxOccur  "1"^^xsd:nonNegativeInteger ;
  dsp:minOccur  "1"^^xsd:nonNegativeInteger ;
  dsp:resourceClass eoap:EarthImage ;
  dsp:standalone "true"^^xsd:boolean ;
 [...] ]
  dsp:statementTemplate
  [  a     dsp:NonLiteralStatementTemplate ;
      dsp:maxOccur  "infinity" ;
      dsp:minOccur  "1"^^xsd:nonNegativeInteger ;
      dsp:NonliteralConstraint
      [  a     dsp:NonLiteralConstraint ;
          dsp:DescriptionTemplate
          <eoap:GeographicExtent_T>;  
          dsp:valueStringOccurrence
          "disallowed"^^<dsp:Occurrence>;  
          dsp:VocabularyEncodingSchemeOccurrence
          "disallowed"^^<dsp:Occurrence>;  
      ];  
      dsp:property dcterms:coverage
  ].
<eoap:GeographicalExtent_T
  a     dsp:DescriptionTemplate ;
  dsp:maxOccur  "infinite" ;
  dsp:minOccur  "1"^^xsd:nonNegativeInteger ;
  dsp:resourceClass iso19115:EX_GeographicalBoundingBox ;
  dsp:standalone "false"^^xsd:boolean .
[...]
```

**Figure** : EOAP RDF excerpt in N3
Image discovery : Uses cases

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Targeted users

- **Researcher**: Studies on the structure, functioning or dynamics of ecosystems
- **Governmental units**: Cartographic products and monitoring governmental policies
- **Local authorities**: Management of the environment
- . . .
Non expert use case: Enforce the regulations on exploitation of forest resources

- Production of a map identifying the clearcuts of the forest resource
- The map require two high-resolution images covering the same area acquired in the same season between an interval of one or two years

High-resolution images that were acquired during the period from April to May for the years 2014 and 2015, covering the area from latitudes 43.97; 45.06 longitudes -1.56; -0.133
Expert use case: Identifying wetlands in the Madagascan forest

- Using multi-source and multi-resolution images: Landsat 7 ETM+ 30m and SPOT 5 2.5m
- Using spatial extent of the images
- Using date of acquisition of the images

Images acquired by Landsat 7 platform and the images acquired by the SPOT5 in panchromatic mode whose spatial footprints are between the latitudes -20.58; -22.35 and longitudes 47.85; 46.44, which were acquired between the month May and June.
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Conclusion and future work

- Defined a DCAP for earth observation satellite images
  EOAP: http://purl.org/eoap/

- Initiate a work toward meta-modelling activities to complete the RDF-based DSP model with higher levels of abstraction to efficiently drive the building of a thematic DSP model
Conclusion and future work

On going work

- Developing a generic RDF-based editor to build DSP models from the defined UML profiles

- explore adding OCL(Clarck,2002) constraint to the DSP meta-model
Thank you!

Welcoming questions :}

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