Tools for Incorporating ISO 19115 Metadata in Earth Science Data Systems

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July 12, 2011

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Tools for ISO 19115 Metadata in Earth Science Data Systems

Objective

- Ease the implementation and utilization of the ISO 19115 metadata standard into Earth Science Data Products
  - Initial goal - Enable the proposed Soil Moisture Active Passive (SMAP) mission to incorporate ISO metadata into data products.
  - Follow-up goal – Provide infrastructure and documented experience that enables other NASA sponsored teams to implement and incorporate ISO 19115 metadata into their data products and data systems.

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Major Products

• This effort will generate:
  – A reusable common reader/writer API for accessing ISO 19115 metadata in ISO 19139 compliant XML file format.
  – A generic tool that provides direct and easy access to specific metadata elements of interest that conform to the ISO 19115 standard and its ISO 19139 XML encodings.
  – A generic HDF5 tool to support the conversion from ISO 19139 compliant XML file format to and from standard HDF5 metadata representation.
  – Technical and user oriented documentation of the ISO 19115 APIs and tools.
Implementation Plan

• Implement reader/writer APIs that provide access to the ISO metadata in both XML and HDF5 format.
• Generate an ISO compliant schema for proposed SMAP data products.
• Integrate the tools into the proposed SMAP Science Data System.
• Review the outcome
  – Review tools with potential users within and outside the proposed SMAP project for efficacy and ease of use.
  – Review the ISO schema with the Metadata Evolution for NASA Data Systems (MENDS)/ESDIS team to enable development of a “NASA convention” of ISO 19115.
• Iterate on the above process
• Generate the tool that enables exploration of ISO compliant metadata in XML format during the second implementation iteration.

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Current Progress

• Began working in late May
• Reworked proposed SMAP metadata dataset schema
  – Restricted work to elements in ISO 19115 and 19115-2
  – Restricted work to dataset schema, series schema will follow
  – Removed vestiges of North American Profile
• Used UML tool to generate an initial SMAP XSD schema
• Identified reusable XSD Schema constructs that are commensurate with XML binding approach
• Assessed existing XML Binding tools for handling **expected variations** in XSD Schema model of metadata in ISO 19139
Major Challenges

• MENDS recommendations stipulate the need for a NASA usage convention
  – Anticipated metadata entries always appear in specific ISO elements
  – Flexible guidelines that enable each mission, data center and clearing house to identify and specify locally required values

  **Effective effort requires a convention for ISO usage**

• Within any given mission or entity, the specifications of the ISO schema will vary
  – Different data products from the same mission
  – Different missions serviced by the same organization

  **The API/tool must accommodate design variations with relative ease**
Proposed Approach
Tools for ISO 19115 Metadata in Earth Science Data Systems

Metadata Handling

Data Producer/Consumer Code

ISO 19115 Object Representation In Code

Read/Write in XML Read/Write in HDF5

ISO 19139 XML

ISO 19139 XML Representation In HDF5

Access XML Content Inside HDF5

ISO 19115 Representation In Native HDF5

- ISO 19139 Schema and XML
  - Interoperable metadata interchange format
- ISO 19115 in HDF5
  1. Metadata as hierarchical group/attributes
  2. Metadata as embedded ISO 19139 XML stream
    - Compatible with legacy formats such as HDF4 and NetCDF3
- Conversion cross-walks are possible

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XML Schema Definition (XSD)

• ISO 19139 codifies XML representation of ISO 19115
• XSD provides:
  – A full description of the XML structure
  – Specification of permissible values in an XML document
• Enables validation
  – Can be used to validate the structure and the value of an XML metadata instance
• Can leverage existing UML and XSD documents of ISO 19115
XML Data Binding

- Represents information in an XML document as an object in memory
  - No more XML parsing as in DOM or SAX
- Leverages the model in an XSD Schema to create classes and interfaces that adhere to the information structure defined by the schema.
- Enables serialization/deserialization of XML instances to/from code.
- Supports expected variations in the ISO model
Means of Representing ISO in XSD

- Identify XSD Schema constructs commensurate with XML binding approach
- Use built-in types
  - `xs:string`
  - `xs:decimal`
  - `xs:integer`
  - `xs:boolean`
  - `xs:date`
  - `xs:time`
  - `xs:dateTime`
  - `xs:duration`
- Define Complex Elements at the top-level
  - Follow the “Venetian Blind” approach to XSD layout
Two potential approaches for representation of ISO code lists in XSD

- *Restriction/Facets* provide improved validation
  
  - Restrictions are used to define acceptable values for XML elements or attributes. Restrictions on XML elements are called facets.
  - Restriction of values chosen from an enumeration

- *Indicators*
  
  - Order indicators
    - *choice*: specifies that only one child element may appear
    - *sequence*: specifies that child elements must appear in a specific order
  - Occurrence indicators
    - maxOccurs
    - minOccurs
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Assessment of XML Binding tools

- **C++**
  - **CodeSynthesis XSD**
    - An open-source, cross-platform W3C XML Schema to C++ data binding compiler.
  - **CodeSynthesis XSD/e: XML for Light-Weight C++ Applications**
    - An open-source, dependency-free XML Schema to C++ compiler for mobile, embedded, and light-weight applications
  - **Mel**
    - An open source C language XML Binding tool with *limited* XSD Schema support

- **Java**
  - **Java Architecture for XML Binding (JAXB)**
    - [http://www.oracle.com/technetwork/articles/javase/index-140168.html](http://www.oracle.com/technetwork/articles/javase/index-140168.html)

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Conclusions

- Effort will meet the challenge for SMAP as the first of the Decadal Survey Missions
  - SMAP will be first NASA mission to implement ISO 19115.
  - Provides the necessary tools to implement ISO.
  - Decisions about standard use are still forthcoming. Need to converge as closely as possible with developing standard.
- Effort will encourage collaboration across NASA ESDIS
  - Select optimal technical approach to enable modifications to the metadata schema and reuse by other NASA organizations
  - Regularly review approach and implementation with outside organizations to ensure applicability

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Backup

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Tools for ISO 19115 Metadata in Earth Science Data Systems

CodeSynthesis XSD

• An open-source, cross-platform W3C XML Schema to C++ data binding compiler.
• Free for non-commercial use
• Supports two XML Schema to C++ mappings:
  – in-memory C++/Tree
  – stream-oriented C++/Parser.

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Tools for ISO 19115 Metadata in Earth Science Data Systems

**CodeSynthesis XSD/e**

- An open-source, dependency-free XML Schema to C++ compiler for mobile, embedded, and light-weight applications
- Small footprint
- XML parsing and serialization
- XML Schema validation
- XML data binding
- Mappings
  - C++/Hybrid in-memory mapping creates a light-weight, tree-like object model of the XML data
  - C++/Parser (for XML parsing)
  - C++/Serializer (for XML serialization)


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mel

- An open source C language XML Binding tool with *limited* XSD Schema support
- Produces
  - .h file containing C structures
  - .c file that provides the functions mentioned in the .h file
  - mellib.a to linked against code.

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Many metadata values transfer directly from the input product to the output product

XPaths provide a simple means to codify automated mapping

- XPaths can be used to drive automated mapping calls.
XPath

• An alternative approach to automatic data binding

• Benefits
  – Data binding code only needs tree structure knowledge of XML document
  – Does not require use of an XSD Schema
  – Binds specifically to needed elements

• Drawbacks
  – Without an XSD Schema, application can not validate XML element structure and types
  – Does not create an automated data model
Existing Authoring Tools

- GCMD DIF authoring tool
- FGDC has authoring tools tkme and xtme
  - http://www.fgdc.gov/metadata/geospatial-metadata-tools
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Updated ISO Schema UML Diagram – EX_Extent

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