International Conference on Dublin Core and Metadata Applications

Dublin Core and other metadata schemas

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The speaker

- PhD student at Royal Inst. of Technology, Stockholm
  - Subject: Metadata Standardization and Interoperability
- Engaged in metadata within IEEE, ISO, DCMI
- Co-chair of
  - DC Architecture Forum
  - Joint DCMI / IEEE LTSC Taskforce
- Co-author of
  - DCMI Abstract Model
  - Expressing Dublin Core in RDF
  - Singapore Framework for DC Application Profiles

Overview of tutorial

- **Metadata specifications**
- Interoperability
- The human side of metadata
- The Semantic web
- Metadata records
- Application Profiles

Metadata specifications outside of DCMI

- Many domains:
  - **E-Government**
  - **Education**
  - Geospatial information
  - **Libraries**
  - Business
  - Multimedia
  - Geospatial information
  - etc.

Metadata specifications outside of DCMI

- Many technical environments
  - Low-level (file systems, protocols etc)
  - **File formats** (HTML, Atom, etc.)
  - Ontologies (OWL, etc.)
  - **Repositories**
  - **Harvesting**

Metadata specifications outside of DCMI

- Many expressions
  - **XML**
  - **RDF**
  - **SQL**
  - **HTML**
  - ID3
  - EXIF
  -

Metadata specifications outside of DCMI

- Many complete “schemas”
  - MARC
  - METS
  - MODS
  - IEEE LOM
  - MPEG-7
  - CSDGM
  - etc.

Metadata specifications outside of DCMI

- Many purposes
  - **Search**
  - **Describe**
  - **Administrate**
  - **Structure**
  - etc.

“Interoperable with Dublin Core”?

- What does it take to be called interoperable?
  - Specific domain? **NO**
  - Specific technical environment? **NO**
  - Specific expression? **NO**
  - Specific complete “schema”? **Not really...**
  - Specific purpose? **NO**
- But seriously...?
- ...we obviosly need to talk about the term

“interoperability”

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- Metadata specifications
- **Interoperability**
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The elusive notion of interoperability

- IEEE definition of interoperability:
  - "the ability of two or more systems or components to exchange information and to use the information that has been exchanged."
- DCMI has four notions of "use the information":
  - Use the documented definition of the DCMI terms
  - Use the machine-processable semantics of terms
  - Use the structure of the metadata record
  - Use the constraints in an application profile
- Each usage leads to a different notion of interoperability

DCMI specifications for interoperability

- Textual definition of the DCMI terms:
  - DCMI Metadata Terms
- Machine-processable semantics of terms:
  - DCMI Abstract Model
  - RDF expression of Dublin Core metadata
  - RDF schemas for DCMI terms
- Metadata records
  - DCMI Abstract Model - “description sets”
  - DCMI expressions: XML, (X)HTML, etc.
- Application profiles
  - Singapore Framework
  - Description Set Profiles

Overview of tutorial

- Metadata specifications
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Human semantics for Dublin Core

- The Dublin Core terms have carefully crafted definitions

  Example:

  Label: *Creator*

  Definition: *An entity primarily responsible for making the resource.*

  Comment: *Examples of a Creator include a person, an organization, or a service. Typically, the name of a Creator should be used to indicate the entity.*

- The meaning of these terms is well understood
- Therefore, we often see compatible definitions used in other specifications
- The 15 elements in the "Dublin Core Metadata Element Set" are most often reused

Example: IEEE LOM

- **IEEE LOM is the major metadata specification used for Learning resources**
- **1.6 Coverage**
  - The time, culture, geography or region to which this learning object applies.
  - The extent or scope of the content of the learning object. Coverage will typically include spatial location [...]
  - NOTE —This is the definition from the Dublin Core Metadata Element Set, version 1.1

Example: The Atom Syndication Format

- Atom (like RSS) is used for content syndication (news feeds, podcasts etc.)
- The **"atom:rights"** element
  - is a Text construct that conveys information about rights held in and over an entry or feed. (RFC 4287)
- Cf. the Dublin Core term “Rights”:
  - “Information about rights held in and over the resource.”

Uses of human semantics

- Compatible reuse of Dublin Core element semantics implies:
  - Well-understood definitions
    - Easier to input metadata
    - Easier to process metadata
  - Definitions interoperable with other metadata specifications
    - Less work to design a metadata specification
    - Easier to create crosswalks
  - Etc.
- Human semantics often sufficient for limited locally scoped projects

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Dublin Core in the wild: The Semantic Web

- The DCMI Terms carry machine-readable definitions as well:

```
<rdf:Description rdf:about="http://purl.org/dc/terms/creator">
    <rdfs:label xml:lang="en-US">Creator</rdfs:label>
    <rdfs:comment xml:lang="en-US">An entity primarily responsible for making the
      resource.</rdfs:comment>
    <dcterms:description xml:lang="en-US">Examples of a Creator include a person, an
      organization, or a service. Typically, the name of a Creator should be used to indicate the
      entity.</dcterms:description>
    <rdfs:isDefinedBy rdf:resource="http://purl.org/dc/terms/"/>
    <dcterms:issued>2008-01-14</dcterms:issued>
    <dcterms:modified>2008-01-14</dcterms:modified>
    <rdf:type rdf:resource="http://www.w3.org/1999/02/22-rdf-syntax-ns#Property"/>
    <dcterms:hasVersion rdf:resource="http://dublincore.org/usage/terms/history/#creatorT-001"/>
    <rdfs:range rdf:resource="http://purl.org/dc/terms/Agent"/>
    <rdfs:subPropertyOf rdf:resource="http://purl.org/dc/elements/1.1/creator"/>
    <rdfs:subPropertyOf rdf:resource="http://purl.org/dc/terms/contributor"/>
</rdf:Description>
```

What happens on the Semantic Web?

- Terms are referenced by URI
  - Unique identification part of the framework
- The meaning of terms is carried by the URI
  - No need for manual crosswalks
  - “Context-free” metadata
- Metadata can be merged, mixed and matched
  - No trouble combining metadata from several sources
- Usage of terms is restricted by domains and ranges
  - A “Creator” of a resource is always an Agent.
  - Improves processing possibilities
- “Refinements” are part of the framework
  - A “Vocalist” (marcrel:VOC) of a resource is understood to be “Contributor” (dc:contributor) of the same resource.

Example: Adobe XMP

- Metadata part of media files (JPEG, PDF, RAW, etc.)
- Supported in a wide range of Adobe products
- Mixes Dublin Core properties with
  - EXIF properties
  - PDF properties
  - Etc.

```
<dc:publisher>
  <rdf:Bag>
   <rdf:li rdf:parseType="Resource">
    <rdf:value>James Bond</rdf:value>
    <ns:role>secret agent</ns:role>
   </rdf:li>
  </rdf:Bag>
 </dc:publisher>
 <tiff:ImageDescription>
  <rdf:Alt>
   <rdf:li xml:lang="x-default">TIFF image description</rdf:li>
   <rdf:li xml:lang="de-DE">TIFF Bildbeschreibung</rdf:li>
  </rdf:Alt>
 </tiff:ImageDescription>
 <xmpDM:videoFrameSize
  stDim:w="16"
  stDim:h="9"
  stDim:unit="inch"/>
```

Example: Open Document Format

- ODF 1.2 (OASIS) introduced RDF-based metadata
- Supports metadata in
  - Manifest (metadata file)
  - Inline in text of document

```
<bibtex:Article rdf:about="info:pmid/17445913">
  <dc:title>Neuraminidase inhibitor susceptibility[...].</dc:title>
  <dcterms:abstract>As an intermediate host of avian and [...] .</dcterms:abstract>
  <dc:creator>K Bauer</dc:creator>
  <dc:creator>M Schmidtke</dc:creator>

  <foaf:maker>
    <foaf:Person rdf:about="http://purl.org/net/hubmed/ns/pmids/17445913/authors/Bauer,K">
      <foaf:name>K Bauer</foaf:name>
      <rdf:value>K Bauer</rdf:value>
      <foaf:givenname></foaf:givenname>
      <foaf:surname>Bauer</foaf:surname>
    </foaf:Person>
  </foaf:maker>
  <dc:identifier>10.1016/j.antiviral.2007.03.007</dc:identifier>
  <prism:publicationName>Antiviral Res</prism:publicationName>
  <prism:publicationDate>2007-09</prism:publicationDate>
  <prism:volume>75</prism:volume>
  <prism:number>3</prism:number>
  <prism:startingPage>219</prism:startingPage>
  <prism:endingPage>226</prism:endingPage>
  <prism:isPartOf rdf:resource="urn:issn:0166-3542"/>
</bibtex:Article>
```

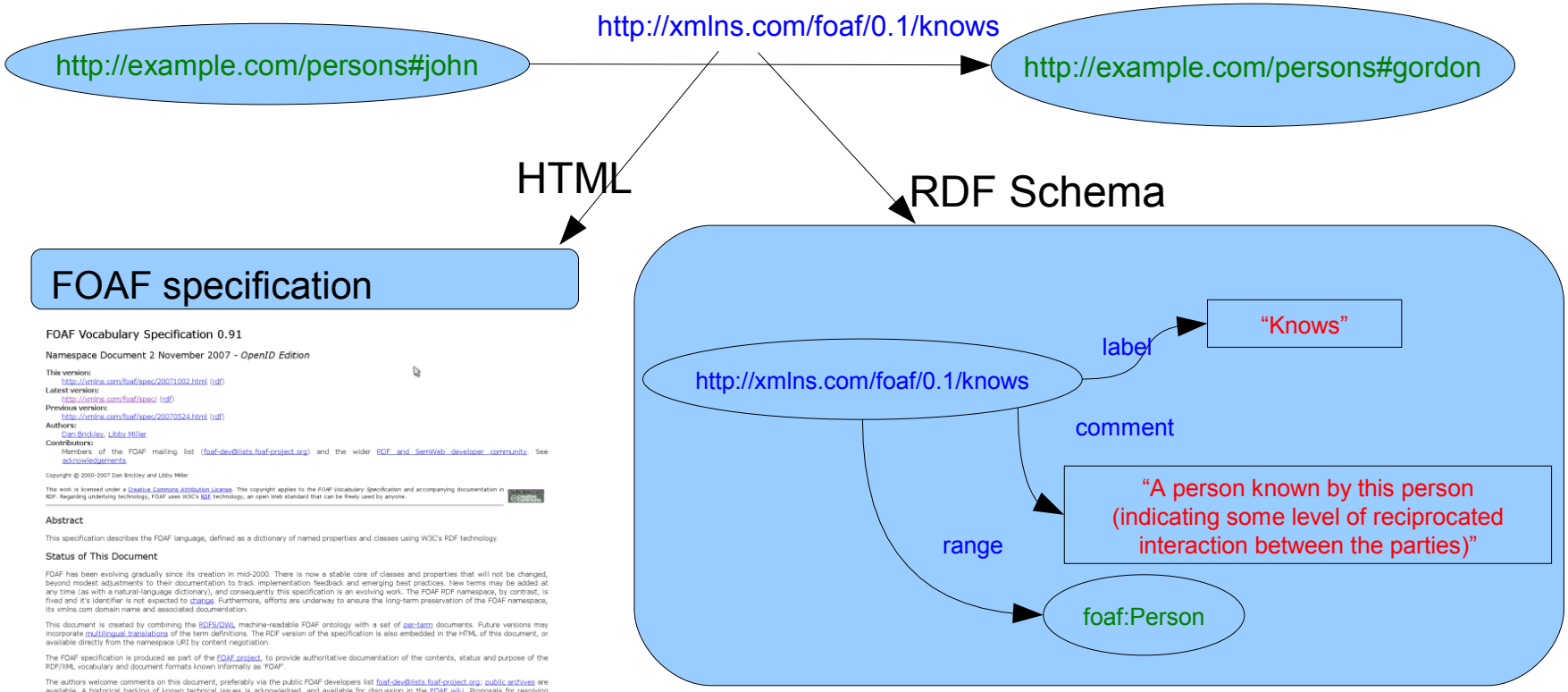
Uses of machine semantics

- The use of a common framework means metadata...
  - from different domains
  - using different vocabularies
  - used in different technical environments...

... can be combined without effort.

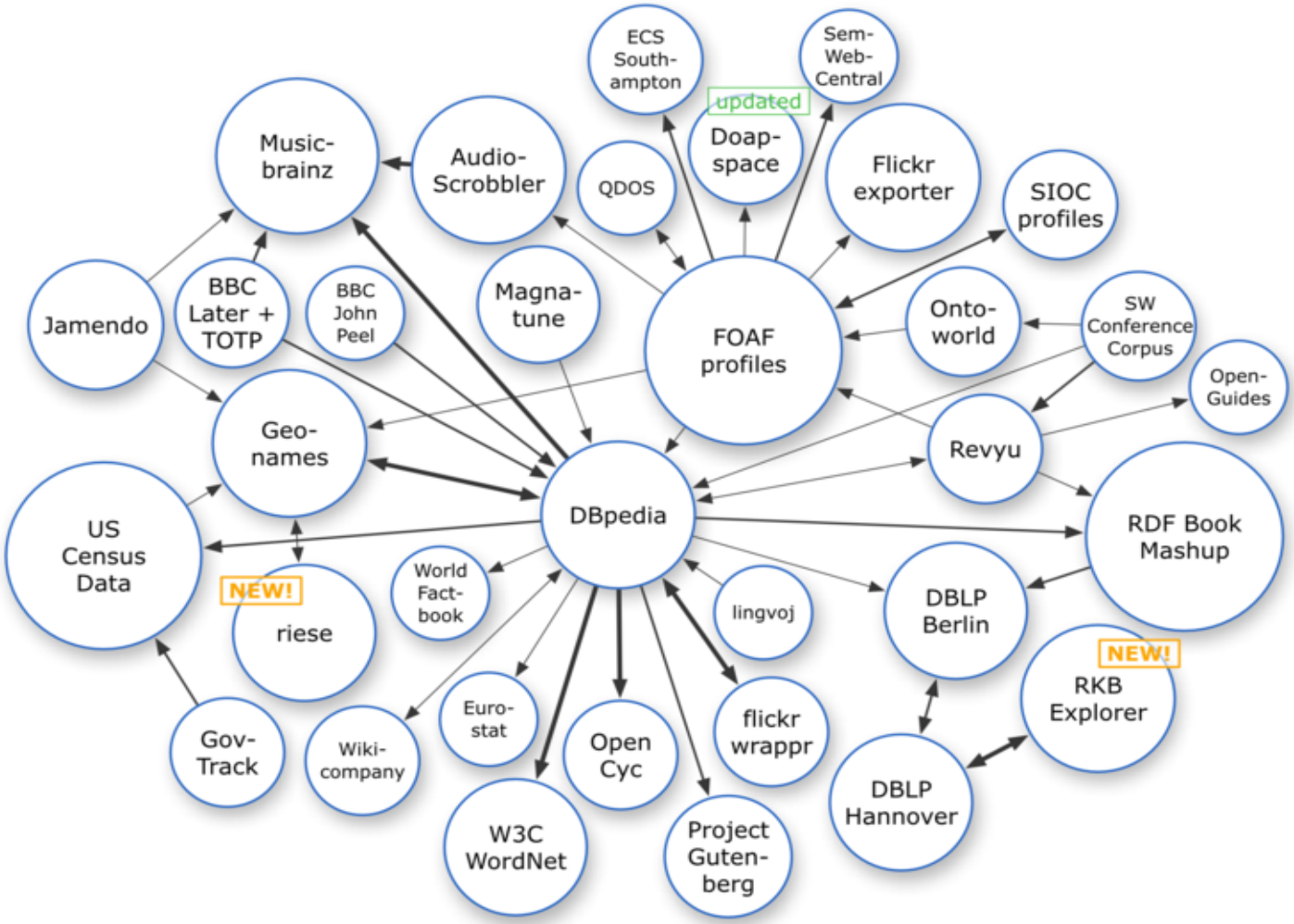
- Ontologies
  - Enable advanced processing of metadata
- Automatic discovery of term definitions
  - “Follow your nose”
- Linked open data
  - Giant global graph of metadata

Follow your nose




```
<rdf:Property rdf:about="http://xmlns.com/foaf/0.1/knows"
vs:term_status="testing" rdfs:label="knows" rdfs:comment="A person known by this
person (indicating some level of reciprocated interaction between the parties).">
    <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
    <rdfs:domain rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
    <rdfs:range rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
    <rdfs:isDefinedBy rdf:resource="http://xmlns.com/foaf/0.1/"/>
  </rdf:Property>
```

Linked Open Data



- More than 2 billion RDF triples

Support for machine semantics in DCMI

- DCMI Abstract Model
  - Lays the foundations for definition and usage of terms in Dublin Core metadata
  - Builds on RDF
- RDF schemas for DCMI terms
  - Available in “follow your nose”-compatible way
- RDF expression of Dublin Core
  - Defines how to express Dublin Core metadata using RDF

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Metadata records: structure in the chaos

- Dublin Core builds on experiences from the library community
- A strong influence is the “library card”
  - A managable “unit of metadata”
- On the other hand: the “one-to-one principle”
  - One resource, one description
  - A Book and its author are described separately
  - A Book and a digital copy are described separately
- The DCMI Abstract Model
  - A formalization of the “library card” for Dublin Core, first formalized in 2005

Why the DCMI Abstract Model?

- A DCMI-specific definition of “metadata record”
  - A framework for designing metadata records
  - A basis for validation of records
  - A basis for exchange formats for records
- The DCAM provides
  - A notion of a “description set”(= record) as a collection of descriptions of individual resources.
  - A formalization of earlier practices in the DC community

Example: DC-DS-XML

- A proposed XML language that provides a generic XML encoding for DC metadata
- Allows for validation with XML schema
- Any properties (even non-DC) can be used.

```
<?xml version="1.0" encoding="UTF-8" ?>
<dcds:descriptionSet
  xmlns:dcds="http://purl.org/dc/xmlns/2008/09/01/dc-ds-xml/">
  <dcds:description
    dcds:resourceURI="http://dublincore.org/pages/home">
    <dcds:statement dcds:propertyURI="http://purl.org/dc/terms/title">
      <dcds:literalValueString xml:lang="en-GB">DCMI Home Page</dcds:literalValueString>
    </dcds:statement>
    <dcds:statement dcds:propertyURI="http://purl.org/dc/terms/publisher"
                dcds:valueURI="http://example.org/agents/DCMI">
      <dcds:valueString>Dublin Core Metadata Initiative</dcds:valueString>
    </dcds:statement>
    <dcds:statement dcds:propertyURI="http://purl.org/dc/terms/date">
      <dcds:literalValueString>2005-05-05</dcds:literalValueString>
    </dcds:statement>
  </dcds:description>
</dcds:descriptionSet>
```

Example: DC-HTML

- HTML encoding of metadata records
- Does not support full version of DCAM
- Any properties (even non-DC) can be used.

```
<?xml version="1.0" encoding="utf-8" ?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
    "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
  <head profile="http://dublincore.org/documents/2008/08/04/dc-html/">
    <title>Services to Government</title>
    <link rel="schema.DC" href="http://purl.org/dc/elements/1.1/" />
    <link rel="schema.MARCREL" href="http://www.loc.gov/loc.terms/relators/" />
    <meta name="DC.title" content="Services to Government" />
    <link rel="MARCREL.EDT" href="http://example.org/agents/DeptOfObfuscation" />
  </head>
```

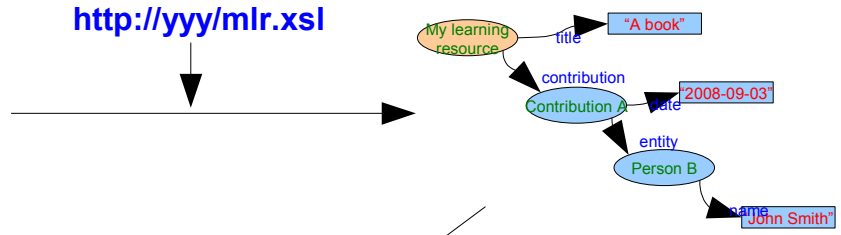
Connecting records and semantics

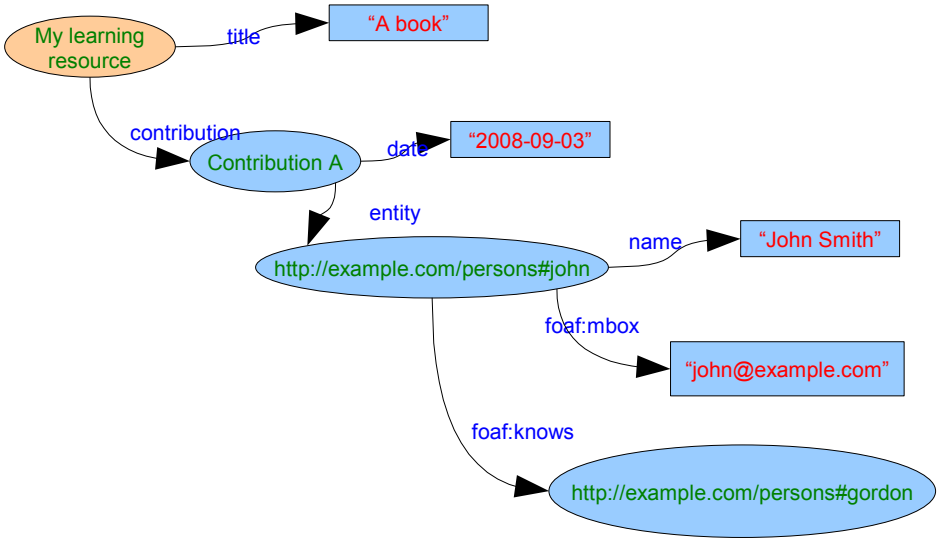
- Newer DCMI syntaxes support GRRDL from W3C
  - “Gleaning Resource Descriptions from Dialects of Languages”
- Idea: All XML-based languages can auto-generate RDF data
- For DCAM-based formats, it's straightforward.
- Other XML languages are starting to use GRDDL
  - In particular, the Microformats community

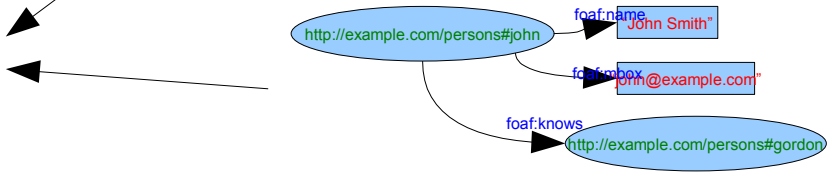
Example: From XML to graphs

```
<LearningResource grddl:transform="http://yyy/mlr.xsl">
    <Title>A book</title>
    <Contribution>
        <Date>2008-09-03</Date>
        <Entity>
            <Name>John Smith</Name>
        </Entity>
    </Contribution>
</LearningResource>
```

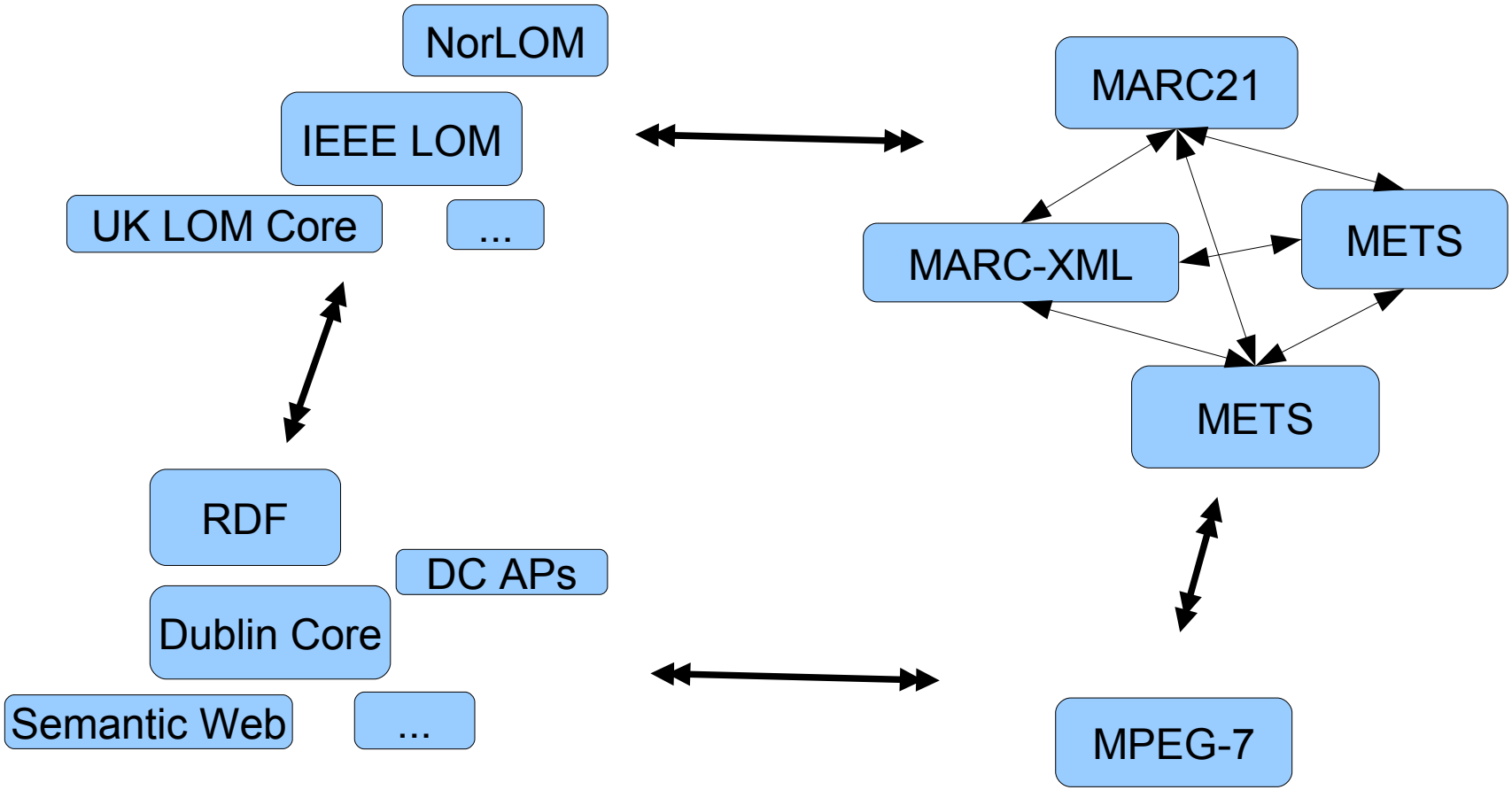
http://yyy/mlr.xsl



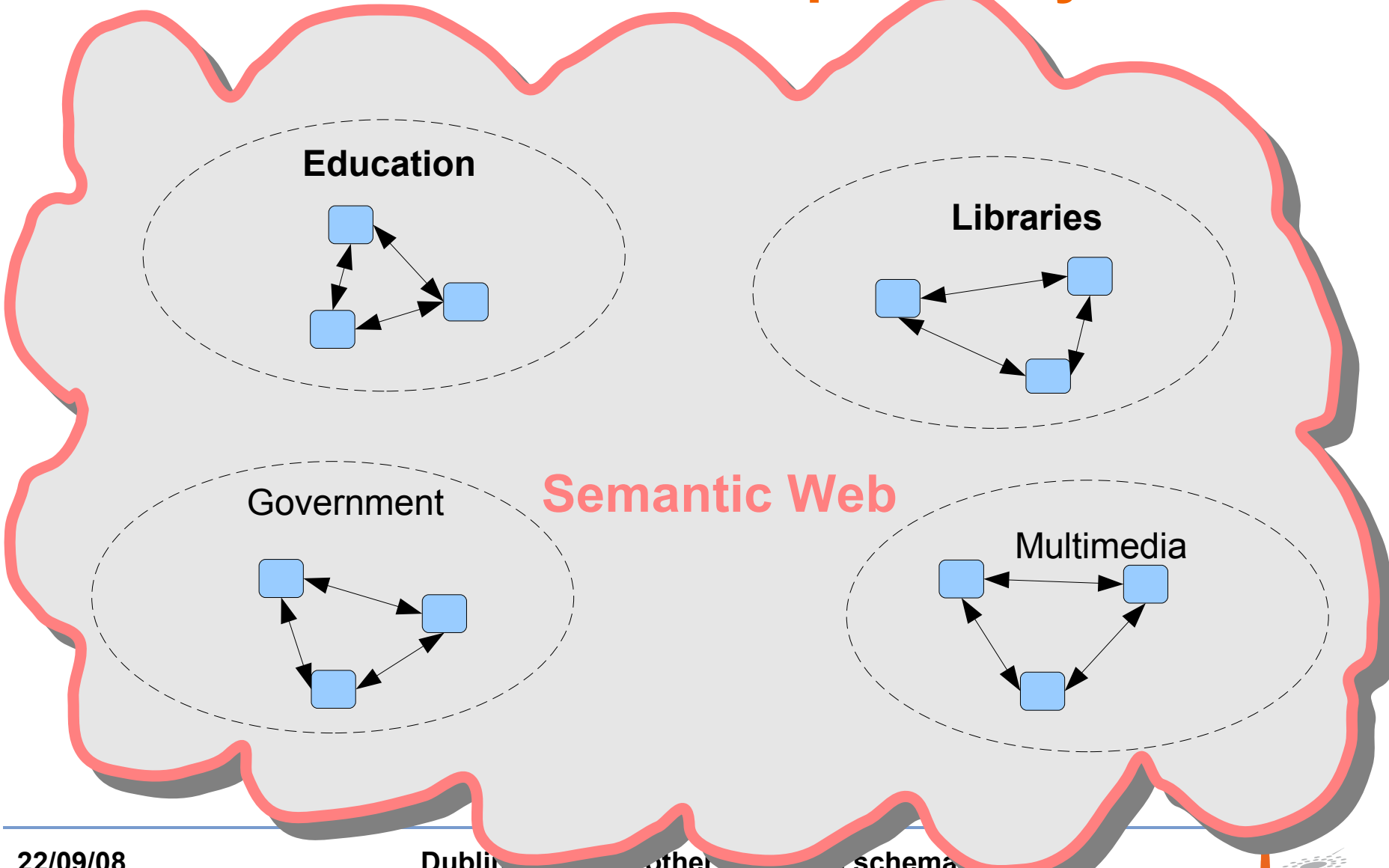




Metadata islands...



... and a metadata interoperability vision



Metadata records in DCMI specifications

- DCMI Abstract Model
  - Defines “description sets”, the DCMI notion of metadata records
- DC-DS-XML
  - Encodes general description sets in XML
- DC-HTML?
  - Supports a single description in HTML/XHTML
  - With a few limitations
- DC-RDF?
  - Does not represent “records” explicitly

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- **Application Profiles**

Dublin Core Application Profiles

- We have a definition of managable records
- We have the option of global interoperability
- We have the widely used term definitions
- What's left?
  - Community interoperability!
- A particular application, domain or community may want
  - Better documentation of their metadata records
  - More support for quality control / validation
- This is usually described with Application Profiles

Application Profiles

- Specifies a community's use of metadata records
- Defines
  - What things are described?
  - Why?
  - Which properties are used?
  - What kinds of values are used?
  - What vocabularies are referenced?
  - What guidelines for data entry are used?
  - etc.

A word of Warning

- DCMI uses “application profile” to mean:
  - A specification of which metadata terms are used
  - A specification of how those terms are constrained and interpreted in the local context
- Other communities use “profile” to mean
  - A customization of an existing schema
  - Starts from a “base” standard, adds context-specifics
- The two notions are not very interoperable!

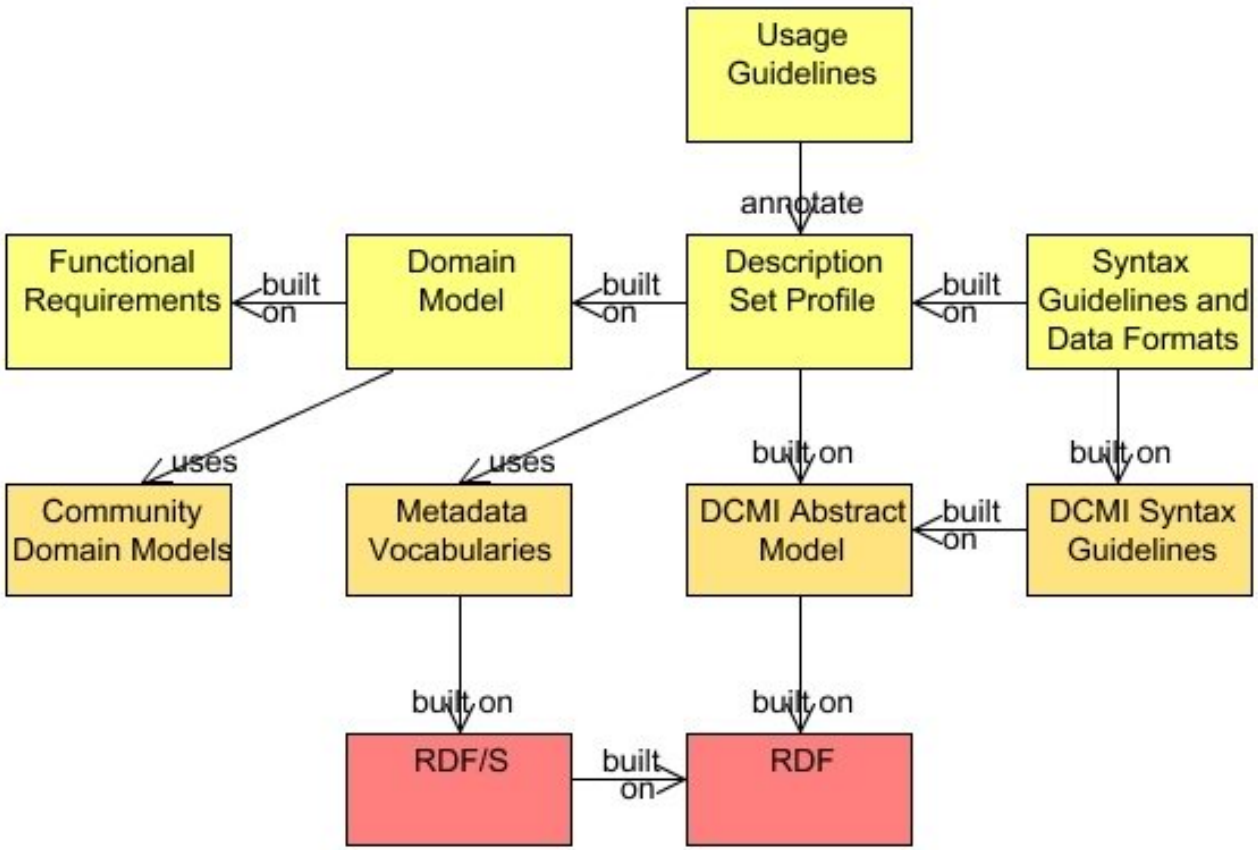
The Singapore Framework

- In Singapore, at DC2007, a new definition of a “Dublin Core Application Profile” was introduced
- A “DC Application Profile” is packet of documentation which consists of:
  - Functional requirements (mandatory)
  - Domain model (mandatory)
  - Description Set Profile (DSP) (mandatory)
  - Usage guidelines (optional)
  - Encoding syntax guidelines (optional)

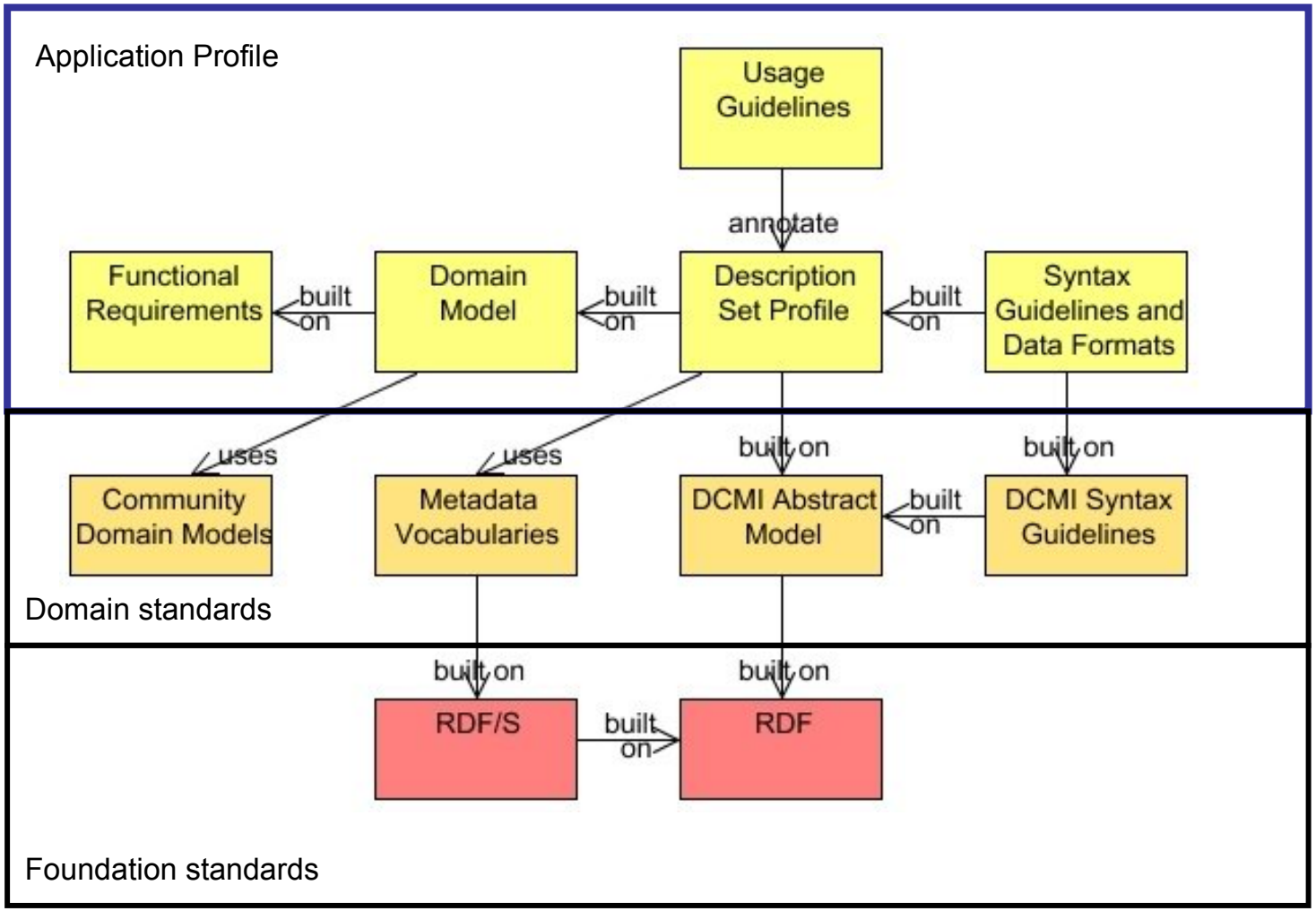
Profiles and standards

- Profiles are based on domain standards:
  - Standard metadata vocabularies (e.g., Dublin Core elements)
  - Standard domain models (e.g., FRBR)
    - Functional Requirements for Bibliographic Records
  - A standard record model (DCMI Abstract Model)
- Foundation is Resource Description Framework (“Semantic Web”)
  - RDF is the model underlying the DCMI Abstract Model
  - RDF Schema is the model underlying the machine processable definitions of terms

The Singapore Framework



The Singapore Framework



Functional requirements

- Describe the functions that the application profile is designed to support
  - as well as functions that are out of scope.
- Form the basis of evaluating the application profile for internal consistency
- Gives guidance on the appropriateness of the application profile for a given use.

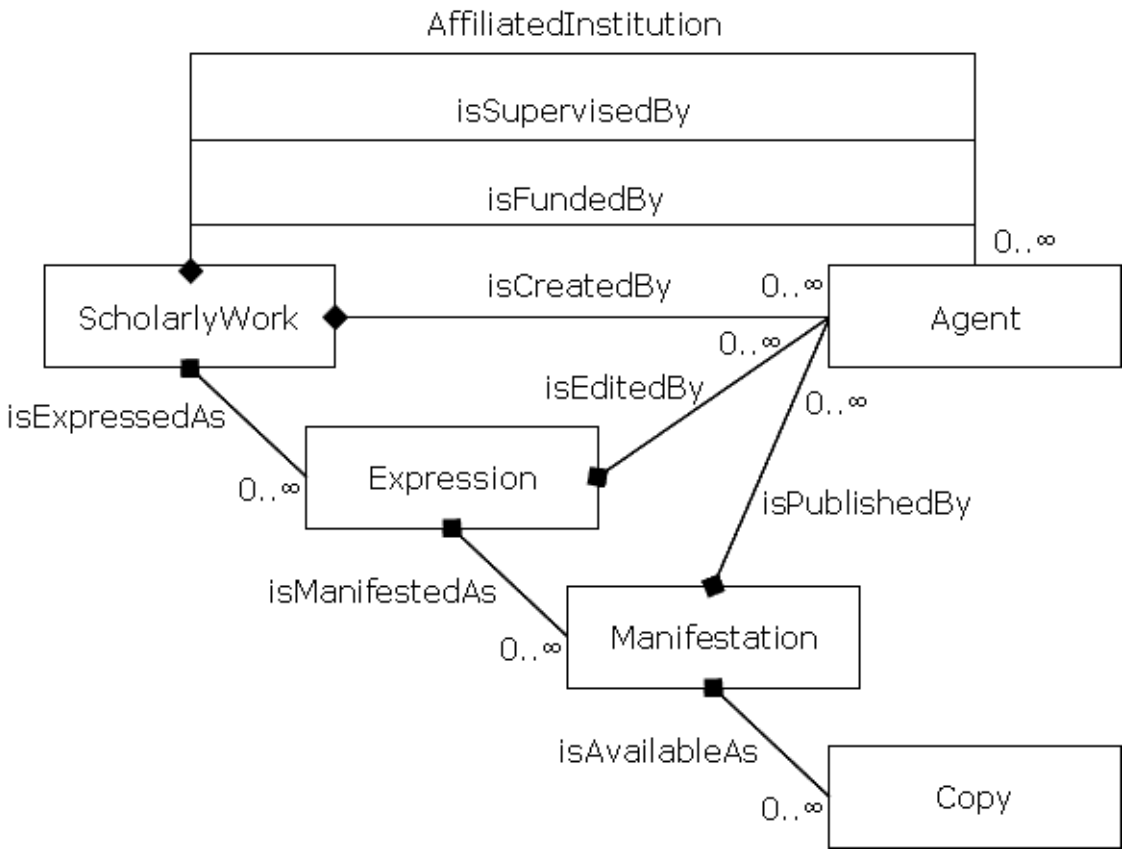
Example: ePrints Functional requirements

- Requirement: Provide a richer set of metadata than is currently possible with simple DC
- Requirement: Be compatible with preservation metadata approaches.
- Requirement: Support extensibility of the application profile for other types of material.
- Requirement: Implement an unambiguous method of identifying the full-text(s).
- Requirement: Support navigation between different 'versions' of the same eprint
- etc.

Domain models

- Defines the basic entities described by the application profile and their fundamental relationships.
- Concretizes the scope for the application profile.
- The domain model can be expressed using just text or using a more formal approach such as UML.
- Does NOT say what properties to use

Example: ePrints domain model

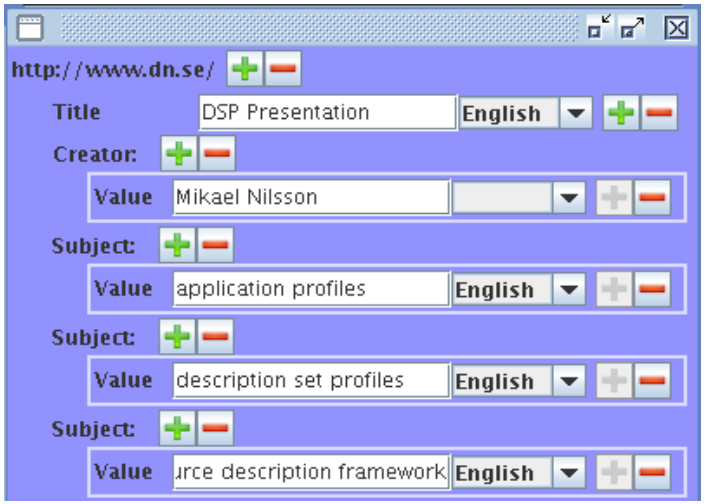


Description Set Profiles

- Defines a set of metadata records that are valid instances of an application profile.
- The Description Set Profile model is currently being developed within the Dublin Core Architecture Forum
- Designed to offer a simple constraint language for Dublin Core metadata, based on the DCMI Abstract Model
- A DSP constrains
  - the resources that may be described by descriptions in a description set conforming to the application profile,
  - the properties that may be used,
  - the ways a value may be referenced.

Description Set Profiles

- A Description Set Profile can be used for purposes such as:
  - formally representing constraints used in metadata
  - configuring databases
  - configuring metadata editing tools



Example: ePrints DSP

Property	http://purl.org/dc/terms/abstract
Literal?	No
Definition	A summary of the content of the resource.
Eprint-specific recommendation	A summary of the important points of the eprint.

Identifier

Property	http://purl.org/dc/elements/1.1/identifier
Min occurrence	1
Literal?	Yes
Definition	An unambiguous reference to the resource within a given context.
Eprint-specific recommendation	A URI for the eprint.
Value (Literal)	**Syntax Encoding Scheme:** **Occurrence**: mandatory **Choose from**: http://purl.org/dc/terms/URI

Description Template: Book

Statement template: literal title

Property: dcterms:title

Literal value | Language | SES

Statement template: creator

Property: dcterms:creator

Description reference: Creator

Value URI

Vocabulary Encoding Scheme

Value string | Language | SES

Description Template: Creator

Statement template: literal name

Property: foaf:name

standalone:no

Literal value | Language | SES

Usage guidelines

- Usage guidelines describe how to apply the application profile
- How are the used properties intended to be used in the application context?
- What principles are used when gathering data?
- What other principles governs the implementation and use of the application profile

Example: Collections description

- Guildelines for Title element:
  - Where an existing name is used, the value string should preserve the original wording, order and spelling of an existing name.
  - Punctuation need not reflect the usage of the original.
  - Subtitles should be separated from the title by a sequence of space-colon-space, for example:
    - Voices from the Dust Bowl: The Charles L. Todd and Robert Sonkin Migrant Worker Collection “

DCMI specs for Application Profiles

- Singapore Framework
  - http://dublincore.org/documents/singapore-framework/
  - Documentation guidelines, January 2008
- Description Set Profiles
  - http://dublincore.org/documents/dc-dsp/
  - Formal (machine-readable) part of Singapore Framework
  - Working draft, March 2008
- Implementation expercience still needed

Summary

- Dublin Core metadata defined by different forms of "interoperability"
  - For human understanding
  - Machine semantics
  - Metadata records
  - Application Profiles
- Projects need to place themselves on this map
  - What do I need? How can I achieve it?
- The Dublin Core community is open to implementers at all levels

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DC-2008
BERLIN

Interoperability Levels for Dublin Core metadata

- Level 1: Informal interoperability
  - Shared concepts with natural-language definitions
  - No use of formal models or term URIs
  - Test: Is there a mapping to shared elements?
  - Example: IEEE LOM reuses some definitions and maps to 15-element “Dublin Core” (ISO 15836)

Interoperability Levels for Dublin Core metadata

- Level 2: Semantic Interoperability
  - Correct use of formal RDF graph model with conformant vocabularies (eg DCMI Metadata terms)
  - Use of URIs and formal semantic relationships between terms (eg subproperties)
  - Test: Is there a mapping to RDF triples?
  - Examples:
    - All RDF data (by definition)
    - All RDF data extracted from non-RDF formats (eg via GRDDL transforms)
    - All XHTML or HTML data using RDFa or DC-HTML/2008.

Interoperability Levels for Dublin Core metadata

- Level 3: Description set syntactic interoperability
  - Level-2-compatible data packaged in bounded description sets (records) as per DCMI Abstract Model (DC-AM)
  - Conventions for citing vocabulary encoding schemes (controlled vocabularies)
  - Test: Is there a mapping to “Expressing Dublin Core metadata using the DC-Text format”?
  - Examples: All data using DC-AM-compatible specifications, such as DC-DS-XML.

Interoperability Levels for Dublin Core metadata

- Level 4: Description Set Profile Interoperability
  - Level-3-compatible data that follows the specification "Description Set Profiles: A constraint language for Dublin Core Application Profiles"
  - Additional interoperability via shared Functional Requirements and Domain Model ("Singapore Framework for Dublin Core Application Profiles")
  - Test: Is there a mapping to DSP constraints?
  - Examples:
    - Scholarly Works Application Profile

Interoperability Levels for Dublin Core metadata

- Level 4: Description Set Profile Interoperability
- Level 3: Description Set syntactic interoperability
- Level 2: Semantic interoperability
- Level 1: Informal interoperability