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Functional and Architectural Requirements for Metadata

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Functional and Architectural Requirements for Metadata:

Supporting Discovery and Management of Scientific Data

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Metadata standards for scientific data

Ecological Metadata Language (EML)

ClinicalTrials.gov
Protocol Registration System

CSDGM

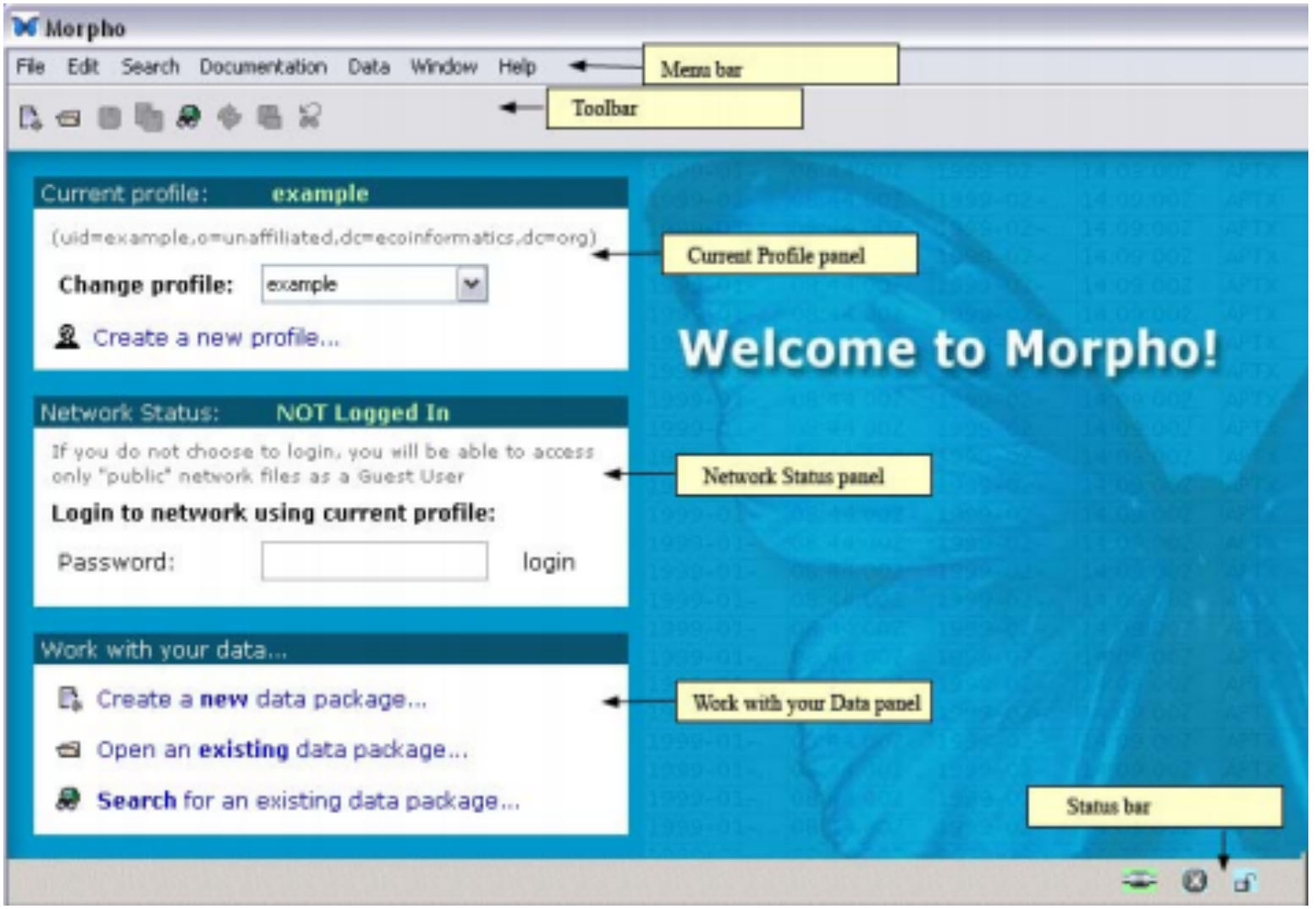
FederalGeographicDataCommittee

Biodiversity Information Standards TDWG

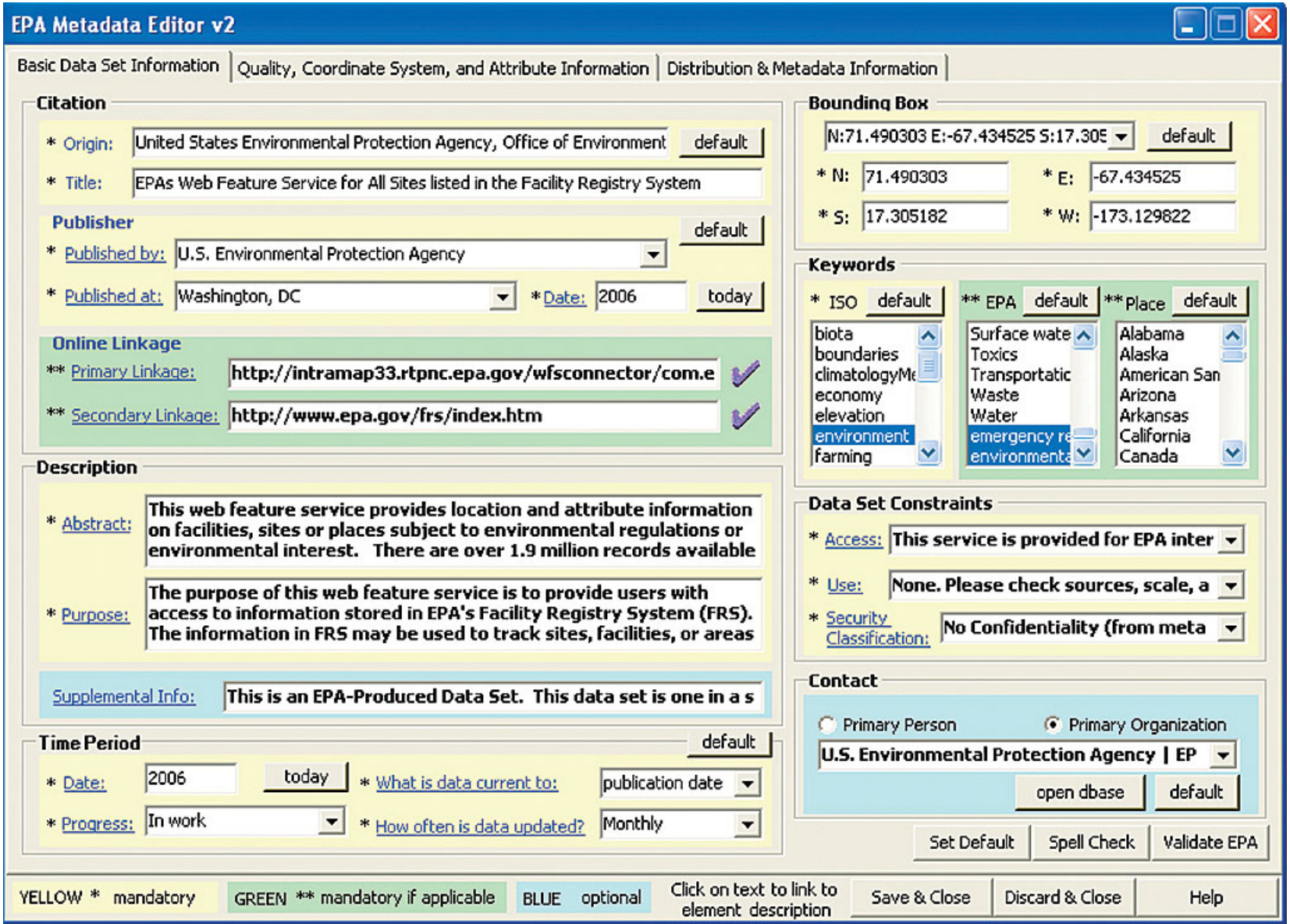
Access to Biological Collections Data – ABCD

Darwin Core

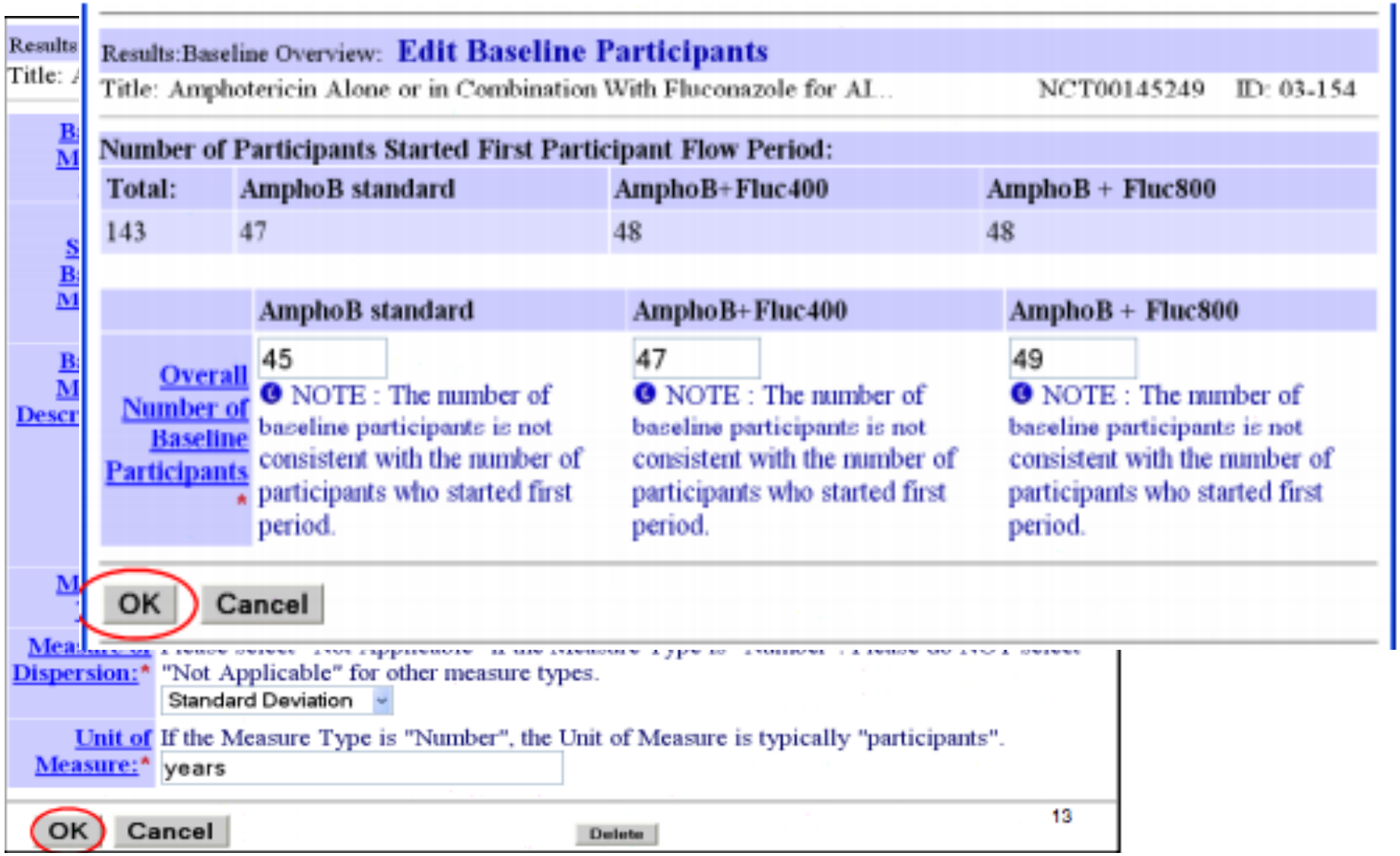
Many tools have been developed…



Many tools have been developed…



Many tools have been developed…



Motivation for adoption

- Standardize the format and terminology of metadata
- Enable fast and effective discovery of datasets across different data repositories
- Enable data sharing, reuse, and preservation
- Provide information for obtaining datasets from the data owners

Hindering factors

Metadata standards for scientific data have:

- large numbers of elements
- many layers in structure
  - "Unwieldy to apply"
- been created for manual data entry, rather than for automatic generation

Effects on metadata generation:

- steep learning curve
- difficult to automate metadata generation
- unnecessary duplicate data entry
- high costs in time, resource, and personnel expertise

Same entity data repeated in the same record…

Seamless Daily Precipitation for the Conterminous United States

Metadata:

Identification_Information
Data_Quality_Information
Spatial_Data_Organization_Information
Spatial_Reference_Information
Entity_and_Attribute_Information
Distribution_Information
Metadata_Reference_Information

Citation_Information:

Originator:
Mauro Di Luzio, Blackland Research Center, Texas Agricultural Experiment Station, Texas A&M University System, Temple, Texas
Publication_Date: 200710
Title: Seamless Daily Precipitation for the Conterminous United States
Edition: First

Data_Set_Credit:
Mauro Di Luzio Blackland Research Center, Texas Agricultural Experiment Station, Texas A&M University System, Temple, Texas

Metadata_Reference_Information:

Metadata_Date: 20071001
Metadata_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Mauro Di Luzio
Contact_Organization:
Texas Agricultural Experiment Station, Blackland Research Center

Point_of_Contact:

Contact_Information:

Contact_Person_Primary:

Contact_Person: Mauro Di Luzio
Contact_Organization:
Texas Agricultural Experiment Station
Center

…and they are already in…

```
LOCUS       SCU49845     5028 bp    DNA
DEFINITION  Saccharomyces cerevisiae TCP1-be
            (AXL2) and Rev7p (REV7) genes, c
ACCESSION   U49845
VERSION     U49845.1  GI:1293613
KEYWORDS    .
SOURCE      Saccharomyces cerevisiae (baker'
  ORGANISM  Saccharomyces cerevisiae
            Eukaryota; Fungi; Ascomycota; Saccharomycotina; Saccharomycetes;
            Saccharomycetales; Saccharomycetaceae; Saccharomyces.
REFERENCE   1  (bases 1 to 5028)
  AUTHORS   Torpey,L.E., Gibbs,P.E., Nelson,J. and Lawrence,C.W.
  TITLE     Cloning and sequence of REV7, a gene whose function is required for
            DNA damage-induced mutagenesis in Saccharomyces cerevisiae
  JOURNAL   Yeast 10 (11), 1503-1509 (1994)
  PUBMED    7871890
REFERENCE   2  (bases 1 to 5028)
  AUTHORS   Roemer,T., Madden,K., Chang,J. and Snyder,M.
  TITLE     Selection of axial growth sites in yeast requires Axl2p, a novel
            plasma membrane glycoprotein
  JOURNAL   Genes Dev. 10 (7), 777-793 (1996)
  PUBMED    8846915
REFERENCE   3  (bases 1 to 5028)
  AUTHORS   Roemer,T.
  TITLE     Direct Submission
  JOURNAL   Submitted (22-FEB-1996) Terry Roemer, Biology, Yale University, New
            Haven, CT, USA
```

Publication record associated with the data

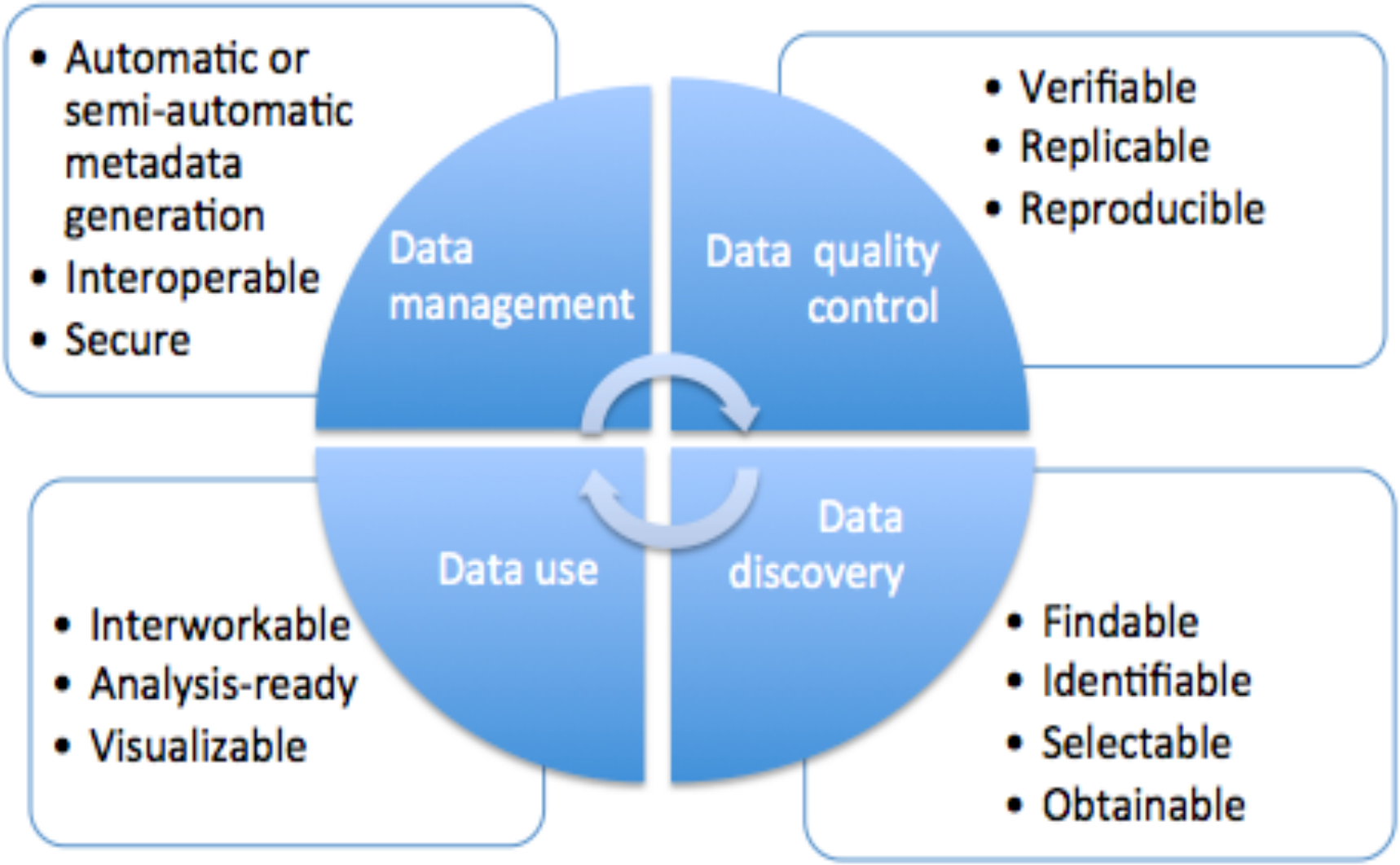
Research questions

- What functions do metadata standards for scientific data serve?
- How should metadata standards for scientific data be modeled to support these functions by meeting the associated requirements?

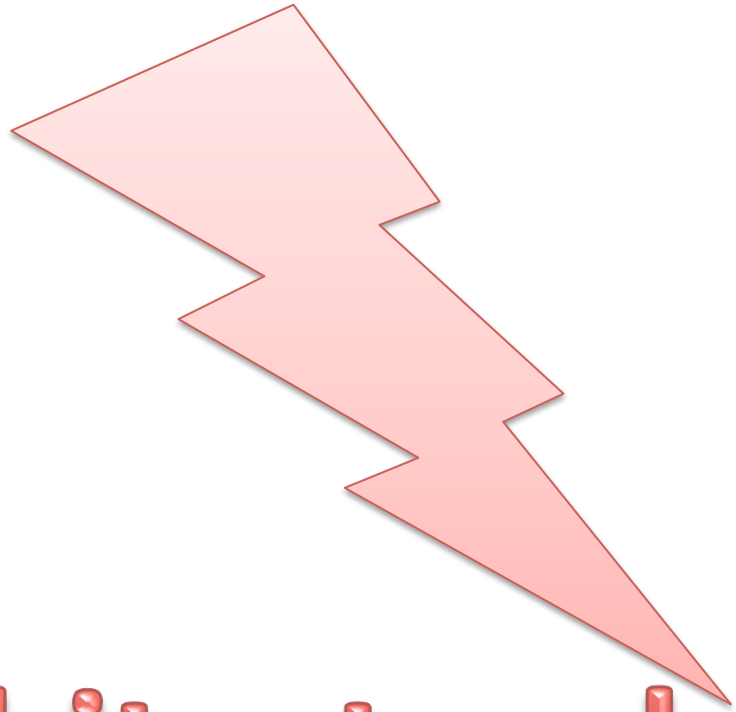
Functions expected

- Resource discovery and use,
- Data interoperability,
- Automatic and semi-automatic metadata generation,
- Linking of publications and underlying datasets,
- Data/metadata quality control, and
- Data security.

Metadata requirements for scientific data

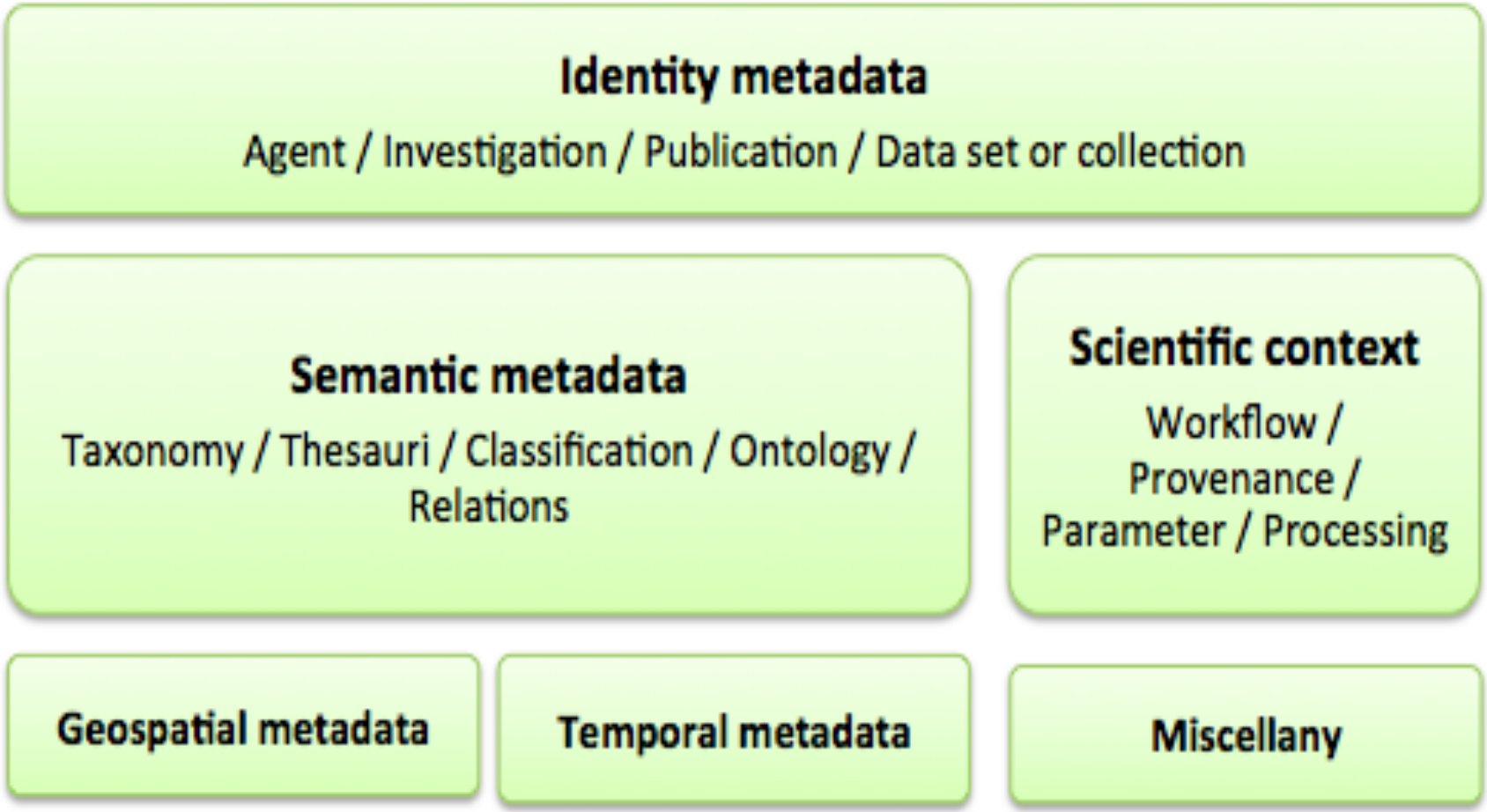


Functional view



Architectural view

Architectural view



Identity metadata

Globally, uniquely identify entities

- Person: researcherID, URI, FOAF, ORCID
- Institution: ORCID, URI
- Data object: DOI, Handle, URI
- Associated publication: DOI

Build a metadata infrastructure service

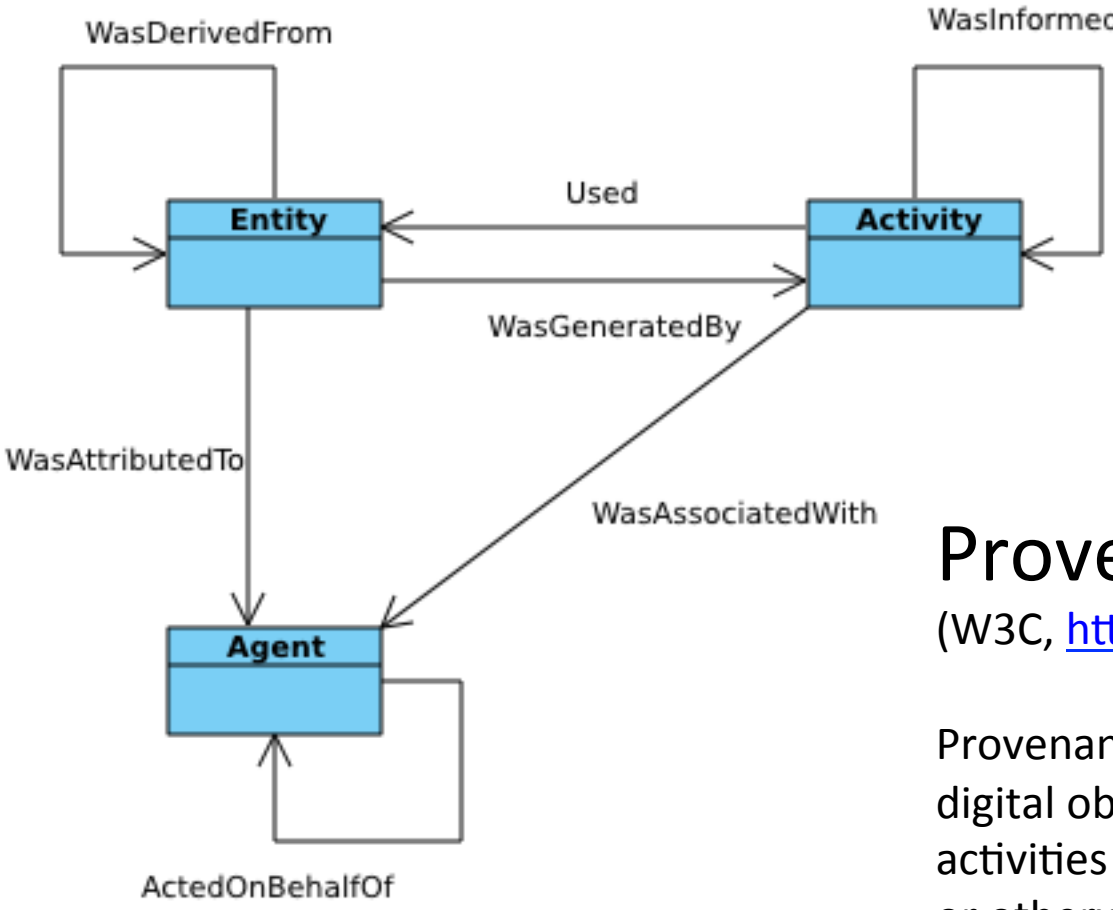
- Name repositories
- Linked data architecture
- Customizable research group/community member name lists

Semantic metadata

- Large semantic resources available in linked data format, but usually not suitable for representing scientific data because they are designed for publications, especially books and journals (containers)
- Format is contemporary but the content is far from it

Smaller, specialized semantic resources are necessary for automatic semantic metadata generation

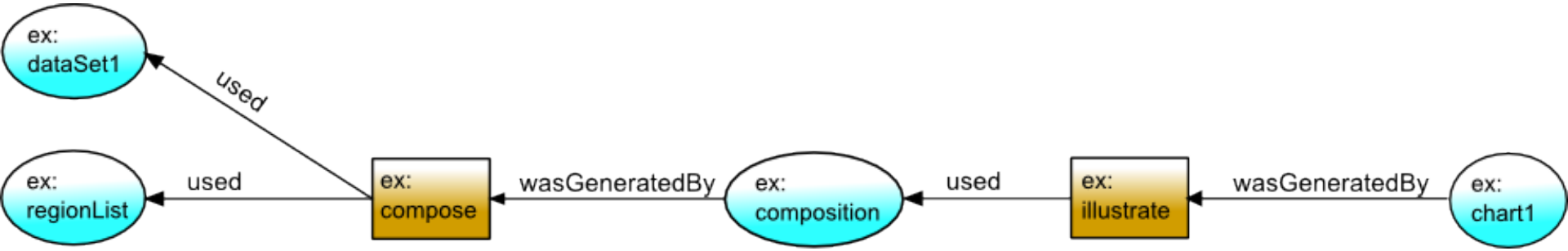
Contextual metadata



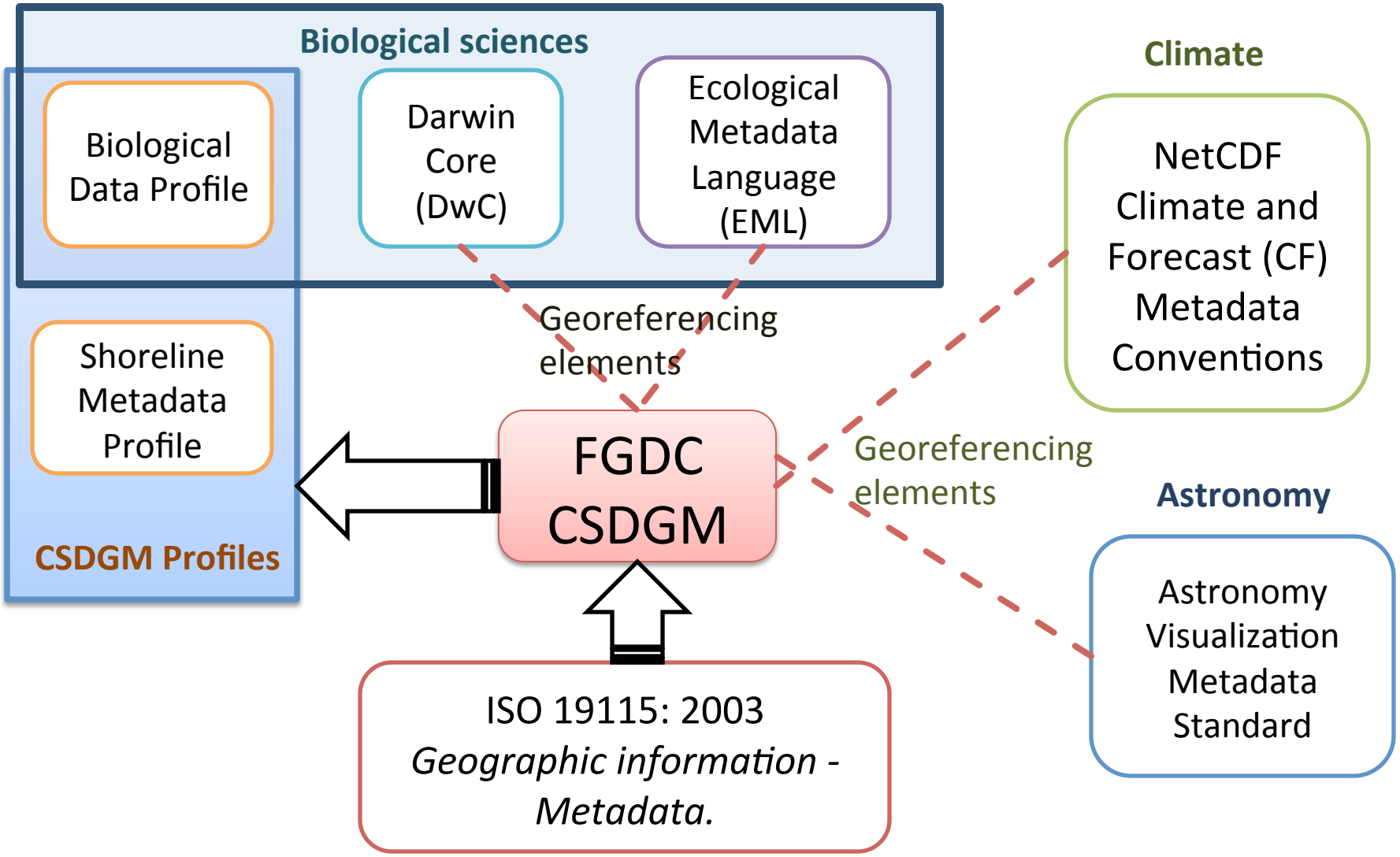
Provenance data model

(W3C, http://www.w3.org/TR/prov-primer/)

Provenance data represent the origins of digital objects and describe the entities and activities involved in producing and delivering or otherwise influencing a given object.



Geospatial metadata



Temporal metadata

- Mean solar time
- Civil time
- GPS time
- Terrestrial time
- Atomic time
- …
- Geologic time

- Different measurement systems result in different units and format
- Conversion between systems

Three Principles

- The least effort principle
- The infrastructure service principle
- The portable principle

TABLE 1. Mapping data user tasks with metadata functions and architectural building blocks

Data user tasks	Metadata function	Architectural building block
Discover	Descriptive metadata	Identity and semantic metadata
Identify	Descriptive metadata	Identity metadata
Select	Descriptive, technical metadata	Identity, semantic, scientific context, geospatial, temporal, miscellany metadata
Obtain	Descriptive metadata	Identify metadata
Verify	Descriptive metadata	Scientific context metadata
Analyze		Scientific context, geospatial, and temporal metadata
Manage	Descriptive, administrative, structural, and technical metadata	Identify, semantic, scientific context, geospatial, temporal, miscellany metadata
Archive	Descriptive, administrative, structural, and technical metadata	Identify, semantic, scientific context, geospatial, temporal, miscellany metadata
Publish	Descriptive metadata	Identity, semantic, scientific context, geospatial, and temporal metadata
Cite	Descriptive metadata	Identify metadata

Development potentials

- An infrastructure of metadata services
  - Entities as linked data
  - Tools for “slicing” members by research group, community, or institution to customize the entity set
  - Tools for grabbing entity data from existing resources through interoperability protocols

Application scenarios

- Cross-domain discovery and verification
- Automatically populating entity information from customized slices of entities into metadata records
- And more…

Conclusion

- Scientific data are inherently complex and diverse
- Functional metadata requirements should be translated into an effective and efficient architecture
  - Three principles for modeling metadata for scientific data
- Metadata for scientific data (or other domains at large) should adopt an infrastructure service approach
- Much to be explored, experimented, and evaluated

Thank you!

Questions?