Topics

- **Terminology**
- **Problem Statement**
  - Problem 1 - Limited Definitions
  - Problem 2 - Enabling Interoperability
- **Case Study**
  - Questions to ask of a Data Dictionary
- **ISO/IEC 11179**

Terminology

- **A Data Model defines the entities to be processed, their attributes, and the relationships that add meaning.**
- **An attribute has alternate names.**
  - Data Element
  - Vocabulary Term
- **The set of all attributes in a data model is also called its vocabulary and is collected into a data dictionary.**
- **When defining an attribute, a set of meta-attributes or "attributes about attributes" are used.**
  - The *name* of an attribute is a meta-attribute.
  - For example when defining the data element *sample_type*, the meta-attribute, *attribute_name*, has the value "sample_type".

Problem Statement

- **The data model for the existing Planetary Science Data Dictionary (PSDD) has technical problems and is limited in its capabilities.**
  - The data model needs an upgrade.
- **This task does not address the content of the data dictionary.**
  - The content of the data dictionary is addressed when the data model is addressed.

Problem 1 – Limited Definitions

- **The ability to define an attribute is limited in most data modeling tools**.
  - **Meta-attributes that are typically captured.**
    - Name
    - Description
    - Data type
    - Valid values
    - Cardinality of values
  - **Additional meta-attributes that are often needed.**
    - Alternate names (aliases, acronyms, etc)
    - Registration authority
    - Representation information
    - Classification Schemes
    - Namespace
    - Valid Value definitions and formation rules
    - …

Problem 2 – Enabling Interoperability

- **Option 1 - The adoption of a common vocabulary by two or more repositories enables inter-operability between those entities.**

- **Option 2 - Where a single vocabulary is not in common between two repositories, inter-operability is dependant on the identification of commonalities between vocabulary terms.**
  - The use of a common mechanism for defining vocabulary terms makes it easier to identify commonalities between vocabulary terms.
  - A common mechanism for defining vocabulary terms provides interoperability at a deeper level.

Planetary Science Data Dictionary Example

- **Data Element_Name - Sample_Type**
- **Data_Element_Description - The sample_type element indicates the data storage representation of sample value *(within an image).***
- **Value_Type: Identifier (*Enumerated)***
- **Valid_Values: ieee_real**
  lsb_integer
  lsb_unsigned_integer
  msb_integer
  msb_unsigned_integer
  pc_real
  unsigned_integer
  vax_real

Some Questions a Data Dictionary Should Answer

- What is the organization that is responsible for managing the data element Sample_Type? Who can be contacted about its management? What is the source of the definition?
- What changes have been made to the definition and by whom? What is its version?
- What is the rationale for the data element? Is this a common concept shared by other data elements?
- What alternate names does the data element have?
- What natural languages are used in the definition?
- How is the data element classified? E.g. science vs operations, science discipline, etc.

More Questions

- Who controls the valid value “ieee_real? Who can be contacted about its management? What is the source of the valid value?
- What is the definition of “ieee_real”?
- What changes have been made to the definition of “ieee_real” and by whom? What is its version? What is the window within which this value was valid?
- What is the rationale for the set of valid values? Is this a common valid vale concept that other data elements might use?
- What character set is used for the valid values? How many characters can be used for a valid value?
- How is the valid value represented and what is the unit of measurement?
- What are the minimum and maximum values allowed?
- What values signify Missing, Not Applicable, and Unknown for this data element.

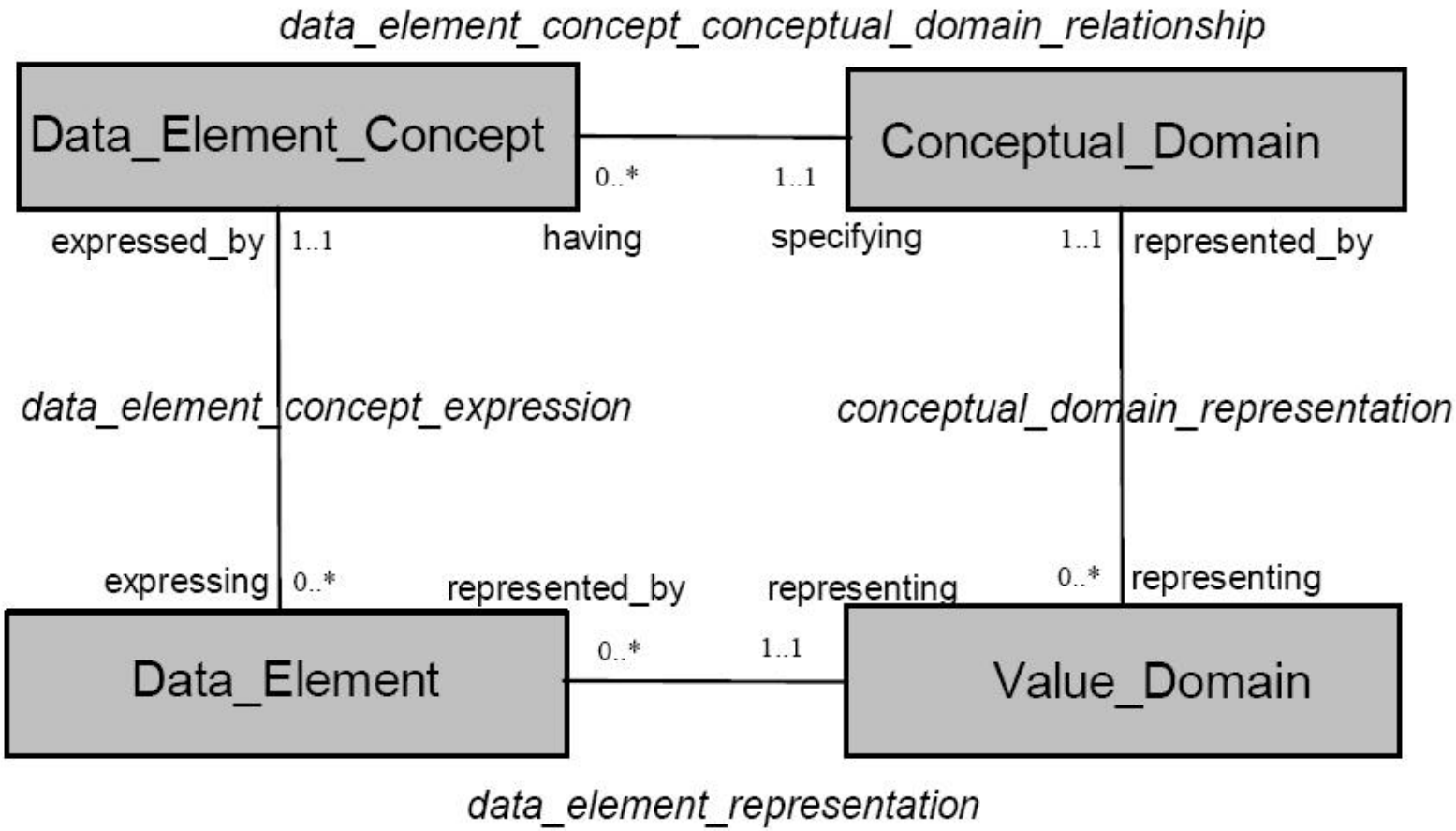
ISO/IEC 11179

- **ISO/IEC 11179 - Metadata registries (MDR)**
  - Addresses the semantics of data, the representation of data, and the registration of the descriptions of that data.
  - It is through these descriptions that an accurate understanding of the semantics and a useful depiction of the data are found.
- **The purposes of ISO/IEC 11179 are to promote the following:**
  - Standard description of data
  - Common understanding of data across organizational elements and between organizations
  - Re-use and standardization of data over time, space, and applications
  - Harmonization and standardization of data within an organization and across organizations
  - Management of the components of data
  - Re-use of the components of data
- **In ISO/IEC 11179 the basic container for data is called a data element. It may exist purely as an abstraction or exist in some application system.**

ISO/IEC 11179
Data Element Information

- **Data Element**
  - Data Element, Data Element Concept
  - Concept Domain, Value Domain
- **Administration and Registration**
  - Status, Creation_Date, Effective_Date, Last_Change_Date, Registration_Authority, Steward, Submitter, Language
- **Classification Scheme** - User defined
  - Scope – e.g. Common, Imaging, Atmospheres
  - Mission – e.g. MEX, MER
- **Other**
  - Description, Data Type, Enumeration, Unit of Measurement, Value Meaning, Alternate Names, Language, Reference Documents, Relationships, Terminology
  - Effective begin and end date

ISO/IEC 11179 – High Level Meta-Model



Sample Type – Data Element

Instance: de_sample_type

Types
- DataElement

Own Slots

	Slot Name	Value
	administrationRecord	Test_Load
	classification	
	contextEntry	Context_Entry_NASA_PDS
	dataElementPrecision	
	dataIdentifier	de_sample_type
	derivation	
	exemplifiedBy	
	expressedBy	dec_sample_type
	reference	
	registeredBy	RA_0001_NASA_PDS_1
	registrationAuthorityIdentifier	0001_NASA_PDS_1
	representationClassQualifier	
	representing1	
	steward	Steward_PDS
	submitter	Submitter_PDS
	typeBy	
	versionIdentifier	0.080410

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Sample Type – Data Element Concept

Instance: dec_sample_type

Types
- DataElementConcept

Own Slots

	Slot Name	Value
	administrationRecord	Test_Load
	classification	
	contextEntry	Context_Entry_NASA_PDS
	dataIdentifier	dec_sample_type
	expressing	de_sample_type
	objectClass	
	objectClassQualifier	
	property	
	propertyQualifier	
	reference	
	registeredBy	RA_0001_NASA_PDS_1
	registrationAuthorityIdentifier	0001_NASA_PDS_1
	relationship	
	specifying	ecd_sample_type
	steward	Steward_PDS
	submitter	Submitter_PDS
	versionIdentifier	0.080410

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Sample Type – Concept Domain

Instance: ecd_sample_type

Types
- EnumeratedConceptualDomain

Own Slots

	Slot Name	Value
▬	administrationRecord	Test_Load
▬	classification	
▬	containedIn2	vm_sample_type_IEEE_REAL, vm_sample_type_LSB_INTEGER, vm_sample_type_LSB_UNSIGNED_INTEGER, vm_sample_type_MSB_INTEGER, vm_sample_type_MSB_UNSIGNED_INTEGER, vm_sample_type_PC_REAL, vm_sample_type_UNSIGNED_INTEGER, vm_sample_type_VAX_REAL
▬	contextEntry	Context_Entry_NASA_PDS
▬	dataIdentifier	ecd_sample_type
▬	dimensionality	
▬	having	dec_sample_type
▬	reference	
▬	registeredBy	RA_0001_NASA_PDS_1
▬	registrationAuthorityIdentifier	0001_NASA_PDS_1
▬	relationship	
▬	representing2	evd_sample_type
▬	steward	Steward_PDS
▬	submitter	Submitter_PDS
▬	versionIdentifier	0.080410

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Sample Type – Value Domain

Instance: evd_sample_type

Types
- EnumeratedValueDomain

Own Slots

	Slot Name	Value
▬	administrationRecord	Test_Load
▬	classification	
▬	containedIn1	pv_sample_type_IEEE_REAL, pv_sample_type_LSB_INTEGER, pv_sample_type_LSB_UNSIGNED_INTEGER, pv_sample_type_MSB_INTEGER, pv_sample_type_MSB_UNSIGNED_INTEGER, pv_sample_type_PC_REAL, pv_sample_type_UNSIGNED_INTEGER, pv_sample_type_VAX_REAL
▬	contextEntry	Context_Entry_NASA_PDS
▬	dataIdentifier	evd_sample_type
▬	datatype	IDENTIFIER
▬	maximumCharacterQuantity	255
▬	reference	
▬	registeredBy	RA_0001_NASA_PDS_1
▬	registrationAuthorityIdentifier	0001_NASA_PDS_1
▬	relationship	
▬	representedBy1	ecd_sample_type
▬	representedBy2	de_sample_type
▬	steward	Steward_PDS
▬	submitter	Submitter_PDS
▬	typeBy	
▬	unitOfMeasure	N/A
▬	valueDomainFormat	
▬	versionIdentifier	0.080410

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Sample Type – Value Meaning and Permissible Values

Instance: pv_sample_type_IEEE_REAL

Types
- PermissibleValue

Own Slots

	Slot Name	Value
▬	aggregate	
▬	beginDate	1990-06-01
▬	containing1	evd_sample_type
▬	endDate	2019-12-31
▬	usedIn	vm_sample_type_IEEE_REAL
▬	value	IEEE_REAL

Instance: vm_sample_type_IEEE_REAL

Types
- ValueMeaning

Own Slots

	Slot Name	Value
▬	beginDate	1990-06-01
▬	containing2	ecd_sample_type
▬	description	TBD Description
▬	endDate	2019-12-31
▬	has	pv_sample_type_IEEE_REAL

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Sample Type – Admin Record

Instance: Test_Load

Types
- AdministrationRecord

Own Slots

	Slot Name	Value
▬	administeredItem	
▬	administrativeNote	Test load from Planetary Science Data Dictionary (PSDD)
▬	administrativeStatus	Final
▬	changeDescription	No changes have been made to PSDD content.
▬	creationDate	2008-07-07
▬	effectiveDate	2008-07-07
▬	explanatoryComment	This is a test load of a ISO/IEC 11179 Data Dictionary using PSDD content.
▬	lastChangeDate	2008-07-07
▬	origin	Planetary Data System
▬	registrationStatus	Preferred
▬	unresolvedIssue	Issues still being determined.
▬	untilDate	2018-04-10

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Sample Type – Registration Authority

Instance: RA_0001_NASA_PDS_1

Types
- RegistrationAuthority

Own Slots

	Slot Name	Value
	documentationLanguageIdentifier	Language_Identification_English
	languageUsed	Language_Identification_English
	organizationMailingAddress	4800 Oak Grove Drive
	organizationName	NASA Planetary Data System
	registering	
	registrar	PDS Registrar
	registrationAuthorityIdentifier_v	0001_NASA_PDS_1

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Sample Type – Registrar

Instance: PDS Registrar

Types
- Registrar

Own Slots

	Slot Name	Value
	contact	Elizabeth Rye
	registrarIdentifier	
	represents	RA_0001_NASA_PDS_1

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Instance: Elizabeth Rye

Types
- Contact

Own Slots

	Slot Name	Value
	contactEmailAddress	Elizabeth.Rye@jpl.nasa.gov
	contactInformation	TBD
	contactMailingAddress	Jet Propulsion Laboratory, MS-169-315, 4800 Oak Grove Dr., Pasadena, CA 91109
	contactPhone	818.354.6135
	contactTitle	Standards Coordinator
	contractName	Elizabeth Rye

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Backup

Requirements

1. Manage Data Dictionary
2. Implement the Data Dictionary
3. Use the Data Dictionary to Create and Validate
4. Use Data Dictionary for Software Development

Implement the Data Dictionary (1 of 2)

1. The Data Dictionary shall define data elements in compliance with the data dictionary model .
2. The Data Dictionary shall define a “data-type” value set in compliance with the data dictionary model.
3. The Data Dictionary shall define a “units-of-measurement” value set in compliance with the data dictionary model.
4. The Data Dictionary shall define a “special-values” value set in compliance with the data dictionary model.
5. The Data Dictionary shall define a “data-element-value-alias” value set in compliance with the data dictionary model.
6. The Data Dictionary shall define a “data-element-value-formation-rule” value set in compliance with the data dictionary model.
7. The Data Dictionary shall define a “standard-value” value set in compliance with the data dictionary model.
8. The Data Dictionary shall define a “namespace” value set in compliance with the data dictionary model.
9. The Data Dictionary shall define a “general-classification” value set in compliance with the data dictionary model.
10. The Data Dictionary shall define a “system-classification” value set in compliance with the data dictionary model.
11. The Data Dictionary shall define linked-in-kind data element relationships in compliance with the data dictionary model.
12. The Data Dictionary shall define “pointer relationships” in compliance with the data dictionary model.
13. The Data Dictionary shall define “sfdu-relationships” in compliance with the data dictionary model.
14. The Data Dictionary shall have a naming standard for the data element title (common name).
15. The Data Dictionary shall provide a namespace attribute for indicating control authorities for groups of data elements.
16. The Data Dictionary shall provide a general data type attribute for classifying a data element according to a non-implementation-specific list of data types.
17. The Data Dictionary shall provide a general classification type attribute for classifying groups of data elements according to common characteristics
18. The Data Dictionary shall provide a system classification type attribute for classifying groups of data elements according to the data system that uses it

Implement the Data Dictionary (2 of 2)

1. The Data Dictionary shall provide a unit attribute for specifying the default unit of measure that is applicable to the referenced data element.
2. The Data Dictionary shall provide a linked-in-kind attribute for identifying relationships between data elements where the use / specification of a data element necessitates the specification of a complimentary data element.
3. The Data Dictionary shall provide an alias attribute for specifying one or more aliases that are applicable to the referenced data element.
4. The Data Dictionary shall provide a standard value type attribute for specifying the type of standard value that is appropriate for the referenced data element.
5. The Data Dictionary shall provide a minimum and maximum column value attribute for specifying the minimum and maximum numeric values that are applicable to the referenced data element.
6. The Data Dictionary shall provide a minimum and maximum length value attribute for specifying the minimum and maximum permissible length of the character values that are applicable to the referenced data element.
7. The Data Dictionary shall provide two identifier attributes for specifying the unique instance of the data element and a locally defined instance of the referenced data element.
8. The Data Dictionary shall provide a textual-description attribute for defining the referenced data element.
9. The Data Dictionary shall provide a data-element-type attribute for specifying the type of data element.
10. The Data Dictionary shall provide a data-element-formation-rule attribute that supplies a rule that is to be applied during the creation of a value for the data element (e.g., the values supplied for reference_key_id must conform to the rules used by a specific professional journal for referencing citations).
11. The Data Dictionary shall provide a special-values attribute for specifying which of the special-values (e.g., “N/A”, “UNK”, “NULL”) are permissible or not permissible as values for the referenced data element.
12. The Data Dictionary shall provide a series-set attribute for specifying if it is permissible or not permissible to specify values in a series or set.
13. The Data Dictionary shall provide a data-element-partial-label attribute that specifies if it is permissible or not permissible for a data element to exist within a partial-label (e.g., a FMT file).
14. The Data Dictionary shall provide a has-units attribute that specifies if it is permissible or not permissible to associate a unit with the referenced data element.
15. The Data Dictionary shall provide a can-be-locally-defined attribute that specifies if it is permissible or not permissible for a data element to be locally defined (i.e., overwrite the attributes of a data element in the PSDD.
16. The Data Dictionary shall provide a can-take-on-identifiers attribute that specifies if it is permissible or not permissible to pre-pend an identifier to a data element.
17. The Data Dictionary shall provide a can-be-a-pointer attribute that specifies if it is permissible or not permissible for the data element / object to be characterized as one of the three types of pointers (e.g., (1) data location pointer, (2) include pointer, and (3) related information pointer).
18. The Data Dictionary shall provide attributes for defining object classes.

Conclusions

- **A data dictionary is required to support a data model since the data modeling tools typically do not capture all the information needed to completely defined the attributes used in the data model.**
- **A common data model for data dictionaries provides inter-operability at the most basic level**.
  - Common terms should be used for defining data elements.
- **The ISO/IEC 11179 Metadata Registry standard was designed to provide a common data model.**
- **The results are positive so far.**
  - An ISO/IEC 11179 data dictionary data model has been developed.
  - An ISO/IEC 11179 data element database has been configured.
  - The test load of the content of the Planetary Science Data Dictionary is successful so far.

Status

- **Use cases have been defined.**
- **Requirements have been written.**
- **Several data dictionary models were reviewed.**
  - CCSDS Data Entity Dictionary Specification Language (DEDSL)
  - SPASE Data Dictionary
- **Three data dictionary models have been captured in an ontology.**
  - Planetary Science Data Dictionary (PSDD) – PDS Data Dictionary
  - ISO/IEC 11179-3:1994 – Specification and standardization of data elements
  - ISO/IEC 11179-3:2002 – Metadata registries (MDR)
- **An ISO/IEC 11179-3:2002 database is being prototyped**
  - Ontology modeling tool allows data to be ingested.
  - Planetary Science Data Dictionary content is being loaded.
  - Validation of model is not yet complete.