BUILDING THE PDS4 LOCAL DATA DICTIONARY FOR CHANDRAYAAN-2 MISSION

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Introduction: The data collected from the instruments from the Chandrayaan-2 orbiter is received, processed and archived at Indian Space Science Data Center (ISSDC) for dissemination and use by scientific community in India and abroad. PDS4 (Planetary Data System) is the de facto international standard for long term archival of planetary science data. Under PDS4 local data dictionary for Chandrayaan-2 mission was designed and developed in order to cater the mission specific attributes that were not present in core PDS4 data dictionary.

Data Dictionary: Data Dictionary defines meta data attributes and their relationships with in a domain. Local Data Dictionary (LDD) – defines a data dictionary that deals within a limited domain. Figure 1 shows relationship between PDS4 Data Dictionaries.

Figure 1 PDS4 Data Dictionary Relationships

Mission dictionary provides a local vocabulary for a specific mission or investigation. A data dictionary is a practical expression of all or part of an information model. In PDS4 archiving, a data dictionary is actually two schema files an XML Schema (.xsd) – defines organization and structure A Schematron (.sch) – defines relationships and dependencies. Attributes are the PDS4 archiving versions of keywords. Classes are organized collections of attributes and optionally, nested classes. Defining our own data dictionary, first define attributes, and then define classes to organize the attributes. LDD Tool allow us to define attributes and classes without having to learn how to write XML schema definitions or re-implementing the PDS4 data types and constrains in your own namespace.

Why Local Data Dictionary is required for Chandrayaan-2 Mission?

Every mission has some conditions based on the events that needs to be handle as an information at output product level. There is an ISRO Science Data Archive (ISDA) established during Chandrayaan-1 mission in 2008. All the products hosted for users under ISDA are PDS compliance. For Chandrayaan-2 mission, PDS4 Archive standard was adopted. PDS4 is currently next and future generation archive standard adopted by all the space agencies including NASA, ESA and JAXA for their current and future mission. To handle the ISRO planetary mission's specific parameters, there is a concept in PDS4 called Local Data Dictionary i.e. LDD. In LDD one can define all the parameters and that can be used as a reference for future planetary missions in India. LDD takes basic data dictionary of PDS4 and then top of it builds local dictionary.

Local Data Dictionary Development:

For Chandrayaan-2 mission and future planetary missions of ISRO, list of parameters as per requirements was identified and defined. After defining the required parameters, LDD Tool was used to generate the local data dictionary. LDD starts with the creation and population of an XML file known as Ingest_LDD file Ingest_LDD is a class with the PDS4 core dictionary. It has methods for defining individual attributes and groups of attributes as classes. It is also, where constraints (rules) for schematron are defined. Below figure shows LDD Tool workflow. LDD Processing Steps:

Figure 2 LDD Tool

- Download ldd tool (lddtool-9.0.0-bin.tar.gz) for information model 1.11
- Extract the tar file and install LDD
- Java is perquisite before running LDD tool
- Created the ingest-LDD file
  - ch2_ingest_ldd.xml
- Run the LDD tool with the following command
  - lddtool -lp ch2_ingest_ldd.xml > lddtool.log

- LDD generates output files
  - ch2_ingest_ldd_ISDA_1300.txt
  - ch2_ingest_ldd_ISDA_1300.csv
  - ch2_ingest_ldd_ISDA_1300.xsd
  - ch2_ingest_ldd_ISDA_1300.sch
  - ch2_ingest_ldd_ISDA_1300.xml

Below Figure shows the LDD design output.

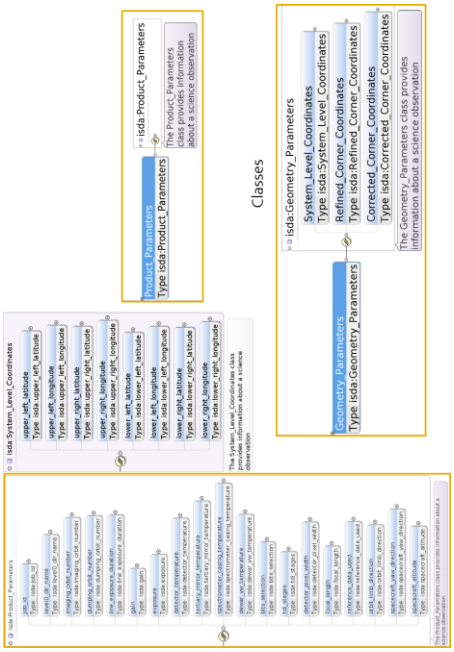

Figure 3 LDD Design Output

Addition of Local Data Dictionary to PDS4 Label Data Products: The Chandrayaan-2 Local Data Dictionary (generated from LDD tool) Attributes were added to the PDS4 label files of Optical Payloads (TMC2, IIRS and OHRC) data products. After adding the attributes label file was successfully validated using validate tool developed by NASA. Following steps were followed to carry out the addition of LDD to a label file:

- Add schema file (ch2_ingest_ldd_ISDA_1300.xsd) inside the xml header

```
<Mission_Area>
        <isda:Product_Parameters>
          <isda:job_id>TMCXXD18CHO0388800NNNN20190210537039_V1_0</isda:job_id>

<isda:level0_dir_name>TMCXXD18CHO0388800NNNN20190210537039_V1_0</isda:level0_dir_na
me>
          <isda:imaging_orbit_number>3887</isda:imaging_orbit_number>
          <isda:dumping_orbit_number>3888</isda:dumping_orbit_number>
          <isda:line_exposure_duration unit="ms">3.236</isda:line_exposure_duration>
          <isda:gain>g1</isda:gain>
          <isda:exposure>e1</isda:exposure>
          <isda:detector_pixel_width unit="micrometer">7</isda:detector_pixel_width>
          <isda:focal_length unit="mm">140</isda:focal_length>
          <isda:reference_data_used>SELENE</isda:reference_data_used>
          <isda:orbit_limb_direction>Descending</isda:orbit_limb_direction>
          <isda:spacecraft_yaw_direction>True</isda:spacecraft_yaw_direction>
          <isda:spacecraft_altitude unit="km">122.72914593037591</isda:spacecraft_altitude>
        </isda:Product_Parameters>
</Mission_Area>
```

Figure 4 Ch2 LDD Ingest File

- Update the product parameters class and all the attributes under the class
- Update the geometry class and all the attributes under the class
- Run the tool with the command validate -v3 <input label file> -x <local schema file> -r validation_report.txt

```
PDS Validate Tool Report

Configuration:
  Version              1.14.0
  Date                 2020-09-15T06:03:11Z
  Core Schematrons     [PDS4_PDS_1B00.sch]
  Model Version        1B00

Parameters:
  Targets
[file:/data1/pds4/pds4_dictionary/ch2/output/labels/ch2_tmc_ncn_20200708T1922155963_d_img_d18.xml]
  User Specified Schemas    [file:/data1/pds4/pds4_dictionary/ch2/output/ch2_ldd_ISDA_1000.xsd]
  Severity Level       ERROR
  Recurse Directories  true
  File Filters Used    [*.xml, *.XML]
  Force Mode           off
  Data Content Validation  on
  Max Errors           100000


Product Level Validation Results

 PASS: file:/data1/pds4/pds4_dictionary/ch2/output/labels/ch2_tmc_ncn_20200708T1922155963_d_img_d18.xml

Summary:

 0 error(s)
 0 warning(s)


End of Report
```

Figure 5 LDD Validation Report

References: [1] Chandrayaan-2 Science data management and Archive plan (Chandryaan-2/DP/SAC/SIPG/HRDPD/TR-06/July 2018), [2] PDS4 Concepts Data Design Working Group October 1, 2018 version 1.11.0, [3] The PDS4 Data Provider's Handbook Guide to Archiving Planetary Data Using the PDS4 Standard Version 1.11.0 October 1, 2018, [6] PDS4 Data Dictionary Abridged – Version 1.11.0.0

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