



# PDS4 Operational Readiness Review

## PDS4 Project Description, Overall Plan, and Status

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Engineering Node



September 17, 2013



# Overview

- Introduction to PDS
- Introduction to PDS4
  - Project, lifecycle, architecture, design
- Build structure and status
- Current deployment and support
- Planned support for LADEE/MAVEN
- Schedule
- Mapping to ToR



# PDS Mission and Vision

## Mission

Facilitate achievement of NASA's planetary science goals by efficiently collecting, archiving, and making accessible digital data and documentation produced by or relevant to NASA's planetary missions, research programs, and data analysis programs.

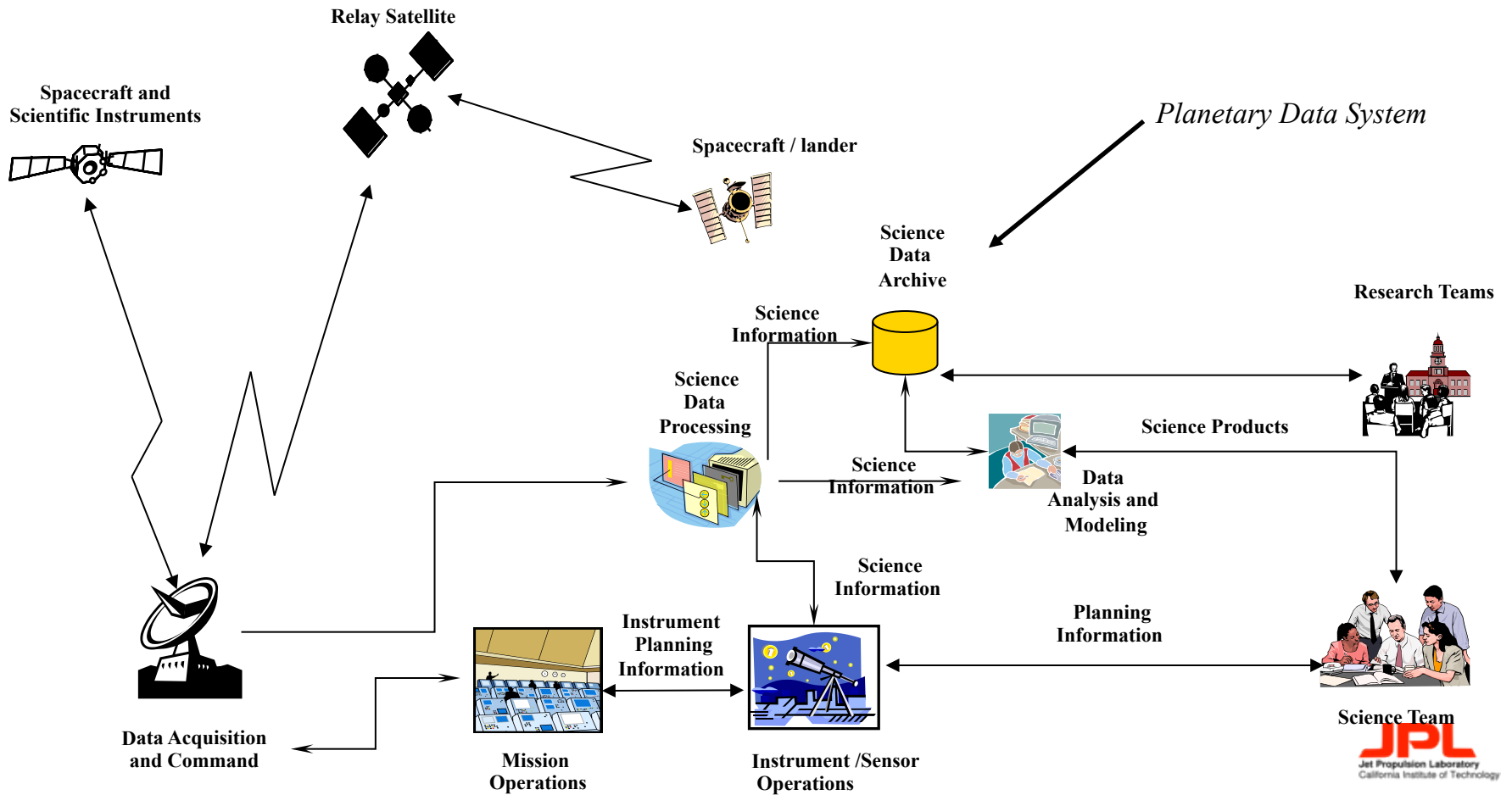
## Vision

- To gather and preserve the data obtained from exploration of the Solar System by the U.S.
- To facilitate new and exciting discoveries by providing access to and ensuring usability of those data to the worldwide community
- To inspire the public through availability and distribution of the body of knowledge reflected in the PDS data collection

PDS is a federation of distributed discipline and service nodes.



# PDS in Context



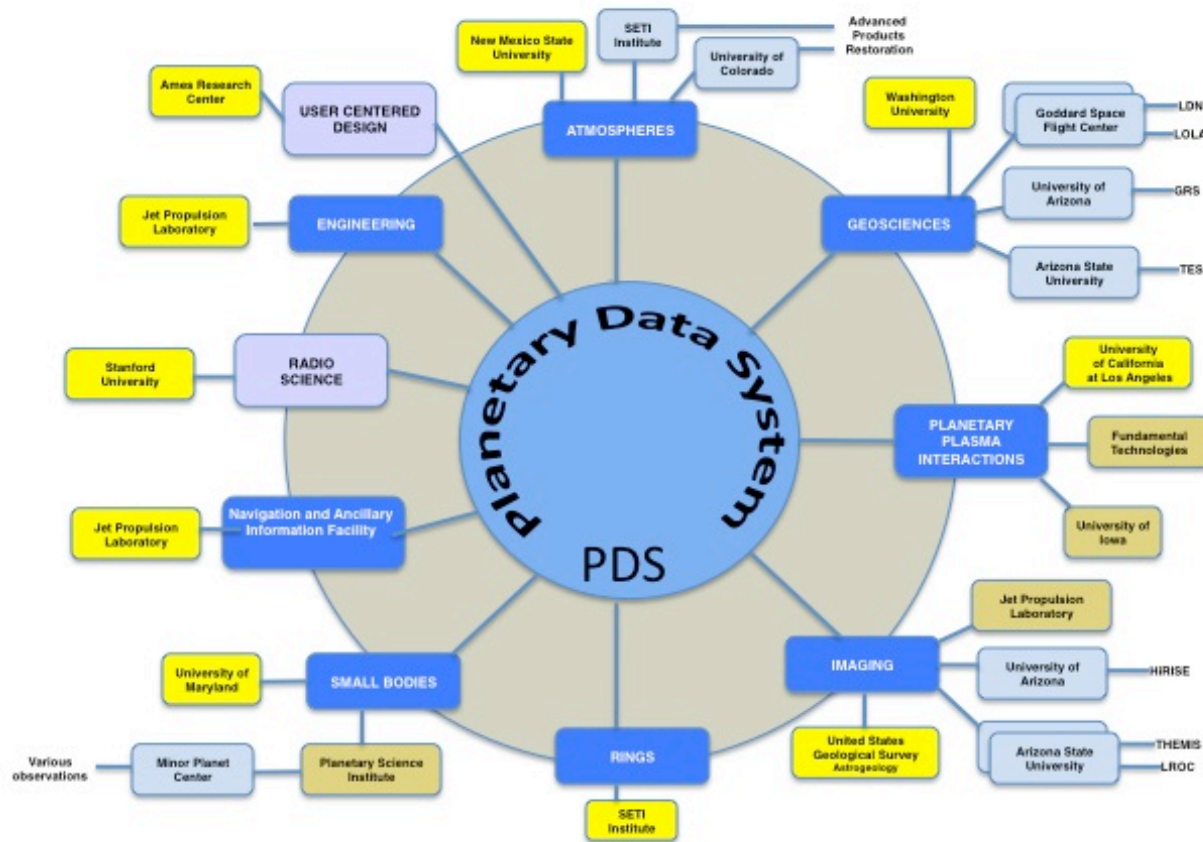


# NASA Planetary Data System



## NODES / SUBNODES / DATA NODES

Function / Nodes Home Institutions





# Timeline of PDS Technical Implementations and Upgrades

- PDS 1 – < 1990
  - High-Level Catalog for finding data sets by mission, instrument, spacecraft and target.
  - Archive volumes stored and distributed on tape.
  - The Object Description Language (ODL) is invented for product labeling and capturing catalog information.
- PDS 2 - 1990
  - CD-ROM becomes the archive and distribution volume of choice.
  - High-Level Catalog simplified by using more text instead of keywords to capture descriptive information.
- PDS 3 - 1992
  - PDS sets up and maintains a web presence.
  - Movement to online distribution of products (PDS-D). (~2002)
  - On-line mass storage and data bricks replace CD/DVD as archive and distribution media.
- PDS4 - > 2010
  - Beginning with prototype/build 1 in 2010
  - Model driven architecture with XML labels
  - Movement to a distributed, service architecture
  - Integrated federation
  - New data standards, data formats and structures
  - International Collaboration



# PDS Challenges

- Number and diversity of missions and instruments
  - PDS is currently receiving data from ~110 instruments from 15 active missions as well as concurrently working with missions in development
  - New mission data nodes being added to PDS (LROC, for example)
- Requirements for preservation of data and for usability are sometimes in conflict
- Budget pressures which affect archiving/usability across data providers/missions, PDS and the users
- International archiving and standards coordination
- Increasing volume of data
  - In 2001, the PDS archive was 4 TBs
  - In 2010, the PDS online archive is over 100 TBs
  - In 2013, the PDS online archive is over 500 TBs
- **Replacing aging technology, tools, standards and processes**



# Motivation for PDS4

- The current PDS3 was designed based on an offline system; Both the standards and software infrastructure have evolved to support online operations.
- The growth of PDS, both for NASA and non-NASA missions, has stressed the structure and capabilities of the PDS3 standards.
- Software tools, infrastructure, technologies and standards have changed which makes continued maintenance and extension of PDS3 very challenging.
- Ultimately, new software technologies and standards provides an opportunity to greatly improve the operation and usability of the PDS long-term.







# PDS4: The Next Generation PDS

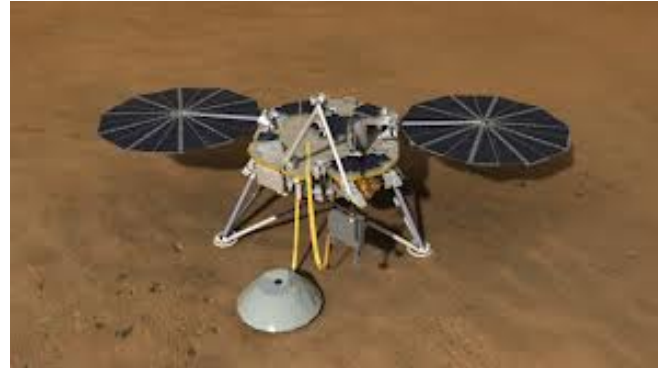
- PDS4 is a PDS-wide project to upgrade from PDS version 3 to version 4 to address many of these challenges
- An **explicit information architecture**
  - All PDS data tied to a common model to improve validation and discovery
  - Use of XML, a well-supported international standard, for data product labeling, validation, and searching.
  - A hierarchy of data dictionaries built to the ISO 11179 standard, designed to increase flexibility, enable complex searches, and make it easier to share data internationally.
- An **explicit software/technical architecture**
  - Distributed services both within PDS and at international partners
  - Consistent protocols for access to the data and services
  - Deployment of an open source registry infrastructure to track and manage every product in PDS
  - A distributed search infrastructure



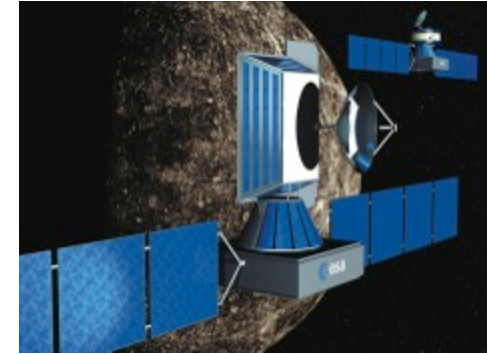
# PDS4 Planned Mission Support



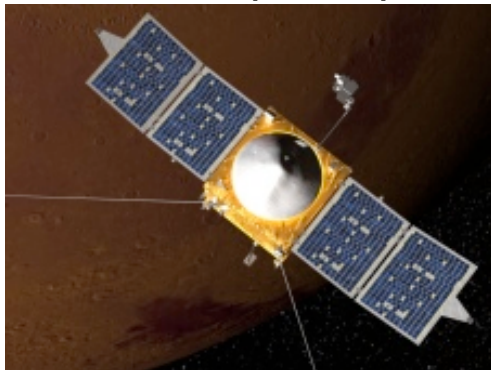
**LADEE (NASA)**



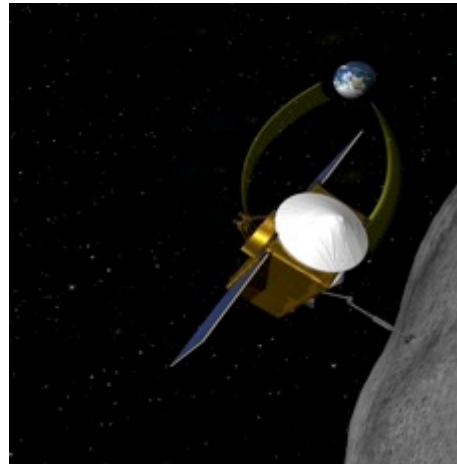
**InSight (NASA)**



**BepiColumbo (ESA/JAXA)**



**MAVEN (NASA)**



**Osiris-REx (NASA)**

ISRO, JAXA  
Planning  
PDS4  
missions



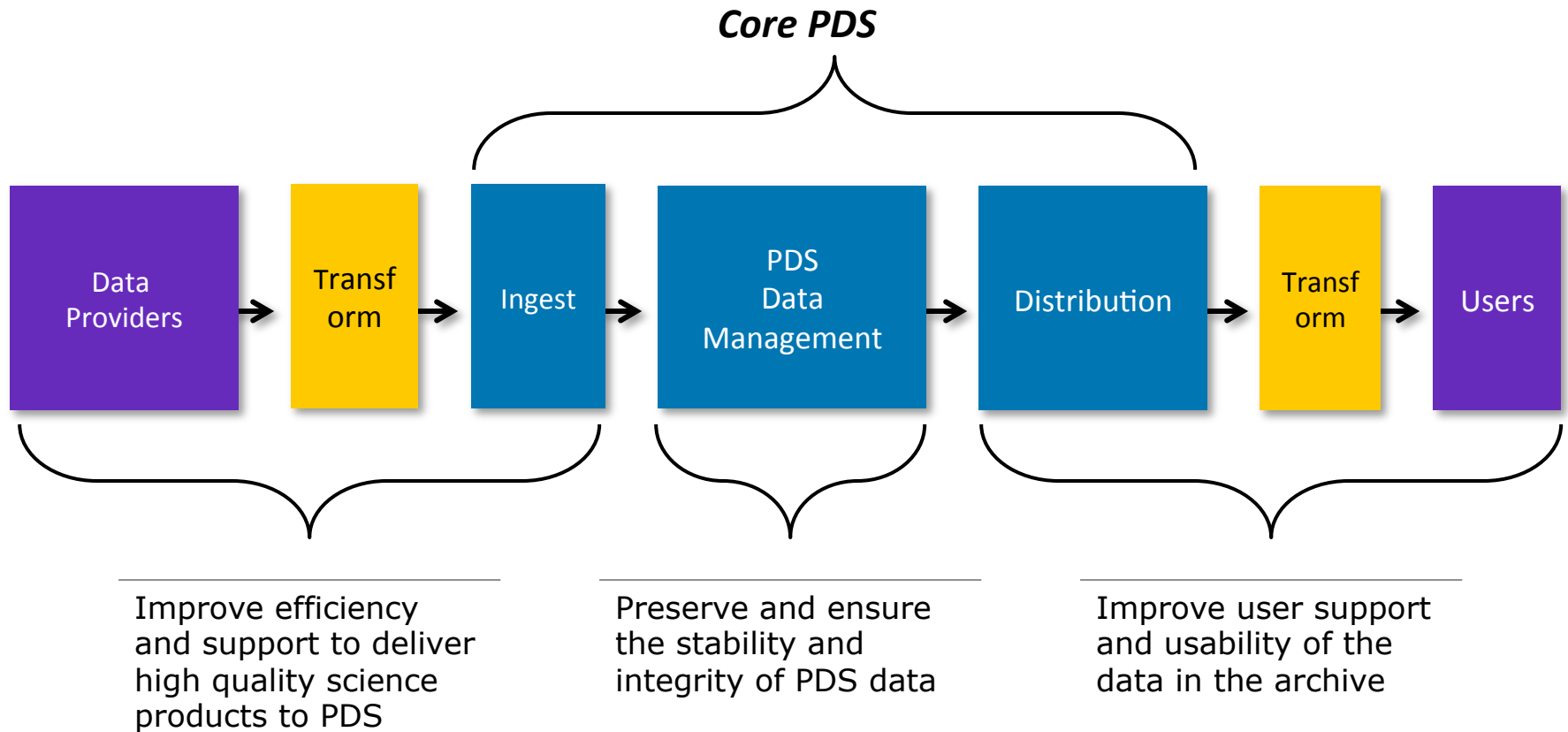
**ExoMars (ESA)**

Endorsed by the **International Planetary Data Alliance** in July 2012 –  
<https://planetarydata.org/documents/steering-committee/ipda-endorsements-recommendations-and-actions>





# Challenge: End-to-End System and Data Integration





# Structured Project Approach

- Phased approach with builds that introduce increasing functionality
- Two key working groups that include members from across PDS
  - DDWG = Data Design WG
  - SDWG = System Design WG
  - Use of several collaboration mechanisms
- Full lifecycle planned out with deliverables for each build (project plan, requirements, design, CM/build, test, release)
  - Reviews at key points in the process





# PDS4 Project Leads

- Project Manager: Dan Crichton
- Project Scientist: Reta Beebe
- PDS4 Data Standards Lead: Steve Hughes
- PDS4 System Development Lead: Sean Hardman
- Transition/Operations: Emily Law
- NOTE: Involvement from discipline nodes across the PDS is critical; they are part of the design and development team so they are intimately involved in each step to ensure support for their discipline.



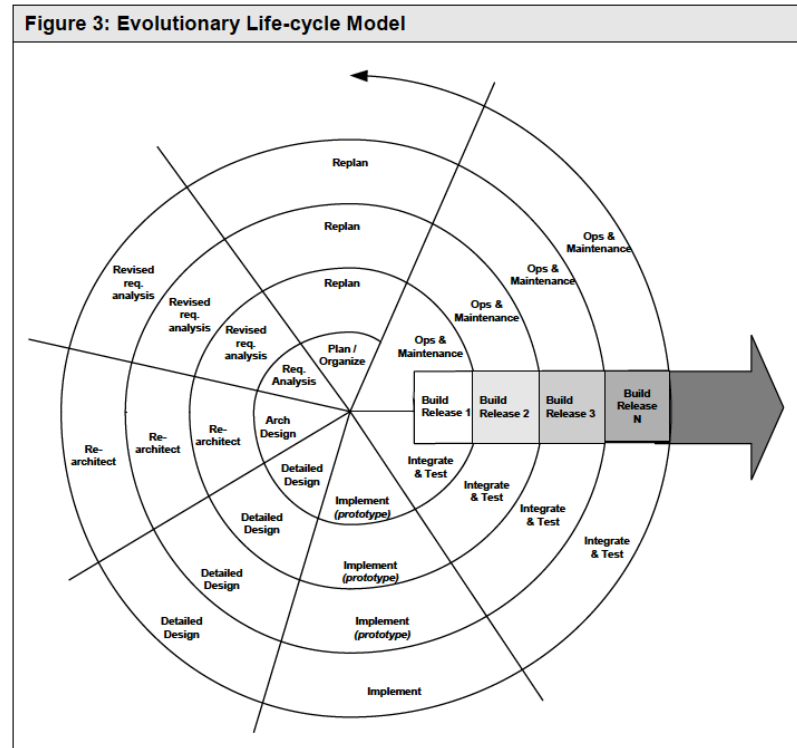
# PDS4 Software Development Lifecycle

## 5.1.3 Evolutionary Development Life-Cycle Model

Table 5–6 summarizes the life cycle defined by the evolutionary development model.

Table 5–6. Summary of Evolutionary Development Life-Cycle Model

<p><b>Summary description and discussion</b></p>	<p>Like the incremental development model, the evolutionary life-cycle model also develops a system in builds, but differs from the incremental model in acknowledging that the user needs are not fully understood and not all requirements can be defined up front. In the evolutionary approach, user needs and system requirements are partially defined up front, then are refined in each succeeding build. The system evolves as the understanding of user needs and the resolution of issues occurs. Prototyping is especially useful in this life-cycle model. (The evolutionary development life-cycle model is sometimes referred to as a spiral development model, but it is not the same as Boehm's spiral model (Reference 11). This model is also sometimes referred to as a prototyping life-cycle model, but it should not be confused with the prototyping technique defined in Section 5.2.1.)</p> <p>This life-cycle model is illustrated in Figure 5–4. Major products and milestone reviews for this model are summarized in Table 5–7.</p>
<p><b>Advantages</b></p>	<ul style="list-style-type: none"> <li>• Not all requirements need be known up front</li> <li>• Addressing high risk issues (for example, new technologies or unclear requirements) early may reduce risk</li> <li>• Like the incremental life-cycle model, interim builds of the product facilitate feeding back changes in subsequent builds</li> <li>• Users are actively involved in definition and evaluation of the system</li> <li>• Prototyping techniques enable developers to demonstrate functionality to users with minimal of effort</li> <li>• Even if time or money runs out, some amount of operational capability is available</li> </ul>
<p><b>Disadvantages</b></p>	<ul style="list-style-type: none"> <li>• Because not all requirements are well-understood up front, the total effort involved in the project is difficult to estimate early. Therefore, expect accurate estimates only for the next cycle, not for the entire development effort.</li> <li>• Less experience on how to manage (progress is difficult to measure)</li> <li>• Risk of never-ending evolution (for example, continual "gold plating")</li> <li>• May be difficult to manage when cost ceilings or fixed delivery dates are specified</li> <li>• Will not be successful without user involvement</li> </ul>
<p><b>Most appropriate when ...</b></p>	<ul style="list-style-type: none"> <li>• Requirements or design are not well-defined, not well-understood, or likely to undergo significant changes</li> <li>• New or unproved technologies are being introduced</li> <li>• System capabilities can be demonstrated for evaluation by users</li> <li>• There are diverse user groups with potentially conflicting needs</li> </ul>



JPL-D 76772 Rev 1  
 NASA Software Management  
 Guidebook – NASA-GB-001  
Evaluation by users as early as possible!



# Project Lifecycle Thru Build 1 & 2

Project Lifecycle	Pre-Formulation	Formulation	Implementation							
<b>Project Lifecycle Gates &amp; Major Events</b>	Begin Study Project 	Study/Concepts  KDP: Study	Project Plan 	PDS4 Prelim Architecture  KDP: Project Plan & Arch	PDS4 Design  KDP: Prelim Design	Build 1: Prototype build 1a (Oct 2010)            1b            1c            1d (Aug 2011) KDP: Beta Release for LADEE/MAVEN	Build 2: Prepare for label design 2a (Sept 2011)            2b (Mar 2012)			
<b>Project Reviews</b>	 PDS MC Concept Review (Dec 2007)	 PDS MC Impl Review (July 2008)	 PDS MC Arch Review (Nov 2008)	 PDS MC Preliminary Design (August 2009)	 PDS External System Design Review I (Mar 2010)	 Build 1b PDS Stds Assessment (Dec 2010)	 Build 1c IPDA Stds Assessment (April 2011)	 Build 1d External Stds Assessment (Aug 2011)	 PDS External System Design Review II (June 2011)	 ORR (Start Label Design) (LADEE/MAVEN) (November 2011)

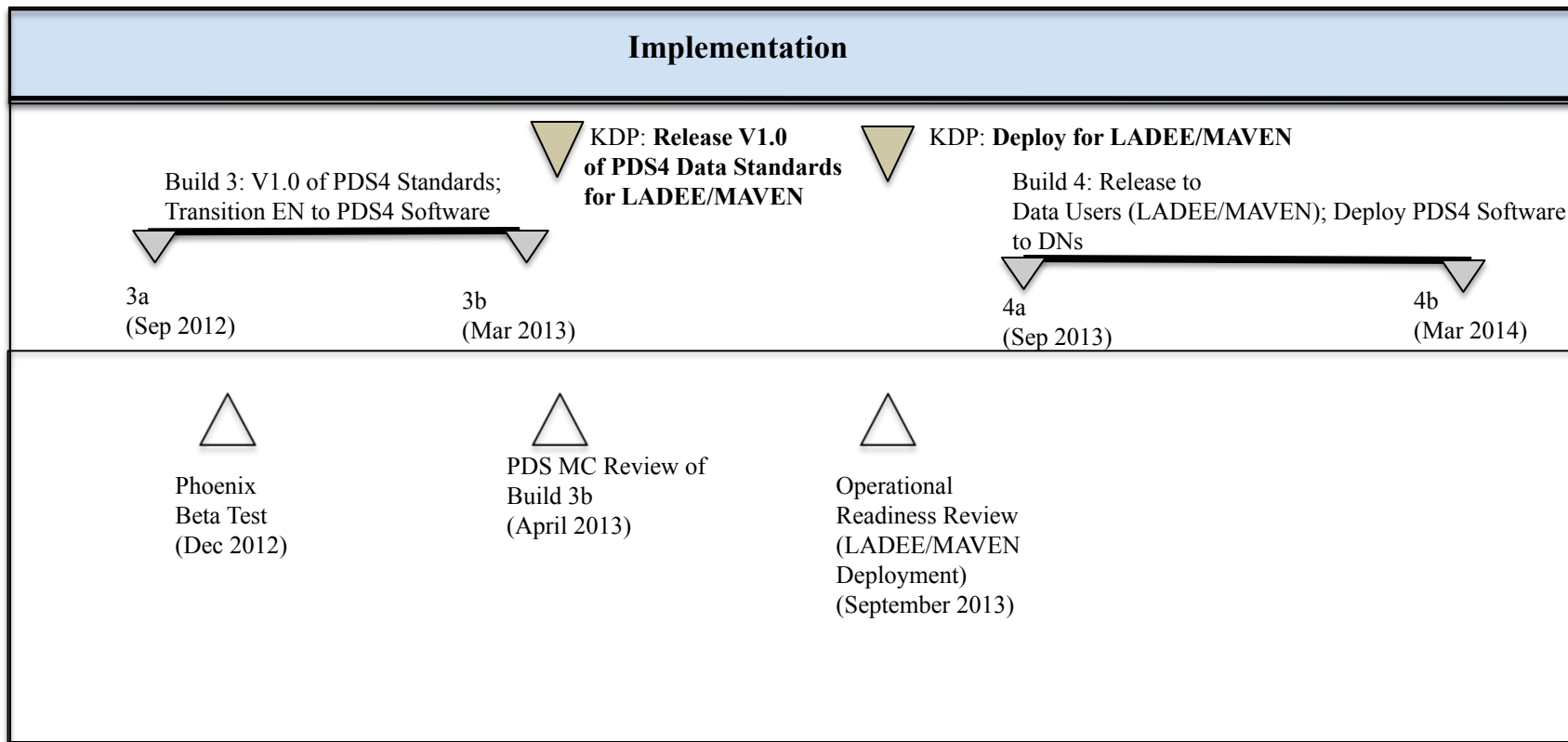
Note: These will be discussed in detail in a later presentation







# Project Lifecycle Builds 3 and Build 4





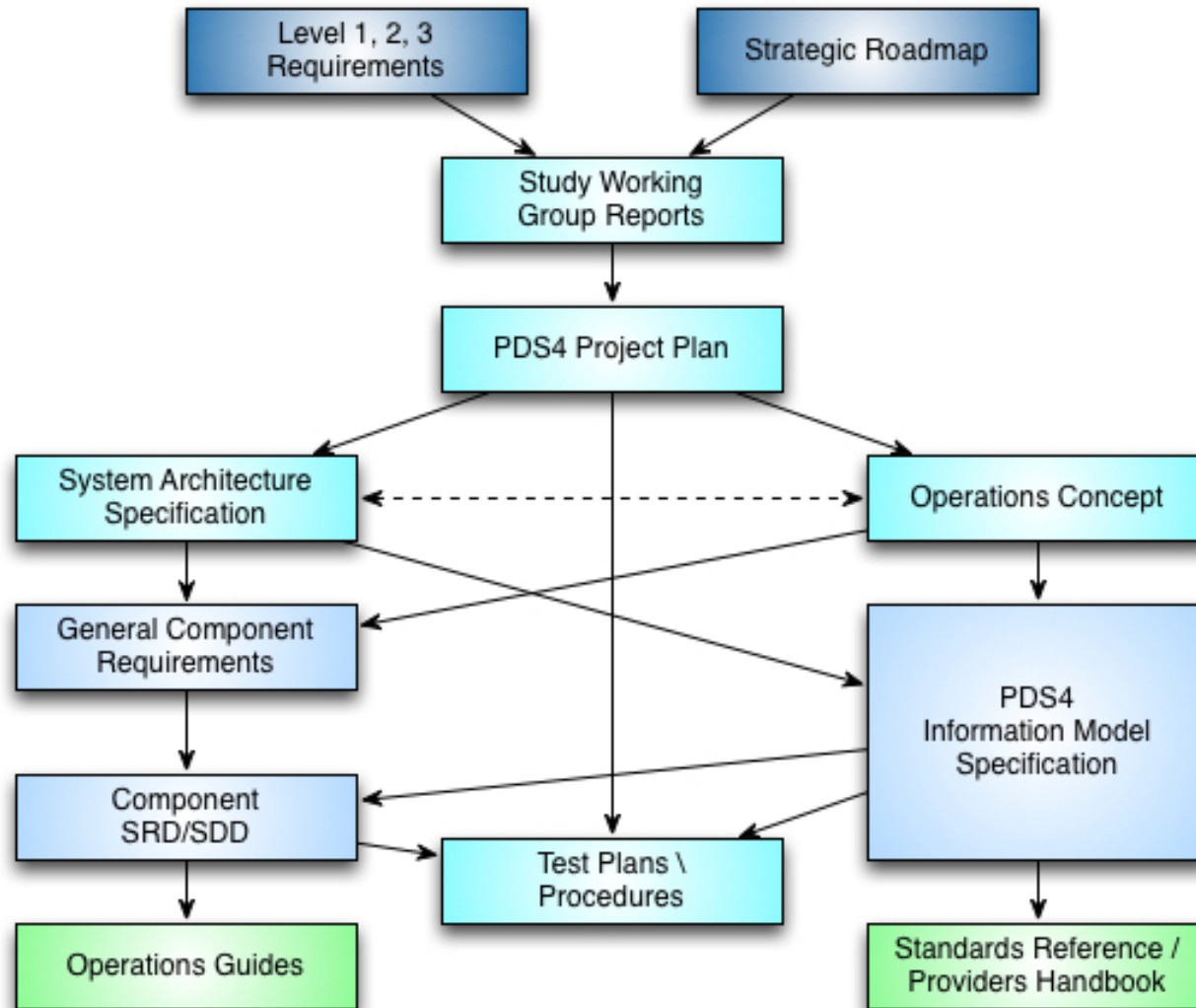


# Key Project Documentation

- Requirements
  - PDS Level 1, 2, 3
- Project Plan
  - Contains management approach and implementation plan
- Multiple Concept Papers
  - Architecture, user services and data design
- System Architecture
  - Defines data and software architecture
- Operations Concept
  - Interactions of PDS across the mission phases and from ingestion thru to distribution
- System Design Specifications for services and tools
- In addition, PDS maintains policies, requirements, standards, and schedule information online at the Management Council and Engineering nodes



# Document Tree



PDS4 ORR LADEE AND MAVEN





# Summary of Progress to Date

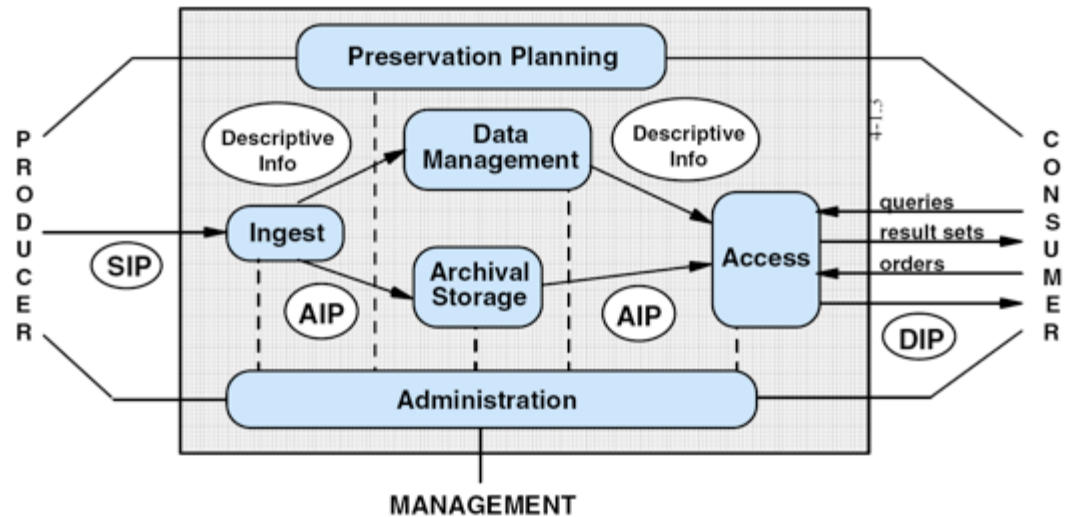


- Requirements in place (approved by MC 3/2010)
- PDS-wide Architecture defined
- Major reviews conducted both internal and external (data providers, users, engineers)
- Initial PDS products defined using maturing PDS4 specification
  - LADEE, MAVEN teams developing PDS4 labels per ORR and decision in Nov 2011/Jan 2012
- System builds grouped by purpose: build 1(a,b,c,d), 2 (a,b,c), 3(a,b)
  - Used to establish a rigorous release process
  - Includes deployment of software, data standards, documents and system integration testing
  - As stability has increased, we have moved to 6 month builds
- Operational capabilities deployed
  - Registry and Harvest infrastructure in place at EN
  - **PDS3 Central catalog migrated to PDS4 registry; High level search migrated**
  - **PDS3 data now being ingested into PDS4 system at EN**
  - **PDS4 Standards Released to V1.0 to prepare for LADEE/MAVEN; Change Control Board enacted for V1.0 and beyond.**
- Beta test conducted by Atmospheres to get user input on PDS4 concepts (XML, Bundles, etc)
- LADEE PDS4 Peer Reviews conducted
- IPDA endorsement and plans to move to PDS4
  - International implementation by PSA for Bepi Colombo underway
  - Deployed international search using PDS4 at the data set level



# System Functions of PDS

- Ingestion
- Data Management
- Storage Management
- Administration
- Preservation Planning
- Distribution/ Access



Reference Model for Open Archive Information System, CCSDS 650.0-B-1, January 2002





# PDS4 Technical Implementation Differences



Function	PDS 3 Implementation	PDS 4 Implementation
<b>Ingestion</b>	Manual process for submission; tools based on PDS internal standards	Automated ingestion; XML-based tools for design, validation and submission
<b>Data Management</b>	Independent data management systems across PDS	Integrated data registries across the PDS to allow for end-to-end tracking and search; interoperability with international partners
<b>Storage Management</b>	All data being migrated online	All data stored online
<b>Preservation Planning</b>	Missions deliver data formatted for the archive	Data maintained in a few simple formats that allow for transformation and long-term use
<b>Distribution/Access</b>	Data distributed in archival format	Data distributed in user formats; user services to better support analysis

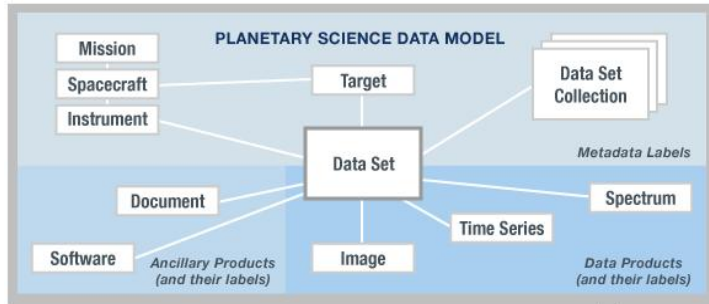




# Data Design Approach



## Information Model



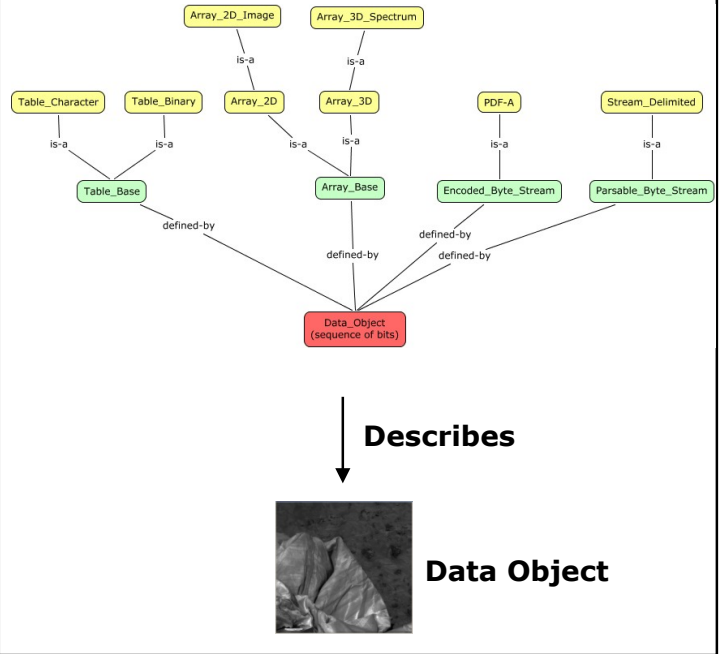
Used to Create

Validates



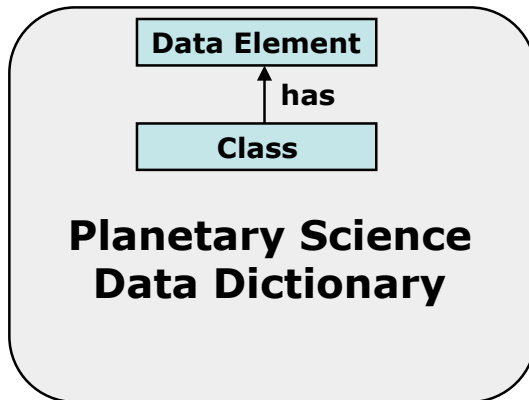
## Product

### Tagged Data Object (Information Object)



Expressed As

Extracted/Specialized

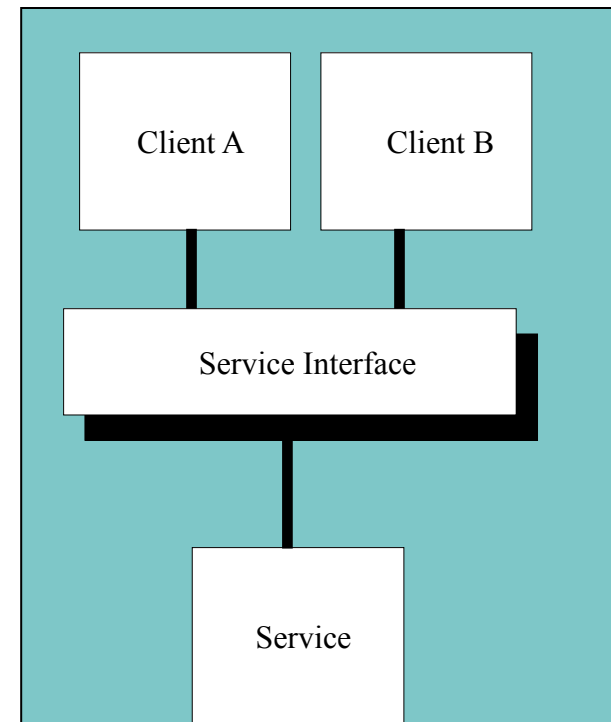




# System Design Approach



- Based on a distributed information services architecture (aka SOA-style)
  - Allow for common and node specific network-based (e.g., REST) services.
  - Allow for integrating with other systems through IPDA standards.
- System includes services, tools and applications
- Use of online registries across the PDS to track and share information about PDS holdings
- Implement distributed services that bring PDS forward into the online era of running a national data system
  - With good data standards, they become critical to ultimately improving the usability of PDS
  - Support on-demand transformation to/from PDS





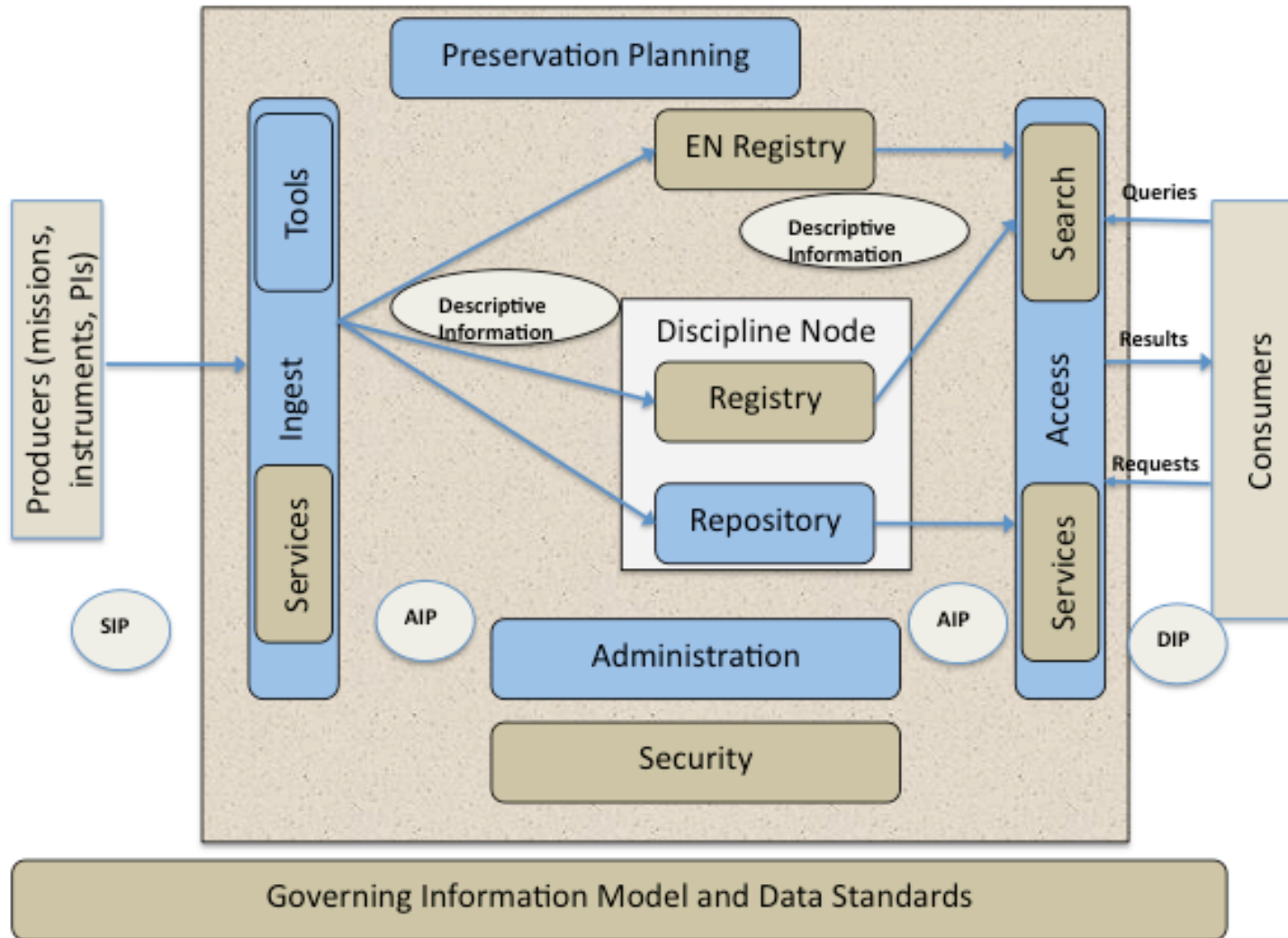
# PDS4 Data Standards Differences

Function	PDS 3 Implementation	PDS 4 Implementation
<b>Data Model</b>	High level information model; ad hoc model for each data set/product	Entire PDS model captured as an explicit model (ontology) defining all aspects including data, missions, instruments, etc
<b>Data Dictionary</b>	Based on a PDS internal structure	Captured using a rigorous, well-defined structure based on the ISO/IEC 11179 standard; elements organized into namespaces to allow for international coordination
<b>Grammar</b>	Object Description Language (ODL) used to capture metadata and annotate data sets, products, and catalog files	Extensible Markup Language (XML) used to capture PDS metadata; Standard XML tools used; <i>separation of the storage and display formats.</i>





# PDS to OAIS Mapping

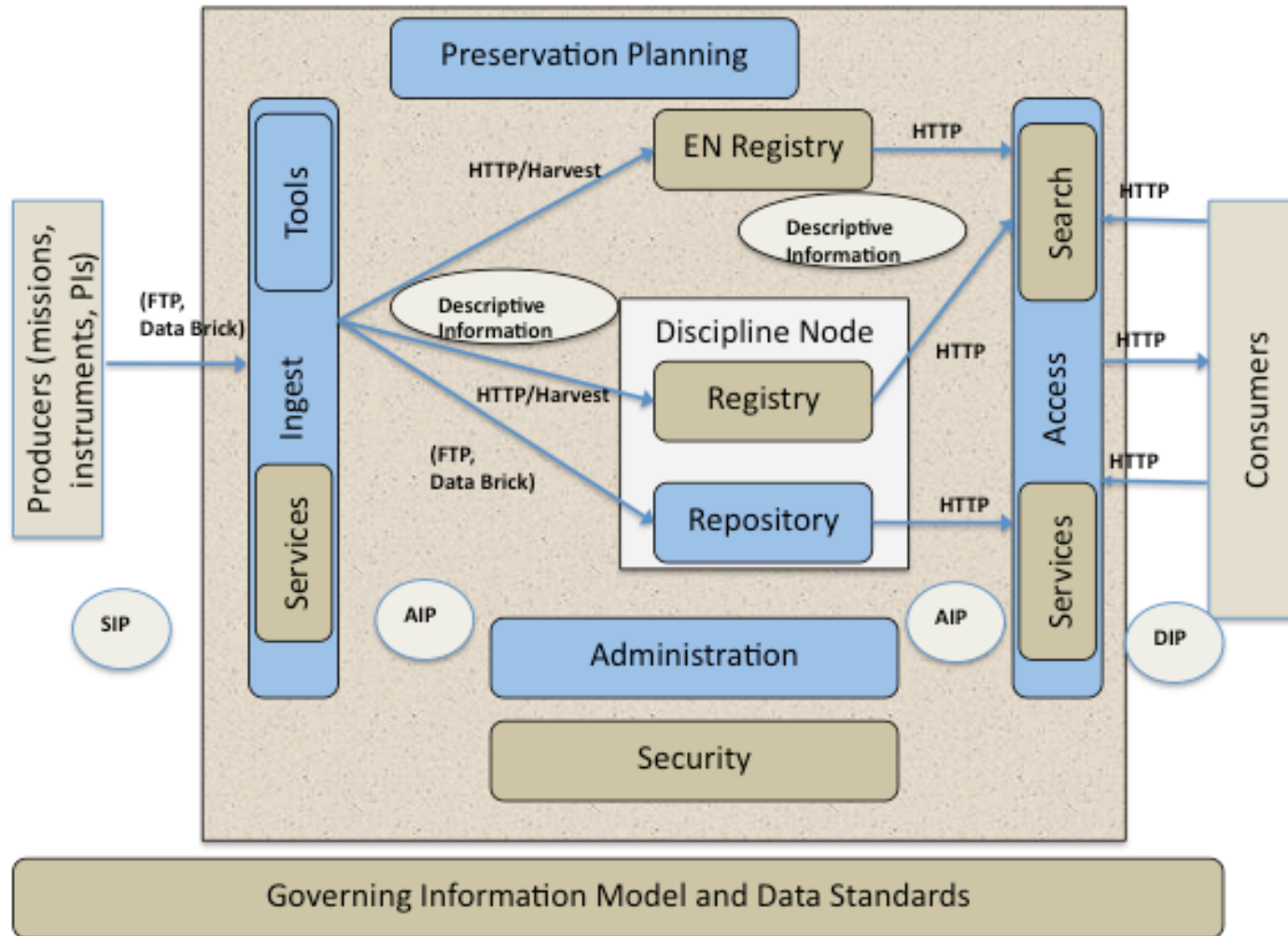


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# PDS to OAIS Mapping

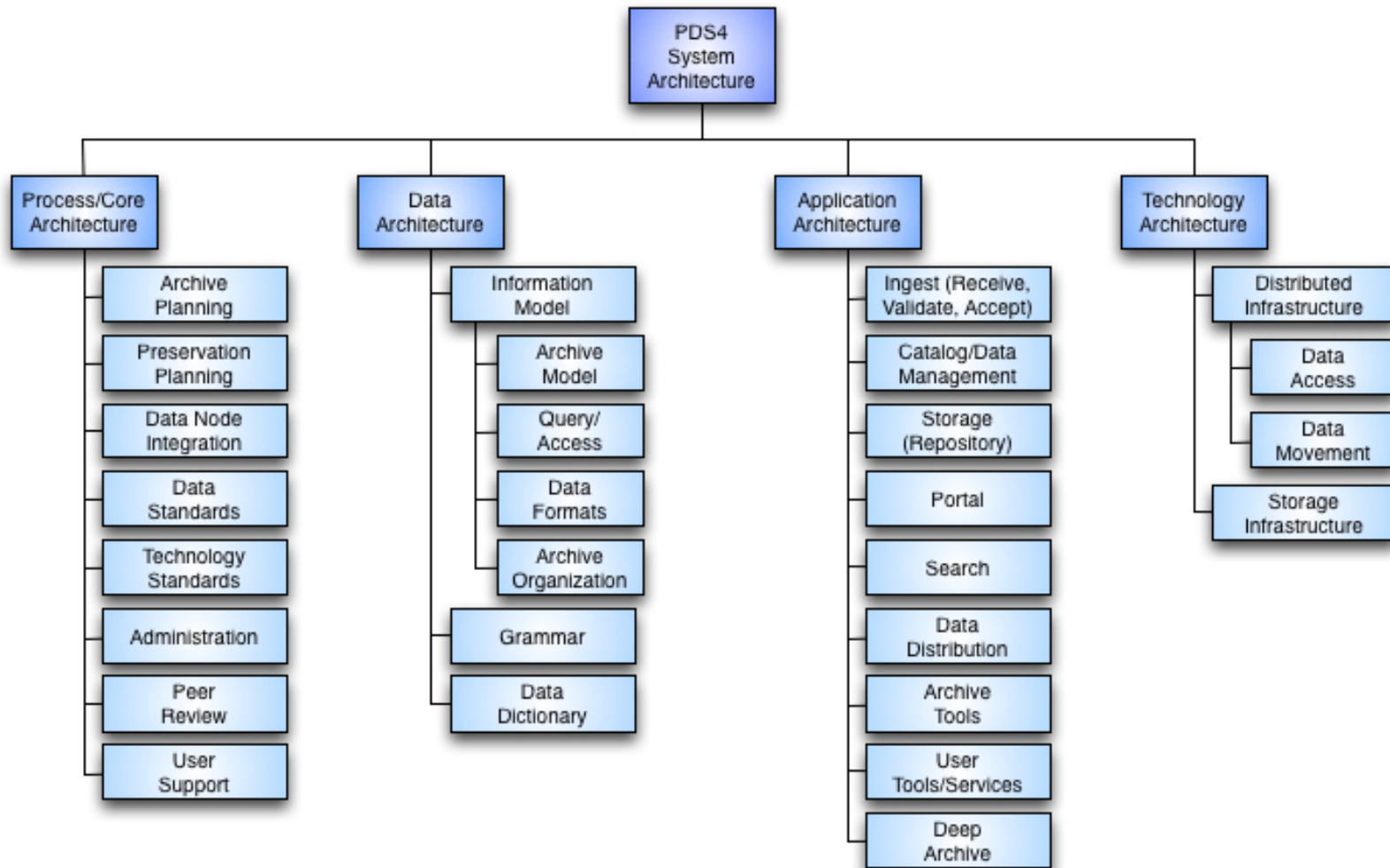


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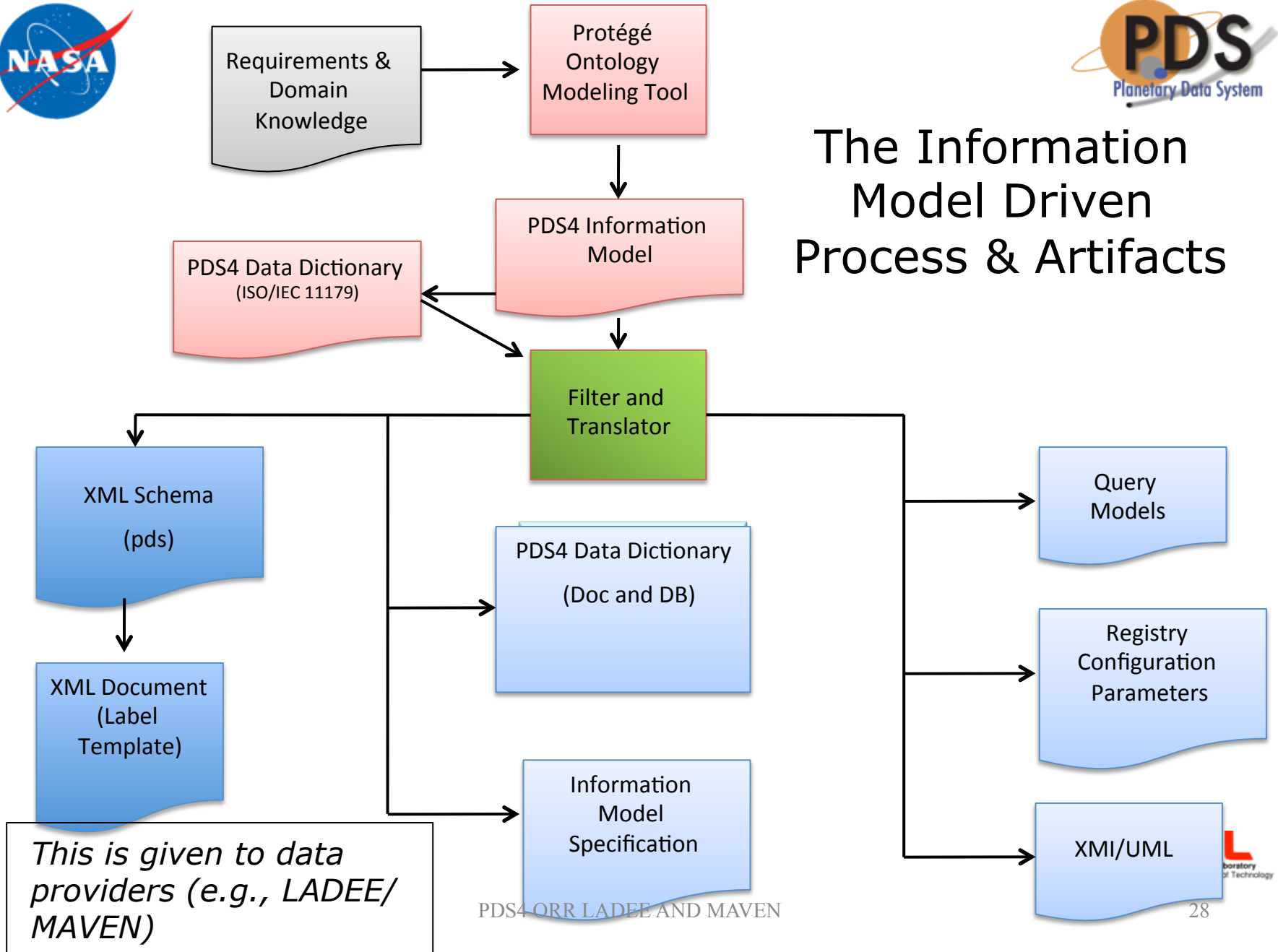


# PDS4 System Architecture Decomposition



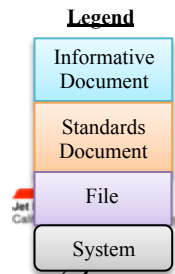
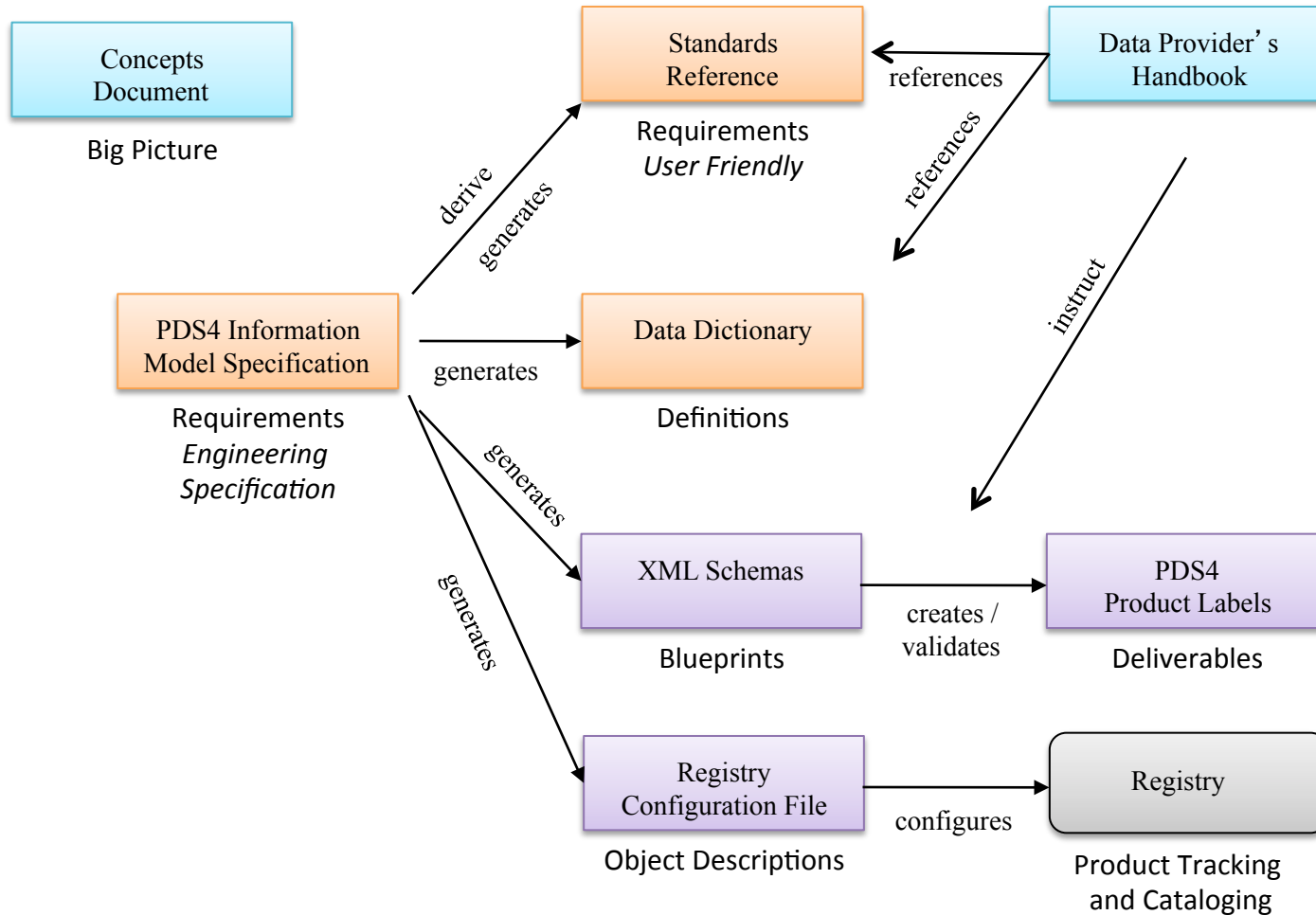


# The Information Model Driven Process & Artifacts





# PDS4 Documents & Artifacts



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# System Builds

- PDS4 uses system builds to bring together the software and the information model
  - Established very early in the project to organize releases
  - Provides a predictable structure to bring the teams together
  - Provides incremental functionality
  - Allows for feedback both inside and outside PDS
  - Allows for adoption by the DNs which have varying needs over time
- Each build provides a full lifecycle to capture, CM, integrate, test and deploy the release



# PDS4: Build Structure



Phase	Purpose	Release	Date
Build 1 Prototype/ Test	<ul style="list-style-type: none"> <li>• Early formalization of the data standards</li> <li>• Early formalization of software</li> <li>• Integration between software and data standards</li> <li>• Stakeholder input</li> </ul>	<ul style="list-style-type: none"> <li>• PDS4 beta info model, standards reference, data dictionary, schemas baseline</li> <li>• Early releases of Harvest, Registry and Security services</li> <li>• First set of process, documentation and tutorial</li> </ul>	Oct 2010 Feb 2010 May 2011 Aug 2011
Build 2 Begin Label Design for LADEE/ MAVEN	<ul style="list-style-type: none"> <li>• Support LADEE, MAVEN Label Design and Planning</li> <li>• Begin pilot deployment of PDS4 at Engineering Node and transition</li> </ul>	<ul style="list-style-type: none"> <li>• PDS4 beta info model, standards reference, data dictionary, schemas baseline</li> <li>• Release of Harvest, Registry, Report and Security services</li> <li>• Validation and catalog ingest tools</li> <li>• Updated documentation</li> </ul>	Sept 2011 Feb 2012 June 2012
Build 3 V1.0 of PDS Data Standards for LADEE/ MAVEN	<ul style="list-style-type: none"> <li>• Transition entire PDS3 catalog to PDS4</li> <li>• Baseline PDS4 standards as version 1.0</li> <li>• Support validation of PDS4 bundles</li> <li>• Support ingestion and PDS4 data into the PDS4 registry</li> <li>• Support search and access to PDS3 data sets and PDS4 bundles</li> <li>• Support LADEE/MAVEN data ingestion</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Stable release of data standards</b></li> <li>• Incremental releases of validation and PD3 catalog ingest tools</li> <li>• Incremental releases of harvest, registry, report and security services</li> <li>• Deployment of Registry Services at EN</li> <li>• Deployment of the PDS4 search service at EN</li> </ul>	Sept 2012 March 2013
Build 4 User Services	<ul style="list-style-type: none"> <li>• Support PDS4 data distribution services for LADEE, MAVEN</li> <li>• Support PDS4 data transformation</li> <li>• PDS4 user tools</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Incremental release of PDS4 Standards</b></li> <li>• Distribution services for initial PDS4 bundles</li> <li>• Transformation services for initial PDS4 bundles</li> </ul>	Sept 2013 March 2014

PDS4 ORR LAD bundles MAVEN





## Build 3b Deliverables\*

- Software System
  - Registry Service
  - Harvest Tool
  - Validate Tool \*
  - Security Service
  - Report Service
  - Search Service
  - Catalog Ingest Tool
  - Upgraded portal search and page views to support PDS4
- Data Standards\*
  - Information Model
  - XML Schemas
  - Data Dictionary
  - Concepts Document
  - Standards Reference
  - Data Providers Handbook
  - PDS4 Example Products

\* Posted to <http://pds.nasa.gov/pds4>





# Build 3b Screenshot



The screenshot shows the PDS Engineering Node website. At the top left is the NASA logo and the text "NATIONAL AERONAUTICS AND SPACE ADMINISTRATION". To the right are links for "+ NASA Homepage", "+ NASA en Español", and "+ Contact NASA". A search bar is labeled "Search the Engineering Node:". Below this is a banner image of planets and spacecraft with the text "Planetary Data System Engineering Node". A navigation bar contains "Home", "Standards", "Tools", "Contact Us", and "Feedback". The main content area has a left sidebar with a tree view under "PDS4" including "Architecture", "Build 1a Deliverables", "Build 1b Deliverables", "Build 1b Assessment", "Build 1c Deliverables", "Build 1c Review", "Build 1d Deliverables", "Build 1d Review", "Build 2a Deliverables", "Build 2a Product Prototype", "Build 2a ORR", "Build 2b Node Test", "Build 2b Deliverables", "Build 2c Node Test", "Build 2c Deliverables", "Build 3a Deliverables", "Build 3b Deliverables", "Design", "Development", "Standards", and "Study". The main content area is titled "PDS4: Build 3b Deliverables" and contains the following text and sections:

This page lists and provides links to the deliverables for PDS4 Build 3b release (3/31/2013). The Build 3b deliverables consist of the PDS4 documents and the PDS4 system software distribution (including documentation).

**Build 3b Documents, Schemas and Examples**

- [Schemas](#)
- [Documents/Examples](#)

**Build 3b Software**

System software release 3.1.0 represents the software portion of the Build 3b delivery. A high-level description of this release can be found in the corresponding [Release Description Document \(RDD\)](#). Each software package includes documentation covering the installation and operation of the software.

**Testing**

**Information Model**

- [EN \(Ron Joyner\) - Bundle](#)

**Software**

- [Test Plan \(.pdf\)](#)
- [Test Procedures \(.pdf\)](#)

**Requests for Action (RFAs)**

- [Build 3a RFAs \(.pdf\)](#)

At the bottom of the sidebar is a link for "Working Groups".



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<http://pds-engineering.jpl.nasa.gov/index.cfm?pid=145&cid=187>



# Key PDS4 Components for LADEE/MAVEN



- Software System
- Registry Service
- Harvest Tool
- Validate Tool \*
- Search Service
- PDS Portal
- Data Standards\*
- Information Model
- XML Schemas
- Data Dictionary
- Concepts Document
- Standards Reference
- Data Providers Handbook
- PDS4 Example Products

\* Posted to <http://pds.nasa.gov/pds4>





# Build Testing

- Test plans provide regression testing for each build
  - Test cases traced to requirements
  - Example data product types are used as input
- Engineering performs regression tests using example bundles and data products
  - Validate functional requirements L3 – L5
- Engineering generates a test report
- For build 3b, the PDS MC voted to accept the data standards/IM as V1.0 to support LADEE/MAVEN
- For build 3b, PPI and ATMOS have participated to validate MAVEN and LADEE needs
- Testing and results will be discussed tomorrow



# Deployed Capabilities for Key PDS Functional Areas



- Design and Generate PDS4 Products
  - COTS tools tested and in use to support PDS4 Schema development ([build 2](#))
  - DN tools for generating PDS4 products developed at multiple nodes ([build 2](#))
  - Information Model V1 released ([build 3b](#)); CCB established.
- Validation
  - Validate tool developed for PDS4 label validation ([build 2](#))
- Harvest/Registration
  - PDS3 central catalog migrated to registry ([build 3a](#))
  - CI tool in place to register PDS3 catalog data (done, e.g., MSL) in a PDS4 registry ([build 3a](#))
  - Harvest in place to register PDS4 bundles and resources in PDS4 registry ([build 3a](#))
  - Registration of PDS4 web resources ([build 3a](#))
  - Registration of PDS4 bundles ([build 3b](#))
- Search/Access
  - Deployment of the PDS4 search service at EN ([build 3a](#))
  - Generation of a PDS4 search index for PDS3 data ([build 3a](#))
  - High level search of PDS3 data sets, PDS4 bundles, web resources, IPDA ([build 3b](#))
- Distribution/user tools ([build 4](#))
  - Deploy build 4a (V1.1 of standards) for LADEE/MAVEN production use (build 4a)
  - Support product level search for LADEE/MAVEN (build 4a)
  - Begin planning support for O-Rex and Insight (build 4b)



## Transition from PDS3 to PDS4



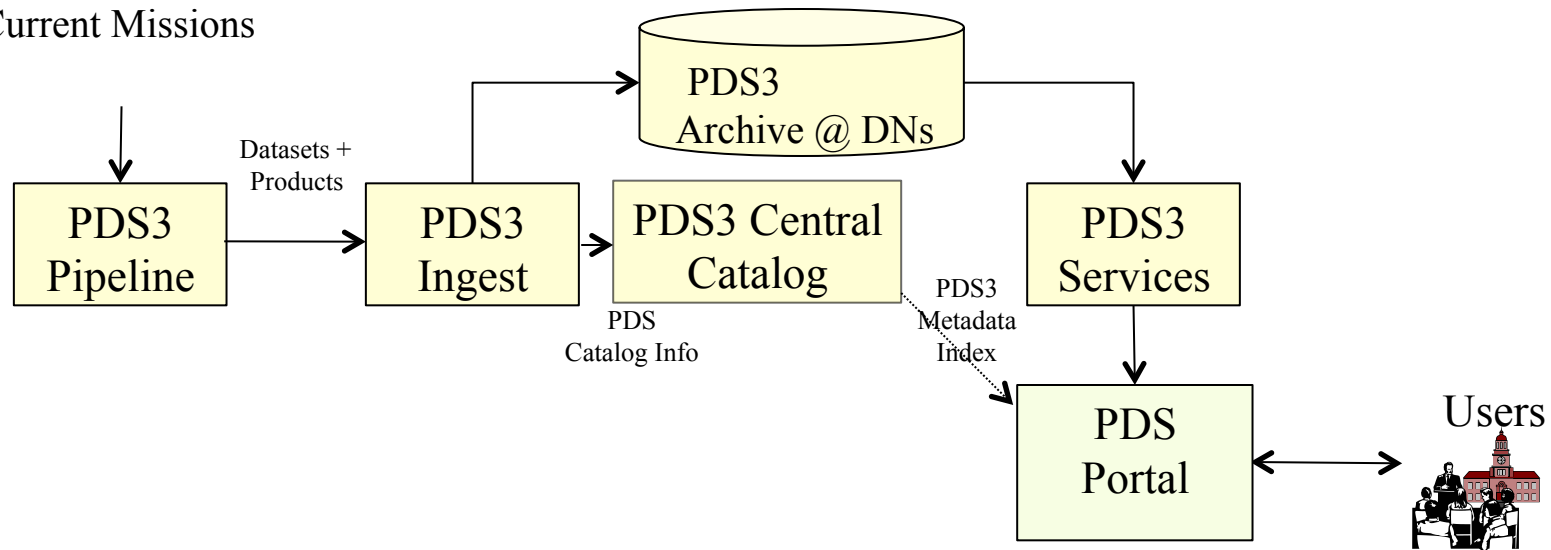
- PDS designed PDS4 to be able to access both PDS3 and PDS4 archives through a single system given that
  - PDS is required to continue to support PDS3 data deliveries from active missions (e.g., Cassini, MSL, etc)
  - Discipline Node adoption to PDS4 will occur independently
  - Desire to support a single, operational system
- The architecture of PDS4 has allowed the Engineering Node to do this by enabling “registration” of PDS3 and PDS4 data
  - PDS3 catalog information explicitly included in the model as a PDS4 product type
  - To date, the PDS3 “catalog” information has been registered as PDS4 products supporting search/access to the distributed PDS3 archives
- This will be discussed in detail tomorrow



# PDS3 Implementation



Current Missions

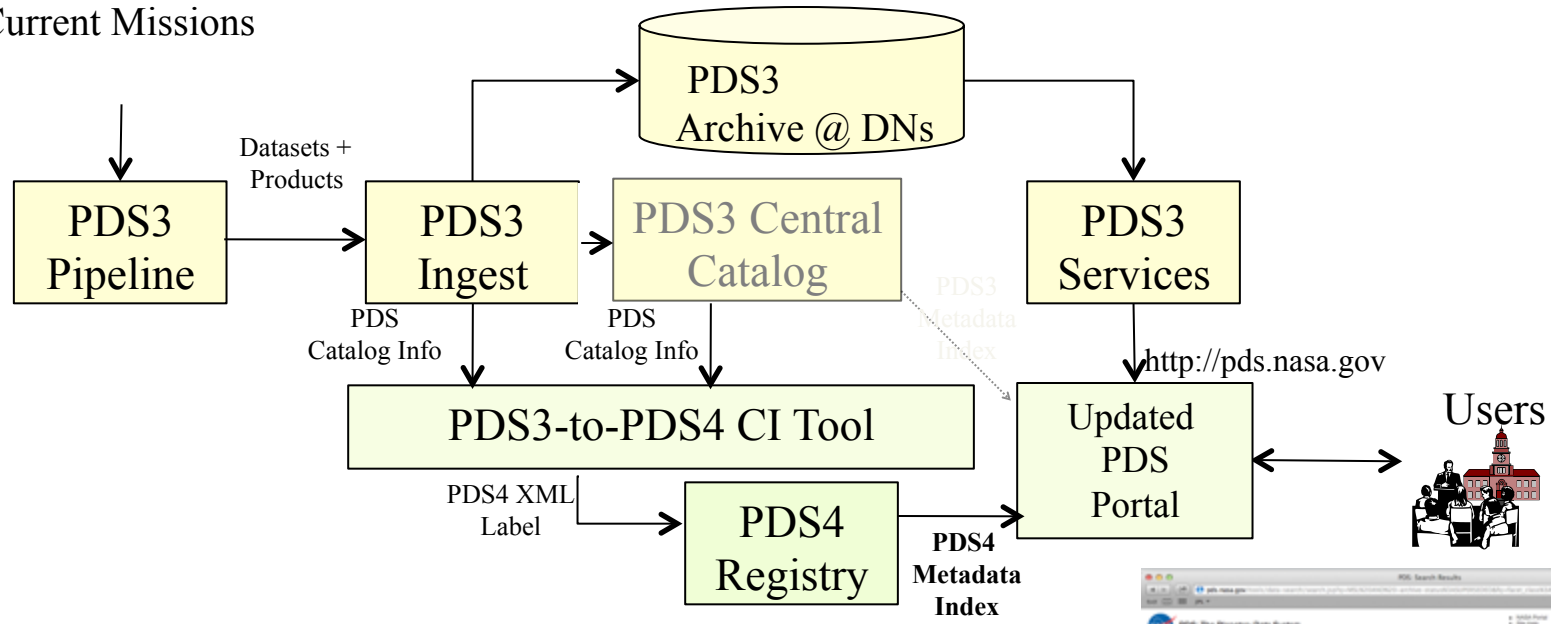




# Today



## Current Missions



(1) PDS4 infrastructure deployed at EN; Central catalog migrated. (done)

PDS4 ORR LADEE AND MAVEN

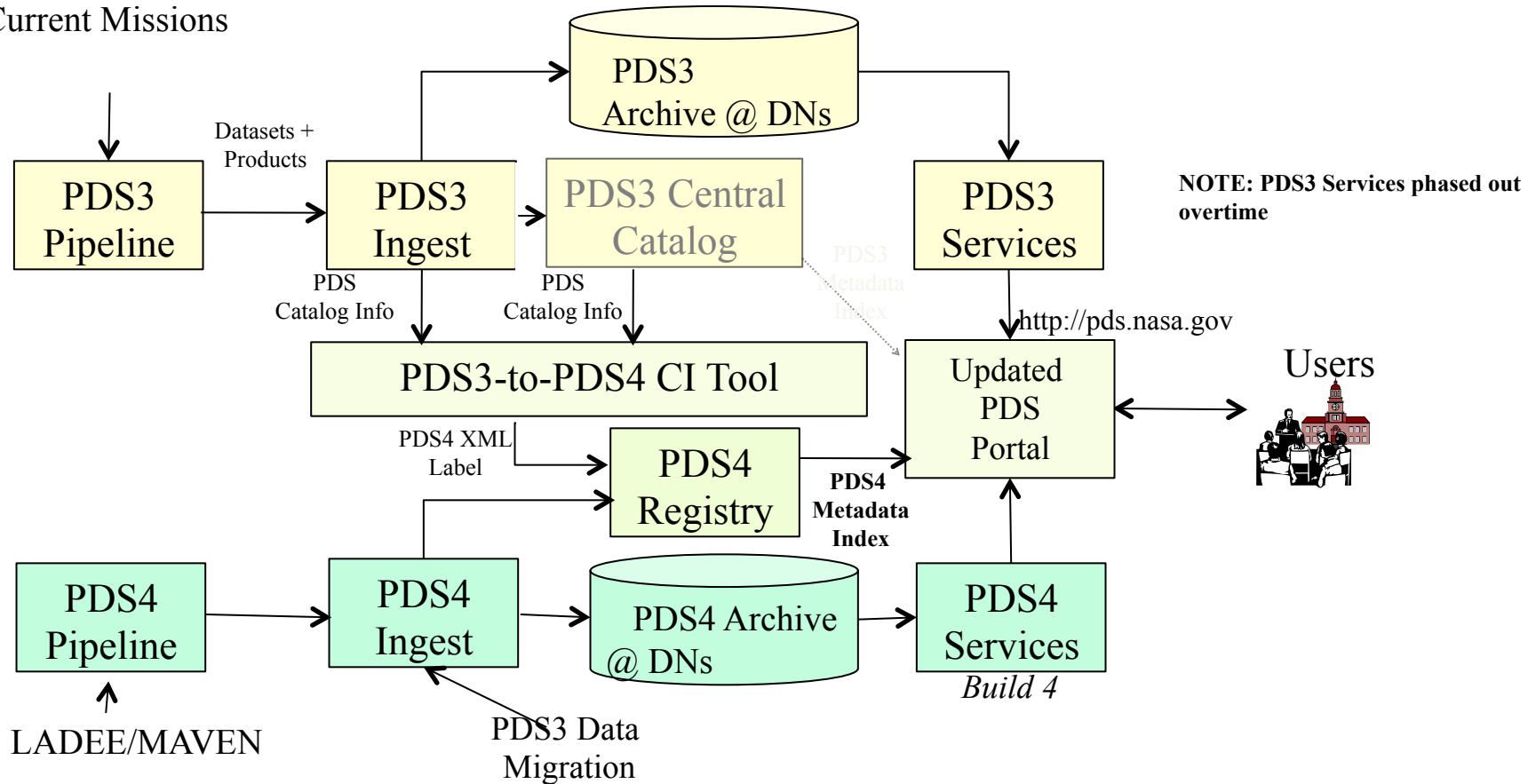
MSL data registered in PDS4 system @ EN



# Planned Support for LADEE/MAVEN



Current Missions



- (1) PDS4 infrastructure deployed at EN; Central catalog migrated. (done)
- (2) Working towards acceptance of LADEE/MAVEN PDS4 mission data

PDS4 ORR LADEE AND MAVEN







# Beta Testing

- PDS4 development has performed increasing levels of beta testing with users since build 1
- Latest beta test by Atmospheres included review of PDS4 labels, bundles and documentation

*Search Service Deployed for Build 3a  
Includes links to Archive Resources*

The screenshot shows a web browser window titled "PDS: Search Results" with the URL [pds.nasa.gov/tools/data-search/search.jsp?q=phoenix&in=all&words=phoenix&search\\_scope=tools%2Fdata-search%2Fsearch](http://pds.nasa.gov/tools/data-search/search.jsp?q=phoenix&in=all&words=phoenix&search_scope=tools%2Fdata-search%2Fsearch). The page header includes the NASA logo and "PDS: The Planetary Data System" with navigation links like HOME, ABOUT PDS, DATA, TOOLS & DOCUMENTS, RELATED SITES, CONTACT US, and CITING PDS DATA. A search bar on the right contains the text "Search for:" and "in PDS data".

The main content area is titled "Search Results" and shows "1-50 of 79 results (0.003 seconds)". It features several sections:

- Archive Information:** A section with a yellow background header.
- Resource: Phoenix Archive Information:** A section with a blue header and text describing the archive.
- Search Tools:** A section with a yellow background header and text describing search tools like "Phoenix Image Search" and "Phoenix Analyst's Notebook".
- Data Sets and Information:** A section with a yellow background header listing specific data sets such as "PHOENIX MARS ROBOTIC ARM 4 RDR DERIVED V1.0", "PHOENIX MARS ATMOSPHERIC STRUCTURE EXPERIMENT DATA V1.0", and "PHOENIX MARS ROBOTIC ARM CAMERA 5 XYZ OPS V1.0".

Jet Propulsion Laboratory  
California Institute of Technology



# PDS4 Archive Support Pages



- A new concept in PDS4 which allows websites to be registered, searched, accessed and used by novice users to get to archival data
- Cassini Archive Support page has been received well
- LADEE and MAVEN pages already developed and sent to teams to review
- Already deployed for Cassini

**Welcome to the Cassini Archive Page**

Phase	Duration	Progress	First Installer Delivered
PRIME	Mar 14, 2004 – July 1, 2008 S01 – S41	100% complete	
EQUINOX	July 1, 2008 – Oct. 11, 2010 S42 – S63	100% complete	
SOLSTICE	Oct. 11, 2010 – Sept. 15, 2017 S64 – S101		1 <sup>st</sup> installer delivered October 1, 2011

Cassini data are delivered to the PDS 9-12 months after acquisition and are delivered every three months. PDS must validate those data before they are considered certified. This may result in a delay between the time when Cassini delivers data and the time when PDS makes the data available. Alternately, PDS may choose to put data online while they are being validated, stating that they are not certified. PDS urges caution when using any data that have been released by the PDS for less than three months.

**Organization of The Cassini Mission.** The mission is divided into 4 phases: the Cruise Phase (including the *Jupiter Flyby* Dec 2000-Jan 2001), the Prime Mission (including the *Huygens Probe* Landing), the Equinox Mission and the Solstice Mission. Data from all phases are stored sequentially in the PDS. Tables and graphics associated with various aspects will help you scope the mission.





# LADEE and MAVEN Support



- Atmospheres and PPI Nodes will discuss their commitments, timeline, and support using PDS4 in later presentations.
- To date,
  - Nodes have worked directly with these missions to support use of PDS4
  - PDS4 label design began after build 2b with concurrence from the PDS MC in Winter 2011. Templates provided to the missions.
  - V1.0 in place with CCB to support LADEE and MAVEN deployment
    - A few change requests for MAVEN will be included in build 4a to allow conforming CDF files to be captured in PDS4 as an archival product.
    - Additional improvements in metadata to support better faceted search will be in V1.1
  - PDS4 product types to be used tested to support design, harvest, registration, and search/distribution.
  - LADEE and MAVEN archive pages developed.
  - Build 3b software infrastructure already deployed at Engineering, Atmos, and PPI. Used operationally at EN to support all PDS data.

PDS4 ORB LADEE AND MAVEN





# Schedule



- Build 4a delivery – September 30, 2013
- Build 4a testing – Sept 30, 2013 – Oct 31, 2013
- Build 4a release – October 31, 2013
- Deployment of build 4a to Atmospheres and PPI – November/December 2013
  - Upgrade registry software at nodes (as needed)
  - Production deployment of the search service
- LADEE Data Delivery & Distribution – March 2014
- LADEE Final Delivery – June 2014
- MAVEN Data Delivery & Distribution – April 2015
- MAVEN Deliveries every 3 month until EOM

*Build 4a will provide the baseline with V1.1 of the PDS4 model, however, additional capabilities can be provided in future builds as needed.*





## Risks Raised in ORR-1

- PDS3 Operations – ensure we can continue supporting PDS3 operations with little to no disruption (ORR-1)
  - The transition from a PDS3 infrastructure to a PDS4 infrastructure supporting PDS3 data has mitigated this risk.
- PDS4-Mission Exposure– using PDS4 for label design (ORR-1)
  - The limited release of PDS4 is allowing for it to be validated incrementally.
  - The delivery of templates to the missions has been an enormous help in lowering the learning curve and constraining the labels.
  - The LADEE and MAVEN experience has provided excellent input for future missions.



# ORR Risks for this Deployment



- PDS4 Formatted CDF Files for MAVEN –
  - Description: PDS is planning to accept a *PDS4 compliant* CDF file for archive. This was negotiated after build 3b and V1.0 and confirmed by the MAVEN mission for their ORR in August.
  - Risk: PDS has not accepted CDF types files into the archive since it is not an international standard.
  - Mitigation
    - PPI has developed a mapping from CDF to PDS4.
    - The PDS4 CCB has approved very minor changes to V1.0 to accommodate the approach. To be released in V1.1.
    - Should CDF present a problem, the data can be converted and archived as a PDS4 table structure.
  
- Changes to PDS4 Data Standards –
  - Description: Changes and Improvements to PDS4 Standards can impact missions if they are required to make changes.
  - Risk: Changes to PDS4 Standards that impact LADEE and/or MAVEN
  - Mitigation:
    - When selecting the first PDS4 missions, Atmos and PPI agreed to upgrading data products, if required.
    - The CCB is intended to ensure that stability is in place and to limit changes which affect LADEE and MAVEN.
    - With V1.0, the number and scope of changes has dropped drastically, but improvements will be made. PDS is testing an upgrade of summary/search metadata that is scheduled to be release for V1.1 which PPI and Atmos would like to adopt.



# ORR ToR/PDS4 Mapping

- Entrance Information\*
  - PDS4 Standards Documents (Standards Reference, Data Providers Handbook, Concepts Document)
  - PDS4 Examples
  - PDS4 Tool
  - Schemas
  - Schedule of deliveries and deployment

\* See <http://pds.nasa.gov/pds4/orr0913/index.cfm>



# ORR ToR/PDS4 Mapping



- Success Criteria
  - All major issues and/or liens/actions identified during the review have been resolved and/or plans established to resolve them.
    - We will work with the chair to ensure RFAs are addressed.
  - PDS4 documents are complete and usable.
    - The documents have continued to be aligned with each build and have gone through significant review inside and outside PDS. They have been developed in parallel as early support was provided to the missions.
  - PDS4 examples are validated and registered.
    - The test cases and results which show the validation of V1.0 data products, the harvesting of those products, and the registration, will be shown to the board.
  - PDS4 deliveries tested by lead nodes for LADEE and MAVEN.
    - Atmospheres and PPI have tested both simulated data products and software. Atmospheres has used migrated data from Phoenix. PPI has used data from MGS and ARTEMIS.
  - Core tools, both off the shelf and custom developed, are in place to support design and validation.
    - Teams have used Oxygen for designing labels. Templates have been delivered to LADEE and MAVEN. The Validate Tool provides validation support for V1.0 (and V1.1 with the build 4a release)







# Resources



- <http://pds.nasa.gov/pds4> (PDS4 site)
- <http://pds-engineering.jpl.nasa.gov/index.cfm?pid=145&cid=190> (CCB Information)
- <http://pds-engineering.jpl.nasa.gov/index.cfm?pid=145&cid=189> (key engineering information: project plan, requirements, architecture, design, reviews, links to builds, etc)

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**Project Management** \* Requirement \* Architecture \* Design \* Review \* Latest Build

This page provides a view of the PDS4 key engineering and design artifacts.

**Project Management**

- PDS4 Project Plan composes the overall plans for PDS4 implementation, documentation, review, test, transition, data migration, training and resources.
- Project Life Cycle details the PDS4 Project life cycle in support of LADRE and MAVEN.
- Operations Concept describes how the PDS4 data architecture and the PDS4 software system work across the PDS4 federation throughout the PDS Archive Lifecycle.
- PDS4 Project Schedule shows PDS4 implementation milestones. It is updated on a monthly basis.

**Requirement**

- PDS Level 1,2, 3 Requirements is the set of high-level requirements that define the characteristics and features of the federated PDS system.
- PDS4 Level 4 and 5 General System Requirements addresses the general software requirements for services, applications and tools within the PDS4 system. Detailed components L4 and L5 requirements are included in the Software Components' Requirements and Design Documents (see 'Design' section below).
- PDS4 Information Model Requirements defines the requirements for the fourth generation of the PDS Information Model.
- PDS4 Science Services Requirements summarizes services required to be supported by the PDS system in support of Planetary Science.
- Requirements Mapping traces how requirements are derived from PDS Level 3 to PDS4 Level 4 and 5.

**Architecture**

- PDS4 Architecture Specification conveys the system architecture for the PDS4 system in a manner that is understandable to the broad spectrum of PDS stakeholders but is intended for the designers and developers of the PDS4 system.

**Design**

The following provides the links to the Software Components' Requirements and Design Documents:

- Harvest Tool SRD/SDO
- Preparation Tools SRD/SDO
- Registry Service SRD/SDO
- Report Service SRD/SDO
- Search Service SRD/SDO
- Security Service SRD/SDO

**Review**

- PDS4 Operational Readiness Review is held on September 17-19, 2013 at the Goddard Space Flight Center (GSFC).
- System Review II Board Report is the Board Report as the result of the second PDS4 System Review held on June 21-22, 2011. Presentations of this review can be found at PDS4 System Review II meeting page.
- PDS4 System Review I Board Report is the Board Report as the result of the first PDS4 System Review held on March 22-24, 2010. Presentations of this review can be found at PDS4 System Review I meeting page.
- System Review II RFA Summary shows all the RFAs have been closed.
- System Review I RFA Summary shows all the RFAs have been closed.

**Latest Build**

PDS4 development follows an incremental and iterative approach. Since the project's inception, a number of system and data model Builds have been completed.

The latest PDS4 Build is Build 3b released on 3/31/2013. Its webpage lists and provides links to all the deliverables which consist of the latest released PDS4 documents, Schemas, software distribution and test documents.

PDS Management Atmospheres Geosciences Imaging NAIF PPI Rings Small Bodies Engineering

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