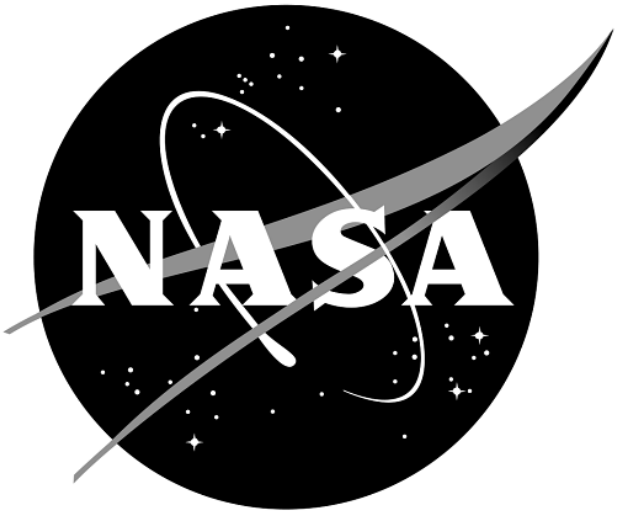
Plan Document

NASA Planetary Data System

PDS4 Project Plan



No index entries found.**Change Log**

Revision	Date	Description	Author
Initial	March 19, 2010	Initial release.	E.Law, S.Hardman, S.Hughes, D.Crichton
V 1.0	July 17, 2013	Renamed PDS2010 to PDS4, updated schedule	E.Law

Contents

1 Introduction

For over fifteen years, the Planetary Data System (PDS) has been NASA's official data system for archiving and distribution of data from planetary exploration missions. It has been a leader in defining data standards, working with missions and instrument teams, and developing data system technologies. The PDS has been instrumental in changing the scientific culture by working with the planetary science community to publicly release and peer review the data it captures. It has also been used as a model by other science data systems interested in establishing distributed scientific networks organized by independent discipline nodes at facilities that are doing leading-edge scientific research.

While PDS has been a leader in developing and exploiting new technologies and ideas, an increasing workload and substantial increases in the volume of delivered data are now threatening the system's ability to accomplish its primary missions of both archiving planetary science data and distributing it to working scientists. PDS identified these challenges in its Roadmap published in 2006. In addition to these challenges, the ten year Roadmap outlined several goals including improving the PDS data standards, increasing user services by leveraging newer technologies and technical standards, and re-architecting PDS to ensure efficient operations of the system while supporting the increasing demands on PDS by both the data providers and end users.

In response to these challenges and goals, PDS has developed a plan for the next generation called "PDS4". The vision for PDS4, as defined by the PDS Management Council at its April 2008 meeting, includes:

- Simplified, but rigorous, archiving standards that are consistent, easy to learn, and easy to use
- Adaptable tools for designing archives, preparing data, and delivering the results efficiently to PDS
- On-line services allowing users to access and transform data quickly from anywhere in the system
- A highly reliable, scalable computing infrastructure that protects the integrity of data, links the nodes into an integrated data system, and provides the best service to both data providers and users

1.1 Purpose

The purpose of this document is to provide an implementation plan for PDS4.

1.2 Scope

The scope of the PDS4 Project involves upgrades to the following areas:

1. Data Standards
2. Software tools to support archive preparation
3. Software services to support ingestion and distribution
4. Archive processes to improve efficiency end-to-end of PDS
5. Software applications for accessing PDS data

1.3 Document Revision

Revisions of this document will be held in the PDS Engineering Node website through the use of its document history functionality. Previous versions of this document can be accessed through the use of that tool.

1.4 Applicable Documents

1.4.1 Controlling Documents

[1] Planetary Data System Strategic Roadmap 2006 - 2016, February 2006.

[2] Planetary Data System Level 1, 2 and 3 Requirements, August 2006.

1.4.2 Referenced Documents

[3] PDS4 Project Executive Summary, July 2008.

2 Project Description

This project is a full implementation project. Phased rollout will occur to align capability with budget availability. PDS nodes will be funded using "overguide" to support design and implementation of PDS4.

2.1 Objectives and Background

The objectives of the PDS4 project are:

- Improve efficiency of archiving data with PDS
- Improve stability of the PDS archive and usability of data in the archive long term
- Improve access and usability of PDS overall

The current PDS implementation is based on a 20-year old implementation with augmentation to support online distribution. This effort modernizes PDS leveraging a modern, online, distributed services design.

2.2 Requirements and Constraints

The top-level requirements for the PDS project are defined by the PDS Level 1, 2 and 3 requirements that were signed off by the Management Council in August 2006 [2].

For more information on Requirements, please refer to section 7, Requirements Management Plan, in this document.

2.3 Dependencies

The PDS4 project depends on "overguide" funding from NASA Headquarters allocated to the PDS Nodes to support design and implementation of PDS4. It also relies on the PDS Management Council to set policies and science priorities.

2.4 Stakeholders

The PDS4 project, its deliverables and processes affect many different organizations involved with PDS. This section lists those groups, describes their roles, involvement and the impact that the project has on them.

2.4.1 Stakeholder Listing

Stakeholder Group	Role	Description
NASA Headquarters	Funding Organization	Provides executive sponsorship of PDS.
PDS Management Council	Oversight	The Management Council provides oversight of all PDS-wide activities.
PDS Program Manager	Management Oversight	The Program Manager is responsible for the day-to-day operations of PDS.
Chief Scientist	Science	The Chief Scientist is responsible for setting the direction of PDS and working with the Management Council.
Engineering Node Mgr	Engineering	The Engineering Node manager is responsible for overall engineering and technical operations of PDS.
PDS Technical Group	Technical Operations and Standards	The PDS Technical Group is responsible for participating in the development and management of the architecture and standards.
PDS Discipline Nodes	Discipline Node	The PDS Discipline Nodes are responsible for design, implementation and operations of their node including the services, IT, and science support.
Data Providers	Delivery	The data providers are responsible for delivery of PDS-compliant data products.
Data Consumers	Users	The data consumers access PDS systems using the archived data products.
International Data	International	International community developing interoperable planetary science

Archive Community	Archivists	archives

3 Implementation Plan

3.1 General

The project will progress following an iterative process of spiral development practices. The spiral consists of gathering requirements, planning, development, test (concurrently) and release. The iterative process is continuous, allowing for the incorporation of user enhancement requests and agile response to those requests. A series of major system build will be conducted to ensure coordination between the system and the data standards development. Incremental builds will be employed between major system builds.

3.2 Organizational Roles and Responsibilities

There are several key teams and roles in this project. The following table defines the project responsibilities and expectation for each role.

Role	Responsibility
PDS4 Project Management	Responsible for overall design and implementation of the PDS4 project
Software Systems Team	Responsible for design and implementation of the system
Data Standards /Architecture Team	Responsible for design and implementation of the data standards
System Integration Team	Responsible for deployment of the system and services

In addition, two working groups will be used during implementation as follows:

Data Design Working Group (DDWG): Will be responsible for working with the Data Standards/Architecture Lead to develop the overall design. In particular, members will be drawn from across PDS nodes to support the design and development of data standards. These members should possess a deep understanding of the PDS3 data standards, existing and planned data products and represent the science needs of the PDS Discipline Nodes.

System Design Working Group (SDWG): Will be responsible for supporting development of the high level design for PDS4. The working group will also support review of the critical interfaces and service specifications. Members will be drawn from the PDS software community and should possess a deep understanding of modern practices and standards in use in the distributed systems and science data systems communities.

Furthermore, the PDS Management Council (PDS MC) is comprised of node managers across the PDS nodes. As such, it provides the governance for PDS as a whole. The PDS Management Council will ultimately be responsible for the portfolio, selection and schedule of projects. The PDS4 Project Manager will coordinate, track and report on the status of projects to the Management Council.

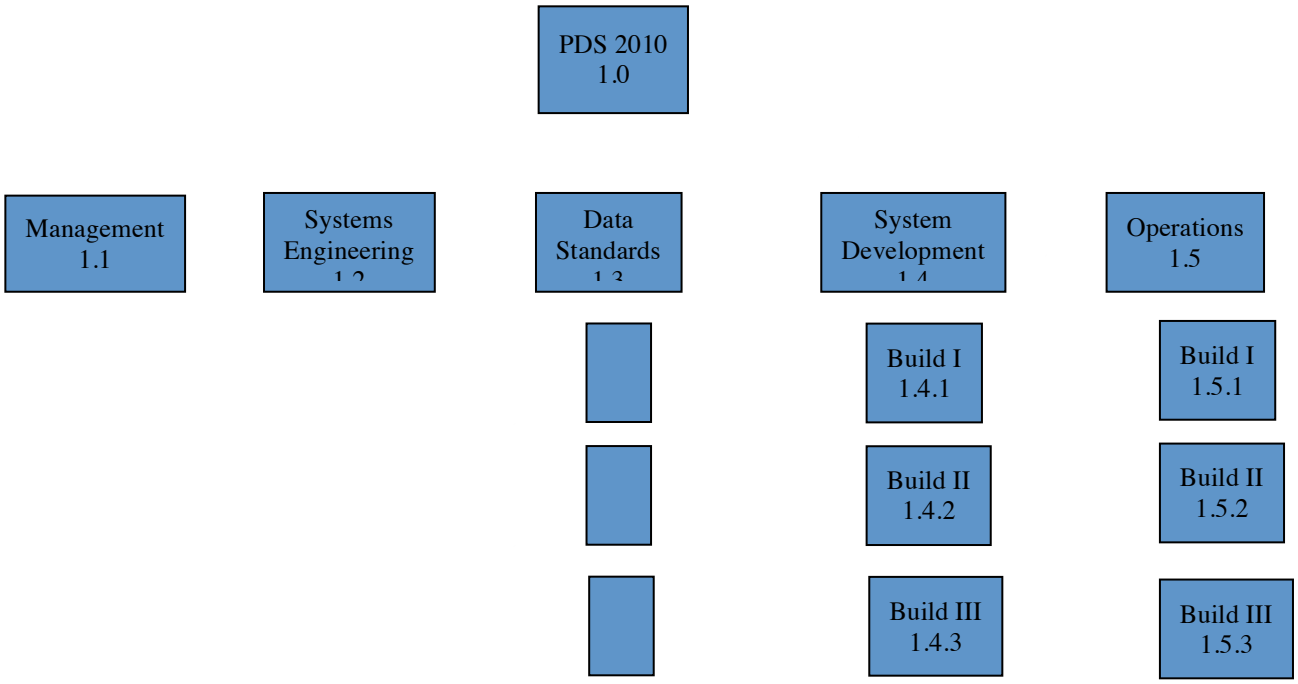
3.3 Deliverables

The following table details the deliverables that are expected at the end of the project as well as during its execution. A brief description of each deliverable is given and the quality objective that the deliverable fulfills.

Deliverable	Description	Quality Objective
Status for Program Management and Management Council	Monthly status reports will be provided for Program Management	To ensure that project priorities and progress are on track
Review for Technical Staff and External Board	System and data architecture and design technical reviews	To ensure that PDS4 architecture and design are sound and meet requirements
PDS4 Specification	PDS4 Architecture, Information Model Specification, Schema, Data Dictionary, Standards Reference, Data Providers' Handbook	To ensure PDS4 architecture, data model, standards and user's guide are documented
System Specification	System Architecture, system service specifications	To ensure PDS4 system architecture and design are documented
Project Document	Project Plan and Test Plan	To guide project execution and control
System Releases and Reviews	Incremental Builds and Reviews	To ensure quality and timely deliveries

3.3.1 WBS Structure

The Work Breakdown Structure is as follows for the PDS4 project:



The data standards, system development and operations areas will be integrated through a series of "builds". The builds will ensure there is a coordinated testing and deployment of functionality coupled with upgrades of the standards. It is also the intention that there will be incremental builds between the major system builds.

3.3.2 WBS Dictionary

The following chart contains the descriptions of each WBS element:

WBS Number	WBS Element	Description
1.0	PDS4	This is the top-level task for the PDS4 project. It represents the project scope and structure.
1.1	Management	The project management leg of the WBS at level two collects the expenditures related to overhead activities for the life of the project. They include: ➢ Project Management ➢ Communication The project is being managed by a series of builds as the major deliverables. These builds are negotiated with the PDS management that consists of Headquarters, the PDS Program Office at GSFC, and the PDS Management Council. Regular reporting is conducted monthly via teleconferences.
1.2	System Engineering	System Engineering is responsible for requirements and definition of systems architecture including the software and data architecture components and the connections between them.
1.3	Data Standards	Data Standards is responsible for development of the core information model, discipline information models, data product definitions, data structures, data dictionary, and other data standards necessary to support the archiving and distribution requirements of the PDS.
1.4	System Development	System Develop is responsible for development of the core system including the services and tools to support ingest, data management and data distribution. NOTE: core system development does not

		encompass specific PDS discipline node development
1.5	Operations	Operations is responsible for on-going infrastructure support, integration and test, as well as deployment of hardware and software for the builds.

3.4 Facilities

PDS, as a distributed system, has facilities at each Discipline Node. These facilities include hardware, software and operations. PDS4 is expected to upgrade the facilities at each discipline node to support better integration of the federation.

3.5 Risk Assessment (Management)

Project risks will be continuously assessed. Once identified, they will be brought to the PDS MC for discussion. The Project Manager will work closely with the PDS MC to identify mitigation tasks. Risks will be monitored and controlled through the monthly status reports. Risks include those items that either affects the success of PDS4 or operations of the current "PDS 3.x" system.

3.6 Development and Verification Process

Both the software system and standards will require substantial effort to test and ensure that the system and standards meet the needs of the planetary science community. As such, each discipline will work to develop and ensure that the PDS 4.0 standard will meet the needs of the scientific community. This will occur by both prototyping existing products as well as projecting the needs for future scientific products.

The system software will undergo software testing by both the developers as well as testers at the Engineering and PDS Discipline Nodes. Methods of testing and test procedures will be documented in a project integration and test plan.

In addition, PDS 4.0 Standards and system software will be placed under a PDS established configuration management system.

3.7 Engineering Decision Process

During the implementation of the PDS4 project, there will be many instances when a decision needs to be made that will affect the future technical progress of the project. When an important strategic decision arises and needs to be made, the project manger will involve the PDS MC in the decision process.

4 Development Plan

The development plan for PDS4 started with a study phase that began in August 2007 and consisted of three working groups:

- Architecture
- Data Model
- User Support

Each working group produced a white paper, which fed into the development activities described below.

4.1 Data Development Plan

The development of the PDS data standards for PDS4 started with a white paper containing recommendations that was produced by the Data Model working group during the study phase of the project. Starting in January 2008, the project definition phase produced several documents including the requirements, a project plan, and implementation plan. A data architecture team was formed in July 2008, comprised of several PDS discipline node staff. This team formulated high-level data architecture, two straw-man information models, a compilation of PDS3 issues and problems, a development approach, and a data modeling response to the PDS4 requirements. The current implementation phase, started in January 2009, is focused on the implementation of the PDS4 Information Model, Data Dictionary, and supporting documents such as the PDS4 Standards Reference. The W3C XML standard has been adopted as the grammar for capturing the archive metadata.

Using an ontology modeling tool and existing information system standards such as the ISO/IEC 11179 Metadata Registry reference model, the information model and data dictionary have been designed to support PDS4 functional requirements. For example, PDS4 data products have been designed to be compliant with PDS4 registries and services. In addition, using a data driven methodology, modeling information is used to configure PDS4 services and tools.
The following synopsis identifies the key data architecture components currently being implemented.

Information Model

Fundamental Structures - Array, Table, Parsable Byte Stream, Encoded Byte Stream
Data Formats – Science extensions to fundamental structures, e.g., Image_Grayscale
Product Model - Product Image Grayscale
Context Model – e.g., Mission, Instrument
XML/Schema implementation of Product Model
Discipline Models – Both data formats and description models e.g., Camera_Model

Data Dictionary

Model – ISO/IEC 1179

Content – Definitions of Classes, Data Elements, and Permissible Value with assigned Stewards.

Documents
- PDS4 Standards Reference
- Data Dictionary Document
- Concept of Operations
- Data Providers Handbook
- Tutorial Material

Management Process

4.2 System Development Plan

Development of the PDS4 system started with the white paper produced by the Architecture working group during the project study phase that included identification of PDS drivers, identification of requirements, and the decomposition of the system into elements. In January 2008, the System Architecture working group was formed to define and capture the system architecture for PDS4 to be used as the basis for the guiding the PDS4 sub-projects. The result of this effort was the PDS4 System Architecture Specification document that captured the process, data, application and technology architectures for the system as well as defining the architectural drivers, architectural principles and stakeholders.

The current implementation phase started in January 2009, with the formation of the System Design working group. This group will define the software system architecture and implementation of the core services that will support ingestion, data management, and distribution of PDS products. The components (services and tools) are defined in the System Architecture Specification document. The engineering process for each component shall be as follows:

- Prepare a brief white paper identifying the state-of-the-art for such a component and whether there are COTS or open source options available.
- Identify use cases and/or requirements for the component.
- Prepare a design for implementing the component from scratch or for integrating a COTS or open source solution. The use cases, requirements and design will be captured in a Software Requirements and Design Document (SRD/SDD) for the component.
- Implement and/or integrate the component according to the design.
- Prepare installation and operation guides for the component.
- Perform unit and integrated testing against the requirements.
- Prepare release documentation and deploy the component to the target environment.

5 Documentation Plan

The documentation that is associated with the PDS4 project will be held in the PDS Engineering Node website through the use of its document history functionality. The PDS Engineering Node website will be used to support the configuration management, sharing and archival of documents.

5.1 PDS4 Project Document

The following PDS4 project documentation will be created, maintained and posted on the PDS Engineering website:

- PDS4 Project Plan
- PDS4 Operations Concept
- PDS4 Integration and Test Plan

5.2 PDS 4.0 Documentation

The following PDS 4.0 documentation will be created, maintained and posted on the PDS Engineering website:

- PDS4 Specification
- PDS4 Schemas
- PDS4 Standard Reference
- PDS4 Data Dictionary
- Data Providers' Handbook

5.3 System Documentation

The following PDS4 System documentation will be created, maintained and posted on the PDS Engineering website:

- System Architecture Specification
- Service Requirements
- Service Software Requirements and Design, for the following:

    - Dictionary, Harvest, Ingest, Monitor, Order, Security, Subscription, Registry (Inventory, Document and Service), Report, Search and Transport
- System Installation Guide
- System Operation Guide
- System Release Document

5.4 Documentation Release

The updated documentation will be released in conjunction with the release of the software.

5.5 Project Quality Records

Project quality records include the following types of artifacts:

- Review Presentations
- Test Reports

These artifacts will be stored on the PDS Engineering website.

Issues List will be held in an established PDS JIRA system located at:

http://oodt.jpl.nasa.gov/jira/secure/Dashboard.jspa

6 Review Plan

6.1 Monthly Management Review

A monthly report will be provided to the PDS Program and NASA Headquarters Management. The progress and risks of the project will be presented to the PDS MC on the monthly MC teleconference and at each MC face-to-face meeting. In addition, status will be reported to the PDS Program Manager and Chief Scientist on regular monthly Engineering Node teleconferences.

6.2 Technical Review

Peer and external technical reviews will be held throughout the project life cycle to ensure that data (model and product) and system architecture and design are sound and meet the PDS requirements and missions' needs, as well as to demonstrate the effectiveness of the project in meeting its goals and vision. These include Preliminary System and Data Meeting, PDS4 Product Design and Prototyping (which includes science community input) Review, System IT Reviews, Tools and System Services Reviews. They will be organized by DDWG, SDWG and by the Project and will be conducted via teleconferences, face-to-face technical staff meetings, and external review meetings. Artifacts of these reviews will be posted on the PDS Engineering website.

6.3 Release Review (Operation Readiness Review)

Prior to release of a PDS4 build, a review will be held with the major stakeholders to ensure that it will meet the needs it was intended for. During this review, subjects such as new capabilities, issue resolution, and integration test compliance will be covered.

7 Procurement Plan

The procurements for the project are covered by PDS in-guide activities under existing PDS task plans. As a result, there is not a need for a formal procurement plan for the PDS4 project.

8 Requirements Management Plan

The project will drive its activities and deliverables according to the requirements that have been expressed to it from the stakeholders.

The project will follow the established PDS Requirements Process which is posted on the PDS Engineering website at the following location:

http://pds-engineering.jpl.nasa.gov/system_eng/requirements-process-20070329-v2.pdf

9 Configuration Management Plan

PDS Configuration Management (CM) process will be utilized by the PDS4 project. It will be followed as laid out and maintained by the System Integration Team who will act as the configuration management process engineer. Any process issues that arise concerning how to approach the use of the CM system, Subversion (the configuration management software tool) or the release process will be deferred to Build and Release Manager's expertise with the approval of the Project Manager.

10 Quality Assurance Plan

PDS4 Integration and Test Plan with procedures will be utilized by the PDS4 project. The System Integration Team will coordinate the testing while defining the scope and depth of testing as confirmed by the Project Manager.

10.1 Quality Control Activities

Program management and the PDS MC will review the project and its deliverables as the project progresses.

Stakeholders will also review the progress of the project as it progresses and provide direction to ensure that deliverables are meeting their needs.

10.2 Product Quality Assurance

In addition to all of the system testing activities that are described in this document, other activities will be performed to keep the quality of the product high.

10.2.1 DDWG Product Prototypes

Product prototypes are derived from the PDS4 information model and are validated starting with their initial design through to data product creation and registration.

The generic product model was formally designed by the DDWG using an ontology modeling tool. This tool enforces a data modeling discipline and maintains the consistency of the data product model. The model is subsequently used to create generic product XML schemas. Both the model and the generated schema are under configuration management and registered in the system registry.

The design of a product label for a specific product starts by deriving a specific XML schema from a generic XML schema. The design process is performed using either a commercial XML editor or a PDS4 design tool. These tools both validate the XML schemas and checks then for being well-formed. Once the specific XML schema is defined, the tool is used to generate a sample XML label. One or more copies of the sample are populated using the tool and validated against the specific label schema.

Archive collections, consisting of data products, software, documentation, and calibration information have also been designed in the PDS4 information model. In a manner similar to data products an archive collection specific schema will be derived from a generic schema and used to generate, populate and validate XML labels for the archive collection.

As an archive collection is prepared for the PDS, the specific XML schema for all data products in the collection will be included as part of the archive. These schemas may be used for validating the data products in the future and as additional information resources for archive users.

10.2.2 Mission Infusion

A mission data provider desiring to design and implement software that is capable of auto-generating volumes of data products works with the PDS to define a PDS compliant data product using the approach mentioned in 10.2.1. The data provider then writes software that will auto-generate XML data product labels for each data product in the data set. The label generation software can either validate each auto-generated data product label as the label is being produced. Or, the data product labels can be validated after the fact. In either case, every data product label will be validated against the set of specific XML schemas to ensure PDS compliance.

Similar to the method the PDS uses to maintain its model and schemas, a mission can either work with the PDS to add mission specific schema to the PDS's authorized schema registry or choose to implement its own. The PDS generic schema allows for the import of external XML schema.

11 Test Plan (System Verification)

This section describes the testing processes that are put into practice for the PDS4 project. It also includes activities that are performed for the verification of the functionality and capabilities that are delivered. The PDS4 build structure is organized such that the system (software, data standards) can be tested and verified early on and to ensure that transition will be seamless.

11.1 Verification Testing

Verification Testing is the execution and management of tests by the System Integration Team to ensure that a release of the PDS4 build meets the intended functionality. The process of verification testing includes the selection of verification items, unit testing, integration testing and beta testing.

11.1.1 Verification Items

Any functionality that is added to the system is treated as a new verification item. However, code is not the only type of verification item. Verification items also include documentation and the test code associated. They are as follows:

- Software (operational and test code) in Configuration Management
- The documentation associated with the build

11.1.2 Unit Testing

The objective of Unit testing is to isolate each part of the application and show that the individual components function correctly. It is the responsibility of the PDS4 developers to document the unit test procedures, perform unit testing, and to record the unit test results. Unit Tests will be:

1. Developed to exercise the interface and functionality of a single component.
2. Exercised by the developers at build time.
3. Allow developers to spot immediate detection of coding anomalies.
4. Can be included with the source code providing a good source of documentation and enabling on-site testing.

11.1.3 Integration Testing

The objective of Integration Testing is to catch a class of errors that cannot be found by Unit Testing (i.e., errors which relate to the interaction / aggregation of different program components). Integration Testing assures that external and internal interfaces function as

designed; the aggregates of components perform accurately together; and the system performance is satisfactory. Integration Testing starts after the successful completion of Unit Testing. Integration testing will be performed by the PDS4 Integration and Test team and will be limited to testing of system functionality using PDS4 test cases.

The PDS4 test cases will be developed by the System Integration Team and will be documented in the PDS4 Integration and Test Plan. Where feasible, test suites will be automated and will consist of cross-platform tests against PDS4-supported platforms. Problems found are reported in the PDS Issue database (JIRA) and are documented as part of the test report.

11.1.4 Beta Testing

The objective of the Beta Testing Phase is to involve the end-user in an informal audit of the PDS4 system. Following successful completion of Integration Testing, a Beta version of the system along with user's documentation will be made available to customers and stakeholders for "local" testing.

12 Deployment, Transition and Data Migration Plan

12.1 Definition

Deployment is the process of making new PDS4 system and PDS4 standards available for use.

Transition is transition to a PDS4 system to support ingestion and distribution of PDS3 and PDS4 data.

Data Migration is the process of migrating existing data in the archive from PDS3 to PDS4.

12.2 Strategy

Due to current PDS being an operational system, the strategy is to employ multiple opportunities to deploy and transition from current PDS to PDS4, namely, multi-phased.

The deployment phases will follow closely by development phases planned and mapped to components decomposed from the PDS4 system architecture. Thus, those phases will align with the system releases.

System transition planning started with an effort of tradeoffs and impacts analysis. We will focus on completion of initial PDS4 Standard (v4.0). We will work new mission startups to define PDS4 products for future deliveries (e.g., 2012 and beyond). We will also work with International Planetary Data Alliance (IPDA) for adoption of the core when tools, infrastructure and standards in place. Validation of PDS4 will occur during first 2 phases. Version 4.0 data standards will be baselined with the first build of the system. This provides a standard to support development of PDS4 products for new mission startups. It will also support and validate PDS4 system development. This approach is to allow for phased transition to PDS4 over time. We will make sure that existing PDS3 pipelines will remain supported during life of mission. We will support ingestion and distribution of PDS4 data when ready. Missions and IPDA partners can transition when they want to. Every effort is made to ensure the new system will serve data from PDS3 and PDS4 repositories.

PDS data migration from PDS3 to PDS4 must also be taken into account. Migration planning also started with an effort of tradeoffs and impacts analysis. This migration entails on-going planning of what existing PDS3 data and when they best be migrated to PDS4, as well as staging when to accept PDS4 data from what missions. In addition, a well-defined data migration process will be established to support the migration of exiting PDS3 data to PDS4. The actual data migration tasks are expected to be phased and on-demand (as needed basis), executed by the Nodes and funded via the Nodes' POP proposals.

Decommission of aged system components/capabilities occur only after new ones are in place and proven ready. Contingency plan will be in place to handle worst-case failure scenario.

Complete deployment is planned in 2011 to accept PDS4 data. The acceptance of PDS4 data from new missions will be carefully staged.

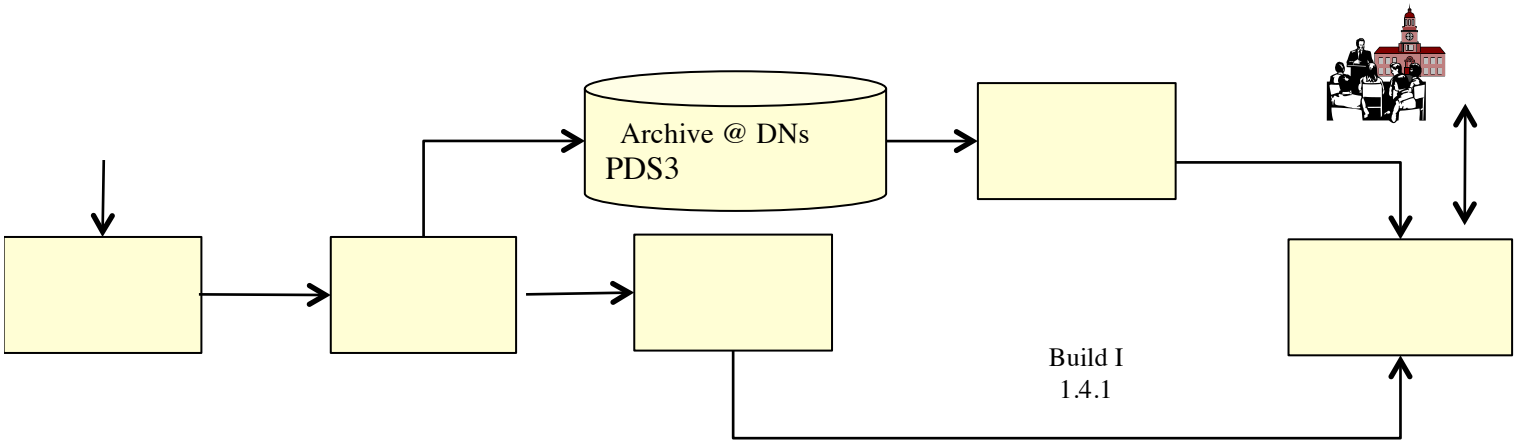
Adequate support will be in place for each phase.

12.3 System Transition

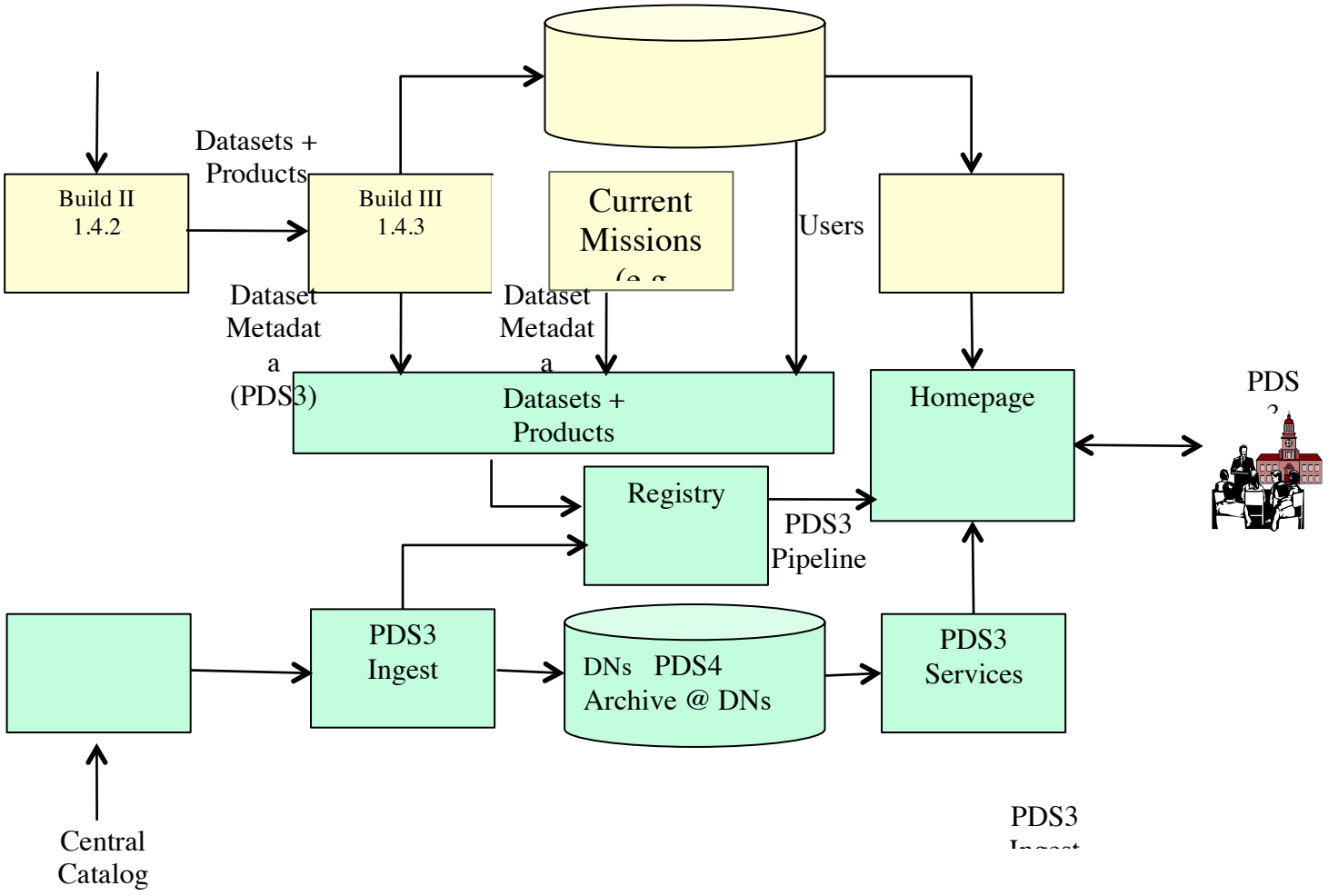
As part of the PDS4 system transition, PDS Central Catalog will be replaced with a registry system that will support BOTH PDS3 and PDS4 data collection and product registration. Tools will be provided to support PDS3 and PDS4 standards. Central PDS homepage will link to both PDS3 and PDS4 resources, as they are available.

It is expected that PDS3 resources will decrease and PDS4 will increase overtime. Each node will execute their own transition timeline in term of providing new PDS4 services. Overall plan is that existing PDS3 services will remain while new PDS4 services will be added.

It is utmost important that existing PDS3 pipelines will be supported as we transition to new system and beyond. The following depicts current PDS3 support in place today:



The following depicts transition to PDS4 support (PDS3 can be phased out overtime):



12.3.1 Transition Tradeoffs

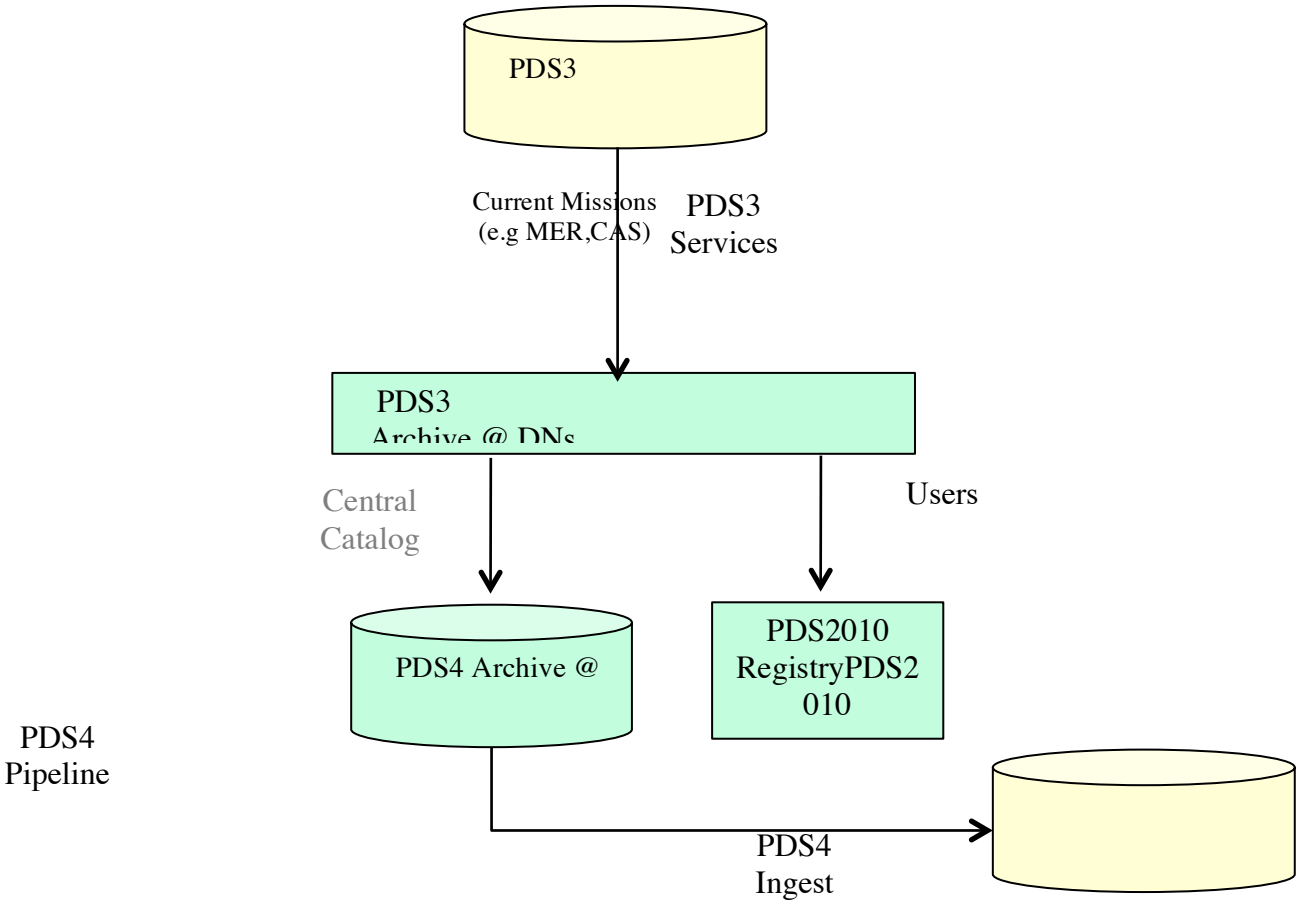
	Resources	**Training**	**Usability**	**Efficiency**
Big Bang	Resources will be fixed, however, the schedule can scale which can delay the release of PDS4	Not a major transition issues	If all services are in place first, then this will increase usability. However, deployment of PDS4 could be delayed longer affecting the ability to put PDS4 model in place	Less efficient of the two approaches since it delays rolling out PDS4
Incremental	Resources and the timeline can be scaled with PDS budget (whether overguide is provided or not)	Not a major transition issues	Critical capabilities are put in place earlier, but the trade off is number of functional capabilities that must be supported prior to ingestion/distribution	More efficiency of the two approaches since it allows for delivery of increasing capability and the MC can then determine functional capabilities required in order to accept and distribute PDS4 data

12.3.2 Transition Impacts on Stakeholders

	Data Providers	Data Users	Discipline Nodes	Engineering Node
Big Bang	Capabilities and services are delayed, however, greater functionality would be in place when they begin to deliver PDS4 data	Data users would get data in PDS4 format later, but could potentially have more tool support	Larger impact on the nodes if all nodes need to put services and capabilities in place first	Larger impact on the Engineering Node to put services and tools in place and ensure PDS-wide readiness to accept data for all new missions in PDS4 at once
Incremental	Capabilities can be put in place earlier and begin flow of PDS4 data and support	Data users would get data in PDS4 format earlier, but would possibly have less tool support	Less impact on the nodes if data is accepted in stages	Less impact on the Engineering Node and improved project performance since results can be realized earlier and PDS can deploy services and train over time

12.4 Data Migration

Migration of PDS3 data to PDS4 will occur on demand, on an as needed basis. Operational system will continue to support legacy pipeline to accept PDS3 data, allow users to access PDS3 data, and provide science services for PDS3 data. The schedule for migration will exist within the Discipline Nodes and funding will be provided via the PDS POP process. The following depicts the migration concept:



A Data Migration Process will be established to facilitate the migration. Depending on the level of complicity, data will be converted by one or more of the following methods:

1. Convert PDS3 label to PDS4 label and register the PDS4 label in the PDS4 registry without changing the data object of the product
2. Convert PDS3 label to PDS4 label and register the PDS4 label in the PDS4 registry plus convert the PDS3 data object to PDS4 data object

Migrated data will be sent to the National Space Science Data Center (NSSDC) for deep archive.

12.4.1 Migration Decision Criteria

	Resources	Training	Usability	Efficiency
No Migration	No impact on resources to convert data, however, PDS software will need to support PDS3 and PDS4	Users will need to be capable of working with PDS3 and PDS4 data	Limited support for working with PDS3 data in the future	Most cost-effective solution
On Demand Migration	Impact on conversion of a subset of critical data sets; PDS software will need to support PDS3 and PDS4	Users will need to be capable of working with PDS3 and PDS4 data	Limited support for working with PDS3 data in the future; critical data sets will be converted to PDS4 to improve usability	More costly than "No Migration", however, improves usability following a pragmatic approach
Full Migration	Substantial impact in converting data, redelivering to NSSDC, and developing supporting software	Users will ultimately need to only be familiar with PDS4	Usability would be improved since PDS data will be brought up to date	Substantial costs in migrating all data

12.4.2 Migration Impacts

	Data Providers	Data Users	Discipline Nodes	Engineering Node
No Migration	No impact	Users will need to be familiar with PDS3 and PDS4 data formats	Nodes will need to continue to provide support for PDS3 data	Engineering Node must continue to provide software support for PD and PDS4
On Demand Migration	No impact	Users will need to be familiar with PDS3 and PDS4 data formats. However, critical data sets can be migrated to enhance usability.	Nodes will need to continue to provide limited support for PDS3 data; minor impact in migrating critical data sets	Engineering Node must continue to provide software support for PD and PDS4
Full Migration	No impact	Data users will need to eventually only learn PDS4	Substantial impact in migrating and redelivering all data to PDS4	PDS3 tools and services can be retired once migration is complete

12.5 Releases

The PDS4 project will progress in releases. Included in the scope of releases will be release documentation and training. Release phasing is detailed in the following table:

Phase	Purpose	Release	Date
Build 1 Prototype	• Early formalization of the data standards • Early formalization of software • Integration between software and data standards • Stakeholder input	• PDS4 beta info model, standards reference, data dictionary, schemas baseline • Early releases of Harvest, Registry and Security services • First set of process, documentation and tutorial	October 2010
Build 2 Early Release to Select Data Providers	• Support LADEE, MAVEN and Early Migration Planning • Begin deployment of PDS4 at Engineering Node and transition • Stakeholder input, particularly from LADEE and MAVEN	• PDS4 beta info model, standards reference, data dictionary, schemas baseline • Production release of Harvest, Registry, Report and Security services • Validation and catalog ingest tools • Updated documentation	March 2012 (build 2b)
Build 3 V1.0 of PDS Data Standards	• Transition entire PDS3 catalog to PDS4 • Baseline PDS4 standards as version 1.0 • Support validation of PDS4 bundles • Support ingestion and PDS4 data into the PDS4 registry • Support search and access to PDS3 data sets and PDS4 bundles • Ensure LADEE/MAVEN can move on	• **Stable release of data standards** • Incremental releases of validation and PD3 catalog ingest tools • Incremental releases of harvest, registry, report and security services • Deployment of the PDS4 search service at EN	October (build 3a) March 2013 (build 3b)

Build 4 User Services	• Support PDS4 data distribution services for LADEE, MAVAEN • Support PDS4 data transformation • PDS4 user tools	• **Incremental release of PDS4 Standards** • Distribution services for initial PDS4 bundles • Transformation services for initial PDS4 bundles	September 2013/March 2014

Schedule and user training will be included in Project Schedule maintained by the Project Manager. Release will be preceded by approval of the PDS MC.

12.6 Phase I

During Phase I, the following Prototype Software will be deployed at the EN:

- PDS Ingest subsystem (Harvest, Registry (Inventory, Document, Dictionary services), Report and Security services
- Tools suite (Label design and validation, Label and Schema generation)
- Internal administrative portal

The following Prototype Software will be deployed at one or two Discipline Nodes:

- Registry, Harvest services, and Report client

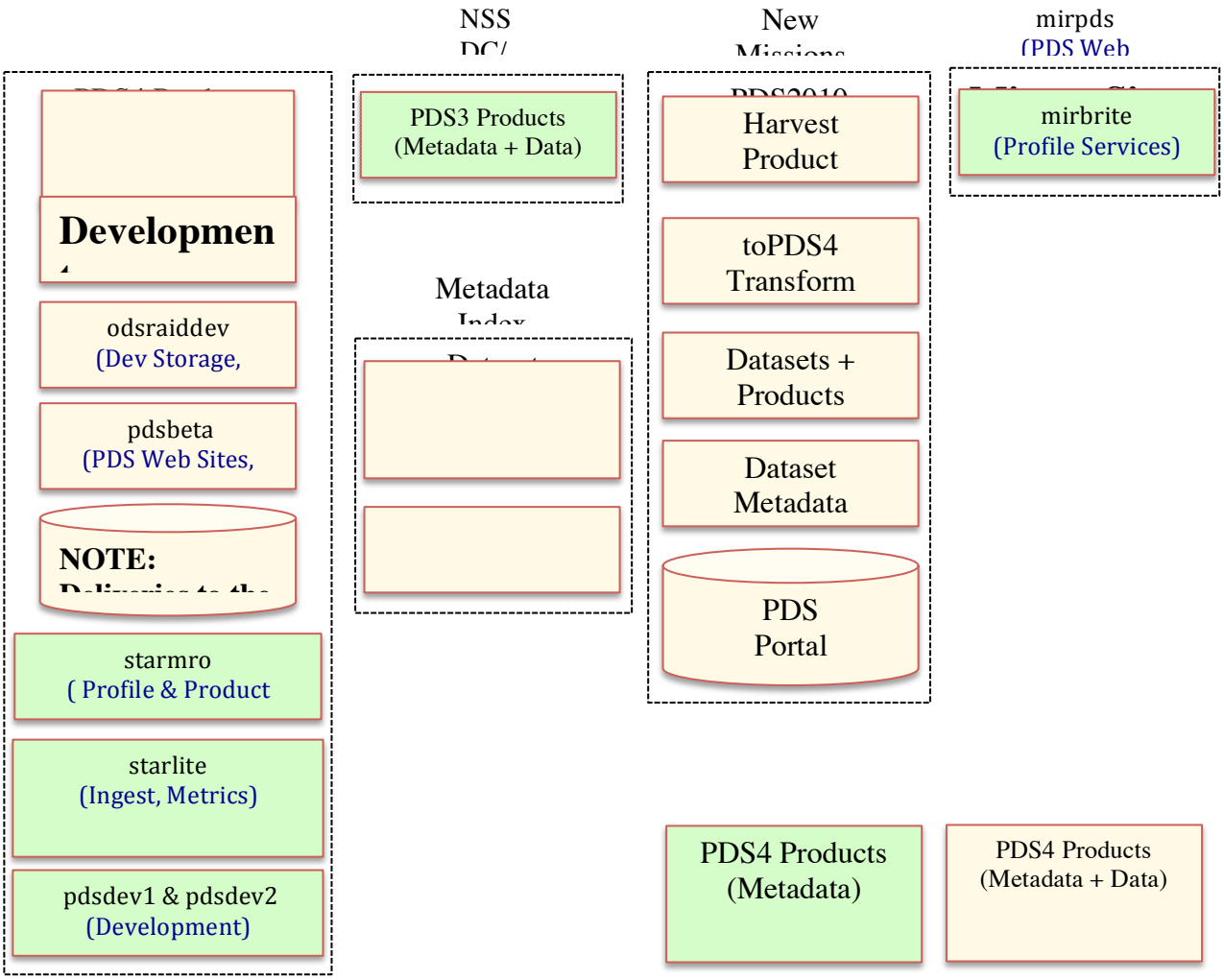
Detailed prototype release description document will be generated to facilitate and to detail the deployment activities.

In addition, we will release a baseline version of PDS4 Model Specification, Standards Reference, Data Dictionary, Schemas, Data Provider's Handbook, as well as Tutorials.

Testing will be performed per Phase I test plan. Test resource will include EN developer to support unit testing, and Integration Team (which consists of EN and Node staff) to perform integration testing. Phase I Test Report will be generated upon completion.

12.6.1 Hardware

The following diagram depicts the hardware deployment plan for Phase I:



12.6.2 Activities

The following summarizes the of list of Phase I tasks:

Engineering Node to do list:

- Install Ingest subsystem, tool suite and admin portal
- Make baseline PDS4 specification, Standards Reference, Data Dictionary, Schemas, documentations and training material available to Nodes
- Continue to support PDS3 pipeline
- Work with Nodes to perform catalog migration
- Provide training to node staff and data providers

Discipline Node(s) to do list:

- Continue to support PDS3 pipeline
- Install Registry, Harvest and Report clients
- Support testing
- Support catalog migration
- Help provide training to data providers

12.7 Phase II

During Phase II, the following initial Operational Software will be deployed at the EN:

- Initial PDS4 System with Search and Distribution, Monitor services in addition to Ingest subsystem
- Tool suite with additional Product Validation Tool
- Revised web site

The following Operational Software will be deployed at all Discipline Nodes:

- Registry, Harvest, Search services, Report Client
- DN Integration with PDS4 System

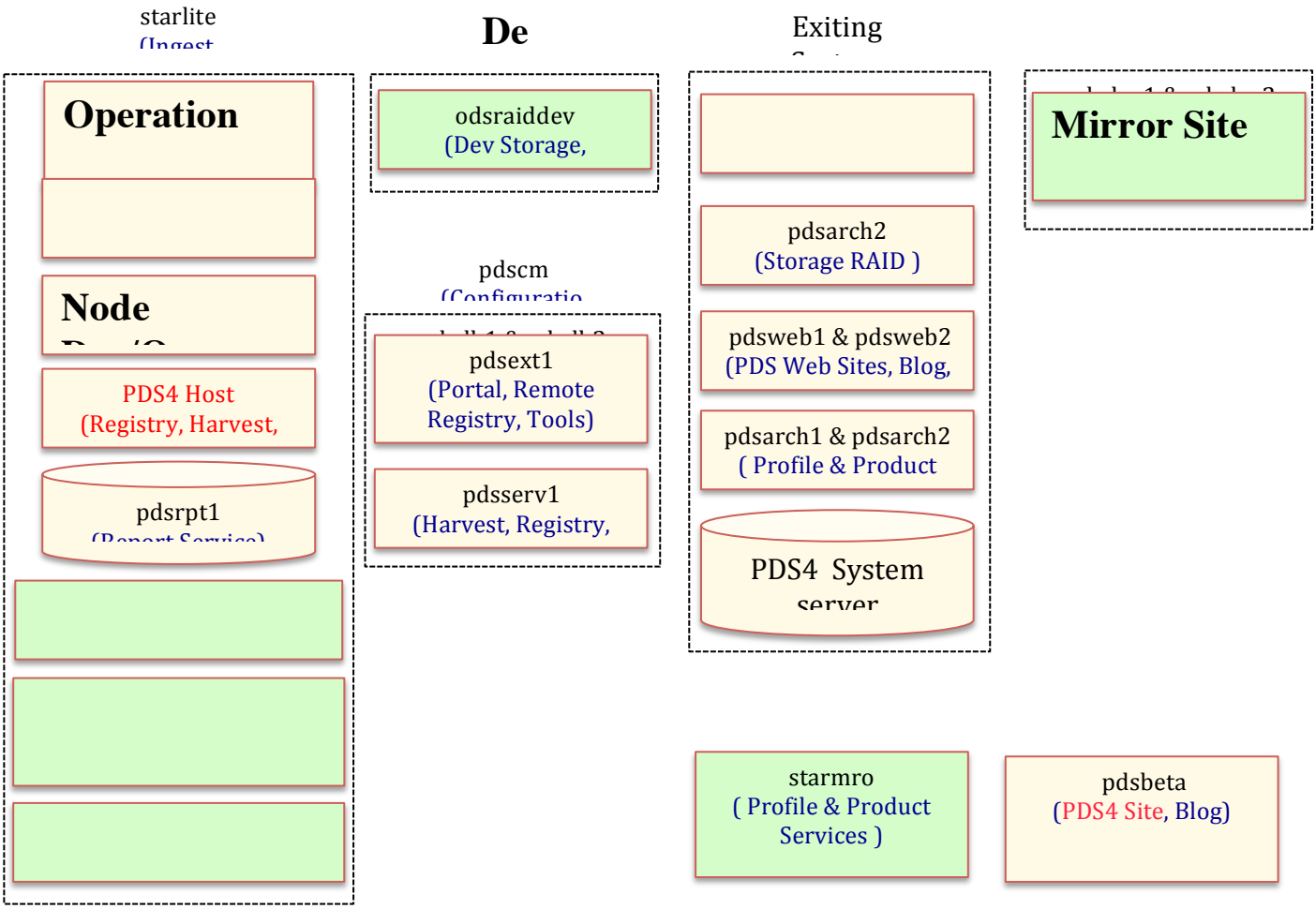
Detailed operational release description document will be generated to facilitate and to detail the deployment activities.

In addition, we will release the first version of PDS4 Model Specification, Standards Reference, Data Dictionary, Schemas, Data Provider's Handbook, as well as Tutorials.

Testing will be performed per Phase II test plan. Test resource will include EN developer to support unit testing, and Integration Team (which consists of EN and Node staff) to perform integration testing. In addition, we will select and recruit Node staff and Data Providers to perform beta testing. Phase II Test Report will be generated upon completion.

12.7.1 Hardware

The following diagram depicts the hardware deployment plan for Phase II:



12.7.2 Activities

The following summarizes the list of Phase II tasks:

Engineering Node to do list:

- Operational installation and support of PDS4 system, tool suite, revised web site
- Release PDS4 specification, Standards Reference, Data Dictionary, Schemas, documentations and training material available to Nodes
- Continue to support PDS3 pipeline
- Continue to provide training to node staff and data providers

Discipline Nodes to do list:

- Continue to support PDS3 pipeline
- Operational installation and integration of new system
- Support testing

- Help provide training to data providers and Science Community

12.8 Phase III

During Phase III, the following Operational Software will be deployed at the EN:

- 2nd release of PDS4 System with additional Order and Subscription service and science services
- New portal with content management capabilities

The following Operational Software will be deployed at all Discipline Nodes:

- Science Services
- DN Integration with PDS4 System

A new Mirror Site will be deployed at the University of Maryland to replace the old Mirror Site.

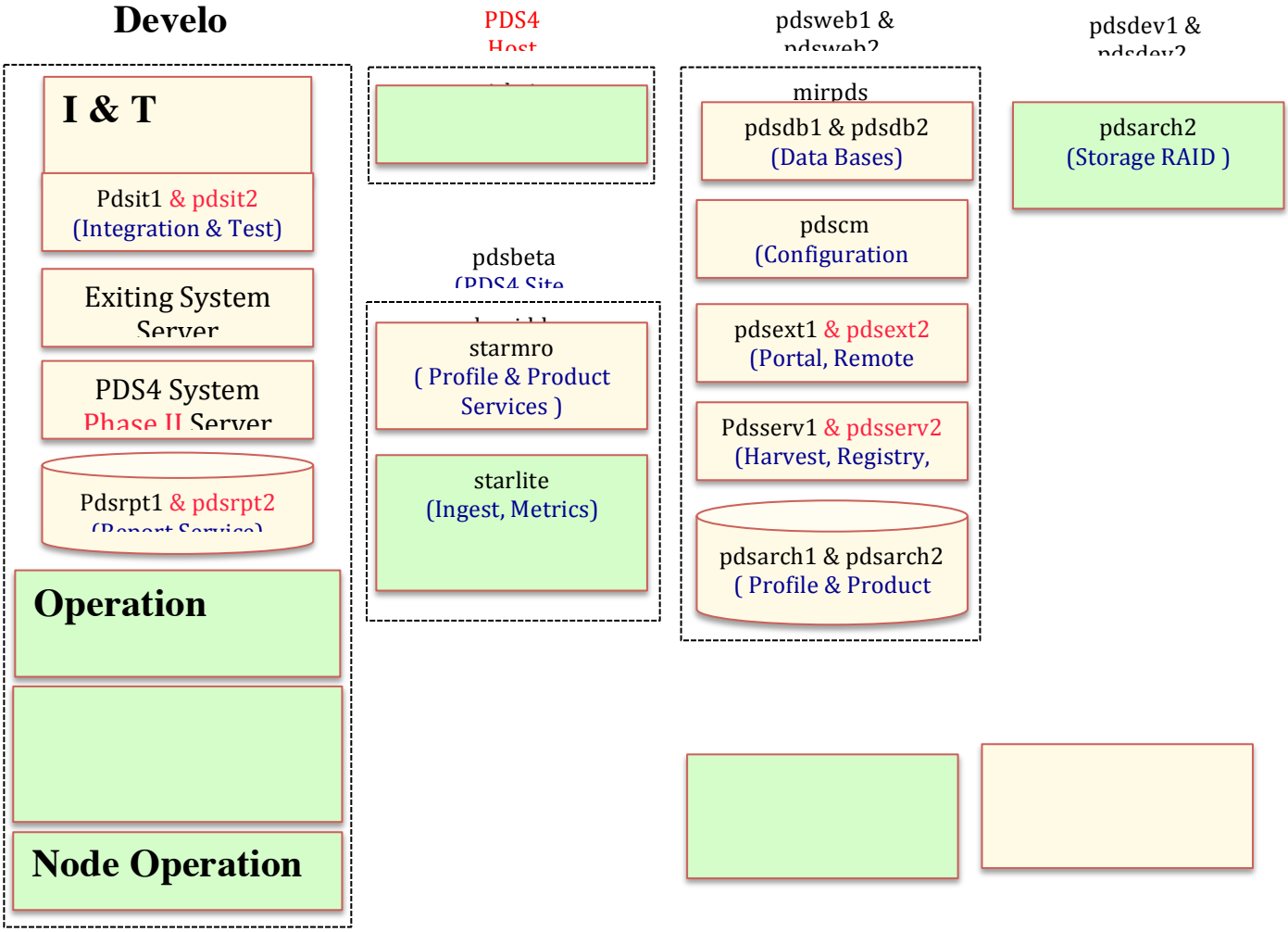
Detailed operational release description document will be generated to facilitate and to detail the deployment activities.

We will also release an updated version of PDS4 Model Specification, Standards Reference, Data Dictionary, Schemas, Data Provider's Handbook, as well as Tutorials if needed.

Testing will be performed per Phase III test plan. Test resource will include EN and DN developers to support unit testing, and Integration Team (which consists of EN and Node staff) to perform integration testing. In addition, we will select and recruit Data Providers and users to perform beta testing. Phase III Test Report will be generated upon completion.

12.8.1 Hardware

The following diagram depicts the hardware deployment plan for Phase III:



12.8.2 Activities

The following summarizes the list of Phase III tasks:

Engineering Node to do list:

- Operational installation and support of PDS4 mirror system, 2nd release of PDS4 system, tool suite, new web site and science services
- Release revision of PDS4 specification, Standards Reference, Data Dictionary, Schemas, documentations and training material available to Nodes
- Continue to support PDS3 pipeline
- Continue to provide training to node staff and data providers
- Retire old system components no longer needed

Discipline Nodes to do list:

- Continue to support PDS3 pipeline
- Operational installation and support science services
- Support testing
- Continue to provide training to data providers and Science Community

12.9 Maintenance

System maintenance will consist of active monitoring of the system. Anomalies will be captured, prioritized. Bug fixes and enhancements will be scheduled with either PDS4 build releases incrementally. All bug reports and enhancement requests will be gathered using the PDS JIRA issue tracking system. Spare hardware will be available to support system maintenance as needed.

PDS4 maintenance will be supported by the PDS Standards Working Group composed of PDS Node technical staff. The Standards Change Approval Process that describes the process for development, review and approval of changes to the PDS3 and PDS4 will be followed.

13 Training Plan

Training is a key part of the PDS4 project to ensure that data providers learn how best to generate PDS 4.0 products, the PDS node staff learn how best to use the PDS tools and work with the PDS4 system, and that the science community learns how best to use the PDS4 system. Training will be created to demonstrate the features of PDS 4.0 and the functionality of the PDS4 system.

13.1 Data Providers Training

Documentation for both instrument proposers as well as already funded data providers will be provided. Material for instrument proposers will assist them in understanding the basic responsibilities involved in delivering data to the PDS and in estimating the costs involved. More detailed documentation for data providers will be provided in the form of a Data Providers' Handbook, which will be available on the PDS website. This handbook serves as a step-by-step guide for data provides to prepare PDS4 compliant data.

Assistance with more complex issues is always available from data engineers at the PDS engineering and discipline nodes. Additionally, the PDS Data Dictionary and the Standards Reference are available to all data providers on the PDS website with considerable detail on all aspects of data archiving.

Formal training materials for training instrument team members during the early phases of mission development will be developed and available both online and for in-person training by PDS node staff.

13.2 Node Staff Training

Informal training sessions will be scheduled over the project development phase to familiarize the node staff of PDS4 as well as the PDS4 system. This training will be facilitated by PDS personnel involved in the development of the standards and software tools for PDS4. This training will utilize a "hands on" approach that encourages PDS personnel to work through various sample products and develop PDS compliant labels for them.

13.3 Science Community Training

Informal one-on-one training of members of the science community will be available at the PDS booth at various planetary and astronomy conferences. Training will be carried out by PDS node staff. The focus of this conference-based training is primarily to familiarize scientists with the website and how to find and download PDS archived products.

13.4 Training Website

All of the documentation mentioned in the above sections will be available on the PDS website.

14 Resource and Schedule

14.1 Funding

The PDS4 project will be funded by the NASA Headquarters as "over-guide" funds through the PDS task funding vehicles to the PDS Nodes as proposed in the POP. The resource allocation will be based on the POP with caveats that the "in-guide" repurposed to support the PDS4 project by the way of reprioritizing the key staff. Staffing support focuses on PDS data standards initially, then shifts to system development followed by testing and deployment.

Each PDS node operates with a guideline budget that covers node development and operations providing on-going support for PDS. The data migration of PDS3 to PDS4 will be funded out of the PDS operations budgets.

14.1.1 Staff Profile

The initial focus will be on supporting the DDWG tasks of PDS4 data model/standards design and development activities. The focus will shift to system and tools development in the later part of the project. A total of 2.2 FTE from the Discipline Nodes and 1.4 FTE from the Engineering Node have been supporting the PDS4 standards development through FY09. A 0.2 FTE per Node in support of burst activities is also anticipated. A total of 3 FTE from the Engineering Node and a total of 0.15 FTE from the Discipline Nodes have been supporting the system development effort during FY10.

For development in FY11 and FY12, we will continue with 3.0 FTE from the Engineering Node, 0.4 FTE per Node. One FTE from User Interface Design support (ARC) is also anticipated in GUI and tool development.

For operations, Engineering Node staff will be responsible for development of test plan, integration and test, overall configuration and build management and deployment. 0.4 FTE in FY10, 0.75 FTE in FY11 and FY12 are planned for these activities respective to the incremental builds and deployment. In addition, 0.1 FTE per Node is needed to support integration and test as well as deployment at the node.

For maintenance, a half Engineering Node staff is estimated to support system and data maintenance. In addition, a tenth of FTE per Discipline Node will be needed to support PDS3 maintenance.

14.2 Schedule

The PDS4 project manager is responsible for the project master schedule. The master schedule details the activities that are being performed to support the PDS4 project. It includes project management, system engineering, training activities as well as technical capability development. The master schedule will be updated monthly and posted at the PDS Engineering website at the http://pds-engineering.jpl.nasa.gov/index.cfm?pid=145

14.2.1 High Level Schedule

The PDS4 project high-level schedule is as follows:

1. Study Phase (August 2007 - March 2008)
2. Project Definition (January 2008 - July 2008)
3. High Level Architecture (July 2008 – January 2009)
    a. Include trade studies and transition planning
4. Development/Deployment (2009 –2014)
    a. Build 1 (October 2010)
    b. Build 2 (March 2012)
    c. Build 3 (October 2012 - March 2013)
    d. Build 4 (September 2013 – March 2014)

14.2.2 Key Review Schedule

Review	Working Group	Date
Preliminary PDS MC System and Data Review	SDWG/DDWG	August 2009

PDS4 Data Stds Internal Assessment/Science Requirements Vetting by Nodes/Managers	DDWG	November 2009
System Review, Ingestion Subsystem	SDWG/DDWG	March 2010
PDS4 Data Stds Prototype Reviews	DDWG	December 2009 – August 2010
PDS4 Data Stds Readiness Review	DDWG	September 2010
Distribution Subsystem Review	SDWG	March 2010

15 Appendix A: Acronyms

ARC – Ames Research Center
CM – Configuration Management
DDWG – Data Design Working Group
DN – PDS Discipline or Data Node
GUI – Graphical User Interface
EN – PDS Engineering Node
FTE – Full Time Employee
ISO/IEC – International Organization for Standardization / International Electro technical Commission
IPDA – International Planetary Data Alliance
NASA – National Aeronautics and Space Administration
NSSDC - National Space Science Data Center
PDS – Planetary Data System
PDS3 – Version 3.8 of the PDS Data Standards
PDS4 – Version 4.0 of the PDS Data Standards
PDS4 – PDS4 Project
PDS MC – PDS Management Council
SDD – Software Design Document
SRD – Software Requirements Document
SDWG – System Design Working Group
W3C – World Wide Web Consortium
XML – Extensible Markup Language