NASA PDS Support for Data Analysis Programs & Data Users

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U.S. Public Data Access

- ***President's Office of Science & Technology Policy***
  - Issued memo on February 22, 2013, signed by Director Holdren
    - https://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp_public_access_memo_2013.pdf
  - "Increasing Access to the Results of Federally Funded Scientific Research"
  - Directs federal funding agencies with an annual R&D budget >$100 million to develop a public data access plan for disseminating the results of their research
- ***NASA Plan***
  - A response was released by NASA on November 21, 2014
    - http://science.nasa.gov/media/medialibrary/2014/12/05/NASA_Plan_for_increasing_access_to_results_of_federally_funded_research.pdf
  - "NASA Plan: Increasing Access to the Results of Scientific Research"
  - Part A addresses **Digital Scientific Data**
  - Part B addresses **Publications**

U.S. Public Data Access (cont.)

- ***NASA Plan, Part A***
  - Affirm and enhance NASA's commitment to public access to scientific research results;
  - Ensure access to and reliable preservation of NASA-funded scholarly publications and digital data sets for research, development, commercialization, and education…;
  - Preserve and increase the use of scientific research results to enhance scientific discovery and application of research results;
  - Affirm NASA's commitment to its scientific integrity policy and support the reproducibility of scientific research results;
  - Ensure that all extramural researchers receiving NASA grants, cooperative agreements, and contracts for scientific research and intramural researchers develop data management plans … describing how they will provide for long-term preservation of, and access to, scientific data in digital format;
  - Optimize archival and dissemination of data and publications, including long-term stewardship;
  - Support training, education, and workforce development, related to scientific data management, analysis, storage, preservation, and stewardship;
  - Support governance of and best practices for managing public access to peer-reviewed scholarly publications and digital data across NASA.

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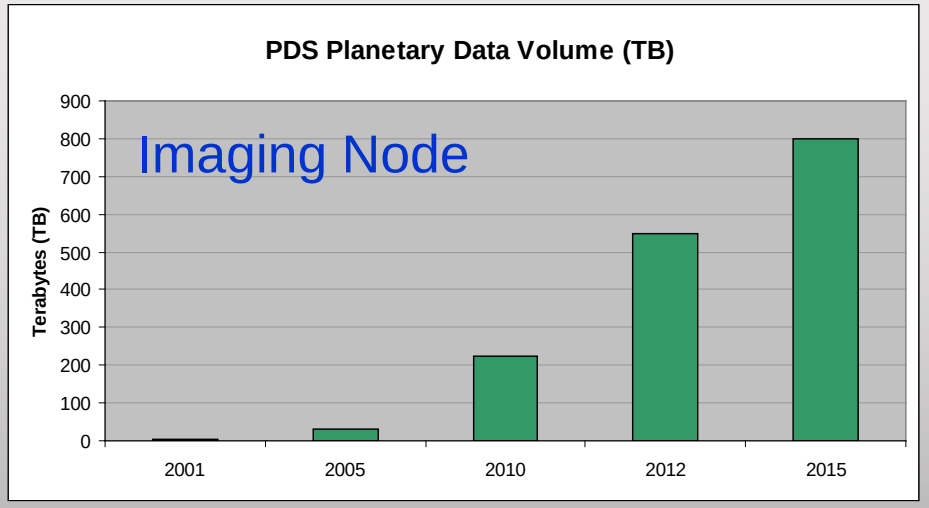
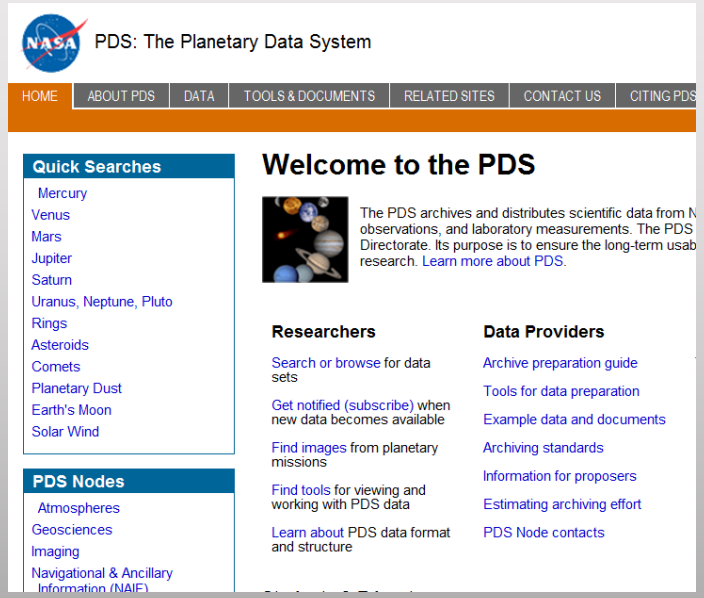
Planetary Data: Scope & Volume

- ***What are planetary data?***
  - Documents, hardcopy data, photographic negatives & prints
  - Digital data tables, arrays, images, profiles, measurements, etc.
- ***Sources***
  - Spacecraft missions, telescopic observations, research, laboratory analyses, etc.
- ***Volume***
  - Increased significantly in ~15 years
  - Approaching a petabyte
    - 1000 TB
    - 1 quadrillion bytes



High-density digital data storage arrays

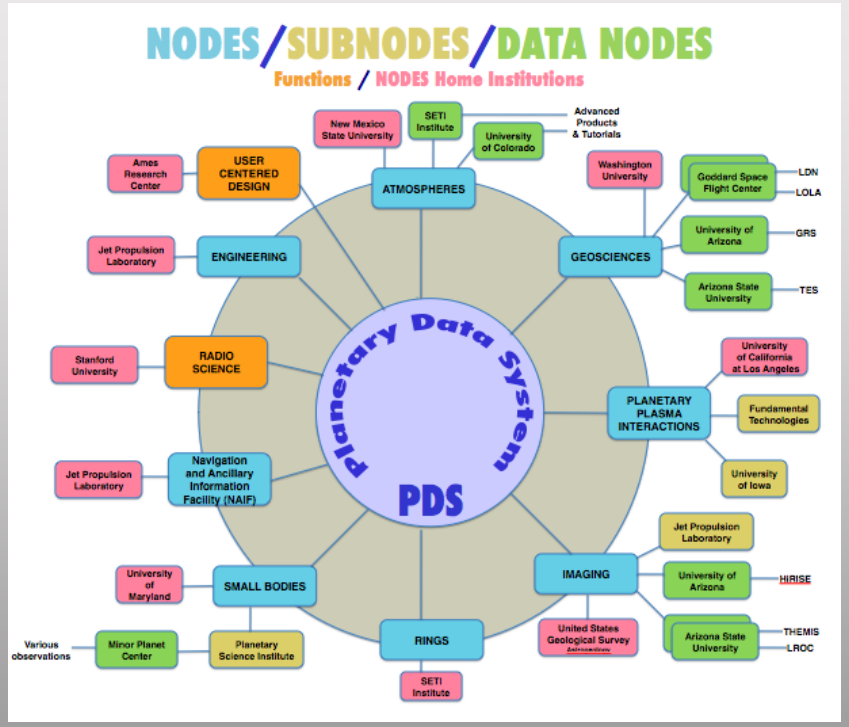
NASA Planetary Data System



http://pds.nasa.gov/

- In 1982, the US National Academy of Sciences chartered the Committee on Data Management and Computation (CODMAC)
  - Address concerns about how data were managed by NASA
  - No formal archives, unstable media, little documentation usable by any but mission teams
- CODMAC initial recommendations (1982)
  - Scientific involvement & oversight
  - Data availability with usable formats, ancillary data
  - Timely distribution, validated data, proposer documentation
  - Use of proper, stable storage media and facilities
  - Data storage in permanent and retrievable form
  - Structured, transportable, documented software
  - Adequate data system funding
- Planetary Data System (PDS) established in 1989
  - Purpose is to ensure the long-term usability of NASA data and to stimulate advanced research
  - Funded by NASA Science Mission Directorate

A Short History of PDS



http://pds.nasa.gov/

National Space Science Data Center (NSSDC) is the deep archive for PDS and NASA space mission archives

- **26 years later, PDS archives & serves data from all planetary bodies**
  - Planets, moons, atmospheres, rings, small bodies, fields & particles
  - 53 historic missions (mostly US, a few non-US), 31 currently active missions
  - Now working with next-generation archive system, PDS4
- **Organization**
  - 6 science discipline nodes, 4 sub-nodes
    - Atmospheres, Geosciences, Imaging, Planetary Plasma Interactions, Planetary Rings, Small Bodies
  - 2 overarching support nodes, 1 function
    - Engineering, Navigation & Ancillary Information Facility (NAIF), Radio Science
  - PDS Project Management
    - Solar System Exploration Data Services Office, Goddard Space Flight Center
- **Data Nodes**
  - 10 active data nodes

Planetary Data: PDS Delivery Services

- **Data Access**
  - PDS Home and central catalog provide access to all PDS data
  - All nodes provide search services and science expertise to help you find “the right data”
  - Support for current NASA proposal opportunities
- **Examples of PDS tools & services**
  - ***Imaging Node***
    - Photojournal, Planetary Image Atlas, Map-a-Planet, Planetary Image Locator Tool (PILOT), Data Portal
  - ***Geosciences Node***
    - Orbital Data Explorers (Mars, Mercury, Moon), Analyst’s Notebook (MER, Phoenix, LCROSS, Apollo), workshops, spectral libraries
  - ***Planetary Rings Node***
    - OPUS search tool, Planet Viewers, Moon Trackers, Ephemeris Generators
  - ***Small Bodies Node***
    - Data Ferret, Statistical Asteroid Model, Online Archiving Facility (OLAF)
  - Other Nodes point to one or more of these services to avoid duplication & simplify access

Web links listed at the end

Planetary Data: PDS Support Nodes & NASA Software Systems

- **Engineering Node**
  - Provides systems engineering support to the entire PDS
    - Standards, technology, system-wide software, data ordering and distribution, and PDS data catalog & distribution service
  - International Planetary Data Alliance (IPDA)
    - Supports archives from ESA, JAXA, ISRO, CNSA, etc.
- **Navigation & Ancillary Information Facility (NAIF)**
  - Navigation node, focus on SS geometry, SPICE
    - Information system for space geometry & event data
  - SPICE Toolkit & Tutorials
    - Large suite of software/subroutines to read SPICE data files and compute derived observation geometry (altitude, latitude/longitude, and lighting angle, etc.)
- **Software systems & environments, viewers**
  - *Cartography:* VICAR (JPL/MIPL), ISIS (USGS), Ames Stereo Pipeline (ARC)
  - *Viewing & Access:* LMMP Data Portal (JPL), ILIADS (GSFC)
  - *Mission Planning & Targeting:* JMARS (ASU), REACT (ACT)
  - *Non-NASA:* SOCET Set, ENVI, ESRI/ArcMAP, Google Moon/Mars, World-Wide Telescope, Matlab

Web links listed at the end

Planetary Data: Mission Operation Centers & Data Nodes

- **Mission activities**
  - Communication, uplink & downlink, targeting, tracking image & data acquisition, surface operations, data viewing, mission planning, documentation, processing, software development, archiving, delivery services, etc.
- **Data nodes**
  - **10 currently active**
  - Temporary adjuncts to PDS structure, funded by NASA flight missions
  - Provide direct archiving interface for active flight missions & expert science support for data users
  - Scheduled data deliveries to PDS

Web links listed at the end

Planetary Data: Mission Operation Centers & Data Nodes

- **Examples of tools & services (Mars)**
  - Mars Space Flight Facility (ASU)
    - JMARS, Mars Image Explorer, MO THEMIS Data Map, Global Mars Maps, Davinci
  - MRO HiROC (UA)
    - HiView, Conductor, Kapellmeister
  - MRO CRISM Data viewer, Analysis Toolkit (APL)
- **Examples of tools & services (Moon)**
  - LROC SOC (ASU)
    - ACT/REACT QuickMap LROC & M3 online data viewer
    - LROC WMS Image Map, image browser
  - Apollo Digital Image Archive (ASU)
- **Examples of tools & services (Other)**
  - Cassini CICLOPS

Web links listed at the end

U.S. Public Data Access (cont.)

- ***NASA Plan, Part A***
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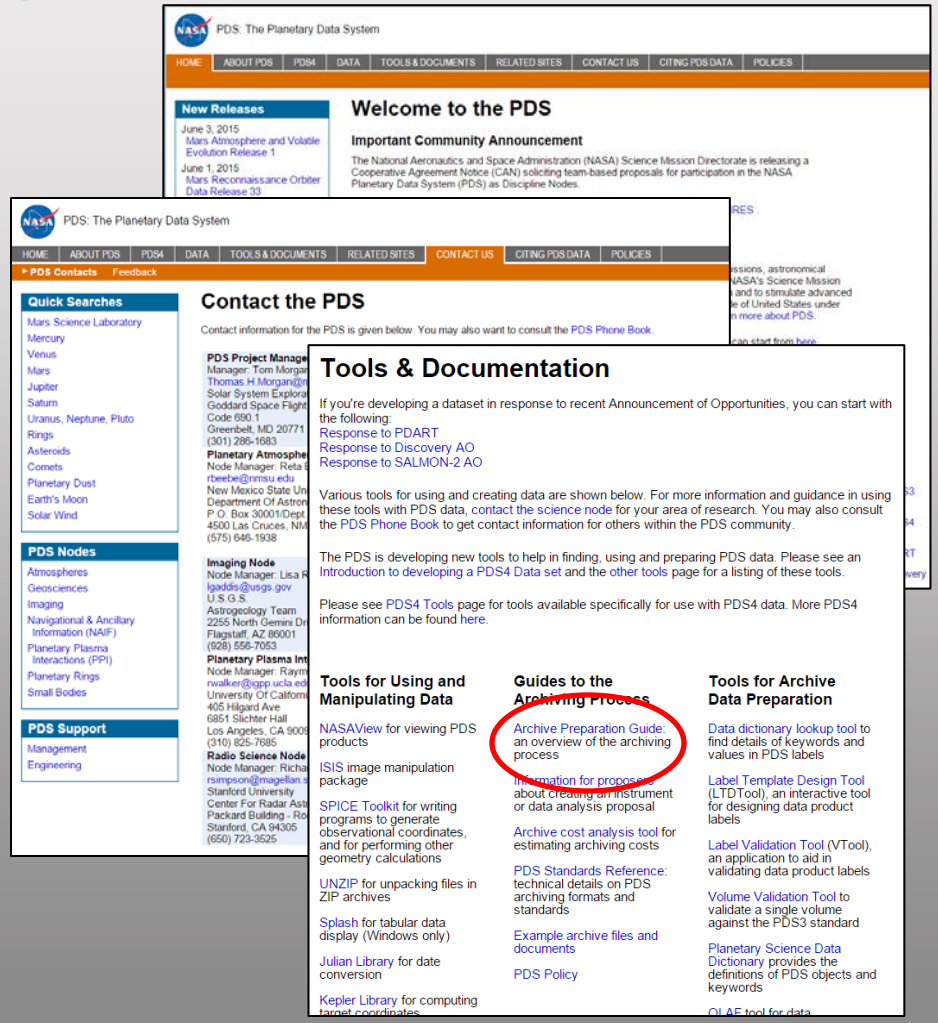
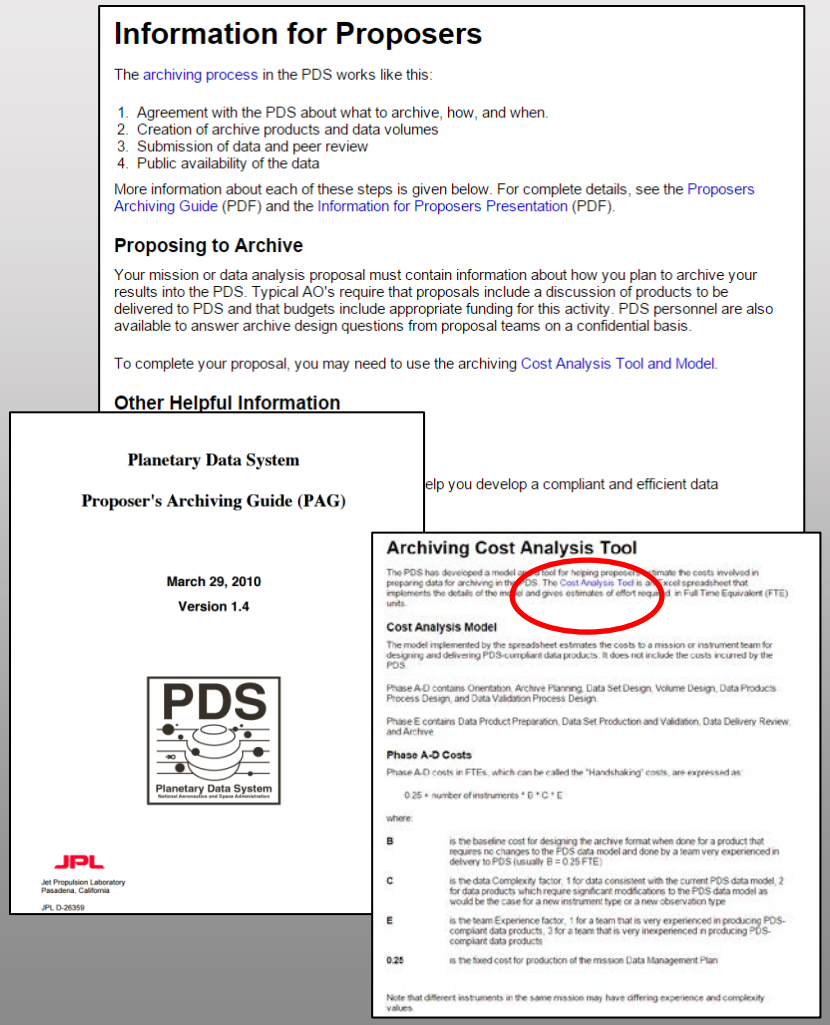
Planetary Data: Data Management Plans

- **PDS Home Page:**
  - Start here: https://pds.nasa.gov/
  - Find contacts, tools & documents, examples, etc.
  - ***Contact a discipline node lead***
- **Archive Preparation Guide:**
  - https://pds.nasa.gov/tools/archiving.shtml
  - Sample documents (**missions and instruments**)
    - Data Management and Archiving Plans (DMAPS)
    - Interface Control Documents (ICD), interface between provider and node
    - Software Interface Specifications (SIS), archive data structures and volumes



Planetary Data: Data Management Plans

- **For Data Analysis, Research Programs:**
  - Information for Proposers
  - Archiving steps, Archive checklist, Costing examples
  - https://pds.nasa.gov/tools/proposing.shtml
- **Proposers' Archive Guide:**
  - Overview of archiving process, elements of an archive, PDS, expected products, etc.
- **Cost Analysis Tool & Model**
  - Excel spreadsheet for helping proposers estimate the costs involved in preparing data for archiving in the PDS
  - Estimates of effort required, in Full Time Equivalent (FTE) units, for all archiving phases



Information for Proposers

The archiving process in the PDS works like this:

1. Agreement with the PDS about what to archive, how, and when.
2. Creation of archive products and data volumes
3. Submission of data and peer review
4. Public availability of the data

More information about each of these steps is given below. For complete details, see the Proposers Archiving Guide (PDF) and the Information for Proposers Presentation (PDF).

Proposing to Archive

Your mission or data analysis proposal must contain information about how you plan to archive your results into the PDS. Typical AO's require that proposals include a discussion of products to be delivered to PDS and that budgets include appropriate funding for this activity. PDS personnel are also available to answer archive design questions from proposal teams on a confidential basis.

To complete your proposal, you may need to use the archiving Cost Analysis Tool and Model.

Other Helpful Information

elp you develop a compliant and efficient data

Planetary Data System

Proposer's Archiving Guide (PAG)

March 29, 2010

Version 1.4

PDS Planetary Data System

JPL

Jet Propulsion Laboratory
Pasadena, California

JPL D-26359

Archiving Cost Analysis Tool

The PDS has developed a model and tool for helping proposers estimate the costs involved in preparing data for archiving in the PDS. The Cost Analysis Tool is an excel spreadsheet that implements the details of the model and gives estimates of effort required, in Full Time Equivalent (FTE) units.

Cost Analysis Model

The model implemented by the spreadsheet estimates the costs to a mission or instrument team for designing and delivering PDS-compliant data products. It does not include the costs incurred by the PDS.

Phase A-D contains Orientation, Archive Planning, Data Set Design, Volume Design, Data Products Process Design, and Data Validation Process Design.

Phase E contains Data Product Preparation, Data Set Production and Validation, Data Delivery Review, and Archive

Phase A-D Costs

Phase A-D costs in FTEs, which can be called the "Handshaking" costs, are expressed as:

0.25 + number of instruments * B * C * E

where:

B	is the baseline cost for designing the archive format when done for a product that requires no changes to the PDS data model and done by a team very experienced in delivery to PDS (usually B = 0.25 FTE)
C	is the data Complexity factor. 1 for data consistent with the current PDS data model, 2 for data products which require significant modifications to the PDS data model as would be the case for a new instrument type or a new observation type
E	is the team Experience factor. 1 for a team that is very experienced in producing PDS-compliant data products, 3 for a team that is very inexperienced in producing PDS-compliant data products
0.25	is the fixed cost for production of the mission Data Management Plan

Note that different instruments in the same mission may have differing experience and complexity values.

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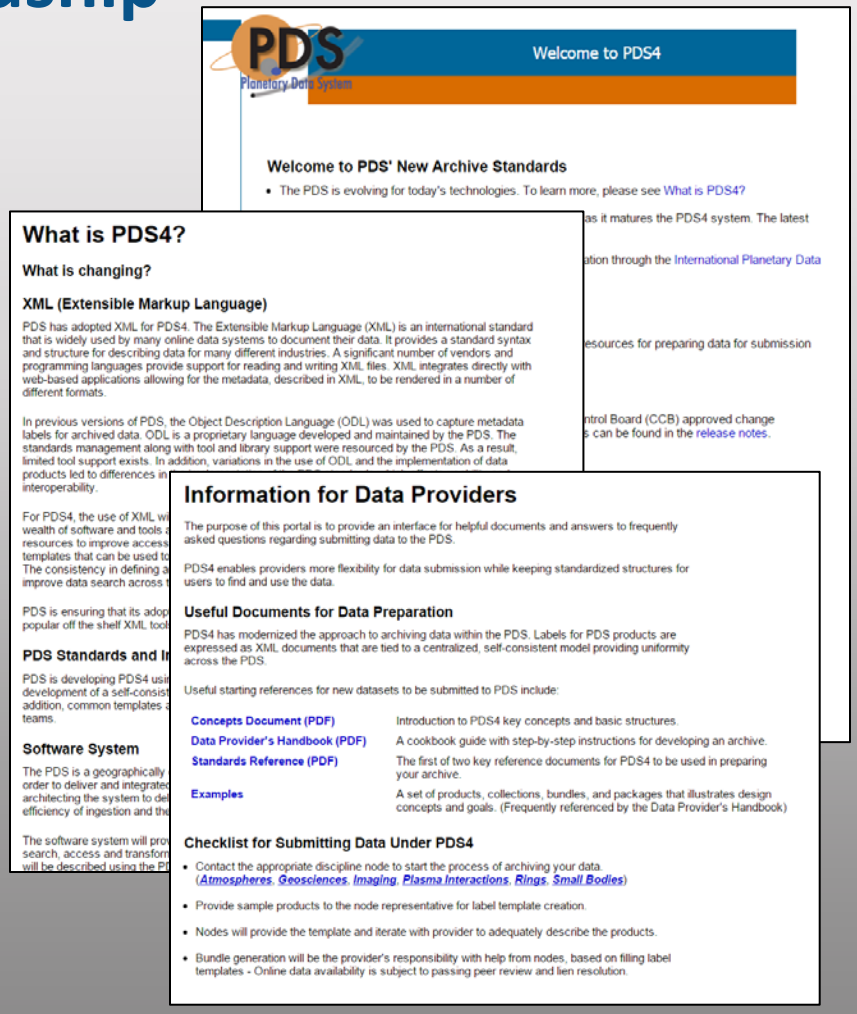
Planetary Data: Data Stewardship

- **PDS4:**
  - ***The new PDS***, an integrated data system to improve access to PDS data
  - A re-architected, modern, online data system
  - Improves efficiency both ingestion and distribution of data
  - Uses Extensible Markup Language (XML) and standard data format templates with keywords & labels
  - Self-consistent information model & software system
    - https://pds.nasa.gov/pds4/about
  - Concepts, examples, checklist, ***software***
    - Use templates to make labels, validate them, etc.



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  - Support governance of and best practices for managing public access to peer-reviewed scholarly publications and digital data across NASA.

Planetary Data: User Training & Education

- **Planetary Data Workshop:**
  - ***You are here!***
  - Every two years
  - *Please complete the online survey*
- **PDS Guides, Tools & Tutorials:**
  - Many nodes offer tutorials and workshops for specific data
  - Often data access & delivery services offer user guides & tutorials
- ***If you don't find what you need, contact a node manager!***

Summary

- PDS provides a ***wide variety*** of data and support services for creating data archives and using planetary data
- PDS addresses many aspects of Part A of the NASA Plan of 2014 (response to OSTP memo of 2/22/13)
- This quick overview provides context for presentations & discussions this week
  - I've left some elements and details out!

- ***Links to online data services***
  - PDS Home: http://pds.nasa.gov/
  - Atmospheres Node: http://atmos.pds.nasa.gov/
  - Geosciences Node: http://geo.pds.nasa.gov/
  - Imaging Node: http://pds-imaging.jpl.nasa.gov/
  - Planetary Plasma Interactions Node: http://pds-ppi.igpp.ucla.edu/
  - Planetary Rings Node: http://pds-rings.seti.org/
  - Small Bodies Node: http://pds-smallbodies.astro.umd.edu/
  - Engineering Node: http://pds-engineering.jpl.nasa.gov/
  - NAIF: http://naif.jpl.nasa.gov/naif/
  - NSSDC: http://nssdc.gsfc.nasa.gov/
  - IPDA: http://planetarydata.org/

- ***Links to online data services***
  - Geosciences Node:
    - Mars Orbital Data Explorer: http://ode.rsl.wustl.edu/mars/
    - Mercury Orbital Data Explorer: http://ode.rsl.wustl.edu/mercury
    - Lunar Orbital Data Explorer: http://ode.rsl.wustl.edu/moon/
    - Analyst's Notebooks: http://an.rsl.wustl.edu/
  - Imaging Node:
    - Photojournal: http://photojournal.jpl.nasa.gov/index.html
    - Planetary Image Atlas: http://pds-imaging.jpl.nasa.gov/search
    - Data Portal: http://pds-imaging.jpl.nasa.gov/portal/
    - Map a Planet: http://www.mapaplanet.org/
    - PILOT: http://pilot.wr.usgs.gov/
  - Planetary Rings Node:
    - OPUS: http://pds-rings.seti.org/search/
  - Small Bodies Node:
    - Data Ferret: http://sbn.psi.edu/ferret/
  - NAIF:
    - SPICE Toolkit: http://naif.jpl.nasa.gov/naif/toolkit.html

- ***Links to online data services***
  - Mars Space Flight Facility (ASU): http://mars.asu.edu/
  - MRO HiRISE HiView: http://hirise.lpl.arizona.edu/hiview/
  - LROC QuickMap: http://target.lroc.asu.edu/da/qmap.html
  - LROC WMS Map: http://wms.lroc.asu.edu/lroc/
  - MRO CRISM Data Viewer: http://crism-map.jhuapl.edu/
  - MO THEMIS Maps: http://global-data.mars.asu.edu/bin/themis.pl
  - Mars Global Data: http://www.mars.asu.edu/data/
  - JMars/JMoon: http://jmars.asu.edu/
  - RPIF Network: http://www.lpi.usra.edu/library/RPIF/
  - Mars Handlens-Scale Image Database: http://pds-geosciences.wustl.edu/missions/labdata/marshandlens.htm
  - Lunar Sample Catalog: http://curator.jsc.nasa.gov/lunar/samplecatalog/index.cfm
  - Meteor Crater Sample Collection: http://astrogeology.usgs.gov/research/Meteor-Crater-Sample-Collection
  - Apollo Digital Image Archive: http://apollo.sese.asu.edu/
  - Gazetteer of Planetary Names: http://planetarynames.wr.usgs.gov/
  - Astropedia: http://astrogeology.usgs.gov/astropedia

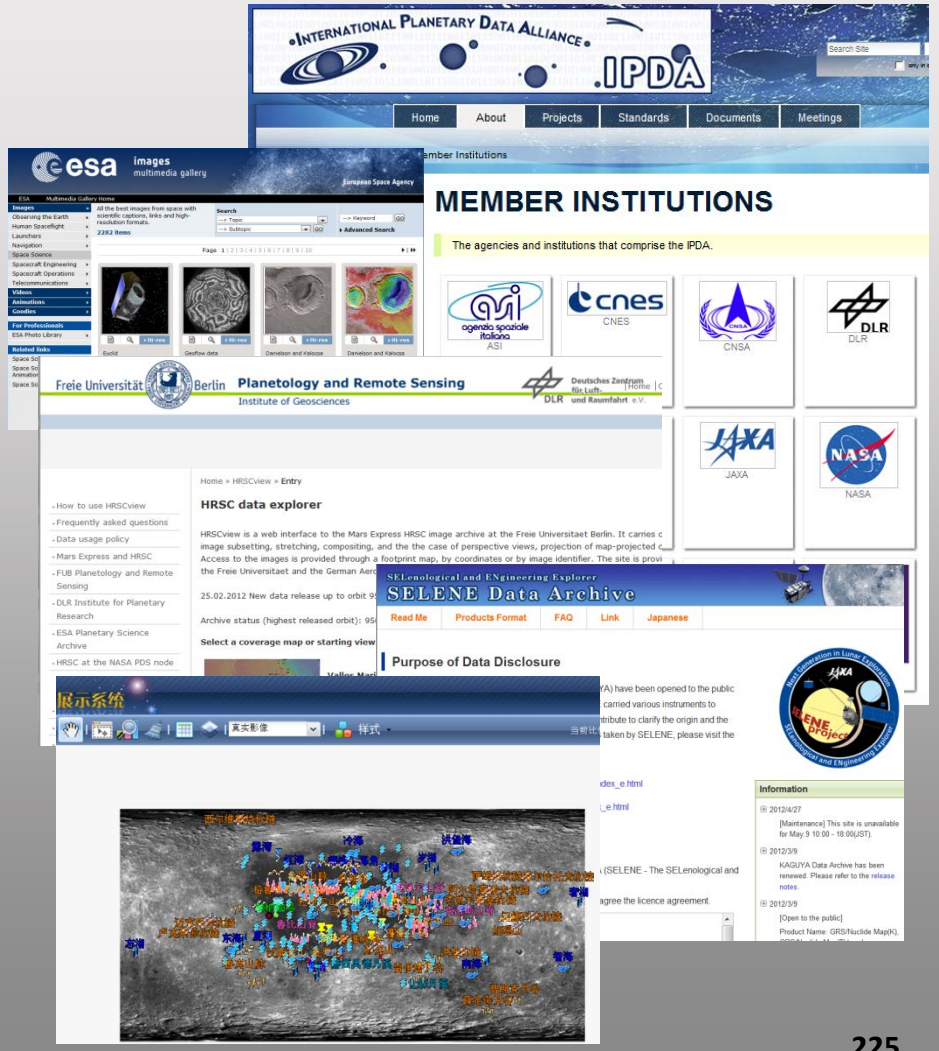
- ***Links to online data services***
  - Cassini CICLOPS: http://ciclops.org/?js=1
  - Lunar Orbiter Digitization Project: http://astrogeology.usgs.gov/Projects/LunarOrbiterDigitization/
  - VICAR: http://www-mipl.jpl.nasa.gov/external/vicar.html
  - ISIS: http://isis.astrogeology.usgs.gov/
  - Ames Stereo Pipeline: http://ti.arc.nasa.gov/tech/asr/intelligent-robotics/ngt/stereo/
  - LMMP Data Portal: http://pub.lmmp.nasa.gov/
  - ILIADS: http://esc.gsfc.nasa.gov/exploration/esp/Exploration-Support.html
  - ACT/REACT: http://www.actgate.com/home/act-react.htm
  - HRSC Data Explorer: http://hrscview.fu-berlin.de/cgi-bin/ion-p?page=entry2.ion
  - SELENE Kaguya online archive: http://l2db.selene.darts.isas.jaxa.jp/
  - Chang'e-2 Lunar Global Mosaic: http://159.226.88.30:8080/CE2release/cesMain.jsp
  - ESA Multimedia Image Gallery: http://www.esa.int/esa-mmg/mmg.pl?collection=Space+Science&type=I

Planetary Data: Other Resources

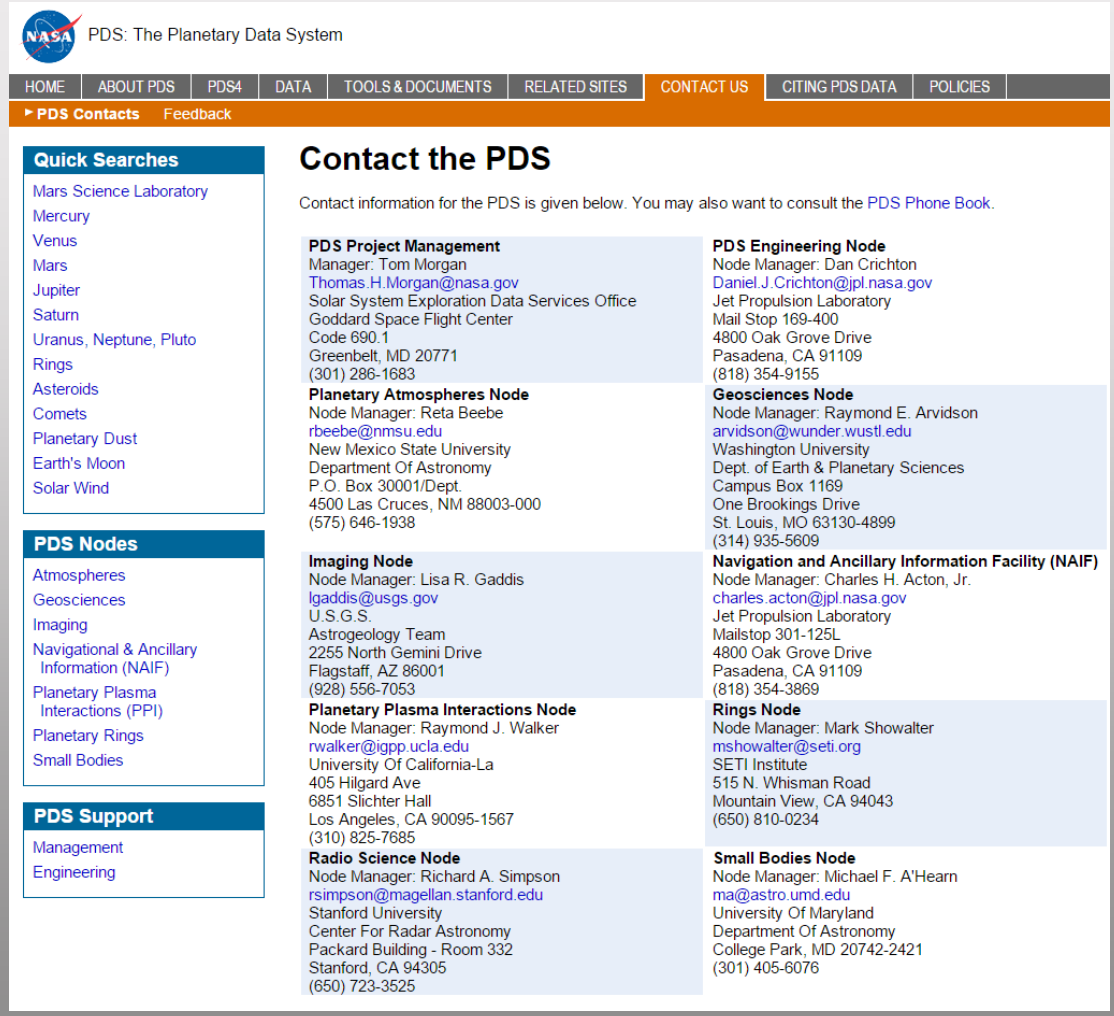
- **Examples of tools & services (Other)**
  - Regional Planetary Image Facility Network
    - Globally distributed network of data libraries
      - 9 U.S. & 8 in other countries
    - Maintain photographic & digital data, mission documentation & cartographic data
  - Cartographic and photogrammetric products
    - Gazetteer of Planetary Names, PIGWAD/MRCTR, Astropedia
    - Lunar Orbiter Digitization Project
    - LMMP portal & products
  - Data Analysis Program, Science Institute, Participating Scientist products
    - Lunar Sample (Image) Catalog
    - Mars Analog Handlens-Scale Image Database
    - Meteor Crater Database

Planetary Data: Non-US Archives & Services

- **International Planetary Data Alliance:**
  - 12 International members
  - An international standard for query, access and usage of data across international planetary data archive systems
- **Examples of tools & services:**
  - ESA Multimedia Image Gallery
  - MEX HRSC Data Explorer, CraterTools
  - SELENE Kaguya online archive, Image Gallery, 3D GIS
  - Chang'e-2 Lunar Global Mosaic



PDS Contacts



PDS: The Planetary Data System

HOME | ABOUT PDS | PDS4 | DATA | TOOLS & DOCUMENTS | RELATED SITES | CONTACT US | CITING PDS DATA | POLICIES

▸ PDS Contacts Feedback

Quick Searches

- Mars Science Laboratory
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus, Neptune, Pluto
- Rings
- Asteroids
- Comets
- Planetary Dust
- Earth's Moon
- Solar Wind

PDS Nodes

- Atmospheres
- Geosciences
- Imaging
- Navigational & Ancillary Information (NAIF)
- Planetary Plasma Interactions (PPI)
- Planetary Rings
- Small Bodies

PDS Support

- Management
- Engineering

Contact the PDS

Contact information for the PDS is given below. You may also want to consult the PDS Phone Book.

PDS Project Management
Manager: Tom Morgan
Thomas.H.Morgan@nasa.gov
Solar System Exploration Data Services Office
Goddard Space Flight Center
Code 690.1
Greenbelt, MD 20771
(301) 286-1683

PDS Engineering Node
Node Manager: Dan Crichton
Daniel.J.Crichton@jpl.nasa.gov
Jet Propulsion Laboratory
Mail Stop 169-400
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-9155

Planetary Atmospheres Node
Node Manager: Reta Beebe
rbeebe@nmsu.edu
New Mexico State University
Department Of Astronomy
P.O. Box 30001/Dept.
4500 Las Cruces, NM 88003-000
(575) 646-1938

Geosciences Node
Node Manager: Raymond E. Arvidson
arvidson@wunder.wustl.edu
Washington University
Dept. of Earth & Planetary Sciences
Campus Box 1169
One Brookings Drive
St. Louis, MO 63130-4899
(314) 935-5609

Imaging Node
Node Manager: Lisa R. Gaddis
lgaddis@usgs.gov
U.S.G.S.
Astrogeology Team
2255 North Gemini Drive
Flagstaff, AZ 86001
(928) 556-7053

Navigation and Ancillary Information Facility (NAIF)
Node Manager: Charles H. Acton, Jr.
charles.acton@jpl.nasa.gov
Jet Propulsion Laboratory
Mailstop 301-125L
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-3869

Planetary Plasma Interactions Node
Node Manager: Raymond J. Walker
rwalker@igpp.ucla.edu
University Of California-La
405 Hilgard Ave
6851 Slichter Hall
Los Angeles, CA 90095-1567
(310) 825-7685

Rings Node
Node Manager: Mark Showalter
mshowalter@seti.org
SETI Institute
515 N. Whisman Road
Mountain View, CA 94043
(650) 810-0234

Radio Science Node
Node Manager: Richard A. Simpson
rsimpson@magellan.stanford.edu
Stanford University
Center For Radar Astronomy
Packard Building - Room 332
Stanford, CA 94305
(650) 723-3525

Small Bodies Node
Node Manager: Michael F. A'Hearn
ma@astro.umd.edu
University Of Maryland
Department Of Astronomy
College Park, MD 20742-2421
(301) 405-6076

https://pds.nasa.gov/contact/contact.shtml