RENEWING THE PLANETARY DATA SYSTEM — ROADMAPPING THE NEEDS OF THE COMMUNITY 2017-2026.

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Introduction: NASA established the Planetary Data System (PDS) pursuant to one of our responsibilities under the Space Act of 1958; specifically, "to provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof" [1]. NASA maintains archives of the data returned by its mission investigations. This growing archive of planetary data (now almost 1 petabyte in data volume) from almost 50 missions will allow current and future members of the scientific community to perform deep analyses using multiple data collections from successive missions to address fully the overall goal for Planetary Science within NASA: "Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere" [2]. The PDS archive is publicly accessible, providing the fruits of NASA's missions to the public at large. The PDS is responsive to NASA's "Open Data" initiative [3].

Background: The PDS archives electronic data products from NASA planetary missions, sponsored by NASA's Science Mission Directorate. It actively manages the archive to maximize its usefulness, and the PDS has become a basic resource for scientists around the world.

All PDS-curated products are peer-reviewed, well documented, and available online to scientists and to the public without charge. Online search capabilities are also provided. The PDS uses standards for describing and storing data that are designed to enable future scientists who are unfamiliar with the original experiments to analyze the data and to do this using a variety of computer platforms, with no additional support. These standards address the data structure, description contents, media design, and a set of terms.

The Planetary Data System version 4 (PDS4) is the largest upgrade in the history of the PDS, supporting the capture of nearly 1 petabytes of data within the planetary data archives. PDS4 became operational in December 2013 to support the LADEE and MAVEN missions. PDS4 provides a scalable data science infrastructure coupled with a rigorous planetary science set of data standards that is used to integrate the diversity of PDS data and systems into the federated system. These standards adopt the use of XML for capturing detailed metadata that is used to support the capture, management, and distribution of data across the PDS Discipline Nodes. The success of PDS4 has led to the adoption of PDS4 for upcoming missions by ESA, JAXA, and India, among others, as well as the U.S. PDS4 is now an international standard supported by the IPDA (International Planetary Data Alliance).

Though the PDS does not fund the production of archive data from active missions, it works closely with project teams to help them design well-engineered products that can be released quickly.

PDS Discipline Nodes are now working closely with the community to provide higher-order data products (and new archive materials) by supporting investigators in NASA's Planetary Data Archiving, Restoration, and Tools Program (PDART).

While PDS-curated products are freely available online, the PDS provides teams of scientists to help users select and understand the data. It also offers special processing for products tailored to the needs of individual users.

Current Structure of the PDS: The PDS is organized as a federated data system; data are archived by scientist-led organizations, called Discipline Nodes, which present a single interface to the world (http://pds.nasa.gov). The organization of the PDS is shown below in Figure 1. Additional functional groups provide engineering and user interface design services.

The Discipline Nodes are organized around broad areas—as summarized below:

- Atmospheres (composition, structure, meteorology, and aeronomy) of planets.
- Geosciences (geology, geophysics, surface properties, and tectonics) of planets.
- Small Bodies (comets, asteroids, dwarf planets, and dust).
- Planetary Plasma Interactions (PPI) (solar wind–planetary interactions, magnetospheres, ionospheres, plasma tori) of planets.
- Ring-Moon Systems.
- Cartography and Imaging Science (pushbroom imagers, hyperspectral imagers, analysis tools) of solar system objects.

In addition, the PDS has two technical Support Nodes:

- The Engineering Node (systems engineering support, standards [data, software, documentation, operating procedures], technology investigations, coordination and development of system-wide software, PDS catalog development and implementation, and maintenance).
- NASA's Navigation and Ancillary Information Facility (the observation geometry information system commonly known as SPICE [Spacecraft/Planet/Instrument/C-

matrix/Event] that is widely used by both NASA mission scientists and engineers).

Finally, there is a small project office to manage funding and budgets and establish common policies across the PDS.
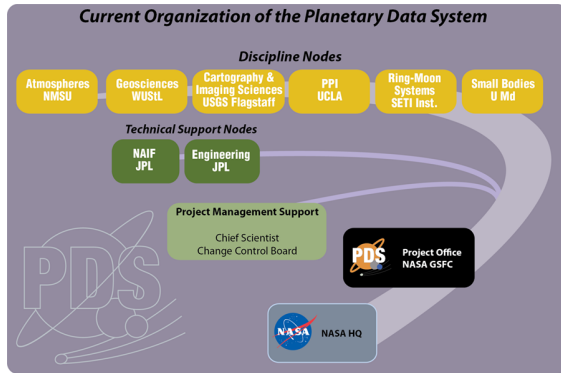

Figure 1. Organization of the PDS

Revitalization of the Planetary Data System: NASA is in the process of a multi-year effort to revitalize the PDS. This includes:

1. Competition of all Science Nodes through the means of a cooperative Agreement Notice (NNH15ZDA006C). This activity was completed in September, 2015, and all of the new Science Nodes are now funded for 5 years with an option for an additional 5 years. The Cooperative Agreement process provides a different governance model for PDS, similar to the "Institute Model" used elsewhere in NASA.
2. Performance Reviews of the two internal nodes not competed through the PDS CAN, the Engineering Node and the Navigation and Ancillary Data Facility (NAIF) are scheduled for completion in early February 2016.
3. The initiation of a Planetary Data System Roadmap for the 2017–2026 period. This activity began in October 2015 with the release of a Request for Information (RFI) asking for community input. An initial summary will be given in our talk.

PDS Roadmap: NASA has asked Dr. Ralph McNutt, as PDS Chief Scientist, to lead the Roadmap activity. As noted above, the initial step was the release of an RFI to the NASA science and information technology (IT) communities to seek ideas and comments with respect to the role and mission of the PDS and the implementation of an active accumulating archive like the PDS in the current IT environment.

Our guidance from NASA Headquarters is to think:

- 20 years out for missions;
- 10 years out for flight technologies.
- 5 years out for changes in the IT infrastructure.

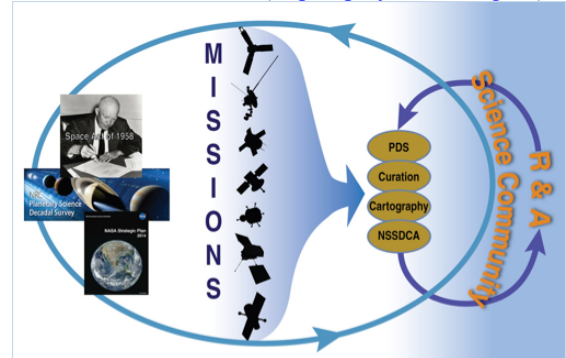The Roadmap process will consider how we can ensure that IT implementation is consistent with Federal Best Practices (https://playbook.cio.gov/).

Figure 2. PDS within the PSD architecture

Relation to other Planetary Science Division Facilities: PDS is one of a number of organizations that fill a unique niche in the Planetary Science Division (PSD) Architecture. The PDS has a long-standing relationship with the NASA Space Science Data Coordinated Archive (NSSDCA). A Memorandum of Understanding (MOU) governs the roles of the organizations, both of which also fall under the National Archives and Records Administration (NARA).

The Minor Planet Center is currently a sub-node of the PDS Small Bodies Node. We are working to strengthen our ties with the Minor Planet Center. We expect, as part of the Roadmap process to establish or renew MOUs with NASA's Astromaterials and curation office, and with NASA's Cartography program.

Next Steps in the Roadmap Process: Following the review of comments and input from the RFI, a roadmap team will be assembled. The panel membership will include a balance of members from inside and outside NASA, including members of the user community, both those who provide and those who make use of PDS data. This is a planned yearlong activity with three meetings, exclusive of Town Halls held at scientific conferences. The team will be independent of the PDS Management Council and will provide a written Roadmap report to the NASA Planetary Science Division (PSD) management.

References: [1] Pub. L. No. 85-568, 72 Stat. 426-438 (Jul. 29, 1958), Section 203, Subhead (3). [2] NASA 2014 Science Plan. [3] NASA Plan: Increasing Access to the Results of Scientific Research (2014).