

**THE NASA PLANETARY DATA SYSTEM: PAST, PRESENT, AND FUTURE.** R. E. Arvidson, Earth and Planetary Sciences, McDonnell Center for the Space Sciences, Washington University in Saint Louis, Saint Louis, MO, 63130, [arvidson@wunder.wustl.edu](mailto:arvidson@wunder.wustl.edu)

**Introduction:** Archiving and distributing data sets from NASA's planetary missions has evolved from depositing data in central repositories, without systematic reviews, to a structured process of planning, reviewing, validating, and distributing archives containing raw and derived data sets and extensive documentation. The need for and history of development of the Planetary Data System is described, followed by current status and prospects for the future. Personal perspectives are used, based on experience working on missions and archiving starting from the Mars Viking Lander Missions in 1976 through current missions.

**History:** Archiving in the 1960s and 1970s focused on depositing data sets and documentation in the National Space Science Data Center (<http://nssdc.gsfc.nasa.gov/>) and was typically done without peer review of the nature, content, or thoroughness of the archives. The development of the Regional Planetary Image Facilities (<http://www.lpi.usra.edu/library/RPIF/index.shtml>) enhanced the ability of researchers to access hardcopies of images acquired by planetary missions, along with derived data sets such as topographic and geologic maps. The RPIFs were sited at geographically dispersed locations where planetary scientists were present to direct the RPIFs and to provide expert advice to visitors. The RPIFs continue to expand their holdings and still focus on image collections, expert advice, and local outreach and education.

The National Research Council's Space Science Board initiated a Committee on Computation and Data Management (CODMAC) to provide an analysis of the state of archiving and recommendations for improvement. Three reports were generated in the 1980s before CODMAC was decommissioned [1,2]. A key finding, based on extensive analysis of archive facilities and the extent to which they were used by science communities for data mining and discoveries, was that the most useful archives were managed by scientists who used the data and understood the details of the holdings. This led to the recommendation that distributed archives, sited at institutions with significant science presence, and run by scientists, would provide archives that would maximize the ability to make new discoveries.

The CODMAC recommendations were critical to the development of the Pilot Planetary Data System (PPDS) in which concepts associated with development and management of distributed data centers were tested. Proposals were then solicited and peer-

reviewed, and a set of discipline-oriented data nodes were selected in 1989 to form the core of the PDS. These included Geosciences, Atmospheres, Small Bodies (asteroids and comets), Planetary Plasma Interactions, Rings, Imaging (focused on archiving large raw and derived imaging data sets and the ability to generate derived data), Navigation and Ancillary Information Facility (NAIF), and a Central Node for management.

**Current Status:** The current version of the PDS has the same discipline nodes, the Imaging and NAIF Nodes, and the addition of an Engineering Node to help facilitate developments that transcend individual nodes. Structured approaches have been developed and followed for working with mission instrument teams and other suppliers of candidate archives. This approach includes initial planning of archive contents and delivery schedules, generation and peer review of contributions, ingestion into the relevant PDS Node, making the archives available via web-based interfaces, and deposition of archives with the NSSDC for long-term back-up. As an example, the Geosciences Node supports archives totaling ~165 terabytes of data for Mercury, Venus, Earth's Moon, and Mars, with 346 data sets and ~4.3 terabytes of user downloads per month. User interfaces include Orbital Data Explorers (<http://ode.rsl.wustl.edu/>), and for landed missions, Analyst Notebooks (<http://an.rsl.wustl.edu/>). Both interfaces retrieve data from other PDS Nodes, if needed, packaging on the fly archives for user downloading. On an international level PDS standards have been adopted by European, Russian, Indian, Chinese, and Japanese missions when generating archives.

**Prospects for the Future:** The PDS is currently transitioning from the existing PDS-3 archive structures and formats to a more modern, streamlined PDS-4 approach. PDS-4 features more strictly defined data formats, an updated information model based on international standards, and use of XML to facilitate data and metadata access by multiple software tools. New mission contributions will be archived using these streamlined approaches. In addition, a renewed emphasis on recovery of old data sets and generation of new derived products by the research community (e.g., PDART Program) is leading to a rapid increase in archive contributions that will be of direct benefit to the community. A major task for archivists in general will be to integrate across various planetary archives and data holdings (e.g., extraterrestrial sample holdings at

the NASA Johnson Space Center and the Planetary Cartography and Geodesy Program at the USGS, Flagstaff) to provide a more seamless way for users to search, access, and utilize planetary archives. Finally, although management limitations rather than technology limitations have always been considered the greatest impediments to better archives, the PDS must continue to be aware of and take advantage of new technologies to make archiving and distributing more efficient and informative. A recent example is the announcement by Microsoft of HoloLens technology that will allow three dimensional visualization of planetary archives in an office environment.

**References:**

- [1] Bernstein, R. et al. (1982) NAS Press.
- [2] Arvidson, R. E. et al. (1986) NAS Press.