THE ROLE OF THE PLANETARY DATA SYSTEM IN A PLANETARY SPATIAL DATA INFRASTRUCTURE. L. Gaddis, J. Laura[1] and R. Arvidson[2]. [1]USGS Astrogeology Science Center, Flagstaff, AZ, [2] Dept. Earth & Planetary Sciences, Washington University in St. Louis, St. Louis, MO (lgaddis@usgs.gov).

Introduction: Ongoing discussions of an initiative to develop a community Planetary Spatial Data Infrastructure (PSDI) [1-7] have engendered two persistent questions: (1) how is PSDI different from NASA's Planetary Data System (PDS) and (2) what is the role of the PDS and the envisioned PSDI? Here we address these questions from the perspective of PDS science discipline node lead scientists and PSDI experts.

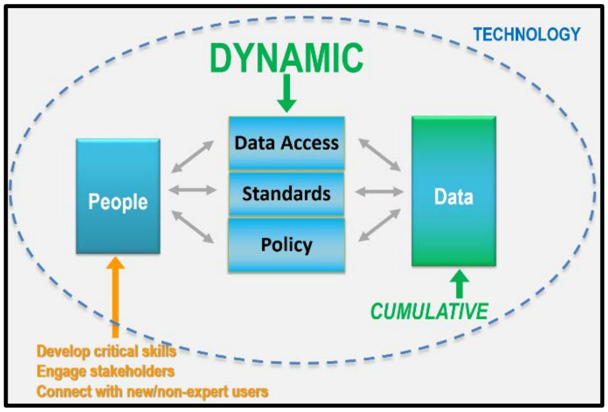

Figure 1. Elements of a Spatial Data Infrastructure (SDI), modified from [9].

Planetary Spatial Data Infrastructure: A PSDI encompasses aspects of users, policies, standards, data access mechanisms, and the planetary spatial data ([8, 9], ***Figure 1***). PSDI is both a theory defining what elements are required to support effective use of spatial data and the implementation of that theory.

Users**:** An effective PSDI removes the burden of data processing from the user, and improves data access, discovery, and usage so that users can focus on the science.

Policies**:** An effective PSDI requires policies to ensure that community standards support the collection and sharing of data, and to ensure longevity and evolution of infrastructural service that can take advantage of cutting edge technologies.

Standards**:** To ensure data usability, the development, codification, and adoption of data formatting and delivery standards to support data interoperability and use in widely available tools is essential.

Data Access**:** Effective data access is fundamental to enhancing data discovery. However, access mechanisms depend on the use of standard, interoperable formats by data providers. Often access services are designed for a single user community for a limited time (e.g., for a mission science team during a mission).

Data**:** Spatial data encompassed by a PSDI can be divided into two categories: *foundational* and *framework*. Foundational data are wide reaching and support a range of scientific and decision-making processes; these include a geodetic coordinate reference frame, geodetically controlled, orthorectified images and topography designed to provide the highest level of accuracy supported by the data [1]. Framework data are those products of critical importance to a smaller subset of the research community. Framework data may be used for a specific scientific objective, such as geologic or thematic mapping of a planetary surface to identify resources or units of interest.

The Planetary Data System: NASA's PDS is "the formal archive for the planetary sciences" [10], created to preserve and make data from NASA missions available to the planetary science community. The PDS is comprised of six federated discipline nodes (Atmospheres, Cartography and Imaging Science, Geosciences, Planetary Plasma Interactions, Ring-Moon Systems, Small Bodies) and two technical support nodes (Engineering, Navigation and Ancillary Information). PDS personnel work with planetary mission instrument teams and individual data providers to plan and implement ingestion of peer-reviewed archives that meet strict standards using PDS4 protocols and formats. These archives are then made available world-wide using web-based data search interfaces.

Data Usability as a Common Goal: The PDS emphasizes data preservation, integrity, and access, while PSDI focuses on data integration and interoperability for improved discoverability and usability. Although both entities support adherence to standards to improve data usability, they address this goal in different but complementary ways.

The PDS Roadmap Study Team [RST, 10] recently recognized a fundamental need for improved data usability. The RST report focused initially on data usability from the perspective of data discoverability, including the integration of data with metadata to facilitate the development of deep understanding of the data characteristics. In this sense, the data are ***usable*** when the user can find and access data via searches of available, relevant metadata. The RST report also characterized usability as a form of long-term accessibility. In this case, data usability is addressed by the PDS practice of limiting the number and complexity of data formats. This PDS approach can be described as an archival view of data usability, comparable to that which was widely adopted by second-generation terrestrial spatial data infrastructures (SDIs) [11].

In contrast, a PSDI addresses development of a third-generation SDI that depends on the existence of first- and second-generation SDIs, but shifts the focus of usability from the technical (archival) to the user. The PSDI view of discoverability leverages extensive, tightly coupled metadata with spatially and semantically enabled search capabilities to ensure that users can find desired data, as well as understand the spatial accuracy, spatial efficacy, and value of a given data product or set. Data are then not necessarily organized by science discipline, but by semantic meaning and context linkages. The identification of *foundational* and *framework* data sets [1] as distinct from a specific science application is evidence of this separation. Enabling this type of usability necessitates the generation and use of higher-order data products in widely interoperable data formats that addresses user needs but may not be usable over the long term. The PSDI view is driven by the goal that data not require spatial expertise to be used for science. In other words, the spatial data should just work [2] for a wide variety of user applications; the burden of PSDI usability is explicitly shifted from the user to the provider or deliverer.

The Relationship Between PSDI and PDS: The largely archival versus user-centric approach to data usability effectively delineates the boundary between the PDS and PSDI. We note that high-quality solutions to address user needs for improved data usability are being implemented currently within the PDS, including the map-based searches for data enabled by the PDS Cartography and Imaging Sciences Node's Planetary Image Atlas [e.g., 4] and Planetary Image Locator Tool (PILOT, [e.g., 4]), and the PDS Geosciences Node's Orbital Data Explorers [12]. These solutions could be considered second generation PSDIs, with the goal of promoting cross-discipline and -mission data searches.

However, the goal of enhanced data usability can extend well beyond these capabilities to include explicit definitions of how data components and services should interact, what format standards should be utilized, what the lifetime of derived data products that support improved usability should be, and how infrastructural data services can be decoupled from interfaces. ***Thus, the envisioned PSDI seeks to extend the PDS data delivery services and reframe these issues from a user perspective to ensure that data become even more usable to support science and exploration needs.*** To support this need, planetary data should be made available in ways that remove the requirement for spatial and data processing expertise, which immediately means that long-term usable (archival) formats and short-term usable (end-user) formats sometimes will differ. Also, the PSDI approach de-emphasizes the need for archiving of software because usable data formats may evolve along with tool requirements, highlighting the need to maintain and archive the capability to move from long-term archived data to shorter term, user-focused data formats. Although it may be desirable to capture and share the most usable data products, it may not be necessary for these to be archived by PDS for long-term preservation.

The PSDI Initiative: A PSDI framework has been developed [1] to address user-centric and data interoperability issues directly in a manner similar to that used by the terrestrial community to transition from second to third generation SDIs. This framework supports disentanglement of the needs of a long-lived archive from the needs of a rapidly changing user landscape. Discussions are ongoing between the PSDI developers and PDS Discipline Nodes to provide guidance in development of node and internode data usability and access.

Summary: Although the PDS provides a valuable data archive service and has implemented some aspects of PSDI, future PSDI development will focus on a broader role in addressing user needs that then may propagate back into archival systems such as the PDS. The PDS and the PSDI framework are complementary components of a mechanism to make raw data highly usable for end users while maintaining long-term preservation. No single format, storage mechanism, or management structure can adequately support the myriad of competing goals inherent in both long- and short- to medium-term usability. Several current PDS data services serve as foundational, first and second generation PSDIs from which user-centric, third generation PSDIs can be developed. The PSDIs will depend on the PDS for lower-order data, long-term availability, and adherence to format standards, while the PDS may rely upon PSDIs to provide the usability that the planetary science community is requesting through the creation of higher order, interoperable, spatially enabled data products and services that are flexibly available in a rapidly changing technical and standards compliance environment.

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