THE RELATIONSHIP BETWEEN PLANETARY SPATIAL DATA INFRASTRUCTURE AND THE PLANETARY DATA SYSTEM. J. Laura[1], R. E. Arvidson[2], and L. R. Gaddis[1] [1]USGS Astrogeology Science Center, Flagstaff, AZ, [2] Dept. Earth & Planetary Sciences, Washington University, St. Louis, MO (jlaura@usgs.gov).

Introduction: The recent codification of a theoretical Planetary Spatial Data Infrastructure (PSDI) framework [1] and concurrent presentation of PSDI themes at several planetary science conferences [2, 3, 4] and advisory group meetings [5, 6, 7] have engendered two consistent questions: (1) how is PSDI different from the Planetary Data System (PDS) and (2) what is the relationship between PSDI and the PDS? This abstract addresses these questions from the perspective of PDS science discipline node lead scientists and PSDI experts. While the PDS provides a valuable planetary data archive service and has taken steps towards implementing aspects of PSDI, future PSDI development will play a significant role in addressing user needs that then propagate into archival systems such as the PDS.

Planetary Spatial Data Infrastructure: A PSDI is the collection of users, policies, standards, data access mechanisms, and the data proper [8, 9]. PSDI components are grouped into two themes: human- data interaction (data and people), and facilitating technologies (policy, access, and standards). Below we describe each component of a PSDI. PSDI is both a theory defining what elements must be addressed to support effective spatial data use and the realization of said theory.

***Users*:** A PSDI seeks to remove the burden of data processing from the user, and to improve data access, discovery, and usage to support increased focus on the resulting 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 services. ***Standards*:** The development, codification, and adoption of data formatting and delivery standards to support data interoperability and use in widely available tools are essential for ensuring data usability. ***Data Access*:** Effective data access is embodied by the ability to efficiently discover, ascertain, and utilize spatial data. Fundamentaly, access mechanisms are dependent upon the use of standard, interoperable formats by data providers. Rapid technological advancement requires access mechanisms that are adaptable as standards and protocols change. ***Data*:** Data can be divided into two broad categories: *foundational* and *framework*.. The former includes geodetic control, topography, and orthorectified images [1], and are essential as baseline data products across a range of scientific and decision-making processes. 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.

The Planetary Data System: The NASA-sponsored PDS is “the formal archive for the planetary sciences” [10], created to preserve and make available data from NASA missions 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 specific standards, using PDS-4 protocols and formats. These archives are then made available on a world-wide basis using web-based interfaces.

Usability as a Common Goal: The PDS primarily supports data preservation, integrity, and access, while PSDI emphasizes data integration and interoperability for improved discoverability and usability. Although both entities ultimately support adherence to standards to improve data usability, this goal is addressed in different, but complementary ways.

In addition to the fundamental role of PDS in capturing, archiving and serving planetary data, the PDS Roadmap Study Team [RST, 10] recognized the fundamental need for improved data usability as a requirement for supporting users of planetary data. The RST report focused initially (Section 3.3) 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 [10] also identified 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 and requiring tools to be flexible in supporting them (i.e., “the PDS archival file formats are simple to support across generations (human and technological) without requiring format migration to preserve usability” [10, p.31]). This PDS approach can be described as an engineering view of data usability, comparable to that which was widely adopted by first- and second-generation terrestrial spatial data infrastructures (SDIs) [11].

In contrast, the proposed PSDI addresses development of a third-generation SDI that is fundamentally more user-centric. Third-generation systems depend upon the existence of first- and second-generation SDIs (the PDS being one example), but shift the focus of usability from the technical (engineering) to the user. For example, the PSDI view of discoverability leverages extensive, tightly coupled metadata (a technical requirement) 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 contextual linkages. The identification of *foundational* and *framework* data sets [1] as completely distinct from a specific science application is evidence of this separation. Enabling semantic usability necessitates the generation and use of higher-order data, controlled, coregistered, and interoperable products that may not be usable over the long term in an engineering context. The PSDI view is driven by the desire to focus on the requirement that data not require spatial expertise to be utilized. In other words, the spatial data should just work [2] and this will invariably require (re)processing data archived in the PDS to higher-order, spatial products with reported spatial efficacy.

The Relationship Between PSDI and PDS: The distinction in approaches to defining and addressing usability has become apparent within the planetary science community, as exemplified by the RST report discussions, and thus it requires clarification. The largely engineering 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 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 could be considered second generation PSDIs, with the goal of promoting cross-discipline and -mission data searches.

However, the goal of enhanced data usability should extend well beyond these capabilities to include explicit definitions of how data components and services should interact, what format standards should be utilized for high interoperability, 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 proposed 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; this immediately means that long-term usable (engineering) 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. While it may be desirable to capture and widely 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 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.

Conclusion: The PDS and the PSDI framework are complementary components of a mechanism to make raw data highly usable for end users while still 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 of the current PDS data services serve as foundational first and second generation PSDIs from which user-centric, third generation PSDIs can be developed. The implementation of PSDIs will be dependent upon the PDS for lower order data products and long term availability. The PDS benefits from PSDIs providing the shorter term spatially enabled 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. Existing PDS efforts (described above as 2nd generation PSDIs) and future efforts by PDS or non-PDS entities can fulfill the vision of a user-centric planetary spatial data infrastructure composed of data processing services to delivery higher-order spatial data, standards compliant map services that are usable by multiple clients, and semantic search capabilities for improved data discovery.

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