Becoming A More FAIR NASA Planetary Data System. Padams, J. H.[1], Raugh A.[2], Hughes, J. S.[1], Loubrieu, T. G.[1], Young, J. [1], Tang, V. [1], Crichton, D. J.[1],Joyner, R. S.[1], Collins, S.[1], Arevalo, E.[1], Suh, C.[1]. [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA. [2]University of Maryland.

Introduction: The NASA Planetary Data System (PDS) captures, archives, and distributes data from robotic exploration of the solar system. In supporting this mission, it has developed an innovative architectural approach called "PDS4" to support the highly diverse set of heterogeneous data from over 600 instruments. The PDS is implemented as a set of distributed archives with different "nodes" managing repositories for this federated system [1]. To enable this federated approach, the PDS uses an information model to drive configuration of its archive and services, enabling it to evolve as data from the mission evolves, as well as the structure of the PDS. This approach has also enabled the PDS to work with and share its standards and architectures with the international community though the International Planetary Data Alliance (IPDA) [2].

The development of PDS4 has not only focused on the construction of compatible archives, but also on becoming a more FAIR system through improving access, (re)use, and interoperability of the data in the big data era.

Interoperable Data Services: As NASA and the planetary science community continue to evolve the science observations and analysis possible with planetary science data, so does the PDS4 Information Model need to evolve. To support this, the PDS uses the Information Model to drive the development of consistent services across all international-sponsored archives, enabling access, search and transformation of archival planetary science data. In turn, with the Information Model as the basis for these services, they are able to dynamically change and adapt as the Information Model evolves into the future. This provides seamless search capabilities to all archival planetary science data, regardless of the node or space agency that data "belongs" to, thereby dramatically improving the accessibility and findability of the data.

By providing consistent services enabling access to the data archives, the PDS, IPDA, and planetary science community can shift their focus more towards innovations in tools and platforms to enhance the usability of the data, through portals, analytics and data science (e. g. artificial intelligence, machine learning, etc.). By doing so, as a community we can begin to provide consistent, analysis-ready data and develop re-usable libraries for reading and analyzing data that can lead to a future of open science in planetary science.

PDS and DOIs: The PDS began investigating the use of Digital Object Identifiers (DOIs) in 2017 with the objective of assigning DOIs to various PDS data objects. To address the challenge of adopting and developing a consistent DOI solution applicable across the entire PDS and its international partners, the PDS Management Council (MC) approved a pilot project for creating and registering PDS4 data using DOIs. A working group, with members from each Discipline Node (DN) and international partners from the IPDA, was later formed in 2020 to establish the PDS DOI Policy [4], best practices for assigning DOIs to data sets, and improvements in the user documentation for citing PDS data [5].

NASA PDS has implemented an operational DOI system - where DOIs are assigned to PDS3 data sets, PDS4 data bundles, PDS4 data collections, and associated documents that are produced, archived, and distributed by the PDS Discipline Nodes (DNs). Each Discipline Node (DN) serves a different planetary science discipline user community and, accordingly, has a unique approach and process for generating and archiving a variety of data products. Such variation has brought about the need to establish DOI policies and processes, while still permitting enough flexibility to accommodate each DN's individual needs.

By assigning DOIs for all PDS data sets, and providing sufficient means for the community to cite that data, we can enable open science through reproducibility of analysis using DOIs to trace back to the original data products used in the analysis.

PDS Cloud: The PDS is striving towards establishing a presence in the cloud in order to leverage cloud technologies to provide *seamless, streamlined access* to archive data. These new technologies will provide enhanced analysis capabilities for the existing planetary science community, as well as potentially expand the community by providing the access needed to enable cloud-enabled computational capabilities. These technologies will allow the PDS to reach prospective scientists that previously did not have access to the computing capabilities needed to perform complex analysis, thereby making the PDS a more available and inclusive system.

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References: [1] About the PDS. https://pds.nasa.gov/home/about/. [2] International Planetary Data Alliance. https://planetarydata.org/. [3] The DOI System. https://www.doi.org/. [4] PDS Data Object Identifier (DOI) Policy. https://pds.nasa.gov/datastandards/documents/policy/PolicyOnDOI10142020.pdf.
[5] Citing PDS Data. https://pds.nasa.gov/datastandards/citing/.