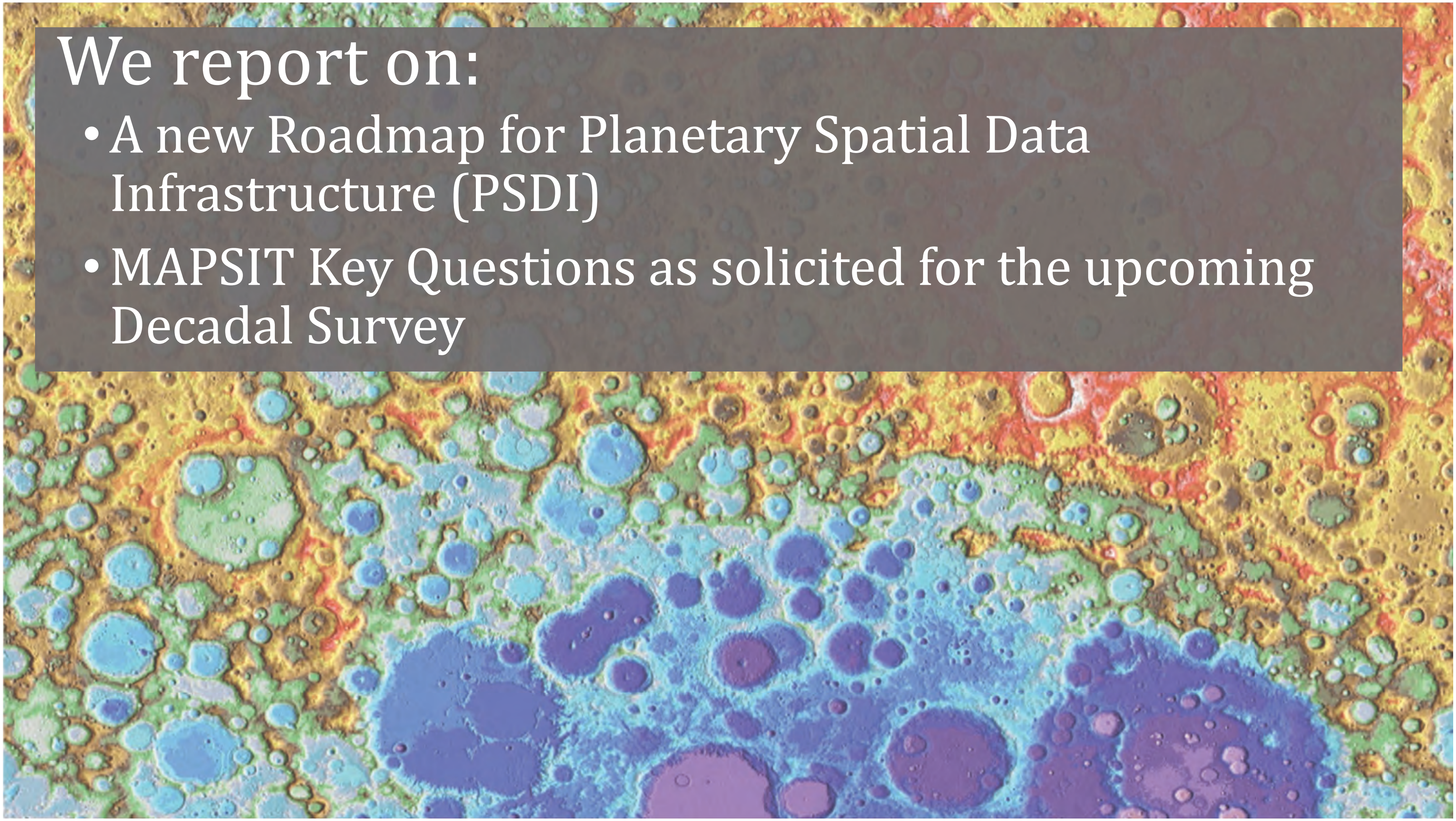
The Mapping and Planetary Spatial Infrastructure Team

Jani Radebaugh, Brad Thomson, Brent Archinal, Ross Beyer, Dani DellaGiustina, Caleb Fassett, Lisa Gaddis, Justin Hagerty, Trent Hare, Jay Laura, Sam Lawrence, Andrea Naß, Alex Pathoff, Sarah Sutton, Dave Williams, Pete Mouginis-Mark, Sander Goossens, Julie Stopar

Report to CAPS, September 2019

We report on:

- A new Roadmap for Planetary Spatial Data Infrastructure (PSDI)
- MAPSIT Key Questions as solicited for the upcoming Decadal Survey

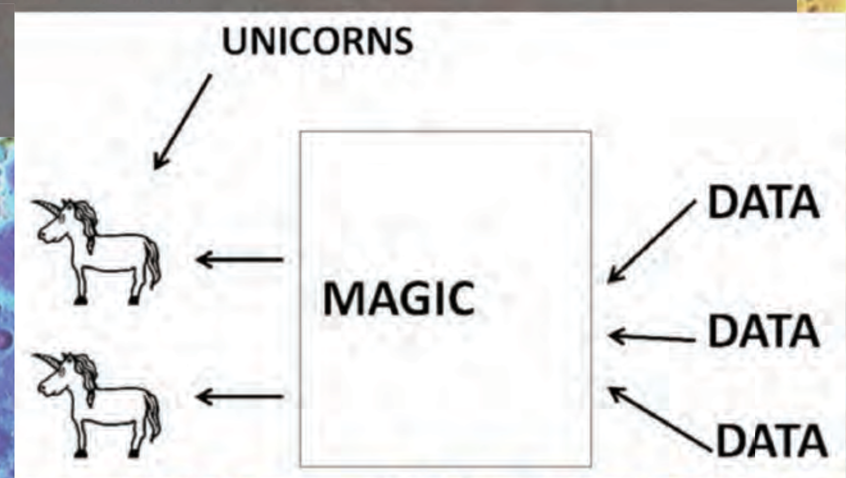


A PSDI Roadmap: Rationale

- Spatial data contribute significantly to the success of NASA endeavors *if they are correctly acquired, accessible, and usable.*
- Often, spatial data are *not readily interpretable* to users outside mission science teams or they are processed in ways that are *non-standard*.
- MAPSIT is tasked with strategizing within the planetary science community on ways to obtain spatial data appropriately and making them accessible and usable to the community.
- This effort has been recently completed as the Mapping and Planetary Spatial Data Infrastructure Roadmap 2019-2023.
  - https://www.lpi.usra.edu/mapsit/roadmap/MAPSIT-Roadmap-2019-06-19.pdf

What is Planetary Spatial Data Infrastructure?

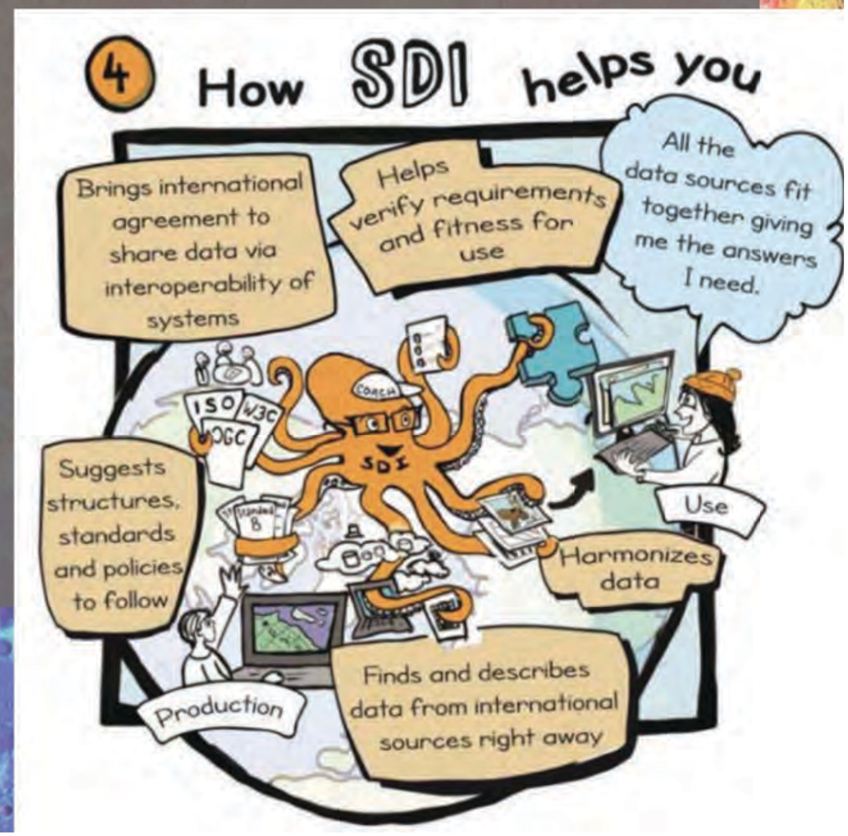
- A plan for obtaining and organizing data in a standardized way to make them discoverable, accessible and usable.
  - Often implemented as an online data center designed for a specific target or scientific purpose
- Most users want the data to *just work* – a PSDI should enable this!

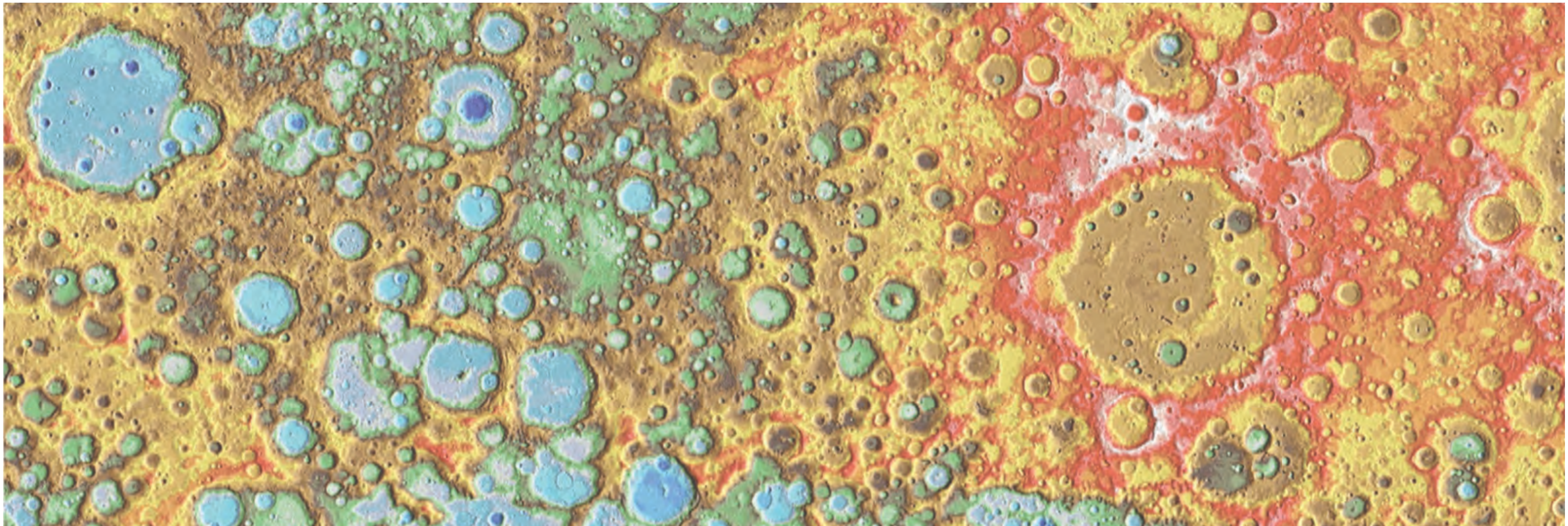


Don't we already have online applications?

- PSDIs are more dynamic than most data servers and tools
- Often the controlled, foundational data need to be created and registered to the body, so that the popular web-based tools or GIS-based applications can work.

Lots of Earth-based SDIs





Example of a **FOUNDATIONAL DATA PRODUCT** – provides basic positional information on which all other data can be placed.

Lunar Reconnaissance Orbiter (LRO) WAC Color Shaded Relief Map of the Lunar far side showing the northern South Pole Aitken basin, created from the Global Lunar Digital Terrain Model (100 m/pixel) and LOLA 30-m gridded DTM. (lroc.sese.asu.edu).

The Mapping and Planetary Spatial Data Infrastructure Roadmap 2019-2023 (summary)

- **Finding I:** NASA missions should obtain high-quality data that can be incorporated into foundational data products and thus maximize the value of the NASA science return.
- **Finding II:** NASA-funded projects, including missions and R&A projects, that obtain or create spatial data should deliver data that are usable and conform to standards.
- **Finding III:** Existing and new planetary spatial data should be easily discoverable and accessible, and data access tools must evolve with the technology.
- **Finding IV:** MAPSIT should coordinate with community representatives and groups, such as AGs, to ensure that foundational data products are produced and Planetary Spatial Data Infrastructures (PSDIs) are developed and maintained.
- **Finding V:** NASA and the planetary community should support the development of tools, technologies and expertise to ensure planetary spatial data are properly acquired, processed and available now and into the future.

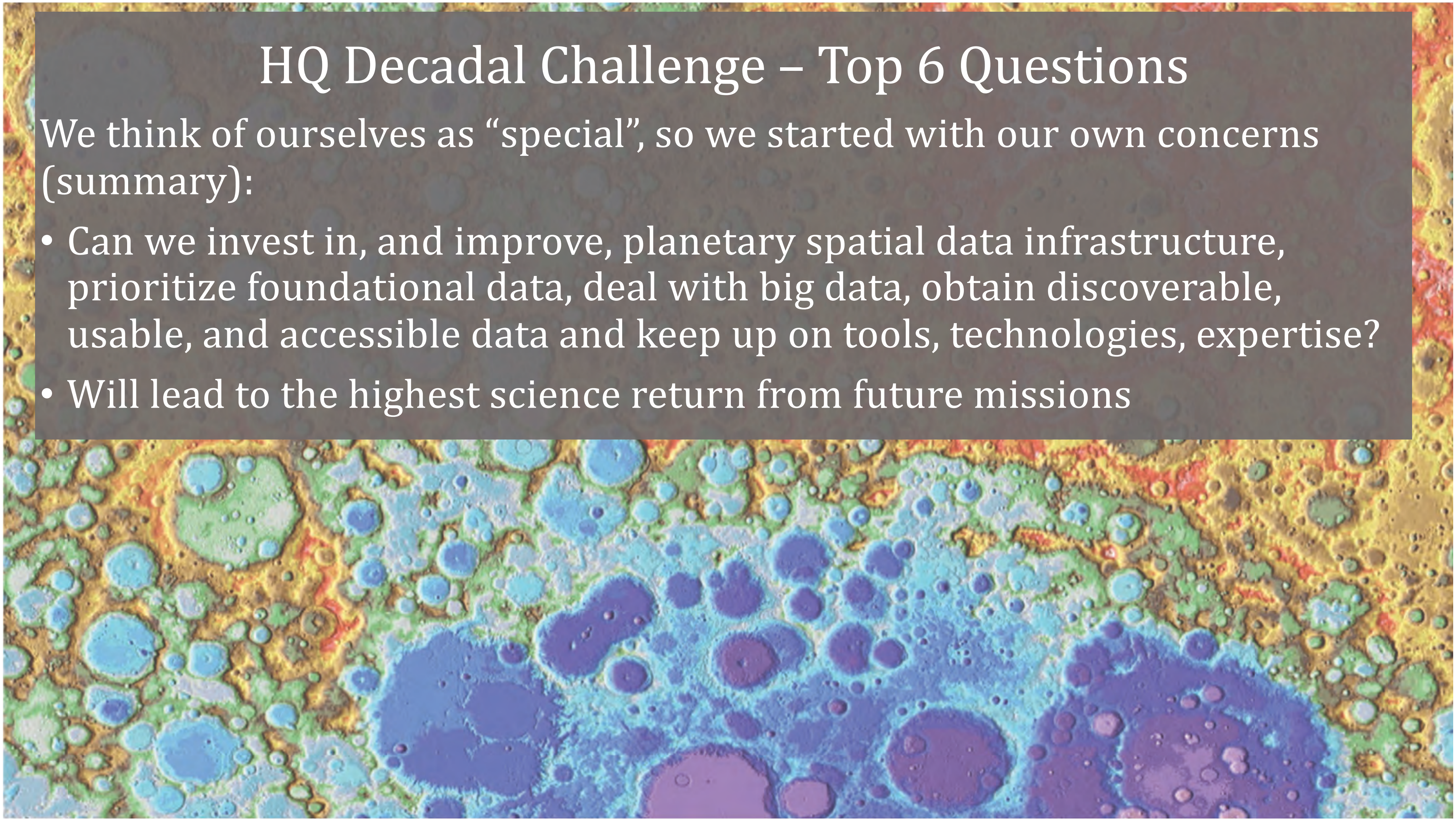
The Roadmap SCHEDULE

- The Roadmap was delivered to Sarah Noble at NASA HQ in May 2019, it will be discussed with other PMs at HQ in the coming months.
- In nearly final form it was presented at the LPSC town hall in March 2019, we will present it at the EPSC meeting in Geneva next week.
- Moving forward: DISCUSS WITH AGs our best interpretations for your PSDI haves and needs, try to help with your most current concerns, provide a basis to help you get funding to support this effort
  - Trial run at SBAG in spring 2019 – we heard a lot about Bennu, Psyche, and being responsive to NEO hazards

HQ Decadal Challenge – Top 6 Questions

We think of ourselves as “special”, so we started with our own concerns (summary):

- Can we invest in, and improve, planetary spatial data infrastructure, prioritize foundational data, deal with big data, obtain discoverable, usable, and accessible data and keep up on tools, technologies, expertise?
- Will lead to the highest science return from future missions



HQ Decadal Challenge – Best of the Top 6 Questions

- **1 -** Is or was there life in the Solar System beyond Earth?
- **2 -** What is the nature and distribution (in space and time) of habitable environments in the Solar System, and how do they help inform us about the early Earth and evolution of life?
- **3 -** What was the orbital evolutionary and impact history of our Solar System, and how does that relate to the compositions, atmospheres, interiors and geologic histories of planetary bodies?
- **4 -** What is the nature of the evolution of objects in the Solar System after their formation? How did their interiors change over geologic time, how did their surfaces evolve, and how did their atmospheres form and change?
- **5 -** What scientific objectives on the Moon, Mars, or small bodies are better solved with a human presence, and what are the needs for accomplishing these tasks once there?

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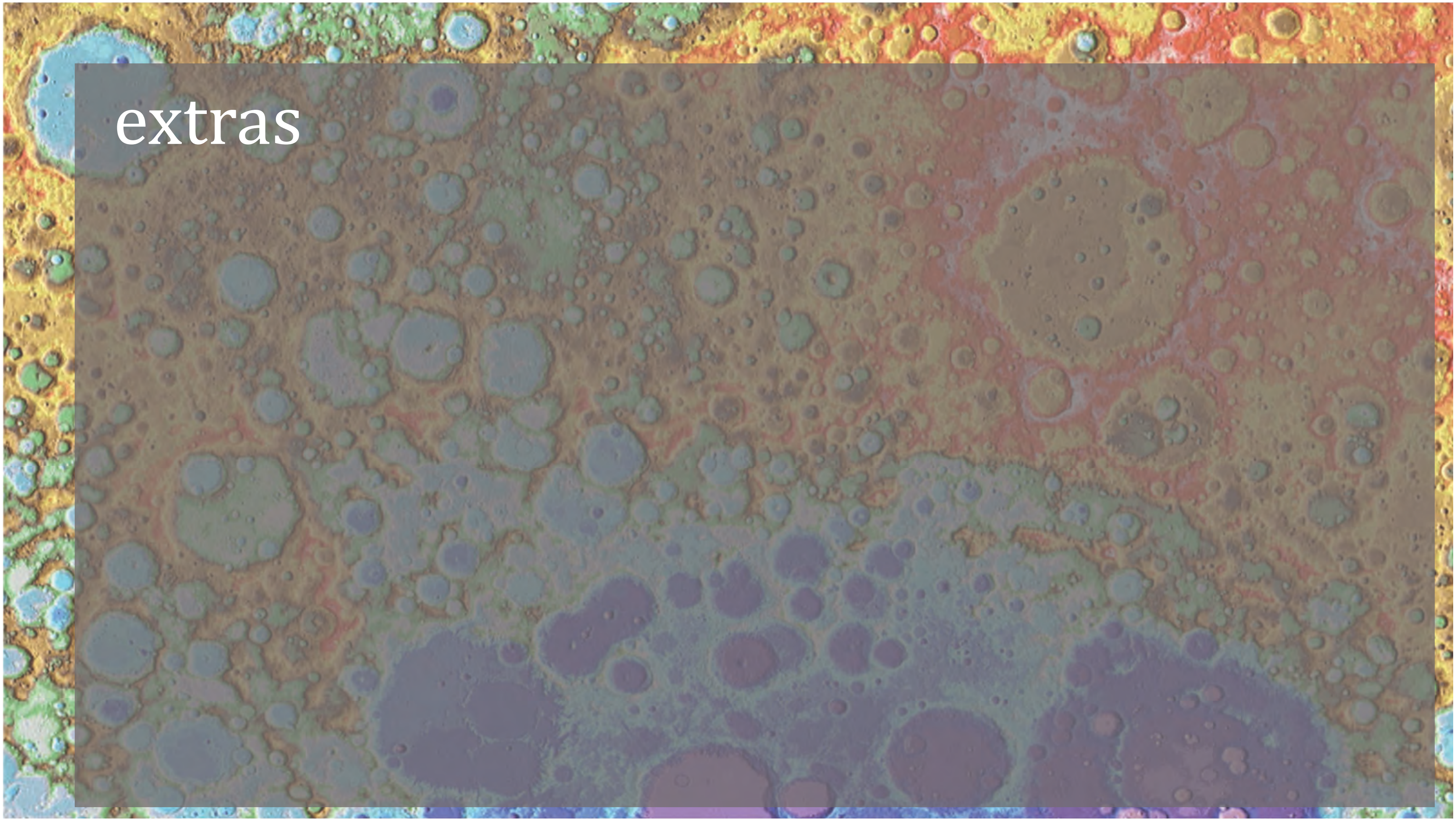
NEED PSDIs

extras



The Mapping and Planetary Spatial Data Infrastructure Roadmap 2019-2023

- **Finding I:** NASA missions should be encouraged to obtain high-quality data that can be incorporated into existing foundational data products, or create new foundational data products for unseen territory, and thus maximize the value of the NASA science return.
- **Finding II:** NASA-funded projects, including missions and R&A projects, that obtain or create spatial data should be encouraged to deliver data in formats that are easily usable and that conform to standards agreed upon by the community.
- **Finding III:** Existing and new planetary spatial data should be easily discoverable and accessible, and data access tools must evolve with the technology.
- **Finding IV:** MAPSIT should coordinate with community representatives and groups, such as other NASA Assessment Groups (AGs), to ensure that foundational data products are produced and that Planetary Spatial Data Infrastructures (PSDIs) are developed and maintained for each planetary body in the Solar System to best enable NASA exploration and mission goals.
- **Finding V:** NASA and the planetary community should support the development of tools, technologies and expertise to ensure planetary spatial data are properly acquired, processed and available for effective use to the fullest extent, now and into the future.

HQ Decadal Challenge – Top 6 Questions

We think of ourselves as “special”, so we started with our own concerns:

- 1) Can we invest in, and improve, the spatial data infrastructure presently used for planetary surfaces to accelerate the rate of scientific discoveries and maximize the return from past and future missions? What improvements in data, formats, standards, access and agency policy would lead the planetary science community to make the most progress going forward?
- 2) What steps can be taken so that future missions prioritize high-quality foundational data—obtained with accurate spacecraft tracking, ephemerides, and high geodetic fidelity—enabling future science and exploration? What can be done to improve the delivery of high-quality calibrated data, documentation, and higher-order data products to the broad scientific community by missions and instruments?
- 3) In an era with petabytes of data, how will individual scientists and institutions be able to address the community’s most important science questions with the full scope of information that current and future missions will gather?
- 4) How can we ensure future programs, missions, and projects obtain datasets that are not only archived appropriately, but also discoverable, usable, and accessible to future science users?
- 5) What investments in tools, technologies, and scientific expertise will lead to the highest science return from future missions?

HQ Decadal Challenge – Top 6 Questions

We think of ourselves as "special", so we started with our own concerns (summary):

- 1) Can we invest in, and improve, the spatial data infrastructure for planetary surfaces to accelerate the rate of scientific discoveries and maximize the return from past and future missions?
- 2) What steps can be taken so that future missions prioritize high-quality foundational data—obtained with accurate spacecraft tracking, ephemerides, and high geodetic fidelity—enabling future science and exploration?
- 3) In an era with petabytes of data, how will we be able to address the community's most important science questions with the full scope of information that current and future missions will gather?
- 4) How can we ensure future programs, missions, and projects obtain datasets that are not only archived appropriately, but also discoverable, usable, and accessible to future science users?
- 5) What investments in tools, technologies, and scientific expertise will lead to the highest science return from future missions?

MAPSIT – Mapping and Planetary Spatial Infrastructure Team

- The planetary community and NASA recognized the need for community input on how to help missions obtain useable data, and how to help users access and use data
- This team is the result
- An Analysis/Assessment Group (AG) like *VEXAG* etc., but independent of location in Solar System
  - Point of Contact at NASA HQ is Sarah Noble

MAPSIT – Mapping and Planetary Spatial Infrastructure Team

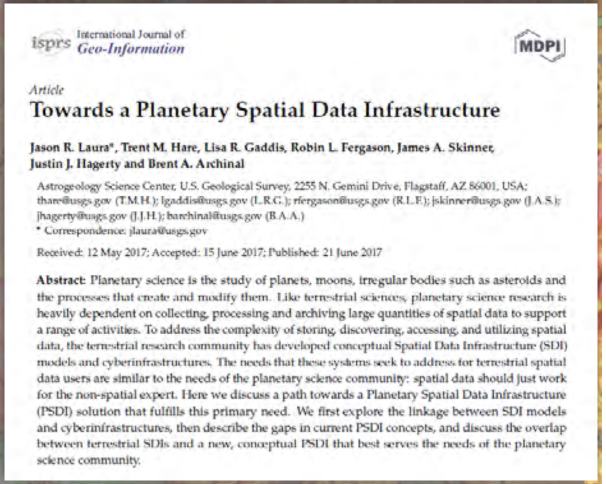
Steering Committee

- Jani Radebaugh, Brigham Young University [Chair]
- Samuel Lawrence, Johnson Space Center [Chair Emeritus]
- Brad Thomson, University of Tennessee Knoxville [Vice Chair]
- Brent Archinal, United States Geological Survey
- Ross Beyer, SETI Institute
- Daniella DellaGiustina, University of Arizona
- Caleb Fassett, NASA Marshall Spaceflight Center
- Lisa Gaddis, United States Geological Survey
- Sander Goossens, Univ. Maryland, NASA Goddard Space Flight Center
- Trent Hare, United States Geological Survey
- Jay Laura, United States Geological Survey
- Erwan Mazarico, NASA Goddard Space Flight Center
- Pete Mouginis-Mark, University of Hawaii
- Andrea Naß, German Aerospace Center DLR
- Alex Patthoff, Planetary Science Institute
- Sarah Sutton, University of Arizona
- Julie Stopar, Lunar & Planetary Institute
- David Williams, Arizona State University

- Website: http://www.lpi.usra.edu/mapsit

What is a Spatial Data Infrastructure?

- A theoretical concept developed in terrestrial community
- For planning, not a canned solution
- Goals are to improve data
  - Discoverability
  - Accessibility
  - Usability
- Broader than just data
  - Data sets and products
  - Technologies (access, processing, use, preservation)
  - Human resources (training and continuity of knowledge, outreach)
  - Standards



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Article

Towards a Planetary Spatial Data Infrastructure

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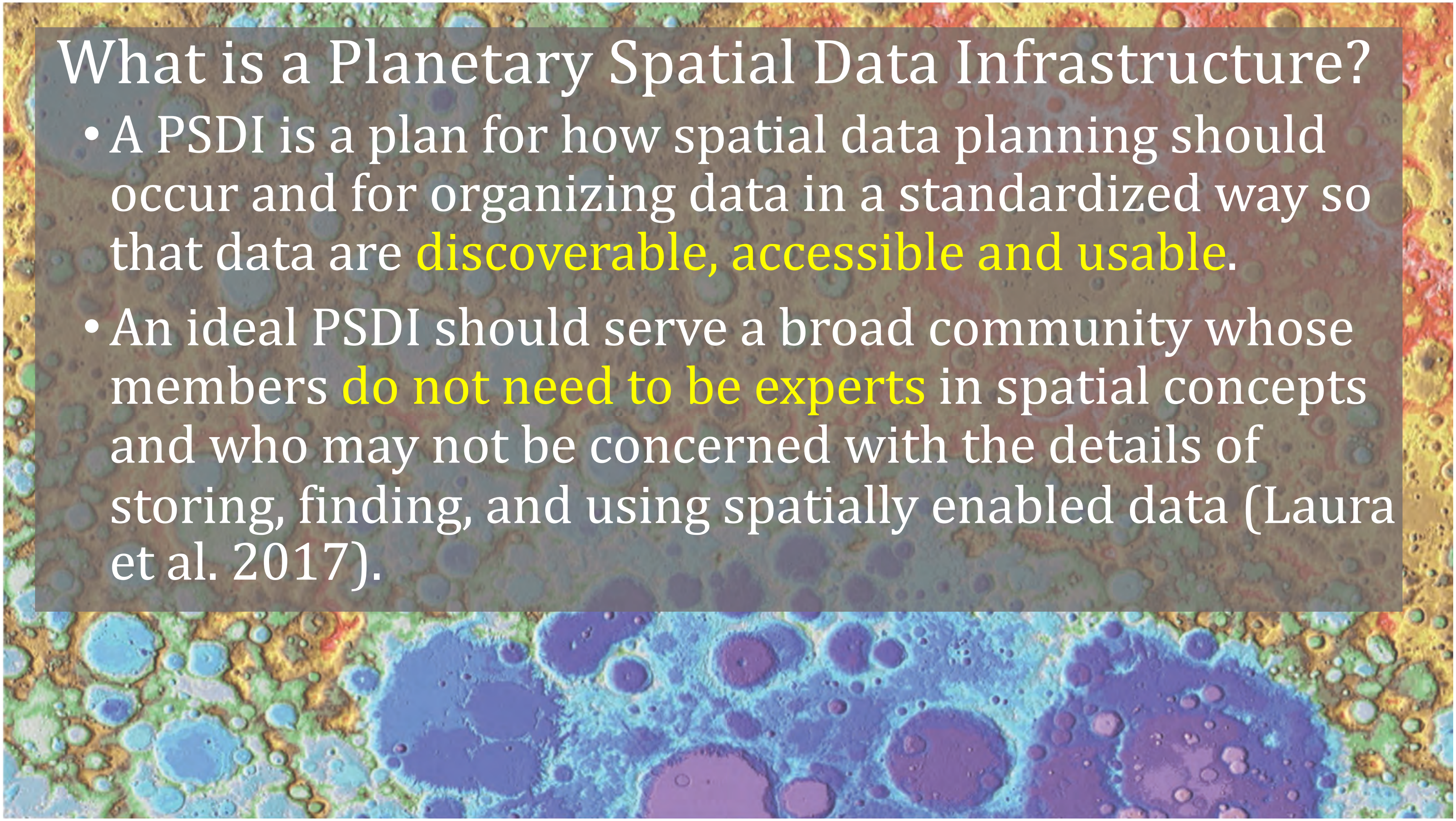
Abstract: Planetary science is the study of planets, moons, irregular bodies such as asteroids and the processes that create and modify them. Like terrestrial sciences, planetary science research is heavily dependent on collecting, processing and archiving large quantities of spatial data to support a range of activities. To address the complexity of storing, discovering, accessing, and utilizing spatial data, the terrestrial research community has developed conceptual Spatial Data Infrastructure (SDI) models and cyberinfrastructures. The needs that these systems seek to address for terrestrial spatial data users are similar to the needs of the planetary science community: spatial data should just work for the non-spatial expert. Here we discuss a path towards a Planetary Spatial Data Infrastructure (PSDI) solution that fulfills this primary need. We first explore the linkage between SDI models and cyberinfrastructures, then describe the gaps in current PSDI concepts, and discuss the overlap between terrestrial SDIs and a new, conceptual PSDI that best serves the needs of the planetary science community.

- *See Laura et al.* (2017) ISPRS Int. J. Geo-Inf., 6, 181, doi:10.3390/ijgi6060181 *for a theoretical framework for a Solar System-wide PSDI*

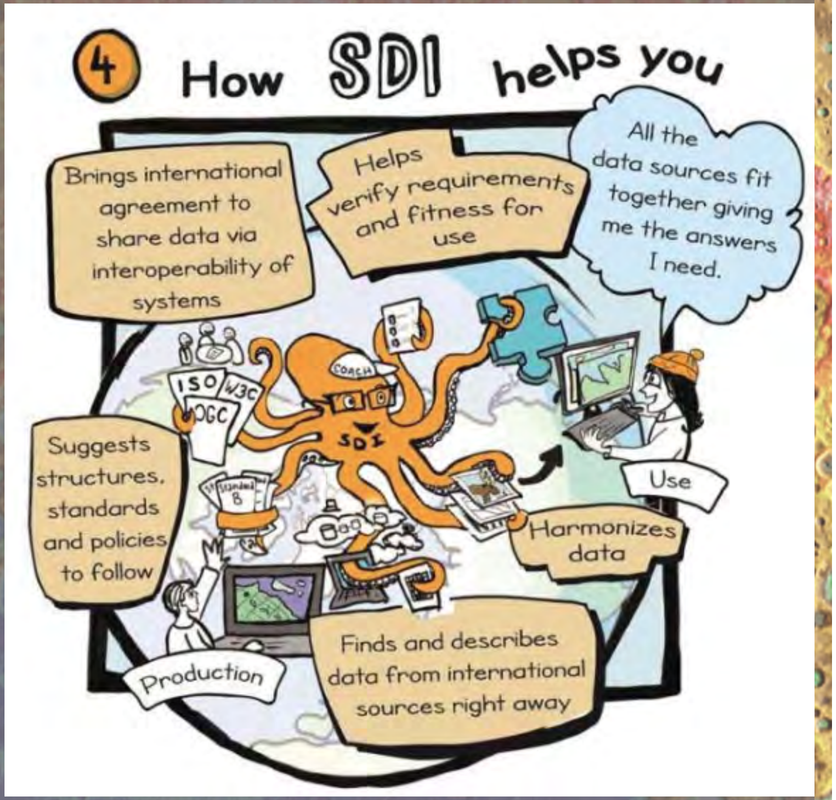


What is a Planetary Spatial Data Infrastructure?

- A PSDI is a plan for how spatial data planning should occur and for organizing data in a standardized way so that data are discoverable, accessible and usable.
- An ideal PSDI should serve a broad community whose members do not need to be experts in spatial concepts and who may not be concerned with the details of storing, finding, and using spatially enabled data (Laura et al. 2017).

What is a Spatial Data Infrastructure?

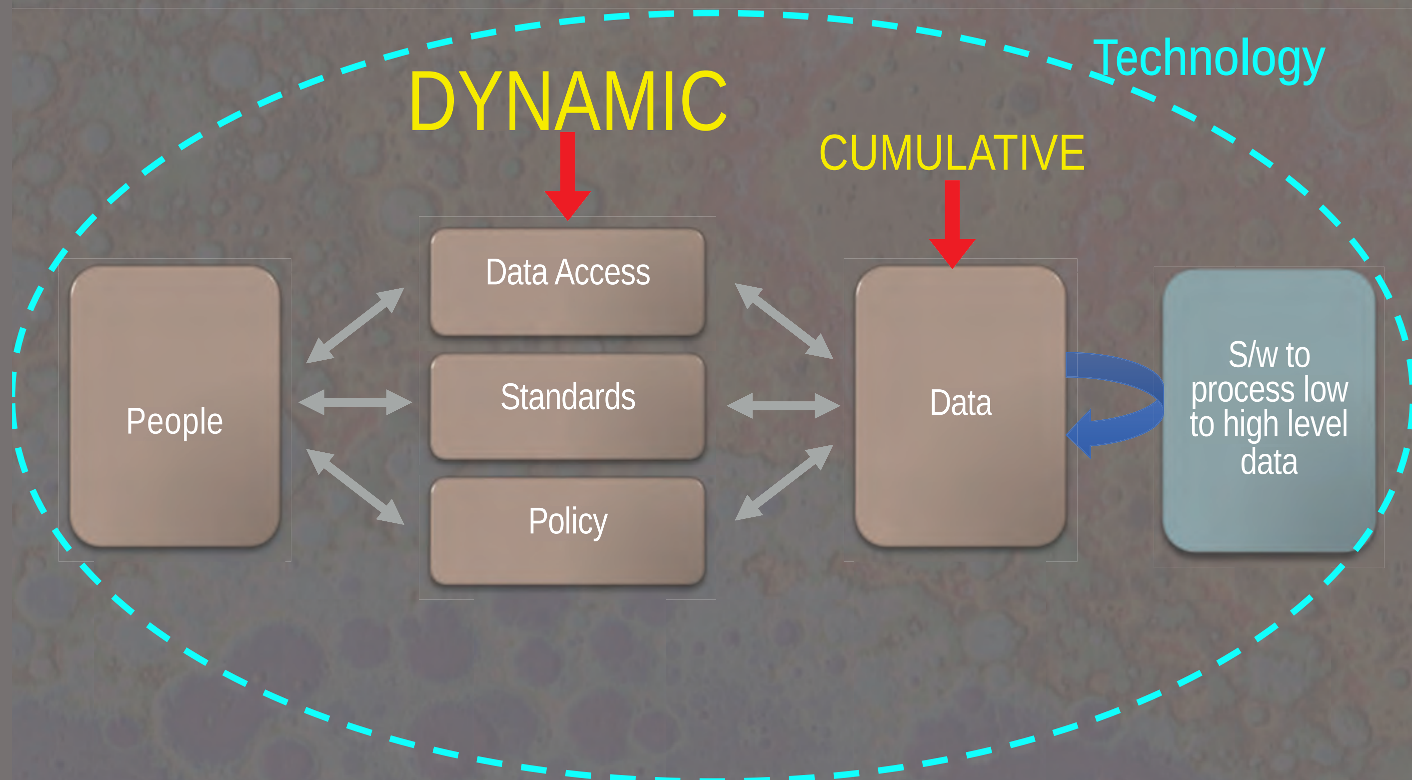
- Conceptual tool
- Goals are to improve data...
  - Discoverability
  - Accessibility
  - Usability
- Also include:
  - Data sets and products
  - Technologies (access, processing, use, preservation)
  - Human resources (training, continuity of knowledge, outreach)
  - Standards



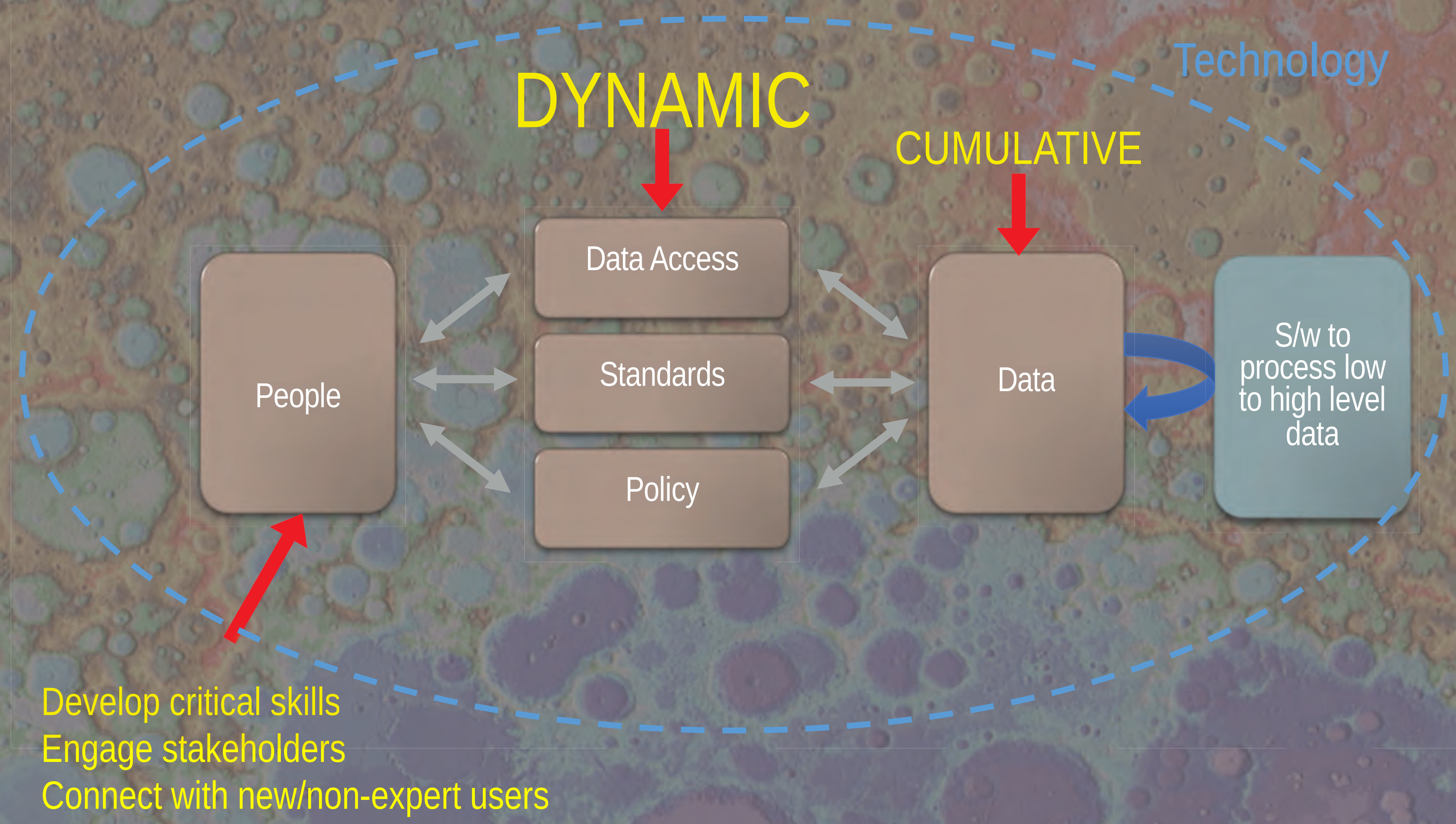
- *See Laura et al.* (2017) *Solar System-wide PSDI*

What is a Planetary Spatial Data Infrastructure?

- Involves data ***and*** users, standards, policy, access
- ***Data should just work!***
- Users can:
  - develop critical skills
  - Engage stakeholders
  - connect with new/non-expert users
- *See Laura et al.* (2017) *Solar System-wide PSDI*



Elements of a Spatial Data Infrastructure

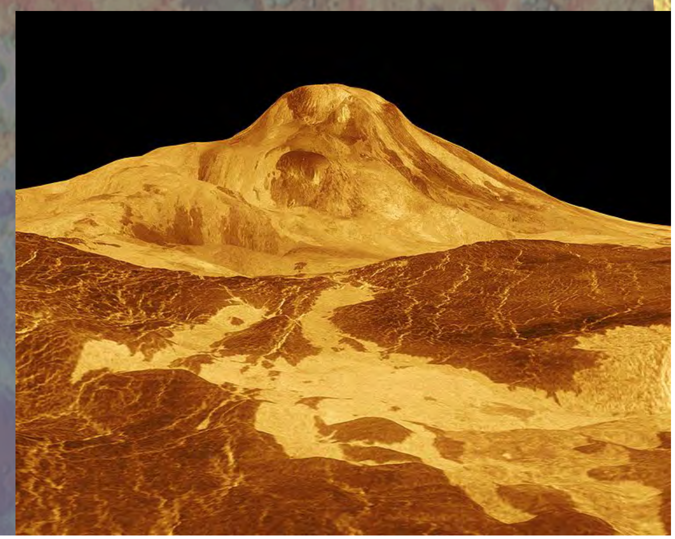


Types of Data Products

- Geodetic Coordinate Reference Frame
- Elevation (Topographic) Data
- Orthoimages / Orthomosaics

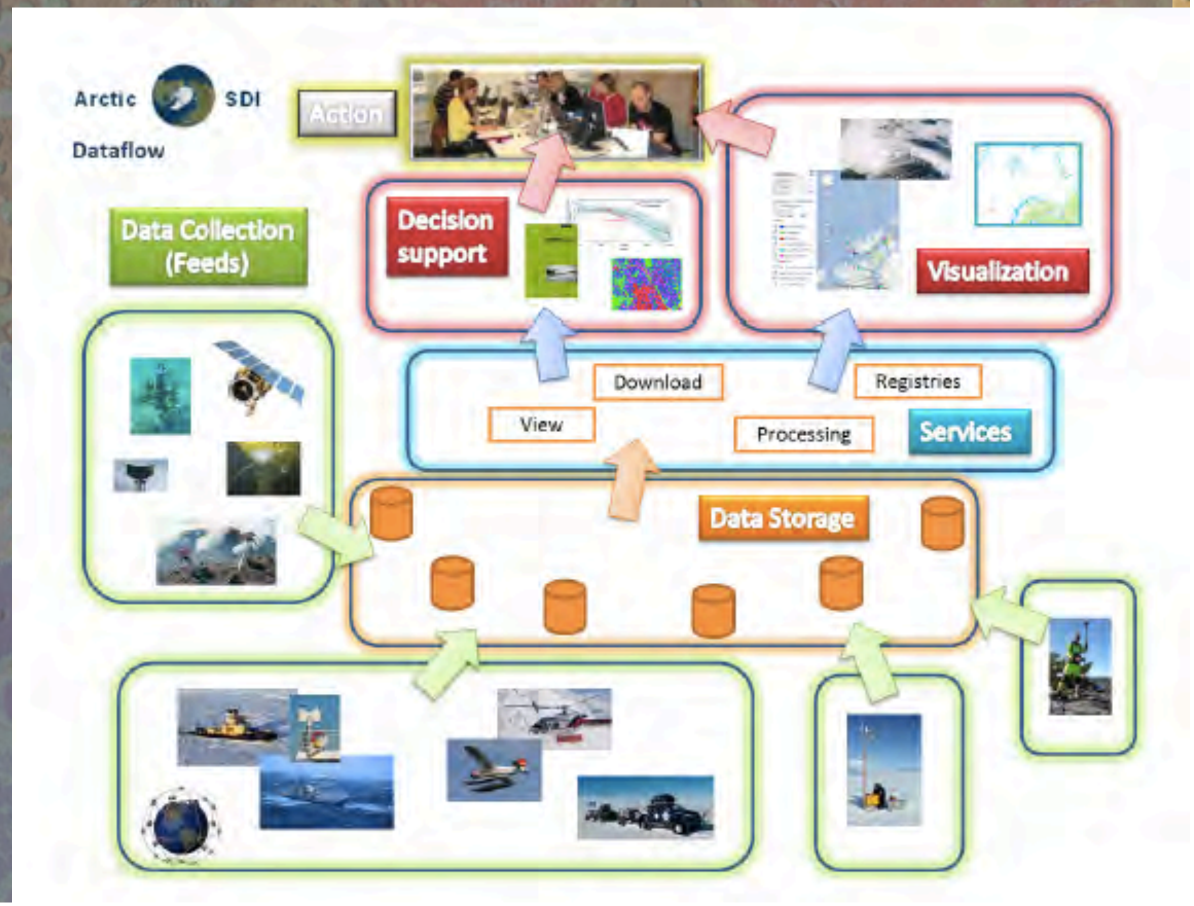
Planetary Examples

- Geodetic Coordinate Reference Frames
  - IAU defined lat/lon and ephemeris
  - Planetary is special: geodetic coordinate reference frames are iteratively defined as data improves. (laser altimetry (e.g. LOLA) for the Moon)
  - As a non spatial expert - these should just work
- Elevation Data
  - Mars DTM from MOLA, Magellan DEM
  - As a non spatial expert - these should just work
- Orthorectified Orthomosaics
  - Global Io Voyager/Galileo basemap
  - As a non spatial expert - these should just work



Example – Arctic Spatial Data Infrastructure

- Data from 12 different organizations – required heavy standardization
- Available in widely used geospatial formats
- Search enabled by tight data/information coupling
- Data available to all kinds of users



Doesn’t the PDS serve all data needs?

- PDS is tasked with long-term preservation of data
- Most frequently, data stored within the Planetary Data System (PDS) archive are not spatially enabled for immediate use by non-expert research scientists.
- Instead, adequate metadata are provided along with the image data that enable the user to create spatially enabled products.
- Significant expertise is required to perform these operations and interpret the spatial correctness of the products.

The Mapping and Planetary Spatial Data Infrastructure Roadmap

- Encourages the creation of initiatives to ensure that planetary spatial data are correctly obtained and processed and are discoverable and usable for a wide range of research and exploration purposes.