EXPLORE
SOLAR SYSTEM&BEYOND
With The Planetary Data System Search API

**Jordan Padams, Thomas Loubrieu, Jimmie Young, Albert Niessner,
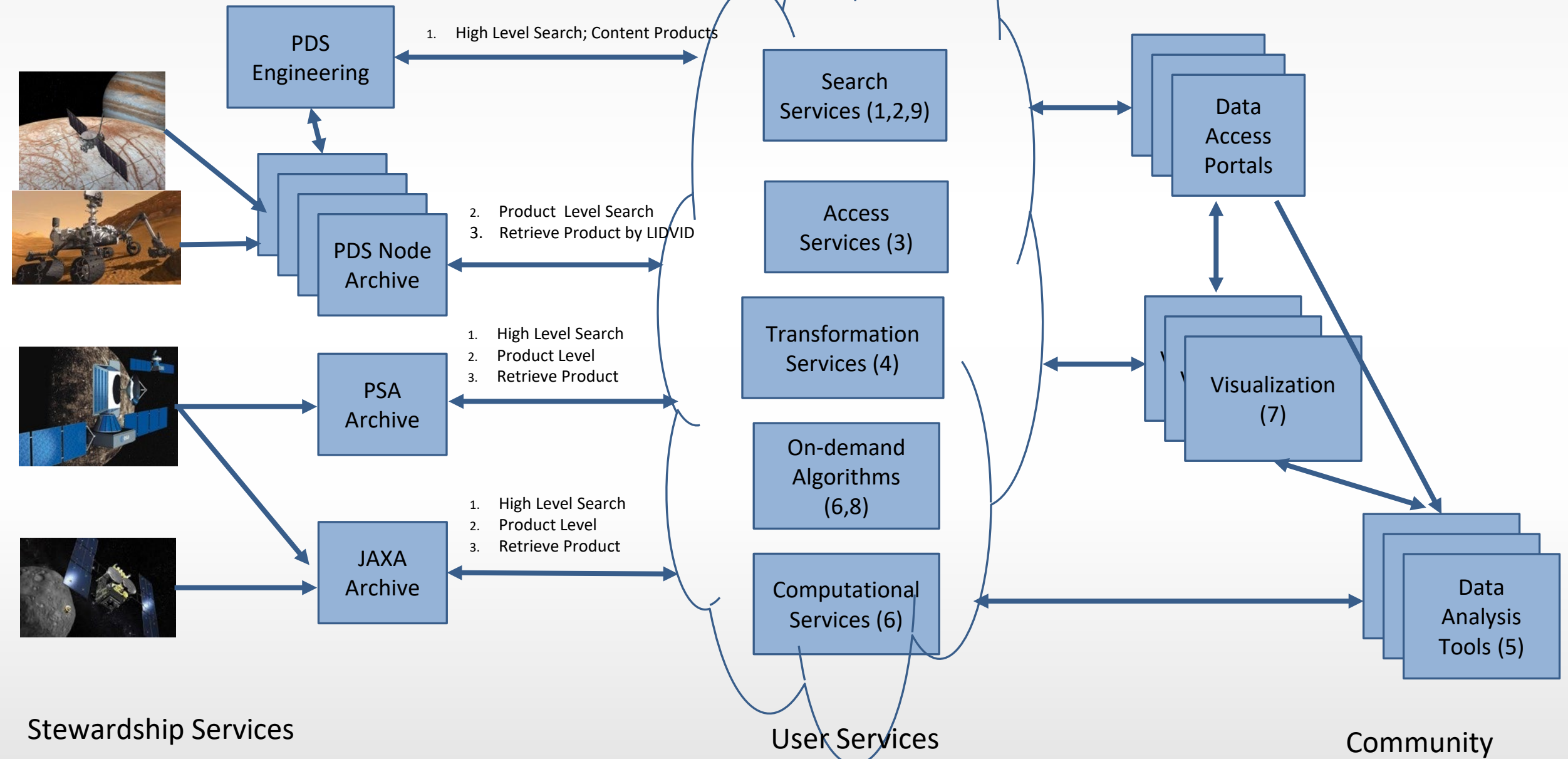John S. Hughes, Daniel Crichton, Vivian Tang**

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
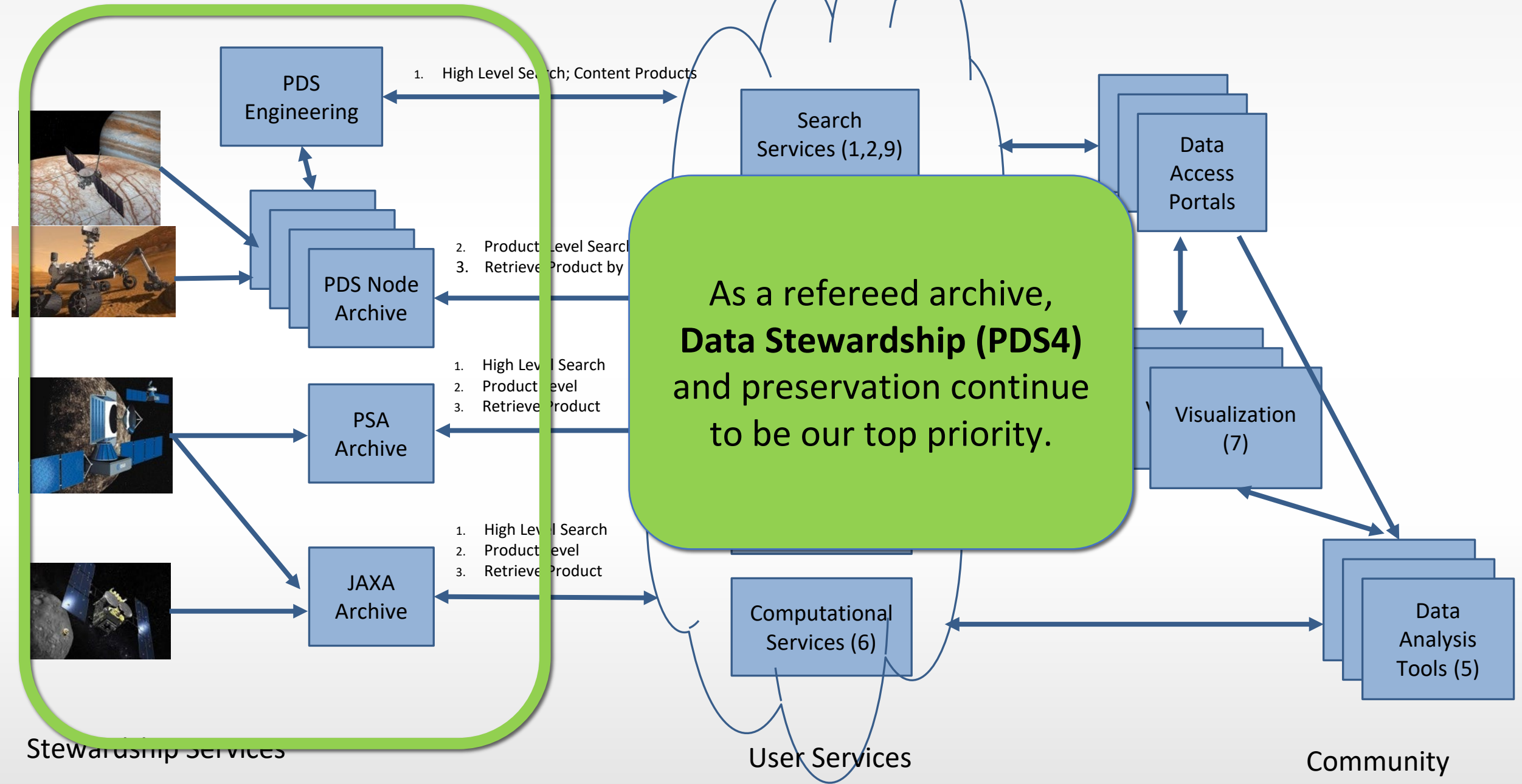
BACKGROUND

DATA SERVICES VISION

Providing an **integrated world-wide data services platform** that enables the efficient **discovery**, **dissemination**, **use** and **analysis** of internationally sponsored **planetary science archives.**

PDS Data Services Initiative

PDS Engineering

1. High Level Search; Content Products

Search Services (1,2,9)

Data Access Portals

PDS Node Archive

2. Product Level Search
3. Retrieve Product by

As a refereed archive,
Data Stewardship (PDS4)
and preservation continue
to be our top priority.

PSA Archive

1. High Level Search
2. Product Level
3. Retrieve Product

Visualization (7)

JAXA Archive

1. High Level Search
2. Product Level
3. Retrieve Product

Computational Services (6)

Data Analysis Tools (5)

Stewardship Services

User Services

Community

PDS Data Services Initiative

But, we need to improve **discoverability, accessibility,** and **usability** of the archives
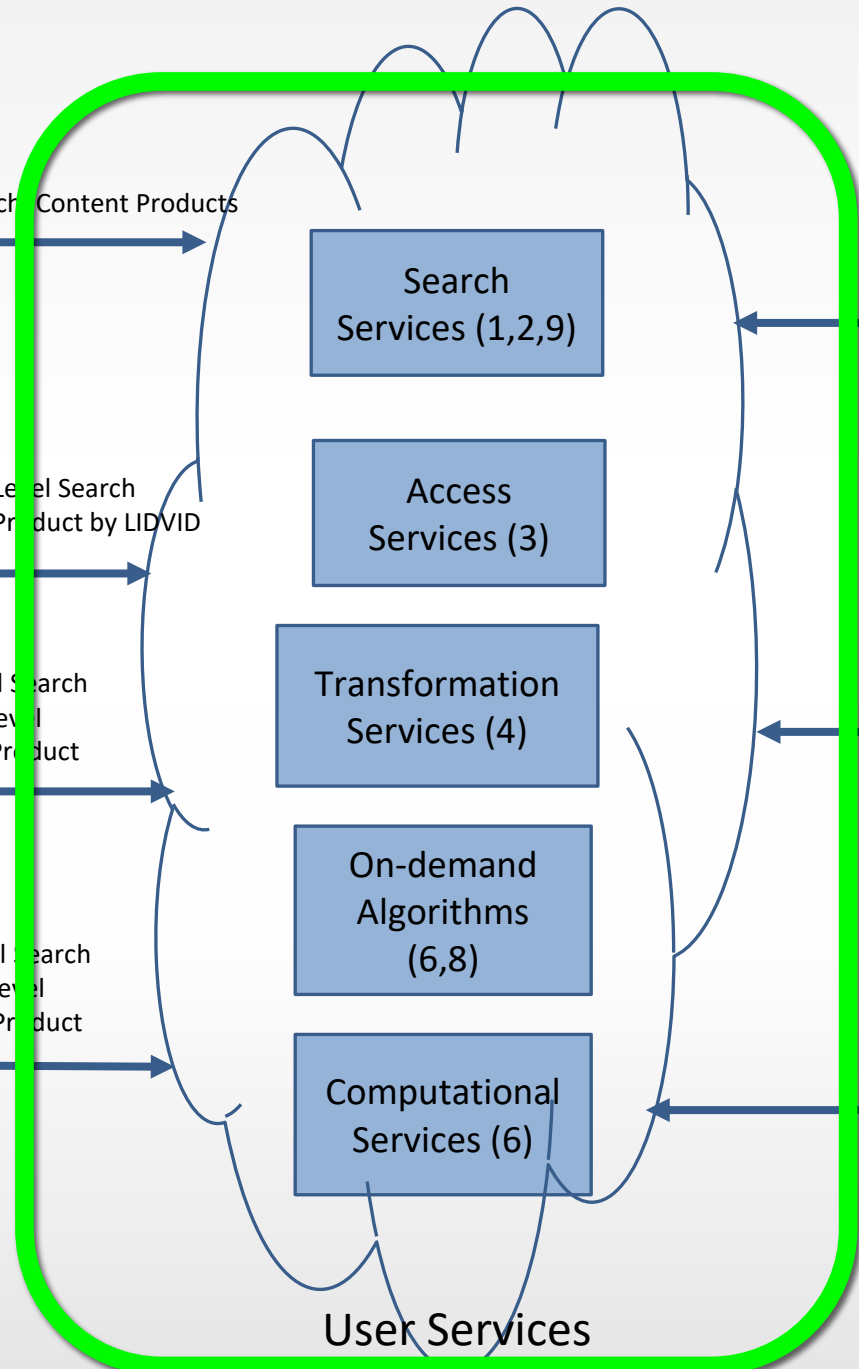
PDS Engineering

1. High Level Search Content Products

...duct Level Search
...rieve Product by LIDVID

...n Level Search
...duct Level
...rieve Product

JAXA Archive

1. High Level Search
2. Product Level
3. Retrieve Product

Search Services (1,2,9)

Access Services (3)

Transformation Services (4)

On-demand Algorithms (6,8)

Computational Services (6)

Data Access Portals

Visualization (7)

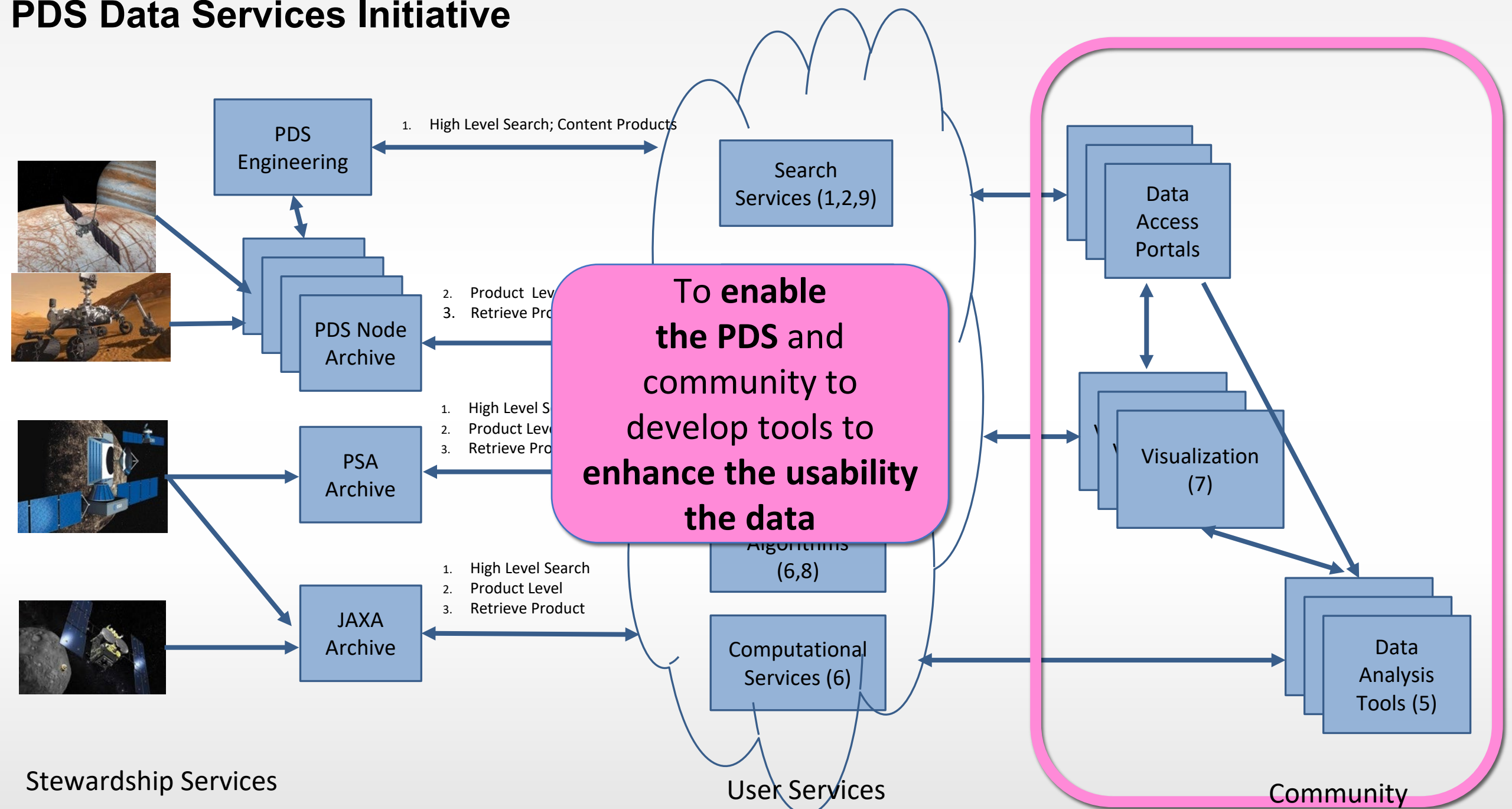Data Analysis Tools (5)

Stewardship Services

User Services

Community

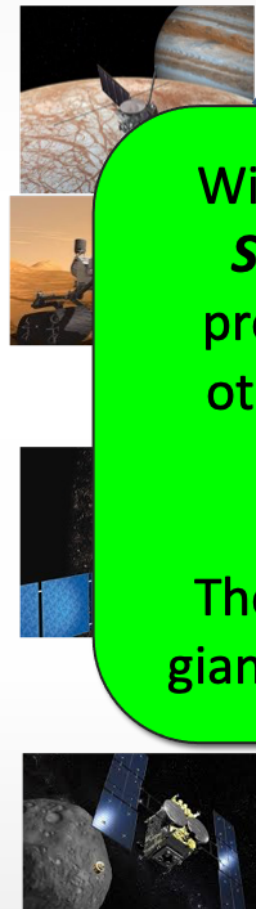# PDS Data Services Initiative

Stewardship Services   User Services   Community

With PDS4 driving the system, *Search and Access services* provide the foundation for all other tool and services in the system.

The **PDS Search API** is the first giant leap towards enabling this.

Search Services (1,2,9)

Access Services (3)

Transformation Services (4)

On-demand Algorithms (6,8)

Computational Services (6)

PDS Engineering

1. High Level Search; Content Products

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PDS SEARCH API INTRO

The PDS Search API provides endpoints:

- to search for bundles, collections and any PDS products with advanced search queries.

- to browse the archive hierarchically downward (e.g. collection's products) or upward (e.g. bundles containing products),

- to resolve an identifier (lid or lidvid) and retrieve the product label and data where ever it is in the Planetary Data System.

SEARCH

- **Query Parameters** re-use the PDS4 Information model and metadata definitions in the API itself.
  - Names
  - Data types (time vs. integer vs. string)

PDS4

```
<Time_Coordinates>
      <start_date_time>2021-02-22T21:21:45.014Z</start_date_time>
```

Search API

```
Time_Coordinates.start_date_time gt 2021-02-01T00:00:00Z
```

https://nasa-pds.github.io/pds-api/search-api-user-guide/endpoints.html#search-products

QUERY PARAMETERS

q	(Optional, string) Query string you wish to parse and use for search. See query string syntax	q=target_name eq "Mars"
keyword	(Optional, string) String used for text search on title and description of the PDS4 labels	insight
fields	(Optional, array of strings) Array of fields you wish to return.	fields=lid,Time_Coordinates.start_date_time
start	(Optional, integer, default=0) The search result to start with in the returned records. For instance, start=10 will return records 10-19. Useful for pagination of the results.	start=100

QUERY PARAMETERS

limit	(Optional, integer, default=100) The number of records/results to return.	limit=100
sort	(Optional, string, default=LIDVID) Field to sort on and whether it should be sorted ascending (ASC) or descending (DESC). *fieldName asc* or *fieldName desc*. There can be several sort parameters (order is important).	sort=lidvid asc, Time_Coordinates.start_date_time desc
summary-only	(Optional, boolean, default=False) When true, only the summary of the results is returned, not the individual results	true

BROWSE
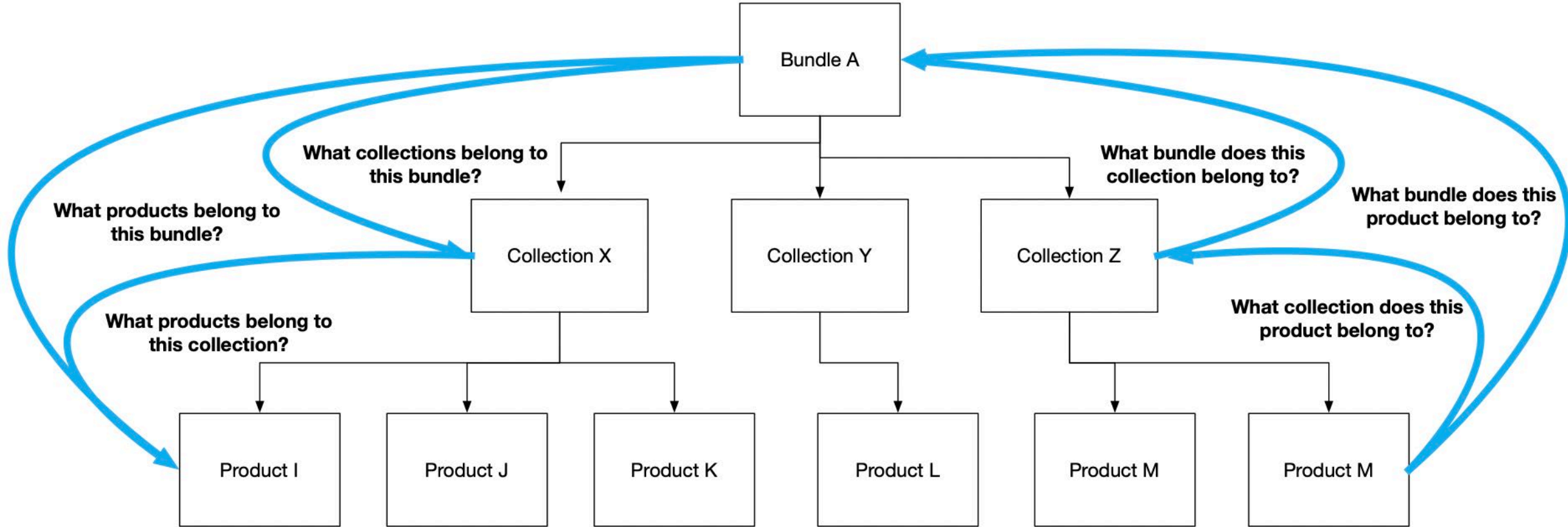
bundles ⌃

GET `/bundles` returns all PDS bundles that meet all given constraints. ⌄

GET `/bundles/{identifier}` returns one product with the identifier selected from all PDS bundles. See identifier for details on how it determines what is returned. ⌄

GET `/bundles/{identifier}/latest` returns one product with the identifier selected from all PDS bundles. See identifier for details on how it determines what is returned. ⌄

GET `/bundles/{identifier}/all` returns all product versions with the identifier (lid) selected from all PDS bundles. See identifier for details on how it determines what is returned. ⌄

bundle's collections ⌃

GET `/bundles/{identifier}/collections` returns one or more latest version collections that are contained or referenced by the bundle specified by identifier. See identifier for details on how it determines what is returned. ⌄

GET `/bundles/{identifier}/collections/latest` returns one or more latest version collections that are contained or referenced by the bundle specified by identifier. See identifier for details on how it determines what is returned. ⌄

GET `/bundles/{identifier}/collections/all` returns one or more collections that are contained or referenced by the bundle specified by identifier. See identifier for details on how it determines what is returned. ⌄

bundle's products ⌃

GET `/bundles/{identifier}/products` returns one or more latest version products that are contained or referenced by the bundle specified by identifier. See identifier for details on how it determines what is returned. ⌄

collections ⌃

GET `/collections` returns all PDS collections that meet all given constraints. ⌄

GET `/collections/{identifier}` returns one product with the identifier selected from all PDS collections. See identifier for details on how it determines what is returned. ⌄

GET `/collections/{identifier}/latest` returns one product with the identifier selected from all PDS collections. See identifier for details on how it determines what is returned. ⌄

GET `/collections/{identifier}/all` returns all collection versions with the identifier (lid) selected from all PDS collections. See identifier for details on how it determines what is returned. ⌄

collection's containing bundles ⌃

GET `/collections/{identifier}/bundles` returns one or more bundles that contain or reference the product specified by identifier selected from all PDS collections. See identifier for details on how it determines what is returned. ⌄

collection's products ⌃

GET `/collections/{identifier}/products` returns one or more latest version products that are contained or referenced by the collection specified by identifier. See identifier for details on how it determines what is returned. ⌄

GET `/collections/{identifier}/products/latest` returns one or more latest version products that are contained or referenced by the collection specified by identifier. See identifier for details on how it determines what is returned. ⌄

GET `/collections/{identifier}/products/all` returns one or more products that are contained or referenced by the collection specified by identifier. See identifier for details on how it determines what is returned. ⌄

RESOLVE

- Pre-requisite: I know the LID or LIDVID identifier of a product

- Add LID / LIDVID (aka **{identifier}**)into the following curl request to retrieve the products metadata:

```
curl --location --header 'Accept: application/json' --request GET
      `https://pds.nasa.gov/api/search/1.0/products/{identifier}`
```

For example:

```
curl --location --header 'Accept: application/json' --request GET \
      'https://pds.nasa.gov/api/search/1.0/products/urn:nasa:pds:insight_rad::2.1'
```

RESPONSE FORMATS

Accept Header	Format	Note
application/json	JSON	Simplified JSON view of the PDS4 metadata label. Contains "flattened" PDS4 properties extracted from the metadata label
application/xml	XML	Same as application/json, but in an XML
application/vnd.nasa.pds.pds4+json	JSON	JSON response containing the full PDS4 metadata translated to JSON, along with some additional supplemental
application/vnd.nasa.pds.pds4+xml	XML	Same as application/vnd.nasa.pds.pds4+json, but in an XML format. This response format contains the original PDS4 labels.
application/kvp+json	JSON	JSON response containing key-value-pairs for the applicable metadata.
text/csv	CSV	Returns a CSV table containing values for the parameters in the request. If no parameters were specified in the request, a default set is returned. The first row of the CSV is a header that describes the values in each column.
text/html	HTML	JSON response embedded in an HTML body. This format is provided for requests coming from the browers (e.g. Google Chrome) URL bar.

EXAMPLE

Use the PDS demo web API server

Connect to the demo server. See User Interface of the web API: https://pds-gamma.jpl.nasa.gov/api/swagger-ui.html

Note: this piece of code will be wrapped into a helper function so that 1 line will be enough to connect to the API using a default host

```python
configuration = pds_api.Configuration()

# demo server
configuration.host = 'https://pds-gamma.jpl.nasa.gov/api/'

api_client = pds_api.ApiClient(configuration)
```

Get observations around specific spot (lat=12, lon=24) closer than 4 km

Get the result found in part1 by directly posting the search criteria to the API

The query syntax is described in the PDS API specification. It uses the following operators:

- comparison: lt, le, ...
- boolean: and, or, not
- groups: (,)

```python
start_time = time.time()

products_api = pds_api.ProductsApi(api_client)

criteria = "((orex:spatial.orex:target_range lt 4.0)"
criteria += " and (orex:spatial.orex:latitude ge 9.0) and (orex:spatial.orex:latitude le 15.0)"
criteria += " and (orex:spatial.orex:longitude ge 21.0) and (orex:spatial.orex:longitude le 27.0))"

properties_of_interest = ['orex:spatial.orex:latitude', 'orex:spatial.orex:longitude', 'orex:spatial.orex:target_range', '

closer_products = products_api.products(q=criteria, fields=properties_of_interest)

elapsed = time.time() - start_time
print(f'retrieved {len(closer_products.data)} products in {elapsed} seconds')
```

Plot the data (FITS files)

Plot the spectra of the 4 observations on the same figure, one figure per dimension of the instrument.

```python
hduls = [fits.open(data_file) for data_file in data_files]

for i in range(20): # for each dimension of the instrument
    fig, ax = plt.subplots()
    ax.set_title(f'detector {i}')
    for hdul in hduls: # for each observation
        ax.plot(hdul[2].data[0, i, :], hdul[0].data[0, i, :])
    ax.set_xlabel('wavelength (micrometers)')
    ax.set_ylabel('radiance')
```
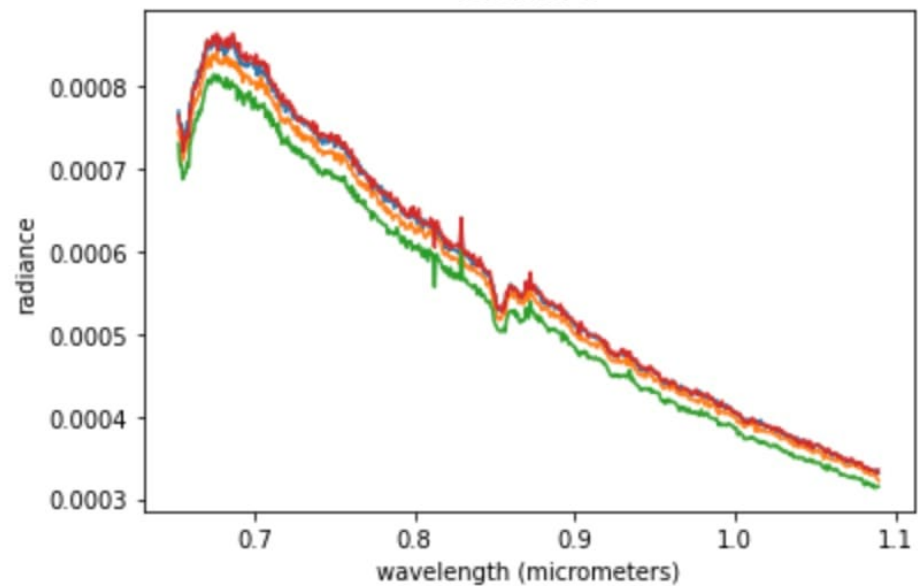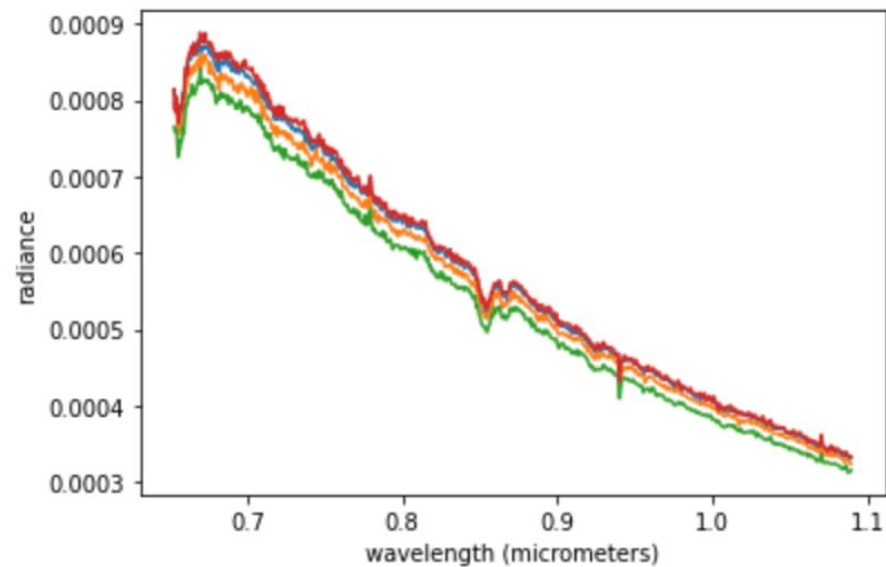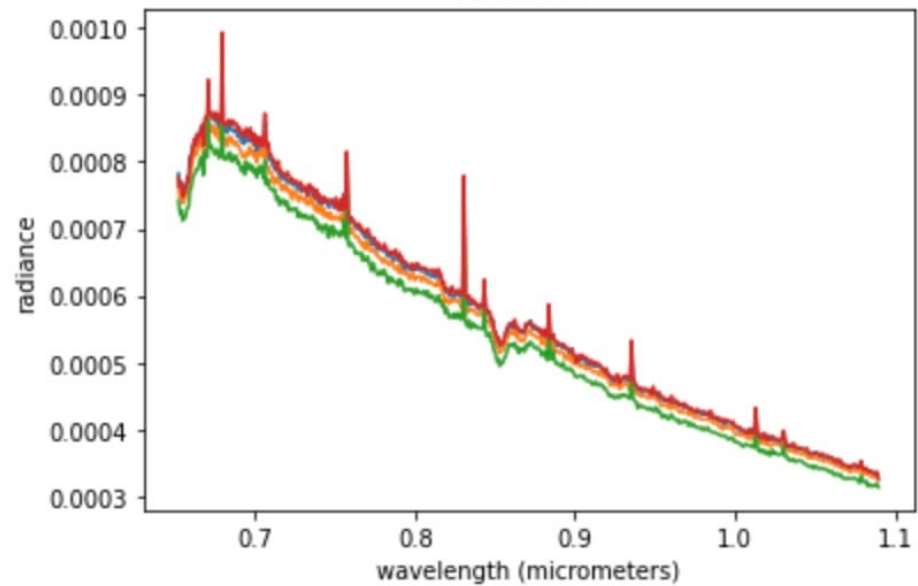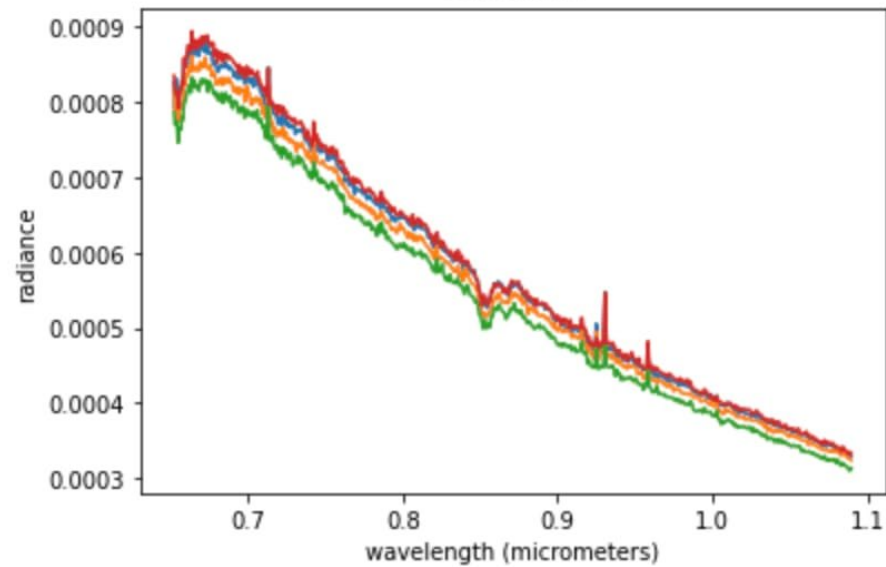
COMING SOON...

- More PDS4 data!

- Document API-enabled data sets

- Faceting

- Enhanced free-text / keyword search

FUTURE PLANS

- Load more data!
    - PDS3 Data Sets
    - Annex derived data sets (non-"archival")
    - Data tags (e.g. machine-learning labels)

- Integration, integration, integration
    - With other APIs (e.g. EPN-TAP, PDAP)
    - With other Planetary Science Archives (e.g. PSA, JAXA)
    - With other components of the Planetary Data Ecosystem (e.g. Treks, Quickmaps)
    - With other data systems (e.g. Astrophysics, Earth Science, Heliophysics)

- Workshops and Tutorials
    - Build out Jupyter Notebooks Library with additional examples
    - Virtual workshops to walk through demos and real-world analysis examples

FUTURE PLANS

- New PDS Search Engine
  - Search across all PDS data sets and documentation
  - Forwarded to discipline-specific search and tools for product-level searching
  - Part of overall PDS Web Modernization effort

NASA Planetary Data System

PDS Nodes ⌄   🔍 Search

Marvel at the beauty of our Universe!

View stunning imagery captured by various NASA missions and catalogued by Photojournal.

Explore Photojournal

WHAT IS PHOTOJOURNAL
Learn about Photojournal ➜

WHAT IS CATALOGUED
Tour the Photojournal archive ➜
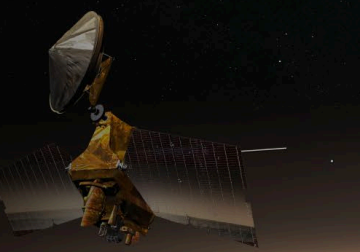
WHAT'S NEW
Discover the latest imagery ➜

Search The Planetary Data System

🔍 Search our website

Featured Announcements

More PDS Announcements ➜

DATA RELEASE

PLANETARY DATA SYSTEM
Mars Reconnaissance Orbiter (MRO) Data Release #60
This release includes new CRISM data, SHARAD EDRs and RDRs, and SHARAD radargrams.
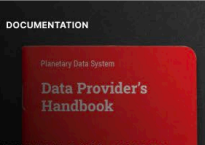
TOOLS & SERVICES

RING-MOON SYSTEMS
OPUS 3.11.02 Release Notes

DATA RELEASE

PLANETARY DATA SYSTEM
Insight Release #11

DOCUMENTATION

PLANETARY DATA SYSTEM
Updated Data Provider's Handbook

NASA

Planetary Data System

PDS Nodes ⌄

🔍 Search

Find Data ⌄   Tools   Submit Data ⌄   Learn ⌄   About ⌄

Home / Search Results

Showing **Everything** for **msl chemcam**

1–10 of 142 results (0.002 seconds)

🔍 Search our website

Everything 142   Data 100   Documentation 38   Tools 4

SORT: RELEVANCE ⌄   VIEW: ▤ ▭

Filters

⊥ **INVESTIGATIONS** 3

MARS SCIENCE LABORATORY

LUNAR CRATER OBSERVATION AND SENSING SATELLITE

MARS RECONNAISSANCE ORBITER

⊥ **INSTRUMENTS** 7

SPECTROMETER

CAMERA

CHEMISTRY CAMERA LASER INDUCED BREAKDOWN SPECTROMETER

OTHER

ACCELEROMETER

ALPHA PARTICLE X-RAY SPECTROMETER

PHOTOMETER

⊥ **TARGETS** 2

PLANET

Result	Category
MSL ChemCam Passive Surface Spectra Bundle Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	DATA →
MSL ChemCam Passive Surface Spectra Reflectance Data Collection Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	DATA →
MSL ChemCam Passive Surface Spectra Document Collection Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	DATA →
MSL ChemCam Documentation Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	DOCUMENTATION →
MSL ChemCam Passive Surface Spectra Radiance Data Collection Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	DATA →
Mars Orbital Data Explorer Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor	TOOLS →

FUTURE PLANS

- New PDS Search Engine
  - Search across all PDS data sets and documentation
  - Forwarded to discipline-specific search and tools for product-level searching
  - Part of overall PDS Web Modernization effort

- **More Tools and Services driven by the PDS API and PDS metadata**

ENABLING SEARCH AND ACCESS FOR ALL PDS DATA
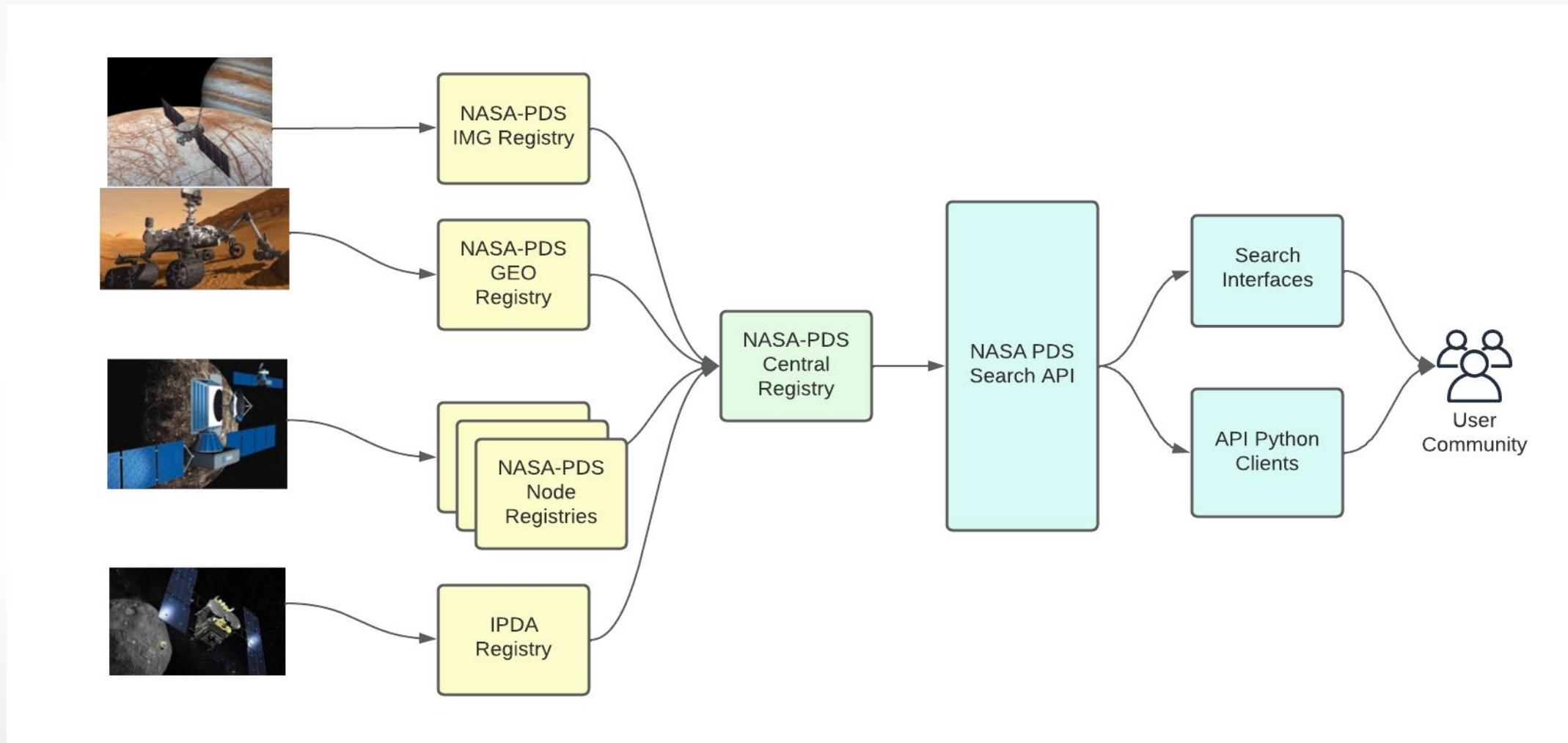
Towards an International Platform for Planetary Data Archiving, Management and Research

New Feature Requests?

Found a Bug?

Have a Question?

Missing a Data Set you need?

Find us on Github

https://github.com/NASA-PDS/pds-api/

SPECIAL THANKS

To the PDS API WG for providing technical expertise and guidance the PDS MC and international community on the design, development, and implementation of the PDS API Specification.

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Rishi Verma (PDS IMG)
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Mark Bentley (PSA)

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Jordan Padams (PDS EN)
Boris Semenov (PDS NAIF)

BACKUP

Why a PDS-specific API?

- All APIs must be driven by some underlying domain-specific vocabulary
  - Earth Common Metadata Repository -> Unified Metadata Model
  - EPN-TAP -> EPNCore

- For example:
  - INSTRUMENT_HOST_NAME=perseverance
  - TARGET_NAME=mars

- For planetary science, PDS4 is the de-facto international standard vocabulary endorsed by the IPDA.

PDS Data Services Initiative
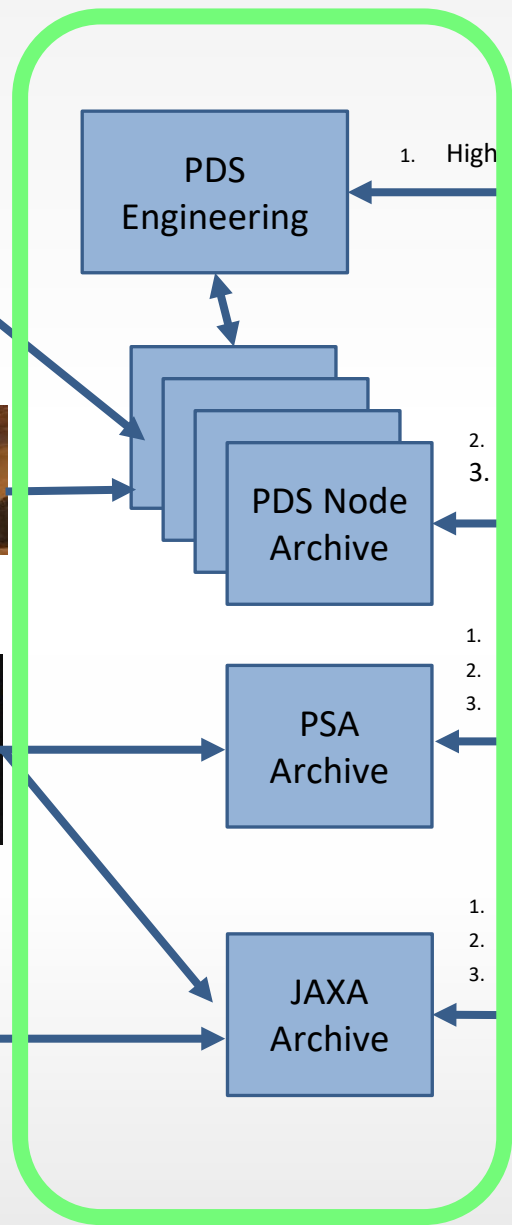
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Access

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3. Retrieve Product

Visualization (7)

PDS4 Information Model provides the common, consistent vocabulary and relationship definitions for planetary science data.

Algorithms (6,8)

JAXA Archive

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3. Retrieve Product

Computational Services (6)

Data Analysis Tools (5)

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User Services

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WHY A PDS-SPECIFIC API?

- *Other APIs exist for accessing PDS data*, but would require custom, manual mapping of PDS4 attributes to yet-another data model

- Currently, no consistent, well-defined API exists for accessing planetary science resources

> **A PDS4-driven API will enable search of all data in the planetary science domain**

REFERENCES

[1] Crichton, D., et al. "Evolving Towards Data-Driven Capabilities to Enable Planetary Science Research from the PDS", 4th Planetary Data Workshop, 2019, vol. 2151.