



# The Planetary Science Ontology A Case Study in an Ontology- Based Information Architecture

J. Steven Hughes

7th International Protégé Conference  
Tuesday 6th - Friday 9th, July 2004  
Washington, DC

*steve.hughes@jpl.nasa.gov*

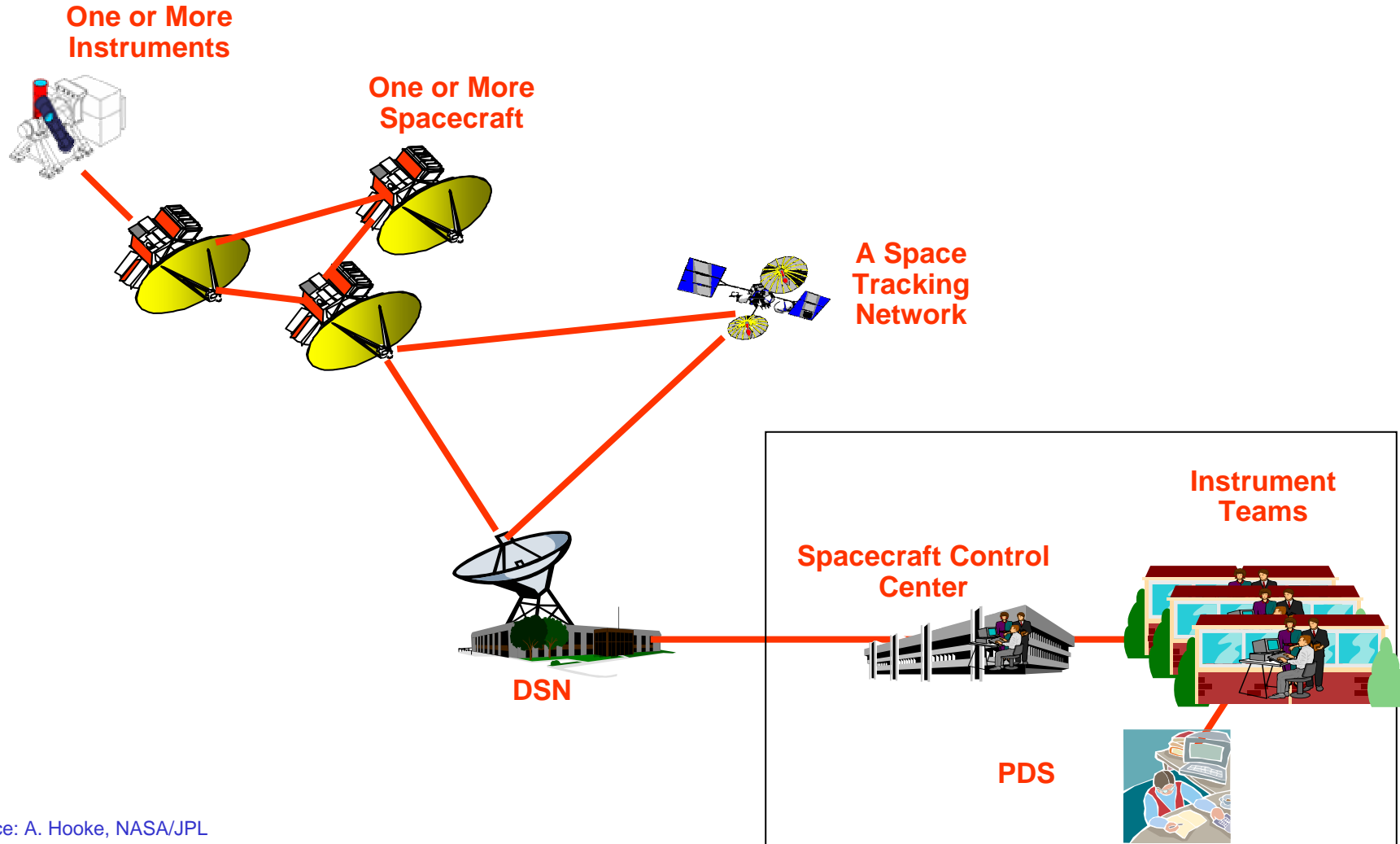


- Overview of the Planetary Data System (PDS)
- Planetary Science Ontology
- Infrastructure Components
  - Intelligent Resource Discovery Service
  - Catalog and Archive Service
- Benefits



# The Planetary Science Ontology

## Planetary Science Domain



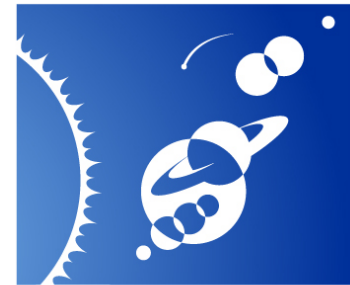
Source: A. Hooke, NASA/JPL



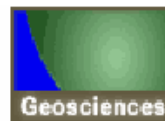
*The PDS acquires, preserves, and distributes the large volume of unique and valuable data returned by Solar System Exploration missions*

## Key PDS Products and Services

- High quality peer-reviewed data archives
- Data distribution to planetary community
- Archiving expertise to planetary missions
- Scientific expertise and support for users
- Value-added aggregated data products
- Education and outreach data products and services



**Planetary Data System**



JPL

New Mexico State Univ.

Wash Univ. St. Louis

JPL/USGS Flagstaff

JPL

UCLA

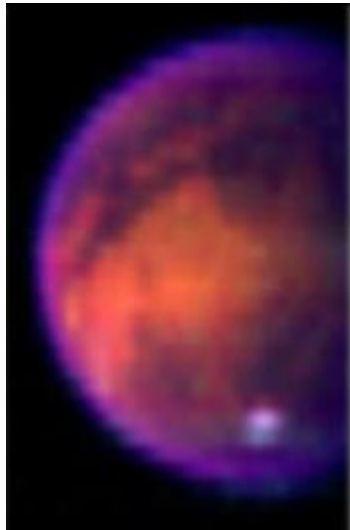
NASA Ames

U. Maryland

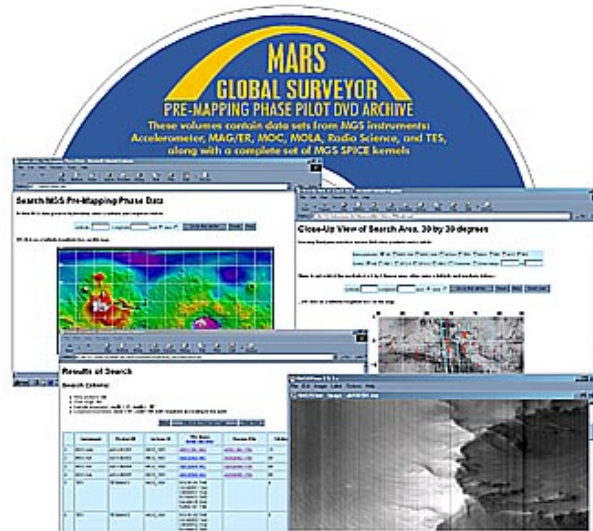
*Node structure provides focus on key disciplines*



# The Planetary Science Ontology Products



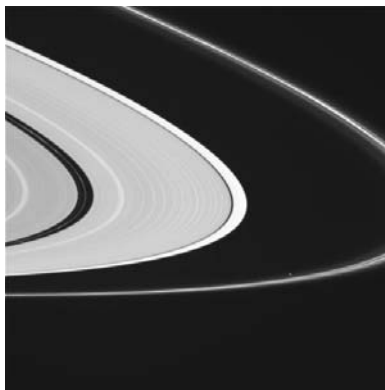
*Cassini Vis/IR Map Spec of Titan  
Catalog #: PIA06406:2004-07-03*



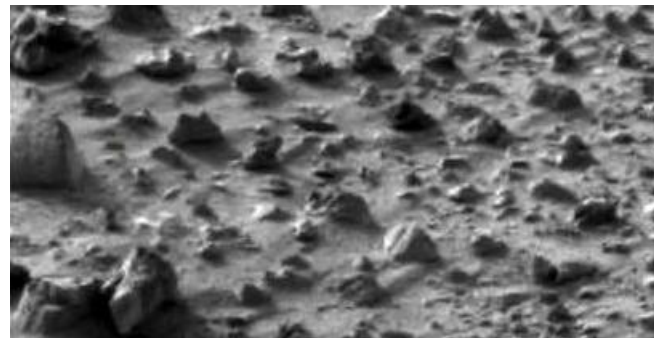
*MGS Pre-Mapping Phase Pilot DVD Set*



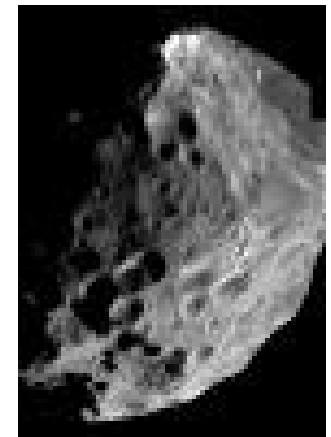
*Opportunity PanCam of Endurance Crater Exposures  
Catalog #: PIA06355:2004-06-30*



*Cassini ISS of Rings  
Image Id=W00000379,  
2004-07-01*



*Mars Rover  
2004-06-25*



*Cassini ISS Image of Phoebe  
Catalog #: PIA0607:2004-06-23*



# The Data Model

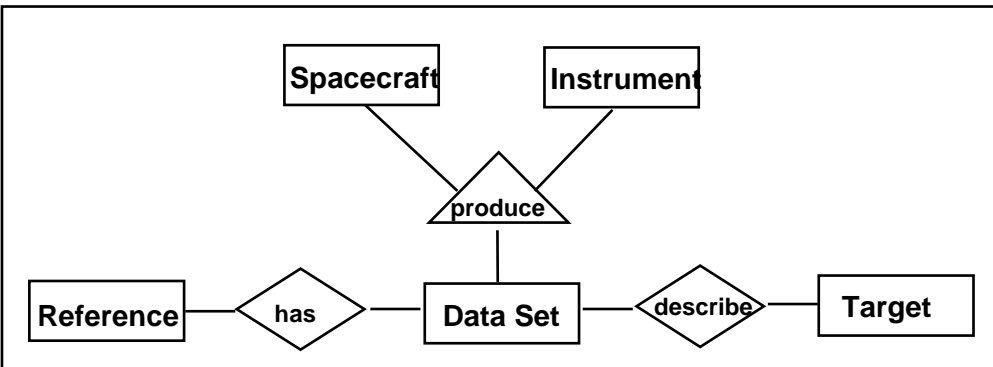


Level	Group/Element Structure
1	spacecraft instrument identification group
2	instrument identification
2	instrument name
2	spacecraft identification
2	instrument type
1	instrument description
...	...
1	filter group
2	filter name
2	filter number
2	filter type
...	...

```

OBJECT                = INSTRUMENT
INSTRUMENT_ID         = VISA
SCID                  = VO1
INSTRUMENT_NAME       = VISUAL_IMAGING...
INSTRUMENT_TYPE       = VIDICON_CAMERA
...
END_OBJECT

```



instinfo				
instid	instname	insttype	scid	...



## An Image Label (partial)

**DATA\_SET\_ID** = "VO1/VO2-M-VIS-5-DIM-V1.0"  
**SPACECRAFT\_NAME** = {VIKING\_ORBITER\_1, ...  
**TARGET\_NAME** = MARS  
**IMAGE\_ID** = MG88S045  
**^IMAGE** = 2  
**SOURCE\_IMAGE\_ID** = {"383B23", "421B23", ...  
**INSTRUMENT\_NAME** = {VISUAL\_IMAGING\_SUBSYSTEM ...  
**NOTE** = "MARS DIGITAL IMAGE ...

**OBJECT** = IMAGE  
**LINES** = 160  
**LINE\_SAMPLES** = 252  
**SAMPLE\_TYPE** = UNSIGNED\_INTEGER  
**SAMPLE\_BITS** = 8  
**SAMPLE\_BIT\_MASK** = 2#11111111#  
**CHECKSUM** = 2636242  
**END\_OBJECT**



# Re-hosting the Data Model



Project Edit Window Help

Classes Slots Forms Instances Queries

Relationship Supercl... V C ↕ X

image\_Data\_Set (type=:STANDARD-CLASS) C X

Name: image\_Data\_Set Documentation: A collection of related image data products Constraints: V C + -

Role: Concrete

Template Slots V V C X + -

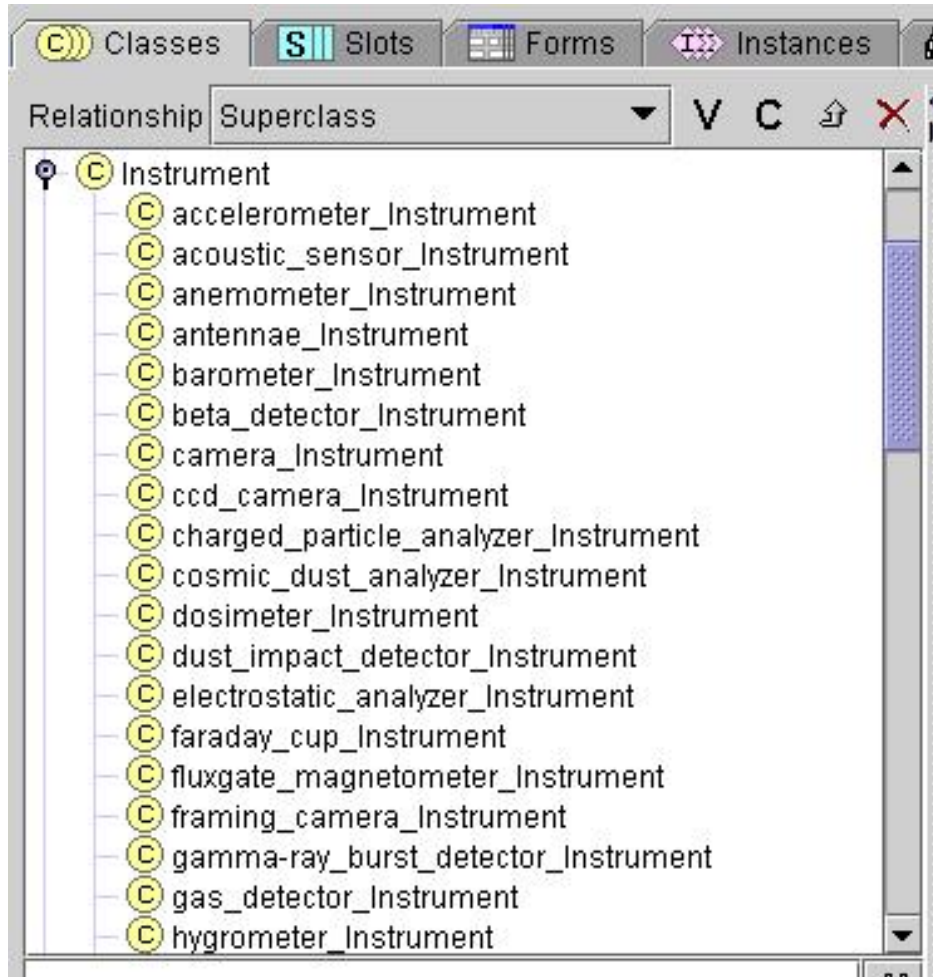
Name	Type	Cardinality	Other Facets
data_set_desc	String	required single	value={Text} default={UNK}
detailed_catalog_flag	Symbol	required single	allowed-values={N,Y}
curated_by	Instance	required single	classes={Node}
confidence_level_notes	String	required single	value={Text} default={UNK}
data_object_type	Symbol	required single	allowed-values={ARRAY,CONTAINER,CUB...}
describes	Instance	required multiple	classes={Target}
associated_resource	Instance	multiple	classes={Resource}
archive_status_date	String	single	value={YYYY-MM-DDTHH:MM:SS.SSSZ} det...
created_by	Instance	required multiple	classes={Person}
data_set_release_date	String	single	value={YYYY-MM-DDTHH:MM:SS.SSSZ} det...
curating_node_id	Symbol	single	allowed-values={ATMOS,CN,GEOSCIENCE...}
abstract	String	required single	value={Text} default={UNK}
distributed_by	Instance	multiple	classes={Node}
producer_full_name	String	single	value={First,Middle,Last} default={N/A}
archive_status_note	String	single	value={Text} default={N/A}
produced_by	Instance	required multiple	classes={Instrument}
data_set_id	String	required single	value={EAR-A-5-DDR-DERIVED-LIGHTCURF...}
stop_time	String	single	value={YYYY-MM-DDTHH:MM:SS.SSSZ} det...
data_set_collection_member_flg	Symbol	required single	allowed-values={N,Y}
resource_size	String	required single	value={ddd,ddd,ddd} default={N/A}
archive_volume	Instance	required multiple	classes={Volume}
data_set_terse_desc	String	required single	value={Text} default={UNK}
citation_desc	String	required single	value={Text} default={UNK}
data_set_name	String	required single	value={ASTEROID_LIGHTCURVE_DERIVE...}
archive_status	Symbol	required single	allowed-values={ACCUMULATING,ARCHIV...}
start_time	String	single	value={YYYY-MM-DDTHH:MM:SS.SSSZ} det...
data_engineer_full_name	String	single	value={First,Middle,Last} default={N/A}

Superclasses: Data\_Set





# Some Statistics



~50 Base Classes

~1,200 Common Data Elements

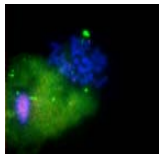
1,000s of Parameters

~4,500 Product Types

1,000,000s of Products

# Intelligent Resource Discovery

**1. Science data tools and applications** use “APIs” to connect to a virtual data repository



*Visualization Tools*

OODT API



*Web Search Tools*

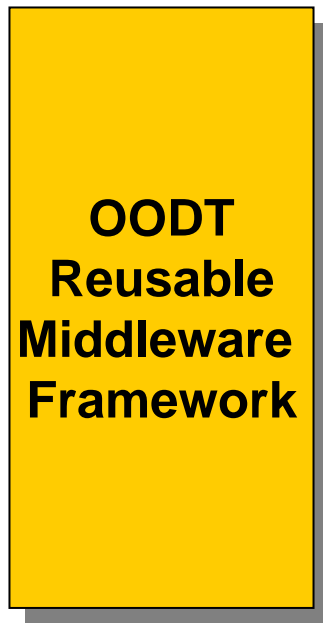
OODT API



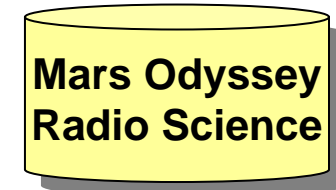
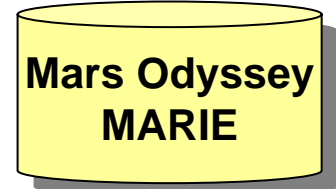
*Analysis Tools*

OODT API

**2. Middleware** creates the informatics infrastructure connecting distributed heterogeneous systems and data



**3. Distributed Repositories** for storing and retrieving many types of data





## Key Characteristics

- **Multi-tiered information architecture**
  - Client Tier (Data Browsers)
  - Service Tier (Product and Profile Servers)
  - Storage Tier (Data Repositories)
- **Distributed Heterogeneous Data Repositories**
  - Locally managed by discipline experts
  - Underlying heterogeneity is encapsulated and hidden from the users
- **Separate data and technology architectures**
  - Data model evolves with discipline
  - Technology evolves with industry



## Resource Descriptions

- **Profile**
  - Single structure for describing any resource\*
  
- **Profile Server**
  - Using a profile database
    - Search for profiles using any attribute as constraint
    - Return any subset of attributes of matching profiles

\*Resource – Any instance of any class



## PROFILE DTD

**<!ELEMENT profiles  
(profile\*)>**

**<!ELEMENT profile  
(**profAttributes**,  
**resAttributes**,  
**profElement**\*)>**

**<!ELEMENT profAttributes  
(**profId**, **profVersion?**, **profType**,  
**profStatusId**, **profSecurityType?**, **profParentId?**, **profChildId\***,  
**profRegAuthority?**, **profRevisionNote\***, **profDataDictId?**)>**

**<!ELEMENT resAttributes  
(**Identifier**, **Title?**, **Format\***, **Description?**, **Creator\***, **Subject\***,  
**Publisher\***, **Contributor\***, **Date\***, **Type\***, **Source\***,  
**Language\***, **Relation\***, **Coverage\***, **Rights\***,  
**resContext+**, **resAggregation?**, **resClass**, **resLocation\***)>**

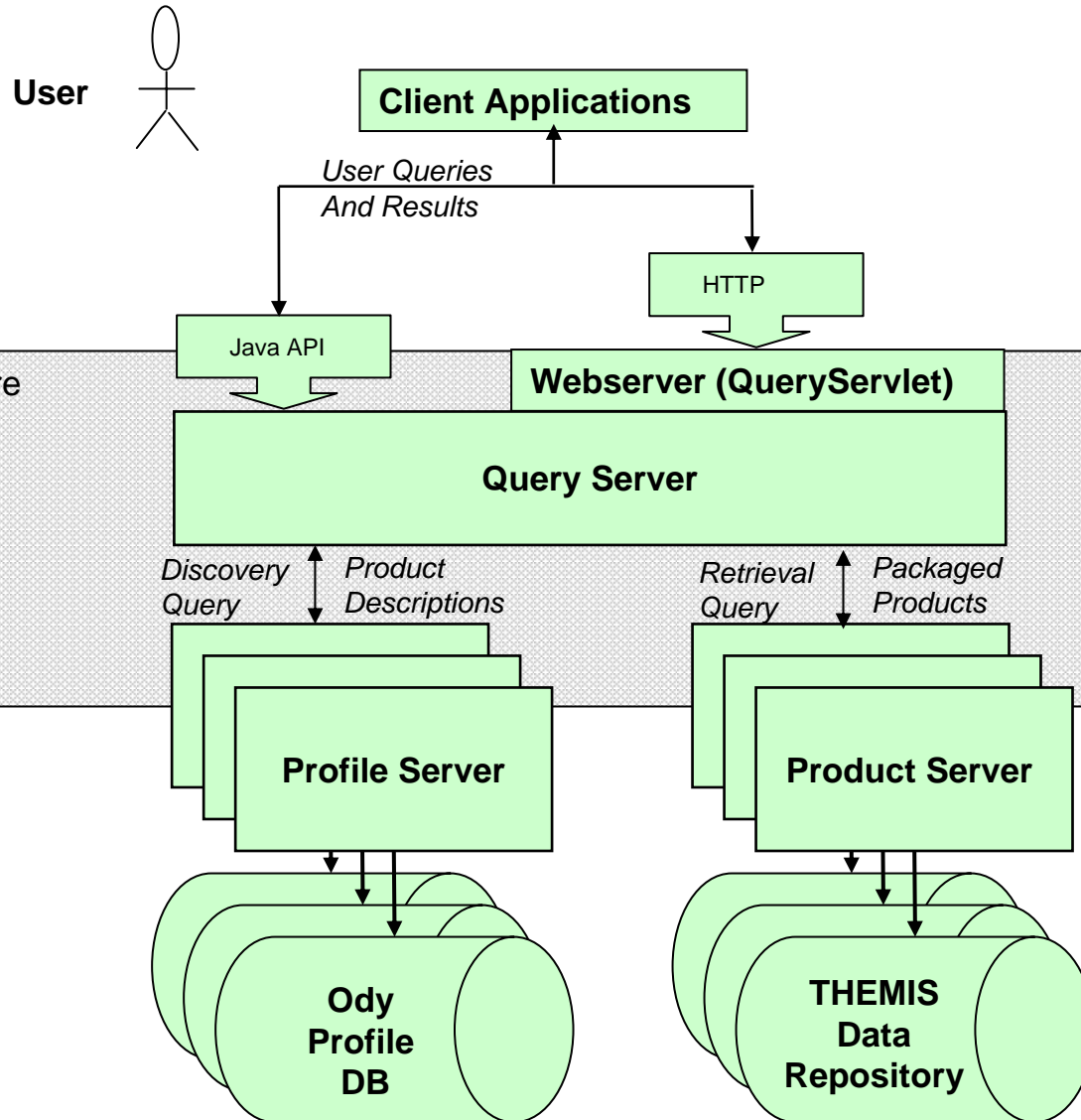
**<!ELEMENT profElement  
(**elemId?**, **elemName**, **elemDesc?**, **elemType?**, **elemUnit?**,  
**elemEnumFlag**, (**elemValue\*** | (**elemMinValue**, **elemMaxValue**)),  
**elemSynonym\***, **elemComment?**)>**



## Data Product Profile

```
-<profile>
  -<profAttributes>
    <profId>1.3.6.1.4.1.1306.2.104.10018791</profId>
    <profVersion>null</profVersion>
    <profType>profile</profType>
  </profAttributes>
  -<resAttributes>
    <Identifier>ODY-M-HEND-EDR-2-V1.0:H0133</Identifier>
    <Title> ODYSSEY-MARS-HEND-EDR-2-V1.0:H0133</Title>
    <Description>null</Description>
    <resContext>NASA.PDS</resContext>
    <resAggregation>null</resAggregation>
    <resClass>data.product</resClass>
    <resLocation>URI for product ...</resLocation>
  </resAttributes>
  -<profElement>
    <elemName>FILE_SPECIFICATION_NAME</elemName>
    <elemValue>/ody_2001/xxx/H0133.DAT</elemValue>
  </profElement>
  -<profElement>
    <elemName>INSTRUMENT_ID</elemName>
    <elemValue>HEND</elemValue>
  </profElement>
</profile>
```

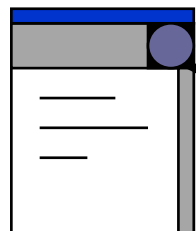
# Resource Discovery and Distribution Infrastructure





# Catalog and Archive Infrastructure

PDS Portal

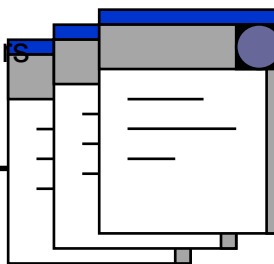


User query



PDS Product and Profile Servers  
XMLQuery (Profiles + Data)

PDS Missions

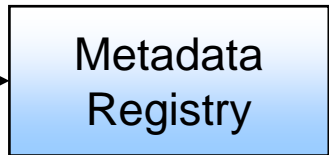


Ingest PDS Data Products  
(Meta + Data)

PDS Ontology

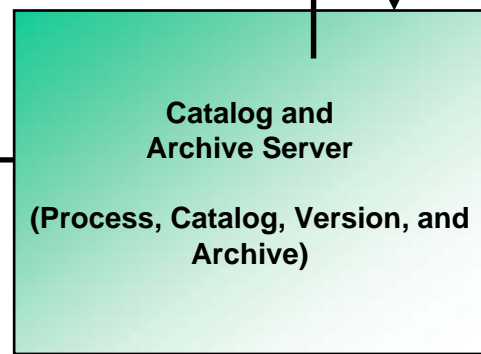
ISO/IEC 11179

PDS DD & Product Schemas



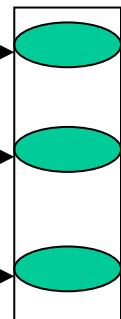
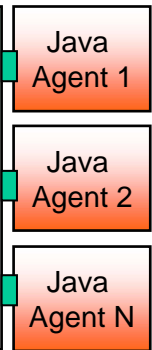
DE Database

Validate



Execute

Process



Data set 1

Data set 2

Data set n

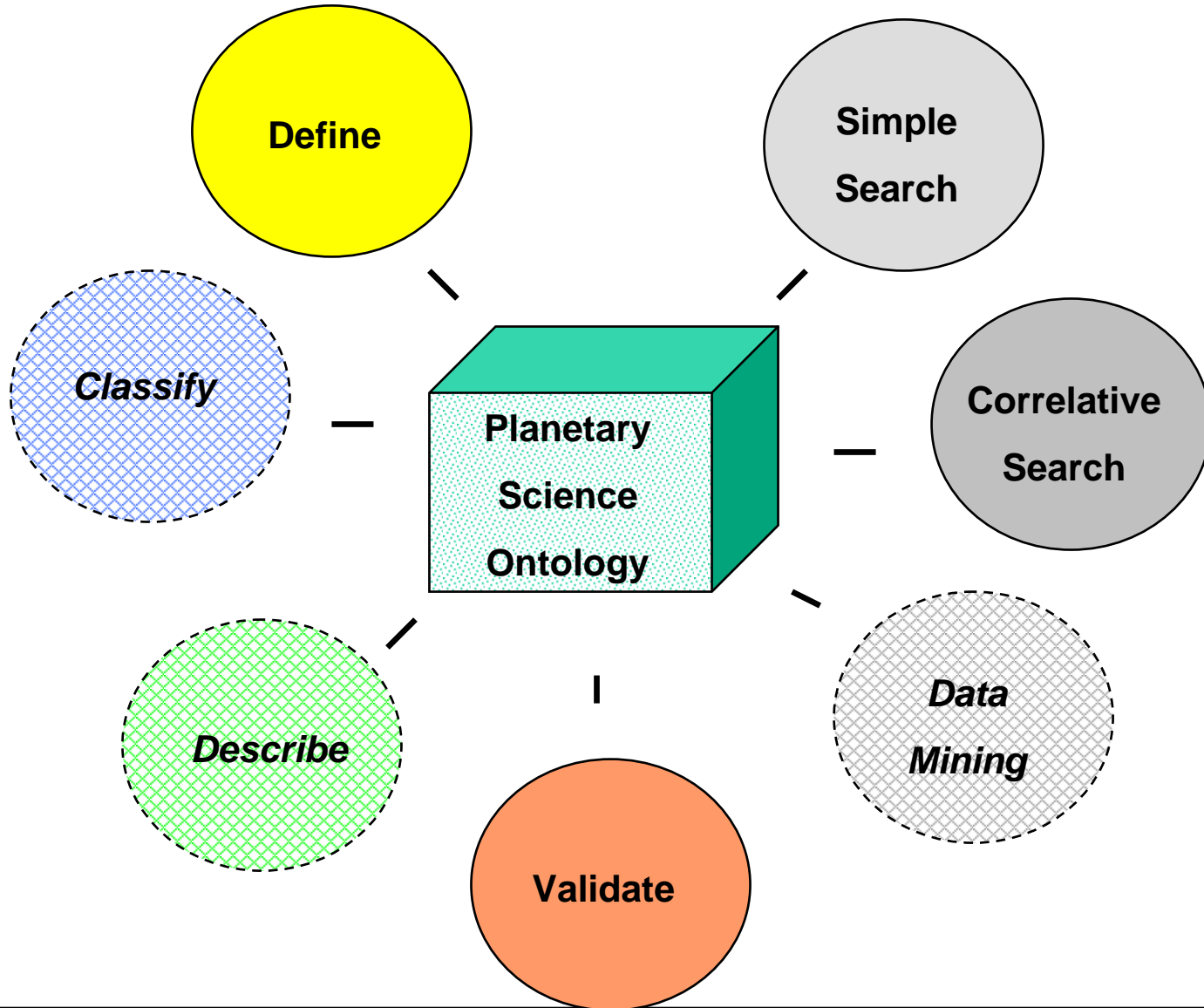
Data set Rule-base

Product Catalog (DE-based)





# Benefits





**J. Steven Hughes**

**steve.hughes@jpl.nasa.gov**

**PDS**

**<http://pds.jpl.nasa.gov/>**

**Daniel Crichton**

**dan.crichton@jpl.nasa.gov**

**OODT Site**

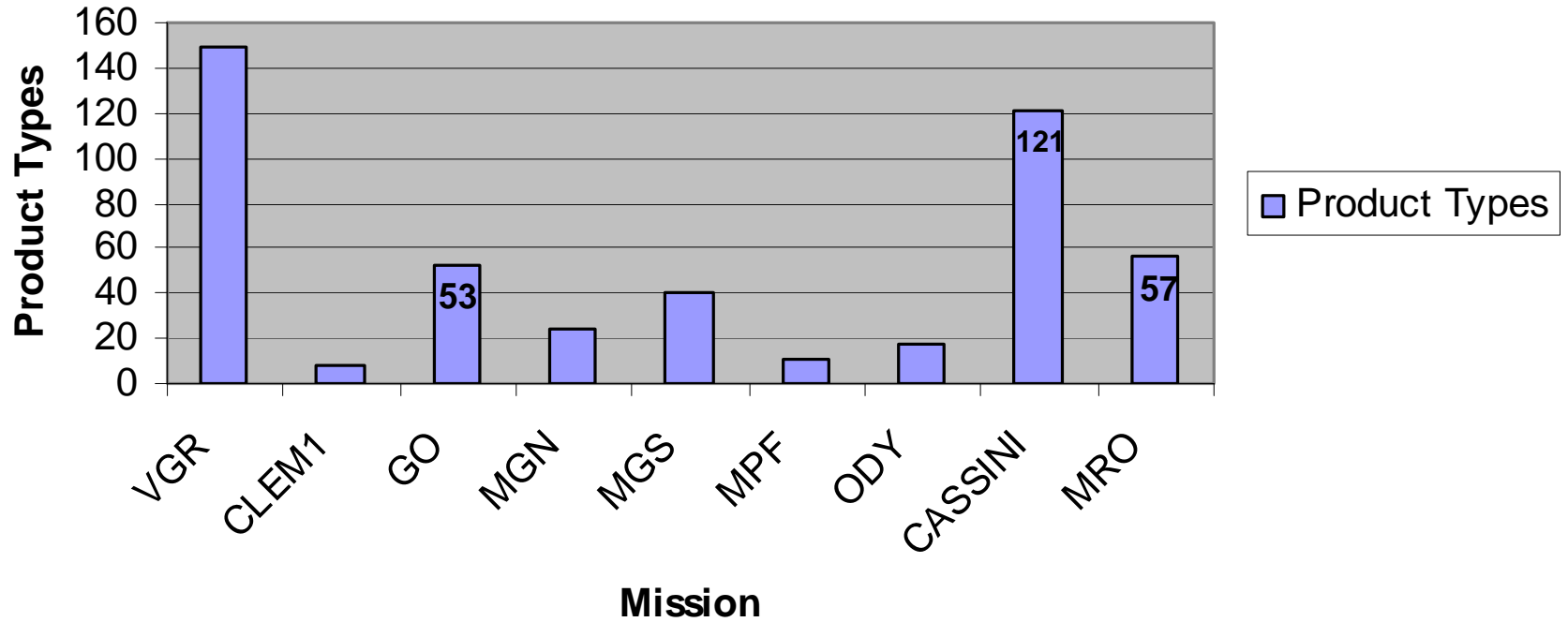
**<http://oodt.jpl.nasa.gov/oodt-site/index.html>**



# Backup



## Product Types by Mission



### Sources

CASSINI and MRO - SISes

Other – PDS Data Set Catalog