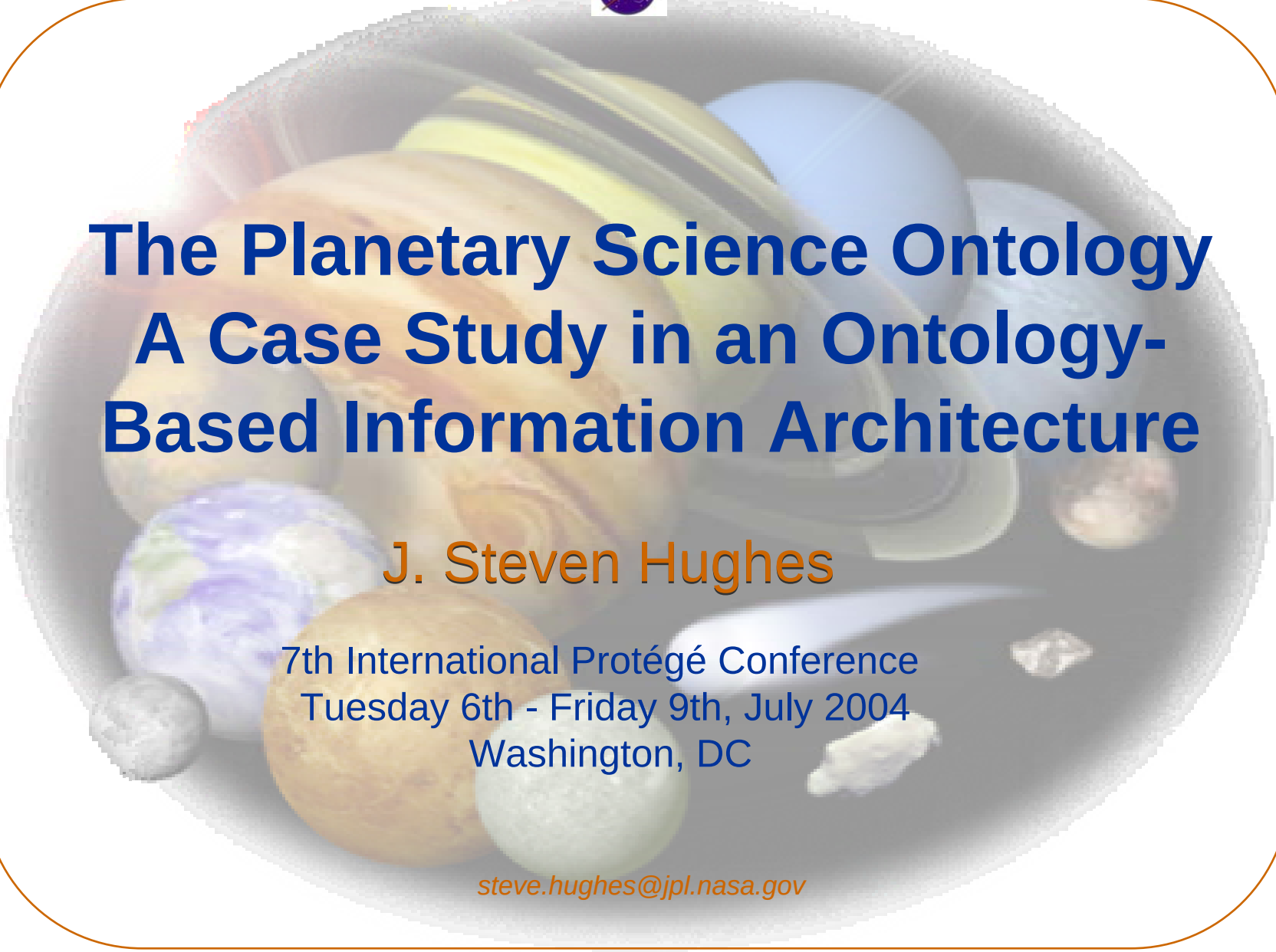


The Planetary Science Ontology A Case Study in an Ontology-Based Information Architecture

J. Steven Hughes

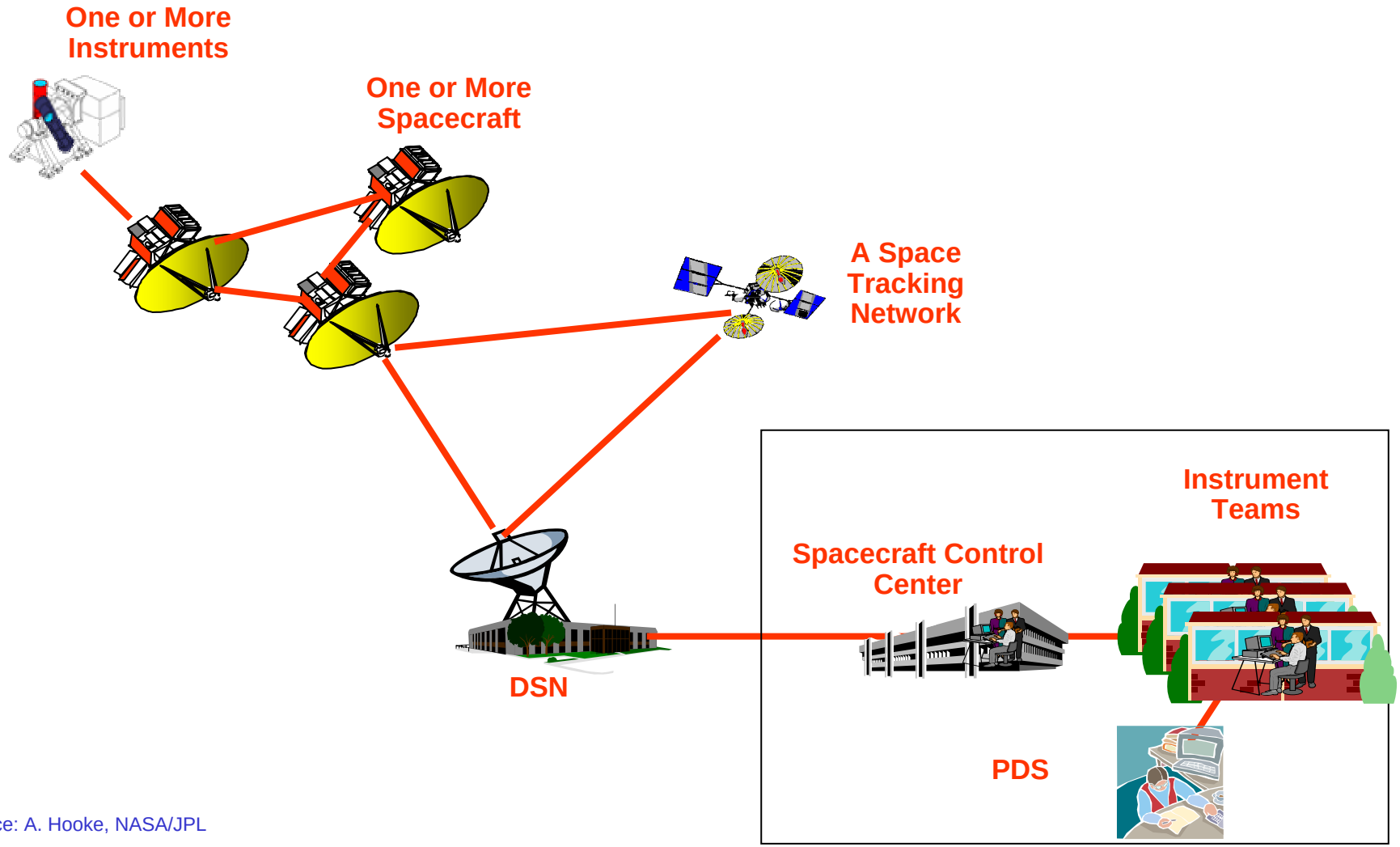
7th International Protégé Conference
Tuesday 6th - Friday 9th, July 2004
Washington, DC

steve.hughes@jpl.nasa.gov

Topics

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

Planetary Science Domain



Source: A. Hooke, NASA/JPL

PDS Overview

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

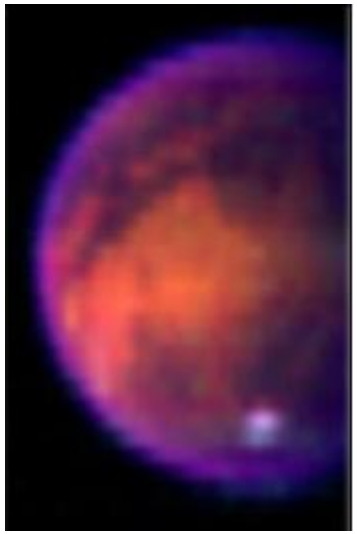
Education and outreach data products and services

Planetary Data System

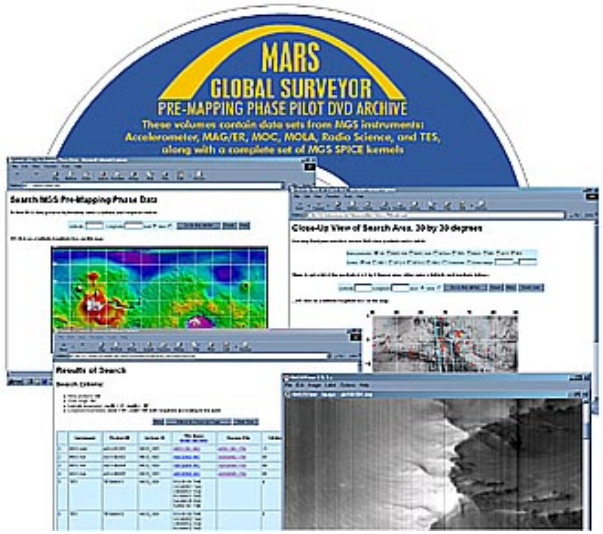
Central Node	Atmospheres	Geosciences	Imaging	NAIF	PPI	Rings	Small Bodies
JPL	New Mexico State Univ.	Wash Univ. St. Louis	JPL/USGS Flagstaff	JPL	UCLA	NASA Ames	U. Maryland

Node structure provides focus on key disciplines

Products

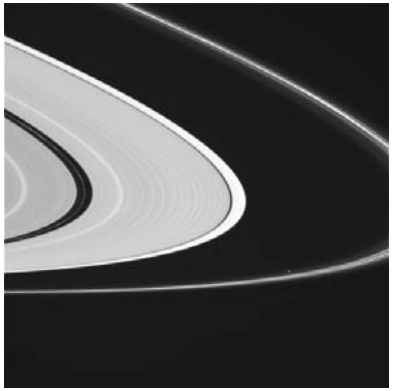


Cassini Vis/IF Map Spec of Titan
Catalog #: PIA06406:2004-07-03

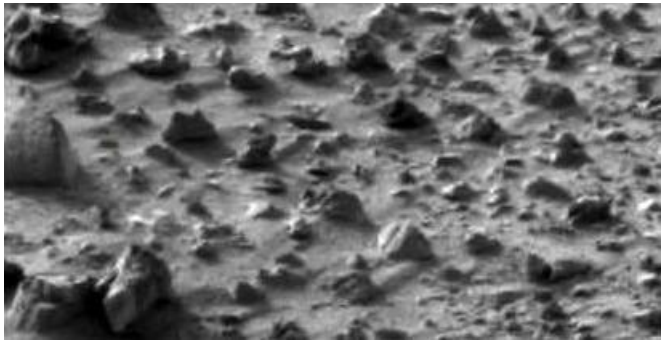


MGS Pre-Mapping Phase Pilot DVD Set

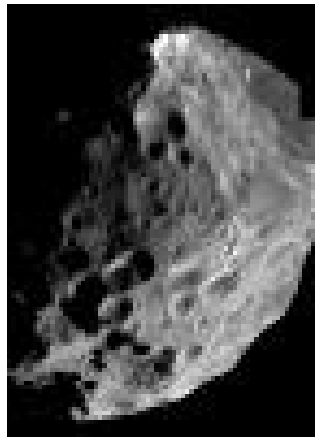
Opportunity PanCam of Endurance
Crater Exposures
Catalog #: PIA06355:2004-06-30



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



Mars Rover
2004-06-25

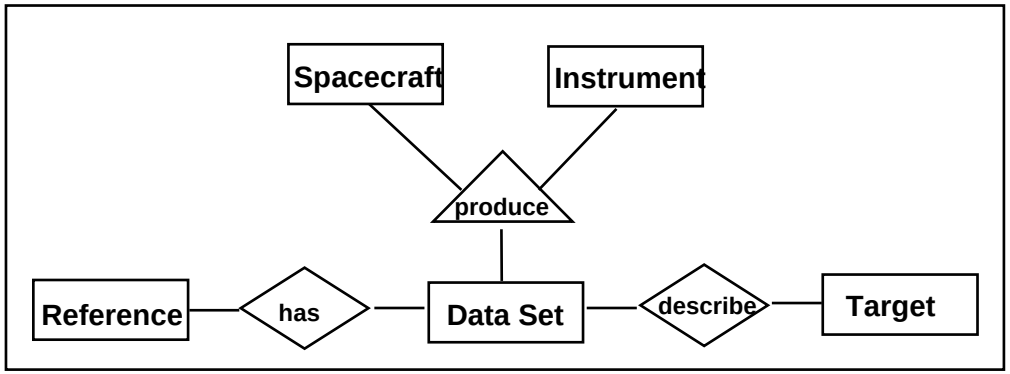


Cassini ISS Image of Phoebe
Catalog #: PIA0607:2004-06-23

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
```

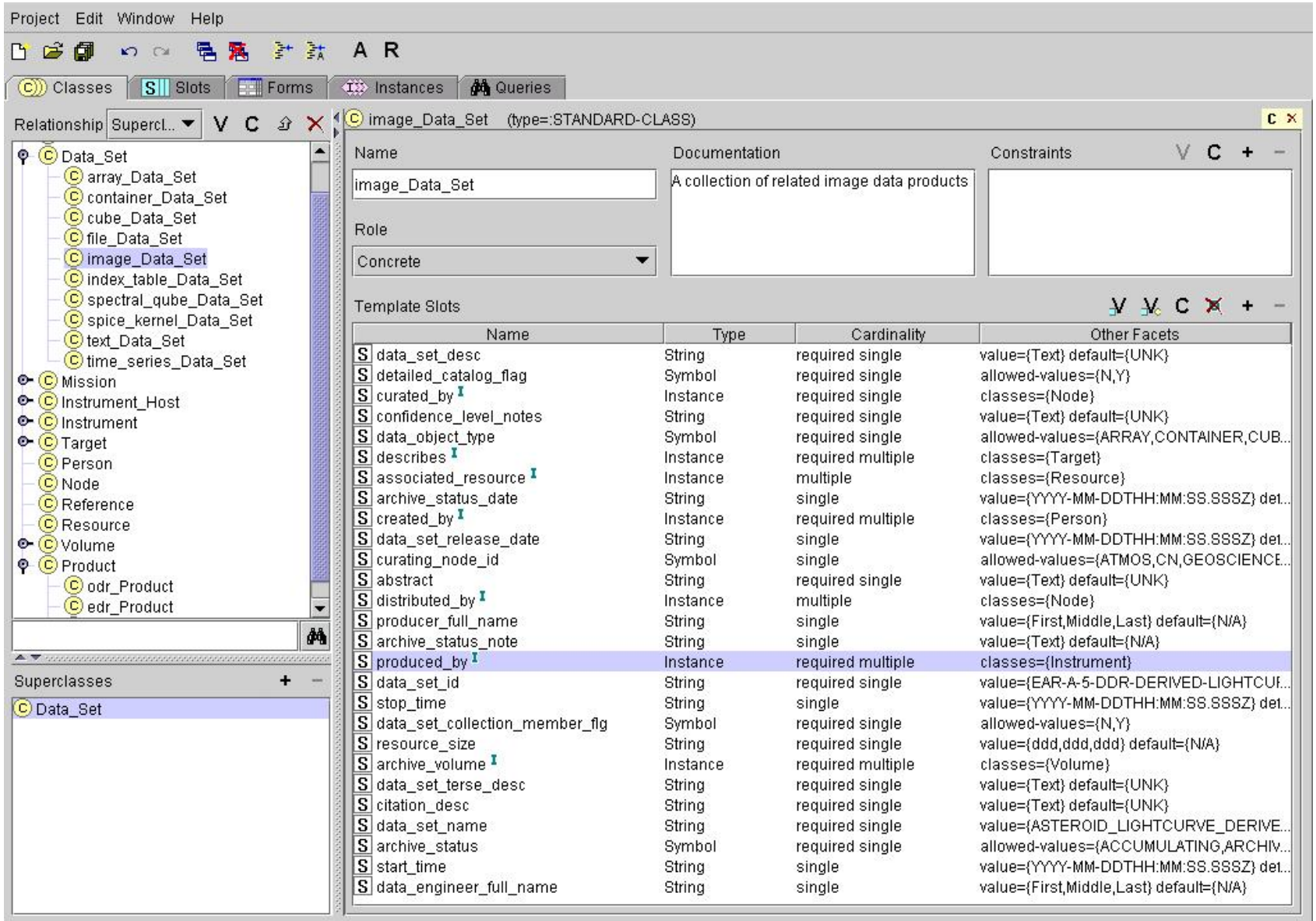


instinfo				
instid	instname	insttype	scid	...

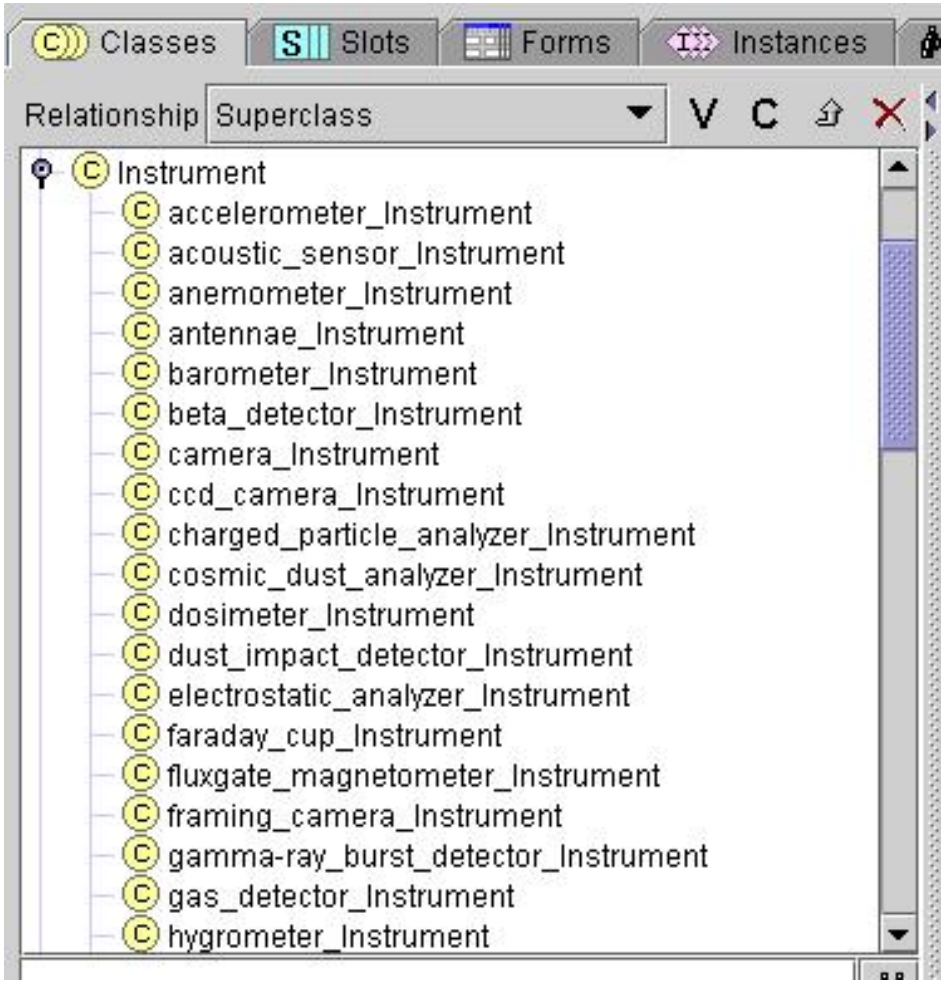
An Image Label (partial)

```
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



Some Statistics



~50 Base Classes

~1,200 Common Data Elements

1,000s of Parameters

~4,500 Product Types

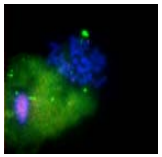
1,000,000s of Products

Intelligent Resource Discovery

1. Science data tools and applications use "APIs" to connect to a virtual data repository

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

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



OODT API

Visualization Tools

OODT API

Web Search Tools

OODT API

Analysis Tools

OODT Reusable Middleware Framework

Mars Odyssey THEMIS

Mars Odyssey MARIE

Mars Odyssey Radio Science

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

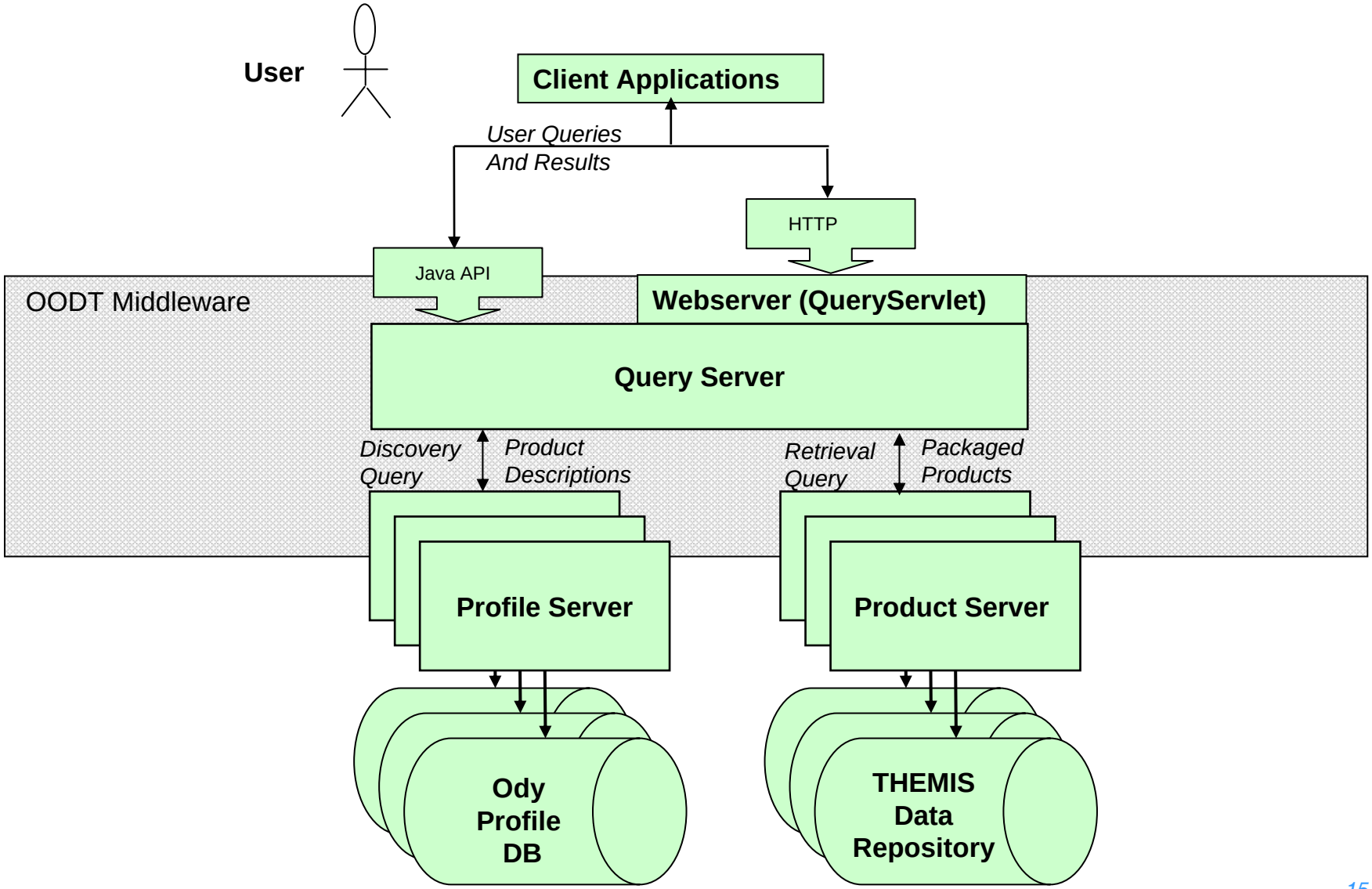
PROFILE DTD

```
<!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?)>
```

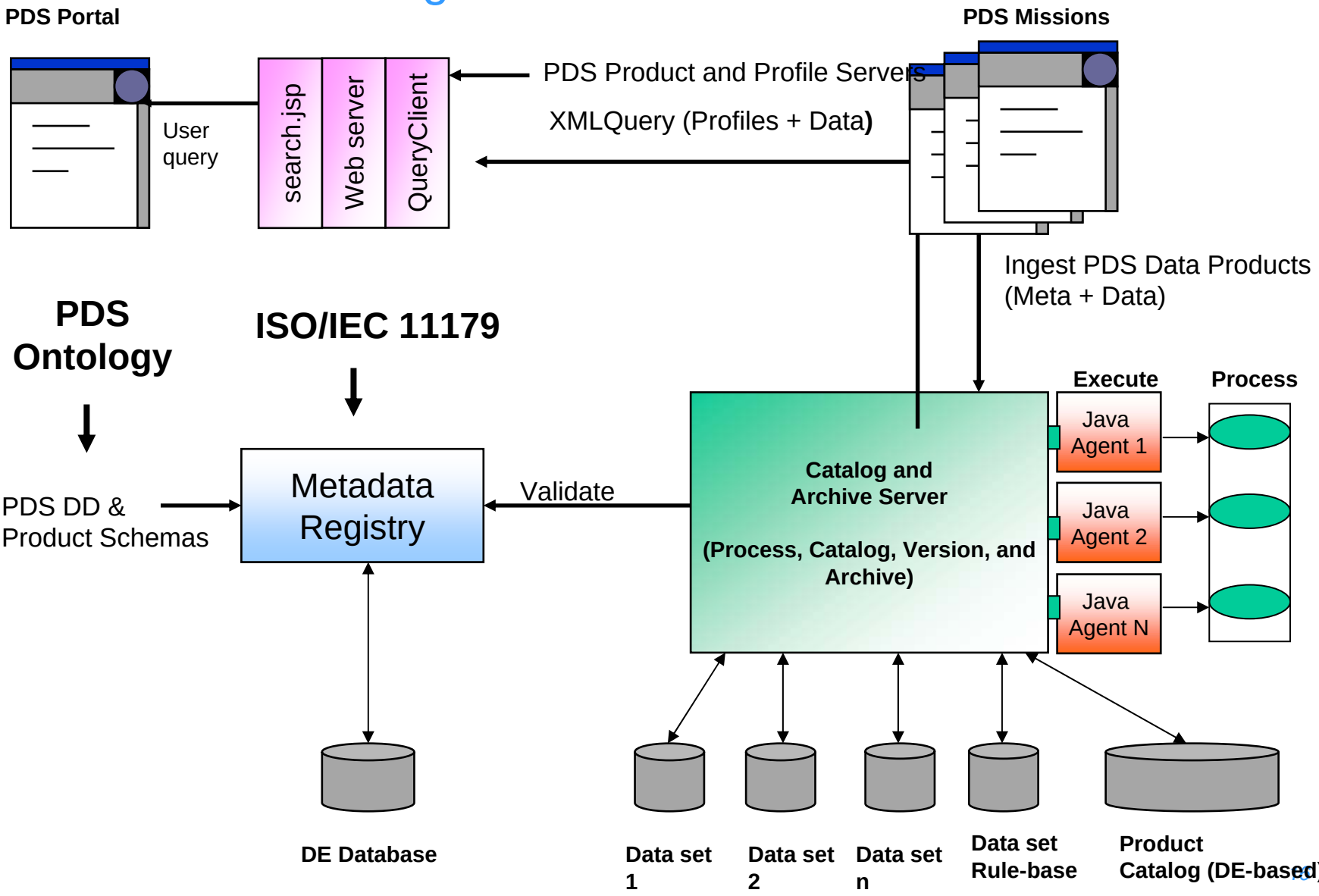
Data Product Profile

```
-<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>
```

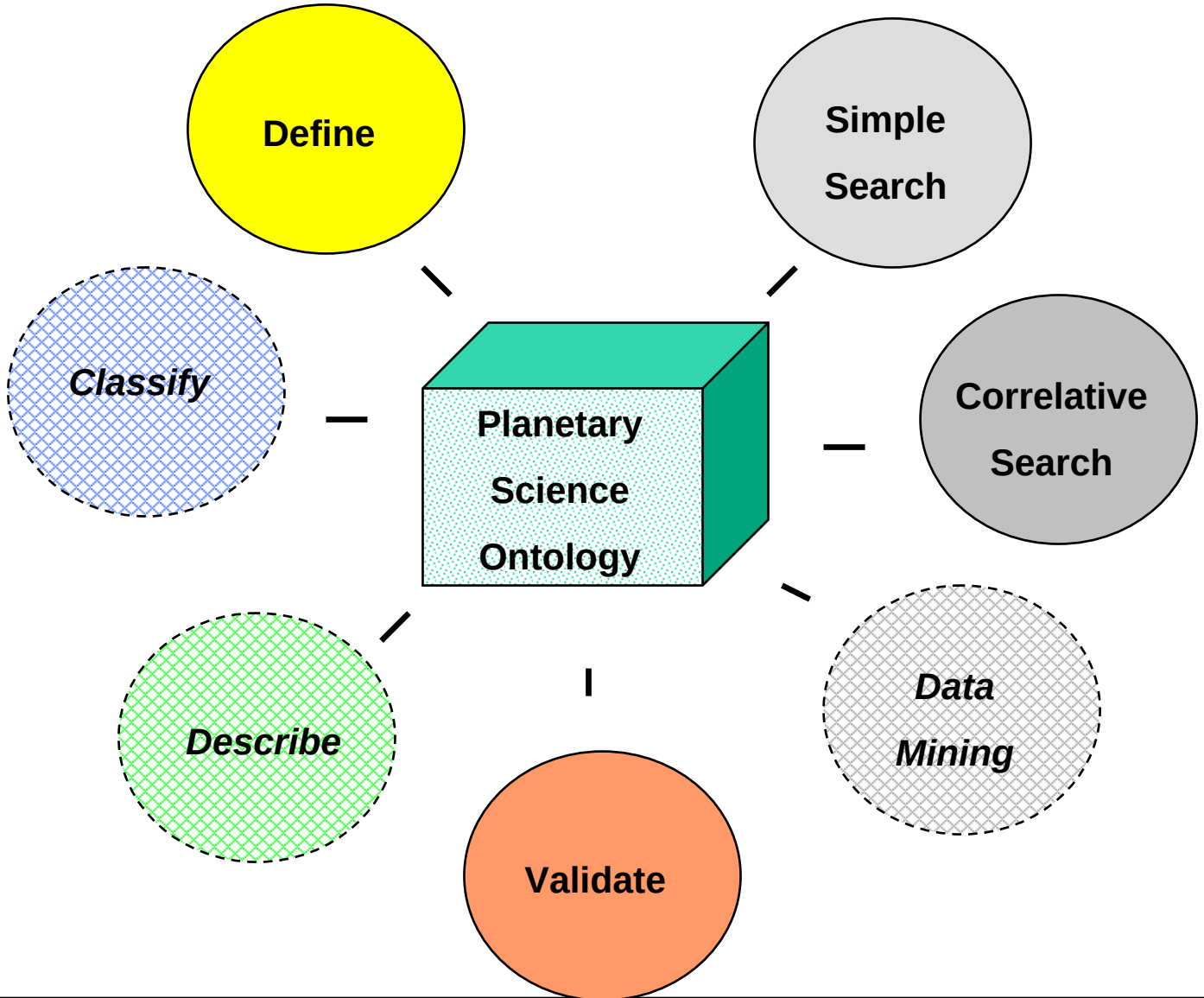
Resource Discovery and Distribution Infrastructure



Catalog and Archive Infrastructure



Benefits


Define
Simple Search
Classify
Planetary Science Ontology
Correlative Search
Describe
Data Mining
Validate

Contacts

J. Steven Hughes
steve.hughes@jpl.nasa.gov

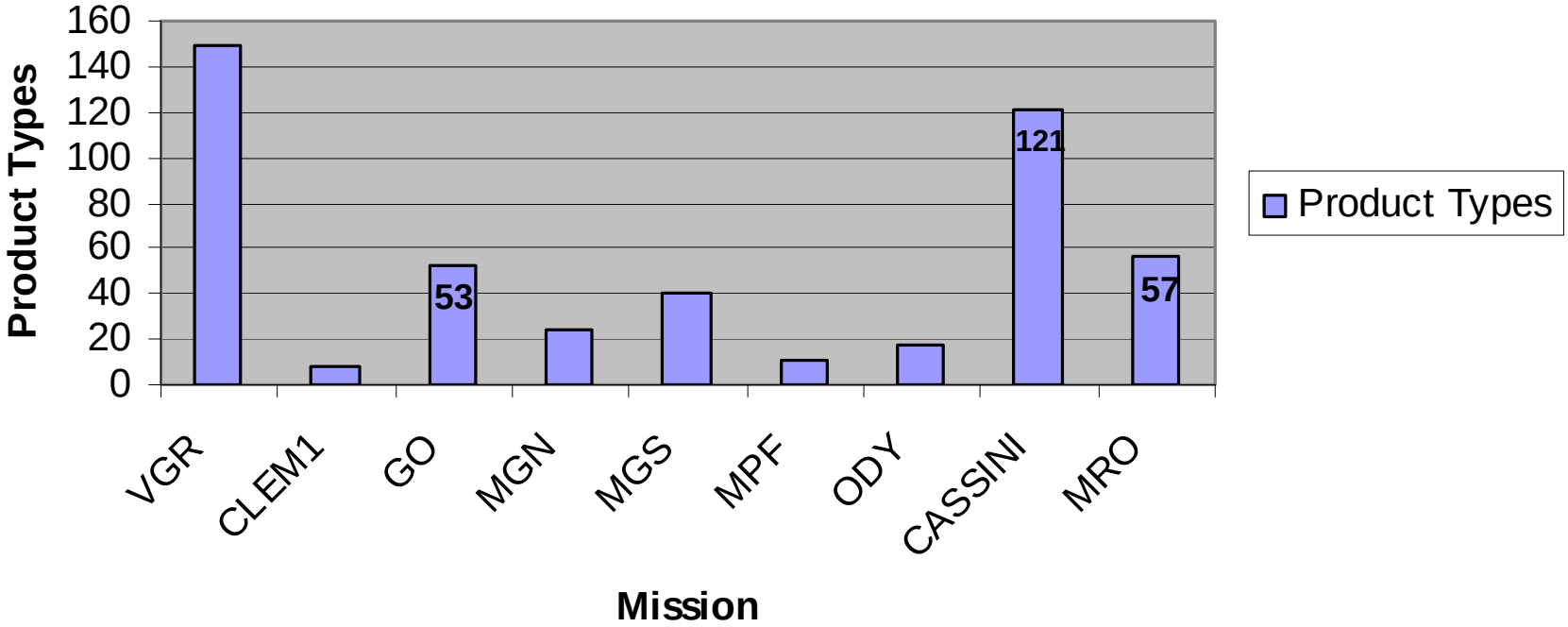
PDS
http://pds.jpl.nasa.gov/

Daniel Crichton
dan.crichton@jpl.nasa.gov

OODT Site
http://oodt.jpl.nasa.gov/oodt-site/index.html

Backup

Data Catalog



Sources

CASSINI and MRO - SISes

Other – PDS Data Set Catalog