Planetary Data System

Search Scenarios

Sean Hardman

September 1, 2013
Version 1.0

Jet Propulsion Laboratory
Pasadena, California

CHANGE LOG

Revision	Date	Description	Author
0.1	2011-02-21	Initial draft.	S. Hardman
0.2	2011-06-12	Updated the Cassini-specific scenarios based on comments from R. Beebe. Began population of the scenario evaluations.	P. Ramirez, S. Hardman
1.0	2013-09-01	Changed PDS 2010 references to PDS4.	S. Hardman

TABLE OF CONTENTS

1.0 INTRODUCTION

The PDS4 effort will overhaul the PDS data architecture (including, but not limited to, the data model, data structures, data dictionary, data etc.) and deploy a software system (including, but not limited to, data services, distributed data catalog, data etc.) that fully embraces the PDS federation as an integrated system while taking advantage of modern innovations in information technology (including, but not limited to, networking capabilities, processing speeds, and software breakthroughs).

1.1 Document Scope and Purpose

This document captures search scenarios for the PDS4 data system. These scenarios are intended to specify additional requirements on the data model, associated services and user interfaces of the system.

1.2 Method

This document represents the scenarios in narrative form with an evaluation of how the system will satisfy the scenario.

1.3 Notation

This document does not utilize special notations.

1.4 Controlling Documents

[1] Planetary Data System (PDS) Level 1, 2 and 3 Requirements, March 26, 2010.

[2] PDS4 Project Plan, July 17, 2013.

[3] PDS4 System Architecture Specification, Version 1.3, September 1, 2013.

[4] PDS4 Operations Concept, September 1, 2013.

1.5 Applicable Documents

[5] PDS4 User Support White Paper, December 2007.

[6] PDS4 Information Model Use Cases, March 2008.

[7] Cassini Observational Archive Search Guide, August 2010.

[8] User Scenarios Associated With Searching for and Retrieving Mars Reconnaissance Orbiter and Associated Data in the Planetary Data System, August 2003.

1.6 Document Maintenance

The system design will evolve over time and this document should reflect that evolution. This document is under configuration control.

2.0 GENERAL SCENARIOS

General search scenarios represent requests that users would likely make when looking for high-level information or searching by common attributes within the PDS.

2.1 Available Resources by Common Attribute

This scenario was gleaned from existing functionality that is available from the PDS home page.

Scenario
The user is in search of existing data sets or search services that meet their desired criteria. They may search by mission, instrument host, instrument host type, instrument, instrument type, target, target type, data type, start date and stop date. The result set should include a listing of data sets that match the search criteria with a corresponding URI for each data set for obtaining additional information. In addition, the result set should include a listing of additional search services enabling the user to perform product-level search. The corresponding URIs for the search services should include the attributes specified in the search criteria in accordance with the protocol of the given search service. This alleviates the need for the user to reenter the search criteria when redirected to the desired search service.

Evaluation
In order to attain interoperability between search services standard HTTP mechanisms will be employed (i.e. query and path parameters). For example, given the above scenario the corresponding URIs for the search services should include the attributes specified in the search criteria in accordance with the protocol of the given search service. This alleviates the need for the user to reenter the search criteria when redirected to the desired search service. This scenario would require an understanding of the mapping of between parameter names and values used by each service. The information model, being worked on by the DDWG, will resolve a portion of this as it can be used as a guideline for interoperability.

2.2 Measurement Type

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A User is seeking all resources that observed a particular type of phenomenon. The type of phenomenon observed is constrained by the measurement type. This scenario can be broken down into two different classes. The first is finding all

resources that were observed using a particular type of measurement; which is also related to the type of instrument used to make the observation. The second is identifying all the resources that contain a particular phenomenon, which would be a byproduct of examining the measurement taken.

Evaluation

The first scenario could be accomplished by utilizing the information provided directly in the labels. In particular the subject area of a product label, as dictated by the information model, provides enough information to annotate the product with the measurement type. If the measurement type is captured as a classification node within a classification scheme, as available in the registry service, the set of measurement types that apply can be expanded, contracted, or updated over time as the schemes can be hierarchical in nature and one than one classification per registered item. This would replace the functionality that is currently maintained for the PDS home page search but not exposed through out the infrastructure. The classification scheme for measurement type could be managed by the DDWG to maintain conformance across PDS.

The second scenario could require a bit more than simply examining the product label if the tracked phenomenon is something that is not captured at archiving time. If however, the product was tagged at archival; the phenomenon could have been captured in the product label and therefore would be exposed to the search service. How and where this type of information would be captured within the label would be done under the guidance of the information model but likely exposed in the registry service.

If however, the phenomenon was not captured at archival time a means to later annotate the phenomenon will need to be employed. This could be realized by consulting an external service for annotations to the product at index time. The means to retrieve such annotations could be through time and space attributes that are dictated by the information model and are captured in the product label. These annotations would then be exposed through the search service thus allowing the phenomenon and their applicability to evolve over time.

Another mechanism to relate phenomenon to data products would be to overlay the data based on either time or space constraints. This would allow one to recognize the overlap and retrieve the data that was considered pertinent. This approach is not as much a search service function but rather a data discovery function; much akin to the way layers is presented in typical GIS applications to uncover a correlation.

2.3 Time Range

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A User is seeking all resources that contain an observation within a particular time range. The time range is described with the start and end times of the interval.

Evaluation
Exposing the times captured in the product labels to the search service can be used to satisfy the time range scenario. The reference of time used also needs to be captured, as there is a difference between something measured in a local time versus solar time. The reference of time can either be present directly in the label or available by examining the model; the determination of where this reference is found is left to the information model.

2.4 Geographic Location

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A User is seeking all resources that were observed with a particular geographic location. The location is described with a latitude, longitude and radial distance or with lower and upper latitudes along with leftmost and rightmost longitudes.

Evaluation
To supporting geographical searches is dependent on whether archived products are processed to a level at which geographic metadata can be ascertained. For instance, level one data would not likely include geographic metadata and in order to derive such metadata for annotations some level of processing would be required.

The information model affords for geographic information to be captured and is being compared with common practice standards to ensure compatibility with GIS systems. When a product contains this type of information it can be hosted on GIS services that support location type searches; which generally fall into bounding box or point radius queries. Moreover, this type of search requires that the data can be represented as some sort of geometry. These geometries are currently captured in formats such as KML, ESRI Shapefiles, WKT, GeoRSS, etc. but as long as a mapping is understood the relevancy of the format becomes less of a concern as it can change over time. The assurance of this mapping is something that is left to the DDWG and information model.

Given that geographic location searches are specialized it is probable that an off the shelf service will be utilized. The exact mechanism to convey the search criteria, bounding box or point radius, may be custom to a particular service but the concept remains the same.

2.5 Resource Identifier

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A User knows the identifier for a resource and is seeking all artifacts associated with the resource.

Evaluation
The resource identifier will be propagated to the search service when the index is built to allow for direct lookups of items. In addition, all information from the identification area of a label, as outlined in the information model, will be copied into the search index these items are typical access mechanisms and allow for traceability.

2.6 Target

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A user wishes to locate data relevant to a particular target. The user knows at least part of an official designation for the target.

Evaluation
In order to satisfy target name searches the subject area for a given product can be utilized. This area within label, as specified by the information model, contains a target reference. This would satisfy the search using the official identifier for a target but if there were alternate names for a target a means to annotate these synonyms would be needed at index time. This information may be gleaned from the label for the target but could also be found in some external annotation source that would be tied in via the official identifier. The source of these synonyms for targets will be determined by the DDWG.

3.0 DISCIPLINE-SPECIFIC SCENARIOS

Discipline-specific search scenarios represent requests that users would likely make when looking for results from a single science discipline (i.e. atmospheric data). Many, if not all, of the PDS Discipline Nodes offer search interfaces that are tailored to the data residing at that Node.

3.1 Atmospheric Observations

This scenario was gleaned from the PDS4 Data Model Study [6] and augmented by Reta Beebe.

Scenario
A user wishes to locate data relevant to atmospheric observations of a giant planet that occurred within a particular time range or detected a particular atmospheric phenomenon.

Selection of products within a specific time range should reveal which instruments on what spacecraft were active and provide observational parameters such as range, incident and emergent angle, etc.

To select data associated with a specific cloud feature the user would need to enter

- The time and estimated latitude & longitude of the feature from the frame they were considering.
- A drift rate of the feature in the UAI System III longitude or call for the nominal drift rate at that latitude.
- An initial and final time the user wishes to track the feature.

The search utility would need to locate a set of images at that latitude and computed longitudes for the specified time period.

Evaluation
This scenario is a blend of the scenarios described for a generic time range search and measurement type search. However, in this scenario it is very likely that the relevant phenomenon will be tagged in a catalog specifically for this data. This external source of annotations can be consulted at index time to enable a given search service to support finer grain search.

For time based searches with a particular target body it may be that the reference of time be that of the target body. This will allow for a more localized and finer grain comparison as product at this level have a commonality of target. This may require a mapping to and from different reference times to be annotated on the product at index time but would not be possible as long as there is a clear means to glean the reference of time being used in the product.

3.2 Ring Observations

This scenario was gleaned from the PDS4 Data Model Study [6].

Scenario
A User wishes to obtain a subset of data that conforms to a large set of parameters including objects and/or features in the observation or observational field of view, physical parameters including the viewing and illumination geometry, timing, wavelength, mission, instrument, instrument type, and observation type.

Evaluation
This scenario describes an adaption of general search by common attributes by extending them with discipline specific attributes. There are two ways in which these discipline specific attributes can make their way into the search service. The first is through the product label as the PDS4 information model supports extensions for domain specific attributes. The second would be annotations provided by an external source, most likely maintained by the disciplined node, to extend attributes beyond what is represented in the model. The search service would support searching against these attributes in the same way it does common attributes as by the time the get indexed by the search service they are no different. Ties to external annotations will be made with the indentifying, geographic, and temporal information found in the label.

3.3 Cassini ISS Movie

Bill Kurth provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario
To search for an ISS movie, for example, you'd select the instrument, target, and enter a start/end time, and a description value of "movie" to reduce the search space. You could also enter geometry values to narrow the results further. The query results would be displayed as a list showing the observation request(s) name and the related data sets beneath. If you hover your mouse over the observation request a pop-up will present you with the full observation description.

Evaluation
The distinguishing characteristic of this scenario is that the expected return result is a movie instead of an image or table. In PDS3, the user would have been limited to discovering the term “movie” in the product description. In PDS4, movies will be classified with their own object type allowing for targeted retrieval and appropriate handling of movie objects.

3.4 MAPS Time Series

Bill Kurth provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario

The vast majority of Magnetosphere and Plasma Science (MAPS) requests (time-wise) are MAPS survey (going under a set of project-consistent naming conventions). Consider a use case for MAG data where a user searches for time intervals when MAG was acquiring data between 8 and 15 R_s and within 10 degrees of the equator on the night side.

Using the search interface, specify the instrument as "MAG", the phase angle greater than 90 degrees (night side), the sub observer latitude between +10 and -10 and the central body distance (km) between 8x60330 and 15x60330. This query should return a list of appropriate observations.

Evaluation

Much like the Rings search a MAPS time series search seems to expand on the common attributes with very specific attributes for this domain; for instance central body distance and sub observer latitude. These attributes when propagated to a search service will be available to search against in the same manner. The other nuance presented in this scenario is the types of values and units of measure. These searches are filters on numeric values and thus the search service must be able to handle numeric ranges. To address units the search service will index a value in a fixed unit for a given attribute. If one wanted to support a different set of units for an attribute one could simply index the converted value in another attribute named slightly different.

One possibility introduced in this scenario is the ability to add annotations based on common queries such “night side”. To satisfy this type of search requirement the annotations would be done at index time by deriving the annotation based on other attributes if not available through consulting some other source.

3.5 Storm System on Saturn

Reta Beebe provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario

The Cassini ISS team released narrow angle images taken on Aug 11, 2009 of lightening associated with a storm located at 36 deg S and 11 deg W. This data was taken on the dark side of the planet. See the following:

http://photojournal.jpl.nasa.gov/catalog/PIA12575

A science user wants to select a time sequence of both wide and narrow angle frames obtained when the associated storm was visible on the daylight side of the planet. Storms drift around the planet at various rates. What they want to do is to execute a sequence of searches. First, set the gate to include images within +/- one month and retrieve a time-ordered list of start time, max and min latitude (0-20 degrees) min and max longitude (25-45 degrees), camera name, filter and exposure time. Hopefully, after they process selected frames from this data they can derive a longitudinal drift rate for the storm system and return with a series of bracketed searches to isolate the storm and study its evolution over a maximum length of time.

Evaluation

Introduced in this scenario is the possibility of date math to be done to satisfy the constraints conveyed. Specifically, this scenario calls for images within one month of a given date time. Beyond that this scenario repeats the call for searching against domain specific attributes and geographic information; these will be handled as previously discussed.

3.6 Landing Site Characterization

This scenario was gleaned from the MRO user scenarios [8].

Scenario

To enable a landing site study the user would need to find HiRISE, CTX, and targeted mode CRISM data for a particular target, acquired at a particular time. The user might search by data type, target name, location, or time to find the data of interest. The CRISM global multi-spectral map might also be used to find locations for which the surface spectra of spectral indices are suggestive of a viable site. For example, the depth of the 3 micrometer water band in surface materials might be of interest. The CRISM multi-spectral map will be a huge data set, with approximately 100 m/pixel resolution, with many bands, and most likely the user would search the map data via a web browser, perhaps downloading sections for more detailed analyses.

Evaluation

This scenario leans towards a GIS solution where maps are available via a service and can be layered on an interface to help with data discovery. The production and tiling of these maps require processing and data that is geospatially referenced. In addition, the subtlety of how to produce a map that conveys this information in a meaningful manner becomes important. Moreover, the produced maps need to either have a way to tie back to the source data or product footprints need be laid on top of the map or queried against once a region of interest is identified.

3.7 Global Scale Characterization and Mapping of Surface Units

This scenario was gleaned from the MRO user scenarios [8].

Scenario

The user would search and/or download the CRISM-Team spectral library data set and construct what he or she thought would be the best spectra to represent basalt and basaltic andesite. These spectra would then be processed to spectral indices associated with the global multi-spectral map and regions of close fit between the spectra and indices in the map would be found and examined. Results would be compared to maps of spectral end-member concentrations produced from TES data and already published online within PDS.

Evaluation

This scenario describes a situation where maps produced by some external entity could be compared to those produced from data in the PDS. The first question that would need to be answered was whether the map itself was published in PDS and the availability of that map (i.e. is it on a hosted map service). If both maps are hosted on a service that supports current GIS standard there are widely available tools to overlay the maps. The key to bring this scenario full circle would be embedding enough metadata so that there is some traceability back to the source data.

3.8 Mapping Subsurface Ice and Water

This scenario was gleaned from the MRO user scenarios [8].

Scenario

The user would focus on SHARAD radargrams generated for each along track set of observations. These radargrams would be analogous to the products produced by traditional ground penetrating radar systems on Earth, i.e., the x axis would be proportional to distance along the survey track and the y axis would represent time. The presence of reflecting surfaces would be shown on the radargrams. The user might begin looking at maps of Mars (MOLA shaded relief maps, Odyssey neutron maps, etc.) and plotting the ground tracks for the SHARAD observations. When an interesting area is found, the beginning and end points of interest on the ground track would be delineated by the user (by typing or denoting positions along the tracks) and the radargrams for those portions of the tracks would show up in a browser window. In addition, the user might wish to see plots of the individual profiles that were used to generate a portion of one or more segments of the radargrams.

Evaluation

Once again this scenario seems to start from a GIS perspective as the user starts from a map and then identifies the region of interest based on that map. This scenario requires that the maps be readily available and likely served up by a GIS service to allow easily integration into GIS tools. Moreover, in order to correlate the maps to the radargrams the footprints of the radargram would have to be known and served up through a GIS service. The responsibility for generating said maps may fall outside the purview of the PDS but would still need a reference back to the archived product; probably through a PDS identifier.

3.9 Global Circulation Model Data Assimilation

This scenario was gleaned from the MRO user scenarios [8].

<u>Scenario</u>
The user would search for MCS data at a specific latitude and longitude location, and at a specific known absolute time and known local time (at that location on Mars). The data product obtained from the PDS will be mapped onto specified pressure levels to fit with the model requirement.

<u>Evaluation</u>
This scenario requires common attributes of location and time for a specific instrument at a specific target. Mapping to or incorporation of the resulting products with a model is outside the scope of search and discovery.

3.10 Atmospheric Conditions Expected During Landing and Surface Operations

This scenario was gleaned from the MRO user scenarios [8].

<u>Scenario</u>
The user would search for MCS atmospheric profiles for the times and locations of interest. They would be used to delineate the atmospheric conditions expected during landing and surface operations. In particular, temporal and zonal mean profiles at the appropriate seasonal dates (and times) would be constructed for study. To calibrate the approach, similar data sets would need to be constructed by the user for the two MER and the Beagle 2 entry sites and results would be compared to actual entry profile trajectories and derived density, pressure, temperature profiles.

Imaging (MARCI, CTX) data sets and CRISM global and targeting data sets would be used to characterize surface dynamics associated with the landing sites. Locations of frequent changes in surface albedo and markings, as well as evidence for small-scale dust lifting activity and frequent dust devils would be identified for landing sites and seasons of interest.

<u>Evaluation</u>

Although the scenario delves into possible subsetting and model integration activities, the search portion of the scenario requires the common attributes of location and time for a specific instrument at a specific target.

4.0 CROSS-DISCIPLINE SCENARIOS

Cross-discipline search scenarios represent requests that users would likely make when looking for results that span science disciplines. Although not specifically mentioned in each scenario evaluation, the search would typically desire results for more than one Node's holdings. This type of search is not well supported by the PDS.

4.1 Cosmic Dust Data

This scenario was gleaned from the PDS4 User Support Study [5].

Scenario
The user wants to know which direction the magnetic field was pointing (information from PPI/MAG data set) when this Cosmic Dust Analyzer (CDA) data was gathered (information from SBN/CDA data set).

Evaluation
This scenario requires correlation of two data sets from the PPI and SBN Nodes based on time. The user would then have to evaluate the results from the query to determine the answer to the question posed in the scenario.

4.2 Elara Observations

This scenario was gleaned from the PDS4 User Support Study [5].

Scenario
I want to find ground-based observations of the Jupiter satellite Elara (information from SBN) and any serendipitous observations by spacecraft at Jupiter identified by other nodes (e.g., Rings) by asking for all data containing observations of Elara in the PDS.

Evaluation
This would require that data to be tagged with Elara. How and when this data gets tagged are paramount but is not function of the search service as it will simply support looking for the annotation of "Elara." Such annotation could have a specific attribute for this annotation, for the sake of discussion say "object_of_interest", but could also as easily just be captured in a set of keywords associated with the indexed item. To resolve that question would be a matter of specificity when submitting the query and/or whether the attribute had a managed set of values that could occur. This decision would likely flow from the information model as such items are being identified as the details are worked out.

4.3 Auroral Images

This scenario was gleaned from the PDS4 User Support Study [5].

Scenario
I've found something interesting about an aurora; give me all auroral images from this time period.

Evaluation
This scenario is similar to the previous scenario in that the desired images would need to be tagged as "auroral images".

4.4 Lobate Crater Observations

This scenario was gleaned from the PDS4 User Support Study [5].

Scenario
I would like a list of lobate crater observations on planetary surfaces.

Evaluation
As in the two previous scenarios, data products would require tagging to indicate that the observation includes a "lobate crater".

4.5 Magnetic Field Data

This scenario was gleaned from the PDS4 User Support Study [5].

Scenario
Without having to query about specific instruments, give me a listing of all magnetic field data in the PDS.

Evaluation
This scenario is tied to 2.2 as the type of measure should be captured as a classification and is being worked in the information model. Once labeled with this annotation a search service should easily be able to filter on this item.

4.6 Titan Polar Occultations

Reta Beebe provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario
Using the NAIF Geometry Finder, determine the date/time for the stellar/solar occultation of interest. Using the search interface, specify the target as "Titan"

and the observation start and end times bounding the stellar/solar occultation time. This query should return a list of appropriate observations.

Evaluation
This query is simply a mix of scenarios 2.3 and 2.6. This lends more towards a requirement on a search interface that it be able to easily integrate tools such as NAIF's Geometry Finder to formulate queries.

4.7 Huygens Lander Site

Reta Beebe provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario
Using the search interface, specify the target as "Titan", a latitude and longitude for the area of the lander site and the observation start time following the landing. This query should return a list of appropriate observations for specified instruments (e.g., ISS, VIMS, UVIS, RADAR, RSS). The user may also want to extract a time-ordered sequence of data from specific instruments on board the lander.

Evaluation
This scenario is not all together different in that it requires common attributes but instead of returning a list of results the search interface could provide an overlay of the landing site as a feature and a the footprints of the products that match the specified time.

4.8 Titan Northern Lakes Multi-Wavelength Study

Reta Beebe provided this scenario for the Cassini Observational Archive Search prototype [7].

Scenario
A science user wants to characterize atmospheric obscuration and changes over and around Kraken Mare, a large northern lake on Titan (285-330 degrees longitude and 50-80 degrees N latitude). See the following:
http://photojournal.jpl.nasa.gov/catalog/PIA11146

To do this, they will want to recover specific data products:
- They will want to locate all radar scans across this region.
- They will want a time sequence of VIMS data that views the region over a range of solar incident and look angles (from nadir viewing with the sun behind the spacecraft, varying slant angles through the atmosphere to solar occultation where VIMS is looking through Titan's atmosphere above the lake region as the sun appears to emerge from behind the planet).

- They will also want similar searches for the ISS and UVIS instruments.

The goal is to extract a time ordered listing of data products for the radar swaths that cover the region and a listing for each of the other three instruments that includes time of observation, minimum/maximum latitude and longitude, solar incident angle and emergent viewing angle. This allows them to organize a search at the product level and develop a systematic plan for analyzing the data, figure out whom they need as collaborators and write a convincing proposal.

Evaluation

Beyond the common attributes such as time and location, this scenario requires attributes such as viewing angles of the instrument and viewing angles with respect to the location of the sun. Although not particularly common attributes across PDS, they are routinely captured for imaging instruments. The challenge for any search interface is to know when such attributes are valid for a given search. Although not mentioned in this document up to this point, but unit of measurement becomes very important for these types of attributes. Either the metadata needs to be captured in the same unit across PDS, which is not likely, or the software aggregating the metadata needs to apply proper transformations.

APPENDIX A ACRONYMS & ABBREVIATIONS

The following acronyms made an appearance in this document:

CDA	Cosmic Dust Analyzer (Cassini Instrument)
CRISM	Compact Reconnaissance Imaging Spectrometer for Mars (MRO Instrument)
CTX	Context Imager (MRO Instrument)
HiRISE	High Resolution Imaging Science Experiment
ISS	Imaging Science Subsystem (Cassini Instrument)
JPL	Jet Propulsion Laboratory
MAG	Dual Technique Magnetometer (Cassini Instrument)
MAPS	Magnetosphere and Plasma Science
MARCI	Mars Color Imager (MRO Instrument)
MCS	Mars Climate Sounder (MRO Instrument)
MGS	Mars Global Surveyor
MOLA	Mars Orbiter Laser Altimeter (MGS Instrument)
MRO	Mars Reconnaissance Orbiter
NASA	National Aeronautics and Space Administration
PDS	Planetary Data System
PDS3	Version 3 of the PDS Standards
PDS4	Version 4 of the PDS Standards
PDS 2010	The initial identifier of the PDS4 Project
PPI	Planetary Plasma Interactions (PDS Node)
SBN	Small Bodies Node (PDS Node)
SHARAD	Shallow Radar (MRO Instrument)
TBD	To Be Determined
TES	Thermal Emission Spectrometer (MGS Instrument)
VIMS	Visual and Infrared Mapping Spectrometer (Cassini Instrument)
UVIS	Ultraviolet Imaging Spectrograph (Cassini Instrument)