International Planetary Data Alliance (IPDA)

IPDA Planetary Access Protocol

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Abstract

This specification defines a protocol for the retrieval of distributed planetary data.

The interface is meant to be reasonably simple to implement by service providers. The basic summarized functionality of the protocol is as follows: a query defining a certain restriction on the available data is used as a first step to query for candidate data. The service returns a list of candidate hits formatted as a VOTable. For each candidate hit an access reference URL may be used to retrieve the real data. Data may be returned in a variety of formats.

This specification describes the "simple" way to access the data through an HTTP protocol. Other types of more complex access, eventually using SQL-like language and more complex transports as SOAP, will be worked on within the IPDA technical experts group.

Status of This Document

This document has been produced by the IPDA Technical Experts Group.

It has been reviewed by IPDA Members and other interested parties, and has been endorsed by the IPDA Steering Committee as an IPDA Recommendation. It is a stable document and may be used as reference material or cited as a normative reference from another document. IPDA's role in making the Recommendation is to draw attention to the specification and to promote its widespread deployment. This enhances the functionality and interoperability inside the Planetary Data Community.

 A list of current IPDA Recommendations and other technical documents can be found at http://planetarydata.org/technical-reports/.

Contents

1   Overview

The Planetary Data Access Protocol (PDAP) is an International Planetary Data Alliance (IPDA) [1][2] protocol that defines how to interchange planetary data. This protocol has been developed as a combination of OGC [3] protocols (mainly for map-projected data) and IVOA protocols (for astronomical data but a science level data) like the Simple Image Access Protocol (SIAP) [4].

This close to other protocols definition allows easy integration with other data sources from other Virtual Observatories, but using particular language and characterization of planetary data.

The PDAP is a two steps protocol. That means that two steps need should be performed in order to access the data, in the following sequence:

Step 1:   Metadata Access
Step 2:   Data Access

In the first step, the archive is asked for the metadata pertaining to the data that obey a certain restriction in the input parameters. Among the compulsory output parameters of this metadata is a reference to the real file holding data. This allows for the second step of the protocol to be executed, as the data are readily made available through the declared link.

2   Requirements for Compliance

The keywords "MUST", "SHOULD", and "MAY" as used in this document are to be interpreted as described in RFC 2119 [7].

An implementation is compliant if it satisfies all the MUST level requirements for the protocols it implements. An implementation that satisfies all the MUST level and all the SHOULD level requirements for its protocols is said to be "unconditionally compliant"; one that satisfies all the MUST level requirements but not all the SHOULD level requirements for its protocols is said to be "conditionally compliant".

Compliance with this specification requires that an access web service be maintained with the following characteristics:

1. The **Metadata Query** web method MUST be supported as defined in section 4 below.

Through this web method, clients search for available data that match certain client-specified criteria. The response is a table that describes the available data, including metadata and access references (implemented here as URLs) for retrieving them.

2. The **Data Retrieval** web method MUST be supported as defined within the different use cases in section 4.8 below.

   This method allows clients to retrieve data through a simple synchronous HTTP GET/POST request using the access reference (URL) returned earlier by the metadata query. The response to the GET/POST request is the requested data, returned with a MIME type such as "image/fits", "image/jpeg", "image/IMG" and so forth.

3. Finally the service MUST be **registered** by providing the information defined in Appendix C below.

   Registration allows clients to use a central registry service to locate compliant PDAP services and select an optimal subset of services to query, based on the characteristics of each service and the data collections it serves.

3 Planetary Data Service Types

The PDAP protocol is very basic in nature: few input/output parameters are required, making the protocol very flexible and open. This flexibility allows the handling of as different data types as images, spectra, plasma information, atmospheric information, etc.

The general PDAP protocol defines "compulsory" input and output parameters within its working scheme for the general case. However, specific services might be specialised in specific subsystems or instruments, for instance only serving images. In this case, specific parameters are needed to ensure interoperability at the granularity level of the specific service.

Current general IPDA PDAP standard will only describe two types of services:

- General Data service
- Map projected data service

The General Data service abides by the input/output parameters described for the general PDAP protocol, whereas the Map projected data Service contains an extended set of input/output parameters with its own set of "compulsory" items.

The Map Projected Data Service will be described below as a specific case of the General Data service

Other services, like Spectral services, Atmospheric services, Plasma services, etc., will certainly need to be specified in a near future. Those services shall be described in PDAP extensions specifications. The way to generate a PDAP extension specification is described in section 6.

4   General Service Metadata Query

The purpose of the metadata query web method is to allow users to search for data for a given set of input parameters. The service will return references to data which most closely match what is requested. How closely the service can match the specifications of the data requested by the client will depend upon the type of data service. The service returns a table listing all available data satisfying the query. Descriptive metadata is returned for each hit to allow the client to decide which, if any, data it wishes to retrieve. An access reference is provided for each hit to permit subsequent staging and retrieval.

4.1   Query Interface General Rules

The metadata query input is transmitted as an HTTP GET/POST request represented by a URL with two parts:

1.   A base URL of the form:
     http://<server-address>/<path>?[<extra-arg>&[...]]

Examples:

http://psa.esac.esa.int/aio/jsp/metadata.jsp?
http://starbrite.jpl.nasa.gov/q?

Note that when it contains extra GET/POST arguments, the base URL ends in an ampersand, **&**; if there are no extra arguments, then it ends in a question mark, **?**. Every query to a given metadata query service uses the same base URL.

2. Constraints expressed as a list of ampersand-delimited GET/POST arguments, each of the form: *<name>=<value>*

Example:

TARGET_NAME=MARS&DATA_SET_ID=TSK-C-RCC-CAL-
RSAWIRTANENV1.0

The constraints represent the query parameters which can vary for each successive query.

The baseURL and constraint list are concatenated to form the query.

Example:

http://psa.esac.esa.int:8000/aio/jsp/metadata.jsp?
TARGET_NAME=MARS&RESOURCE_CLASS=DATA_SET

All the keyword=value parameters are considered AND conditions to filter out a query result. In the case of numerical values, a syntax to define ranges is defined in Appendix A.

All the keyword names are case sensitive and it must be always used in upper case.

4.2 PDAP classes description

The RESOURCE_CLASS input parameter defines the granularity of the PDAP response. As commented before, a valid PDAP response would be, in a general sense, a result table in a certain format (by default VOTable). Every row in the result table contains metadata information of the same kind of abstract object, e.g., the table response could contain a set of datasets (if RESOURCE_CLASS=DATA_SET is selected) one row per dataset, a set of products if RESOURCE_CLASS=PRODUCT is selected) one row per product, etc.

This schema is extensible to other kind of objects, typically extensions of the basic object PRODUCT. In this general PDAP specification document, a product extension object called MAP_PROJECTED is also allowed and described.

This is a summary of the classes supported by present specification and described in the UML diagram below:

- A data set is a self-consistent data package, as per PDS documentation description, that is compliant with an agreed directory structure. See [5] for reference. A data set contains a set of products.
- A product is the atomic self-consistent entity from the scientific point of view or the lowest data entity that has a PDS label for PDS compliant products. It can be composed by one or more physical files.
- Both data sets and products can be downloaded using a data access reference.

- Both data sets and products are defined for a time and spectral ranges. These coverages are reflected by the coverage axis classes.
- As one example of product extension, a map projected product is also included in present specification. This map projected product class has associated a map coverage object described in present specification.
- As an example, although not included in current general PDAP specification, UML contains possible extensions of Map Projected product. Any new extension could require a separate PDAP specification extension document.
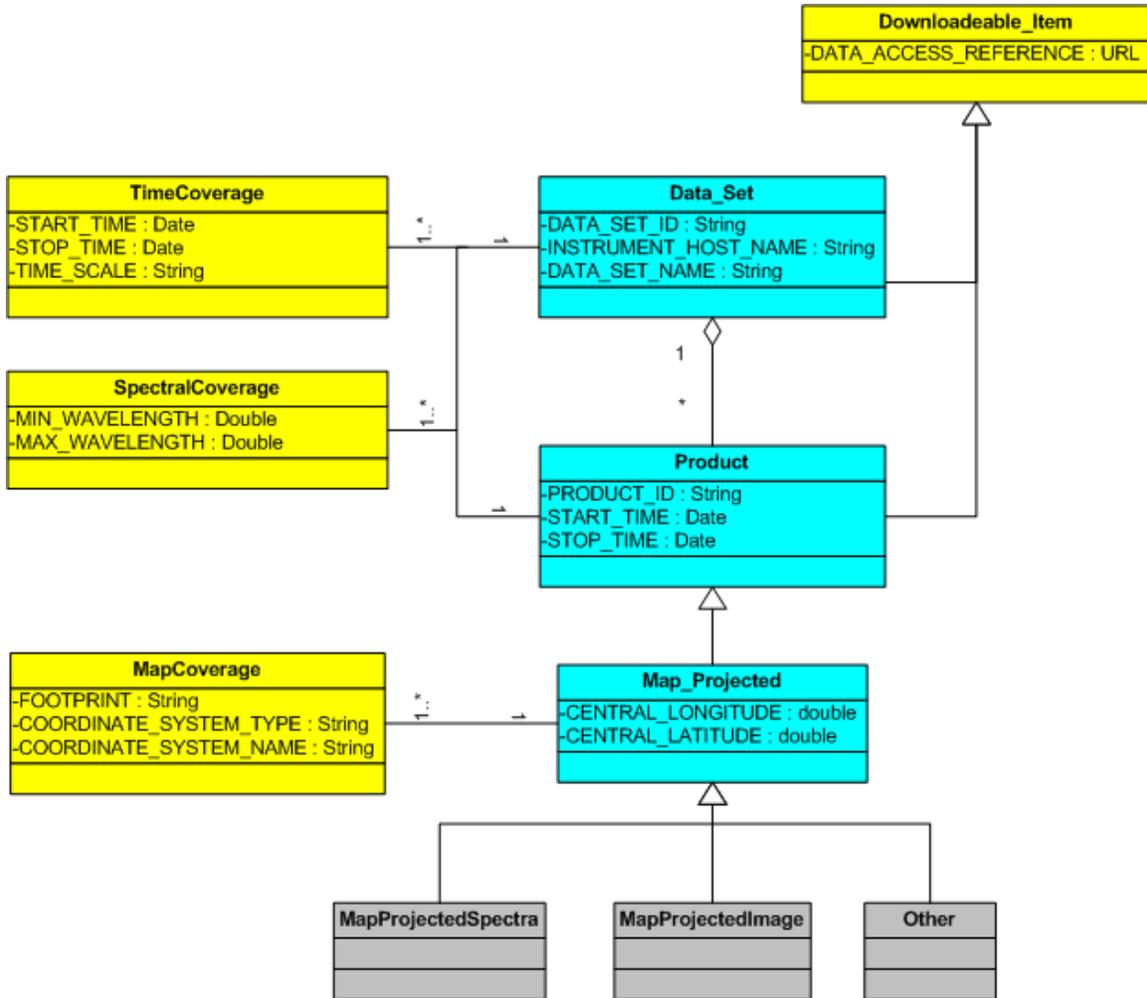
Figure 1: Simplified UML diagram of the resource classes described in the present PDAP specification. In light blue, classes directly described in the specification; in yellow, classes indirectly described in the spec; in gray, examples of possible extensions of map_projected product or product that could be designed in separate PDAP extensions specifications.

Other possible extensions like spectra, plasma data, atmospheric data, etc could be created and easily plugged into the system by the definition of the object data model extension and the direct identification of the new query parameters and

output response that this new object could require. Extensions could be done from map projected product if a footprint could be associated to this product or directly from product (e.g. for fly-by products)

Extensions could be created in other specifications including extra input parameters, level of compliance and extra output fields.

4.3 Compulsory Interface Query Parameters

The following interface query parameters MUST be implemented by any PDAP service in order to have a PDAP compliant interface.

4.3.1 RESOURCE_CLASS

The RESOURCE_CLASS input parameter defines the granularity of the PDAP response. See section 4.2 for a detailed description.

Examples:

http://psa.esac.esa.int:8000/aio/jsp/metadata.jsp?
TARGET_NAME=MARS&RESOURCE_CLASS=DATA_SET

4.4 Optional Interface Query Parameters

The following interface query parameters COULD be implemented by any PDAP service in order to have an added value PDAP service.

It is not necessary that the service implements all the optional query parameters to produce a enriched service but these ones are considered relevant to enhance the it.

4.4.1 WHERE_CONDITION

The WHERE_CONDITION input parameter allows the creation of a complex PDAP query using a simplified and restricted SQL like where condition (included nested AND and OR conditions) using the Metadata Query Parameters listed on this document or other project dependent ones available for a particular PDAP service. The allowed logical operators are:

Logical Operator	Description
OR	For the row to be selected at least one of the conditions must be true.
AND	For a row to be selected all the specified conditions must be true

And the allowed comparison operators are:

Comparison Operator	Description
=	Equals
>	Greater than
<	Minor than
>=	Greater than or equal than
<=	Minor than or equal than
!=	Not equal

The value associated to the where condition must be encoded using the standard URL encoding. The WHERE_CONDITION query parameter can be used in combination with the standard keyword=value paradigm. When added in a query, the where condition generated must be considered as an extra AND condition to the query generated by the rest of the parameters already present in the query.

Examples:

WHERE_CONDITION=(INSTRUMENT_NAME=FLUXGATE AND MISSION_NAME=MEX) OR (START_TIME>'1997-03-03T16:18:39.000' AND MISSION_NAME=VEX)

and in URL encoded format:

http://psa.esac.esa.int:8000/aio/jsp/metadata.jsp?
TARGET_NAME=MARS&RESOURCE_CLASS=DATA_SET&
WHERE_CONDITION=(INSTRUMENT_NAME%3DFLUXGATE%20
AND%20MISSION_NAME%3DMEX)
%20OR%20(START_TIME%3E%E2%80%991997-03-
03T16%3A18%3A39.000%E2%80%99%20AND%20MISSION_NAME%3DVEX)

4.4.2 SELECTED_FIELDS

Usually, a PDAP service will offer a table with values for the fields of the selected RESOURCE_CLASS. However, the output fields could be filtered out if the parameter SELECTED_FIELDS is implemented. The syntax of the value for this parameter is a set of resource class attributes, comma separated

Examples:

http://psa.esac.esa.int:8000/aio/jsp/metadata.jsp?
TARGET_NAME=MARS&RESOURCE_CLASS=DATA_SET&
SELECTED_FIELDS=DATA_SET.DATA_SET_NAME,
DATA_SET.INSTRUMENT_HOST_NAME

4.4.3 Pagination Query Parameters

A PDAP service may implement pagination. This capability should be discovered by a service metadata query as per section 5. In order to implement pagination, the following query parameters should be implemented at server level.

4.4.3.1 PAGE_SIZE

The query parameter PAGE_SIZE will be used by the client to select the page size of the expected result. This should be considered a maximum size. In case the result of the query contains less than the number requested, the full response will be offered in the result.

4.4.3.2 PAGE_NUMBER

The query parameter PAGE_NUMBER will be used by the client to select the page number of the expected result. It should be used in combination with PAGE_SIZE

4.5 Compulsory Query Metadata Parameters

The following is a list of the compulsory query metadata parameters that any service implementing the PDAP protocol **MUST** be able to understand. In this context, the "compulsory" attribute means that the service must be able to respond whenever any of these parameters is input in the "key=<value>" pair of the aforementioned base URL, but it is not needed that the service give compulsorily any result.

At the same time, not all the compulsory input parameters should be present in a valid PDAP URL query.

Values must be URL encoded (e.g. spaces replaced by + or %20)

4.5.1 Time Coverage Input parameters

Searches can be constrained in time by using the following input parameters,

4.5.1.1 START_TIME

The START_TIME element provides the date and time of the beginning of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system

---

Formation rule:

YYYY-MM-DDThh:mm:ss[.fff]

4.5.1.2 STOP_TIME

The STOP_TIME element provides the date and time of the end of an event or observation (whether it be a spacecraft, ground-based, or system event) in UTC system

Formation rule:

YYYY-MM-DDThh:mm:ss[.fff]

Example:

1997-03-11T19:29:36.000

4.5.2 INSTRUMENT_TYPE

The INSTRUMENT_TYPE element identifies the type of an instrument.

Examples:

POLARIMETER
RADIOMETER
SPECTROREFLECTOMETER
VIDICON CAMERA

See [5] for a full list of accepted values.

4.5.3 INSTRUMENT_NAME

The INSTRUMENT_NAME element provides the full name of an instrument.

See [5] for a full list of accepted values.

4.5.4 INSTRUMENT_HOST_NAME

The INTRUMENT_HOST_NAME element provides the full name of the host on which an instrument is based. This host can be either a spacecraft or an earth base.

See [5] for a full list of accepted values.

4.5.5 TARGET_TYPE

The TARGET_TYPE element identifies the type of a named target.

See [5] for a full list of accepted values.

4.5.6 TARGET NAME

The TARGET_NAME element identifies a target. The target may be a planet, satellite, ring, region, feature, asteroid or comet.

Examples:

GANYMEDE
MARS
5797 BIVOJ

See [5] for a exhaustive list of possible values although the list could be extended.

4.5.7 RETURN_TYPE

The return type describes the type of output that should be received after the metadata query. The default response formal will be VOTable [6]. Other possible formats could be HTML, CSV, KML and ASCII although these are not formally defined in present specification.

Examples:

VOTABLE
HTML
CSV

4.6 Optional Query Metadata Parameters

The following is a list of the optional query metadata parameters that any service implementing the PDAP protocol **MAY** understand. Therefore, the implementation of these query parameters would be useful in order to provide extra-functionality to a PDAP service and to fulfill some use cases but it is not considered compulsory.

If these parameters appear in a query done to a PDAP service that does not implement them the correct response should be an empty table response.

Values should be URL encoded (e.g. spaces replaced by + or %20)

4.6.1 MIN_WAVELENGTH, MAX_WAVELENGTH

MIN_WAVELENGTH and MAX_WAVELENGTH elements identify a constraint of the spectral range where this observation can be made or was made.
The unit used for this query parameter is microns.

> **Examples:**
>
> &MIN_WAVELENGTH=0.2&MAX_WAVELENGTH=0.8

Output result should contain all the entities that have a spectral coverage that overlaps with the range (0.2, 0.8) microns and fulfill the rest of the PDAP query.

4.6.2 SPACECRAFT_ALTITUDE

The SPACECRAFT_ALTITUDE element provides the distance from the spacecraft to a reference surface of the target body measured normal to that surface. The format of this range will follow the convention described in Appendix A.

The unit used for this query parameter is km.

> **Example:**
>
> & SPACECRAFT_ALTITUDE =/1000

Output result should contain all the entities that have a spacecraft altitude smaller than 1000 km, following the range format described in appendix A, and fulfill the rest of the PDAP query.

4.7 Query Parameters per Resource Class

Compliant services for specific resource classes could require the implementation of extra compulsory query parameters. We describe in the present specification the ones related with the resource classes covered in this general PDAP specification (DATA_SET, PRODUCT and MAP_PROJECTED).

Query input parameters for other resource classes will be described in the relevant PDAP core specification extensions documents (see section 6)

4.7.1 Resource Class DATA_SET

 PDAP services implementing RESOURCE_CLASS=DATA_SET granularity response **MUST** implement the general PDAP compulsory query input parameters plus the following query input parameter.

4.7.1.1 DATA_SET_ID

The DATA_SET_ID element is a unique alphanumeric identifier for a data set or a data PRODUCT. The DATA_SET_ID value for a given data set or product is constructed according to flight project naming conventions. In most cases the DATA_SET_ID is an abbreviation of the DATA_SET_NAME.

Example:

MR9/VO1/VO2-M-ISS/VIS-5-CLOUD-V1.0

4.7.2 Resource Class PRODUCT

PDAP services implementing RESOURCE_CLASS=PRODUCT granularity response **MUST** implement the general PDAP compulsory query input parameters plus the following query input parameter

4.7.2.1 DATA_SET_ID

The DATA_SET_ID element is a unique alphanumeric identifier for a data set or a data PRODUCT. The DATA_SET_ID value for a given data set or product is constructed according to flight project naming conventions. In most cases the DATA_SET_ID is an abbreviation of the DATA_SET_NAME. For not PDS complaints resources, DATA_SET_ID value should be a unique identifier that allows the grouping of similar products, although it could not have real entity.

Example:

MR9/VO1/VO2-M-ISS/VIS-5-CLOUD-V1.0

4.7.2.2 PRODUCT_ID

The PRODUCT_ID data element represents a permanent, unique identifier assigned to a data product by its producer within a dataset. That means that the combination DATA_SET_ID.PRODUCT_ID should be unique. The PRODUCT_ID can describe the lowest-level data object that has a PDS [5] label.

Example:

TSK_C_RCC_3_19970303T165718

4.7.3 Resource Class MAP_PROJECTED

As already mentioned in point 3, the case of the map projected data access is a very special one in the Inter-planetary science world, as a lot of the information from Planetary science has historically come from e.g. images from the planetary bodies with associated geometrical information.

Rather than defining a new protocol for map projected data access, we have decided to include it in the more general PDAP protocol as a specific case. However, specific input/output parameters are required for this type of data. In particular, the Region Of Interest (ROI) of the observation must be defined for the map projected data access in order to characterize the geometrical information attached to the data.

Although we agree that the definition of these parameters might be difficult due to the very nature of the different planetary bodies, etc., we define a four-corners ROI search as compulsory input parameters, and a so called FOOTPRINT for the output parameters. This definition is quite close to OpenGIS Map Services but using specific planetary data characterization through PDS keywords and describing a standard way to access scientific data.

A *Map Projected Data Service* **MUST** implement the general PDAP input/output parameters plus the following query input parameters to define a Region Of Interest (ROI) for the product search.

4.7.3.1 LONGITUDE

A Map Projected Data Service **MUST** implement a parameter to specify a LONGITUDE range (For range definition, please refer to appendix A)

For a Planetocentric, body-fixed, rotating coordinate system, longitude is defined as: The angle increasing eastward between the prime meridian and the vector from the coordinate system origin to the point of interest, projected into the equatorial plane. This is a right-handed coordinate system. For a Planetographic, body-fixed, rotating coordinate system, longitude is defined as: The angle between the prime meridian and the vector from the coordinate system origin to the point of interest, projected into the equatorial plane. Planetographic longitudes are defined to increase with time for a distant observer. Thus, they increase to the west for prograde rotators, and to the east for retrograde rotators. For the Earth, Moon and Sun, PDS also supports the traditional use of the range (-180,180)

Unless the parameter COORDINATE_SYSTEM_NAME is used to select another coordinate system, default coordinate system for the longitude is planetocentric.

4.7.3.2 LATITUDE

A Map Projected Data Service **MUST** implement a parameter to specify a LATITUDE range (For range definition, please refer to appendix A). Combined with the LONGITUDE range, both parameters define a region of interest.

For a Planetocentric, body-fixed, rotating coordinate system, latitude is defined as: The angle between the equatorial plane and a vector connecting the point of interest and the origin of the planetocentric coordinate system. Positive in the hemisphere north of the equator (i.e., hemisphere to the north of the solar system invariant plane) and negative in the southern hemisphere. For a Planetographic, body-fixed, rotating coordinate system, latitude is defined as: The angle between the equatorial plane and a vector through the point of interest that is normal to a biaxial ellipsoid reference surface. Positive in the hemisphere north of the equator (i.e., hemisphere to the north of the solar system invariant plane) and negative in the southern hemisphere.

Unless the parameter COORDINATE_SYSTEM_NAME is used to select another coordinate system, default coordinate system for the latitude is planetocentric.

4.7.3.3 COORDINATE_SYSTEM_NAME

A Map Projected Data Service **MAY** implement a parameter to specify a COORDINATE_SYSTEM_NAME to characterize the LONGITUDE and LATITUDE parameters. Possible values for a certain server must be discovered using the metadata request action (see section 5)

4.8 Successful Response

The default output returned by a **Metadata Query** is a VOTable [6] version 1.1, an XML table format, returned with a MIME-type of application/x-votable+xml. The table lists all the data available to the client that match the query constraints. The following requirements are placed on the contents of the table when the query successfully returns a list of available data:

1. The VOTable **MUST** contain a RESOURCE element, identified with the tag type="results", containing a single TABLE element which contains the results of the query. The VOTable is permitted to contain additional RESOURCE elements, but the usage of any such elements is not defined here. If multiple resources are present it is recommended that the query results be returned in the first resource element.

2. The RESOURCE element SHOULD contain an INFO with name="QUERY_STATUS". Its value attribute should set to "OK" if the query executed successfully, regardless of whether any matching products were found. All other possible values for the value attribute are described in section 4.3 below.

3. Each table row represents a different data available to the client.
4. Each row of the output VOTable MUST contain FIELDs where a certain *utype* (a reference to a certain UML attribute/entity)_or ID have been set.

4.8.1 PDAP Version Information

A PDAP compliant output **SHOULD** contain an INFO tag with name PDAP_VERSION and value the PDAP specification version implemented by the service. This INFO tag must be inside the RESOURCE tag due to VOTable compatibility. (see RESOURCE_CLASS=METADATA output as an example). This information should appear in a RESOURCE_CLASS=METADATA discovery query.

This tag has two different uses:

- Provide information to client applications about the version of the PDAP specification implemented by the PDAP server so clients could prevent parsing problems.
- Allow one to automatically discover version information by registry servers.

Example:

```
<INFO name="PDAP_VERSION" value="1.0"/>
```

See section Appendix B for a more detailed example.

4.8.2 Pagination Metadata Response

A VOTable response of a service implementing pagination may contain the following PARAMs at RESOURCE level:

- It **MAY** contain one PARAM with the name **TOTAL_RECORDS** and the total number of records that fulfill the query as value

- It **MAY** contain one PARAM with the name **PAGE_SIZE** and number of records present in the current VOTable response

- It **MAY** contain one PARAM with the name **PAGE_NUMBER** page number that corresponds with the current VOTable response as value

```
Example of VOTable header including pagination:

<?xml version="1.0" ?>
<!DOCTYPE VOTABLE (View Source for full doctype...)>
<VOTABLE version="1.1">
 <RESOURCE type="results">

  <DESCRIPTION>PSA Metadata Query Service</DESCRIPTION>

  <INFO name="PDAP_VERSION"   value="1.0"/>
  <INFO name="QUERY_STATUS"   value="OK" />

  <PARAM name="TOTAL_RECORDS" value="10000"/>
  <PARAM name="PAGE_NUMBER"   value="3"/>
  <PARAM name="PAGE_SIZE"     value="1000"/>

  <TABLE>
```

4.8.3 Generic Metadata Response per Resource Class

We describe in this section the metadata response fields to be present in the response of services implementing the resource classes described in the present core PDAP specification (DATA_SET, PRODUCT and MAP_PROJECTED).

Metadata response fields for other resource classes will be described in the relevant PAP core specification extensions documents (see section 8).

4.8.3.1 Resource Class DATA_SET

These are the resource class DATA_SET specific metadata response fields:

- Exactly one field **MUST** have one *utype*=**"pdap:DATA_SET.DATA_SET_ID"** with datatype="char", and arraysize="*", with obvious contents (see previous definitions).

  Exactly one field **MUST** have one *utype*=**"pdap:DATA_SET.INSTRUMENT_HOST_NAME"** with datatype="char", and arraysize="*", with obvious contents (see previous definitions).

- Exactly one field **MUST** have one *utype*=**"pdap:DATA_SET.START_TIME"** and one *utype*=**"pdap:DATA_SET.STOP_TIME"** with datatype="char" and arraysize="*" with obvious contents (see previous definitions)

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- Exactly one field **MUST** have one *ID*=**"RESOURCE_CLASS"** with datatype="char", and arraysize="*". For this resource class, the default value accepted would be DATA_SET but it could be specified a different value if the entity described is a possible extension of this base class

- Exactly one field **MUST** have one *utype*=**"pdap:DATA_SET.DATA_SET_NAME"**, with datatype="char", and arraysize="*", containing a short (usually one line) description of the data set. This should concisely describe the data set to a user, typically identifying the data source (e.g., survey name), object name or field coordinates, bandpass/filter, and so forth. Note that a client application may present the user with a combined list of data from many different queries and sources: the title string is important to identify each data to the user.

- Exactly one field **MUST** have *ID*="**DATA_ACCESS_REFERENCE"**, with datatype="char" and arraysize="*", specifying the URL to be used to access or retrieve the data. Since the URL will often contain metacharacters the URL is normally enclosed in an XML CDATA section (<![CDATA[...]]>) or otherwise encoded to escape any embedded metacharacters.

Example:

<![CDATA[http://psa.esac.esa.int:8000/aio/jsp/product.jsp?dataSetID=MEX-M-ASPERA3-2-EDR-ELS-V1.0&PROTOCOL=HTTP]]>

Although this could be evolved in the future to something more complex, this URL should provide a self-consistent package of the data requested, e.g., a label file and a data file or a set of files for a certain data set.

- Exactly one field **MUST** have one *ID*=**"REFERENCE_FORMAT"** with datatype="char", and arraysize="*" containing a valid mime-type for the data URL

4.8.3.2 Resource Class PRODUCT

These are the resource class PRODUCT specific metadata response fields:

- Exactly one field **MUST** have one *utype*="**pdap:PRODUCT.PRODUCT_ID"** (the combination of DATA_SET_ID plus PRODUCT_ID is required to identify the product) with datatype="char", and arraysize="*", with obvious contents (see previous definitions).

- Exactly one field **MUST** have one
  utype=**"pdap:DATA_SET. INSTRUMENT_HOST_NAME"** with
  datatype="char", and arraysize="*", with same contents than previous
  definition.

- Exactly one field **MUST** have one
  utype=**"pdap:PRODUCT.START_TIME"** and one field **MUST** have
  utype=**"pdap:PRODUCT.STOP_TIME"**, with obvious contents (see
  previous definitions)

- Exactly one field **MUST** have one *ID*=**"RESOURCE_CLASS"** with
  datatype="char", and arraysize="*". Even when there is a query parameter
  RESOURCE_CLASS to filter the query output, this field could contain
  different heterogeneous values, e.g. MAP_PROJECTED, IMAGE or
  SPECTRUM (if these resource classes are defined in an external
  document) for a PRODUCT query. The use of this parameter would be to
  help clients to handle products in a better way, using e.g. specific helper
  applications.

Examples of valid values:

PRODUCT, MAP_PROJECTED

- Exactly one field **MUST** have *ID*=**"DATA_ACCESS_REFERENCE"**, with
  datatype="char" and arraysize="*", specifying the URL to be used to
  access or retrieve the data. Since the URL will often contain
  metacharacters the URL is normally enclosed in an XML CDATA section
  (<![CDATA[...]]>) or otherwise encoded to escape any embedded
  metacharacters.

Example:

<![CDATA[http://psa.esac.esa.int:8000/aio/jsp/product.jsp?dataSetID=MEX-M-HRSC-3-
RDRV2.0&productID=H1483_000_P22.IMG&PROTOCOL=HTTP]]>

- Exactly one field **MUST** have one *ID*=**"REFERENCE_FORMAT"** with
  datatype="char", and arraysize="*" containing a valid mime-type for the
  data URL

- Exactly one field **MAY** have *ID*=**"ICON_ACCESS_REFERENCE"**, with
  datatype="char" and arraysize="*", specifying the URL to be used to

access to an ICON representation of the product. Since the URL will often contain metacharacters the URL is normally enclosed in an XML CDATA section (<![CDATA[...]]>) or otherwise encoded to escape any embedded metacharacters.

Example:

<![CDATA[http://psa.esac.esa.int:8000/aio/jsp/product.jsp?dataSetID=MEX-M-HRSC-3-RDRV2.0&productID=H1483_000_P22.IMG&rule=retrieveBrowseImage&compression=loose&PROTOCOL=HTTP]]>

4.8.3.3 Resource Class MAP_PROJECTED

As MAP_PROJECTED is a PRODUCT extension, output response MUST contain all the compulsory fields for the PRODUCT class, except the ones overwritten in present resource class description.

These are the resource class MAP_PROJECTED specific metadata response fields:

- Exactly one field **MUST** have one utype=**"pdap:MAP_PROJECTED.FOOTPRINT"** with datatype="char", and arraysize="*". The **FOOTPRINT** will be specified as follows:
  - **Polygonal** regions

    POLYGON(LON_1:LAT_1,LON_2:LAT_2,….,LON_n:LAT_n)

  - **Circular** regions:

    CIRCLE(CENTER_LON:CENTER_LAT,RADIUS)

  - **Landmarks**:

    POINT(LON:LAT)

- Exactly one field **MUST** have one *utype*=**"pdap:MAP_PROJECTED.CENTER_LONGITUDE"** with datatype="char", and arraysize="*".
  The *CENTER_LONGITUDE* element provides a reference longitude for certain map projections. For example, in an Orthographic projection, the center_longitude along with the center_latitude defines the point or tangency between the sphere of the planet and the plane of the projection. The map_scale (or map_resolution) is typically defined at the center_latitude and center_longitude.

- Exactly one field **MUST** have one *utype*=**"pdap:MAP_PROJECTED.CENTER_LATITUDE"** with datatype="char", and arraysize="*".
  The *CENTER_LATITUDE* element provides a reference latitude for certain map projections. For example, in an Orthographic projection, the center_latitude along with the center_longitude defines the point or tangency between the sphere of the planet and the plane of the projection. The map_scale (or map_resolution) is typically defined at thecenter_latitude and center_longitude.

- At a maximum of one field **MAY** have one *utype*=**"pdap:MAP_PROJECTED.COORDINATE_SYSTEM_TYPE"** with datatype="char", and arraysize="*" describing the type of coordinates system used for the footprint and the center longitude/latitude fields.
  There are three basic types of coordinate systems:
  1. Body-Fixed Rotating:A body-fixed coordinate system is one associated with a body (e.g., planetary body or satellite), centered in the body and it rotates with the body.
  2. Body-FixedNon-rotating: A body-fixed coordinate system is one associated with a body (e.g., planetary body or satellite), centered in the body but it does not rotate with the body.
  3. Inertial:Fixed at some point in space.

If this field is not present the default value is assumed to be BODY-FIXED ROTATINGPLANETOGRAPHIC.

List of possible values:

BODY-FIXED NON-ROTATING
BODY-FIXED ROTATING
INERTIAL

- At a maximum of one field **MAY** have one *utype*=**"pdap:MAP_PROJECTED.COORDINATE_SYSTEM_NAME"** with datatype="char", and arraysize="*" providing the full name of the coordinate system to which the state vectors are referenced and used for the footprint and the center longitude/latitude fields.
  The coordinate_system_name element provides the full name of the coordinate system to which the state vectors are referenced.
  The Planetocentric system has an origin at the center of mass of the body. The Planetocentric latitude is the angle between the equatorial plane and a vector connecting the point of interest and the origin of the coordinate system. Latitudes are defined to be positive in the northernhemisphere of

the body, where north is in the direction of Earth's angular momentum vector, i.e., pointing toward the hemisphere north of the solar system invariant plane. Longitudes increase toward the east, making the Planetocentric system right-handed.

The Planetographic system has an origin at the center of mass of the body. The planetographic latitude is the angle between the equatorial planeand a vector through the point of interest, where the vector is normal to a biaxial ellipsoid reference surface. Planetographic longitude is defined to increase with time to an observer fixed in space above the object of interest. Thus, for prograde rotators (rotating counterclockwise as seen from a fixed observer located in the hemisphere to thenorth of the solar system invariant plane), planetographic longitude increases toward the west. For a retrograde rotator, planetographic longitude increases toward the east. We also include other kind of coordinate system names used in planetary data as possible values but coordinates should be translated to planetographic or planetocentric whenever possible (e.g. these two coordinates systems are not usually applied for gas giant planets)

If this field is not present the default value is assumed to be body-fixed rotating Planetographic.

List of possible values:

PLANETOCENTRIC
PLANETOGRAPHIC
BODY FIXED SPHERICAL COORDS
EARTH-SUN LINE CARTES COORDS
ECLIPTIC INERTIAL CART COORDS
ECLIPTIC INERTL SPHERCL COORDS
EQUATORIAL INERT SPHRCL COORDS
EQUATORIAL INERTIAL CART COORD
JUPITER MINUS SYSTEM III
MAST_FRAME
MB FRAME
MEAN INERTIAL HG 1950
MI_FRAME
NEPTUNE WEST LONGITUDE SYSTEM
NON-ROTATING SPIN COORDINATES
PLANET CENTERED CYLINDRICAL
PVO INERTIAL SPACECRAFT COORDS
PVO SPINNING SPACECRAFT COORDS
ROVER_FRAME
SATURN MINUS LONGITUDE SYSTEM
SC CENTERED ECLIPTIC COORDS
URANUS MINUS LONGITUDE SYSTEM
URANUS WEST LONGITUDE SYSTEM
VENUS SOLAR ORBITAL COORDS

According to the above set of parameters, a possible PDAP map projected data query could be as follows:

Example:

http://psa.esac.esa.int:8000/aio/jsp/metadata.jsp?TARGET_NAME=MARS
&LATITUDE=25/30&LONGITUDE=35/40&
RESOURCE_CLASS=MAP_PROJECTED&
RETURN_TYPE=HTML

- Exactly one field **MUST** have one *ID*=**"RESOURCE_CLASS"** with datatype="char", and arraysize="*". Even when there is a query parameter **RESOURCE_CLASS** to filter the query output, this field could contain different heterogeneous values, e.g. IMAGE and SPECTRUM (if these resource classes are defined in an external document). The use of this

parameter would be to help clients to handle products in a better way, using e.g. specific helper applications.

See Appendix B for an example valid Map Projected Service response in VOTable (with positional parameters).

4.8.4 General Optional Attributes

The following metadata fields should be present inside any PDAP response for all the resource classes implementations.

- The table response **MAY** content one field with utype="**pdap:<resource_class>.SPACECRAFT_ALTITUDE**" with datatype="char", and arraysize="*", where <resource_class> could be DATA_SET or PRODUCT. The value represents the distance from the spacecraft to a reference surface of the target body measured normal to that surface and it could be either a single value or a range following the format suggested in appendix A and the unit is in kilometers.

- The table response **MAY** content one field with utype="**pdap:<resource_class>.MAXIMUM_WAVELENGTH**" and one with utype="**pdap:<resource_class>.MINIMUM_WAVELENGTH**", both fields with datatype="char", and arraysize="*", where <resource_class> could be DATA_SET or PRODUCT. The values represent the maximum and minimum wavelengths at which the observation was made. The default unit would be microns. Other units or types of spectral range magnitudes could be selected by using the FIELDs qualifiers UCD and unit in the table header of the VOTable response. Possible types of UCDs to define a spectral frame are:

List of possible UCD values:

em.freq
em.wavenumber
em.wl

4.8.5 General Reference Attributes

The following metadata fields should be present inside any PDAP response for all the resource classes implementations.

- Exactly one field **MUST** have one _utype_="**pdap:<resource_class>.PUBLISHER"** with datatype="char", and arraysize="*", where <resource_class> could be DATA_SET or PRODUCT. A _PUBLISHER_ is an entity responsible for making the

resource available. Examples of a Publisher include a person, an organisation, or a service. Typically, the name of a Publisher should be used to indicate the entity. If the field content is the same for all the records within the response, this information could be added through a PARAM in the VOTable response.

- Exactly one field **MUST** have one *utype*=**"pdap:<resource_class>.CONTRIBUTOR"** with datatype="char", and arraysize="*". A *CONTRIBUTOR* is an entity responsible for making contributions to the content of the resource. Examples of a Contributor include a person, an organization, or a service. Typically, the name of a Contributor should be used to indicate the entity. Also, the principal investigator of the experiment would be classified as Contributor. If the field content is the same for all the records within the response, this information could be added through a PARAM in the VOTable response.

- Exactly one field **MUST** have one *utype*=**"pdap:<resource_class>.PUBLISHING_DATE"** with datatype="char", and arraysize="*", including the date when the referenced resource was available. If the field content is the same for all the records within the response, this information could be added through a PARAM in the VOTable response.

- Exactly one field **MUST** have one *utype*=**"pdap:<resource_class>.RIGHTS"** with datatype="char", and arraysize="*". The *RIGHTS* entry represent a person or organization owning or managing rights over the resource. Recommended best practice is to use the URI or name of the Rights Holder to indicate the entity. If the field content is the same for all the records within the response, this information could be added through a PARAM in the VOTable response.

5 Service Metadata

This type of query gives as a result the list of parameters that the server accepts as inputs, which would be an expanded set composed of the compulsory parameters plus others that the server would understand, which are considered "OPTIONAL". Also, relevant information of the PDAP version implemented is also provided what allows clients a better interpretation of the response.

Due to the very nature of the data, different Data Sets might have different metadata optional values associated. This would mean that a "RESOURCE_CLASS=METADATA" query might need a further specification in the input parameters to do a finer grain filtering of the sought metadata parameters.

For the time being we will only specify a general metadata query, and will leave for further discussions which parameters might be used to filter the different cases depending on the Data Sets.

According to the aforementioned points, a prototypical query of this type would be like:

http://psa.sciops.esa.int/PAIO/piap.jsp?RESOURCE_CLASS=METADATA

and a prototypical output could be something like:

```
<?xml version="1.0" ?>
<!DOCTYPE VOTABLE (View Source for full doctype...)>
- <VOTABLE version="1.1">
      - <RESOURCE type="results">
              <INFO name="PDAP_VERSION" value="1.0" />
              <DESCRIPTION>ESA Planetary Science Archive PDAP
              QueryService</DESCRIPTION>
          - <GROUP utype="pdap:PRODUCT">
              - <PARAM name="INPUT:DATA_SET_ID">
                      <DESCRIPTION>"The DATA_SET_ID element is a unique alphanumeric
                      identifier for a data set or a data PRODUCT"</DESCRIPTION>
               </PARAM>
              - <PARAM name="INPUT:PRODUCT_ID">
                       <DESCRIPTION>"The PRODUCT_ID data element represents a
                      permanent, unique identifier assigned to a data product by its producer
                      within a dataset"</DESCRIPTION>
               </PARAM>
          </GROUP>
              - <PARAM name="INPUT:CENTER_LONGITUDE">
                      <DESCRIPTION>Planetocentric Center longitude center of Region of
                      Interest</DESCRIPTION>
              </PARAM>
              - <PARAM name="INPUT:CENTER_LATITUDE">
                      <DESCRIPTION>Planetocentric Center latitude center of Region of
                      Interest</DESCRIPTION>
              </PARAM>
              - <PARAM name="INPUT:SUB_SOLAR_LONGITUDE">
                       <DESCRIPTION>" The sub_solar_longitude element provides the
                      longitude of the subsolar point. The subsolar point is that point on a
                      body's reference surface where a line from the body center to the sun
                      center intersects that surface. Note: The coordinate_system_type data
                      element should be used in conjunction with this data
                      element."</DESCRIPTION>
              </PARAM>
              - <PARAM name="INPUT:SUB_SOLAR_LATITUDE">
                      <DESCRIPTION>"The sub_solar_latitude element provides the latitude
                      of the subsolar point. The subsolar point is that point on a body's
                      reference surface where a line from the body center to the sun center
                      intersects that surface"</DESCRIPTION>
              </PARAM>

      [...] etc., any optional input search parameters accepted by the server.

      </RESOURCE>
 </VOTABLE>
```

This type of query serves the purpose of unveiling the type of information that can be queried to the server. Smart clients can use this feature to build on-the-fly User Interfaces to fill in required parameters to perform complex queries to the server.

As reflected in the example, resource classes specific input parameters can be grouped in the VOTable by using the GROUP tag for the input parameters.

6   PDAP extensions for specific products

PDAP is based in the resource class concept, i.e. a specific class (data set, product, map_projected, etc) requires specific metadata to be handled properly at client side. However, some other extensions are possible and to include all of them in current specification would require a permanent living document.

In order to allow future extensions, the following rules should be followed to create a new resource class that better describe your data:

- Select a new resource class identifier. Current reserved values are DATA_SET, PRODUCT and MAP_PROJECTED
- Identify PDS keywords that could be used to characterize the data
- A standard resource class document extension should be created and raised to IPDA level for review. If considered of general use, this new resource class definition would be incorporated as a standard IPDA specification.

Appendix A: Range definition for input parameters

For a simple HTTP GET/POST service, the constraints in the queries for the input parameters need to be done in a valid URL.

However, the URL standard is not very specific defining special constraints as, e.g., ranges. We describe here some examples of accepted range syntax for URL PDAP services:

param = x	Equality	Equivalent to param=x
param = x/y	Closed range	Equivalent to param>=x AND param<=y
param = x/	Open range	Equivalent to param>=x
param = /y	Open range	Equivalent to param<=y
param = x,y	List	Equivalent to param=x OR param=y
param = x/a,b/y	Range list	Equivalent to [param<=x AND param<=a] OR [param>=b and param<=y]

Appendix B: Valid Map Projected Data Service response in VOTable

```xml
<?xml version="1.0" ?>
<!DOCTYPE VOTABLE>
<VOTABLE version="1.1"  xmls :xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns= "http://www.ivoa.net/xml/VOTable/v1.1" >

<RESOURCE type="results">
<INFO name="PDAP_VERSION" value="1.0"/>

<DESCRIPTION>PSA Metadata Query Service</DESCRIPTION>
<INFO name="QUERY_STATUS" value="OK" />
<TABLE>

<!— Access reference →
<FIELD ID="DATA_ACCESS_REFERENCE"                    ucd="DATA_ACCESS_REFERENCE"
datatype="char"      arraysize="*" />

<FIELD ID="REFERENCE_FORMAT"                    ucd="meta.code.mime"
datatype="char"      arraysize="*" />

<!—Geometrical annotations →
<FIELD ID="PRODUCT.FOOTPRINT"                    ucd="FOOTPRINT"
utype="pdap:MAP_PROJECTED.FOOTPRINT"              datatype="char"      arraysize="*"/>

<FIELD ID="CENTRAL_LONGITUDE"                    ucd="LONGITUDE"
utype="pdap:MAP_PROJECTED.CENTER_LONGITUDE"       datatype="double" />

<FIELD ID="CENTRAL_ LATITUDE"                    ucd="LATITUDE"
utype="pdap:MAP_PROJECTED.CENTER_LATITUDE"        datatype="double" />

<!—Product identifiers →
<FIELD ID="PRODUCT.PRODUCT_ID"                    ucd="PRODUCT_ID"
utype="pdap:PRODUCT.PRODUCT_ID"                   datatype="char"      arraysize="*" />

<FIELD ID="DATA_SET.DATA_SET_ID"                    ucd="DATA_SET_ID"
utype="pdap:DATA_SET.DATA_SET_ID"                 datatype="char"      arraysize="*"/>

<FIELD ID="DATA_SET.DATA_SET_NAME"                    ucd="DATA_SET_NAME"
 utype="pdap:DATA_SET.DATA_SET_NAME"              datatype="char"      arraysize="*" />

<!—Dublin Core information→
<FIELD ID="DATA_SET.INSTRUMENT_HOST_NAME"             ucd="INSTRUMENT_HOST_NAME"
utype="pdap:DATA_SET.INSTRUMENT_HOST_NAME"        datatype="char"      arraysize="*" />

<FIELD ID="DATA_SET.PRODUCER.FULL_NAME"              ucd="FULL_NAME
utype="pdap:DATA_SET.PUBLISHER"                   datatype="char"      arraysize="*" />

<FIELD ID="DATA_SET.PRODUCER"                    ucd="PRODUCER_NAME
utype="pdap:DATA_SET.CONTRIBUTOR"                 datatype="char"      arraysize="*" />

<FIELD ID="DATA_SET. .PRODUCER.FULL_NAME "           ucd="INSTITUTION_NAME"
datatype="char"      arraysize="*" />

<FIELD ID="DATA_SET.PUBLISHING_DATE"                ucd=" PUBLISHING_DATE "
datatype="char"      arraysize="*" />

<!— Target →
<FIELD ID="PRODUCT.TARGET_NAME"                    ucd="TARGET_NAME"
utype="pdap:PRODUCT.TARGET_NAME"                  datatype="char"      arraysize="*" />

<FIELD ID="PRODUCT.TARGET_TYPE"                    ucd="TARGET_TYPE"
utype="pdap:PRODUCT.TARGET_TYPE"                  datatype="char"      arraysize="*"/>
```

```xml
<!— Instrument →
<FIELD ID="PRODUCT.INSTRUMENT_ID"                          ucd="INSTRUMENT_ID"
utype="pdap:PRODUCT.INSTRUMENT_ID"                         datatype="char"    arraysize="*" />

<FIELD ID="PRODUCT.INSTRUMENT_NAME"                        ucd="INSTRUMENT_NAME"
utype=" pdap:PRODUCT.INSTRUMENT_NAME"                      datatype="char"    arraysize="*" />

<!— Time Coverage →
<FIELD ID="PRODUCT.START_TIME"                             ucd="START_TIME"
 utype="pdap:PRODUCT.START_TIME"                            datatype="char"    arraysize="*" />

<FIELD ID="PRODUCT.STOP_TIME"                              ucd="STOP_TIME"
utype=" pdap:PRODUCT.STOP_TIME"                            datatype="char"    arraysize="*" />

<FIELD ID="ICON_ACCESS_REFERENCE"                         ucd="ICON_ACCESS_REFERENCE"
datatype="char"        arraysize="*" />

<FIELD ID="RESOURCE_CLASS"                                ucd="RESOURCE_CLASS"
datatype="char"        arraysize="*" />

<DATA>
 <TABLEDATA>
  <TR>
  <TD>
  <![CDATA[
http://psa.esac.esa.int:8000/aio/jsp/product.jsp?dataSetID=MEX-M-HRSC-3-RDR-
V2.0&productID=H1428_0000_BL2.IMG&PROTOCOL=HTTP
  ]]>
  </TD>
<TD>application/x-tar </TD>
  <TD>POLYGON(30.941999435424805:50.5369987487793,30.961999893188477:50.29100036621094,30.981000900268555:50.04
399871826172,31.000999450683594:49.797000885009766,31.020000457763672: [more polygon data]
84000015258789:49.2239990234375,28.820999145507812:49.47600173950195,28.802000045776367:49.724998474121094,28.78
3000946044922:49.97100067138672,28.76300048828125:50.21699905395508,28.742000579833984:50.4630012512207)</TD>
  <TD>29.7412395123</TD>
  <TD>50.3191296217</TD>
  <TD>H1428_0000_BL2.IMG</TD>
  <TD>MEX-M-HRSC-3-RDR-V2.0</TD>
  <TD>HRSC REDRs</TD>
  <TD>MARS EXPRESS</TD>
  <TD>ESA-PSA</TD>
  <TD>DLR</TD>
  <TD>Deutsches Zentrum fuer Luft und Raumfahrt (DLR), Institut fu</TD>
  <TD>2010-01-11T10:41:00</TD>
  <TD>MARS</TD>
  <TD>SATELLITE,SATELLITE,PLANET</TD>
  <TD>HRSC</TD>
  <TD>HIGH RESOLUTION STEREO CAMERA</TD>
  <TD>2005-02-26 14:36:19.316666666</TD>
  <TD>2005-02-26 14:46:09.236666666</TD>
  <TD>
  <![CDATA[
http://psa.esac.esa.int:8000/aio/jsp/product.jsp?dataSetID=MEX-M-HRSC-3-RDR-
V2.0&productID=H1428_0000_BL2.IMG&rule=retrieveBrowseImage&compression=loose&protocol=HTTP
  ]]>
  </TD>
  <TD>MAP_PROJECTED</TD>
  </TR>
  </TABLEDATA>
  </DATA>
  </TABLE>
  </RESOURCE>
  </VOTABLE>
```

Appendix C: Registering a PDAP compliant service

Registration of PDAP services will be done through a standard IPDA registration service or a external registry associated to other VO initiatives. The registration of PDAP services allows clients to automatically discover new services, prevents denial of service problems when a service is moved to another location due to changes in the server side, allows transparent integration of new servers of new members of the community, allows the update of contact points and information of the services, etc. In general, registration allows a more cleaner and deeper integration of clients and servers.

Although the technical details of the registration of PDAP services is out of the scope of the present document, the following metadata would be required for registration:

- **Title**: The name of the PDAP service. There are no restrictions on the format of the value; however, it is recommended that if the service is associated with a particular data collection, the service Title contain a recognizable form of the collection's name.

- **Publisher**: The entity responsible for making the service available. This is usually the organization or data center name (e.g. "Space Telescope Science Institute/MAST"); however, it can be a person's name.

- **Contact.Name**: The name of a party (i.e. person or group) that can be contacted regarding the content, implementation, or maintenance of the service.

- **Contact.Email**: The email address of a party (i.e. person or group) that can be contacted regarding the content, implementation, or maintenance of the service.

ReferenceURL: A URL pointing to additional information about the service or the PDAP data provided by the service. This can be a human-readable document specifically describing this service, or it can just be the home page for the data provider.

Appendix B: Metadata Output Summary

Pagination Metadata Response				
PARAM	**Compliance Level**	**Meaning**	**Default Value**	**Type**
TOTAL_RECORDS	MAY	Total number of records that fulfill the query		int
PAGE_SIZE	MAY	Number of records present in the VOTable response		int
PAGE_NUMBER	MAY	Page number that corresponds with the current VOTable response		int
DATA_SET				
utype/ID	**Compliance Level**	**Meaning**	**Default Value**	**Type**
ID="RESOURCE_CLASS"	MUST	Object granularity of this row	DATA_SET	string
ID="DATA_ACCESS_REFERENCE"	MUST	URL to be used to retrieve the data		string
ID="REFERENCE_FORMAT"	MUST	mime-type of the data package referenced by the data_access_reference		string
utype="pdap:DATA_SET.DATA_SET_ID"	MUST	Unique alphanumeric identifier for a data set		string
utype="pdap:DATA_SET.DATA_SET_NAME"	MUST	Short description of the data set		string
utype="pdap:DATA_SET.INSTRUMENT_HOST_HAME"	MUST	Full name of the host which an instrument is based		string
utype="pdap:DATA_SET.START_TIME"	MUST	Date and time of the start of the time coverage of the data set		string
utype="pdap:DATA_SET.STOP_TIME"	MUST	Date and time of the finish of the time coverage of the data set		string

PRODUCT				
utype/ID	**Compliance Level**	**Meaning**	**Default Value**	**Type**
ID="RESOURCE_CLASS"	MUST	Object granularity of this row	PRODUCT	string
ID="DATA_ACCESS_REFERENCE"	MUST	URL to be used to retrieve the data		string
ID="REFERENCE_FORMAT"	MUST	mime-type of the data package referenced by the data_access_reference		string
utype="pdap:DATA_SET.DATA_SET_ID"	MUST	Unique alphanumeric identifier for a data set		string
utype="pdap:PRODUCT.PRODUCT_ID"	MUST	Unique within a data set alphanumeric identifier for the product		string
utype="pdap:DATA_SET.INSTRUMENT_HOST_HAME"	MUST	Full name of the host which an instrument is based		string
utype="pdap:PRODUCT.START_TIME"	MUST	Date and time of the start of the time coverage of the product		string
utype="pdap:PRODUCT.STOP_TIME"	MUST	Date and time of the finish of the time coverage of the product		string
ID="ICON_ACCESS_REFERENCE"	MAY	URL to be used to retrieve an icon representation of the product		string

MAP_PROJECTED extends PRODUCT				
utype/ID	**Compliance Level**	**Meaning**	**Default Value**	**Type**
ID="RESOURCE_CLASS"	MUST	Object granularity of this row	MAP_PROJECTED	string
utype="pdap:MAP_PROJECTED.FOOPRINT"	MUST	Representation of the spatial coverage of the product on the surface of the observed object		string
utype="pdap:MAP_PROJECTED.CENTER_LONGiTUDE"	MUST	Reference longitude of the spatial coverage of the product		string
utype="pdap:MAP_PROJECTED.CENTER_LATITUDE"	MUST	Reference latitude of the spatial coverage of the product		string
utype="pdap:MAP_PROJECTED.COORDINATE_SYSTEM_TYPE"	MAY	Type of coordinates used for the longitude, latitude and footprint		string
utype="pdap:MAP_PROJECTED.COORDINATE_SYSTEM_NAME"	MAY	Full name of the coordinates system used for the longitude, latitude and footprint		string

REFERENCE ATTRIBUTES				
utype/ID	Compliance Level	Meaning	Default Value	Type
utype="pdap:<resource_class>.PUBLISHER"	MUST	Identification of the person, organization or service that publish the resource		string
utype="pdap:<resource_class>.CONTRIBUTOR"	MUST	Identification of the person, organization or service that publish the resource		string
utype="pdap:<resource_class>.PUBLISHING_DATE"	MUST	Date when the referenced resource was available		string
utype="pdap:<resource_class>.RIGHTS"	MUST	Person or organization that owns the rights over the resource		string

References

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[2] Osuna P. et al, NASA-PDS/ESA-PSA Planetary Data Interoperability White Paper, http://planetarydata.org/documents/white-paper-wp/

[3] Jeff de la Beaujardiere et al, OGC Web Map Service Interface. OGC standard, http://www.opengeospatial.org/standards/wms

[4] Tody D, Plante R., Simple Image Access Protocol, IVOA Recommendation, http://www.ivoa.net/Documents/SIA/

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[6] Ochsenbein F, Williams R., VOTable Format Definition, IVOA Recommendation, http://www.ivoa.net/Documents/VOTable/

[7] Bradner S, Keywords for use in RFCs to Indicate Requirement Levels, http://www.ietf.org/rfc/rfc2119.txt