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Planetary Sciences Interoperability at VO Paris Data Centre

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1. Introduction

The Astronomy community has been developing interoperability since more than 10 years, by standardizing data access, data formats, and metadata. This international action is led by the International Virtual Observatory Alliance (IVOA). Observatoire de Paris is an active participant in this project. All actions on interoperability, data and service provision are centralized in and managed by VOParis Data Centre (VOPDC).

VOPDC is a coordinated project from all scientific departments of Observatoire de Paris..

2. Interoperability model

Our interoperability model [1] is directly derived from the IVOA one. To face challenges such as a large community and many distributed database around the world, making data interoperable can not rely on a central point managing all the data. The user interface must provide a layer of interoperability over all databases and data centres. It must include a distributed catalogue of available services. Finally, such a model is the only scalable and sustainable way to reliably distribute data to our clients.

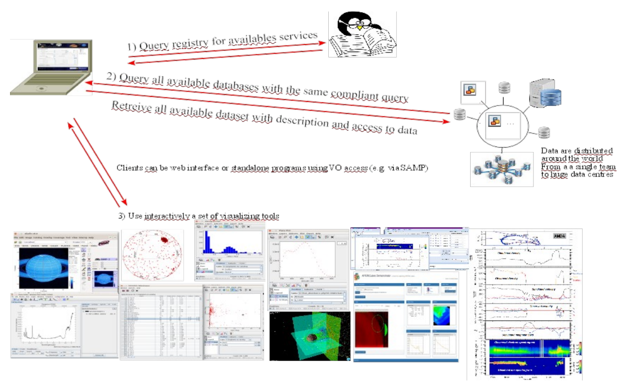

Figure 1: The user in front of the VO infrastructure

Users may request different levels of queries, from a very general one, e.g. "Show me what you have about Jupiter" to more specific, e.g. "Give me the spectra of Saturn from 0.4 to 1.3 microns with a resolution smaller than 0.1 micron, taken after 2010".

In our case, the web client first accesses one IVOA registry where all the services are described and registered, by querying for URL and description of all the Table Access Protocol (TAP) services that can answer a EPN-TAP query. Then the web client queries each of these services in parallel, using the filter defined by the user. The first view displayed is therefore a count of the number of replies per service. From that information the user can look at meta-data for all replies or reformulate his query using a more accurate filter (like limitation on the processing level, mission name, instrument, etc.) From the final list of results, the user can visualize directly a preview of the data, download the result to his computer or display it in one of his favorite VO visualization client.

3. Registry

The services registry is the heart of our Information System. It consists of a database which stores the description of all the services using mainly the Dublin Core meta-data. The registry database is replicated to ensure its availability and sustainability (in particular to avoid a single point of failure). The replication system is based on OAI-PMH from the library world. The interface to the registry in the VO is going to change to a TAP interface which will allow a full text search. VO-Planetary science takes advantage of the IVOA infrastructure to declare (and retrieve) all EPN-TAP services in the registry.

4. Data Access

Data access is made using TAP, (Table Access Protocol) a standard protocol for querying database tables. The query language for TAP is ADQL (Astronomical Data Query Language), designed from SQL 92 and extended to provide polygon delimitations on the celestial sphere. The TAP protocol supports synchronous and asynchronous ADQL queries to perform complex requests on large databases hosted in big data centres.The Planetary data model constrains a set of parameters that are present in all EPN-TAP services, thus the same query can be sent to all services. Several frameworks and libraries allow data providers to install a VO layer on top of their existing database, or create a new database to be compliant with EPN-TAP. Tutorials are available using the GAVO (German VO)– DaCHs framework for publishing planetary data.

5. Data Model

.As Data Access is a general mechanism to query databases, the specificity of planetary science is expressed in a "Data Model" (DM) that describes contents, origin, and context of the data. During this project, initiated during the Europlanet FP7 program, we have designed a list of query-able parameters as the core of the planetary DM. A specific IVOA Working Group is in charge of data model definition and the planetary DM takes advantage of its work. Hence our model references as much as possible the existing IVOA DM.

6. Data Exchange

As Interoperability exists between programs, all information for data exchange must be fully described in a standard way [2] . The file format for exchanging data is the VOTable xml format with some extensions to allow data in binary format for large set of data.The VOTable format is used in exchange between services and client, but can also be a final user data format.

After querying the service, the response contains the list of files matching the query together with information on the contents of the result. The IVOA have developed a machine readable way to describe the physical quantities called Unified Content Descriptor (UCD) based on a list of word and adjustment possibilities. VO-Planetary science has extended this dictionary in coordination with the IVOA.

7. Visualization

The Astronomy and plasma community has developed a set of visualization clients usually dedicated to a data product, for example Aladin and ds9 for images, Topcat for catalogues, VOSpec, Cassis and Specview for spectra, amda for time series, 3D View for orbital and surface representation.

They are all integrated into the VO environment so that they can directly query registries and databases to retrieve the data products they can handle. In order to gather such applications into a self consistent toolbox, the Simple Application Messaging Protocol (SAMP) has been developed to allow them to communicate and exchange data between each other, and even from web

pages. This allows the user to send data to the SAMP-enabled clients from a web portal by simply clicking on a button. However a specificity of Planetary science is the heterogeneity of data format, from PDS to FITS, ASCII, NetCDF. Data transformation engines have been developed to transform specific data products on a fly into a format readable by visualization clients.

8. VO Client

Access can be performed via programming libraries (for Python and Java), or thanks to a web portal vespa designed to query data products using EPN-TAP http://vespa.obspm.fr

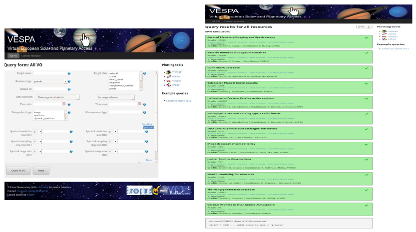

figure 2 : Views of the vespa web client

9. Available Data Services

A first set of services are reachable via EPN-TAP to demonstrate the capability and efficiency of our concept. This set spans a sample of different data products and different scientific disciplines :

Auroral Planetary Imaging and Spectroscopy APIS (images + spectra)
Planetary images databases BDIP (images)
CDPP AMDA DataBase (temporal series)
Extrasolar Planets Encyclopaedia (table-catalog)
Heliophysics Feature Catalog active regions (table)
Heliophysics Feature Catalog type 3 radio bursts (table)
INAF-IAPS RDB NASA dust catalogue TAP service (table)
IR spectroscopy of comet Halley (table)
Jupiter Routine Observations (dynamic spectra)
M4AST - Modeling for Asteroids (spectra)
The Nançay Cometary Database (radio spectra + tables)
Vertical Profiles in Titan Middle Atmosphere (vertical profile).

10. Computational services

Some computational services can not be run on the fly and need an asynchronous interface. We have adopted the Universal Worker Service (UWS) IVOA standard, which uses a REST protocol to define communication between clients and server. Implementation of such services has been done at Observatoire de Paris, using: on the server side an interface with our cluster using the SLURM batch scheduler. on the client side a UWS 1.0 compliant javascript library developed locally.

11. Conclusion

VO Planetary science is a good example of interoperability process built quickly because 1) it focused on the specificities and the needs of planetary science community and 2) it takes advantage of an existing VO infrastructure with a global sustainability. Many standards which have already been designed are ready to be re-used by the community. The success of this project during FP7 has allowed it to be a major part of Europlanet in H2020 program.

Acknowledgements

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