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GIS Technologies for the Planetary Science Archive (PSA)

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Abstract

Geographical information systems (GIS) is becoming increasingly used for planetary science. GIS are computerised systems for the storage, retrieval, manipulation, analysis, and display of geographically referenced data.

Some data stored in the PSA have spatial metadata associated to them. To facilitate users in handling and visualising spatial data in GIS applications, the PSA should support interoperability with interfaces implementing the standards approved by the Open Geospatial Consortium (OGC).

These standards are followed in order to develop open interfaces and encoding that allow data to be exchanged with GIS Client Applications, well-known examples of which are Google Earth and NASA World Wind, as well as open source tools such as Openlayers (2D) and Cesium (3D). Access to this data for use in World Wide Web applications can be provided through OGC Web Service (OWS) implementations.

An existing open source server is GeoServer, an instance of which has been deployed for the PSA, that uses the OGC standards to allow the sharing, processing and editing of data and spatial data through the Web Feature Service (WFS) standard.

Our final goal is to convert the recently released PSA (accessible through http://psa.esa.int) into an archive which enables science exploitation of ESA's planetary missions datasets. This can be facilitated through the GIS framework, offering interfaces (both web GUI and scriptable APIs) that can be used more easily and scientifically by the community, and that will also enable the community to build added value services on top of the PSA.

1. Introduction

Within the ESA planetary missions (where they can be seen in the Table 1), there is a well-defined way of visualize their main targets depending on their nature and shape. For instance, for planets and satellites, which are almost spherical, a GIS tool can be used to represent the geographical information as they can be contained within a ellipsoid. For comets (such as Halley and 67P), they are often irregular bodies, whose 2D mapping can become tedious or almost impossible. Consequently, a 3D tool can be considered a more suitable way to visualize irregular bodies such as asteroids, comets…etc

Mission	Main Target	Visual Tool
Giotto	Comet	3D tool
Huygens	Satellite	GIS tool
SMART1	Satellite	GIS tool
Venus Express	Planet	GIS tool
Mars Express	Planet	GIS tool
Rosetta	Comet	3D tool
ExoMars 2016	Planet	GIS tool

Table 1: ESA Planetary missions, with their main targets types and ways of visualizing them

2. GIS Architecture in the PSA

The new PSA will rely on 3-tiered system for the GIS architecture. The database layer will be composed by a PostgreSQL database with the PostGIS extension to store the spatial info. The server layer will have a Geoserver as a map server which will offer the web application (implemented with Vaadin) the WMS and WFS answers in some formats such as Geojson, xml…etc. Finally, the client layer will be defined by a browser which will executes some GIS jasvascript tools such as Openlayers or Cesium (for planets and satellites) and some 3D javascripts libraries such as ThreeJS (based on WebGL) to visualize the irregular bodies.

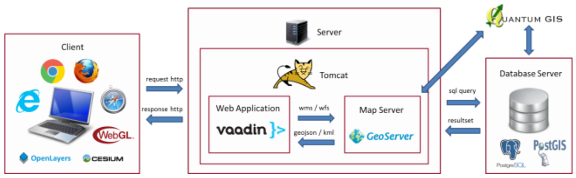

Figure 1: GIS architecture diagram for the PSA

3. GIS tools for the PSA

For regular bodies such as planets or satellites, there are good tools based on Javascript and WebGL to visualize the spatial info like Openlayers and Cesium which offer the typical features like panning, zooming, layers control…etc, even a 3D environment (Cesium). Both are open source. As the PSA is a multi-mission website, some cross-mission queries will be able to do (e.g. retrieving all the footprints from Mars Express and Exomars 2016 and visualize them in 2D or 3D environments. See Figure 2 and 3 respectively)

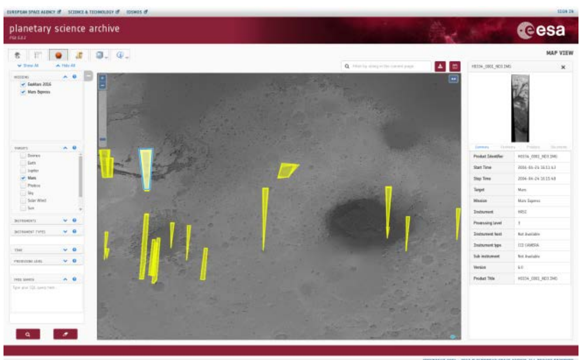

Figure 2: GIS 2D example in the PSA

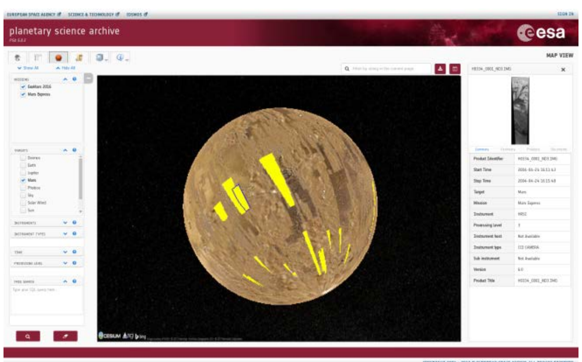

Figure 3: GIS 3D example in the PSA

4. 3D tools for the PSA

For irregular bodies such as comets, asteroids…etc, a GIS tool is not a good approach as long as the body has irregular shapes which cannot be contained in an ellipsoid to be able to generate a consistent datum which can be handled by a GIS. For the 67P/Churyumov-Gerasimenko and its "peanut" shape, a 3D visualization tool is a better candidate to handle this situation. There are some Javascript libraries based on WebGL which can be used to deal with it like ThreeJS. A mockup to visualize this comet within the Rosetta mission can be seen in the figure 4.

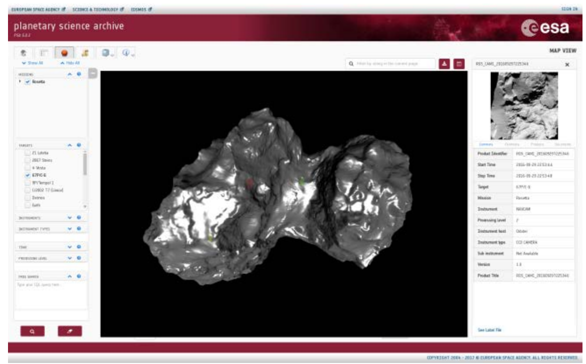

Figure 4: 3D visualization tool example in the PSA

5. Summary and Conclusions

As mentioned before, the new PSA will rely on some different tools to visualize and handle the spatial information depending on the nature of the target for each particular ESA mission.

Regarding interoperability, PSA aims to have ideally a GIS which is able to handle all the visualization geometry layers for the planets, satellites and comets, regardless where they come from (PDS3, PDS4, SPICE…)

References

[1] Besse, S. et al., (2017) Planetary and Space Science (submitted);

[2] Macfarlane, A. et al., (2017) Planetary and Space Science (submitted).