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Multi-missions structured storage and visualization of planetary data - Prototype

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1. Introduction

Current and upcoming planetary missions deliver a huge amount of different data (remote sensing data, in-situ data, and derived products). These data serve as basis for scientific research, and thus result in newly developed information archived in scientific data. Along with recent and upcoming missions to Mercury (BepiColombo), the Outer Solar System moons (JUICE), and asteroids (NASA`s Dawn mission), systematic mapping of surfaces has received new impulses. These systematic surface analyses are based on the comparison and combination of different remote sensing data sets, such as optical image data, spectral-/hyperspectral sensor data, radar images, and/or derived products like digital terrain models. Conditioned by the spatial component, the derived information of such analyses mainly results in map figures, data, and profiles/ diagrams, and serves for describing research investigations within scientific publications. The spatial relation, that all these data have in common, enables combined storage across different topics and subsequently interrelate these data and information.

In the last years web-based GI-systems became a common mean to impart spatial knowledge to all kinds of possible users. Those systems are often built upon a well-established stack of open source software such as PostgreSQL (database) [1], GeoServer (server for sharing geospatial data) [2] and a graphical user interface based on JavaScript [3]. Standards developed by the Open Geospatial Consortium (OGC), such as the Web Map Service (WMS) [4] and the Web Feature Service (WFS) [5], serve as interface between the user interface and the server. While those technologies were developed with geographic data in mind, our present study applies them in the context of planetary data.

For the planetary sciences, the main archives to archived access to archived mission data are ESA's *Planetary Science Archive (PSA)* and the *Planetary Data System (PSA)* Nodes in the USA [6, 7]. Beside these, further platforms and initiatives came up handling planetary data within web-based GIS, services, or/and virtual infrastructures: e.g. *PIGWARD* and *Map-a-planet* (USGS), *PlanetServer* (Jacobs University, Bremen), *HRSC server and Web-GIS* (FU Berlin, i-Mars), *Planetary Geoportal* (MexLab MIIGAIK), *JMars* (ASU), *SolarSystemTrek* (JPL), *VESPA* (EuroPlanet).

The project presented here aims to a prototypical system for the structured storage and visualization of planetary data compiled and developed within or with the contribution of Institute for Planetary Research (PF) at German Aerospace Center (DLR). The system enables different user groups to store and spatially explore scientific data and results centrally, sustainably across multiple missions and scientific disciplines in planetary science. The topic is proposed jointly by PF and German Remote Sensing Data Center (DFD), both at the DLR.
Technically, the prototype will be based on two main components: (1) An infrastructure that provides data storage and management capabilities as well as OGC-compliant interfaces for collaborative and web-based data access services, such as the EOC Geoservice [7]. (2) UKIS (Environmental and Crisis Information Systems), a framework developed at DFD for the implementation of geoscientific web applications [8]. While PF benefits from software and infrastructure developed at DFD, DFD benefits from a new use case that allows for the implementation of new functionalities such as planetary reference systems or generic interfaces to other systems (e.g. DLR's electronic library, ELIB).

2. Framework and implementation

The basis of this prototype is a recent approach developed within PF [9] where an existing database established at *Planetary Spectroscopy Laboratory* (PSL), handling different kind of spatial data, meets a vector-based data collection of thematic, mainly geologic and geomorphologic mapping results [10, 11, and 12], as well as raster-based global mosaics in different resolutions [13, 14] as background. This data merging enables a multi-parameterized querying across different data types, multiple missions, and scientific disciplines in planetary science. These data collection we used as first exemplarily data packages for developing the prototype.

Towards the prototype: Starting the implementation of a prototype, as *first* step (1) a user analysis and inventory of the available data and information diversity in PF is needed. Here, the complementary character and delimitation of this prototype to existing projects is stated. Within the analysis, question should be answered like: Which data should be provided in a combinable way? How existing data structures have to be processed in order to be integrated into an information system? Who is the addressed user group and what kind of information system does this require? Furthermore, an analysis of integration possibilities for DLR BepiColombo data (MERTIS and BELA), will be acquired.
The *second* step will be (2) the implementation of a geospatial information system using UKIS. Within this, the visualization and utilization of the exemplarily data package will be realized in an interactive, web-based system that displays all different datasets with the individual spatial reference system. For the already existing framework of UKIS this means an adaptation of the spatial data frameworks for planetary usage, implementation of numerous additional functionalities, e.g., a dashboard, more automation, and spatiotemporal filtering. This addresses both, internal DLR users' needs for visualization and sharing of structured geospatial information from different sources as well as external scientists interested in DLR data and collaboration. With the integration of a flexible user management system, the prototype could also easily integrate rules for data restriction, needed for ongoing missions.
The *third* and currently final step is to configure generic interfaces. These will enable the connection to 1. other DLR systems and databases like the electronic library (ELIB), and 2. to other systems archiving scientific information outside the DLR, which are substantially related to the internal stored data, but were conducted without DLR involvement.

Benefit: Bundling existing expertise and the resulting synergies offer significant advantages:
For PF, efficient and cross-divisional and cross-departmental access to existing information and insights can be achieved. In the future, this can be continued at a higher level within the institute, in order to develop a nation-wide node, which does not yet exist in this form, for the provision of planetary data and information.
For DFD, the UKIS framework can significantly improve and expand. Just as PF can benefit from previous UKIS developments, future UKIS-based projects will benefit from the technical innovations of the PF/DFD collaboration.

3. Conclusion

The topic of this contribution is to introduce a current work at DLR to implement a (for the time being institutional) platform for PF, which can retrievably provide and visualize various scientific data and information of individual planetary bodies. After prototyping and testing this structure internally, it is planned to make the system also available to the scientific community outside DLR, and the open public. UKIS, as DFD-developed software frame for web-based geographic information systems, together with an infrastructure providing geospatial data access and data management services, such as the DFD-hosted EOC Geoservice, are the ideal basis for such a spatial platform due to their stable architecture. It can adapt to other spatial reference systems, as well as provide and visualize the planetary data after individual system configuration.
An information system of this kind is essential to ensure the efficient and sustainable utilization of the information already obtained and published. This is considered a prerequisite for guaranteeing a continuous and long-term use of scientific information and knowledge within the departments, the institute and potentially also outside of DLR. Finally the utilization of scientific data and results is increasingly demanded by third-party funding agencies (e.g. DFG, EU).

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