PROVISION SCIENTIFIC DATA RESULTS OF SPACE MISSIONS – A PROTOTYPE FOR CENTRAL STORAGE, VISUALIZATION AND USEABILITY. A. Naß, M. d'Amore, M. Mühlbauer, T. Heinen, M. Böck, J. Helbert, T. Riedlinger, R. Jaumann, G. Strunz. German Aerospace Center (DLR), Berlin and Oberpfaffenhofen, Germany
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Introduction: Along with recent and upcoming planetary missions the amount of different data (remote sensing data, in-situ data and derived products) increases constantly and serves as basis for scientific research resulting in derived scientific data and information. Within missions to Mercury (BepiColombo), the Outer Solar System moons (JUICE), and asteroids (NASA`s Dawn mission), one way of scientific analysis, the systematic mapping of surfaces, has received new impulses, also in Europe. These systematic surface analyses are based on the numeric and visual 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 analyses mainly results in map figures, data, and profiles/ diagrams, and serves for describing research investigations within scientific publications. The spatial relation also enables combined storage across different topics and a subsequent interrelation between scientific information and upcoming data.

For planetary sciences, the main archives to archived access to mission data are ESA's *Planetary Science Archive (PSA)* [1] and the *Planetary Data System (PSA)* nodes in the USA [2]. For handling also scientifically derived data and information, in the last years web-based geographic information systems became a common mean to impart spatial knowledge to all kinds of possible users. So, 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 WebGIS* (FU Berlin, i-Mars), *Planetary Geoportal* (MexLab MIIGAIK), *JMars* (ASU), *SolarSystemTrek* (JPL), *VESPA* (EuroPlanet). Those systems are either built upon proprietary software environments, but more common upon a well-established stack of open source software such as PostgreSQL (database) [3], GeoServer (server for sharing geospatial data) [4] and a graphical user interface based on JavaScript [5]. Applicable standards developed by the Open Geospatial Consortium (OGC), such as the Web Map Service (WMS) [6] and the Web Feature Service (WFS) [7] server-based data storage as interface between the user interface and the server.

Purpose: 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 DLR (see also [8]). 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 the German Remote Sensing Data Center (DFD), both DLR research institutes.

Framework: Technically, the system is based on two 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 [9]. 2) UKIS (Environmental and Crisis Information Systems), a framework developed at DFD for the implementation of geoscientific web applications [10]. Substantially the prototype based on a recent approach developed within PF [11] 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 [12, 13], as well as raster-based global mosaics in different resolutions [14, 15] as background; both data from NASA's Dawn mission. This data merging enables a multi-parameterized querying across different data types, multiple missions, and scientific disciplines in planetary science. The existing data collection (Dawn/Ceres) represents a first various data packages of scientific analysis within a planetary mission. However, our current implementation is being extended with data from the High Resolution Stereo Camera (HRSC, [16]) on ESA's Mars Express mission and Mercury spectral data from NASAS's MESSENGER MERTIS instrument. This last dataset is a testbed for the integration of upcoming DLR MERTIS thermal spectrometer and BELA digital elevation data onboard ESA's BepiColombo mission, reaching mercury on 2025. The first true data will collected on 2021 on the first Mercury flyby. Technically, this leads to new features like a dashboard with user-friendly data filtering capabilities and the implementation of further planetary reference systems.

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?

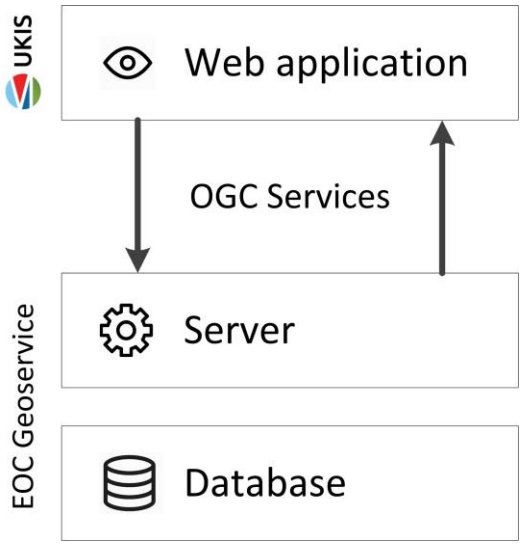

Figure 1 Schematic structure of DLR's EOC Geoservice and UKIS.

The *second* step is (2) the implementation of a geospatial information system using the EOC Geoservice and UKIS (see Figure 1). Within this, the provision, visualization and utilization of exemplarily data packages is 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 further adaptation of already existing software libraries for planetary usage, implementation of numerous additional functionalities, e.g., a dashboard 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 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.

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 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 framework 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 yet flexible architecture. With our work we could show that both components can adapt to other spatial reference systems, as well as provide and visualize planetary data. 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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