15 YEARS OF THE PLANETARY SCIENCE ARCHIVE: LOOKING BACK TO BETTER LOOK FORWARD.

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Introduction: In March 2004, ESA released the 1st version of the Planetary Science Archive (http://psa.esa.int), located at the ESAC Science Data Centre in Villanueva de la Canada, Madrid, Spain.

Throughout the years, the PSA has enriched its content with all ESA's planetary missions data sets, and improved its GUI and scriptable interfaces to offer the best user experience to planetary scientists worldwide. The ultimate goal of the PSA is to enable maximum science data exploitation from ESA planetary missions, and to ensure long term data and associated knowledge preservation for the generation to come.

PSA content and services: When ESA decided to build the Planetary Science Archive, we started with Giotto datasets in 2004 and then it gradually included all the remaining ESA Planetary missions: Mars Express (2005), Huygens (2006), Venus Express (2009), Rosetta and Smart-1 (both in 2010). For the more recent missions, we ensured that datasets could be ingested as soon as operations would start for Exomars TGO (2016) and BepiColombo (2018).

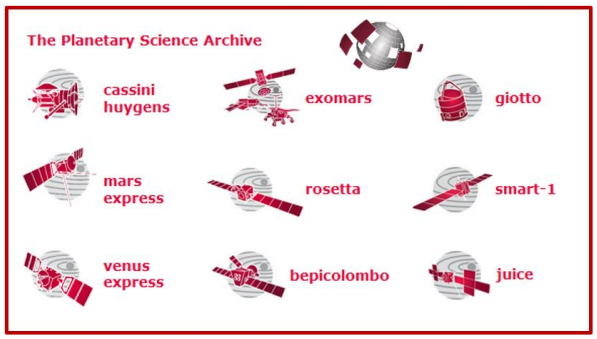

Figure 1: ESA Planetary Missions

Managing both PDS3 and PDS4 datasets: Great care is given to ensure the preservation and dissemination of reliable science data from the missions, as all datasets are scientifically peer-reviewed by independent scientists, and are compliant with the Planetary Data System (PDS) standards. As the PDS standard evolved through time, the PSA had to accommodate initially datasets in PDS3 format, and then to evolve significantly to also manage the more recent and future missions with PDS4 datasets (Exomars, BepiColombo and Juice in the future).

PSA interfaces: The primary way to access ESA planetary science data holdings is through the PSA Graphical User Interface (GUI), which offers a powerful and user friendly faceted search web interface (Figure 2). Lots of work has been done to ensure homogenous metadata between the many instruments, to enable science driven searches across instruments and across missions.

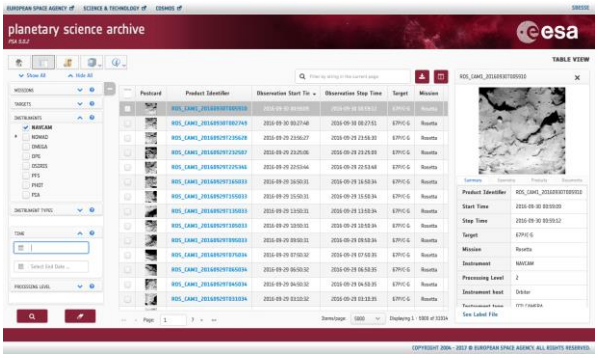

Figure 2: PSA web GUI

Most of the data is public and can be downloaded directly. Login is required for proprietary data download and only authorized users will be able to download proprietary data products. Expert users can also directly download full instruments datasets from the PSA FTP server.

Although planetary scientists represent the main users of the PSA, there are many spectacular images that can also be of interest to the general public. To facilitate access to these, the GUI has been enriched by an image gallery (Figure 3) to quickly search and visualize browse products from most of the missions.

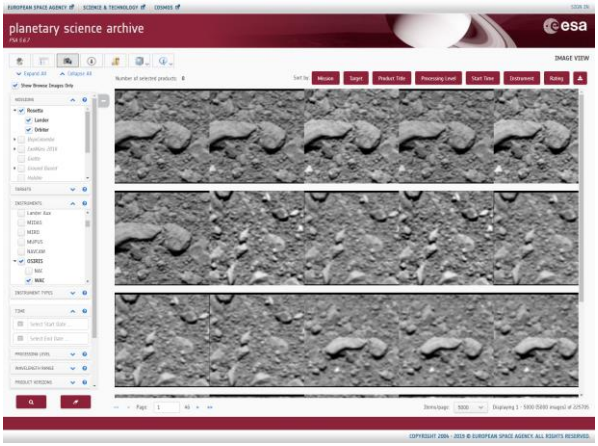

Figure 3: PSA Archive Image Gallery

The PSA also attempts to increase interoperability with the international community by implementing recognized planetary science specific protocols such as the PDAP (Planetary Data Access Protocol) and EPN-TAP (EuroPlanet-Table Access Protocol).

PSA architecture evolution: over the years, the underlying architecture and software systems have drastically changed. Initially based on a Java applet GUI on top of a Sybase RDBMS, the PSA evolved towards more modern technologies. Today, the storage layer consists of a data repository (around 70TB) and a PostgreSQL database. The Client layer offers the main interfaces to scientists, either through a thin web client (based on Vaadin) or through command line interface. The Server layer takes care of handling all database queries, data distribution services and all archive administrative services (ie user login and authentication, usage statistics).

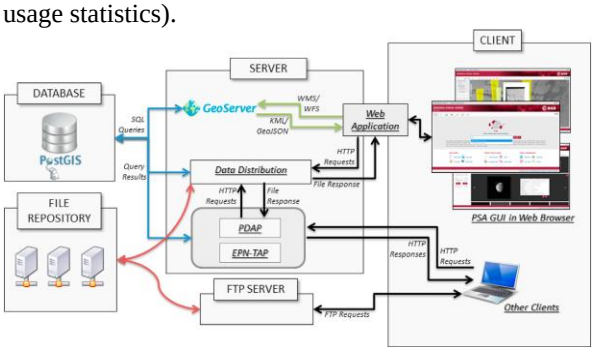

Figure 4: PSA System Architecture

While datasets ingestion in the past used to be an heavy, manual and asynchronous task, special efforts have been made to automatize this process so to ensure that datasets from newer missions (like Exomars and BepiC) can be ingested within one or a few days after they've been taken by the instruments.

PSA and IPDA: The International Planetary Data Alliance (IPDA) is an association of partners worldwide with the aim of improving the quality of planetary science data and services to the planetary science community (http://www.planetarydata.org). IPDA's mission is to facilitate global access to, and exchange of, high quality scientific data products managed across international boundaries. Ensuring proper capture, accessibility and availability of the data is the task of the individual member space agencies. Through the PSA team, ESA has been a co-founder of the IPDA with NASA and PDS and continues to be an active members of the alliance. PSA's interoperability with other planetary data archives is obtained through the usage of common data formats (PDS3 and PDS4) and the implementation of common data interoperability protocols (i.e. PDAP and more recently EPN-TAP).

PSA looking forward

While the primary goal of the PSA has been reached, ensuring the long term preservation and access to ESA planetary missions datasets, we're now looking at providing additional added value services to maximize even further the science exploitation of these datasets. This will include offering newer functionalities to end users, like GIS based map browser for planets and small bodies, ingestion of spacecraft housekeeping parameters, improving and enriching legacy datasets with browse products, ingestion of datasets from external projects, and more interoperability with other PDS compliant archives.

References:

[1] Besse, S. et al. (2017) *Planetary and Space Science*, doi, ESA's Planetary Science Archive: Preserve and present reliable scientific data sets.

Acknowledgement: the authors are very grateful to all the people who have contributed in some way for the last 15 years to the previous and current versions of the ESA's Planetary Science Archive. We are also thankful to the ESA's teams who are operating the missions (Science Operations Centres and Mission Operations Centres) and to the instrument science teams who are generating and delivering scientific calibrated products to the archive.