MARSSI: MARTIAN SURFACE DATA PROCESSING SERVICE. M. Volat[1] and C. Quantin-Nataf[1] and L. Mandon[1], [1]Univ Lyon, Observatoire, F-69622, LYON, France (`matthieu.volat@univ-lyon1.fr`)

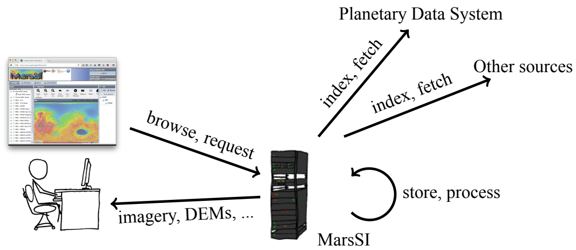

Figure 1: MarsSI overview

Abstract: *MarsSI ("Mars Système d'Information", french for Mars Information System) is a platform and service to catalog, process and retrieve data from orbiters.* *`https://marssi.univ-lyon1.fr/MarsSI`.*

Introduction: Geological investigations of planetary surfaces require the combination of orbital datasets. Missions being often multiple-instruments platforms from multiple space agencies, the quantity of data available increased quickly. It is now large enough that a dedicated system has to be used to explore, calibrate, process and retrieve the relevant information.

MarsSI [1] is a platform developed in the context of the e-Mars project (2012-2017) funded by the European Research Council with the goal to investigate the geological evolution of Mars through the use of combined orbital data. It was certified in 2017 as french national Research Infrastructure by the Centre National de la Recherche Scientifique (CNRS) as part of the Planetary Surface Portal (PSUP) [2]. The permanent staff currently consists of one scientist lead and one engineer.

As of 2019, it indexes the optical (visible, multi and hyper-spectral) data from four missions: Mars Global Surveyor, Mars Odyssey, Mars Express and Mars Reconnaissance Orbiter. The focus, as highlighted by figure 1 is to allow the user to browse and request "ready-to-use" products in regards of calibration, refinements and georeferencing. The user will be able to visualize and interpret the data in GIS or remote sensing software.

Architecture: MarsSI's hardware is hosted at the Université Lyon 1 and is composed of a frontend server, a storage bay and four computing nodes totaling 100 cores. For the software stack, whose functionality is shown on figure 2, we decided to rely mainly on software provided by the Free and Open-source communities.

Catalog. MarsSI retrieve the footprints provided by the NASA Planetary Data System (PDS) in a Postgres database with the PostGIS extension. These data, alongside rasters that will be used as layers of our map

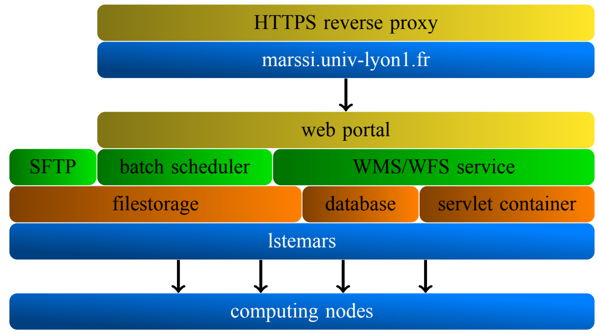

Figure 2: MarsSI service is built on several layers of different solutions to solve issues such as referencing geographical data, imagery, manage processing and serve a web interface.

display, is made available through a OGC-compliant service (Geoserver) using the Web Map Service (WMS) and Web Feature Service (WFS) standards. One recurring issue we faced is the lack of Coordinates Referencing Systems definitions readily available in such services, who rely on EPSG definitions codes. Adding and using non-standard EPSG definition across the system was done to workaround this issue. Once this issue resolved, we had access to a solid and proven set of protocols and software implementations to organize the data.

Once the data are stored in database, we proceed over the CTX and HiRISE optical data collections to find for each dataset overlapping images by at least 60% and a maximum difference of acquisition angle of 10° to generate a list of potential Digital Elevation Models (DEMs).

Pipelines. Alongside the catalog, MarsSI uses several processing pipelines. Those pipelines defines steps and procedures to fetch, calibrate and refine products. A notable pipeline is the use of the Ames Stereo Pipeline [3] software to generate on demand DEMs that the system derivates from the optical imagery.

The pipeline execution is managed using the OAR (`oar.imag.fr`) batch scheduler. The requests are generated by the tomcat webapp server-side code as a client request.

One design choice of MarsSI was to present the products, including those created by the service, as global to all users (in contrast to service creating user-specific products). This was done to have only one reference to products like generated DEMs and reduce storage use. As a result, we only designed fully automated pipelines that do not require user input and parameters.

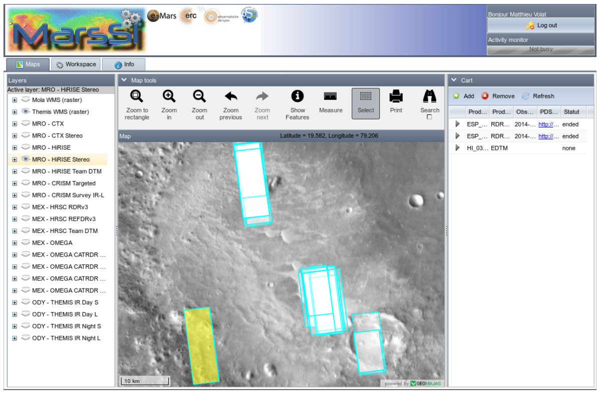

Figure 3: MarsSI web interface map view. The left panel is a layer list from which the user can choose instrument footprints to display on the central map. In this illustration, we displayed HiRISE DEM footprints over a THEMIS-Day background. The datasets can be selected and added to a user cart, whose content is listed on the right panel. When the user is done with selection, he can proceed to the workspace view where data download and processing can be requested.

Frontend. MarsSI client interface is a web component based on Geomajas (`www.geomajas.org`), a free and open source GIS toolkit to build javascript web applications on top of a Java servlet server. Geomajas allowed us to interface directly with the WMS and WFS provided datasets in a web application. Like we did for backend components, we had to import Martian CRS as user-defined EPSG definitions into the CRS databases. This interface allows the user to explore and select datasets, as shown on figure 3 and request downloads, processing, and copy operation.

For the retrieval of the products, we elected to have a workflow that makes the user request copy of products to its home directory where they can be retrieved using the SFTP protocol. Copied files are removed after 30 days.

Usage and data volumes: MarsSI is open to the scientific communities around the world. As of march 2019, we count 215 registered users across 128 institutes. Storage-wise, we benefited to progressively download data as requested, reaching 37To in 2019. The repartition of the requested data is shown on figure 4.

Perspectives: We are currently working on integrating other data types in MarsSI, such as the MARSIS and SHARRAD radar datasets.

Another aspect we are working on is a more efficient and intuitive web interface not based on Geomajas. The rewrite would also take into account other maps such as polar projections and other planetary bodies.

As DEMs are our most requested products, we are investigating how to provide qualitative assessment for those datasets. We are also looking for methods to generate large scale DEMs using mosaicking.

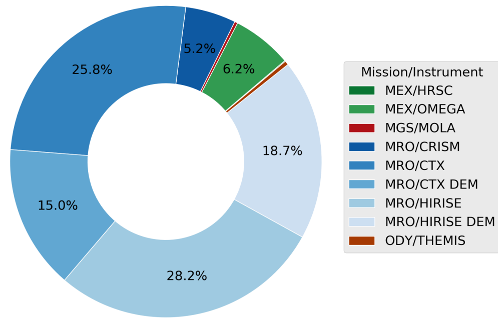

Figure 4: MarsSI storage size by instrument. The share of MRO optical data and DEMs data requests is overwhelming compared to other missions. This can be explained by the high coverage and resolution of the CTX and HiRISE instruments, which result in many requests from our userbase.

Conclusion: Built upon opensources frameworks and using standardized protocols, MarsSI offers the scientific communities a way to search and request data, most notably DEMs that can be derived from CTX and HiRISE data collection. We are now looking to modernize and extend the service with a newer interface that can present other planets and moons data.

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References: [1] C. Quantin-Nataf et al. "MarsSI: Martian surface data processing information system". In: *Planetary and Space Science* 150 (2018). [2] F. Poulet et al. "PSUP: A Planetary SUrface Portal". In: *Planetary and Space Science* 150 (2018). [3] Z. M. Moratto et al. "Ames Stereo Pipeline, NASA's open source automated stereogrammetry software". In: *Lunar and Planetary Science Conference*. Vol. 41. 2010.