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Planetary SubSurface Radar processing centre

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Abstract. The Radar instruments allow to investigate the planets sub-surface. The Planetary Radar Operation Center joins different missions with the purpose of the processing and divulging Radar data and relative works. This paper presents the PROC system with its architecture and functionalities.

1. Introduction

Planetary exploration by means of radar systems, mainly Ground Penetrating Radars (GPR) is an important role of the Italian scientific community and industry: three important experiments under Italian leadership provided by ASI within a NASA/ESA/ASI joint venture framework, are successfully operating and now are entered in a second extension phase (up to 2014):

- MARSIS on-board Mars Express
- SHARAD on-board Mars Reconnaissance Orbiter
- CASSINI Radar on-board Cassini spacecraft

SHOC (Sharad Operating Centre), MOC (Marsis Operating Centre) and CASSINI PAD are devoted to a single instrument management and control, data processing and distribution and operate from the starting of the missions to support all the scientific communities, institutional customers and experiment teams operation. The three centers guarantee the products generation and delivery in the standard PDS (Planetary Data Science) format. Although they had been conceived to operate independently one from each other, synergies and overlaps have been envisaged leading to the suggestion of developing a unified SSR (Sub-Surface Radar) processing center, the Planetary Radar Processing Center (PROC), collocated with the above centers at the TASI premises in Rome, that has been recently enhanced in order to support the mission life extensions.

The Planetary centre is designed and developed to increase capabilities, in terms of data storage, comparison, interpretation and exploitation providing added value products processing capability to support the scientific community for on-going and future Italian planetary exploration programs, such

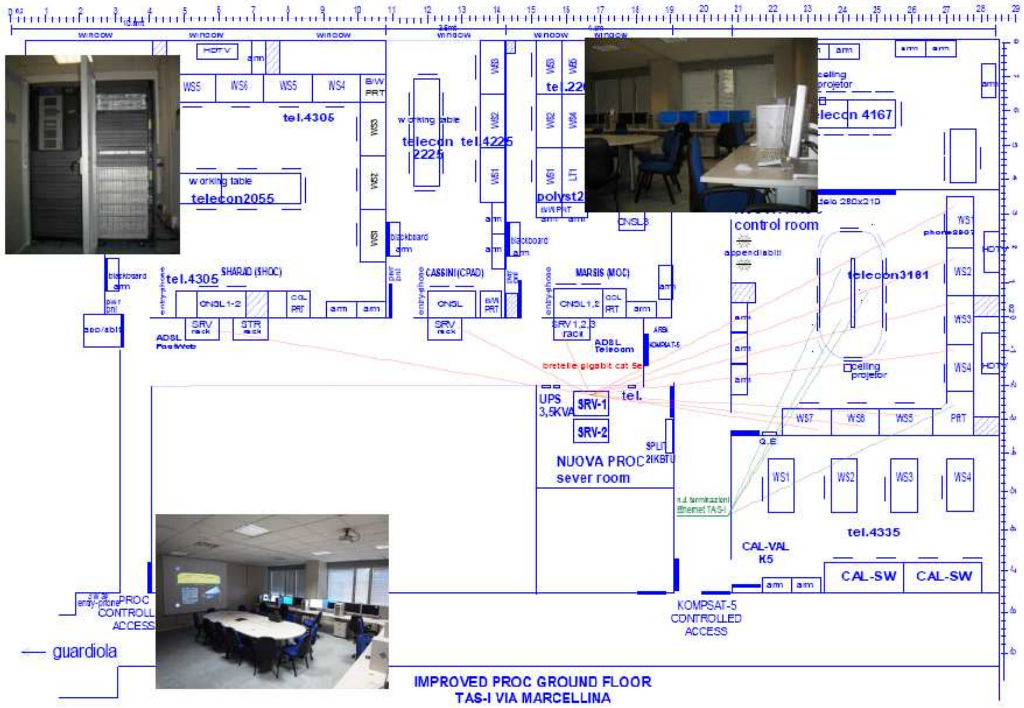

Fig. 1. PROC Center Structure

as Europa-Jupiter System Mission (EJSM) and stratospheric and avionic ones.

2. PROC Web Portal

A specific PROC Web facility and a dedicated high capacity on line storage allow PROC missions status and their relative scientific results spreading, scientific requests submission, news, studies, technical information, radar data images publication and data retrieving (the latter only on science team members request), according to different permissions assigned both to science team members and generic users by means of an appropriate authentication mechanism and of the data integrity and availability. The portal provides the same facilities either for Web Portal either for mass memory availability for future Agency missions (Deep space, stratospheric , avionic ..).

The new facilities host the servers and the main archive: it provides one on-line 80 TB hi-speed disks array, a 70 TB Robot (Tape Library), seven workstations allocated in separate area and a conference room. For example the actual coverage on Mars of the SHARAD products (JPL\NASA and ASI news: March 10, more the 100 Tb, Actually more than 130 Tb) is shown in the following figure:

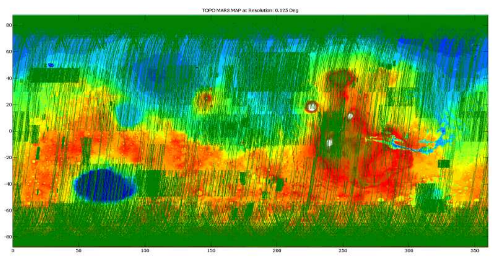

Fig. 2. SHARAD Coverage

PROC is also a reference facility for operative and science meetings and workshops

(COIs, TIMs, Operative and Science periodic meetings, ...)

Fig. 3. Meetings Selection : COI Sept 09 ,Sep 08, Award Delivery

PROC needs have been grouped into three different logic areas. Users of these areas had been identified.

- Scientific area is devoted both to missions data visualization and comparison and to scientific results production and analysis. All data generated in the frame of scientific area are stored in a specific partition of PROC archive (Scientific Partition about 10 TB assigned)
  Users: Science Team Members and the system administrator, all with different permissions
- Archive and Backup area is devoted to store both the three centres data and data generated internally into the PROC. Note that Backup area is reserved to three centres data storage (about 25 TB assigned).
  Users: MOC/SHOC/C-PAD/PROC operators and the system administrator, all with different permissions
- Internet area is devoted to host PROC Web site and all its services and functionalities and is exposed on public IP address. Data generated in the frame of internet area are stored in a specific partition of PROC archive (Web Partition about 5 TB assigned)
  Users: Science Team Members, MOC/SHOC/C-PAD/PROC operators, the system administrator and common people who want to be informed on mission status and scientific results, all with different permissions

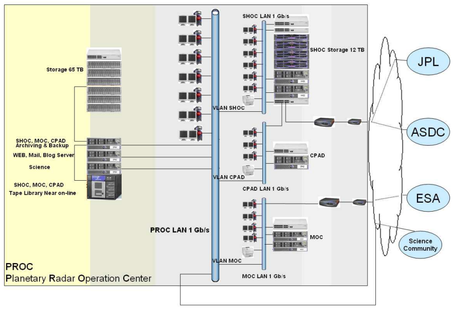

Fig. 4. PROC Archive

The raw engineering data provided by the Sounders, processed by the operative centers (in PDS format) are further catalogued and elaborated by the PROC to produce added value products.

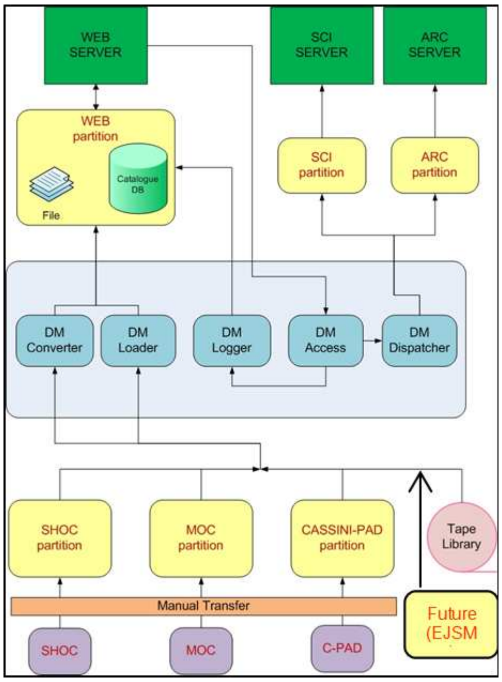

Fig. 5. PROC Web Portal Architecture

The catalog function extracts the metadata (composite raw data frame or OST lines) along with the data ground track, while the conversion provides JPEG2000 files for Web portal dissemination: for example MARSIS PDS data can theoretically contain up to 10 radargrams (2 frequencies , 5 Doppler filters on the same track). The PROC Web Portal is composed by two sections: front-end and back-office. The Web Portal Tool homepage allows to access to every system section.

Fig. 6. PROC Web Portal Homepage

The principal sections are:

– SpaceGIS: it links to the SpaceGIS application (cartographic and radargram viewer);
– Multimedia: it allows to view all multimedia file dealing with PROC data;
– Missions: it contains the description of all the missions and their instruments managed by the PROC;
– Community and Communication Service: it contains forum, newsletter, mailing list, events and FAQ sections;
– Mission Products: last catalogued and/or converted PROC Missions products.

The user can find the catalogued and converted PROC products by the Product Search section.The adminisitrator sets the products permissions and the user can search only permitted products. He can inserts the textual (Product ID, Mission, Level Type etc), the temporal (acquisition date also in Day-Of-Year format) and the spatial product information (target, orbit or search box extent) to search the PROC missions products, as shown in the Fig. 7

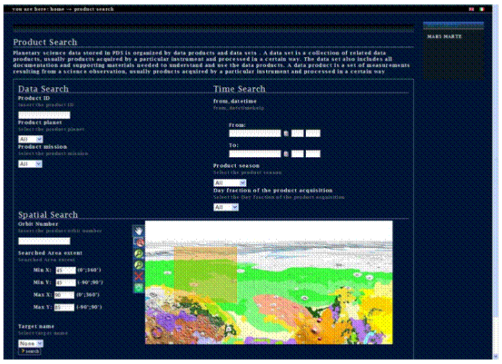

Fig. 7. Products Search page

The products list with some information (orbit, acquisition date, level type and eventually thumbnail of radargram) are returned to the user as shown in the Fig. 8

Fig. 8. Searched Products

The SpaceGIS section allows to show and navigate the mission cartographic data.

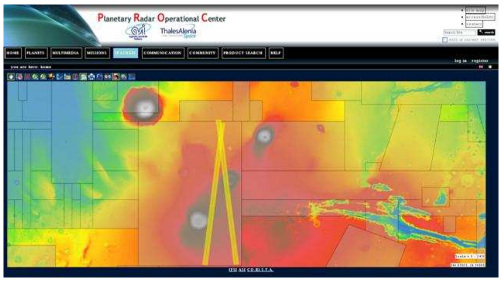

Fig. 9. SpaceGIS

In the SpaceGIS, the user can navigate (pan, zoombox) and select the maps published into PROC. The SpaceGIS application allows to view and navigate also the PROC missions radargrams obtained and by it the user can also follow the radargram on the dataground track

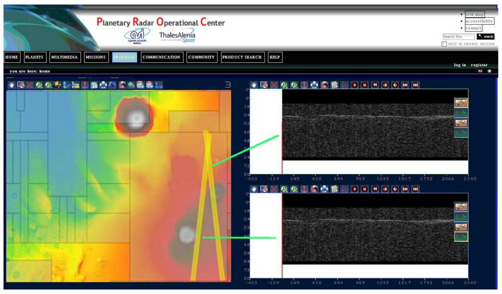

Fig. 10. Radargrams in SpaceGIS

3. SORA

In the framework of the PROC program a dedicated hardware (SORA) has been designed and realized in order to test and study radar response on Earth analogous. SORA (Sounding Radar) is, capable of acquiring radar data upon scientists requests in order to help them refine their models, experiment new algorithms, improve data interpretation capabilities. Such instrument has been accommodated on-board the Italian Space Agency stratospheric balloon and has flown over north polar region under the coordination of Italian scientists.

Fig. 11. SORA

4. Future Planetary Missions

The future missions as EJSM (Europa Jupiter System Mission) will be added into PROC System. The EJSM is one of the major joint European Space Agency (ESA) and NASA missions in the Solar System currently under study. It is aimed at exploring Jupiter and its icy moons with two spacecrafts having different complementary goals: the Jupiter Europa Orbiter (JEO), provided by NASA and devoted to study Jupiter and the Jovian moons Io and Europa, and the Jupiter Ganymede Orbiter (JGO), which represents the contribution of ESA and will investigate Jupiter and the Ganymede and Callisto moons.

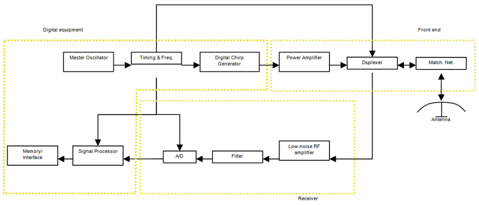

Fig. 12. EJSM Sounder PŁOutline and Dipole Antenna study

5. Conclusions

The PROC system represents a best practice in the exploitation of the investments made in the field of planetary exploration devoted, in particular, to the analysis of the sub-surface and its characterization. This has been done by setting up a unique access point to such data, which is also ready to integrate future different missons on different planets too. In this way the capability to view and analyze different data in an integrated environment provided with social and web 2.0 capabilities will certainly favour the growth and the spread of the academic debate.