PRoGIS: a web tool to understand & process Mars rover imagery in a planetary context. J.G. Morley[1], N. Lin[2], J-P. Muller[3], D. Shin[4], G. Paar[5], [1]Nottingham Geospatial Institute, University of Nottingham (Nottingham Geospatial Building, Triumph Road, Nottingham, UK. NG7 2TU; jeremy.morley@nottingham.ac.uk), [2]Nottingham Geospatial Institute (nan.lin@nottingham.ac.uk), [3]Mullard Space Science Laboratory (MSSL), Department of Space and Climate Physics, UCL (jpm@mssl.ucl.ac.uk), [4]Formerly UCL MSSL, now Department of Computer Science, University of Cambridge, [5]Joanneum Research, Gratz, Austria (gerhard.paar@joanneum.at).

Introduction: In 2005 Google made public the first version of its mapping site, Google Maps (GMaps). This one system marked a revolution in access to maps online. For the public this revlution included the coverage & detail of the data However of greater significance here is the technical leap forward that GMaps represents. GMaps was the first mainstream web mapping application to present a "slippy map" with smooth map panning and zooming. This had become possible through advances in web browser technology, particularly AJAX (Asynchronous Javascript and XML). The asynchronous processing allows the browser to preload tiled map images making the zooming and panning experience seamless with greatly reduced waits for screen refresh. In addition, GMaps presented a radically different interface style from most previous web mapping systems – in GMaps and its successors, the map is foucs with minimal controls & a focus on usability. A further revolution was the opening up of web map application programming through the introduction of GMaps' application programming interface (API) the following year.

GMaps has been a highly disruptive technology for the GIS community, prompting wholesale rethinks over what constitutes good human computer interaction (HCI) in web mapping interface design.

In parallel with this, the Open Geospatial Consortium [1] has for the past 15+ years been working on standards to enable interoperable transfer & processing of geographical information (including sensor description and access frameworks, for example). These standards have had some limited adoption in the planetary science community despite some implicit Earth-centric conventions in the standards [2]. [3].

A final influence in this paper comes from the Earth Observation community. Since 2005, the Group on Earth Observations (GEO, a voluntary partnership of 87 governments, the European Commission and 64 intergovernmental, international, and regional organizations) [4] has been constructing the Global Earth Observation System of Systems (GEOSS) in a 10-year implementation. GEOSS "will proactively link together existing and planned observing systems around the world" [5], particularly through a GeoPortal and is underpinned by the OGC and related ISO standards to enable GEOSS to federate access to the existing separate member environmental & remote sensing systems.

PRoVisG: The PRoGIS system described below is an output from a project, PRoVisG ("Planetary Robotics Vision Ground processing") [6], funded by the European Commission under the FP7 research programme. A core of the work within PRoVisG is to build a reusable image processing system, PRoVIP, designed around planetary rover uses, and in particular using Mars Exploration Rover (MER) use cases. The PRoVIP functions will range from basic outputs such as rover image footprints on the planetary surface through to sophisticated photogrammetric workflows such as wide-baseline stereo processing. PRoVIP supports calls to remote processing components via XML-RPC allow other PRoVisG partners such as the Czech Technical University to support functionality such as Structure From Motion analysis systems for PRoVIP without releasing code.

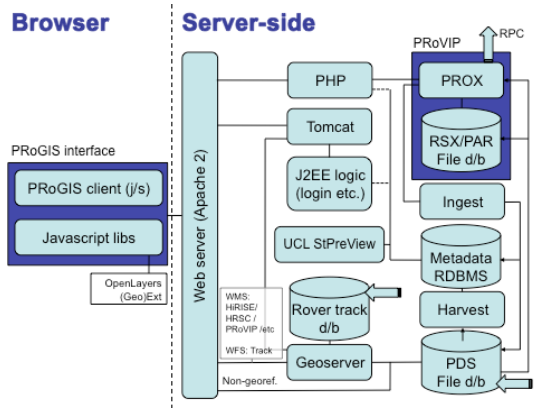
Motivation: PRoGIS is designed for use by scientific users (as opposed to use for rover operations and planning) with three main design goals:

1. To provide a place-led search for MER image data (principally from the Navcam and Pancam cameras).
2. To provide a web-based interface to PRoVIP to allow input data selection (mostly MER imagery + processing parameters); job tracking; and view and possibly interaction with data products.
3. Where possible, data will be presented in an areographic coordinate system and hence on the map (rather than in a site-specific Cartesian coordinate system, for example).
4. To provide a public interface as well as project access via a login process.

The first goal, place-led search, has been derived from the observation that many of the current systems for browsing & searching rover data (such as the JPL PDS Imaging Node [7] or the MER Analyst's Notebook [8]) are based around searching for data either by instrument type & parameters, or by time or proxies for time (such as the sequential site number). These interfaces also assume a high level of familiarity with the organization and nomenclature of the MER datasets. However many scientific/geological queries are more related to places, i.e. locations on the planet. PRoGIS is

therefore designed such that browsing operations are based around locations on the map with the map as the dominant interface element. (For example, see reference [9] for discussion of human-computer interaction design considerations in web mapping). It is to enable this place-based data view that we aim to transform datasets from local coordinate systems through to an areographical system so that data and results from multiple sites can be understood in the same global context.

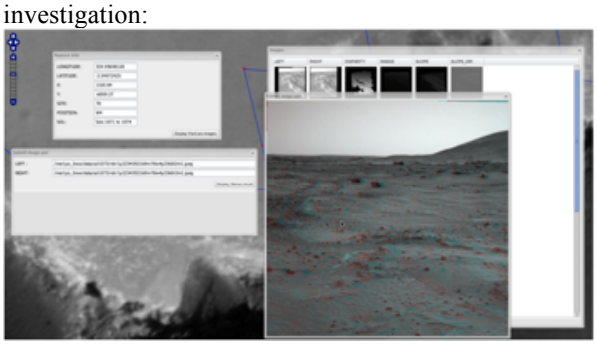
System design: ProGIS is based where possible around IT standards, particularly those from the OGC for web mapping and uses open source components, in particular the PostGIS extension to the PostgreSQL database for storing harvested PDS metadata for fast search access; Geoserver for web map serving; and OpenLayers and GeoExt as the map interface & GUI toolkits to build the web interface. In common with current Web 2.0 practice, the interface is built use HTML and AJAX, technologies built into the browser, avoiding reliance on Java or plug-ins such as Flash. The following diagram summarises the system components:



An important component is the PRoVIP system, which in its current version uses a workflow system called PROX and maintains its own internal database. The PRoGIS system is designed so that a user can not only browse for, preview and download data. The inclusion of PRoVIP means that a user can trigger processing of selected data, e.g. to attempt new photogrammetric processing to build new DTM data of features of scientific interest, and then review the results in PRoGIS.

An important component supplied by UCL MSSL is the StPreView element. This prepares anaglyph views, e.g. of stereo rover images for presentation in the PRoGIS web interface

The screenshot following shows an example of the PRoGIS web page showing the map as interface frame with the MER rover track in blue and the stops in red. The screenshot shows the state following selection of a rover stop with a grid of PDS images acquired at the stop, details of the stop (such as site and sol numbers, etc.). In this case a Pancam image pair has been selected and is being presented in analglyph for further investigation:



Research direction: The PRoVisG project will carry on until June 2012. Work is continuing on integrating PRoVIP in ProGIS and then on extending the range of PRoVIP workflows available through PRoGIS. A test and feedback phase is planned for the second quarter of 2012. The public interface should be available at latest by May 2012.

References:

[1] OGC, http://www.opengeospatial.org.

[2] Dobinson E., Curkendall D., Plesea L. and Hare T.M. (2006) *37th LPSC*, Abstract #1463.

[3] Hare T.M., Plesea L. and Akins S.W. (2011) *42nd LPSC*, Abstract #1608.

[4] GEO, http://www.earthobservations.org

[5] GEO Work Plan, http://www.earthobservations.org/geoss_imp.php

[6] PRoVisG, http://www.provisg.eu/

[7] JPL MER PDS Imaging Node, http://pds-imaging.jpl.nasa.gov/portal/mer_mission.html

[8] Spirit (MERA) Analyst's Notebook, http://an.rsl.wustl.edu/mer/merbrowser/default.aspx

[9] Komarkova, J., Visek, O., Novak, M. (2007), *Lecture Notes in Computer Science*, Volume 4857/2007, 264-278.