ADVANCED USES OF OPEN GEOSPATIAL© WEB TECHNOLOGIES FOR PLANETARY DATA. T.M. Hare[1], L. Plesea[2], E. Dobinson[2], and D. Curkendall[2], [1]U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ, 86001, [2]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, California 91109-8099, thare@usgs.gov.

Introduction: This abstract outlines some of the advanced uses and innovative data sets that we have incorporated into the JPL planetary WMS servers OnMars and OnMoon [1], as well as some of the advanced WMS features. The specific technology used for this work is based on the Open Geospatial Consortium (OGC) Web Mapping Service (WMS) standard. The work presented herein is a continuation of our efforts to build an open, robust server for the planetary community with the ultimate goal of handing over the technology for use by the Planetary Data System (PDS).

Advanced Uses: On the surface, the WMS specification is purposefully simple [2]. The majority of implementations simply allow users to return an 8-bit color Jpeg, GIF or PNG image that covers or transects their area of interest. While this satisfies most casual users, researchers quickly run into analysis limitations. Fortunately, the WMS specification has few concrete rules that limit functionality.

The OnMars and OnMoon server technology owes its inheritance to the original JPL OnEarth WMS server [1,3]. Some of the advanced functions that previously existed in the original Earth-based version included the ability to request layers using Style Layered Descriptors (SLD) and 16-bit PNG images. The JPL WMS server has one of the best known implementations of the SLD standard for raster data. SLDs allows us to, for example, predefine image stretches, specify layer combinations using partial transparency, and layer color mapping. However, the real power is the fact that the JPL server supports user defined SLDs, including several extensions to the standard. Another important feature already supported was the ability to server 16-bit PNGs. This allows users to request higher precision topography data sets (e.g., gridded Mars Orbiter Laser Altimeter (MOLA) information [4]), which can then be used for further analysis and 3D visualizations.

New server-side functions that have been implemented in the last two years include: planetary coordinate reference system encodings, hill-shading based on user-defined parameters, slope calculations, band ratios (band arithmetic) and high byte count Geotiff support. The last feature enables serving of high precision data-sets, effectively making WMS a geolocated data service.

Planetary Encodings. To support the ability for the WMS server to advertise that it is serving planetary data sets, it was necessary to define a new planetary encoding system for the WMS standard [5]. Last year we proposed this encoding system to the OGC community and have already implemented its use. This year we will publish this proposal as an OGC "best practices" paper which can become an official position of the OGC.

Hill-shading. Simulating shading for topographic layers is not only visually appealing but can also be an important tool for geologic mapping and feature identification. Our implementation extends the SLD hill-shading support by allowing user control of the shading direction. Shading from different angles can dramatically enhance the shape of depressed fractures or topographic knobs.

Slope Maps. Like shading, deriving the slope or more simply the angle of surface pitch in degrees, is also an important device for characterizing planetary surfaces. Breaks in slope can help to better define geologic unit delineations like the crest of a crater or the end of a volcanic flow lobe.

Band Arithmetic. To better support the Clementine lunar [6] data sets for mapping, we implemented server-side band arithmetic functions as defined by the user. The Clementine mission captured 11 spectral bands at ~200 meters per pixel using a Ultraviolet/Visible (UVVIS) and a near-infrared (NIR) imaging system. Calculating ratios between spectral bands at full floating point precision can be used, for example, to help map the distribution of regolith types on the Moon. We implemented the arithmetic functionality by encapsulating the band equation into an SLD file using a prefix notation. For the UVVIS layer, the first three bands are defined as b1 (band1) = 750nm, b2 = 415nm, and b3 = 950nm wavelengths. Then, to generate a Clementine mineral ratio, where R=750/415nm, G=750/950nm, B=415/750nm, the SLD would contain the prefix equation: "/_b1_b2,/_b1_b3,/_b2_b1". The server performs the requested arithmetic on the native data precision and then converts the image to the requested output type, for example, a scaled 8-bit RGB Jpeg or 32-bit Geotiff. The server side parser also supports an arbitrary length formula using the four basic operations and also constants.

Geotiff Support. To support higher byte count data values, for example 16-bit signed and 32-bit floating point images, we implemented Geotiff support. This allows users to request image data sets like hyperspectral imagery, band ratios, or slope data sets.

Innovative Data Sets: Thus far we have loaded many of the available Mars and lunar data sets. For Mars, we serve the gridded MOLA topography [4], Mars Digital Image Mosaic 2.1 (MDIM) [7], MSSS Mars orbiter Camera (MOC) Wide Angle Atlas [8], and the Thermal

Emission Imaging System (THEMIS) Infared (IR) mosaic [9]. Of course, from these layers, hillshades, slope maps, colorized topographic, and other interesting layer combinations can be created. For the Moon, we offer access to the gridded Unified Lunar Control Network (ULCN) 2005 [10] topography, Clementine UVVIS 5 band and NIR 6 band mosaics in full precision [6], and the lunar airbrushed (simulated) shaded relief.

The innovative data set that we have implemented this year includes a non-continuous uncontrolled MOC Narrow Angle (NA) [8] mosaic. We also plan to generate an uncontrolled global THEMIS visible (VIS) mosaic.

MOC NA Mosaic. The current MOC NA mosaic contains about 50,000 MOC NA images from -70 to +70 latitude range (Fig. 1). The method we used to create the mosaic was to simply warp the image using SPICE corrected footprint locations [S. Byrne, 2006, comm]. The images are first harvested as Jpegs directly from the MOC NA PDS archive, warped and then merged into a tiled database mosaic on the JPL server using a 5 meter/pixel spacing. If any error was reported in the MOC cumulative index, the image was not used. We understand this in not the most accurate method to map project the images as the MOLA DEM is not used for orthorectifing, but believe the images are still accurately tied for browsing – the locations should not be used directly for science applications. A full uncompressed mosaic would equal about 3 terabytes (TB). Using a compressed and tiled database format that has explicit support for no-data tiles, a format preferred by the JPL server [1], we are able to store this mosaic only using 130 GB of space including reduced resolution versions. Once the final MOC NA PDS release occurs, we will update this mosaic, including images closer to the polar areas.

THEMIS VIS Mosaic. Fortunately, the THEMIS team has preprocessed (map projected) many of the THEMIS VIS images and have made them available for download in an ISIS2 and PNG image formats. This will allow us to simply download, re-project and mosaic them on the JPL WMS server. We hope to be ready to showcase this mosaic at the 2007 LPSC conference.

Conclusion: Standardized methods for direct access to on-line planetary data will continue to rapidly mature. We will encourage more facilities, including the PDS, to begin using WMS servers for hosting data sets such that data sets from multiple facilities can then be used together. This project has proven that this technology is ready for diverse data sets like multi-TB sized mosaics, hyper-spectral imagery, and high-resolution non-continuous image stamps while keeping access to the data layers easy but ready for mapping and research applications.

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References: [1] Plesea, L., et. al., this volume. [2] OGC, http://www.opengeospatial.org/standards/wms [3] Dobinson, E., et. al., (2006), LPSC XXXVII, abs. 1463. [4] Smith, D., et. al., (1999), Mars Global Surveyor Laser Altimeter Precision Experiment Data Record, NASA PDS, MGS-M-MOLA-3-PEDR-L1A-V1.0. [5] Hare, T., et. al., (2006), LPSC XXXVII, abs. 1931. [6] Nozette, S. et. al., The Clementine Mission to the Moon: Scientific Overview, Science, 266, 1835-1839. [7] Archinal, B. A., et. al., 2003, Mars Digital Image Model (MDIM) 2.1 control network, ISPRS Working Group IV/9 Workshop "Advances in Planetary Mapping 2003". [8] Malin, M.C., et. al., Malin Space Science Systems Mars Orbiter Camera Image Gallery http://www.msss.com, [9] Christensen, P.R., et. al., THEMIS Public Data Releases, PDS node, ASU, http://themis-data.asu.edu. [10] Archinal, B. A., et. al., (2006), LPSC XXXVII, abs. 2310.

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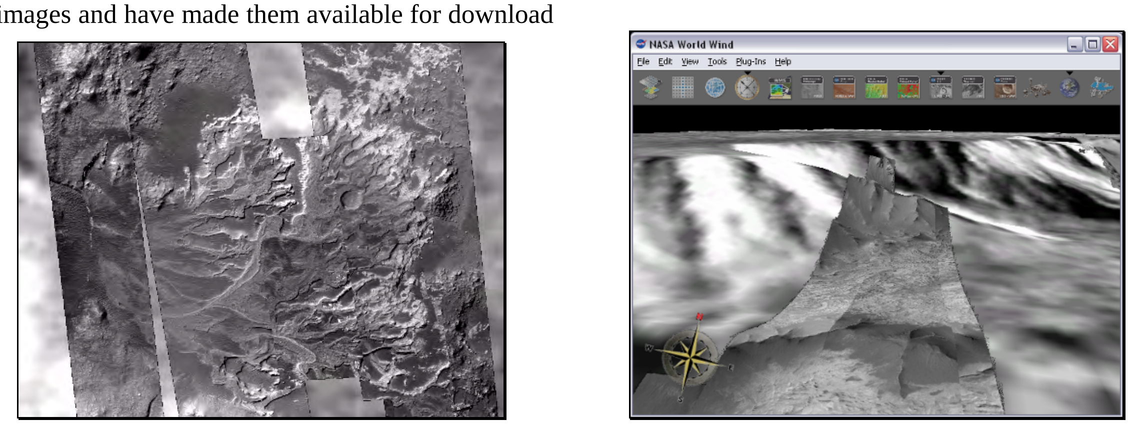

Figure 1. The left image shows an example area of the MOC NA mosaic streamed live from the OnMars JPL WMS server (23.8S, 326.4E, 31km across). The image on the right shows NASAs World Wind, a 3D application, displaying the live MOC NA mosaic over the much lower resolution MDIM21, both layers draped in 3D over the MOLA DEM (4.8S, 282.85E, 1X). URL: http://worldwind.arc.nasa.gov/.