

UNIFIED PLANETARY COORDINATES SYSTEM: A SEARCHABLE DATABASE OF GEODETIC INFORMATION. K.J. Becker¹, L.R. Gaddis¹, L.A. Soderblom¹, R.L. Kirk¹, B.A. Archinal¹, J.R. Johnson¹, J.A. Anderson¹, E. Bowman-Cisneros¹, S. LaVoie², M. McAuley², ¹U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ, 86001, (kbecker@usgs.gov), ²Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, 91109.

Introduction: Over the past 40 years, an enormous quantity of orbital remote sensing data has been collected for Mars from many missions and instruments. Unfortunately these datasets currently exist in a wide range of disparate coordinate systems, making it extremely difficult for the scientific community to easily correlate, combine, and compare data from different Mars missions and instruments. As part of our work for the PDS Imaging Node and on behalf of the USGS Astrogeology Team, we are working to solve this problem and to provide the NASA scientific research community with easy access to Mars orbital data in a unified, consistent coordinate system along with a wide variety of other key geometric variables. The Unified Planetary Coordinates (UPC) system is comprised of two main elements: (1) a database containing Mars orbital remote sensing data computed using a uniform coordinate system, and (2) a process by which continual maintenance and updates to the contents of the database are performed.

Goals: The goals of the UPC are (1) to design, develop, and build a uniform geometric database for all Mars orbital remote sensing data using the IAU/IAG 2000 east planetocentric coordinate system and (2) to make this system available to the scientific community in a variety of forms. We will populate the database with a complete and common set of up-to-date SPICE kernels and searchable flat tables for all existing datasets, provide optional access and full distribution of the native database (for users like the NASA PDS), and integrate the UPC into the ISIS (Integrated Software for Imagers and Spectrometers) system [1] for scientific analysis across the Mars datasets.

Our aim is to correct a series of major problems commonly encountered by the Mars research community. A researcher who wants to compare and correlate Mariner 9, Viking, MOC, TES, THEMIS, and MOLA can face daunting technical challenges. The datasets are in different coordinate systems—some in planetographic, some in planetocentric, some in east longitude, and some in west. They use different Mars IAU cartographic system definitions ranging in vintage from 1974 to 2000—these have different longitude offsets and figures for the planet. Some datasets are mapped onto a spherical planet, others onto ellipsoids.

The UPC will eliminate inconsistencies such as this and place them under a common cartographic sys-

tem, namely IAU 2000 Mars specifications [2], planetocentric latitudes, and 0 to 360 degree positive east longitudes.

Approach: The ISIS system handles the problem of different cartographic coordinate systems used in the many datasets it supports. Inherent is the ability to convert between planetographic and planetocentric latitude coordinates, east and west longitude directions and -180 to 180 and 0 to 360 degree longitude systems. Recent modifications to ISIS provide access to the MOLA DEM for accurate rendering of the data onto a global model of the Mars terrain. These modifications provide the ability within ISIS to align all Mars orbital data into one coordinate system, the goal being to place this ability into the hands of the NASA research community.

The ISIS system is capable of processing data from every Mars mission since Mariner 9 in the early 1970's. ISIS eliminates the problems of inconsistent cartographic systems across these missions and unifies consistent processing techniques. Other organizations offer access to and analysis of Mars datasets [3-5], but there is no consistency in the treatment of cartographic coordinates. The ISIS system will be used to compute, maintain and continually improve the UPC.

This work began with the design of a flexible database system with the ability to store the necessary geometric variables and other information for each Mars mission dataset. Once in place, we will derive new cartographic coordinates for all existing Mars orbital datasets using a common Mars body-fixed coordinate system (IAU/IAG 2000 Mars specifications, planetocentric latitudes, 0 to 360 degree positive east longitudes), consistent NAIF SPICE ephemerides, and updated or improved camera pointing. For the most part, existing ISIS software can be used directly to generate this database, but in a few cases, new software will be required to generate new cartographic variables. The new database will incorporate the most up-to-date and accurate SPICE kernels and pointing information available. As refinements to SPICE kernels and improvements to pointing information become available, the database will be updated with these new data. We will ensure that the system we develop has the underlying architecture necessary to add future Mars mission data to the system with relative ease. This design will also provide us with the

framework to extend the UPC to other missions, planets/bodies and instruments.

Implementation: Figure 1 shows how the UPC fits into the current view of the cartographic data processing system at USGS. ISIS is at the center of the system from initial generation of the UPC, selection and processing of mission observations into higher level products, refinement of geodetic coordinates in the UPC, and creation of accurate image mosaics.

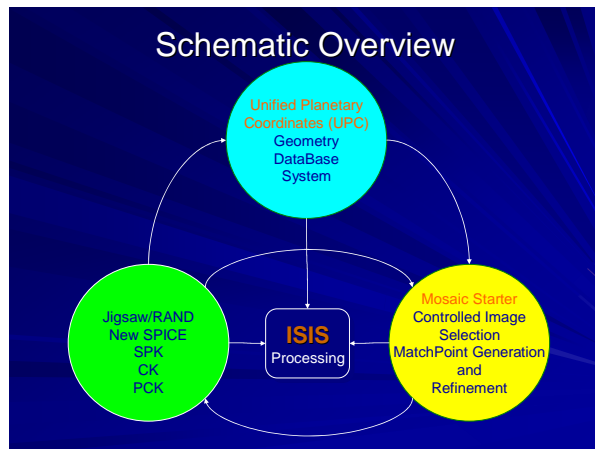


Figure 1. Conceptual overview of USGS cartographic data processing system.

Benefits: After the master or native database is generated, searchable databases (i.e. flat tables) are created that contain revised and consistent new cartographic coordinates for each of the mission datasets. This is akin to the conventional SEDR datasets traditionally generated for missions before the advent of SPICE systems. As soon as the master or native database and flat tables are generated, these will be made available for use by NASA PDS for ingestion into the Planetary Image Atlas [6] as searchable data archives to promote the use of common cartographic coordinates across martian datasets.

External users will be able to query the master database using our ISIS tools via an online web-based interface. These data will be available to the scientific community in a variety of forms so that compatibility with common tools and standards such as OpenGIS [7, 8] will be ensured. This will further unify the data under a common cartographic system, and it will promote use of this system in the scientific community. Individuals and organizations that provide Mars data may request and receive lists in tabular form of individual products along with their updated cartographic coordinates. From these lists, researchers will be able to download the named products using ftp from specified locations.

Figure 2 shows the complete ISIS process whereby the UPC is created, used to assist the user in

the generation of controlled mosaics, and then incorporated back into the UPC for refined accuracy of the geodetic coordinates.

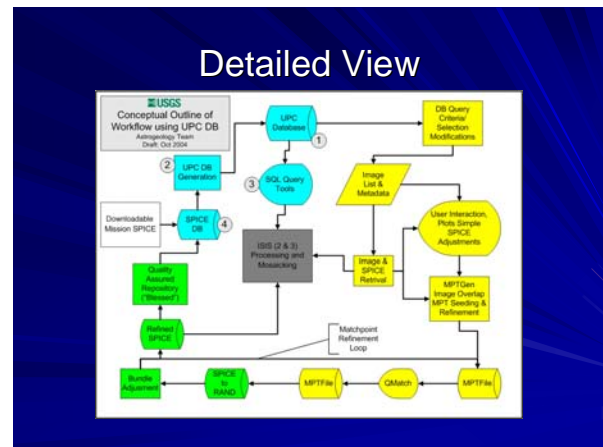


Figure 2. Details of conceptual design of the UPC and its integration and role in the ISIS system.

Summary: ISIS is currently undergoing a complete redesign and implementation using object-oriented technologies (i.e., C++). The UPC is a cornerstone of this process and it will be developed using this version (ISIS 3) which will allow us to easily extend the system to support other missions, planets and instruments. The key benefit to this design is that the end products are SPICE planetary, spacecraft and camera kernels. This allows these kernels to be used in the current ISIS 2 system as well as distributed along with individual mission observation products through venues such as the PDS.

References [1] Torson, J.M., and Becker, K.J., 1997, ISIS—A software architecture for processing planetary images (abs.), Lunar and Planetary Science Conferenc XXVIII, 1443. [2] Duxbury, T.C., Kirk, R.L., Archinal, B.A., Neumann, G.A., 2002, Mars geodesy/cartography working group recommendations on Mars cartographic constants and coordinate systems (abs.), in Symposium on Geospatial Theory, Processing and Applications, Ottawa. [3] Hughes, J.S., LaVoie, S., Wilf, J., Joyner, R., Crichton, D., 2003, PDS-D – The planetary data system distribution system, LPSC XXXIV, 1496. [4] Deardorff, D.G., Gulick, V.C., Briggs, G.A., 2002, MARSOWEB: A collaborative web facility for Mars landing site and global data studies, LPSC XXXIII 1980. [5] Gorelick, N.S., Weiss-Malik, M., Steinberg, B., Anwar, S., 2003, JMARS: A multimission data fusion application, LPSC XXXIV, 2057. [6] Ivanov A., E.D. Duxbury, S.K. LaVoie, J.M. McAuley, and P.J. Woncik, 2000, Access to the Mars Global Surveyor Data Through the Planetary Image Atlas: American Geophysical Union (Fall Meeting), San Francisco, California. [7] Hare, T.M., Tanaka, K.L., 2001, Planetary Interactive GIS-on-the-Web Analyzable Database (PIGWAD), the 20th International Cartographic Conference, Beijing, China. [8] Open Geospatial Consortium (<http://www.opengeospatial.org>).