WebGeocalc and Cosmographia: Modern Tools to Access SPICE Archives. B.V. Semenov,[1] C.H. Acton,[1] N.J. Bachman,[1] E.W. Ferguson,[1] M.E. Rose,[2] and E.D. Wright[1], [1]Caltech/Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena CA 91109, boris.semenov@jpl.nasa.gov, [2]NASA/Ames Research Center, Moffett Field, CA 94035..

Introduction: For more than two decades navigation data from most US and international space science missions have been archived as "SPICE" (Spacecraft, Planet, Instrument, Camera-matrix, Events)[1][2] system data files (a.k.a. SPICE kernels), assembled into PDS compliant data sets, residing at the Navigation and Ancillary Information Facility (NAIF) node of NASA's PDS, ESA's PSA, and JAXA's Hayabusa archives.

The traditional way for accessing data from these archives is by downloading the whole or a subset of a SPICE data set, installing the SPICE toolkit available from NAIF, and writing an application calling APIs from the core SPICE Toolkit library to compute geometric parameters of interest. While this approach provides the greatest flexibility in implementing geometric computations of interest, it proved to be complicated for users with little programming abilities, required data to be always copied to the users' workstations, and lacked any out-of-the-box visualization capabilities.

To address these shortcomings NAIF developed the WebGeocalc (WGC) tool and extended the publicly available Cosmographia program to use SPICE.

WebGeocalc: WGC is based on Web client-server architecture and provides, in a web browser, a convenient GUI to specify computations done by the geometry server accessing SPICE archive data.

WGC users select a calculation from the "Geometry Calculator," "Geometric Event Finder," and "Time Conversion Calculator" categories, select an archived kernel set with which the calculation is to be done, specify various inputs such as time and aberration corrections using menus and other GUI widgets, select optional plots, and click the "Calculate" button. The WGC client running in a browser sends a calculation request to a WGC server, which performs the calculation and sends the results back to the client. The client displays these results, which include echoed input parameters, time-tagged result tables, requested plots, and lists of kernels that were used, in the same browser window, allowing users to view results and plots, download then in a variety of formats, and save results for use in other WGC calculations.

All WGC server computation capabilities can also be accessed via a programmatic REST interface, essentially making it a web service.

The WGC instance running at the NAIF node of PDS (https://naif.jpl.nasa.gov/naif/webgeocalc.html) provides access to all PDS3 SPICE data sets and PDS4 SPICE bundles archived at NAIF as well as to all generic kernels and mission specific kernels available on NAIF's public HTTP/FTP server (https://naif.jpl.nasa.gov/).

Cosmographia: The SPICE-enhanced Cosmographia is a 3D solar system visualization program able to accurately render solar system (target) bodies, spacecraft trajectories and orientations, instrument field-of-view (FOV) "cones" and footprints based on SPICE data. The program, that was originally designed as a general purpose solar system simulator, was extended by NAIF to seamlessly access nearly all types of SPICE kernels, allowing it to accurately model the observation geometry of planetary missions for which complete sets of SPICE kernels, such as PDS3 SPICE data sets and PDS4 SPICE bundles, are available.

In order to use the program, which is a stand-alone application available from NAIF (https://naif.jpl.nasa.gov/naif/cosmographia.html), users download it and SPICE archives of interest and install them on theirs workstations. Then, using instructions provided by NAIF in the SPICE-enhanced Cosmographia User's Guide (https://cosmoguide.org), users configure the program for a mission of interest by creating catalog files in the JavaScript Object Notation (JSON) format defining which SPICE files to use and how to use them, and how spacecraft, its instruments' FOVs and footprints should be rendered by the program. Once configuration is done, using the program's controls users can freely manitpulate time and point of view to visualize various mission and instrument obervation geometry aspects such as trajecoties, reference frames, latitude-longitude grids, instrument FOVs and observation footprints.

References: [1] Acton, C.H. (1996) PSS, 44 No. 1, pp. 65-70. [2] Acton C.H., Bachman N.J., Semenov B.V., Wright E.D. PSS (2017), DOI 10.1016/j.pss.2017.02.013.

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