TITLE: SPICE SYSTEM: OBSERVATION GEOMETRY SUPPORTING DATA VISUALIZATION;
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The Navigation Ancillary Information Facility (NAIF), acting under the directions of NASA's Office of Space Science, has built a data system--called SPICE--to assist scientists in planning and interpreting scientific observations from space borne instruments. The principal objective of this information system is that it will contain the geometric and much other ancillary information needed to recover the full value of science instrument data, and that it will facilitate correlation of individual instrument data sets with data from other instruments on the same or other spacecraft.

The primary SPICE data sets, called "kernels", contain--in a practical sense--the fundamental set of ancillary information of potential interest to scientists. SPICE kernels are composed of information which has been structured and formatted, without loss of information, for easy access and correct use by the science community. Kernels are produced by the most knowledgeable sources of such information, usually located at a mission operations center. They must include or be accompanied by metadata--consistent with flight project data system standards--that provide pedigree and other descriptive information needed by prospective users.

SPICE kernel file contents are summarized below.

S Spacecraft ephemeris, or more generally, location of an observer, given as a function of time.

P Planet, satellite, comet, or asteroid ephemerides, or more generally, location of a target, given as a function of time.

The P kernel also logically includes certain physical, dynamical and cartographic constants for target bodies, such as size and shape specifications, and orientation of the spin axis and prime meridian.

I Instrument description kernel, containing descriptive and operational data peculiar to a particular scientific instrument, such as mounting alignment, internal timing relative to the spacecraft clock, and field-of-view model parameters.

C Pointing kernel, containing a transformation traditionally called the C-matrix which essentially yields time-tagged pointing (orientation) angles for a spacecraft structure upon which science instruments are mounted.

E Events kernel, the principal contents of which are derived from the integrated sequence of events used to produce actual spacecraft commands.

Several miscellaneous kernel files--spacecraft clock and leapseconds--are also part of SPICE; these are used in converting time tags between various time measurement systems.

The SPICE system includes portable FORTRAN subroutines needed to read the kernel files and calculate most common observation geometry parameters. Users integrate these SPICE "Toolkit" subroutines into their own application programs to compute observation geometry parameters and related information where and as needed.

NAIF has designed the kernel file and software Toolkit architectures with portability and multimission application as principal goals. In addition, because extensive software documentation and examples are provided with the Toolkit, with a reasonable learning effort the software can be confidently used by the full spectrum of the NASA-supported space sciences community.

A flight project's mission operations center will concentrate on producing, cataloging and distributing complete and accurate kernels on a timely basis. Kernel updates will be made promptly if/as improved data sources become available.

Users may order those kernels of interes- - using these at. their home sites to compute needed geometric and related ancillary information. Users may update some kernels and produce their own versions of other kernels to support their own analyses or to provide their colleagues with any improvements in ancillary information resulting from their work.

Each flight project will deliver copies of all SPICE kernels and Toolkit. software to the appropriate permanent archive facility, assuring ready availability of this data for future users. User-produced kernels may also be similarly archived.

Because ephemerides for most solar system target bodies are generally available, SPICE is frequently used for planning observations. In this case the observer could be a terrestrial telescope, a user-provided instrument location or a "predict" spacecraft ephemeris produced by NAIF or a mission design organization. In some cases "predict" versions of other SPICE kernels are also made to help simulate a full data processing system. With this flexibility scientists may use SPICE throughout the experiment lifecycle - - from mission planning to detailed observation design to instrume - data analysis and finally to correlation of results with those from other sources.

The core set of SPICE components is complete. Extension and adaptation of the core system to encompass broader functionality and to meet specific needs of new projects will be an ongoing endeavor. This work will include provision of some broadly useful application programs ant] development of additional kernel types.

The SPICE system is or soon will be used on numerous international] space missions in the planetary, astrophysics, space physics and earth science disciplines. Scientists in many countries may be counted as SPICE customers.

In addition to providing SPICE technology to NASA anti international space missions the NAIF Group serves as the Ancillary Data Node of NASA's Planetary Data System. in this role NAIF provides a permanent a~.chive and distribution and consultation functions for planetary project ancillary data sets.

SPICE files and NAIF Toolkit software may be requested by contacting the NAIF group located in the Navigation Systems Section of Caltech's Jet Propulsion Laboratory in Pasadena California. Orders are filled as resources permit and priority is given to scientists doing data analysis directly supported by NASA's Office of Space Science.

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