'] 'owards Ancillary Data Standards

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Abstract

NASA'S SPICE information system for archiving, distributing and accessing spacecraft navigation, orientation and other ancillary data is described. A proposal is made for the further evolution of this concept to an international useful standard, to be "owned>' by all interested parties.

Decreasing funding available to national space agencies and the ever increasing internationalization of space science endeavors emphasize the need to share data amongst scientists and engineers world-wide. This points to the advisability of the usc of standard formats, portable files and clear, concise metadata for both science data products and the ancillary data used to help plan and analyize space science observations.

Equally important to maximizing the usc of space science data are the preparation of high quality archive products and the provision of easy access to these products to all interested parties. These factors become even more important as wc return to target bodies or environments such as MaIS, and because the recent losses Of several scientific spacecraft--Mars Observer, Cluster and Mars %--make each piece of data in hand more precious.

In the United States, a 1982 report of the National Academy of Sciences[1] detailed the inadequacies of NASA's data archiving and distribution efforts, and emphasized that these shortcomings would become still bigger problems as missions and instruments would become more complex and as interest in correlations of multiple observations would grow. A result of this study was the formation of several space science information systems, including the Planetary Data System (1'11S). Onc component of the PDS is the Navigation and Ancillary information Facility (N AIF), located at the NASA/Caltech Jet Propulsion Laboratory in Pasadena, California. NAIF was chartered to address requirements for the archive and distribution of several kinds of ancillary (supplemental) data used to help interpret space science observations--data such as spacecraft and target body ephemerides, tar.get body size/shape/orient ation, instrument point ing direction, and mission sequence of events,

A small group of scientists specified the proposed architecture of this ancillary information system, and even provided its name--SPICE--an acronym derived from the following words:

- **S** Spacecraft
- P Planet (more generally, any target body)
- 1 Instrument
- C C-matrix (the name traditionally used for spacecraft orientation information)
- E Events

[1] Data Management and Computation, Volume 1; Committee on Data Management and Computation, Space Science Board, National Reseal-ch Council; 1982

The scientists proposed that ancillary data, separated more-or-less according to this scheme, be assembled, archived and made available to the community. The guiding principle was that scientists should have access to rather "low level" (not highly derived) ancillary data--often called "kernels", accompanied by the software tools and metadata (provenance information) needed to easily and properly use these kernels,

The NA11? Group has implemented such a SPICE system. Its principle components arc a basic suite of SPICE kernel files and software used to produce and utilize them, summarized in Table 1. important characteristics of SPICE arc portability of both the kernel data files and allied software, modularity, broad applicability and extensibility to handle new requirements,

The SPICE system has achieved broad acceptance within the U. S. planetary science community, ancl is also utilized in some non-planetary applications and by some foreign agencies and science groups. Despite this acceptance, customers have proposed numerous additions and improvements, many of which the NA11; Group hopes to implement (some are being implemented now).

NA1 F proposes that specialists from all interested countries consider if anti how the international space sciences community might further evolve or transform this system to reasonably satisfy multidiscipline and multinational requirements.

This research was carried out by the Jet l'repulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

	Primary Data
SPK	Ephemeris for any spacecraft, satellite, comet or asteroid, or for a designated body-fixed location.
PCK	Size, shape and orientation of any target body. Can also include additional physical or cartographic data such as Gm values.
IK	Asset-(cd instrument information, such as mounting alignment, field-of-view size/shape/orientation. Might also include internal timing delays, command dictionary, etc.
CK	Orientation of a spacecraft, or of an articulating, instrument platform attached 10 a spacecraft, given as a function of time.
EK (ESP) (ESQ) (ENB)	Events, consisting of up to three sub-components: - Science Plan - Spacecraft and Instrument Commands - Experimentor's Notebook
	Additional Data
LSK	Tabulation of leapseconds used in time conversions
SCLK	Spacecraft clock coefficients
	Software
SPICELIB	Subroutines used to: - write SPICE files - read SPICE files - compute derived quantities based on SPICE and possibly other data
UTILITIES	Utility programs associated with using SPICE

Table 1
Principal SPICE Components