Towards 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 worldwide. This points to the advisability of the use of standard formats, portable files and clear, concise metadata for both science data products and the ancillary data used to help plan and analyze space science observations.

Equally important to maximizing the use 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 we return to target bodies or environments such as Mars, and because there are 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 Sciences1 detailed the inadequacies of NASA's data archiving and distribution efforts, and emphasized that these shortcomings would become even 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 (PDS). One component of the PDS is the Navigation and Ancillary information Facility (NAIF), 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, target body size/shape/orientation, instrument pointing 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:

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

1 Data Management and Computation, Volume 1; Committee on Data Management and Computation, Space Science Board, National Research 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:systen. Its principle components are 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:systen has achieved broad acceptance within the U. S. planetary science community, and 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).

NA11 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.

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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.

JK
- 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 to a spacecraft, given as a function of time.

FK
- Events, consisting of up to three sub-components:
  - (F:SP)
  - (F:SQ)
  - (F:NB)
    - Science Plan
    - Spacecraft and Instrument Commands
    - Experimenter's Notebook

Additional Data

LSK
- Tabulation of leap seconds used in time conversions

SCLK
- Spacecraft clock coefficients

Software

SPICl:LIB
- Subroutines used to:
  - write SPICl: files
  - read SPICl: files
  - compute derived quantities based on SPICl: and possibly other data

UTILITIES
- Utility programs associated with using SPICl:

Table 1
- Principal SPICl: Components