Multimission Software Interface Specification (SIS)

SPICE
C-Matrix Kernel

CK

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Version 1.0

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PURPOSE: This SIS describes the format and content of SPICE C-matrix Kernel (CK) file, used to provide orientation of a spacecraft or any articulating structure.

CHANGE LOG

Version	Date	Page Nos.	Reason
1.0	14 June 2000	All	New multimission version.

List of Acronyms

ANSI   American National Standards Institute
ASCII   American Standard Code for Information Interchange
CCSDS   Consultative Committee on Space Data Standards
CK   SPICE C-kernel
ET   Ephemeris Time
FK   SPICE Frames Kernel
FTP   File Transfer Protocol
JPL   Caltech/Jet Propulsion Laboratory
MSOO   Mars Surveyor Operations Office
NAIF   Navigation and Ancillary Information Facility
PDB   Project Data Base
PDS   Planetary Data System
SCLK   SPICE Spacecraft Clock Kernel
SFDU   Standard Formatted Data Unit
SIS   Software Interface Specification
SPICE   S-, P-, I-, C- and E-kernels; the principal logical data components of a
                particular NASA ancillary information system
TMOD   Telecommunications and Mission Operations Directorate

Section 1
General Description

1.1   Purpose of Document

        This Software Interface Specification (SIS) describes the purpose of a SPICE C-matrix Kernel (CK) file and SPICE Toolkit software available to work with CK files..

1.2   Scope

        This is a multimission SIS, applicable for all flight projects.

1.3   Applicable Documents

No.	Document ID	Version	Title
1.	NAIF Doc. No. 174	Latest release	C-kernel Required Reading
2.	NAIF Doc. No. 358	Latest release	Quaternions: Standard NAIF Conventions
3.	NAIF Doc. No. 214	Latest release	Rotations Required Reading
4.	NAIF Doc. No. 167	Latest release	DAF Required Reading
5.	NAIF Doc. No. 222	Latest release	SCLK Required Reading

1.4   Functional Description

        A C-kernel holds orientation information, and optionally angular rate data, for a named structure relative to a specified reference frame. In particular, a CK file contains time-tagged quaternions that specify the rotation from a base reference frame to a "target" frame fixed to the spacecraft of other structure for which orientation information is being given. Optionally (option to the CK producer) the CK file may contain angular velocity of the target frame relative to the base frame.

        A CK may be a "predict" file, describing the planned orientation of a structure, or it may be a "reconstruction" file, providing the actual (measured) orientation of a structure, generally based on data returned from sensors associated with that structure.

        Reference Document No. 2 provides detailed descriptions of quaternions as used within SPICE and as specified in other areas. Reference Document Nos.2 and 3 describe how these quaternions are used in rotation matrices.

1.4.1   Data Source, Destinations, and Transfer Method

C-kernels are made available to flight projects through whatever mechanism is used for providing access to SPICE products, such as a Project Database (PDB), a File Interchange System (FIS) or a SPICE Server.

1.4.2 Labeling and Identification

CK files may include identification information within an internal "comment area.", although this is not a hard requirement. CK file names may utilize any syntax picked by a flight project, although limiting the length to the "27.3" specification adopted by the Planetary Data System (PDS) is suggested. NAIF further suggests using the "*.bc" and "*.xc" standard generally used by NAIF.

Section 2
Data Object Definition

2.1   Structure and Organization

In normal use CK files are binary files, consisting of a "comment area" provided to hold metadata, and the data area, holding quaternions, optional angular velocity, and the infrastructure used to organize these. CK files are specific instances of an underlying data structure named Double Precision Array File (DAF), which is described in great detail in Reference 4.

To port binary CK files between machines that do not use the same binary standard the SPICE "transfer format" is utilized. In a transfer format file CK data re encoded in a hexadecimal format that uses only ASCII characters. Transfer format files may be moved between computers using ASCII mode of ftp. The SPICE Toolkit contains utility programs (TOBIN and TOXFR) to convert from binary to transfer format, and vice-versa.

2.2   Data Format and Definition

2.2.1   Metadata Description

A CK file should contain "comments" providing the provenance of the file. These metadata should describe when, why, how and by whom the file was made. They should detail any and all significant data gaps, and provide any similar information that could help the end user of the CK file to select an appropriate CK file for some purpose, and to understand how best to use that file.

While providing comments is HIGHLY recommended, it is not a technical requirement on the CK producer.

Because many CK files do contain significant metadata, and because there are frequently problems with attitude data returned from a spacecraft, the user of CK files is STRONGLY encouraged to examine the comment area of any CK file for possibly important metadata.

2.2.2   Data Description

The description and layout of data in a CK file is described in Reference Nos. 1 and 4. This information is usually not important to most users; rather the user's view of a CK file is via the SPICELIB or CSPICE interface software outlined in Reference 1 and also discussed in the SPICE C-Kernel tutorial.

Section 3
CK Data Access

3.1   Reading CK Files

        The SPICE Toolkit contains special software (subroutines) for reading CK files. This is described in great detail in Reference 1 and in the C-Kernel tutorial. That process is briefly stated here in a Fortran example. The Toolkit CK Required Reading for a CSPICE version of the Toolkit contains C examples.

Initialization ... typically once per program run
  Tell your program which SPICE files to use ("loading" files)
   CALL FURNSH('lsk_file_name')
   CALL FURNSH('sclk_file_name')
   CALL FURNSH('ck_file_name')

Loop ... do as often as you need
  Convert UTC to SCLK ticks
   CALL STR2ET('utc_string', tdb)
   CALL SCE2T (spacecraft_id, tdb, sclkdp)

  Get orientation matrix and angular velocity at requested time
   CALL CKGPAV (instid,sclkdp,tol,'ref_frame',cmat,av,clkout,found)

        The arguments are described below.

Inputs:

instid	**NAIF ID for the spacecraft or structure for which the orientation is to be returned**
sclkdp	**the time at which the orientation matrix and angular velocity are to be computed. The time system used is encoded spacecraft clock time (SCLK). The units are ticks since the beginning of the mission**
tol	**the tolerance, expressed as number of SCLK ticks, to be used in searching for and computing the orientation data**
ref_frame	**the name of the reference frame with respect to which the orientation is to be computed**

Outputs:

cmat	**the 3x3 rotation matrix that you requested**
av	**the angular velocity that you requested**
clkout	**the exact time for which the orientation and angular velocity was computed**

found   the logical flag indicating whether the orientation and angular velocity data were found. Note that if the loaded CK file(s) do not contain angular velocity data, CKGPAV will return a FALSE found flag even when orientation can be computed