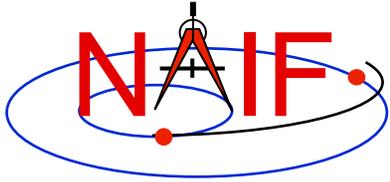


Navigation and Ancillary Information Facility

Summary of Key Points

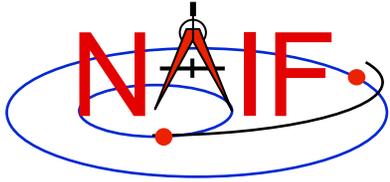
April 2016



Which Pieces of SPICE Must I Use?

Navigation and Ancillary Information Facility

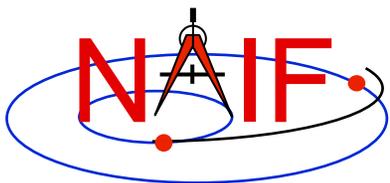
- **There's not a simple answer**
 - Depends on what mission or activity you are working on
 - Depends on what computation(s) you wish to make
- **Don't feel overwhelmed**
 - Many complex computations can be made using just a few SPICE APIs
- **The next several charts highlight some key points**
 - We assume you have already looked at the major SPICE tutorials, or already have some familiarity with SPICE
 - We assume you have successfully downloaded and installed the SPICE Toolkit
- **Consider printing this tutorial and keeping it near your workstation**



Reminder of Key Subsystems

Navigation and Ancillary Information Facility

- SPK:** Position (and velocity) of things
- PCK:** Size/shape/orientation of target bodies
For binary PCKs, only orientation is provided; use a text PCK to obtain size/shape
- IK:** Instrument field-of-view geometry (see also FK below)
- CK:** Orientation of spacecraft or spacecraft structures that move
- FK:** Definition and specification details for many reference frames, including instrument mounting alignments
- DSK:** High fidelity shape data, better than what's in a PCK
- LSK:** Time conversion: UTC (SCET) \longleftrightarrow ET (TDB)
- SCLK and LSK:** Time conversion: SCLK \longleftrightarrow ET (TDB)



Primary Kernel Interfaces - 1

Navigation and Ancillary Information Facility

Which SPICE modules are most commonly called to use data obtained from a given kernel type?

| | |
|------------|-----------------------------------|
| SPK | SPKEZR, SPKPOS, SPKCOV, SPKOBJ |
|------------|-----------------------------------|

| | |
|------------|--|
| PCK | SXFORM, PXFORM, SPKEZR, SPKPOS, BODVRD |
|------------|--|

| | |
|-----------|----------------|
| IK | GETFOV, G*POOL |
|-----------|----------------|

| | |
|-----------|---|
| CK | SXFORM, PXFORM SPKEZR, SPKPOS, CKCOV, CKOBJ (CKGPAV, CKGP) |
|-----------|---|

| | |
|-----------|-----------------------------------|
| FK | SXFORM, PXFORM, SPKEZR, SPKPOS |
|-----------|-----------------------------------|

| | |
|------------|---|
| LSK | STR2ET, TIMEOUT, SCE2C, SCT2E, SCE2S, SCS2E |
|------------|---|

| | |
|-------------|---|
| SCLK | SCS2E, SCE2S SXFORM, PXFORM, SPKEZR, SPKPOS |
|-------------|---|

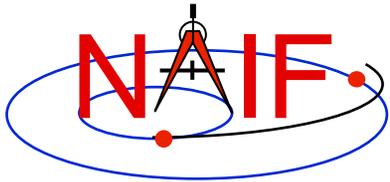
| | |
|-------------|-------------------------------------|
| DSK* | Many: read the DSK documentation |
|-------------|-------------------------------------|

* Partial implementation starting with N66 Toolkit

Notes: FURNISH is used to load (provide access to) all SPICE kernels.

API names shown are for FORTRAN versions:

- use lower case and add an “_c” when using C
- use lower case and prepend “cspice_” when using Icy (IDL) and Mice (MATLAB)



Primary Kernel Interfaces - 2

Navigation and Ancillary Information Facility

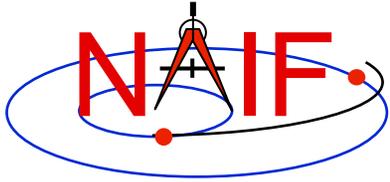
For a given high-level module, which kind(s) of kernel(s) will or may be needed?

Kernel Type(s) Needed

| Module Name | SPK | PCK | IK | CK | FK | LSK | SCLK | DSK* |
|--------------------------------|-----|-----|----|----|----|-----|------|------|
| SPKEZR, SPKPOS | Y | M | | M | M | L | M | |
| SXFORM, PXFORM | M | M | | M | L | M | M | |
| CKGP, CKGPAV | M | M | | Y | M | L | L | |
| GETFOV | | | Y | | | | | |
| G*POOL | | M | M | | | | | |
| STR2ET, TIMOUT | | | | | | Y | | |
| SCS2E, SCE2S | | | | | | Y | Y | |
| CHRONOS (time conversion app.) | M | M | | M | M | Y | M | |

Yes = is needed
Likely = very likely needed
Maybe = may be needed

* Partial implementation starting with N66 Toolkit



Primary Kernel Interfaces - 3

Navigation and Ancillary Information Facility

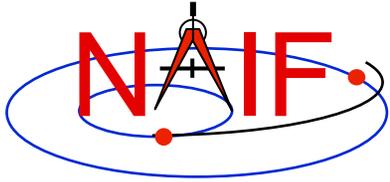
For a given high-level module, which kind(s) of kernel(s) will or may be needed?

Kernel Type(s) Needed

| Module Name | SPK | PCK | IK | CK | FK | LSK | SCLK | DSK* |
|------------------------|-----|-----|----|----|----|-----|------|------|
| SINCPT | Y | L | | M | L | L | M | M |
| DSKXV, DSKXSI | M | M | | M | M | M | M | Y |
| LATSRF | M | M | | M | M | M | M | M |
| ILUMIN, ILLUMG, ILLUMF | Y | L | | M | M | L | M | M |
| SUBPNT, SUBSLR | Y | L | | M | M | L | M | M |
| GFOCLT, OCCULT | Y | L | | M | M | L | M | M |
| SRFNRM | M | M | | M | M | M | M | M |
| LIMBPT | Y | L | | M | M | L | M | M |
| TERMPT | Y | Y | | M | M | L | M | M |

* Partial implementation starting with N66 Toolkit

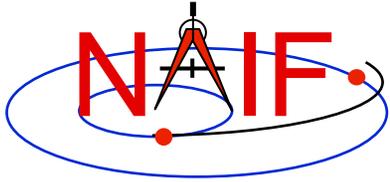
Yes = is needed
Likely = very likely needed
Maybe = may be needed



Kernel “Coverage” Cautions

Navigation and Ancillary Information Facility

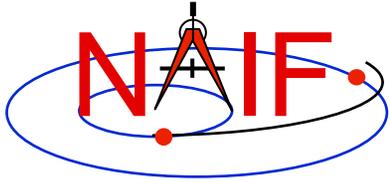
- **Your set of kernels must:**
 - contain data for all “objects” of interest
 - » Sometimes you must include intermediary objects that provide a connection (recall the chaining discussion in the SPK tutorial)
 - contain data covering the time span(s) of interest to you
 - » Watch out for data gaps within that time span
 - » Watch out for the difference between ET and UTC
 - The difference as of 2016 March 01 is 68.185 seconds (ET > UTC)
 - contain all the kernel types needed by SPICE to answer your question
 - » As the previous charts allude, you may need one or more kernels that are not obvious
 - be managed (loaded) properly if there are overlapping (competing) data within the set of files you are using



What Kernels are Available?

Navigation and Ancillary Information Facility

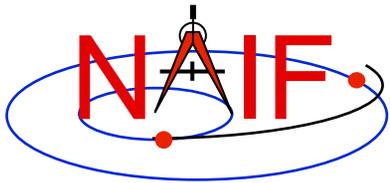
- It depends on the mission or task you are working on...
- There typically are three categories of kernel data available.
 - **Mission operations** kernels – those used by the flight teams to fly the mission and prepare the archival science products
 - **PDS Archived** kernels – those that have been selected from (or made from) the mission ops kernels, and then are well organized and documented for the PDS archive. These data sets also contain helpful meta-kernels.
 - **Generic** kernels – those that are used by many missions and are not tied to any one mission
 - » Relevant generic kernels are usually included in the **PDS Archived** and the **Mission Operations** kernels data sets mentioned above
 - All three types can be found here: <http://naif.jpl.nasa.gov/naif/data.html>
- The situation might be similar for non-JPL missions, but this is up to whatever agency/institution is producing the kernels.



How Can I Find Possibly Useful Toolkit Modules?

Navigation and Ancillary Information Facility

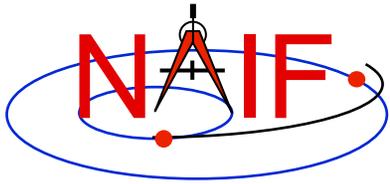
- Review the previous charts
- Look at the appropriate SPICE tutorial(s)
- Look at the “Most Used xxx APIs” document `.../doc/html/info/mostused.html`
- Search the permuted index:
 - `spicelib_idx` for the FORTRAN toolkits `.../doc/html/info/spicelib_idx.html`
 - » This index also correlates entry point names with source code files.
 - `cspice_idx` for the C toolkits `.../doc/html/info/cspice_idx.html`
 - `icy_idx` for the IDL toolkits `.../doc/html/info/icy_idx.html`
 - `mice_idx` for the MATLAB toolkits `.../doc/html/info/mice_idx.html`
- Read relevant portions of a SPICE “required reading” technical reference document (e.g. “`spk.req`”)
 - `.../doc/html/req/spk.html` for the hyperlinked html version (best)
 - `.../doc/spk.req` for the plain text version



How Can I Understand How To Use Those Modules?

Navigation and Ancillary Information Facility

- **The primary user-oriented documentation about each module is found in the “header” located at the top of each source code file and in the module’s HTML page in the API reference guide.**
 - (More documentation is found at the additional entry points for those FORTRAN modules that have multiple entry points.)
- **Reference documentation for major subsystems is found in like-named “required reading” documents (e.g. spk.req, ck.req, etc.)**
- **The SPICE tutorials contain much helpful information.**



Does NAIF Provide Any Examples?

Navigation and Ancillary Information Facility

- **Nearly all module headers contain one or more working examples**
- **“Most Useful SPICELIB Subroutines” has code fragments**
.../doc/html/info/mostused.html
- **The “required reading” reference documents often contain examples**
.../doc/html/req/index.html
- **The “Program_<language>” tutorial contains a substantial working example**
- **Some simple “cookbook” programs are found in the Toolkit**
.../src/cookbook/...
- **Make use of the SPICE Programming Lessons available from the NAIF server**
 - **ftp://naif.jpl.nasa.gov/pub/naif/toolkit_docs/Lessons/**