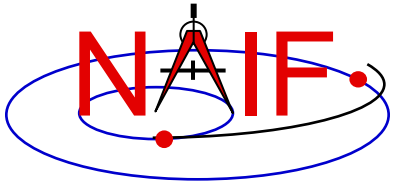


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# Summary of Key Points

**April 2023**

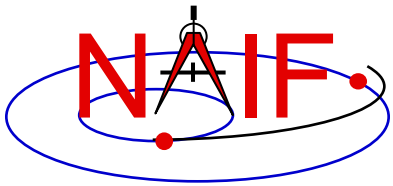


# Which Pieces of SPICE Must I Use?

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- **There's not a simple answer**
  - Depends on what activity or mission you are working on
  - Depends on what computation(s) you wish to make
- **Don't feel overwhelmed**
  - Many seemingly 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**

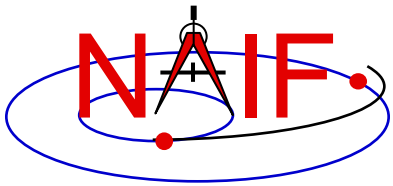


# Reminder of Key Subsystems

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



# Primary Kernel Interfaces - 1

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**Which SPICE APIs are most commonly used with a given kernel type?**

SPK	SPKEZR, SPKPOS, SPKCOV, SPKOBJ
PCK	SXFORM, PXFORM, SPKEZR, SPKPOS, BODVRD
IK	GETFVN, GETFOV, G*POOL
CK	SXFORM, PXFORM SPKEZR, SPKPOS, CKCOV, CKOBJ (CKGPAV, CKGP)

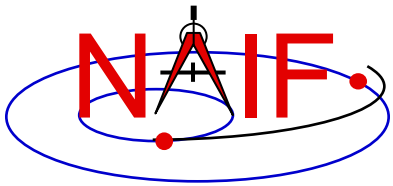
FK	SXFORM, PXFORM, SPKEZR, SPKPOS
LSK	STR2ET, TIMEOUT, SCE2C, SCT2E, SCE2S, SCS2E
SCLK	SCS2E, SCE2S SXFORM, PXFORM, SPKEZR, SPKPOS
DSK*	SINCPT, LATSRF, ILLUMF, SRFNRM, LIMBPT, TERMPT, ...

\* Partial implementation starting with N66 Toolkits

**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

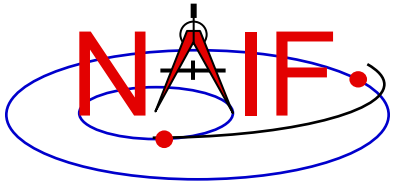
Navigation and Ancillary Information Facility

**For a given high-level Toolkit API, which kinds of kernels will or may be needed?**

*Kernel Type(s) Needed*

<b>API Name</b>	<b>SPK</b>	<b>PCK</b>	<b>IK</b>	<b>CK</b>	<b>FK</b>	<b>LSK</b>	<b>SCLK</b>	<b>DSK</b>
SPKEZR, SPKPOS	Y	M		M	M	L	M	
SXFORM, PXFORM	M	M		M	L	M	M	
CKGP, CKGPAV	M	M		Y	M	L	L	
GETFVN, 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



# Primary Kernel Interfaces - 3

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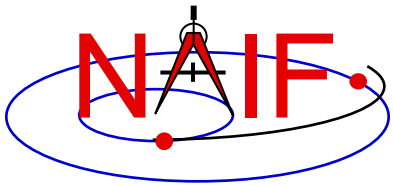
**More: for a given high-level API, which kinds of kernels will or may be needed?**

*Kernel Type(s) Needed*

<i>API Name</i>	SPK	PCK	IK	CK	FK	LSK	SCLK	DSK*
SINCPT	Y	L	M	M	L	L	M	M
TANGPT	Y	Y	M	M	L	L	M	
DSKXV, DSKXSI	M	M	M	M	M	M	M	Y
LATSRF		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
LIMBPT	Y	L		M	M	L	M	M
TERMPT	Y	Y		M	M	L	M	M

\* Partial implementation starting with N67 Toolkits

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

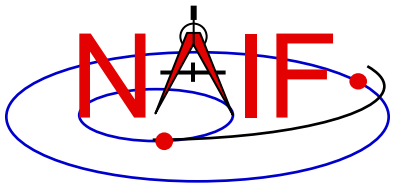


# Kernel “Coverage” Cautions

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- **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 2017 January 01 is ~69.182 seconds (ET > UTC)
  - contain all the kernel types needed by SPICE to answer your question
    - » As the previous charts show, 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



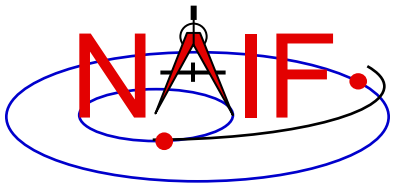
# What Kernels are Available?

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- It depends on the mission or task you are working on.
- There are typically 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
    - » These are the most up to date, but it could be a challenge to select the ones you need
  - **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 are well organized, well documented, and contain helpful “furnsh” kernels (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: <https://naif.jpl.nasa.gov/naif/data.html>
- The situation might be similar for non-JPL missions, but this is up to whatever institution is producing the kernels.

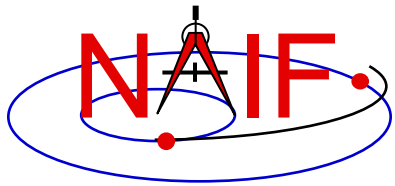




# How Can I Find Possibly Useful Toolkit APIs?

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- **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

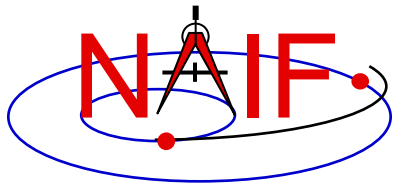


# How Can I Understand How To Use Those APIs?

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- The primary user-oriented documentation about each API is found in the “header” located at the top of each source code file and also in the API's HTML page in the API reference guide.
  - You can “Google” an API name to see its header
    - » For example: `spkezr`, `spkezr_c`, or `cspice_spkezr` (for `lcy` or `Mice`)
  - (More documentation is found at the additional entry points for those FORTRAN APIs 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.
- NAIF’s self-training materials provide an orderly approach to learning about SPICE:
  - [https://naif.jpl.nasa.gov/naif/self\\_training.html](https://naif.jpl.nasa.gov/naif/self_training.html)



# Does NAIF Provide Any Examples?

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- **Nearly all API headers contain one or more working examples**
- **“Most Used 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**
  - [https://naif.jpl.nasa.gov/pub/naif/toolkit\\_docs/Lessons/](https://naif.jpl.nasa.gov/pub/naif/toolkit_docs/Lessons/)