



Navigation and Ancillary Information Facility

Non-Toolkit Applications

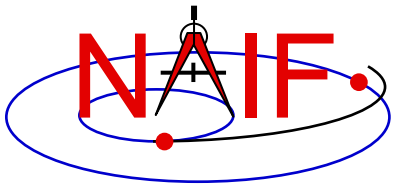
April 2023



Summary

Navigation and Ancillary Information Facility

- **NAIF makes available a set of applications *not* included in the Toolkits. This set includes programs for:**
 - making, modifying, validating, inspecting, and converting SPK files:
 - » *pinpoint, dafcat, bspidmod, dafmod, spy, oem2spk, spk2oem*
 - making and modifying CK files
 - » *prediCkt, ckslicer, ckspanit, dafcat, cksmrg, dafmod*
 - making SCLK files
 - » *makclk*
 - merging and modifying DSK files
 - » *dlacat, dskmod*
 - computing derived quantities
 - » *orbnum, optics, spy*
 - determining SPICE kernel type and binary format, and converting between native and non-native formats
 - » *archtype, bff, bingo*
- **Executables and User's Guides are on the NAIF server at:**
 - <https://naif.jpl.nasa.gov/naif/utilities.html>



Using Non-Toolkit Apps

Navigation and Ancillary Information Facility

- **All of these apps are meant to be used as operating system shell executables**
 - One generally cannot run these within IDL or MATLAB—run them from an operating system shell
 - » In some cases you can run from within IDL or MATLAB, but this is not recommended:
 - In IDL, use the “spawn” command
 - In MATLAB, use the “system” command



PINPOINT

Navigation and Ancillary Information Facility

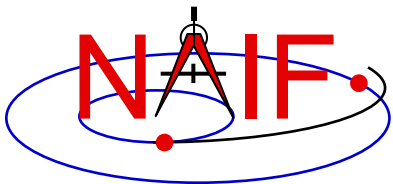
- ***pinpoint*** is a program for creating SPK files and topocentric frames FK files for objects for which the position is a constant offset with respect to another object

- Ground stations
- Landing sites, sites along a rover path
- Relative positions of manipulator joints, etc.

- ***pinpoint*** is a command line program with the following usage:

```
pinpoint -def deffile -spk spkfile [-pck tkfile] [-fk fk] [flags]
```

- “deffile” is an input definitions file following text kernel file format and containing a set of keywords defining ID, center, reference frame, position (as XYZ or Gaussian Lat/Lon/Alt) and time coverage boundaries, and optionally velocity and topocentric frame axes specifications, for one or more objects
 - » The contents of “deffile” are included in the comment area
- “spkfile” is an output SPK file containing a type 8 SPK segment for each of the objects specified in the “deffile”
- “tkfile” is an optional input PCK file (needed if positions in the “deffile” are given as Lat/Lon/Alt) or FK file (needed if one or more of the frames specified in “deffile” is not one of the frames built into the Toolkit)
- “fk” is an optional output topocentric frames FK file



PINPOINT Example

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```
Terminal Window

$ more mer1_meridiani.def

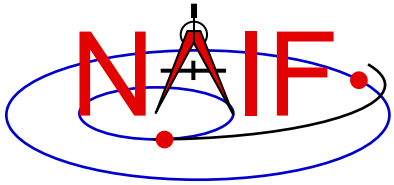
Sample PINPOINT input for MER-1 landing site coordinates.
\begindata
    SITES      = ( 'LS' )
    LS_CENTER  = 499
    LS_FRAME   = 'IAU_MARS'
    LS_IDCODE  = -253900
    LS_XYZ     = ( +3.3764222E+03  -3.2664876E+02  -1.1539218E+02 )
    LS_BOUNDS  = ( @2001-01-01-00:00:00.000, @2100-01-01-00:00:00.000 )
\begintext

$ pinpoint -def mer1_meridiani.def -spk mer1_meridiani.bsp

$ brief mer1_meridiani.bsp
Brief.  Version: 2.2.0          (SPICE Toolkit N0057)

Summary for: mer1_meridiani.bsp
Body: -253900* w.r.t. MARS (499)

      Start of Interval (ET)                End of Interval (ET)
      -----
2001 JAN 01 00:00:00.000          2100 JAN 01 00:00:00.000
```



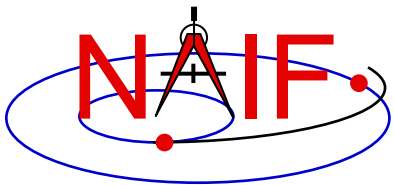
DAFCAT

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- ***dafcat* is a program for concatenating binary DAF files by simply copying all data segments from all input files, in the order they are provided, into the output file**
 - ***dafcat* works on SPKs, CKs, and binary PCKs**
 - » It will not merge different types of kernels together, i.e. it will not merge SPKs with CKs, CKs with PCKs, etc.
 - » For merging SPKs, in most cases *spkmerge* should be used instead because it provides a much more powerful and sophisticated capability
- ***dafcat* is a command line program with the following usage**

```
dafcat output_file
```

 - “output_file” is the output file name and is the program’s only argument
 - Input file names are provided from standard input
 - » this is very convenient for use with Unix shell pipes
- ***dafcat* does not put any information into the comment area of the output file, leaving this responsibility to the user (use *commnt* to do so)**



DAFCAT Example: SPK

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```
Terminal Window

$ dafcat m01_merged.bsp

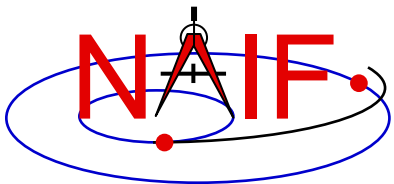
DAF binary files concatenation program version 1.00

spk_m_od33905-33993_rec_v1.bsp
spk_m_od33992-34065_rec_v1.bsp
^D
Concatenating files:
    spk_m_od33905-33993_rec_v1.bsp
    spk_m_od33992-34065_rec_v1.bsp
to:
    m01_merged.bsp

$ ls -l spk_m_od*_rec_v1.bsp | dafcat m01_merged_2.bsp

DAF binary files concatenation program version 1.00

Concatenating files:
    spk_m_od32371-32458_rec_v1.bsp
    ...
to:
    m01_merged_2.bsp
```



DAFCAT Example: CK

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```
Terminal Window

$ dafcat m01.bc

DAF binary files concatenation program version 1.00

m01_sc_2004-04-20.bc
m01_sc_2004-04-21.bc
^D
Concatenating files:
    m01_sc_2004-04-20.bc
    m01_sc_2004-04-21.bc
to:
    m01.bc

$ ls -l m01_sc_2004-04-2*.bc | dafcat m01.bc

DAF binary files concatenation program version 1.00

Concatenating files:
    m01_sc_2004-04-20.bc
    m01_sc_2004-04-21.bc
to:
    m01.bc
```



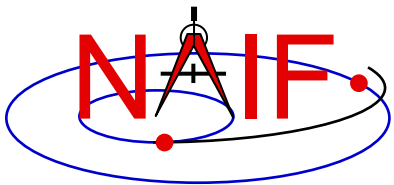

DLACAT

Navigation and Ancillary Information Facility

- ***dlacat*** is a program for concatenating binary DLA files by simply copying all data segments from all input files, in the order they are provided, into the output file
 - Works on DSKs
- ***dlacat*** is a command line program with the following usage

```
dlacat output_file
```

 - “output_file” is the output file name and is the program’s only argument
 - Input file names are provided from standard input
 - » this is very convenient for use with Unix shell pipes
- ***dlacat*** does not put any information into the comment area of the output file, leaving this responsibility to the user (use *commnt* to do so)



DLACAT Example: DSK

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```
Terminal Window

$ dlacat phoebe_shape.bds

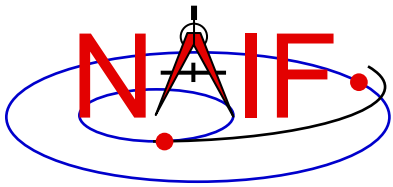
DLA binary files concatenation program version 1.00

phoebe_shape_part1.bds
phoebe_shape_part2.bds
^D
Concatenating files:
    phoebe_shape_part1.bds
    phoebe_shape_part2.bds
to:
    phoebe_shape.bds

$ ls -1 phoebe_shape_part?.bds | dlacat phoebe_shape_2.bds

DLA binary files concatenation program version 1.00

Concatenating files:
    phoebe_shape_part1.bds
    phoebe_shape_part2.bds
to:
    phoebe_shape_2.bds
```



BSPIDMOD

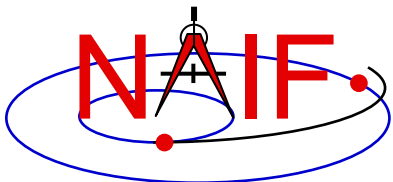
Navigation and Ancillary Information Facility

- ***bspidmod* is a program for altering the object IDs in a binary SPK file**
 - It can be used to modify IDs in an SPK file(s) produced with a “bogus” spacecraft ID (or a simulation spacecraft ID)
 - It can be used to replace “official” IDs with “bogus” IDs if two different trajectories for the same object need to be used in the same program at the same time (for example for comparison, such as is done by *spkdiff*)
 - Works only in kernels in “native” binary format

- ***bspidmod* has the following usage:**

```
bspidmod -spki inpspk -idi inpid -ido outid -mod item -oflg
```

- “inpspk” is the input SPK file; “inpid” and “outid” are the current ID and new ID
- “item” indicates which IDs are to be replaced – TARGET (only target IDs are replaced), CENTER (only center IDs are replaced), or OBJECT (both target and center IDs are replaced)
- Replacements are made only when “inpid” matches an ID found in the input SPK
- “-oflg” flag indicating that changes should be made directly in the input file; if not specified, the program produces an output file with name that has “_out” appended to the name of the input file
 - » In order for changes to be made in the input file it must be in the native binary format; if it is not, *bingo* may be used to convert it to the native binary format
- A note stating which IDs were modified is put in the comment area



BSPIDMOD Example

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```
Terminal Window

$ brief mer2_crus_sim_id.bsp
Brief.  Version: 2.2.0          (SPICE Toolkit N0057)

Summary for: mer2_crus_sim_id.bsp

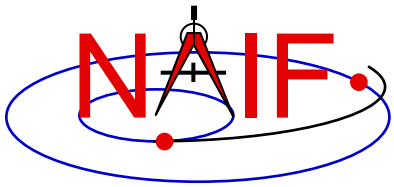
Body: -255
      Start of Interval (ET)          End of Interval (ET)
      -----
      2003 JUL 09 00:15:00.000        2004 JAN 04 04:25:42.557

$ bspidmod -spki mer2_crus_sim_id.bsp -idi -255 -ido -254 -mod target -oflg
The file mer2_crus_sim_id.bsp has been updated.

$ brief mer2_crus_sim_id.bsp
Brief.  Version: 2.2.0          (SPICE Toolkit N0057)

Summary for: mer2_crus_sim_id.bsp

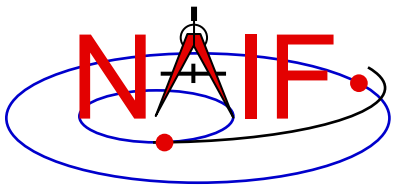
Body: MER-2 (-254)
      Start of Interval (ET)          End of Interval (ET)
      -----
      2003 JUL 09 00:15:00.000        2004 JAN 04 04:25:42.557
```



DSKMOD

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- ***dskmod* alters selected segment attributes in a binary DSK file:**
 - body, surface, or reference frame ID
 - data class ID
 - coordinate system bounds
 - coverage start and stop times
- ***dskmod* can modify attributes “in place” in the input DSK or can write output to a new DSK file**
- ***dskmod* puts into the comment area a warning note stating which items in which segments of the file were changed**
- ***dskmod* works with files in native binary format**



DSKMOD Example

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```
Terminal Window

$ dskbrief phobos_2014_09_22.bds
...
Summary for: phobos_2014_09_22.bds

Body:                401 (PHOBOS)
  Surface:            401 (Name not available)
...

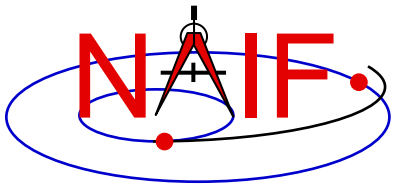
$ dskmod -dskin phobos_2014_09_22.bds -mod SURFACE -from 401 -to 1001 -overwrite

DSKMOD Program; Ver. 1.0, 16-NOV-2021; Toolkit Ver. N0067

DSK input file: phobos_2014_09_22.bds.
The descriptor field SURFACE has been changed from 401 to 1001 in DSK segment 1.
The file phobos_2014_09_22.bds has been modified and saved as phobos_2014_09_22.bds.

$ dskbrief phobos_2014_09_22.bds
...
Summary for: phobos_2014_09_22.bds

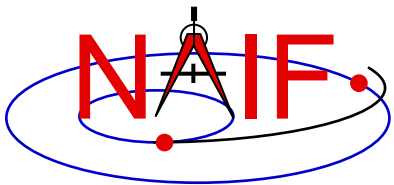
Body:                401 (PHOBOS)
  Surface:            1001 (Name not available)
```



DAFMOD

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- ***dafmod* is a program for altering selected segment attributes in a binary SPK, CK, or PCK file**
 - In an SPK file it can alter the target, center, or reference frame ID
 - In a CK or binary PCK file it can alter the object or reference frame ID
- ***dafmod* is an interactive program. When executed it prompts the user for**
 - name of the file to be modified
 - “item” to be modified
 - » the set of items depends on the kernel type
 - “old” item value
 - “new” item value
- ***dafmod* puts into the comment area a warning note stating which items in which segments of the file were changed**
- ***dafmod* works only on files in native binary format**
 - *bingo* may be used to convert a non-native binary kernel to native binary format



DAFMOD Example: SPK

Navigation and Ancillary Information Facility

```
Terminal Window

$ brief mer2_crus_sim_id.bsp

Summary for: mer2_crus_sim_id.bsp

Body: -255
...

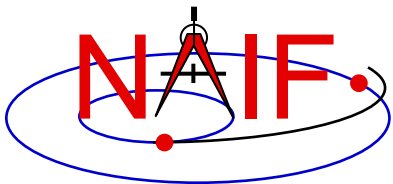
$ dafmod

DAFMOD -- Version 2.0.0, January 30, 2008 -- Toolkit Version N0063
(... banner providing usage instructions ...)
1) File      : mer2_crus_sim_id.bsp
2) Item      : target
3) Old Value: -255
4) New Value: -254
The file mer2_crus_sim_id.bsp has been updated.

$ brief mer2_crus_sim_id.bsp

Summary for: mer2_crus_sim_id.bsp

Body: MER-2 (-254)
```

DAFMOD Example: CK

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```
Terminal Window

$ ckbrief -rel mro_sc_pred.bc mro.tsc naif0009.tls

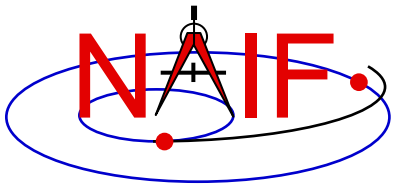
Summary for: mro_sc_pred.bc
...
2009-AUG-15 23:31:02.347 2009-AUG-30 00:00:58.388 Y    -74900

$ dafmod

DAFMOD -- Version 2.0.0, January 30, 2008 -- Toolkit Version N0063
(... banner providing usage instructions ...)
1) File      : mro_sc_pred.bc
2) Item      : frame
3) Old Value: -74900
4) New Value: 16
The file mro_sc_pred.bc has been updated.

$ ckbrief -rel mro_sc_pred.bc mro.tsc naif0009.tls

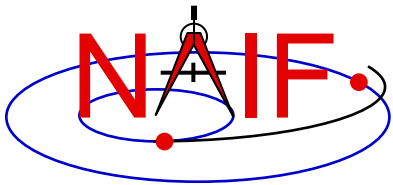
Summary for: mro_sc_pred.bc
...
2009-AUG-15 23:31:02.347 2009-AUG-30 00:00:58.388 Y    MARSIAU
```



SPY

Navigation and Ancillary Information Facility

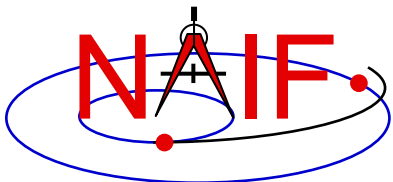
- ***Spy* is a command line program for validating, inspecting, and analyzing SPK files**
- **Spy can:**
 - **check SPK files**
 - » **Validate SPK structure**
 - » **Check sampled data for bounds violations**
 - » **Locate invalid double precision numbers**
 - **sample data from a set of loaded kernels**
 - » **Sample position, distance, velocity, derived velocity, speed, acceleration, acceleration magnitude, osculating elements**
 - **dump SPK file contents**
 - » **Data**
 - » **Summary information**
 - » **Comment area**
 - » **Bookkeeping information**
 - **find some geometric events**
 - » **Distance: find times when specified constraints on observer-target distance are met**
 - » **Elevation: find times when specified constraints on elevation of target in specified frame are met**



SPY: Selected Features

Navigation and Ancillary Information Facility

- **Operating modes**
 - Interactive, batch, shell command line
- **Auxiliary files**
 - Start-up file, command files, log file, save file
- **Interactive command support**
 - Command history: recall, repetition, and command editing; editor selection; command error detection; (limited) automatic command error correction
- **User default support**
 - Set, show, reset default values
- **Input options**
 - Define user symbols in commands
 - Embed prompts in commands
- **Output options**
 - Dump subsets of SPK data
 - Show epoch and packet deltas in data dumps
 - Set sample count or density
 - Set time and number formats
 - Set angular units
 - Set coordinate system for sampled data
 - Control error diagnostic verbosity
- **Online help: command language summary**



SPY Example: Dump SPK Data

Navigation and Ancillary Information Facility

Terminal Window

```
Spy > dump data spk testspk.bsp segment index 13 stop packet 2;
```

```
Dump of SPK File testspk.bsp
```

```
=====
Segment number 13
-----
```

```
Segment Summary:
```

```
Segment ID      : SPY test segment: type 18 subtype 0
Target Body     : Body 1800
Center Body     : Body 1899
Reference Frame  : Frame 17, ECLIPJ2000
SPK Data Type   : Type 18
  Description    : Mex/Rosetta Hermite/Lagrange Interpolation
UTC Start Time  : 2000 JAN 01 11:59:05.816
UTC Stop Time   : 2000 JAN 01 12:32:15.816
ET Start Time   : 2000-JAN-01 12:00:10.000000 (TDB)
ET Stop Time    : 2000-JAN-01 12:33:20.000000 (TDB)
DAF Begin Address: 35287
DAF End Address  : 37890
-----
```

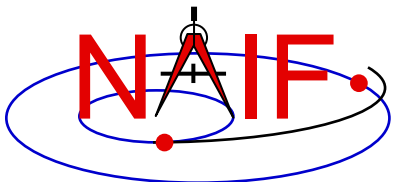
```
Segment Parameters:
```

```
Packet Count    : 200
Directory Count  : 1
Window Size - 1 : 6
Polynomial Degree: 13
Subtype         : 0
  Description    : Hermite interpolation, 12-element packets
-----
```

```
Time Tags and Packets:
```

```
State Components: Position X, Y, Z (km)
                  Velocity X, Y, Z (km/s)
                  Velocity X, Y, Z (km/s)
                  Accel.   X, Y, Z (km/s^2)
```

1	2000-JAN-01 12:00:10.000000 (TDB)	1.00103333E+03	1.00203333E+03	1.00303333E+03	1.00403333E+03	1.00503333E+03	1.00603333E+03
		1.00703333E+03	1.00803333E+03	1.00903333E+03	1.01003333E+03	1.01103333E+03	1.01203333E+03
2	2000-JAN-01 12:00:20.000000 (TDB)	2.00103333E+03	2.00203333E+03	2.00303333E+03	2.00403333E+03	2.00503333E+03	2.00603333E+03
		2.00703333E+03	2.00803333E+03	2.00903333E+03	2.01003333E+03	2.01103333E+03	2.01203333E+03



SPY Example: Sample State Vectors

Navigation and Ancillary Information Facility

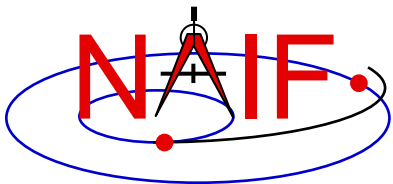
Terminal Window

```
Spy > load naif0009.tls;
Spy > load de421.bsp;
Spy > sample states
observer earth
target moon
start time 2008 oct 28 00:00:00.000000 TDB
stop time 2008 oct 28 00:01:00.000000 TDB
frame eclipJ2000
aberration correction none
coordinates latitudinal
time format numeric E23.16
number format F13.6
step size 10.0;
```

Sample STATE Results

```
=====
Target           : moon
Observer         : earth
Frame            : eclipJ2000
Aberration Correction: none
Coordinate System : latitudinal
=====
```

0.2784240000000000E+09	395800.315095	-156.260092	-4.660937	0.035837	0.000145	-0.000005
0.2784240100000000E+09	395800.673459	-156.258644	-4.660983	0.035836	0.000145	-0.000005
0.2784240200000000E+09	395801.031820	-156.257196	-4.661028	0.035836	0.000145	-0.000005
0.2784240300000000E+09	395801.390177	-156.255748	-4.661074	0.035836	0.000145	-0.000005
0.2784240400000000E+09	395801.748532	-156.254300	-4.661120	0.035835	0.000145	-0.000005
0.2784240500000000E+09	395802.106883	-156.252851	-4.661165	0.035835	0.000145	-0.000005
0.2784240600000000E+09	395802.465231	-156.251403	-4.661211	0.035835	0.000145	-0.000005



SPY Example: Check SPK Integrity

Navigation and Ancillary Information Facility

Terminal Window

```
Spy > check integrity spk testspk.bsp;
```

```
Structure Inspection of SPK File testspk.bsp
```

```
=====
```

```
Segment Number 11
```

```
-----
```

```
Segment Summary:
```

```
Segment ID      : SPY test segment: type 15
Target Body     : Body 1501
Center Body     : Body 1599
Reference Frame  : Frame 17, ECLIPJ2000
SPK Data Type   : Type 15
  Description    : Two-Body with J2 Precession
UTC Start Time  : 2000 JAN 01 11:59:05.816
UTC Stop Time   : 2000 JAN 01 12:32:15.816
ET Start Time   : 2000-JAN-01 12:00:10.000000 (TDB)
ET Stop Time    : 2000-JAN-01 12:33:20.000000 (TDB)
DAF Begin Address: 35259
DAF End Address  : 35274
```

```
-----
```

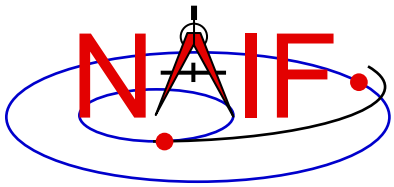
```
%% Error:  Invalid Unit Periapsis Pole Vector
```

```
    The periapsis pole vector should have unit length but in fact has length 4.58257569E+04.
```

```
-----
```

```
One error diagnostic and no warnings generated for SPK file testspk.bsp
```

```
=====
```

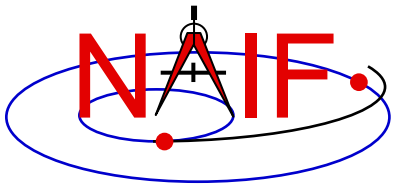


OEM2SPK and SPK2OEM

Navigation and Ancillary Information Facility

- ***oem2spk* is a program for converting a CCSDS* “Orbit Ephemeris Message” (OEM) text file to a Type 9 or 13 SPICE SPK file**
 - It is a command line program using a setup file to specify conversion parameters
 - It can process OEM versions 1 and 2
 - It is primarily used for exchange of spacecraft trajectories between space agencies
- ***spk2oem* is a program for converting a Type 1, 9 or 13 SPICE SPK to an OEM file**
 - It is a command line program using a setup file to specify conversion parameters
 - It performs conversion in “data-driven” or “uniform sampling” mode
- **For more details see the *oem2spk* and *spk2oem* user guides**

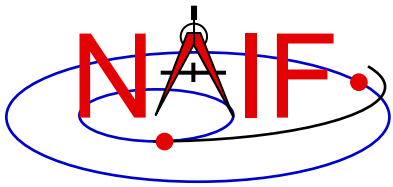
*CCSDS = Consultative Committee on Space Data Systems



PREDICKT

Navigation and Ancillary Information Facility

- ***prediCkt*** is a command line program for making CK files from a set of orientation specification rules, using schedules defining when these rules are to be applied
 - It requires orientation and schedule specification to be provided in a setup file that follows the SPICE text kernel syntax
 - It requires all supporting kernels -- SPK, PCK, etc -- to be loaded using a meta kernel
 - For more details see the “Making a CK Tutorial”



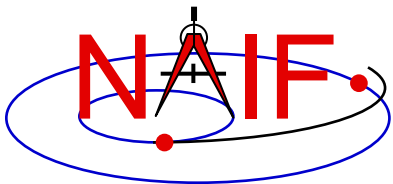
CKSLICER

Navigation and Ancillary Information Facility

- ***ckslicer*** is a command line program for subsetting a CK file
- ***ckslicer*** has the following usage

```
ckslicer -lsk <lsk_file_name>  
         -sclk <sclk_file_name(s)>  
         -inputck <ck_file_name>  
         -outputck <ck_file_name>  
         -id <naif_id>  
         -timetype <utc|sclk|ticks>  
         -start <start_time>  
         -stop <stop_time>
```

- ***ckslicer*** is useful in the situation when only a portion of a CK covering a short interval of time is needed (for example when the whole CK is not needed and it takes up a lot of space) or to cut out parts from a few CKs with the intent to merge them together (if reconstructed CKs from different sources have too much overlap to simply “cat” them together)
- A note stating which subset was extracted is put into the comment area of the output CK file



CKSLICER Example

Navigation and Ancillary Information Facility

```
Terminal Window

$ dir mgs_sc_ab1_v2.bc
-rw-rw-r--  1 naifuser  195535872 Jul 17  1999 mgs_sc_ab1_v2.bc

$ ckslicer -lsk naif0007.tls -sclk MGS_SCLKSCET.00054.tsc -inputck
mgs_sc_ab1_v2.bc -outputck mgs_sc_ab1_970915.bc -id -94000 -timetype utc -start
1997-SEP-15 18:00 -stop 1997-SEP-15 21:00

CKSLICER: Version 1.0.1 July 17, 1999; Toolkit Version N0057

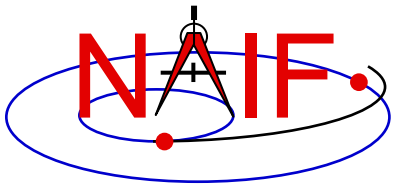
$ dir mgs_sc_ab1_970915.bc
-rw-rw-rw-  1 naifuser  480256 Apr 25 10:23 mgs_sc_ab1_970915.bc

$ ckbrief mgs_sc_ab1_970915.bc naif0007.tls MGS_SCLKSCET.00054.tsc -utc

CKBRIEF Version: 2.0.0, 2001-05-16. SPICE Toolkit Version: N0057.

Summary for: mgs_sc_ab1_970915.bc

Object:  -94000
Interval Begin UTC      Interval End UTC      AV
-----
1997-SEP-15 18:00:00.001 1997-SEP-15 21:00:00.000 Y
```



CKSPANIT

Navigation and Ancillary Information Facility

- ***ckspanit*** is a command line program for modifying interpolation interval information in type 3 CK segments
 - It can also convert a type 1 CK to a type 2 or 3 CK
- ***ckspanit*** is used when one is dealing with a type 3 CK containing many small gaps within segments. It allows you to alter the CK in such a way that SPICE will interpolate over those gaps

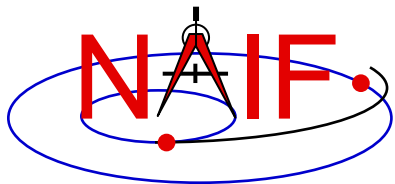
- ***ckspanit*** has the following usage

```
ckspanit -in inp_ck -out out_ck -tol threshold [-frm fk]
```

- “Threshold” is the longest time interval over which interpolation is to be permitted in the output CK file
 - » Must be specified in SCLK ticks
 - For example if 1 tick is 1/256 of a second and interpolation over 30 second intervals is needed, “threshold” must be set to $256 \times 30 = 7680$
- “fk” is an optional FK file name, needed only if the base frame in the input CK is not one of the frames built into the Toolkit

- See also the description of ***cksmrg***

CAUTION: before running ***ckspanit***, make sure that interpolation over larger gaps is appropriate for the vehicle or structure you are dealing with. And don't forget to add appropriate comments to the newly created CK file.



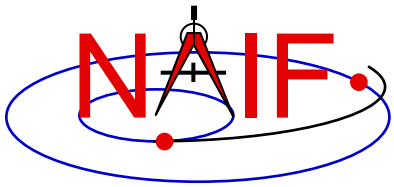
CKSPANIT Example

Navigation and Ancillary Information Facility

```
Terminal Window
$ ckbrief m01_sc_2004-04-22.bc naif0007.tls ORB1_SCLKSCET.00078.tsc -utc -dump
CKBRIEF Version: 2.0.0, 2001-05-16. SPICE Toolkit Version: N0057.
Summary for: m01_sc_2004-04-22.bc
Segment No.: 1
Object: -53000
Interval Begin UTC      Interval End UTC      AV
-----
2004-APR-22 00:00:05.455 2004-APR-22 18:53:29.054 Y
2004-APR-22 18:55:05.054 2004-APR-22 21:44:22.979 Y
2004-APR-22 21:51:34.974 2004-APR-22 23:59:58.919 Y

$ ckspanit -in m01_sc_2004-04-22.bc -out m01_sc_2004-04-22_sp.bc -tol 153600

$ ckbrief m01_sc_2004-04-22_sp.bc naif0007.tls ORB1_SCLKSCET.00078.tsc -utc -dump
CKBRIEF Version: 2.0.0, 2001-05-16. SPICE Toolkit Version: N0057.
Summary for: m01_sc_2004-04-22_sp.bc
Segment No.: 1
Object: -53000
Interval Begin UTC      Interval End UTC      AV
-----
2004-APR-22 00:00:05.455 2004-APR-22 23:59:58.919 Y
```



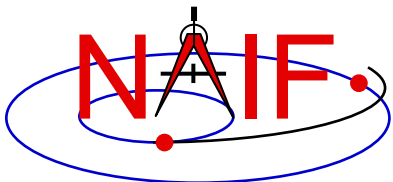
CKSMRG

Navigation and Ancillary Information Facility

- ***cksmrg*** is a command line program that merges data from Type 3 CK segments provided in a single CK file, having the same ID and base frame
- ***cksmrg*** is used for eliminating gaps between segments (that cannot be removed by ***ckspanit***) and removing duplicate data points contained in different segments
- ***cksmrg*** has the following usage

```
cksmrg -k|-kernels <meta kernel name|kernel file names>
      -i|-input <input ck file name>
      -o|-output <output ck file name>
      -s|-segid <output ck segment id string>
      -f|-fileid <output ck file id string>
      -b|-body <body id|name>
      -r|-reference <reference id|name>
      -a|-av <drop|keep|make|makeavg>
      -t|-tolerance <tolerance (number units)>
      [-c|-correction <time delta|cor. table file>]
```

CAUTION: ***cksmrg*** should not be used to merge CK segments from different sources (e.g. predicted and reconstructed), nor should it be used to merge overlapping predict CK segments



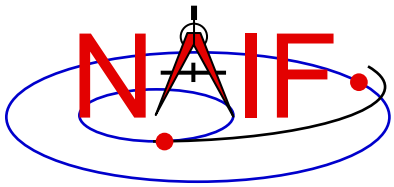
CKSMRG Example

Navigation and Ancillary Information Facility

```
Terminal Window
$ ckbrief m01.bc naif0007.tls ORB1_SCLKSCET.00078.tsc -utc -rel
. . .
Object: -53000
Interval Begin UTC      Interval End UTC      AV  Relative to FRAME
-----
2004-APR-20 00:00:03.622 2004-APR-20 23:59:56.288 Y  MARSIAU
2004-APR-21 00:00:02.288 2004-APR-21 23:59:59.455 Y  MARSIAU

$ cksmrg -k naif0007.tls ORB1_SCLKSCET.00078.tsc -i m01.bc -o m01s.bc -s
'CKSMRGed' -f 'CKSMRGed' -b -53000 -r 'MARSIAU' -a keep -t 60 seconds
. . .
(cksmrg displays quite a lot of diagnostics and progress information)
. . .

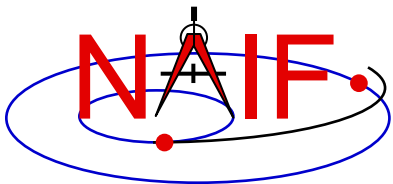
$ ckbrief m01s.bc naif0007.tls ORB1_SCLKSCET.00078.tsc -utc -rel
. . .
Object: -53000
Interval Begin UTC      Interval End UTC      AV  Relative to FRAME
-----
2004-APR-20 00:00:03.622 2004-APR-21 23:59:59.455 Y  MARSIAU
```



MAKCLK

Navigation and Ancillary Information Facility

- ***makclk*** is a program for converting a SCLKSCET file to an SCLK kernel
 - SCLKSCET (a.k.a. SCLKvSCET) is a time correlation file used by most JPL missions
 - It is an ASCII text file providing piece-wise linear clock correlation function as an array of triplets consisting of the reference on-board time, the reference UTC time, and the clock rate
 - NAIF found that in many cases it is much easier to write an application to first make a SCLKSCET file and then convert it to an SCLK kernel using *makclk* than to write an application to make an SCLK kernel from “scratch”
- ***makclk*** is an interactive program prompting for a single input - the name of the setup file
- The setup file uses KEYWORD=VALUE assignments to specify input files (SCLKSCET, template SCLK, and LSK), output files (SCLK kernel and log), and control parameters (spacecraft ID, partition tolerance, time filtering flag, and rate adjustment flag)
- The ***makclk*** User's Guide provides detailed information about the setup file parameters and the SCLKSCET file format and contents.



MAKCLK Example

Navigation and Ancillary Information Facility

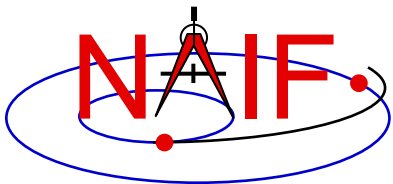
```

Terminal Window

$ more makclk.setup
SCLKSCET_FILE           = flc_sclkscet.00007
OLD_SCLK_KERNEL         = flc_template.tsc
FILE_NAME               = flc_sclkscet.00007.tsc
NAIF_SPACECRAFT_ID      = -77
LEAPSECONDS_FILE        = naif0009.tls
PARTITION_TOLERANCE     = 10
LOG_FILE                = flc_sclkscet.00007.log

$ more flc_sclkscet.00007
(... SCLKSCET SFDU header ...)
CCSD3RE00000$$scet$$NJPL3IS00613$$data$$
*  _____ SCETO _____ DUT _____ SCLKRATE _____
   _____
      0.000      2000-001T11:58:55.816  64.184  1.000000000
  189345665.000  2006-001T00:00:00.816  64.184  0.000010000
  189345666.000  2006-001T00:00:00.817  65.184  1.000000000
  268620868.000  2008-188T12:53:23.211  65.184  0.999998631
  276588129.000  2008-280T18:00:53.314  65.184  0.999999788
  281552200.000  2008-338T04:55:23.270  65.184  1.000000029
  284040077.000  2009-001T00:00:00.341  65.184  0.000010000
  284040078.000  2009-001T00:00:00.342  66.184  1.000000029
  287261113.000  2009-038T06:43:55.535  66.184  1.000000131
  291848718.000  2009-091T09:04:01.136  66.184  1.000000166
CCSD3RE00000$$data$$CCSD3RE00000$$sclk$$

```

MAKCLK Example (continued)

Navigation and Ancillary Information Facility

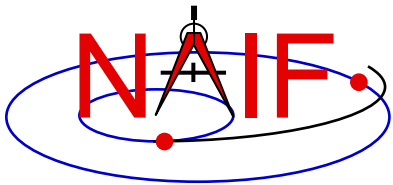
```
Terminal Window
$ more flc_template.tsc
KPL/SCLK
  \begindata
    SCLK_KERNEL_ID           = ( @2009-04-07/12:00 )
    SCLK_DATA_TYPE_77        = ( 1 )
    SCLK01_TIME_SYSTEM_77    = ( 2 )
    SCLK01_N_FIELDS_77       = ( 2 )
    SCLK01_MODULI_77         = ( 4294967296 256 )
    SCLK01_OFFSETS_77        = ( 0 0 )
    SCLK01_OUTPUT_DELIM_77   = ( 1 )
    SCLK_PARTITION_START_77  = ( 0.00000000000000E+00 )
    SCLK_PARTITION_END_77    = ( 1.0995116277750E+12 )
    SCLK01_COEFFICIENTS_77   = ( 0.E+00 0.E+00 1.E+00 )
  \begintext

$ makclk
.....
Enter the name of the command file

> flc_sclkscet.00007.setup

flc_sclkscet.00007.tsc created.

$
```



ORBNUM

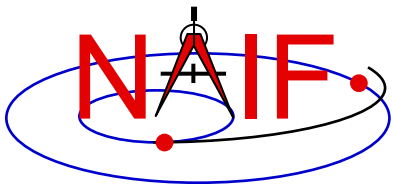
Navigation and Ancillary Information Facility

- ***orbnum*** is a program for generating a SPICE orbit number file containing orbit numbers and corresponding orbit start/stop times, along with some additional derived quantities (orbital elements and coordinates of sub-spacecraft and sub-solar points)
 - The orbit number increment can be specified as occurring at one of these events: periapsis or apoapsis, ascending or descending equatorial node crossing, min or max value for the s/c position's Z-coordinate, or min or max value of the s/c's latitude
- ***orbnum*** is a command line program with the following usage

```
orbnum -pref pref_file -num init_orbit -file orbnum_file -d -v -audit -tdb -verbose
```

optional

 - “pref_file” is a preferences file using text kernel syntax, specifying setup parameters along with the kernels containing data to be used to search for orbit start and stop events, spacecraft trajectory SPKs, center body PCK, spacecraft SCLK, etc.
 - “init_orbit” is the number to be assigned to the first orbit determined using the kernels provided; subsequent orbits are assigned by incrementing “init_orbit” by 1
 - “orbnum_file” is the name of the orbit number file to be created
- **An orbnum file is not considered a SPICE kernel**
 - It's just a convenient, derived product that NAIF offers to make for orbital missions that wish to have it



ORBNUM Example

Navigation and Ancillary Information Facility

```
Terminal Window

$ more mex_orbnum.setup
\begindata
TARGET                = -41
OBSERVER               = 499
EVENT_DETECTION_FRAME = 'MARSIAU'
EVENT_DETECTION_KEY   = 'PERI'
ELEMENTS_INERTIAL_FRAME = 'MARSIAU'
ABERRATION_CORRECTION = 'NONE'
ORBIT_PARAMS          = ( 'Sub Sol Lon', 'Sub Sol Lat', .. )
TEXT_KERNELS          = ( 'de-245-masses.tpc', 'NAIF0007.TLS', 'mex_030722_step.tsc', .. )
BIN_KERNELS           = ( 'ORMF_PSTPIX_DB_00001.bsp', 'DE405S.BSP' )
SAFETY_MARGIN          = 0.5
STEP_SIZE_TDB         = 'DEFAULT'
\begintext

$ orbnum -pref mex_orbnum.setup -num 1 -file mex_orbnum.orb
....Loading Kernels

Start UTC (RET for default = 2004 JAN 13 15:54:19.8):<RETURN>
End   UTC (RET for default = 2004 AUG 05 02:10:24.8):<RETURN>

Working, please wait.
Program Finished!
```

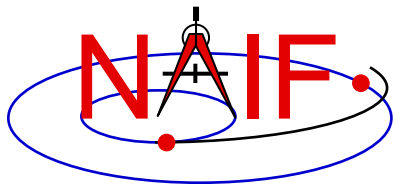


OPTIKS

Navigation and Ancillary Information Facility

- ***optiks*** is a command line program that generates information about instrument fields of view (FOV) from parameters present in IK and FK files
 - FOVs must be defined using the keywords required by the GETFOV routine
- ***optiks*** is used in one of two ways

```
optiks [options]... kernel ...
optiks [options]... meta-kernel ...
```
- ***optiks*** uses a set of SPICE kernels specified on the command line; one or more of these kernels may be a meta-kernel
- The output data are organized in three tables
 - The first table lists the angular extents (size) of circular, elliptical, and rectangular FOVs. Using command line options “-units” and “-half” the user can select the unit of measure for the angular measurements, and whether half or full FOV angular extents are listed.
 - The second table contains FOV boresights in a user specified frame at a particular epoch, specified using the “-epoch” option
 - The third table shows FOV boundary vectors and boresights as returned from the GETFOV API, or unitized and rotated into a user-specified frame at a particular epoch



OPTIKS Example

Navigation and Ancillary Information Facility

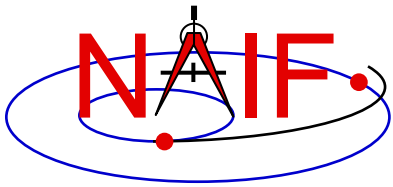
```

Terminal Window
$ optiks -frame CASSINI_SC_COORD cas_iss_v09.ti cas_v37.tf naif0007.tls
cas00084.tsc

. . .
Kernels Loaded:
. . .
FOV full-angular extents computed in RADIANS

Field of View          Shape          Length          Width
-----
CASSINI_ISS_NAC        RECTANGULAR      +0.006108652382  +0.006108652382
CASSINI_ISS_NAC_RAD    CIRCULAR         +3.141592653590  +3.141592653590
CASSINI_ISS_WAC        RECTANGULAR      +0.060737457969  +0.060737457969
CASSINI_ISS_WAC_RAD    CIRCULAR         +3.141592653590  +3.141592653590

FOV boresights computed at epoch 2001-JAN-01 12:00
FOV boresights computed in frame CASSINI_SC_COORD
Field of View          Boresight Vector
-----
CASSINI_ISS_NAC        ( +0.000575958621, -0.999999819520, -0.000170972424 )
CASSINI_ISS_NAC_RAD    ( +1.000000000000, -0.000000000000, +0.000000000000 )
CASSINI_ISS_WAC        ( +0.001218344236, -0.999999225446, +0.000254451360 )
CASSINI_ISS_WAC_RAD    ( +1.000000000000, -0.000000000000, +0.000000000000 )
  
```



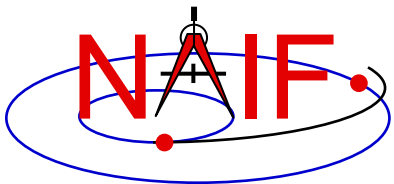
ARCHTYPE

Navigation and Ancillary Information Facility

- ***archtype* is a program that displays the file architecture and type of a SPICE kernel; it is useful for scripting applications**
 - To identify the architecture and type *archtype* uses the same mechanism as the FURNISH routine
- ***archtype* has a simple command line interface and requires only one argument -- the name of a kernel file:**

```
archtype kernel_name
```

- ***archtype* prints architecture and type to standard output as two space delimited acronyms**
 - Architecture can be:
 - » 'DAF' or 'DAS' for binary kernels
 - » 'KPL' for text kernels
 - Type can be 'SPK', 'PCK', 'IK', 'CK', 'EK', 'LSK', 'SCLK', 'FK', 'MK', 'DSK'
- **If architecture and/or type cannot be determined, the program displays 'UNK'**
- **In order for text kernels to be recognized, the first few characters of the file must contain 'KPL/<type>' (i.e. 'KPL/IK', 'KPL/FK', etc.)**



ARCHTYPE Examples

Navigation and Ancillary Information Facility

```
Terminal Window

$ archtype 020514_SE_SAT105.bsp
DAF SPK

$ archtype 04135_04171pc_psiv2.bc
DAF CK

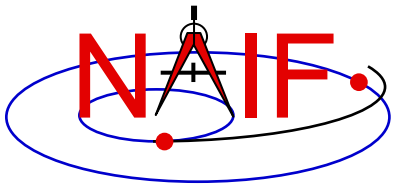
$ archtype cas00084.tsc
KPL SCLK

$ archtype cas_v37.tf
KPL FK

$ archtype cpck05Mar2004.tpc
KPL PCK

$ archtype naif0008.tls
KPL LSK

$ archtype .cshrc
UNK UNK
```



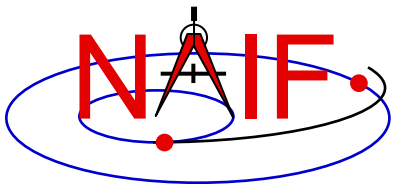
BFF

Navigation and Ancillary Information Facility

- ***bff* is a program that displays the binary file format of one or a few SPICE kernels**
- ***bff* has a simple command line interface requiring kernel names to be listed on the command line:**

```
bff kernel_name [kernel_name ...]
```

- ***bff* prints the binary file format string ('BIG-IEEE' or 'LTL-IEEE') to standard output**
 - When run on a single kernel, it prints only the format string
 - When run on more than one kernel, it prints the format string followed by the file name on a separate line for each file
- **If an input file is not a binary kernel, the program displays the format string 'N/A'**
- **If the binary file format cannot be determined (for DAS files produced by applications linked to SPICE Toolkit N0051, April 2000 or earlier), the program displays the format string 'UNK'**



BFF Examples

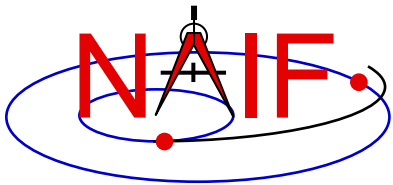
Navigation and Ancillary Information Facility

```
Terminal Window

$ bff mer2_surf_rover.bsp
BIG-IEEE

$ bff ./*.bc ./*.bsp ./*.tf ./*.xsp
BIG-IEEE ./MRO_PHX_EDL_07260_PASS1_sc_20070917181502.bc
LTL-IEEE ./070416BP_IRRE_00256_14363.bsp
LTL-IEEE ./mars_north.bsp
BIG-IEEE ./mer2_surf_rover.bsp
LTL-IEEE ./sb406-20pb.bsp
LTL-IEEE ./zero_offset.bsp
N/A      ./vo.tf
N/A      ./mgn06127.xsp

$
```



BINGO

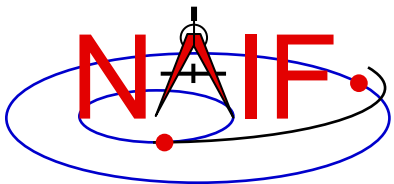
Navigation and Ancillary Information Facility

- ***bingo* is a program that converts:**
 - binary SPICE kernels between IEEE big endian and little endian formats
 - text format SPICE kernels between DOS and UNIX text formats

- ***bingo* has a simple command line interface:**

```
bingo [option] input_kernel output_kernel
```

- “option” is a flag specifying the conversion direction: ‘-ieee2pc’ or ‘-pc2ieee’ for binary kernels and ‘-unix2dos’ or ‘-dos2unix’ for text format kernels
 - “input_kernel” is the input kernel file name
 - “output_kernel” is the output kernel file name. If the output file already exists, the program overwrites it.
- **The conversion direction flag does not need to be specified for DAF-based binary file conversions (SPK, CK, binary PCK) and post-N0051 DAS-based binary file conversions (EK, DBK, DSK)**
 - The program automatically determines the input file format and performs conversion to the other format
- **The conversion direction flag must be specified for pre-N0051 DAS-based binary file conversions, and for text file conversions**



BINGO Examples

Navigation and Ancillary Information Facility

```
Terminal Window

--- DAF-based binary kernel conversions:

$ bingo de405s_ieee.bsp de405s_pc.bsp

$ bingo de405s_pc.bsp de405s_ieee.bsp

--- Modern DAS-based binary kernel conversions:

$ bingo 10A_ieee.bdb 10A_pc.bdb

$ bingo 10A_pc.bdb 10A_ieee.bdb

--- Text kernel conversions:

$ bingo -unix2dos naif0008_unix.tls naif0008_dos.tls

$ bingo -dos2unix naif0008_dos.tls naif0008_unix.tls
```