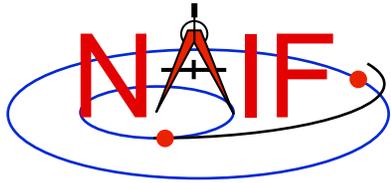


Navigation and Ancillary Information Facility

Time Conversion and Time Formats

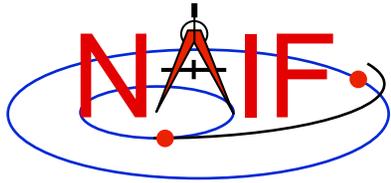
January 2012



Topics

Navigation and Ancillary Information Facility

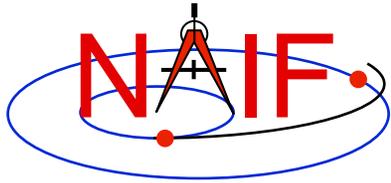
- **Time Systems and Kernels**
- **Converting Time Strings**
- **Converting Numeric Times**
- **Additional Time Conversions**
- **Pictorial Layout of the Time Conversions**
- **Backup**



Time Systems and Kernels

Navigation and Ancillary Information Facility

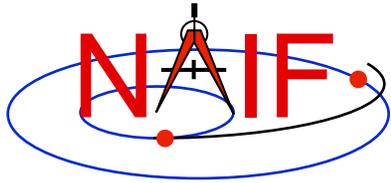
- Time inputs and outputs in users' SPICE-based programs are usually **strings** representing epochs in these three time systems:
 - Coordinated Universal Time (**UTC**)
 - Spacecraft Clock (**SCLK**)
 - Ephemeris Time (**ET**, also referred to as Barycentric Dynamical Time, **TDB**)
- Time stamps in kernel files, and time inputs and outputs to SPICE routines reading kernel data and computing derived geometry, are double precision **numbers** representing epochs in these two time systems:
 - Numeric Ephemeris Time (TDB), expressed as ephemeris seconds past J2000
 - Encoded Spacecraft Clock, expressed as clock ticks since the clock start
- SPICE provides routines to perform conversions between string and numeric times using data from these two kernels:
 - Leapseconds Kernel (LSK) containing data for UTC \Leftrightarrow ET conversion
 - Spacecraft Clock Kernel (SCLK) containing data for ET \Leftrightarrow SCLK conversion



Converting Time Strings

Navigation and Ancillary Information Facility

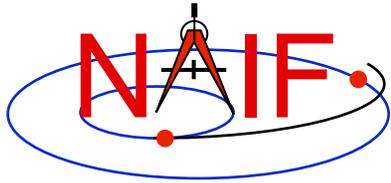
- **UTC, TDB, or TDT (TT) String to numeric Ephemeris Time**
 - **STR2ET (*string*, *ET*)**
 - » **Converts virtually any time string, excepting SCLK. For example:**
 - '1996-12-18T12:28:28' '1978/03/12 23:28:59.29' 'Mar 2, 1993 11:18:17.287 p.m. PDT'
 - '1995-008T18:28:12' '1993-321//12:28:28.287'
 - '2451515.2981 JD' 'jd 2451700.05 TDB'
 - '1988-08-13, 12:29:48 TDB' '1992 June 13, 12:29:48 TDT'
 - » **Requires the LSK kernel**
- **Spacecraft Clock String to numeric Ephemeris Time**
 - **SCS2E (*scid*, *string*, *ET*)**
 - » **Converts SCLK strings consistent with SCLK parameters. For example:**
 - '5/65439:18:513' (VGR1) '946814430.172' (MRO) '1/0344476949-27365' (MSL)
 - » **Requires a SCLK kernel, and usually the LSK kernel (to handle a very small ~2 msec, difference between TDB and TT)**
- **Spacecraft Clock String to Encoded Spacecraft Clock (used in the mid-level interfaces of the C-kernel system)**
 - **SCENCD (*scid*, *string*, *SCLKDP*)**
 - » **Requires a SCLK kernel**



Converting Numeric Times - 1

Navigation and Ancillary Information Facility

- **Numeric Ephemeris Time to Calendar, DOY or Julian Date UTC, TDB, or TDT String**
 - **TIMOUT (*et*, *fmtpic*, **STRING**)**
 - » ***fmtpic*** is an output time string format specification, giving the user great flexibility in setting the appearance of the output time string and the time system used (UTC, TDB, TDT).
 - See a backup slide for examples of format pictures to produce a variety of output time strings
 - See the TIMOUT header for complete format picture syntax
 - The module TPICTR may be useful in constructing a format picture specification from a sample time string
 - » **Requires LSK Kernel**
 - **ETCAL (*et*, **STRING**)**
 - » **STRING**, fixed format ephemeris calendar time string, for example
'2000 JAN 01 12:16:40.123'
 - » **No LSK Kernel is required**



Converting Numeric Times - 2

Navigation and Ancillary Information Facility

- **Numeric Ephemeris Time to Spacecraft Clock String**

- SCE2S (*scid*, *et*, SCLKCH)

- » Requires both LSK and SCLK kernels

- » Output SCLK string examples:

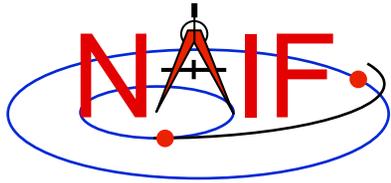
- `'1/1487147147.203'` (Cassini, MGS)

- `'1/05812:00:001'` (Voyager 1 and 2)

- **Encoded Spacecraft Clock to Spacecraft Clock String**

- SCDECD (*scid*, *sclmdp*, SCLKCH)

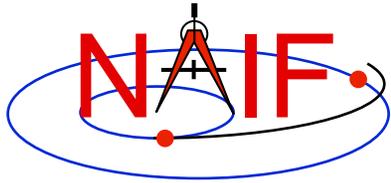
- » Requires only a SCLK kernel



Additional Time Conversions

Navigation and Ancillary Information Facility

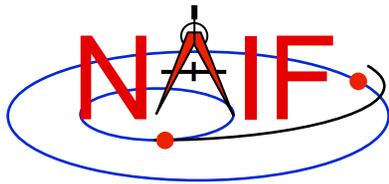
- **Conversion between uniform time systems – numeric representations of TDB(ET), TAI, TDT, JDTDB(JED), JDTDT**
 - **Return value** = UNITIM (*epoch*, *insys*, *outsys*)
 - » Requires LSK kernel
- **Numeric Ephemeris Time to Local Solar Time String**
 - ET2LST(*et*, *body*, *long*, *type*, *HR*, *MN*, *SC*, *TIME*, *AMPM*)
 - » Requires SPK (to compute *body* position relative to the Sun) and PCK (to compute *body* rotation) kernels
- **Numeric Ephemeris Time to planetocentric longitude of the Sun (Ls)**
 - **Return value** = LSPCN (*body*, *et*, *abcorr*)
 - » While Ls is not a time system, it is frequently used to determine *body* season for a given epoch
 - Spring – 0° Ls; Summer – 90° Ls; Autumn – 180° Ls; Winter – 270° Ls
 - » Requires SPK and PCK kernels



Conversions of Future Times

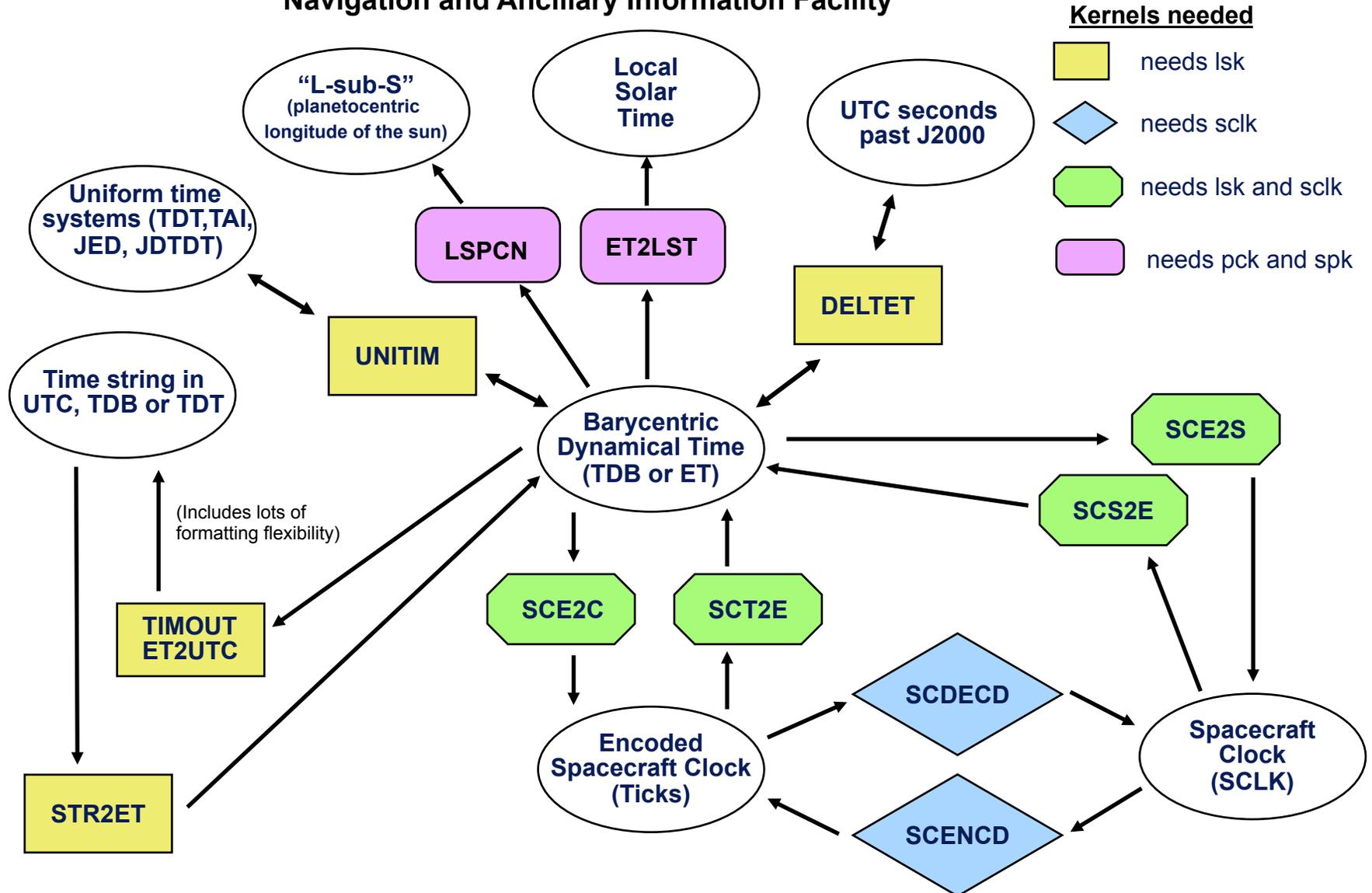
Navigation and Ancillary Information Facility

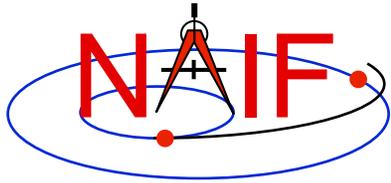
- **Caution: the long-term future relationships between UTC, TDB, and SCLK time systems cannot be accurately predicted due to:**
 - Leapseconds
 - Spacecraft clock drift



Principal Time System Interfaces

Navigation and Ancillary Information Facility

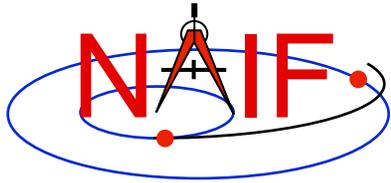




Backup

Navigation and Ancillary Information Facility

- **Customizing the Time System**
- **Use of time format picture**



Customizing the Time System

Navigation and Ancillary Information Facility

- **Defaults**
 - Two digit year (a bad idea but supported):1969-2068
 - Time System:
 - » For inputs and outputs: UTC
 - » For internal computations: TDB (ET)
 - Calendar: Gregorian
- **Adjustments**
 - The one hundred year interval to which two digit years belong may be set. For example 1980-2079
 - Time Systems: UTC, TDB, TT (Terrestrial Time)
 - Calendar: Gregorian, Julian, or Mixed.
- **See the TIMDEF module header and *Time Required Reading* (time.req) for details**



Use of Time Format Picture

Navigation and Ancillary Information Facility

Example Time Strings and the Corresponding Format Pictures

Common Time Strings

Format Picture Used (*fmtpic*)

1999-03-21T12:28:29.702

YYYY-MM-DDTHR:MN:SC.###

1999-283T12:29:33

YYYY-DOYTHR:MN:SC ::RND

1999-01-12, 12:00:01.342 TDB

YYYY-MM-DD, HR:MN:SC.### ::TDB TDB

2450297.19942145 JD TDB

JULIAND.##### ::TDB JD TDB

Less Common Time Strings

Format Picture Used (*fmtpic*)

465 B.C. Jan 12 03:15:23 p.m.

YYYY ERA Mon DD AP:MN:SC ampm

04:28:55 A.M. June 12, 1982

AP:MN:SC AMPM Month DD, YYYY

Thursday November 04, 1999

Weekday Month DD, YYYY

DEC 31, 15:59:60.12 1998 (PST)

MON DD, HR:MN:SC YYYY (PST)::UTC-8