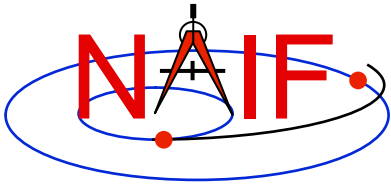


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Navigation and Ancillary Information Facility

# Time Conversion and Time Formats

March 2010

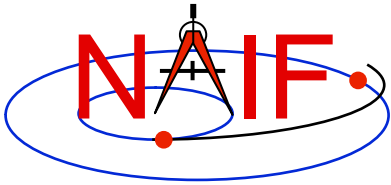


# Topics

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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**

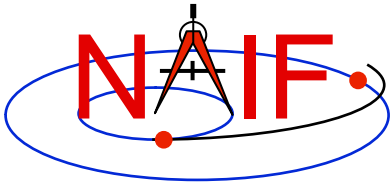


# Time Systems and Kernels

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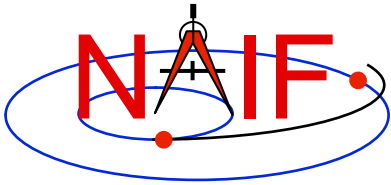
- Time inputs and outputs in users' SPICE-based programs are usually **strings** representing epochs in these three time systems:
  - Coordinated Universal Time (**UTC**)
  - Spacecraft Clock (**SCLK**)
  - Ephemeris Time (**ET**, also referred to as Barycentric Dynamical Time, **TDB**)
- Independent time variable in kernels, 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
- **Caution: the long-term future relationships between UTC, TDB, and SCLK time systems cannot be accurately predicted**



# 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 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)
    - » The "LSK and SCLK" tutorial discusses SCLK string formats in detail
    - » Requires SCLK kernel, and usually 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 only SCLK kernel

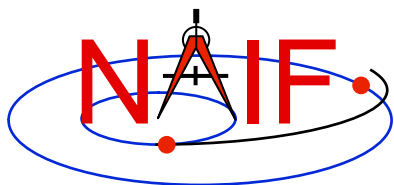


# Converting Numeric Times - 1

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Navigation and Ancillary Information Facility

- **Numeric Ephemeris Time to Calendar, DOY or Julian Date UTC, TDB, or TDT String**
  - **TIMOUT ( *et*, *fmpic*, **STRING** )**
    - » ***fmpic*** 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 next 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**



# Use of Format Picture

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## 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

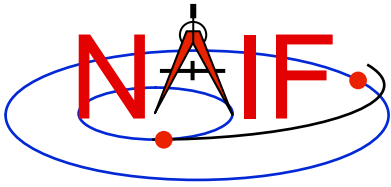
AP:MN:SC AMPM Month DD, YYYY

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

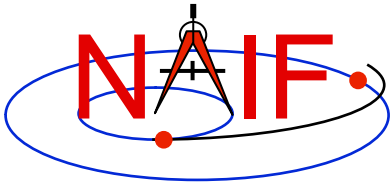


# Converting Numeric Times - 2

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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 SCLK kernel

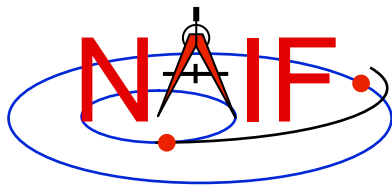


# Additional Time Conversions

Navigation and Ancillary Information Facility

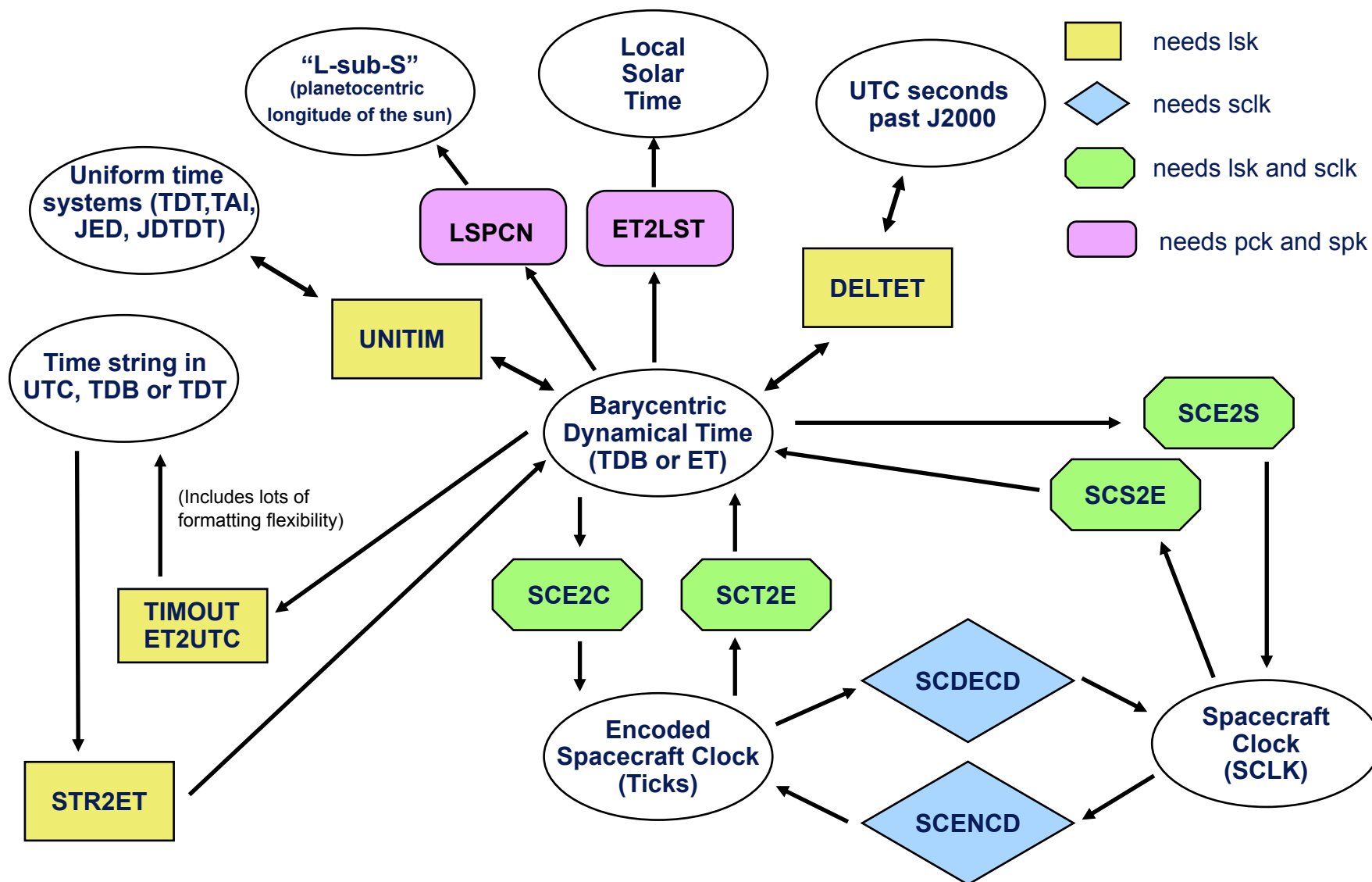
- **Conversion between uniform time systems – numeric representations of TDB(ET), TAI, TDT, JDTDB(JED), JDTDT**
  - **Return value** = UNITIM ( *epoch*, *insys*, *outsys* )
    - » Requires LSK kernel
- **Numeric Ephemeris Time to Local Solar Time String**
  - ET2LST( *et*, *body*, *long*, *type*, *HR*, *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

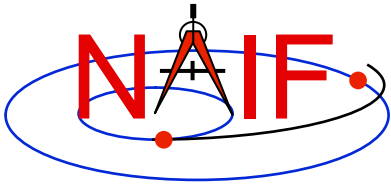




# Principal Time System Interfaces

Navigation and Ancillary Information Facility



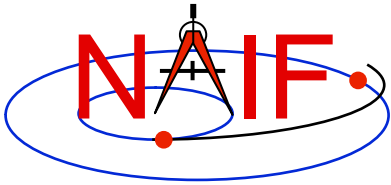


# Backup

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Navigation and Ancillary Information Facility

- Customizing the Time System



# Customizing the Time System

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Navigation and Ancillary Information Facility

- **Defaults**
  - Two digit year (a bad idea but supported): 1969-2068
  - Time System: UTC
  - 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**