Time Conversion and
Time Formats

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• Time inputs to and outputs from user’s programs are usually strings representing epochs in these three time systems:
  – Ephemeris Time (ET, also referred to as Barycentric Dynamical Time, TDB)
  – Coordinated Universal Time (UTC). This is the default for calendar strings.
  – Spacecraft Clock (SCLK)

• Time stamps in kernel files, and time inputs to and outputs from 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
    » J2000 = 2000 Jan 1 12:00:00 TDB
  – Encoded Spacecraft Clock, expressed as clock ticks since the clock start

• SPICE provides routines to convert between these string and numeric representations.

• A time string used as an argument in a SPICE API must be provided in quotes.
  – Fortran, Matlab, IDL and Python: use single quotes
  – C and JNI: use double quotes
Converting Time Strings

UTC, TDB, or TDT (TT) String to numeric Ephemeris Time

- **STR2ET** (string, ET)
  - Converts virtually any time string format known to the SPICE Time subsystem, excepting SCLK.
  - Examples of acceptable string inputs:
    - ‘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’
    - ‘2451515.2981 JD’
    - ‘jd 2451700.05 TDB’
    - ‘1988-08-13, 12:29:48 TDB’
  - Requires the LSK kernel

Spacecraft Clock String to numeric Ephemeris Time

- **SCS2E** (scid, string, ET)
  - Converts SCLK strings consistent with SCLK parameters.
  - Examples of acceptable clock string inputs:
    - ‘5/65439:18:513’ (VGR1)
    - ‘946814430.172’ (MRO)
    - ‘1/0344476949-27365’ (MSL)
  - Requires a SCLK kernel and the LSK kernel

These example inputs all use the single quote required by Fortran, IDL MATLAB and Python APIs. Use double quotes for C and JNI APIs.
Converting Numeric Times

- Numeric Ephemeris Time to a string, where the format is Calendar, DOY or Julian Date, and the time system is UTC, TDB or TDT
  - 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 the 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

- Numeric Ephemeris Time to Spacecraft Clock String
  - SCE2S(scid, et, SCLKCH )
    » Requires the LSK and a SCLK kernel
    » Output SCLK string examples:
      1/05812:00:001 (Voyager 1 and 2)
      1/1487147147.203 (Cassini, MRO)
      1/0101519975.65186 (MEX, VEX, Rosetta)
## Example Time Strings and the Corresponding Format Pictures

### Common Time Strings

<table>
<thead>
<tr>
<th>Time String</th>
<th>Format Picture Used (\textit{fmtpic})</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-01-12, 12:00:01.342 TDB</td>
<td>YYYY-MM-DD, HR:MN:SC.### ::TDB TDB</td>
</tr>
<tr>
<td>2450297.19942145 JD TDB</td>
<td>JULIAND.###### ::TDB JD TDB</td>
</tr>
</tbody>
</table>

### Less Common Time Strings

<table>
<thead>
<tr>
<th>Time String</th>
<th>Format Picture Used (\textit{fmtpic})</th>
</tr>
</thead>
<tbody>
<tr>
<td>465 B.C. Jan 12 03:15:23 p.m.</td>
<td>YYYY ERA Mon DD AP:MN:SC ampm</td>
</tr>
<tr>
<td>04:28:55 A.M. June 12, 1982</td>
<td>AP:MN:SC AMPM Month DD, YYYY</td>
</tr>
<tr>
<td>Thursday November 04, 1999</td>
<td>Weekday Month DD, YYYY</td>
</tr>
<tr>
<td>DEC 31, 15:59:60.12 1998 (PST)</td>
<td>MON DD, HR:MN:SC.## YYYY (PST) ::UTC-8</td>
</tr>
</tbody>
</table>
Additional Time Conversions

• 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 ($Ls$)
  - $LS = LSPCN(\ body, \ et, \ abcorr )$
    » While $Ls$ is not a time system, it is frequently used to determine $body$ season for a given epoch
      • $LS = 0^\circ$, Spring
      • $LS = 90^\circ$, Summer
      • $LS = 180^\circ$, Autumn
      • $LS = 270^\circ$, Winter
    » The $Ls$ calculation requires SPK and PCK kernels

For the northern hemisphere
Principal Time System Interfaces

Navigation and Ancillary Information Facility

- **Barycentric Dynamical Time (TDB or ET)**
  - UTC seconds past J2000
  - ENCODED
  - SCE2C
  - SCT2E
  - SCDECD
  - SCENCED

- **Local Solar Time**
  - “L-sub-S” (planetocentric longitude of the sun)
  - UNITIM
  - ET2LST

- **Uniform time systems (TDT, TAI, JED, JDTDT)**
  - Time string in UTC, TDB or TDT

- **Spacecraft Clock (SCLK)**
  - SCE2S
  - SCS2E

- **ETCAL**
  - TDB string in calendar format

- **STR2ET**

- **TIMOUT**

- **ET2UTC**

Kernels needed:
- Needs lsk
- Needs sclk
- Needs lsk and sclk
- Needs pck and spk
- Needs no kernels

= Time APIs mentioned in this tutorial