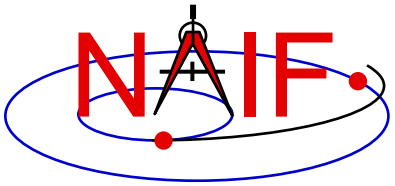

Frames Kernel
FK

June 2019

(Class version)

Introduction

What does the SPICE FRAMES subsystem do?

1. It establishes relationships between reference frames used in geometry computations – it "chains frames together" in a frame tree.

2. It connects frames with the sources of their orientation specifications.
   - In some cases those data are included in the Frames kernel itself.

Based on these relationships and the orientation source information, the frames subsystem allows SPICE software to compute rotations between neighboring frames in the frame tree, and to combine these rotations in the right order, thus providing an ability to compute the orientation of any frame in the tree with respect to any other frame in the tree, at any time.

Sample Frame Tree

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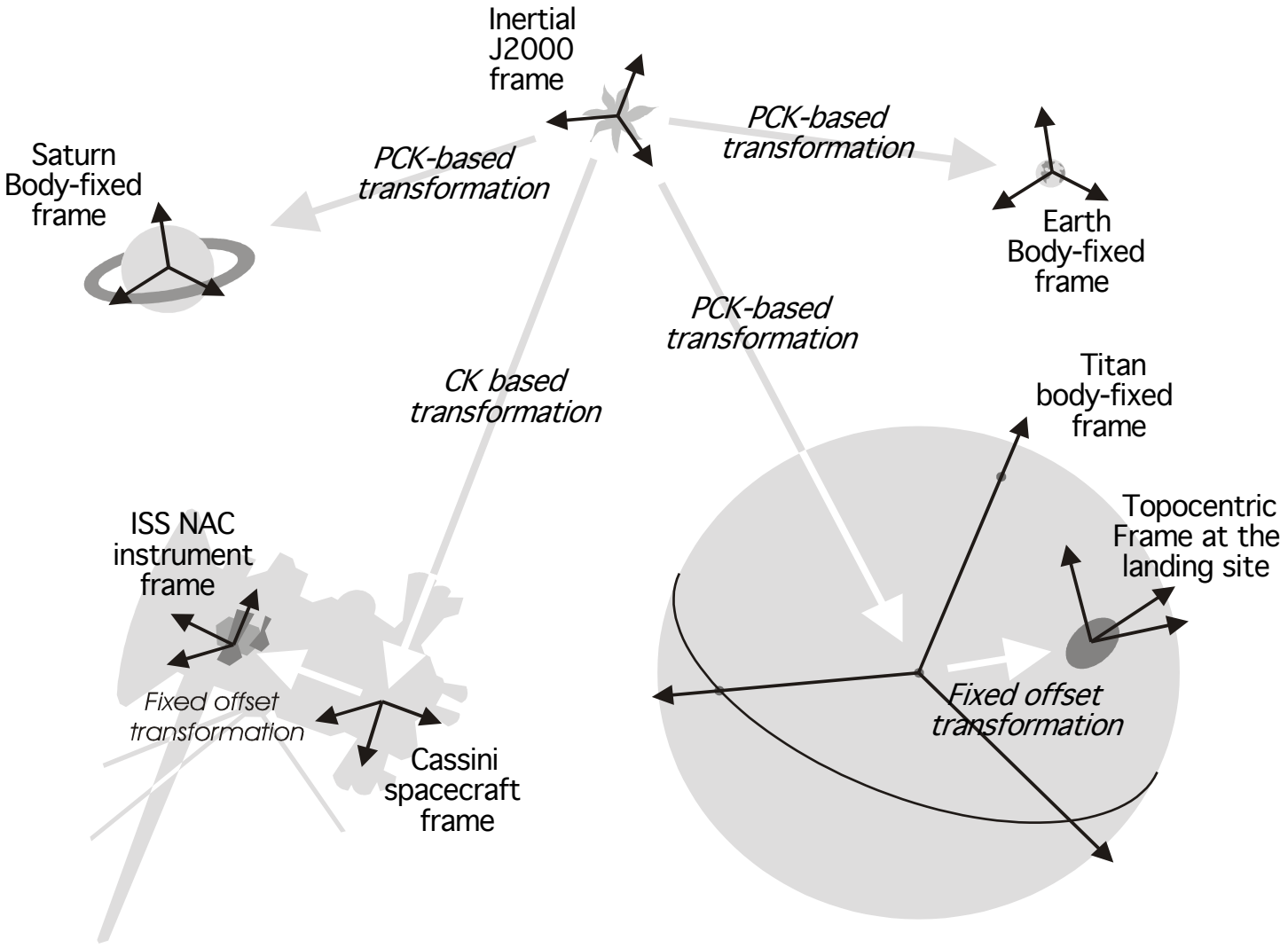

Frame Classes and Examples

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Frame class	***Frame Examples (with real frame names)***
Inertial	• Earth Equator/Equinox of Epoch (ICRF, also called J2000 in SPICE) • Planet Equator/Equinox of Epoch (MARSIAU, ...) • Ecliptic of Epoch (ECLIPJ2000, ...)
Body-fixed	• Solar system body IAU frames (IAU_MARS, IAU_SATURN, …) • High accuracy Earth frames (ITRF93, …) • High accuracy Moon frames (MOON_PA, MOON_ME)
CK-based	• Spacecraft (CASSINI_SC_BUS, …) • Moving parts of an instrument (MPL_RA_JOINT1, ...)
Fixed Offset	• Instrument mounting alignment (CASSINI_ISS_NAC, …) • Topocentric (DSS-14_TOPO, …)
Dynamic	• Geomagnetic • Geocentric Solar Equatorial • Planet true equator and equinox of date

Frames Kernel File Overview

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- Uses the SPICE text kernel standards
- Loaded using the FURNSH routine
- Usually contains comprehensive information about the defined frames in the comment section(s) of the file
- Contains frame definition information consisting of a set of assignments in the data sections of the file. Below are examples defining a CK-based frame and a fixed-offset frame.

CK-based Frame Example

```
FRAME_DAWN_SPACECRAFT   = -203000
FRAME_-203000_NAME      = 'DAWN_SPACECRAFT'
FRAME_-203000_CLASS     =  3
FRAME_-203000_CLASS_ID  = -203000
FRAME_-203000_CENTER    = -203
CK_-203000_SCLK         = -203
CK_-203000_SPK          = -203
```

Fixed-offset Frame Example

```
FRAME_DAWN_FC1             =  -203110
FRAME_-203110_NAME         = 'DAWN_FC1'
FRAME_-203110_CLASS        =  4
FRAME_-203110_CLASS_ID     =  -203110
FRAME_-203110_CENTER       =  -203
TKFRAME_-203110_RELATIVE   = 'DAWN_SPACECRAFT'
TKFRAME_-203110_SPEC       = 'ANGLES'
TKFRAME_-203110_UNITS      = 'DEGREES'
TKFRAME_-203110_ANGLES     = ( 0.0, 0.0, 0.0 )
TKFRAME_-203110_AXES       = ( 1,   2,   3   )
```

- See the on-line FK tutorial for details about these assignments

CK-Based Frames "Must Know"

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These are VERY IMPORTANT points you must understand!

- **The frames routines (SPKEZR, SPKPOS, SXFORM, PXFORM) all read CK files using tolerance = 0**
  - **For discrete CKs (Type 1) the orientation of a CK-based frame will be computed only if the time provided to a Frames routine exactly matches one of the times stored in the CK file; otherwise an error will be signaled.**
  - **For continuous CKs (Types 2 – 6) the orientation of a CK-based frame will be computed only if the time provided to a Frames routine falls within one of the interpolation intervals defined by the CK file; otherwise an error will be signaled.**
- **Using SPKEZR or SXFORM requires CKs that contain angular rate data**
  - **Since these routines return a state vector (6x1) or state transformation matrix (6x6), angular rate must be present in the CK in order to compute vectors and matrices; if angular rate is not present an error will be signaled.**
  - **SPKPOS and PXFORM, which return a position vector (3x1) and a position transformation matrix (3x3) respectively, can be used when angular rate data are NOT present in a CK.**
- **Ephemeris time input to Frames routines is converted to SCLK to access CKs**
  - **SCLK and LSK kernels must be loaded to support this conversion.**
  - **The SCLK ID is specified in one of the CK frame definition keywords; if not, it's assumed to be the Frame ID divided by 1000.**

Frame Tree Example: ASPERA Instrument on Mars Express

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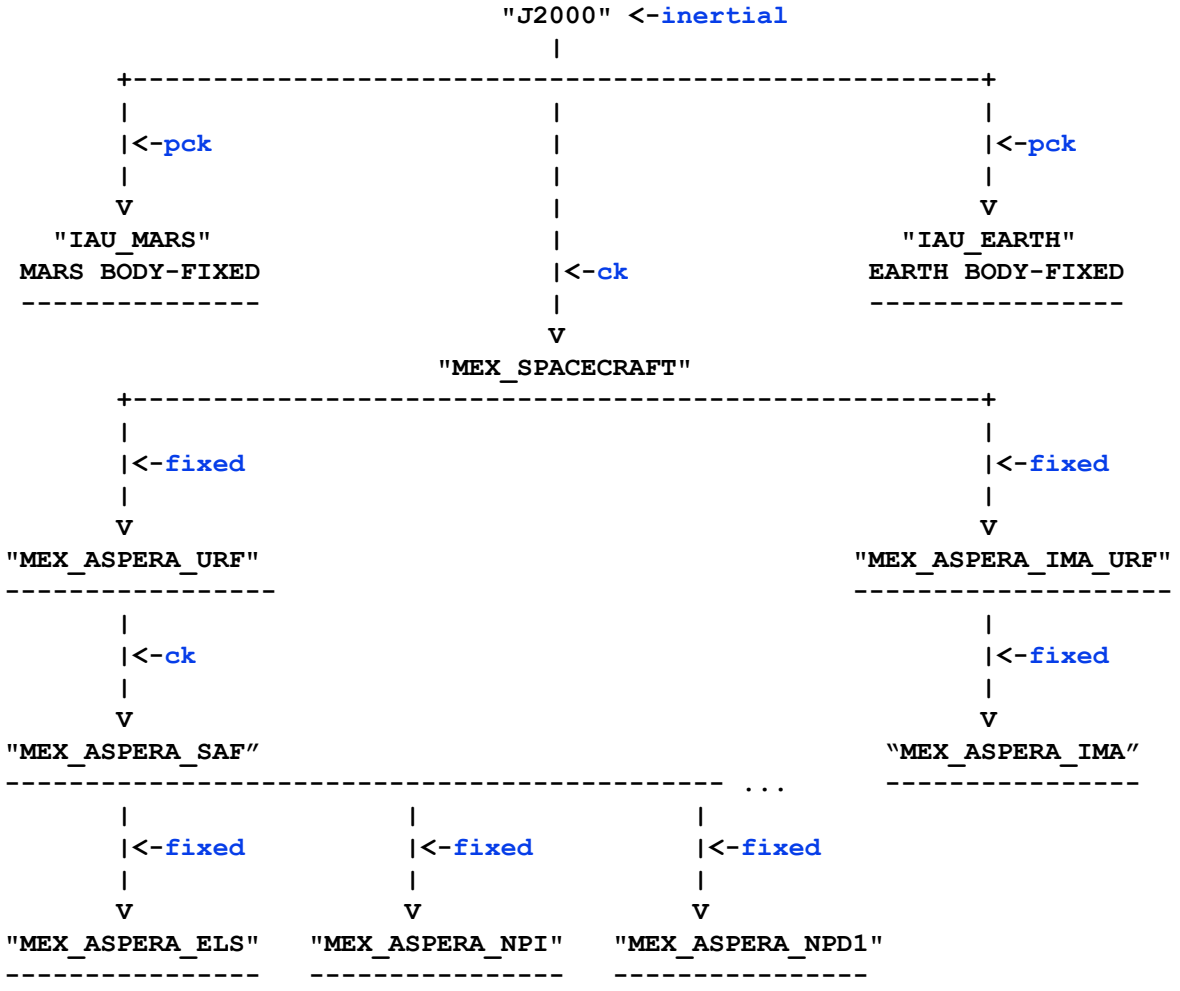

Blue text indicates frame class