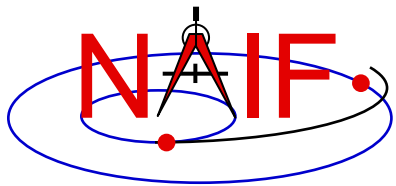# Frames Kernel
FK

January 2017
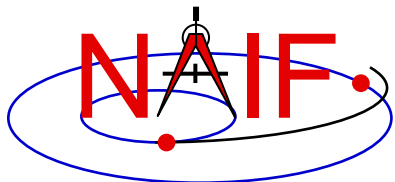
Navigation and Ancillary Information Facility

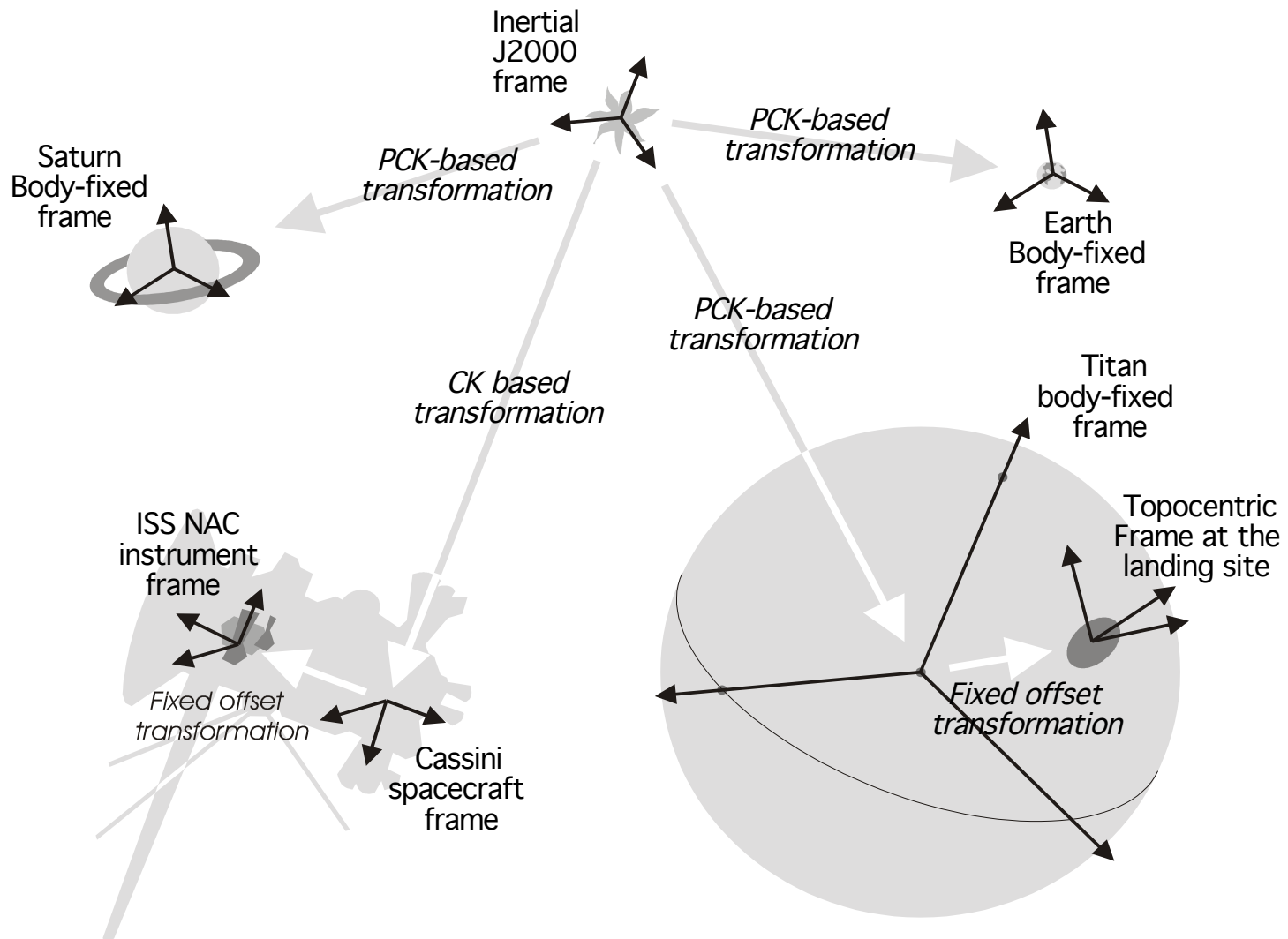## What does the FRAMES subsystem do?

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.**

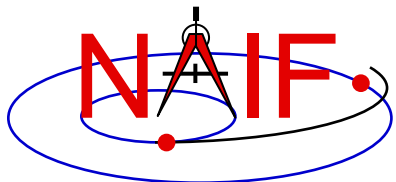   –   **In some cases those data are included in the Frames kernel itself.**

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

Inertial
J2000
frame

Saturn
Body-fixed
frame

*PCK-based
transformation*

*PCK-based
transformation*

Earth
Body-fixed
frame

*PCK-based
transformation*

Titan
body-fixed
frame

*CK based
transformation*

Topocentric
Frame at the
landing site

ISS NAC
instrument
frame

*Fixed offset
transformation*

*Fixed offset
transformation*

Cassini
spacecraft
frame

Frame Names

- **Frame names are character strings used to identify frames to Toolkit APIs**

- **Examples of frame names:**
  - **J2000**
  - **IAU_MARS**
  - **DAWN_SPACECRAFT**
  - **MEX_OMEGA**
  - **DSS-14_TOPO**
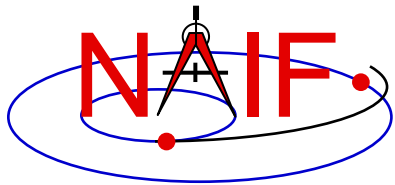
Examples of Frame Classes

| _Frame class_	_Examples_
Inertial	• Earth Equator/Equinox of Epoch (J2000, …) • 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
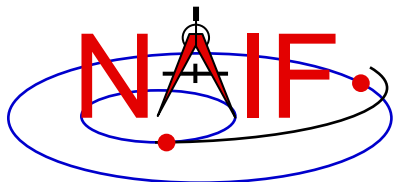
Frame class	*Frame Defined in:*	*Orientation data provided in:*
Inertial	Toolkit software	Toolkit software
Body-fixed	Toolkit software or FK	PCK
CK based	FK	CK
Fixed offset	FK	FK
Dynamic	FK	Toolkit software, or computed using FK, SPK, CK, and/or PCK
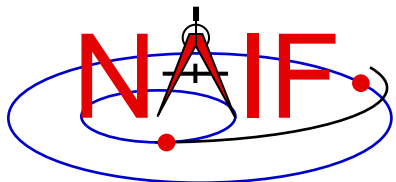
Navigation and Ancillary Information Facility

- **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 keywords 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   )
```

- **These examples are discussed in detail in the next few slides**