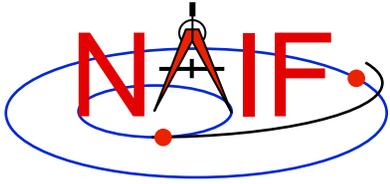


Navigation and Ancillary Information Facility

# **IDs and Names**

## **for Physical Objects and Reference Frames**

**April 2016**



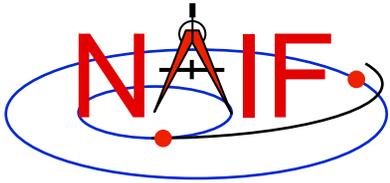
# Topics

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Navigation and Ancillary Information Facility

- **Summary of naming/numbering schemes used in SPICE**
- **Naming/numbering of physical objects**
- **Naming/numbering of reference frames**
- **Connection between the schemes**

**Caution: users sometimes confuse the ID assigned to an object and the ID(s) assigned to reference frame(s) associated with that object.**

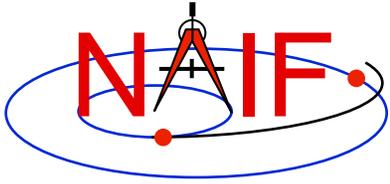


# Overview - 1

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- **SPICE uses IDs and names to identify:**
  - physical objects
  - reference frames
- **An ID is an integer number**
- **A name is a text string**
  
- **IDs are used primarily as data identifiers inside SPICE kernels**
- **Names are used primarily as input and output arguments in SPICE software interfaces (APIs)**

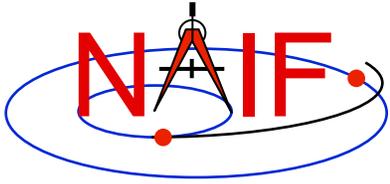


## Overview - 2

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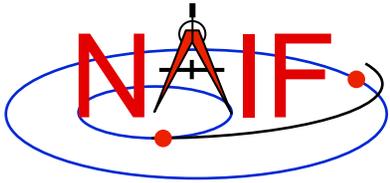
Navigation and Ancillary Information Facility

- **The schemes used for assigning IDs and names to physical objects and to reference frames are **independent!****
  - This means that, in general, SPICE does not make any assumptions about reference frame names and IDs based on the physical object names and IDs
    - » There are some exceptions; they will be mentioned later



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# **Names and IDs associated with Physical Objects**

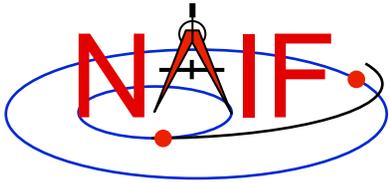


# Physical Object IDs and Names

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Navigation and Ancillary Information Facility

- **A single ID is assigned to a **physical object** of any of the following types:**
  - Natural bodies -- planets, satellites, comets, asteroids
  - Artificial bodies -- spacecraft, spacecraft structures, science instruments, individual detectors within science instruments, DSN stations
  - Any other point, the location of which can be known within the SPICE context
    - » Barycenters of solar system and planetary systems, landing sites, corners of solar arrays, focal points of antennas, etc.
- **One or more names can be assigned to that object**
- **Within SPICE software there is a 1-to-MANY mapping between the ID and the object's name(s)**
  - On input, the names are treated as synonyms
  - On output, the name that was last associated with the ID is returned

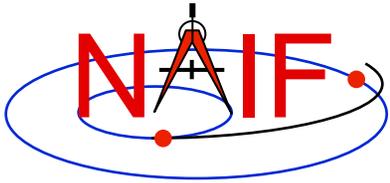


# Object IDs: Where Used? - 1

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Navigation and Ancillary Information Facility

- **Physical object IDs** are used in kernels as data identifiers:
  - » in SPKs -- to identify a body and its center of motion
  - » in text PCKs -- in keywords associated with a body
  - » in IKs -- in keywords associated with an instrument
  - » in FKs -- to specify the center used in computing light-time correction, and to identify the body in PCK-based frames
  - » in FKs -- to identify target and observer in dynamic frame specifications
  - » in SCLKs -- normally the SCLK ID used in keywords is the negative of the spacecraft's ID (thus is a positive integer)
  - » ... and more...

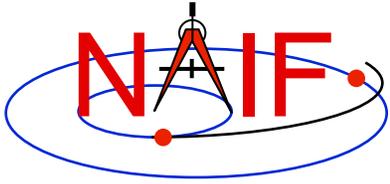


## Object IDs: Where Used? - 2

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Navigation and Ancillary Information Facility

- Physical object **IDs** are used in some APIs as input and/or output arguments:
  - » in older SPK routines -- SPKEZ, SPKEZP, SPKGEO, ...
  - » in older derived geometry routines -- ET2LST, ...
  - » in older PCK routines -- BODVAR, BODMAT, ...
  - » in IK routines -- GETFOV, indirectly in G\*POOL, ...
  - » in SCLK routines -- SCE2C, SCT2E, ...
  - » in coverage routines -- SPKOBJ, SPKCOV, CKOBJ, CKCOV
  - » ... and more...

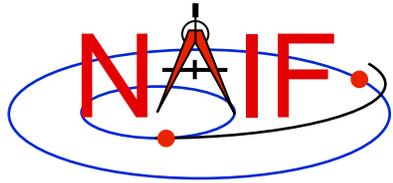


# Object Names – Where Used?

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Navigation and Ancillary Information Facility

- Physical object **names** are used in the high-level user APIs as input and/or output arguments:
  - » in newer SPK routines -- SPKEZR, SPKPOS
  - » in newer derived geometry routines -- SINCPT, ILUMIN, SUBPNT, SUBSLR, ...
  - » in newer PCK routines -- BODVRD, ...
- Physical object **names** are **not** used as data identifiers within kernels

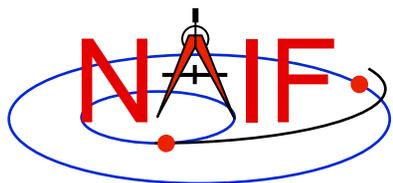


# Object IDs and Names – Where Defined?

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Navigation and Ancillary Information Facility

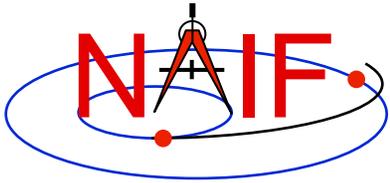
- **Physical object name-to-ID mappings used by SPICE may be defined in two places**
  - **Built into Toolkit software:** hard-coded in source code
    - » See `NAIF_IDS.REQ` for a complete listing of these built-in (default) assignments
  - **In text kernels**
    - » Normally used to define name/ID mappings for instruments, their subsystems/detectors and spacecraft structures
      - See comments and the actual data sections in a text kernel for the complete listing of the names/IDs defined in that kernel
    - » These assignments exist most often in FKs (e.g. MER, MEX, JUNO, MSL), sometimes in IKs (e.g. CASSINI, MGS), but can be placed in any text kernel
  - Mappings defined in text kernels take precedence over those defined in Toolkit source code



## Examples of Object IDs and Names Spacecraft and Ground Stations

Navigation and Ancillary Information Facility

- **Spacecraft (negative numbers)**
  - Within NASA, this number is generally the negative of the numeric ID assigned by the NASA control authority at GSFC
    - -6                   ‘PIONEER-6’, ‘P6’
    - -64                  ‘OSIRIS-REX’, ‘ORX’
    - -74                  ‘MARS RECON ORBITER’, ‘MRO’
    - -82                  ‘CASSINI’, ‘CAS’
    - ...
  - Unfortunately sometimes NASA re-uses a number
    - » This will happen with increasing frequency in the future
    - » Probably a new scheme is needed
- **DSN ground stations (399000 + station number)**
  - 399005           ‘DSS-05’
  - ...
  - 399066           ‘DSS-66’
- **Non-DSN stations (398000 + some integer 0 to 999)**
  - 398990           ‘NEW\_NORCIA’
  - ...

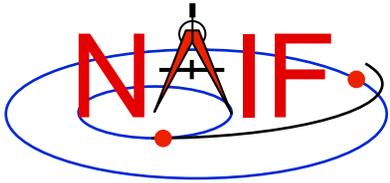


# Examples of Object IDs and Names Planets\*

Navigation and Ancillary Information Facility

- **Sun and Solar System Barycenter (10 and 0)**
  - 0 'SOLAR SYSTEM BARYCENTER', 'SSB'
  - 10 'SUN'
- **Planetary system barycenters (numbers from 1 to 9)**
  - 1 'MERCURY BARYCENTER'
  - 2 'VENUS BARYCENTER'
  - 3 'EARTH MOON BARYCENTER', 'EMB', ...
  - 4 'MARS BARYCENTER'
  - ...
  - 9 'PLUTO BARYCENTER'
- **Planet-only mass centers (planet barycenter ID \* 100 + 99)**
  - 199 'MERCURY'
  - 299 'VENUS'
  - 399 'EARTH'
  - 499 'MARS'
  - ...
  - 999 'PLUTO'

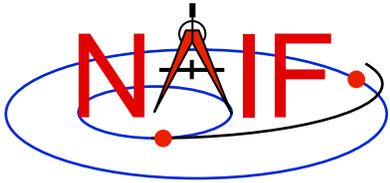
\* Within the SPICE system Pluto is still treated as a planet.



## Examples of Object IDs and Names Satellites

Navigation and Ancillary Information Facility

- **Satellites (planet barycenter ID\*100 + number <1... 98>)**
  - 301 'MOON'
  - 401 'PHOBOS'
  - 402 'DEIMOS'
  - 501 'IO'
  - ...
  - 901 'CHARON', '1978P1'

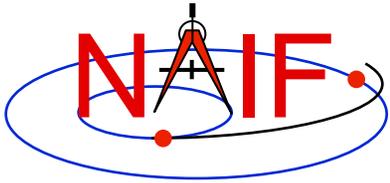


## Examples of Object IDs and Names Comets & Asteroids

Navigation and Ancillary Information Facility

- **Periodic Comets (1000000 + sequence number\*)**
    - 1000001            'ARENDA'
    - 1000002            'ARENDA-REGAUX'
    - ...
    - 1000032            'HALE-BOPP'
  - **Numbered Asteroids (2000000 + IAU asteroid number)**
    - 2000001            'CERES'
    - 2000004            'VESTA'
    - ...
    - 2009969            'BRAILLE', '1992KD'
- There are three exceptions, for Gaspra, Ida and Dactyl
- **One can search on SPK ID or name and find the other item here:**
    - <http://ssd.jpl.nasa.gov/sbdb.cgi>

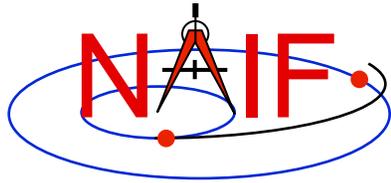
\*Sequence number is assigned by JPL's Solar System Dynamics Group



## Examples of Object IDs and Names Instruments

Navigation and Ancillary Information Facility

- **Science Instruments (s/c ID\*1000 - instrument number)**
  - An instrument number should be picked for EVERY instrument, instrument subsystem or detector, or spacecraft structure, the parameters for which are to be stored in IKs, or the location of which is to be stored in SPKs
  - Instrument numbers are picked from the range 0...999. The only requirement is that they must be unique within each mission
    - ...
    - -82760      'CASSINI\_MIMI\_CHEMS'
    - -82761      'CASSINI\_MIMI\_INCA'
    - -82762      'CASSINI\_MIMI\_LEMMS1'
    - -82763      'CASSINI\_MIMI\_LEMMS2'
    - ...
    - -82001      'CASSINI\_SRU-A'
    - -82002      'CASSINI\_SRU-B'
    - -82008      'CASSINI\_SRU-A\_RAD'
    - -82009      'CASSINI\_SRU-B\_RAD'
    - ...



# Object IDs/Names -- Mapping APIs

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Navigation and Ancillary Information Facility

- **SPICE provides two routines to map physical object IDs to names, and vice versa**

- To get the ID for a given physical object name:

**CALL BODN2C ( NAME, ID, FOUND )**

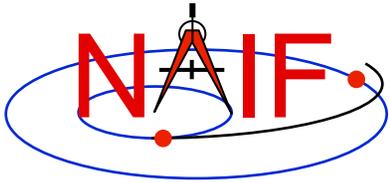
**CALL BODS2C ( NAME, ID, FOUND )**

(This is a more general version as compared to BODN2C. Use this one.)

- To get the name for a given physical object ID:

**CALL BODC2N( ID, NAME, FOUND )**

- If the “FOUND” flag returned by either of these routines comes back FALSE, then the input ID or name cannot be mapped



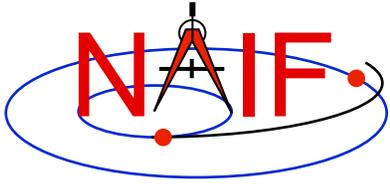
# Adding New or Additional Name-to-ID Mappings

Navigation and Ancillary Information Facility

- You may define new or additional name-to-ID mappings using **KEYWORD = VALUE** assignments inside any text kernel.
- For example, for a spacecraft:

```
NAIF_BODY_NAME      += ( 'my_spacecraft_name'      )  
NAIF_BODY_CODE      += (  my_spacecraft_ID        )
```

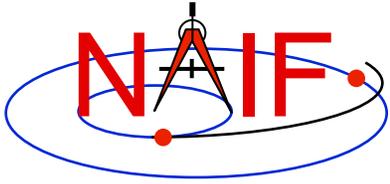
- See “NAIF\_IDs Required Reading” for details



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Navigation and Ancillary Information Facility

# **Names and IDs associated with Reference Frames**

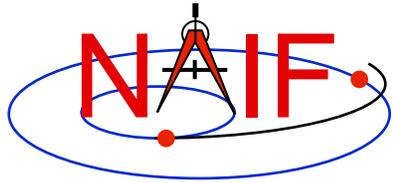


# Frame IDs and Names

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Navigation and Ancillary Information Facility

- A single ID and a single name are assigned to a **reference frame** of any of the following types
  - Inertial frames
  - Body-fixed frames
  - Spacecraft and instrument frames
  - Topocentric frames
  - Any other reference frame for which the orientation may be needed to compute observation geometry

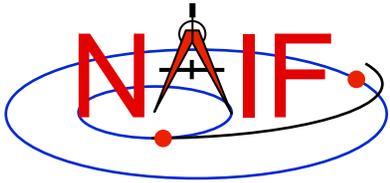


# Frame IDs and Names – Where Defined?

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Navigation and Ancillary Information Facility

- **The reference frame name-to-ID mappings used by the SPICE system are defined in two places**
  - **Built into the Toolkit:** hard-coded in source code
    - » For inertial frames
    - » For body-fixed frames defining the orientation for planets and most satellites
    - » See **FRAMES REQUIRED READING** for a complete listing
  - **In text kernels:** provided by **KEYWORD=VALUE** sets
    - » Almost always in FKs (MER, MEX, JUNO, MSL, ...)
    - » Very rarely in other kernels, but can be in any text kernel
      - (For example during operations MGS frames were defined in IKs and SCLK)
- **Unlike for physical objects, only one name may be directly associated with a **reference frame ID****

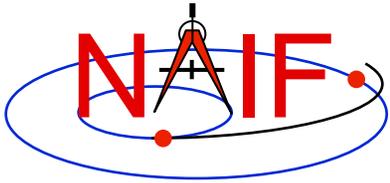


# Frame IDs and Names – Where Used?

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Navigation and Ancillary Information Facility

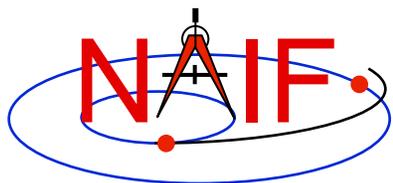
- Reference frame **IDs** are used in the following kernels as data identifiers
  - » in FKs -- to “glue” frame definition keywords together
  - » in SPKs -- to identify base reference frames
  - » in PCKs -- to identify base reference frames
  - » in CKs -- to identify base reference frames
  - Reference frame IDs are **not** used in as input and/or output arguments in any high level user APIs
- Reference frame **names** are used
  - as arguments in all high level APIs that require a reference frame to be specified as an input
    - » in derived geometry routines -- SINCPT, ILUMIN, SUBPNT, ...
    - » in frame transformation routines -- PXFORM, SXFORM
    - » In SPK routines -- SPKEZR, SPKPOS, ...
  - Frame names are **not** used as data identifiers within kernels



# Examples of Frame IDs and Names Inertial and Body-fixed

Navigation and Ancillary Information Facility

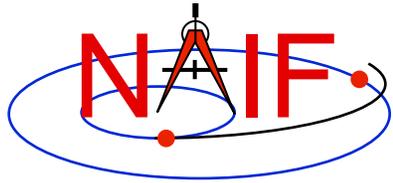
- **Inertial frames (positive integers starting at 1)**
  - 1            'J2000'
  - ...
  - 17           'ECLIPJ2000'
  - ...
- **Body-fixed frames (positive integers starting at 10001)**
  - ...
  - 10012        'IAU\_VENUS'
  - 10013        'IAU\_EARTH'
  - 10014        'IAU\_MARS'
  - ...
  - 10020        'IAU\_MOON'
  - ...
  - 13000        'ITRF93'
  - ...
- **NOTE: SPICE users would rarely if ever need to know or use the frame IDs; you use only the frame name**



# Examples of Frame IDs and Names Spacecraft and Instrument

Navigation and Ancillary Information Facility

- **IDs for frames associated with spacecraft, spacecraft structures, and instruments are usually defined as:**  
s/c ID times 1000 minus an arbitrary number
- **Examples based on Cassini:**
  - **Spacecraft frame (ID and name)**  
-82000 'CASSINI\_SC\_COORD'
  - **Spacecraft structure frame (ID and name)**  
-82001 'CASSINI\_SRU-A'
  - **Instrument frames (ID and name)**  
-82760 'CASSINI\_MIMI\_CHEMS'  
-82761 'CASSINI\_MIMI\_LEMMS\_INCA'  
-82762 'CASSINI\_MIMI\_LEMMS1'  
-82763 'CASSINI\_MIMI\_LEMMS2'  
-82764 'CASSINI\_MIMI\_LEMMS\_BASE'  
-83765 'CASSINI\_MIMI\_LEMMS\_ART'  
...
- **NOTE: SPICE users would rarely if ever need to know or use the frame IDs; you use only the frame name**



# Frame IDs/Names -- Mapping APIs

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Navigation and Ancillary Information Facility

- **SPICE provides two routines to convert (map) reference frame IDs to names, and vice versa**

- To get the ID for a given reference frame name:

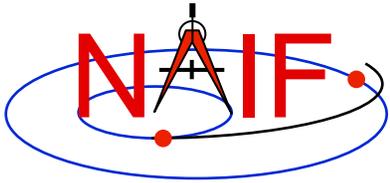
```
CALL NAMFRM( NAME, ID )
```

- To get the name for a given reference frame ID:

```
CALL FRMNAM( ID, NAME )
```

- If the ID or name cannot be mapped, these routines return zero and an empty/blank string respectively.

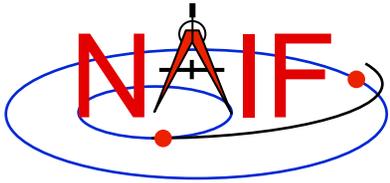
- **Note: SPICE users will rarely if ever need to call these routines**



# Connections between Objects and Frames

Navigation and Ancillary Information Facility

- Although physical object and reference frame naming/numbering schemes are independent, there is nevertheless much overlap in the way **objects** and **frames** are named and numbered
- This overlap is due to the following reasons
  - Conventions adopted over the course of SPICE implementation
    - » Example: PCK-based body-fixed frames for planets and satellites are named 'IAU\_<body name>'
      - However, the IDs of these **frames** have nothing in common with the IDs of the **objects** (bodies) for which these frames are defined
  - The need for the object and frame IDs to be unique
    - » For this reason both the instrument (**object**) IDs and the instrument **frame** IDs are derived from the ID of the spacecraft on which the instrument is flown
  - The need for the object and frame names to be meaningful
    - » For this reason the instrument **frame** names normally contain both the name of the spacecraft and the name of the instrument



# “Odd Ball” Cases

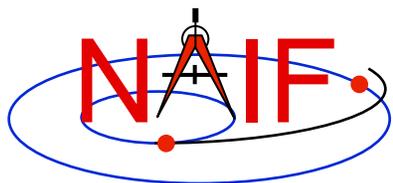
Navigation and Ancillary Information Facility

- **CK IDs**

- Historically IDs used in CKs are called structure IDs but in reality they are much more closely related to frames than to physical objects
- To find which frame is associated with a particular CK ID, look through the FK for a frame whose `_CLASS_ID` keyword is set to the CK ID
  - » For CK-based frames both the frame ID and frame `CLASS_ID` are set equal to the CK ID

- **SCLK IDs**

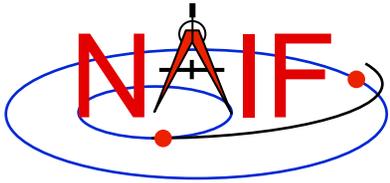
- Because most spacecraft have only one on-board clock, the SCLK ID of that clock is simply the negative of the spacecraft ID (thus a positive)
- Should a spacecraft carry more than one independent clock, unique SCLK IDs for these other clocks would be needed
  - » Normally the ID of an additional clock will be set to the ID of the instrument, of which that clock is a part
- SCLK IDs are used in SCLK APIs (must be provided by the user) and by the frames subsystem when it reads CKs to determine orientation of CK-based frames (gets SCLK ID from `CK_*_SCLK` keyword provided in the frame definition or computes it by dividing CK ID by 1000)



# Name/IDs Example -- CASSINI (1)

Navigation and Ancillary Information Facility

	<u>Objects</u> IDs/Names		<u>Frames</u> IDs/Names	
Ephemeris objects	10	'SUN'	1	'J2000'
	399	'EARTH'	10013	'IAU_EARTH'
	699	'SATURN'	10016	'IAU_SATURN'
	601	'MIMAS'	10039	'IAU_MIMAS'
	602	'ENCELADUS'	10040	'IAU_ENCELADUS'
Spacecraft and its structures	-82	'CASSINI'	-82000	'CASSINI_SC_COORD'
	-82001	'CASSINI_SRU-A'	-82001	'CASSINI_SRU-A'
CDA instrument	-82790	'CASSINI_CDA'	-82790	'CASSINI_CDA'
			-82791	'CASSINI_CDA_ART'
			-82792	'CASSINI_CDA_BASE'
CAPS instrument	-82820	'CASSINI_CAPS_IMS'	-82820	'CASSINI_CAPS'
	-82821	'CASSINI_CAPS_ELS'	-82821	'CASSINI_CAPS_ART'
	-82822	'CASSINI_CAPS_IBS_DT1'	-82822	'CASSINI_CAPS_BASE'
	-82823	'CASSINI_CAPS_IBS_DT2'		
	-82824	'CASSINI_CAPS_IBS_DT3'		



## **Name/IDs Example -- CASSINI (2)**

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Navigation and Ancillary Information Facility

- **The lists provided on the previous page are by no means complete**
  - There are many more Saturnian satellites and other natural bodies of interest to the Cassini mission, each having an associated frame
  - There are many more instruments on the Cassini spacecraft, with multiple frames associated with each of them
- **To find names and IDs associated with these objects and frames, users should refer as follows**
  - For names/IDs of Cassini instruments: Cassini IKs
    - » For other missions this information is in the mission's FK
  - For names of the reference frames associated with the Cassini spacecraft, its subsystems and instruments: the Cassini FK
  - For names of inertial frames and body-fixed frames associated with natural bodies: **FRAMES.REQ**
  - For names/IDs of natural objects: **NAIF\_IDS.REQ**