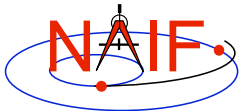


NAIF IDs and Names for Physical Objects and Reference Frames

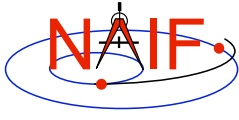
March 2006



Overview

- Summary of naming/numbering schemes used in SPICE
- Naming/numbering of [physical objects](#)
- Naming/numbering of [reference frames](#)
- Connection between the schemes

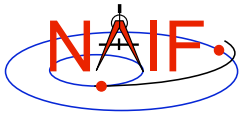
Caution: people frequently confuse the ID assigned to an object and ID(s) assigned to a frame or frames associated with that object.



Overview

Navigation and Ancillary Information Facility

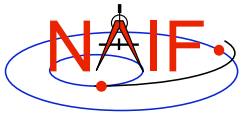
- **NAIF uses IDs and names to identify physical objects and reference frames**
- **A name is a text string; an ID is an integer number**
- **The naming/numbering schemes for physical objects and frames are **independent****
 - This means that in general by default **SPICE does not make any assumptions about frame names/IDs based on the physical objects' names/IDs and vice versa**
 - » There are some exceptions though; they will be mentioned later



Object IDs/Names

Navigation and Ancillary Information Facility

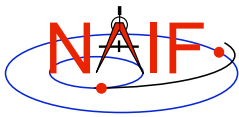
- **Names and IDs are assigned to the following types of **physical objects**:**
 - Natural bodies -- planets, satellites, comets, asteroids
 - Artificial bodies -- spacecraft, spacecraft structures, science instruments, individual detectors within science instruments, DSN stations
 - Any other point, the location of which needs to be known within the SPICE context
 - » Barycenters of solar system and planetary systems, landing sites, corners of solar arrays, focal points of antennas, etc.
- **A single ID is assigned to each object, but multiple names can map to that ID**
 - On input the names are treated as synonyms
 - On output the name that was last associated with the ID is used



Object IDs/Names -- How Used (1)

Navigation and Ancillary Information Facility

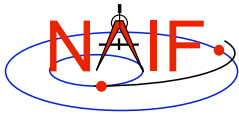
- **Physical object IDs** are used
 - in the following kernels as data identifiers:
 - » SPKs -- to identify object and center of motion
 - » text PCKs -- in keywords associated with a body
 - » IKs -- in keywords associated with instrument/detector
 - » FKs -- to specify the center for computing LT correction, and to identify the body in PCK-based frames
 - » SCLKs -- normally the SCLK ID used in keywords is the negative of the spacecraft's ID
 - in the following APIs as input and/or output arguments:
 - » Older SPK routines -- SPKEZ, SPKEZP, SPKGEO, ...
 - » Older derived geometry routines -- ET2LST, ...
 - » Older PCK routines -- BODVAR, BODMAT, ...
 - » IK routines -- GETFOV, indirectly in G*POOL, ...
 - » SCLK routines -- SCE2C, SCT2E, ...



Object IDs/Names -- How Used (2)

Navigation and Ancillary Information Facility

- **Physical object names** are used in the following APIs as input and/or output arguments:
 - » Newer SPK routines -- SPKEZR, SPKPOS
 - » Newer derived geometry routines -- SRFXPT, ILLUM, SUBSOL, ...
 - » Newer PCK routines -- BODVRD, ...
- **Physical object names** are NOT used as data identifiers within kernels.



Object IDs/Names -- How Defined

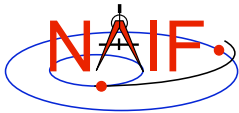
Navigation and Ancillary Information Facility

- **The name/ID mappings used by SPICE are defined in two places**
 - Inside the Toolkit: hard-coded in the source code
 - » See NAIF_IDS.REQ for complete listing of built-in (default) assignments
 - In text kernels
 - » You may define additional mappings using **KEYWORD = VALUE** assignments. For example, for a spacecraft:
 - `NAIF_BODY_NAME += ('spacecraft_name')*`
 - `NAIF_BODY_CODE += (spacecraft_ID_number)*`
 - » These assignments exist most often in FKs (e.g. DI, GNS, M01, MER, SIRTFF), sometimes in IKs (e.g. CASSINI, MGS), but can be placed in any text kernel
 - » Normally text kernels are used to define name/ID mappings for instruments, their subsystems/detectors and other 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
 - » Mappings defined in text kernels take **precedence** over those defined in Toolkit source code.

* See Kernels Required Reading for information about the "+=" operator

NAIF IDs and Names

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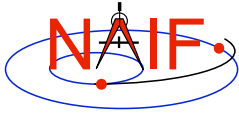
Object IDs/Names -- Spacecraft

Navigation and Ancillary Information Facility

- **Spacecraft (negative numbers)**
 - Within NASA, this number is generally the negative of the numeric ID assigned by the control authority at GSFC
 - -6 'PIONEER-6', 'P6'
 - -7 'PIONEER-7', 'P7',
 - -82 'CASSINI', 'CAS'
 - -94 'MARS GLOBAL SURVYOR', 'MGS'
 - ...
 - 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'
 - ...

NAIF IDs and Names

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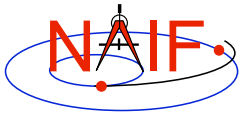
Object IDs/Names -- Planets

Navigation and Ancillary Information Facility

- **Sun and Solar System Barycenter (10 and 0)**
 - 0 'SOLAR SYSTEM BARYCENTER', 'SSB'
 - 10 'SUN'

- **Planetary barycenters (numbers from 1 to 9)**
 - 1 'MERCURY BARYCENTER'
 - 2 'VENUS BARYCENTER'
 - 3 'EARTH MOON BARYCENTER', 'EMB', ...
 - 4 'MARS BARYCENTER'
 - ...
 - 9 'PLUTO BARYCENTER'

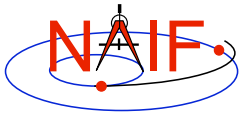
- **Planet centers (planet barycenter ID * 100 + 99)**
 - 199 'MERCURY'
 - 299 'VENUS'
 - 399 'EARTH'
 - 499 'MARS'
 - ...
 - 999 'PLUTO'



Object IDs/Names -- Satellites (1)

Navigation and Ancillary Information Facility

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



Object IDs/Names -- Satellites (2)

Navigation and Ancillary Information Facility

- The scheme described on the previous page can accommodate only 98 natural satellites. How do we handle more than 98?

Has been used.

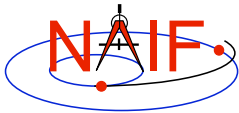
- For IAU provisional assignments, use “psbbb” also, where:
 - » p = planet barycenter ID
 - » s = separator, set equal to “5”
 - » bbb = satellite number
 - Start with the next available unused IAU two-digit number with a “0” pre-pended, when we elect to put this scheme into effect
 - Increment by one thereafter

Not yet needed. Maybe never will be.

- For IAU permanent assignments, use “psbbb” where:
 - » p = planet barycenter ID
 - » s = separator, set equal to “0”
 - » bbb = satellite number
 - Use “099” for the first new permanent assignment after “p98” from the current range is used

NAIF IDs and Names

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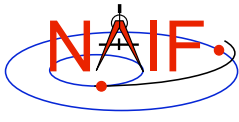
Object IDs/Names -- Satellites (3)

Navigation and Ancillary Information Facility

- The satellite extended numbering scheme described on the previous two pages attempts to, but may not be able to, maintain consistency in the last three digits as the boundary between 98 and 99 is crossed.
 - This is because the IAU sometimes changes the numbering order of new satellites when migrating from provisional to permanent status.
- It has been suggested that some JPL entity maintain a public web page showing the history of all assignments.
- It is recommended that any SPK file made using provisional IDs be trashed (or hidden away) when a new file using permanent IDs is obtained.
 - *If no new file is expected, bspidmod* program can be used to replace provisional ID(s) with official ID(s) in the old file

NAIF IDs and Names

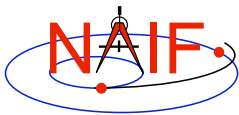
12



Object IDs/Names Comets & Asteroids

Navigation and Ancillary Information Facility

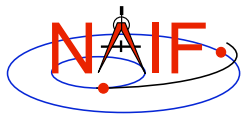
- **Periodic Comets (1000000 + number)**
 - 1000001 'AREND'
 - 1000002 'AREND-REGAUX'
 - ...
 - 1000032 'HALE-BOPP'
- **Numbered Asteroids (2000000 + asteroid number)**
 - 2000001 'CERES'
 - 2000004 'VESTA'
 - ...
 - 2009969 'BRAILLE', '1992KD'
 - There are a few exceptions; see NAIF_IDS.REQ



Object IDs/Names -- Instruments

Navigation and Ancillary Information Facility

- **Science Instruments (s/c ID*1000 - inst. number)**
 - A number should be picked for EVERY instrument, instrument subsystem or detector, or spacecraft structure the parameters for which are to be stored in the 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
 - ...
 - -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

Navigation and Ancillary Information Facility

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

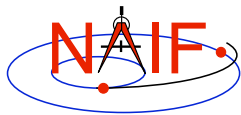
- To get the ID for a given physical object name:

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

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

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

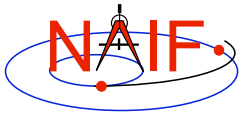
- If the “FOUND” flag returned by either of these routines comes back FALSE, then the input ID or name cannot be mapped



Frame IDs/Names

Navigation and Ancillary Information Facility

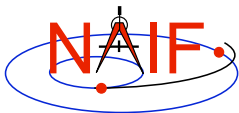
- **Names and IDs are assigned to the following kinds of reference frames**
 - Inertial frames
 - Body-fixed frames
 - Spacecraft and instrument frames
 - Topocentric frames
 - Any other reference frame for which the orientation may be needed to compute observation geometry
- **Unlike for objects, only a single ID and a single name are assigned to each frame**
 - “Aliases” for a frame name can only be set up by defining new zero-offset frames with their own unique names and IDs



Frame IDs/Names -- How Used

Navigation and Ancillary Information Facility

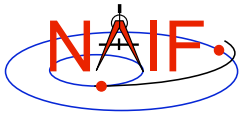
- Reference **frame** IDs are used
 - in the following kernels as data identifiers:
 - » FKs -- to “glue” frame definition keywords together
 - » SPKs -- to identify base reference frame
 - » PCKs -- to identify base reference frame
 - in the following APIs as input and/or output arguments:
 - » Almost nowhere -- users rarely or never need to deal with or be aware of reference frame IDs
- Reference **frame** names are used
 - as arguments in all high level APIs that require a reference frame to be specified on the input
 - » Derived geometry routines -- SRFXPT, ...
 - » Frame transformation routines -- PXFORM, SXFORM
 - » SPK routines -- SPKEZR, SPKPOS, ...
 - Frame names are NOT used as data identifiers within kernels



Frame IDs/Names -- How Defined

Navigation and Ancillary Information Facility

- The reference **frame** name/ID mappings used by the SPICE system are defined in two places
 - Inside the Toolkit: hard-coded into the source code
 - » For inertial frames
 - » For body-fixed frames for planets and satellites
 - » See FRAMES REQUIRED READING for a complete listing
 - In text kernels: provided by KEYWORD=VALUE sets
 - » Almost always in FKs (DI, GNS, M01, MER, SIRTf, ...), very rarely in other kernels, but can be in any text kernel
 - (For historic reasons, MGS frames are defined in IKs and SCLK)
 - » Text kernels define spacecraft frames, instrument frames, spacecraft subsystem frames, DSN station frames, etc.
 - See comments/data sections in a text kernel for the complete listing of the frames defined in that kernel

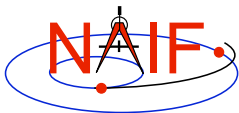


Frame IDs/Names -- Inertial and Body-fixed

Navigation and Ancillary Information Facility

The frame IDs below are shown for completeness. Users would rarely/never need them.

- **Inertial frames (positive integers starting at 1)**
 - 1 'J2000'
 - ...
 - 16 'MARSIAU'
 - 17 'ECLIPJ2000'
 - ...
 - 21 'DE-143'
- **Body-fixed frames (positive integers starting at 10001)**
 - 10001 'IAU_MERCURY_BARYCENTER'
 - ...
 - 10011 'IAU_MERCURY'
 - ...
 - 10020 'IAU_MOON'
 - ...
 - 10081 'EARTH_FIXED'
 - ...

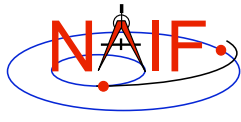


Frame IDs/Names -- Spacecraft and Instrument

Navigation and Ancillary Information Facility

The frame IDs below are shown for completeness. Users would rarely/never need them.

- **IDs for frames associated with spacecraft, spacecraft structures, and instruments are usually s/c ID times 1000 minus an arbitrary number**
- **As example, for Cassini:**
 - **Spacecraft frame**
 - -82000 'CASSINI_SC_COORD'
 - **Spacecraft structure frame**
 - -82001 'CASSINI_SRU-A'
 - **Instrument frames**
 - -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'
 - ...



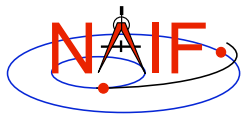
Frame IDs/Names -- Mapping APIs

Navigation and Ancillary Information Facility

- **SPICE provides two routines to 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:

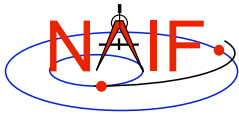
`CALL FRMNAM(ID, NAME)`
 - If ID or name cannot be mapped, these routines return zero or an empty/blank string respectively.
- **Users will rarely if ever need to call these routines**



Name/ID Schemes Connections

Navigation and Ancillary Information Facility

- **Although physical object and reference frame naming/numbering schemes are independent, in practice there is a lot of 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>'
 - At the same time the IDs of these frames have nothing in common with the IDs of the bodies for which these frames are defined
 - Need for the object and frame IDs to be unique
 - » For this reason both instrument IDs and instrument frame IDs are derived from the ID of the spacecraft on which the instrument is flown
 - Need for the object and frame names to be meaningful
 - » For this reason instrument frame names normally contain both the name of the s/c and the name of the instrument



“Odd Ball” Cases

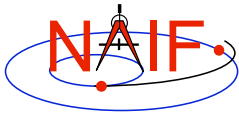
Navigation and Ancillary Information Facility

• 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 FK for a frame whose `_CLASS_ID` keyword is set to the CK ID
 - » In practice, for CK-based frames both the frame ID and frame `_CLASS_ID` are set to the CK ID

• SCLK IDs

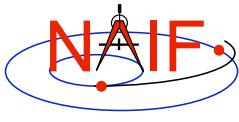
- Because most spacecraft have only one on-board clock, the SCLK ID of that clock is the same as the spacecraft ID
- Should a spacecraft carry more than one independent clock, unique SCLK IDs for these other clocks would be needed
 - » Normally the ID of an additional clock will be set to the ID of the instrument, of which that clock is a part
- SCLK IDs are used in SCLK APIs (must be provided by 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

Objects IDs/Names		Frames IDs/Names	
10	'SUN'	1	'J2000'
399	'EARTH'	10013	'IAU_EARTH'
699	'SATURN'	10016	'IAU_SATURN'
601	'MIMAS'	10039	'IAU_MIMAS'
602	'ENCELADUS'	10040	'IAU_ENCELADUS'
-82	'CASSINI'	-82000	'CASSINI_SC_COORD'
-82001	'CASSINI_SRU-A'	-82001	'CASSINI_SRU-A'
-82790	'CASSINI_CDA'	-82790	'CASSINI_CDA'
		-82791	'CASSINI_CDA_ART'
		-82792	'CASSINI_CDA_BASE'
-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)

Navigation and Ancillary Information Facility

- **The list provided on the previous page is by no means complete**
 - There are many more Saturnian satellites and other natural bodies of interest to the Cassini mission and many frames associated with them
 - There the many more instruments on the Cassini spacecraft and frames associated with them
- **To find names and IDs associated with these objects and frames users should refer:**
 - For names/IDs of natural objects, to NAIF_IDS.REQ
 - For names/IDs of a Cassini instruments and their subsystems, to the IK files
 - » For other missions this information is in the mission's FK file
 - For names of inertial frames and body-fixed frames associated with natural bodies, to FRAMES.REQ
 - For names of the reference frames associated with Cassini spacecraft, its subsystems and instruments, to the FK file