IDs and Names

January 2020
• Summary of naming/numbering schemes used in SPICE
• Naming/numbering of objects
• Naming/numbering of reference frames
• Naming/numbering of DSK surfaces
• Connection between the schemes
• Oddball cases: SCLK and CK IDs
• Some examples
• SPICE uses IDs and names to identify:
  – objects
  – reference frames
  – digital shape kernel (DSK) surfaces

• An ID is an integer number

• A name is a text string

• IDs are used primarily as data identifiers inside SPICE kernels
  – Users rarely have to use IDs

• Names are used primarily as input and output arguments in SPICE software interfaces (APIs)
  – Users deal with lots of names
The schemes used for assigning IDs and names to 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 associated object names and IDs
  » There are some exceptions; they will be mentioned later
Names and IDs associated with Objects
• A single ID is assigned to an 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, such as:
    » 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 same 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 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 DSKs -- to identify 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

- **Object IDs** are used in some APIs as input and/or output arguments:
  - in older SPK routines -- SPKEZ, SPKEZP, SPKGE0, …
  - 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, DSKOBJ, DSKSRF
  - … and more…
• **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, LIMBPT, TERMPT, LATSRF …
  » in high-level Geometry Finder routines – GFPOSC, GFDIST, GFSEP, GFILUM, …
  » in newer PCK routines -- BODVRD, …

• **Object names** are not used as data identifiers within kernels
Object IDs and Names – Where Defined?

• 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 could 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

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• **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
    » For example -18 for MGN and LCROSS, -53 for MPF and M01
    » 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
Examples of Object IDs and Names

Planets

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- Solar System Barycenter and Sun* (0 and 10)
  - 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’  (Within SPICE Pluto is still treated as a planet!)

- Planet-only mass centers (planet barycenter ID * 100 + 99)
  - 199  ‘MERCURY’
  - 299  ‘VENUS’
  - 399  ‘EARTH’
  - 499  ‘MARS’
  - ...
  - 999  ‘PLUTO’  (Within SPICE Pluto is still treated as a planet!)

*Barycenter: the center of mass of a system (collection) of two or more bodies, each of which orbits that point.
See the SPK tutorial for details.
Examples of Object IDs and Names

Satellites

- Satellites (planet barycenter ID*100 + number <1… 98>)
  - 301 ‘MOON’
  - 401 ‘PHOBOS’
  - 402 ‘DEIMOS’
  - 501 ‘IO’
  - 502 ‘EUROPA’
  - ...
  - 901 ‘CHARON’, ‘1978P1’
  - 902 ‘NIX’
Examples of Object IDs and Names
Comets & Asteroids

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• Periodic Comets (1000000 + sequence number *)
  • 1000001 ‘AREND’
  • 1000002 ‘AREND-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
    » See NAIF_IDS.REQ

• One can search here for a name or ID and find the corresponding item: http://ssd.jpl.nasa.gov/sbdb.cgi

*Sequence number is assigned by JPL’s Solar System Dynamics Group
• 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’
  • ...
SPICE provides two routines to map object IDs to names, and vice versa

- To get the ID for a given 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 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
• You may define new or additional name-to-ID mappings using assignments inside any text kernel.

• For example, for a spacecraft:

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

Note the combination of + and =

• See “NAIF_IDS Required Reading” for details

• Caution: the object name length is limited to 36 characters
Names and IDs associated with Reference Frames
• 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?

- The reference frame name-to-ID mappings used by the SPICE system are defined in two places
  - **Built into Toolkit software**: 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 placed in FKs
    - Rarely placed in other kernels, but could be in any text kernel
      - (For example during operations MGS frames were defined in IKs and SCLK)

- Unlike for objects, only one name may be directly associated with a reference frame ID
  - However, an “alias” for a given reference frame can be established by defining a new, zero-offset frame with its own unique name and ID
Frame IDs and Names – Where Used?

- **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
  - in DSKs -- to identify reference frames
  - Reference frame IDs are **not** used 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

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- **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 **names**
• 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 names
• SPICE provides three 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
Names and IDs associated with DSK Surfaces
• A single ID is assigned to each DSK topography data set for a particular body
  – this ID is called DSK surface ID or simply surface ID

• One or more names can be associated with that surface ID
  – These names are called DSK surface names or simply surface names

• Within SPICE software there is a 1-to-MANY mapping between the surface IDs and names
  – On input, the names are treated as synonyms
  – On output, the name that was last associated with the ID is returned
• The surface name-to-ID mappings used by the SPICE system are defined in text kernels
  – usually in FKs
  – using these triplets of keywords that include the ID of the body, placing the name-to-ID mapping in the body’s “namespace”

    ```
    NAIF_SURFACE_NAME += ( 'my_surface_name' )
    NAIF_SURFACE_CODE += ( my_surface_ID )
    NAIF_SURFACE_BODY += ( body_ID )
    ```

    Note the combination of + and =

• Since surface name-to-ID mappings are defined within a body’s “namespace”, the same surface names and IDs can be used for other bodies if desired
• **Surface IDs** are used as data identifiers:
  – inside DSK files
  – in some mid-level DSK APIs -- DSKXV, DSKXSI
  – in place of surface names in the METHOD argument in derived geometry routines

• **Surface names** are used as topography data set identifiers in all high-level, DSK-enabled APIs:
  – in derived geometry routines -- SINCPT, ILUMIN, SUBPNT, …
  – in topography sampling routine -- LATSRF
  – in Geometry Finder routines -- GFOCLT
### Surface IDs and Names – Example

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- **Surface name-ID mappings for ROSETTA targets**

<table>
<thead>
<tr>
<th>DSK Surface Name</th>
<th>ID</th>
<th>Body ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROS_CG_M004_NSPCESA_N_V1</td>
<td>11000</td>
<td>1000012 (comet C-G)</td>
</tr>
<tr>
<td>ROS_CG_K250_NSPCESA_N_V1</td>
<td>11001</td>
<td>1000012</td>
</tr>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROS_CG_M001_OSPGDLR_N_V1</td>
<td>24003</td>
<td>1000012</td>
</tr>
<tr>
<td>ROS_CG_M004_OSPGDLR_N_V1</td>
<td>24004</td>
<td>1000012</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROS_LU_K003_OSPCLAM_N_V1</td>
<td>1000</td>
<td>2000021 (asteroid Lutetia)</td>
</tr>
<tr>
<td>ROS_LU_K006_OSPCLAM_N_V1</td>
<td>1001</td>
<td>2000021</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROS_LU_M003_OSPCLAM_N_V1</td>
<td>1011</td>
<td>2000021</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROS_ST_K020_OSPCLAM_N_V1</td>
<td>1000</td>
<td>2002867 (asteroid Steins)</td>
</tr>
</tbody>
</table>

**Note:** the ROSETTA DSK surface name-ID schema appears rather cryptic because of the need to accommodate multiple shape model versions from multiple producers for three different targets.
SPICE provides four routines to convert (map) surface IDs to names, and vice versa:

- To get the surface ID for a given surface name and body name:
  `CALL SRFS2C( SRFSTR, BODSTR, CODE, FOUND )`

- To get the surface ID for a given surface name and body ID:
  `CALL SRFSCC( SRFSTR, BODYID, CODE, FOUND )`

- To get the surface name for a given surface ID and body name:
  `CALL SRFCSS( CODE, BODSTR, SRFSTR, FOUND )`

- To get the surface name for a given surface ID and body ID:
  `CALL SRFC2S( CODE, BODYID, SRFSTR, FOUND )`

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

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• CK IDs
  – Historically IDs used in CKs are called structure IDs but in reality they are much more closely related to frames than to 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 spacecraft ID. This SCLK ID is used by SPICE APIs. Caution: the negative of the SCLK ID is used in SCLK kernel keywords.
  – 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)

**Objects IDs/Names**

<table>
<thead>
<tr>
<th>ID</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>'SUN'</td>
</tr>
<tr>
<td>399</td>
<td>'EARTH'</td>
</tr>
<tr>
<td>699</td>
<td>'SATURN'</td>
</tr>
<tr>
<td>601</td>
<td>'MIMAS'</td>
</tr>
<tr>
<td>602</td>
<td>'ENCELADUS'</td>
</tr>
</tbody>
</table>

**Frames IDs/Names**

<table>
<thead>
<tr>
<th>ID</th>
<th>Frame Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>'J2000'</td>
</tr>
<tr>
<td>10013</td>
<td>'IAU_EARTH'</td>
</tr>
<tr>
<td>10016</td>
<td>'IAU_SATURN'</td>
</tr>
<tr>
<td>10039</td>
<td>'IAU_MIMAS'</td>
</tr>
<tr>
<td>10040</td>
<td>'IAU_ENCELADUS'</td>
</tr>
</tbody>
</table>

**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'  -
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