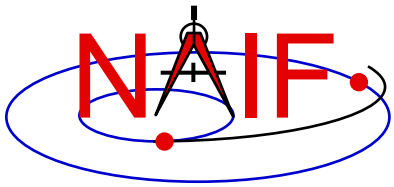


CK File Contents - 1

Navigation and Ancillary Information Facility

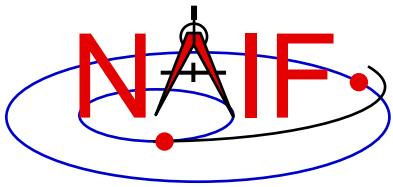
- **A CK file holds orientation data for a spacecraft or a moving structure on the spacecraft**
 - “Orientation data” \Rightarrow quaternions, from which orientation matrices are formed by SPICE software. These matrices are used to rotate position vectors from a base reference frame (the “from” frame) into a second reference frame (the “to” frame)
 - » In SPICE this is often called the “C-matrix or “Camera matrix”
 - Optionally may include angular velocity of the “to” frame with respect to the “from” frame
 - » Angular velocity vectors are expressed relative to the “from” frame.
- **A CK file should also contain comments—sometimes called metadata—that provide some details about the CK such as:**
 - the purpose for this particular CK
 - when and how it was made
 - what time span(s) the data cover



CK File Contents - 2

Navigation and Ancillary Information Facility

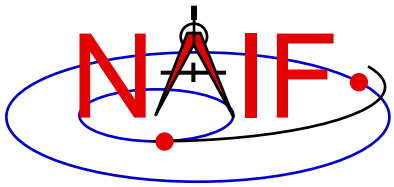
- **A single CK file can hold orientation data for one, or for any combination of spacecraft or spacecraft moving structures**
 - **Some examples**
 1. Huygens Probe
 2. Cassini Orbiter and its CDA instrument mirror
 3. Mars Express Orbiter, PFS scanner, Beagle Lander
 4. MRO orbiter, MRO high gain antenna, MRO solar arrays
- **But in most cases CKs contain data for just one structure**



C-Kernel Varieties - 1

Navigation and Ancillary Information Facility

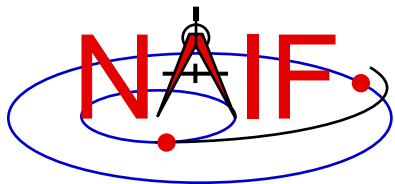
- **“Reconstruction” CK (also called “definitive” CK)**
 - Made from downlinked orientation telemetry returned from a spacecraft or other structure
 - Most often used for science data analysis or spacecraft performance analysis
- **“Predict” CK**
 - Made using information that predicts what the orientation will be some time in the future
 - » Input data usually come from a modeling program, or a set of orientation rules
 - Most often used for science observation planning, quick-look science data analysis, engineering assessments and software testing
 - » If a predict CK is of known high quality, it might be used to substitute for any data gaps in reconstruction CKs



C-Kernel Varieties - 2

Navigation and Ancillary Information Facility

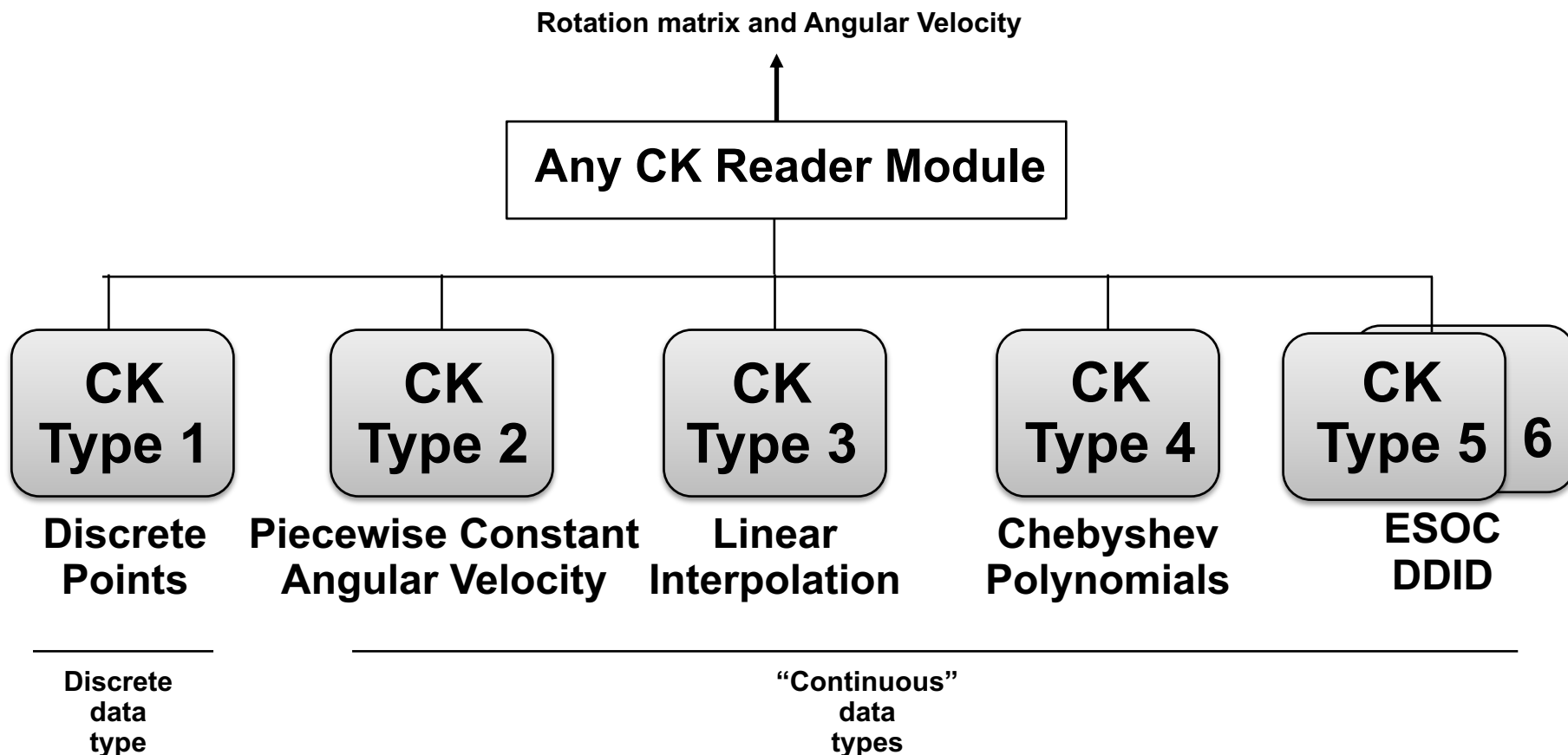
- Knowledge of CK variety—“reconstruction” or “predict”—might be implicit in the file naming schema, and/or might be provided in the comment section, but is not available using a SPICE API
- It is inadvisable that both “reconstruction” and “predict” data be combined in a single file

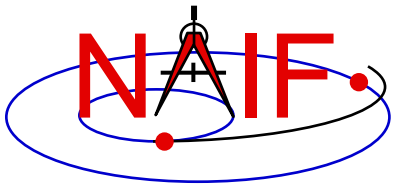


CK Data Types

Navigation and Ancillary Information Facility

The underlying orientation data are of varying types, but the user interface to each of these CK types is the same.

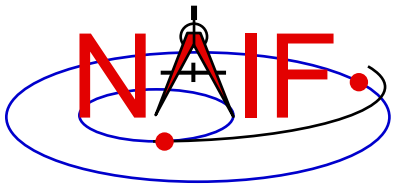




Kernel Data needed

Navigation and Ancillary Information Facility

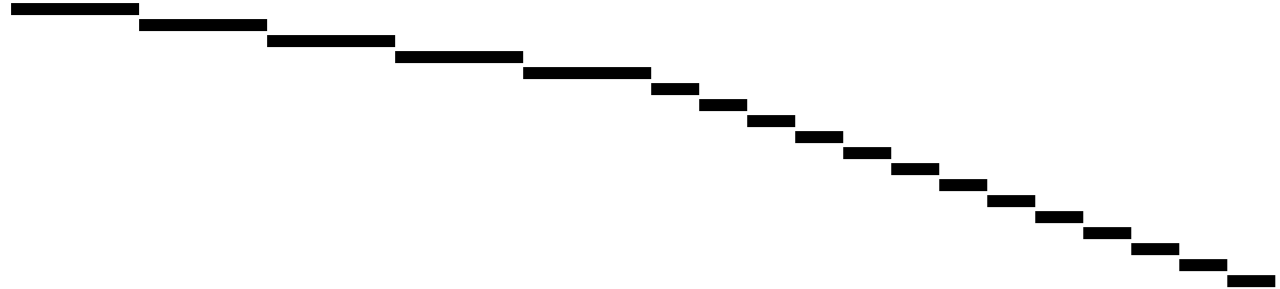
- To obtain orientation one needs at least three SPICE kernel types: **CK**, **SCLK**, and **LSK**.
 - CK contains spacecraft or other structure orientation.
 - SCLK and LSK contain time correlation coefficients used to convert between encoded spacecraft clock time (SCLK) and ephemeris time (ET).
 - » Sometimes an LSK is not needed in this conversion, but it's best to have it available as it is usually needed for other purposes.
- One may also need an **FK** if planning to access CK data via high level SPICE interfaces.
 - FK associates reference frames with CK data via CK IDs.



Sample* CK File Coverage - 1

Navigation and Ancillary Information Facility

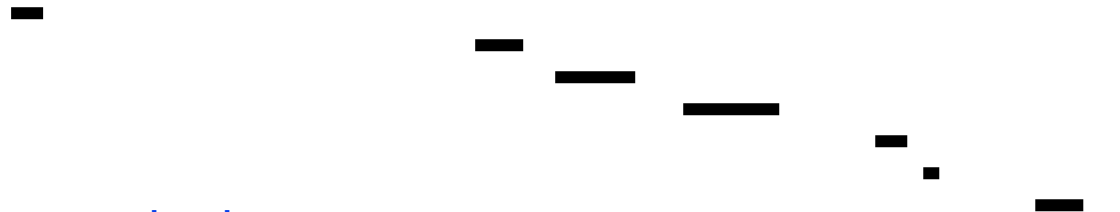
Cassini
orbiter:



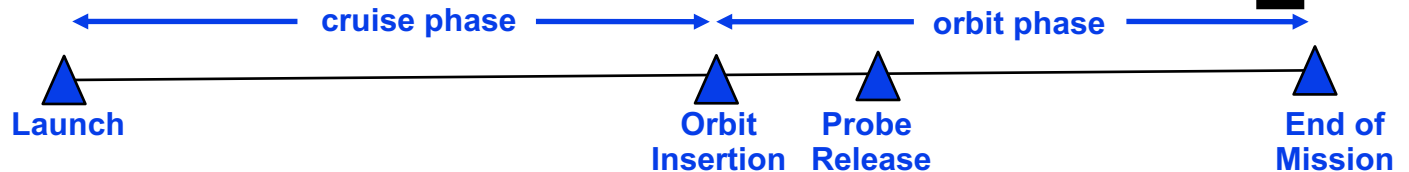
Huygens
probe:



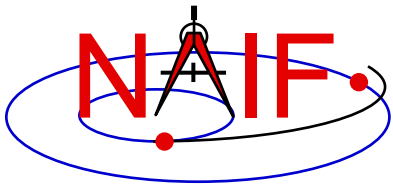
Cassini
instrument
mirror CK:



Time line:



* Note: This is not an actual Cassini/Huygens scenario; it is a highly simplified illustration of some of the possibilities for orientation delivery on a planetary mission.

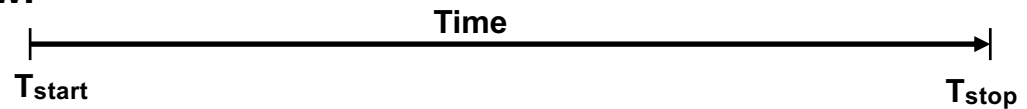


Sample CK Data Coverage - 2

Navigation and Ancillary Information Facility

Even though a project's CK production process may suggest that CK files provide continuous coverage for the interval of time for which they were generated, in reality this is rarely the case. **CK files very often contain gaps in coverage!** An example of this is depicted below.

Coverage of ...



a CK file:
as appears in file name/comments



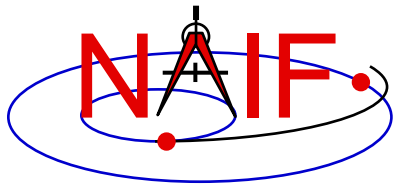
CK file segments:
as appears in ckbrief/spacit summary



CK segments having data gaps:
(CK Types 2 - 6)



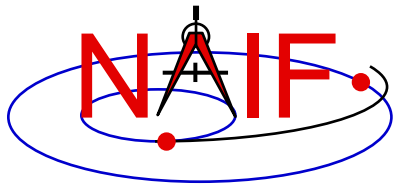
The **blue line segments** represent interpolation intervals – times when pointing will be returned and the FOUND flag is set to “TRUE.”



What is an Interpolation interval?

Navigation and Ancillary Information Facility

- **An interpolation interval is a time period for which routines that access CKs can compute and return pointing.**
 - For CK Types 3, 5 and 6 the pointing is computed by interpolating between the attitude data points that fall within the interval.
 - For CK Type 2 the pointing within each interval is computed by extrapolating from a single attitude and associated angular velocity.
 - For CK Type 4 the pointing is computed by evaluating polynomials covering the interval.
 - For CK Type 1 (discrete pointing instances) the notion of an interpolation interval is not relevant.
- **The time periods between interpolation intervals are gaps during which CK access routines are not able to compute pointing.**

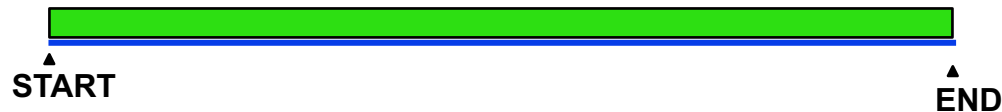


Coverage - Contrast CK with SPK

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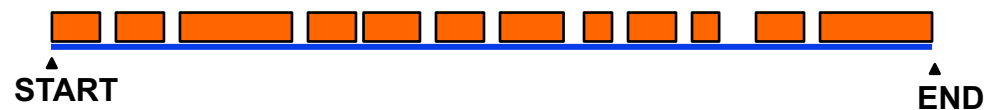
- **SPK segments have continuous coverage for the object included**
 - You can get a result (an answer) at **any** time

SPK segment:



- **CK segments often have gaps, sometimes many!**
 - Due to missing or bad telemetry packets from the spacecraft

CK segment:



- **Any “high-level” SPICE API that needs to use a CK to help determine a reference frame orientation will **NOT** return a result for any time falling in a CK gap!**
 - The orange bars above are called “**interpolation intervals**”
 - The white spaces between the orange bars are gaps