SPICE

A Cross-discipline Ancillary Information System Serving the International Space Sciences Community

Science Data Processing Workshop 2002

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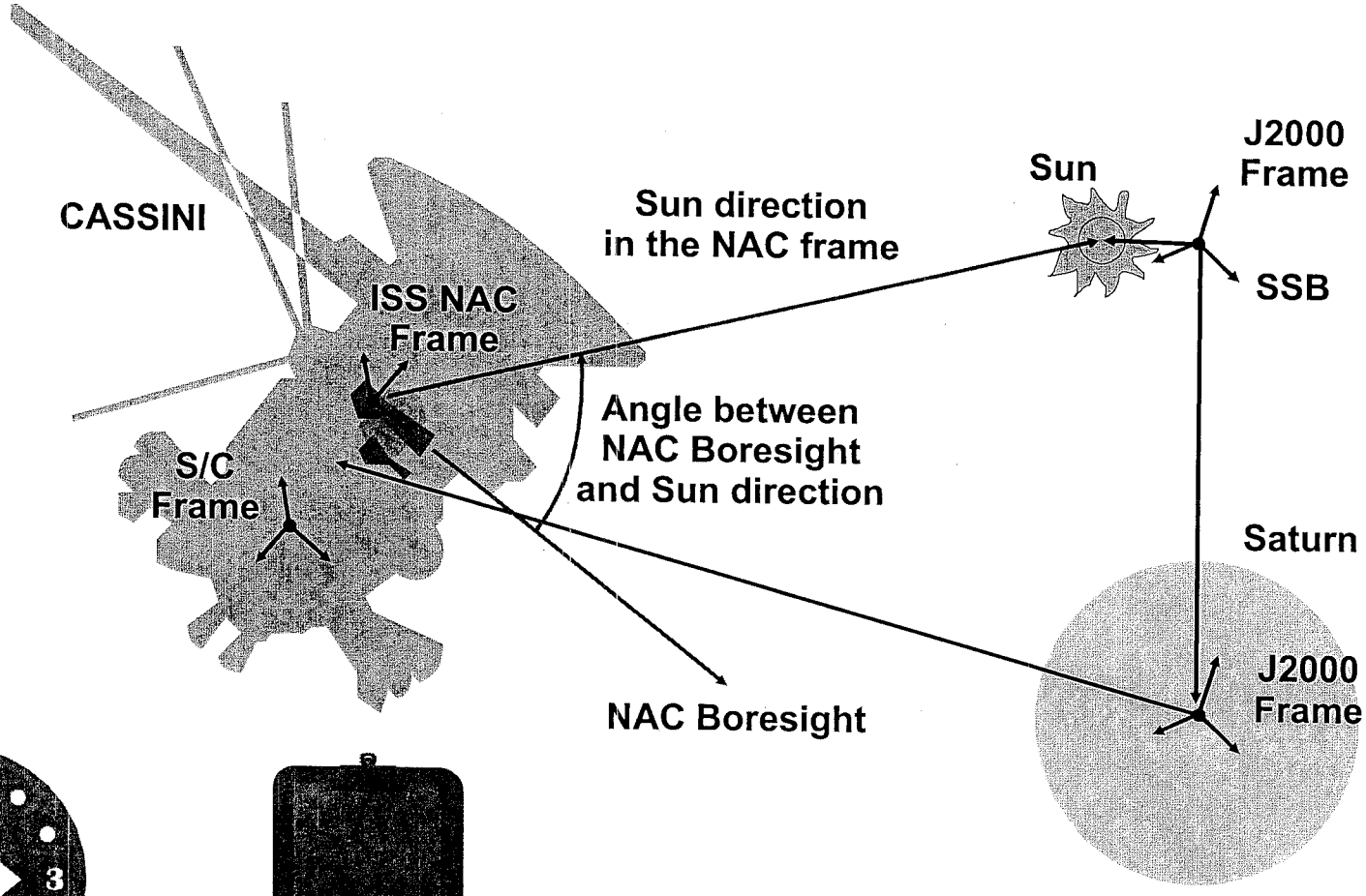
Charles Acton/JPL

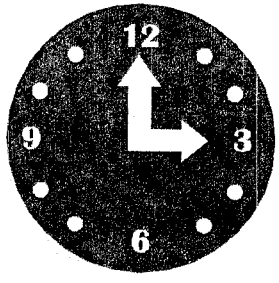
Development of NASA's SPICE system has been carried out by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration

The
SPICE
Ancillary Information System...

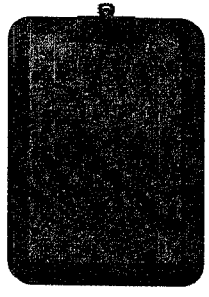
...helps scientists and engineers
plan and analyze
space science observations
and
spacecraft operations

SPICE Deals with Observation Geometry, Time and Events



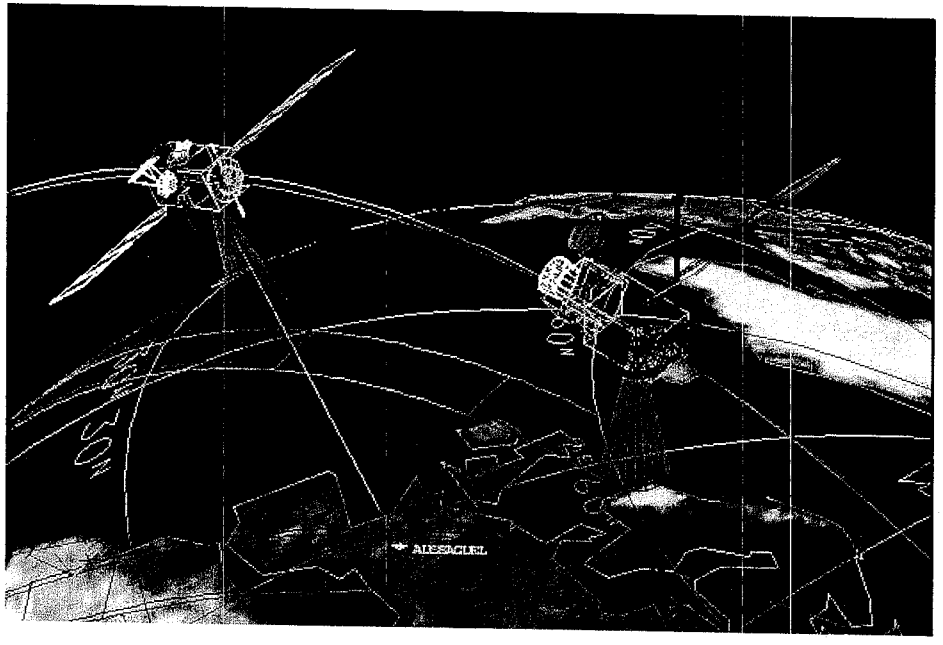


SCET



Today's Plan of Observations

Why SPICE?



Knowing observation geometry and events is an important element in the design of space missions and in the analysis of the science data returned from the instruments.

Having standard methods for producing and using ancillary data reduces cost and risk, and can help scientists achieve more meaningful and accurate results.

SPICE System Functions

- The **SPICE** system can help you:
  - Evaluate and visualize a mission design
  - Plan science observations
  - Analyze science observations
  - Correlate science data with those obtained from another instrument or another spacecraft

SPICE Can Help Answer These Kinds of Mission Evaluation Questions

- What would be the spacecraft's altitude at the time of closest approach?
- How long could our spacecraft "see" the DSN antenna at Goldstone during each orbit?
- What would be the local solar time?
- How long would the Phobos occultation last?
- What stars would be in the field-of-view?

… and many more like these.

SPICE Can Help Answer These Kinds of Science Data Analysis Questions

- Where was the spacecraft?
- What was its altitude above Titan's surface?
- At what latitude and longitude was the instrument field-of-view centered?
- What were the incidence and phase angles?
- What was the local solar time?
- Was the high gain antenna moving at this time?

… and many more like these.

The **SPICE** system is:

- Multi-mission and multi-discipline
- Well tested and well documented
- Widely, successfully used
- Extensible (expandable to new applications)
- Already ported to most popular computers
- Available to your colleagues in the U.S. and around the world

Some of the projects on which **SPICE** is currently being used

- Galileo
- Mars Global Surveyor
- Deep Space 1
- NEAR
- Stardust
- Cassini/Huygens
- Genesis
- SIRTF
- Mars Odyssey
- Mars Exploration Rovers (M'03)
- Mars Express (by ESA)
- Deep Impact
- Contour
- Rosetta (by ESA)
- Mars Reconnaissance Orbiter
- Messenger

Restoration of ancillary data from some older missions into SPICE formats has also been accomplished.

What Vehicle Types Can **SPICE** Support?

- Cruise/Flyby
  - In-situ measurements
  - Instrument calibration
  - Remote sensing
- Orbiters (including earth)
  - Remote sensing
  - In-situ measurements
  - Communications relay
- Balloons*
  - Remote sensing
  - In-situ measurements
- Landers
  - Remote sensing
  - In-situ measurements
  - Surface analysis
  - Rover or balloon relay
- Rovers
  - In-situ measurements
  - Local terrain characterization
- Airplanes*
  - Remote sensing
  - In-situ measurements
- DSN and similar stations

* Not yet demonstrated

SPICE system software is available via anonymous FTP

- In ANSI FORTRAN 77
- In ANSI C
  - Easily called from C++
- Soon with Interactive Data Language (IDL)© "wrappers"
- Get it from:
  - ftp://naif.jpl.nasa.gov/pub/naif/toolkit/FORTRAN/…
  - ftp://naif.jpl.nasa.gov/pub/naif/toolkit/C/...

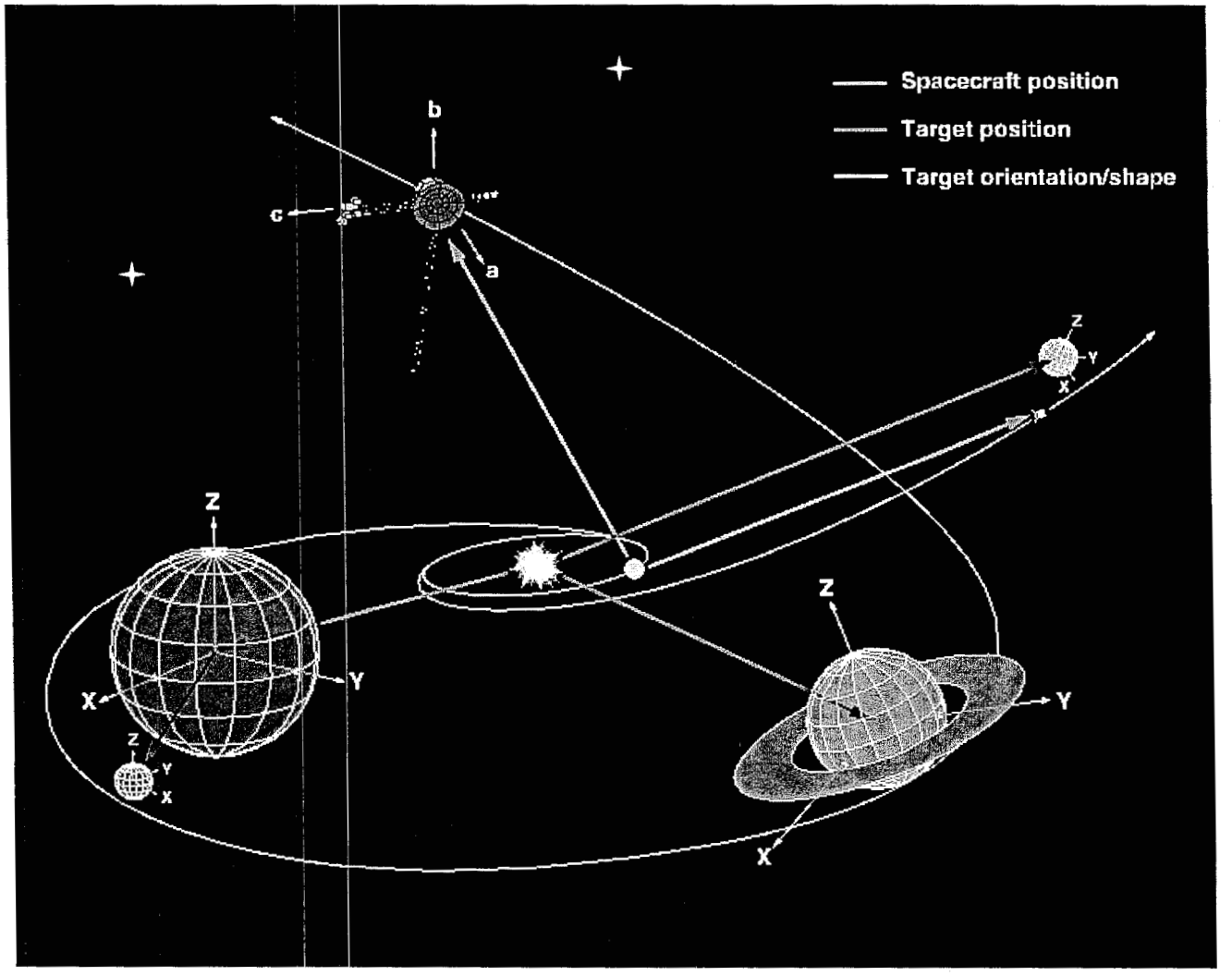
What Does **SPICE** Cost?

- Core development and maintenance are supported directly by NASA
- Flight projects and programs pay for adaptation, deployment and operations
- The Planetary Data System funds archive ingest and post-mission data distribution
- It's generally free to end users:
  - SPICE Toolkit software, documentation and tutorials
  - Kernel files
  - Reasonable consultation

Solar System from a SPICE Perspective

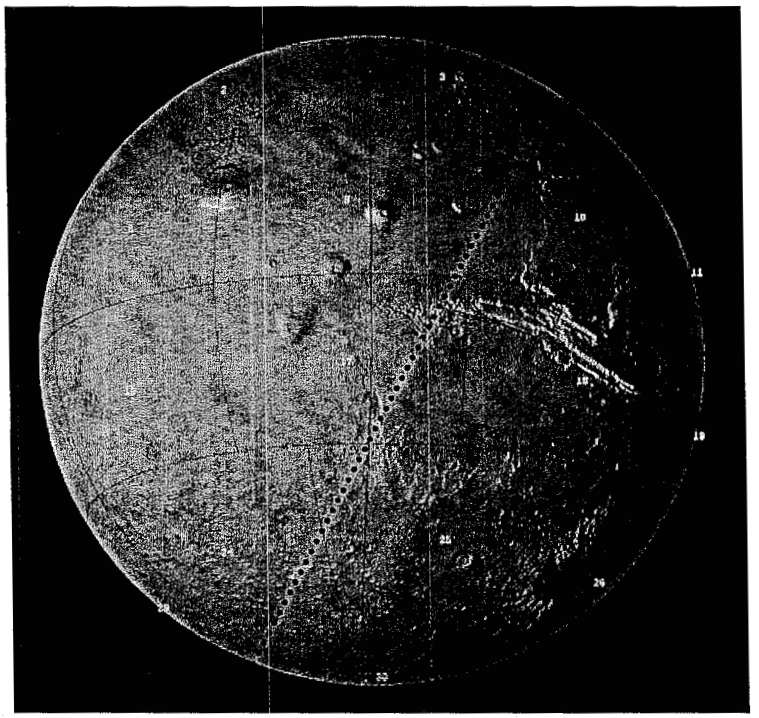
The Macro View

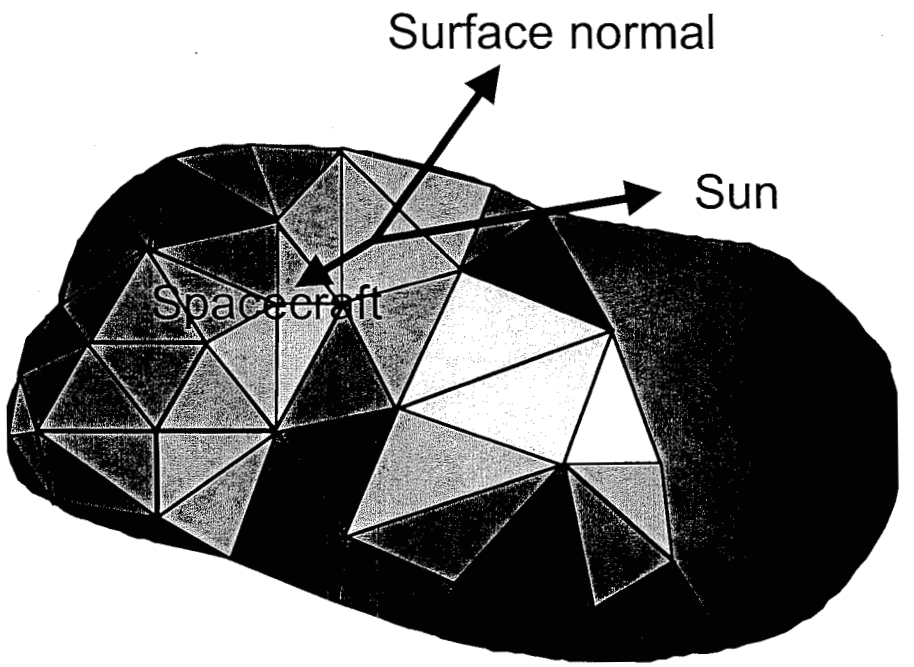
- All spacecraft, planets, satellites, comets, asteroids and the sun have locations and orientations given as a function of time
- All natural bodies have sizes and shapes
- Earth orientation is known to high precision
- The locations of stars or other sky catalog objects can be well integrated



Solar System from a SPICE Perspective

The Mid-scale View

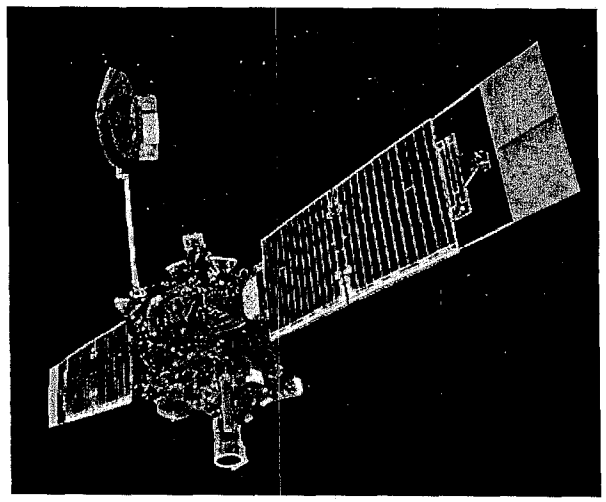




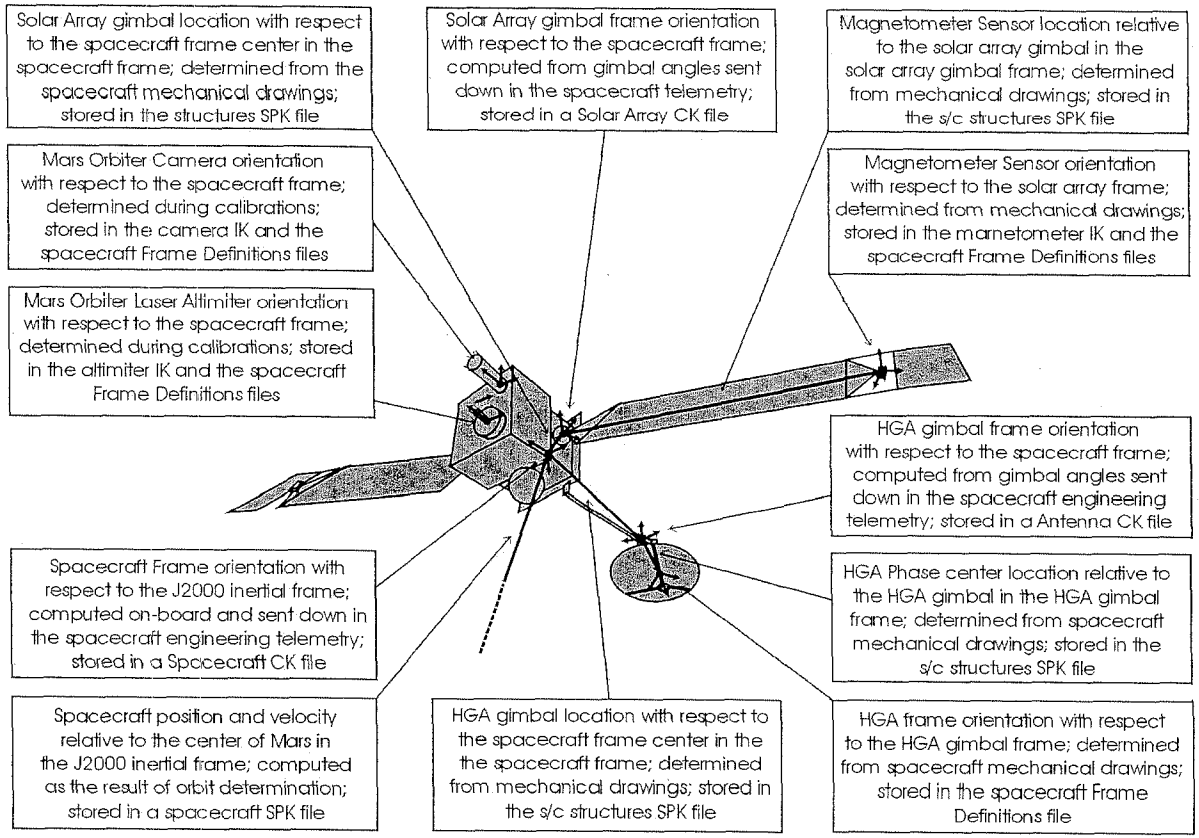
Geometry such as altitude, ground-track latitude and longitude, and lighting angles related to surfaces–either “regular” or “irregular”–may be determined.

Solar System from a SPICE Perspective

The Micro View - 1



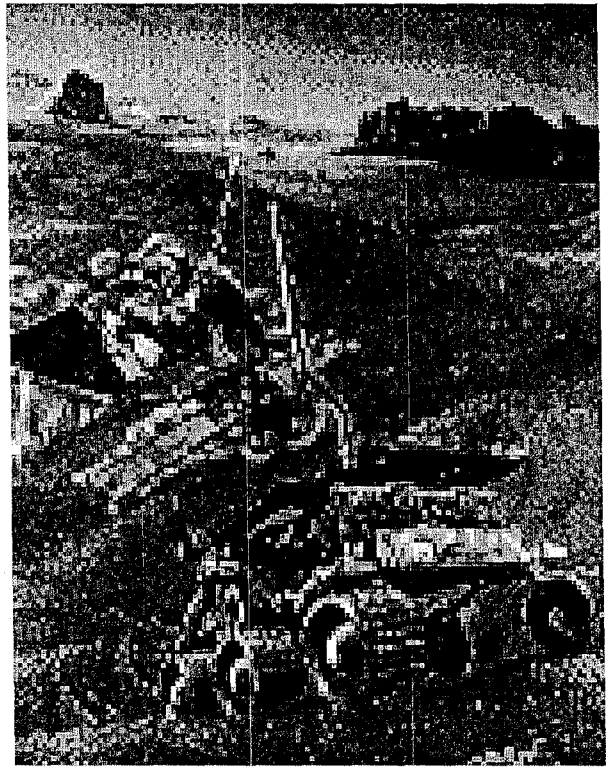
The location and orientation of spacecraft instruments, antennas, or other structures may be specified using SPICE

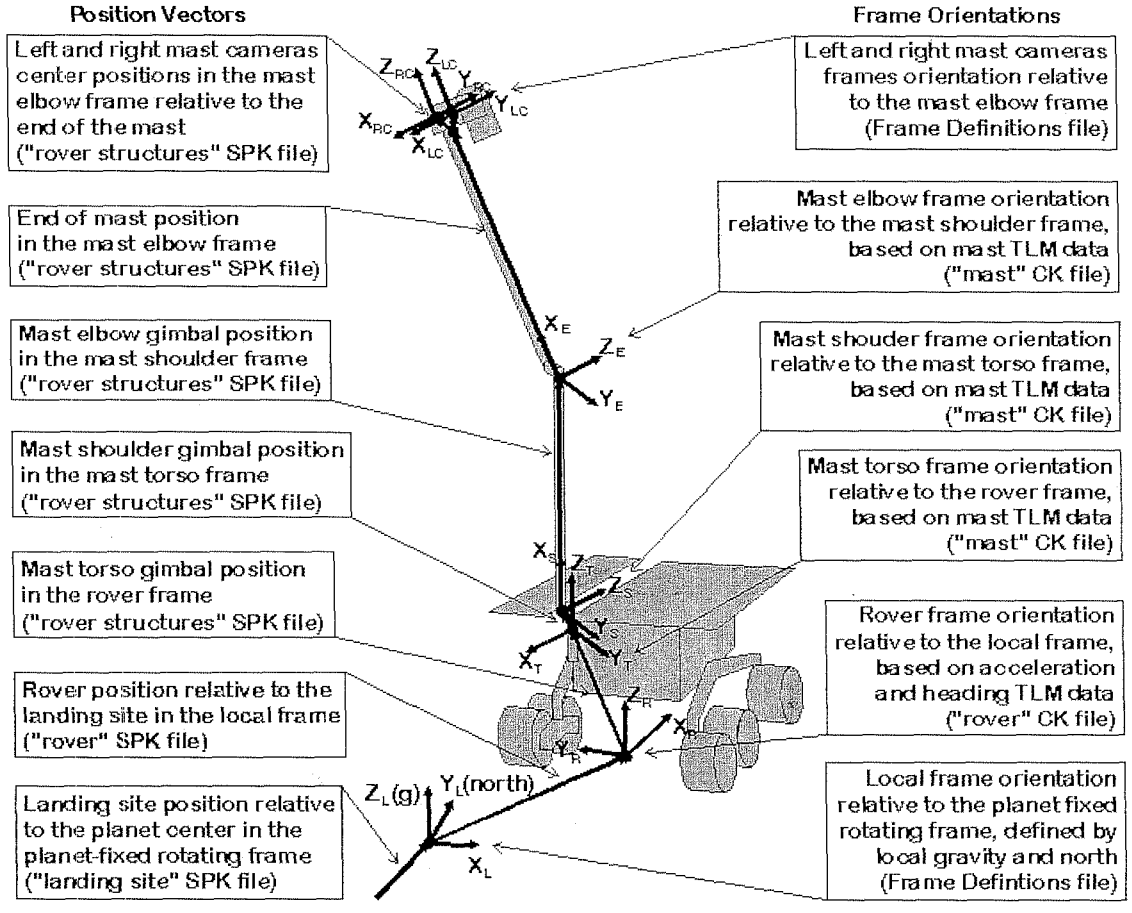


Applying SPICE to an Orbiter (MGS)

Solar System from a SPICE Perspective

The Micro View - 2





The location of a lander, path of a rover, and orientation and location of lander or rover instruments or structures many be specified using SPICE