Space Mission Geometry for CubeSats

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What are "Space Mission Geometry?"

Positions

Sizes and Shapes

Velocities

Orientations

Ranges

Latitude/Longitude

Spacecraft in occultation?

Lighting Angles

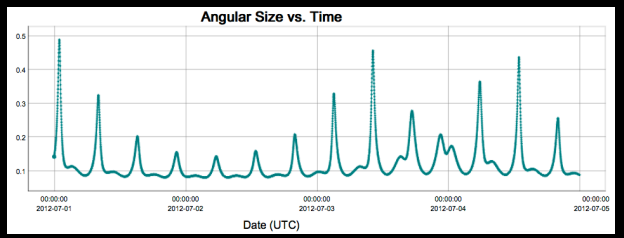
Pointing too close to the sun?

Parameters or Quantities

Events or Conditions

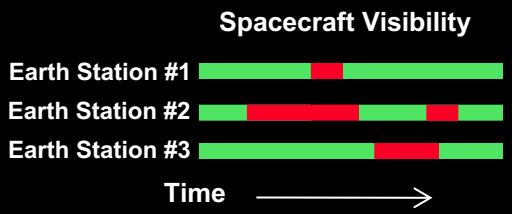
Examples:
Purposes for Space Mission Geometry

Evaluation of a planned trajectory

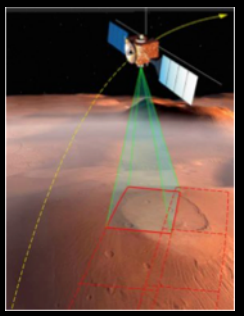


Angular size of Phobos as seen from a Mars orbiter

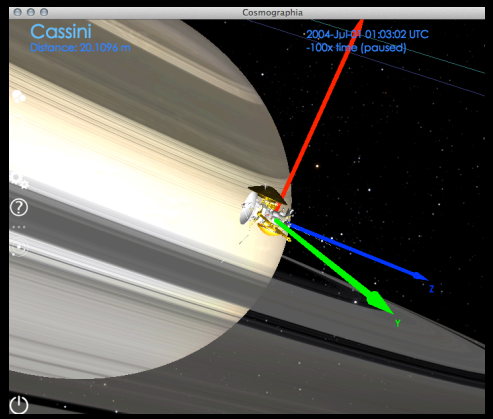
Mission engineering analyses



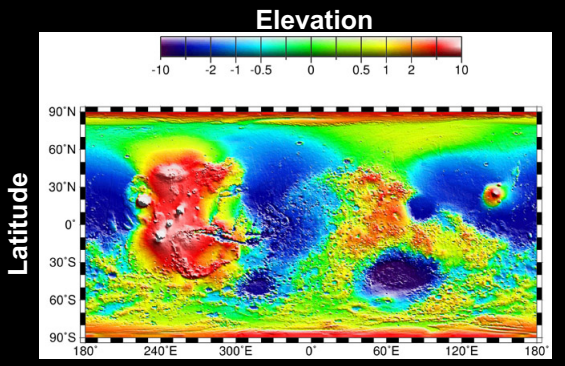
Planning an instrument pointing profile



Observation geometry visualization



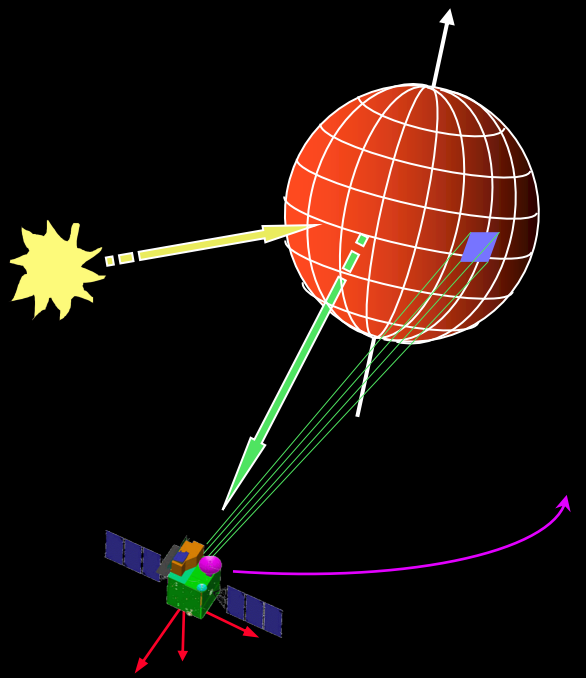
Science data archiving and data analysis



NASA's SPICE System can help you compute a wide assortment of space mission geometry.

What Can One Do With SPICE?

Compute many kinds of observation geometry parameters at selected times



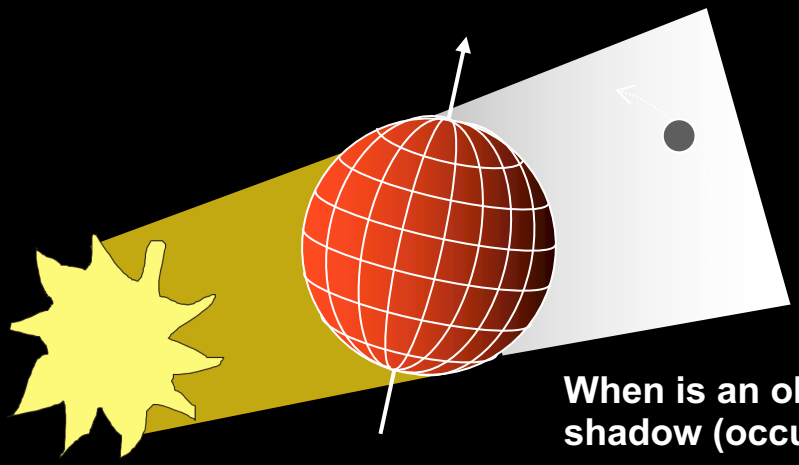
A Few Examples

- **Positions and velocities of planets, satellites, comets, asteroids and spacecraft**
- **Size, shape and orientation of planets, satellites, comets and asteroids**
- **Orientation of a spacecraft and its various articulating structures**
- **Instrument field-of-view location on a body's surface**

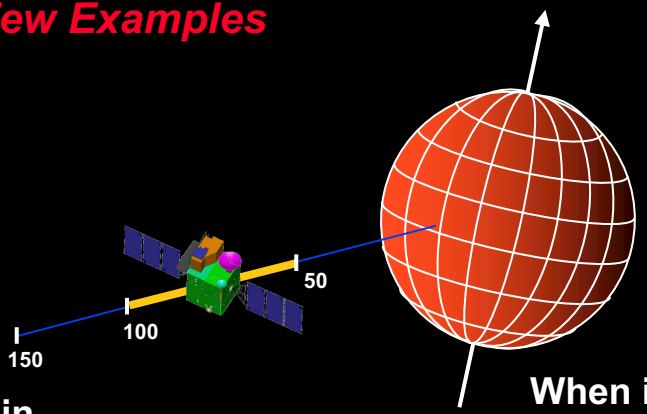
What Can One Do With SPICE?

Find times when a selected "geometric event" occurs, or when a selected "geometric condition" exists

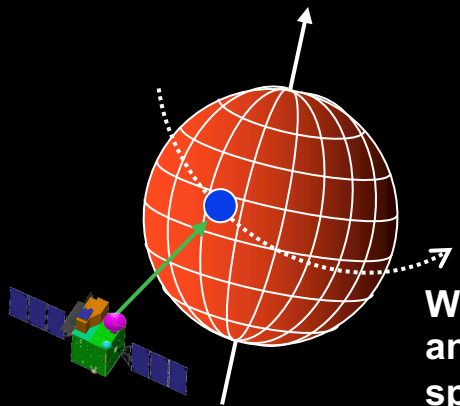
A Few Examples



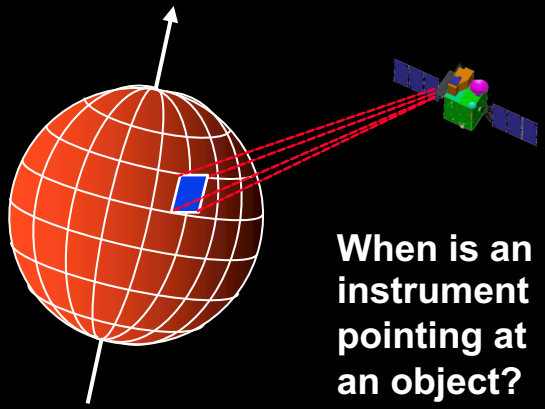
When is an object in shadow (occultation)?



When is the spacecraft's altitude within a given range? (say 50 to 100 km)



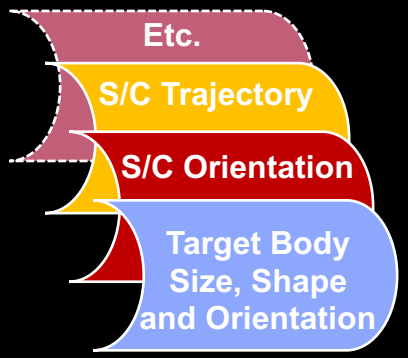
When is an object in front of another, as seen from a spacecraft (transit)?



When is an instrument pointing at an object?

The SPICE Concept

Ancillary Data Files



From various project teams and from other organizations

Nifty Software

Science planning

Science analysis

Engineering operations

Some code written by you and some code comes from NAIF

Wonderful Engineering or Science Results

SPICE System Components

Ancillary data files (“kernels”)……..……

1100
1010
0101

Software (SPICE Toolkit) ……..

Documentation ……..…..

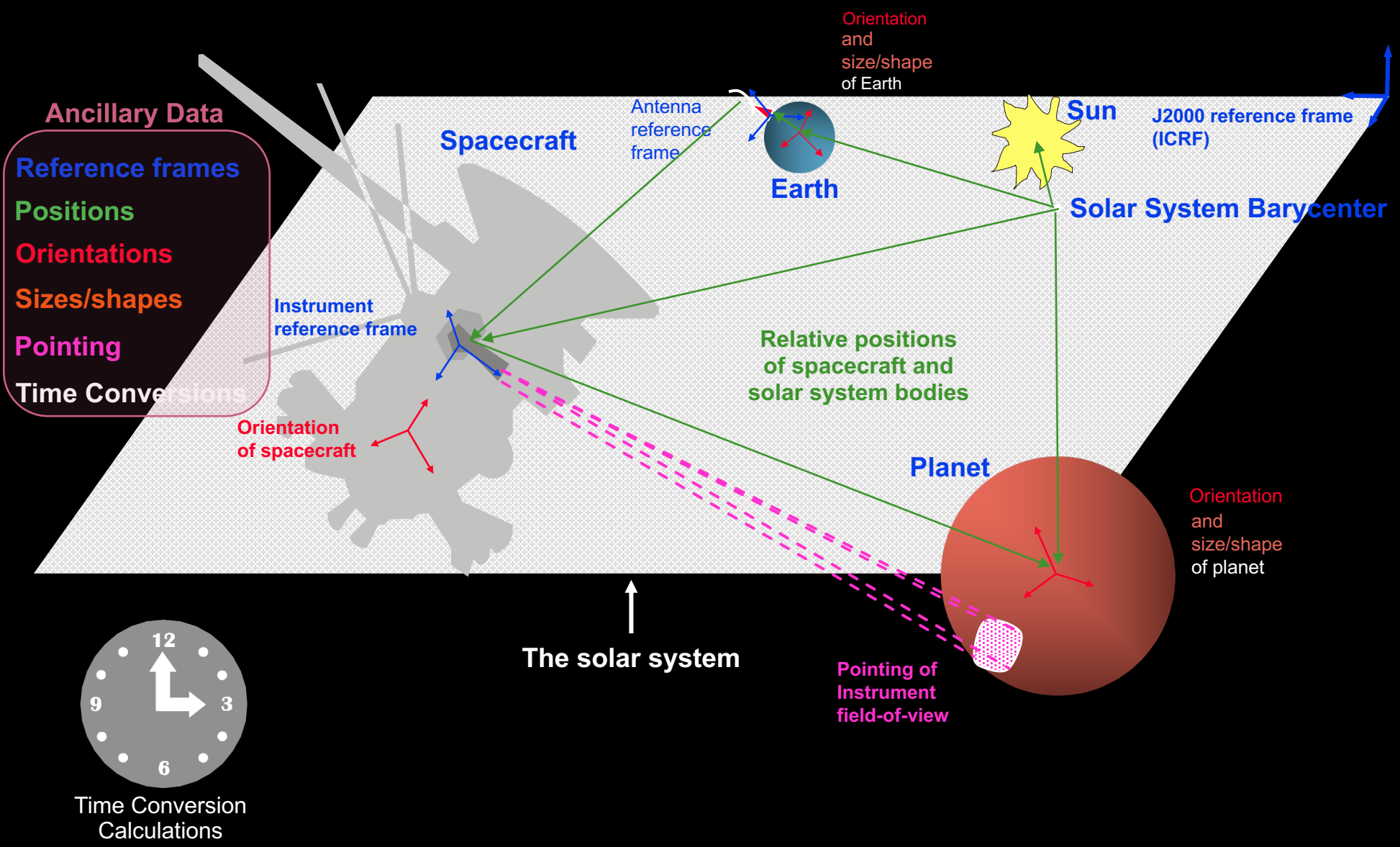
Tutorials ……..…..

Programming lessons …..

Training classes ……..……

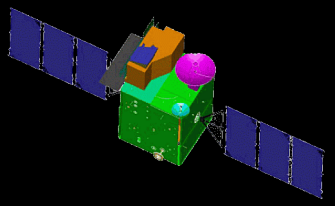
User consultation ……..……..…..

What are “Ancillary Data?”



From Where do Ancillary Data Come?

- From the spacecraft

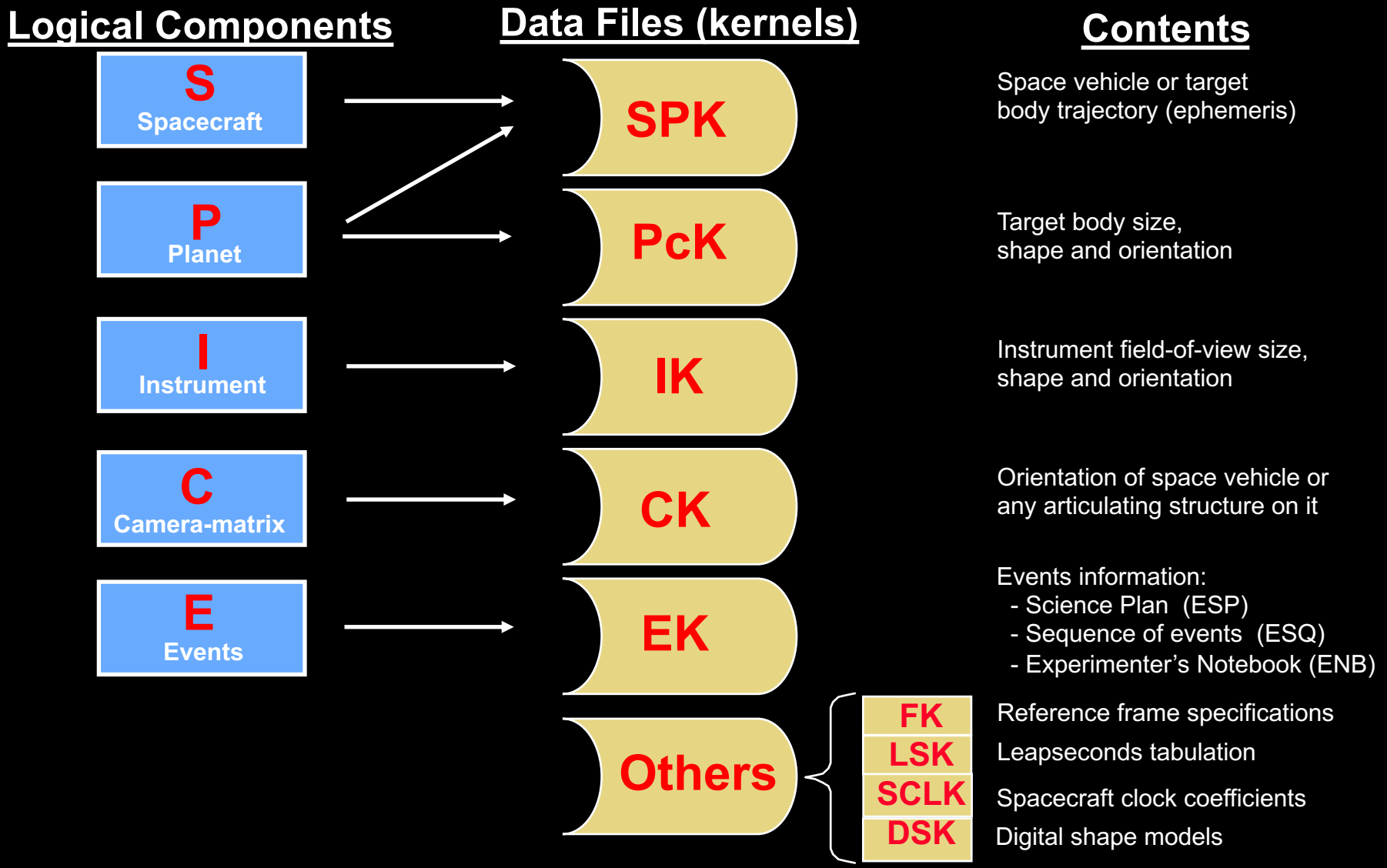


- From the mission control center

- From the spacecraft and instrument builders

- From science organizations

SPICE Ancillary Data Overview



SPICE Toolkit Software

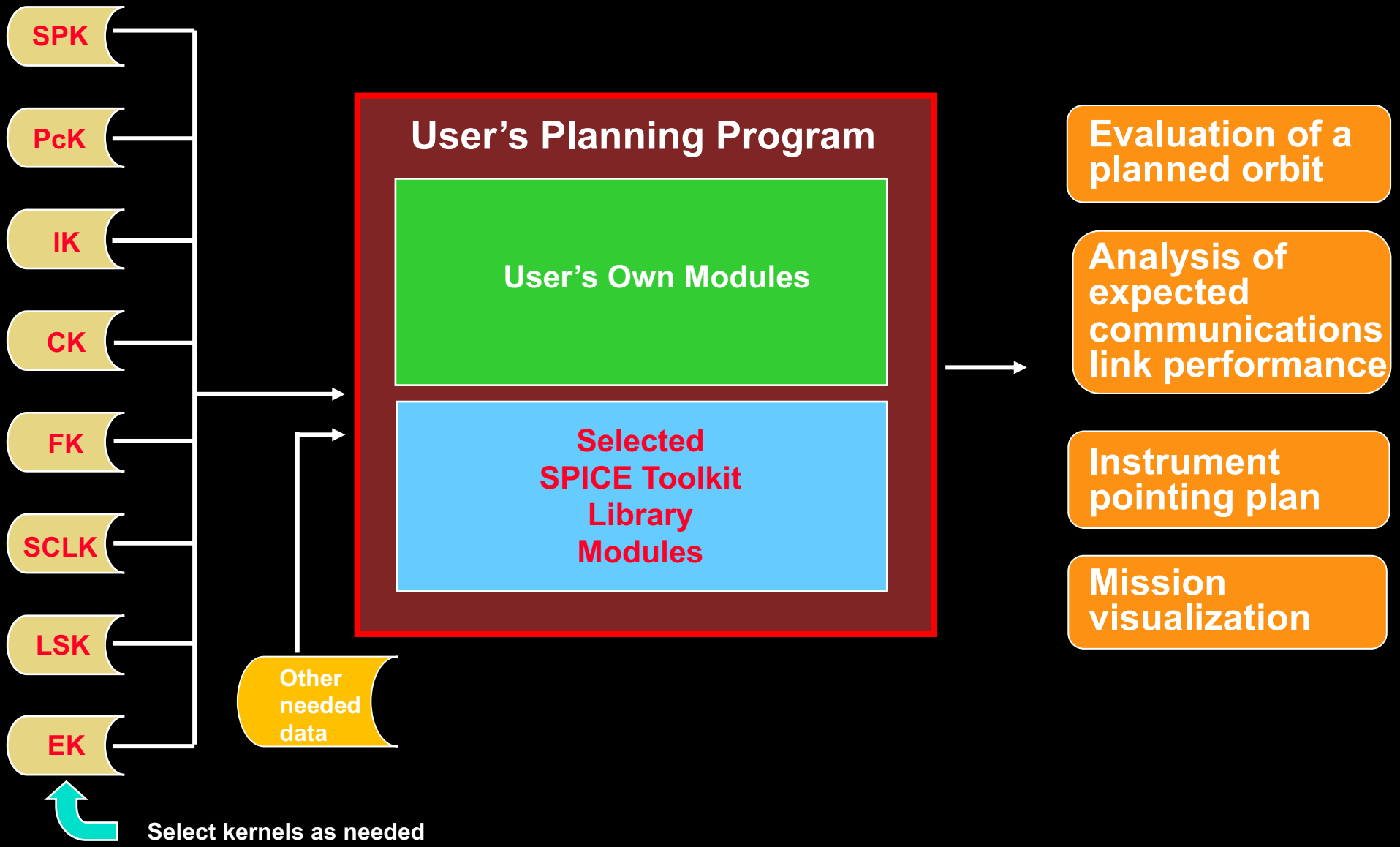
Contents

- **Library of subroutines**
  - Typically just a few are used within a customer's program to compute quantities derived from SPICE data files
- **Programs**
  - SPICE data production
  - SPICE data management
- **Documentation**
  - Highly annotated source code
  - Technical Reference Manuals (23)
  - User Guides for programs
  - Highlights of the most useful subroutines

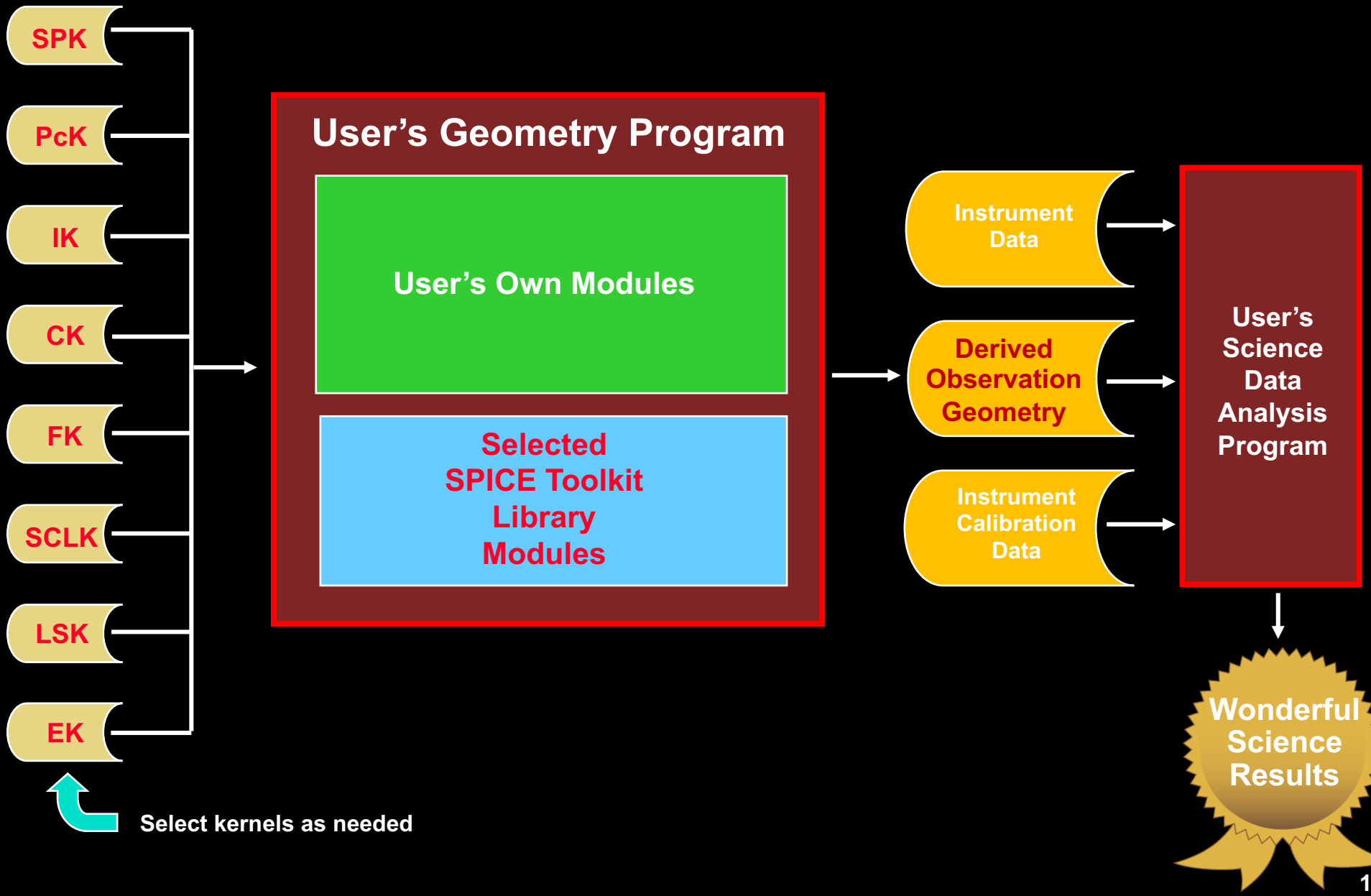
Versions

- **Multiple languages**
  - Fortran 77
  - C
  - Interactive Data Language (IDL)
  - MATLAB
  - Java native interface (JNI)
  - Python, Ruby and Julia (provided by others)
- **Four platforms**
  - PC/Linux
  - PC/Windows
  - Sun/Solaris
  - Mac/OSX
- **Several compilers**
  - For the Fortran and C Toolkits

Using SPICE: A Mission Planning Example



Using SPICE:
A Science Data Analysis Example



Why Use NASA's SPICE System?

- SPICE offers a proven, extensive and reusable means for computing observation geometry.
  - Over more than 20 years of use, SPICE has been adopted by most worldwide space exploration agencies.
- SPICE software is available in many popular languages, works on most popular computers, is thoroughly tested and documented, and is 100% backwards compatible. User's get source code.
- All SPICE components are free of licensing and export restrictions, and are free of cost.
- For more information Google "NASA SPICE"