

SPICE: A Real Example of Data System Re-Use to Reduce the Costs of Ground Data Systems Development and Mission Operations. C. Acton, N. Bachman, L. Elson, B. Semenov, E. Wright; Caltech/Jet Propulsion Laboratory

NASA's SPICE ancillary information system is used by engineers and scientists to capture and access a variety of engineering and other ancillary information throughout the mission lifecycle. SPICE is used by mission architects in defining and analyzing a proposed mission. It is used by scientists to help evaluate a mission design, and to plan scientific observations. It is used by engineers to plan mission operations and to evaluate spacecraft operations. It is used by science instrument teams to help produce data products and to prepare science data for archival. And it is used by the worldwide science community to help find archived science data of interest and to analyze those data.

The SPICE specification encompasses both data files and allied software. SPICE data files contain spacecraft trajectory, target body ephemeris, target body size/shape/orientation, spacecraft orientation, reference frame specifications, instrument mounting alignment and field-of-view geometry, and commands and events associated with the conduct of a mission. These files, often called "kernels," contain low level data from which numerous quantities of interest can be derived—items such as latitude and longitude, range, smear velocity, lighting angles (phase, incidence, emission), visibility windows, and similar quantities. SPICE kernel files can be easily ported to all popular platforms.

The other major component of the SPICE system is a large suite of software—the SPICE Toolkit—consisting primarily of module (subroutine) libraries. These library modules are used to read SPICE files and to compute the derived quantities of most interest to scientists and engineers. Some modules are also used in mission operations to write SPICE files. The customer integrates appropriate SPICELIB subroutines into an application program designed to accomplish whatever is needed. The SPICE Toolkit is available in ANSI FORTRAN 77 and ANSI C. The C version is also becoming available with a set of Interactive Data Language (IDL) “wrappers.” The Toolkit is ported to and tested on nearly all popular platforms used by the space sciences community.

SPICE is the de facto ancillary data standard for essentially all NASA planetary missions. Some SPICE components are used in support of sun-earth connection, astrophysics, earth science and space technology demonstration missions. SPICE was ready for use on the ill-fated Russian Mars 96 mission, and it is now being deployed on ESA's Mars Express mission.

A primary requirement placed on the SPICE system was multimission design, based on software and data structures that can be easily re-used for a wide set of functions. SPICE has been very successful in achieving this goal, resulting in very modest incremental cost for adaptation to a new mission.

SPICE has been applied to landers and rovers as well as to orbiters and fly-by vehicles. While originally focused on science needs, SPICE has found a multitude of applications in mission design and visualization, spacecraft operations, and even operation of core functions of the Deep Space Network tracking system.

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