

SPICE for ESA Planetary Missions



Introduction

The **ESA SPICE Service (ESS)** leads the SPICE operations for ESA Science and Exploration missions. The group is responsible for the generation, development, maintenance and archive of the **SPICE Kernel Datasets for the ESA Planetary Missions** (ExoMars 2016, Mars Express, Rosetta, BepiColombo, JUICE, Venus Express and Solar Orbiter).

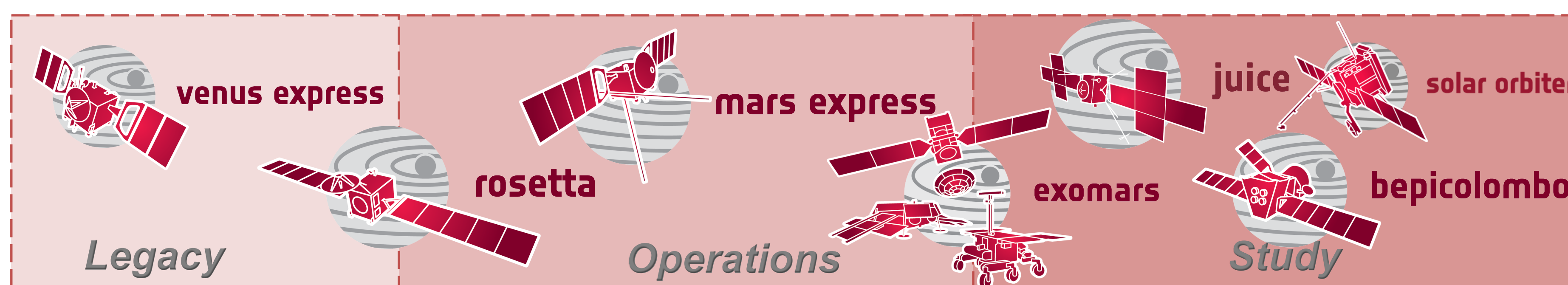
ESS develops and operates software to convert orbit, attitude, telemetry and spacecraft clock correlation data into the corresponding SPICE formats. ESS also provides consultancy and support to the Science Ground Segments and the Science Community of the planetary missions for SPICE and ancillary data management.

SPICE is an information system that uses **ancillary data** to provide Solar System geometry information to scientists and engineers for planetary missions in order to plan and analyze scientific observations from space-born instruments. SPICE is developed and maintained by the Navigation and Ancillary Information Facility (NAIF) team of the Jet Propulsion Laboratory (NASA).

SPICE Kernel Datasets

The main purpose of the ESS for the Planetary Science Community is to provide a **complete, consistent, high-quality, validated and up-to-date SPICE Kernel Dataset (SKD)** for the given mission in order to be able to use SPICE with it.

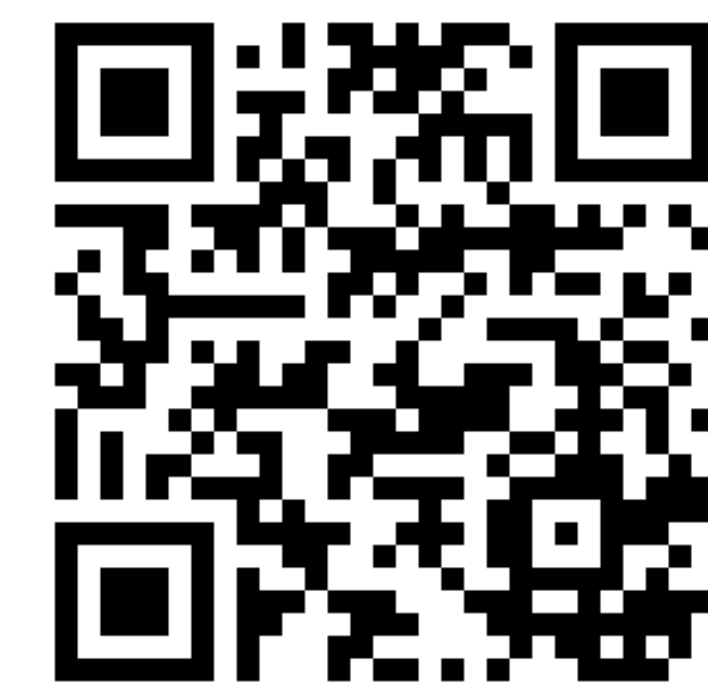
Available, SPICE Kernel Datasets:
Releases and support to the community is provided



- (1) **Studies (pre-operational): JUICE, BepiColombo, Solar Orbiter** (and support to ALTEC for the ExoMars RSP kernels). These kernel datasets are characterized for being highly dynamic with changes in Instrument and S/C frames definitions. Usually different study cases for different consolidated trajectories provided by Mission Analysis and with default and or study S/C Orientations are generated by the ESS.
- (2) **Operational: Mars Express, ExoMars 2016**. These kernel datasets are updated with kernels generated from the periodical trajectory and orientation updates and from the relevant information obtained from housekeeping telemetry. Some updates on Instrument and S/C models might occur responding to operational demands.
- (3) **Legacy (post-operations): Rosetta, Venus Express**: These are final peer-reviewed and consolidated datasets. This process is currently on-going for both missions. Unfortunately no resources are available for Giotto or Huygens.

SKDs are released on a regular basis. The updates may occur in configuration kernels (FK, IK, PCK, LSK). For missions in operational phase updates will include the periodic release of time-dependent kernels (SPK, CK, SCLK). It is also important to distinguish in between SKDs published in the **ESA FTP (Study and Operational)** and the peer-reviewed and **PSA-PDS compliant Archived Kernels** (following the PDS3 and PDS4 standards from the Planetary Data System and IPDA).

ESA SPICE Service Home:



Operational Kernel Datasets:

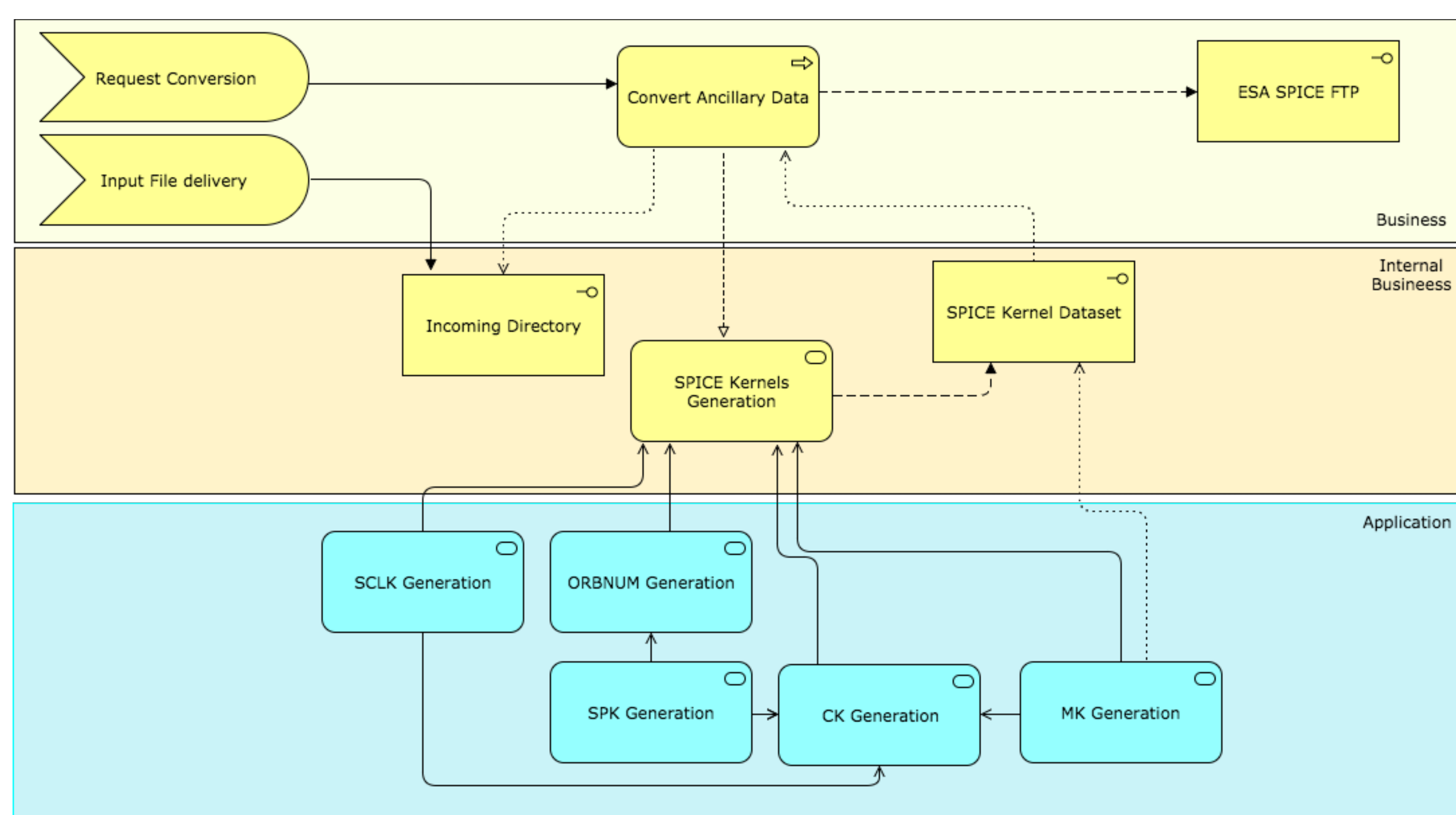


Mission	ESA FTP	NAIF Mirror	PSA Archive	Status
ExoMars2016	Green	Green	PDS4	Operational
Mars Express	Green	Green	PDS3	Operational
Rosetta	Green	Green	PDS3	Legacy
Venus Express	Green	Green	PDS3	Legacy
BepiColombo	Green	Red	PDS4	Studies
JUICE	Green	Red	PDS4	Studies
SolarOrbiter*	Yellow	Red		Studies
SMART-1	Yellow	Red		Legacy
Chandrayaan-1	Yellow	Red		Legacy
Huygens	Red	Red		Legacy
Giotto	Red	Red		Legacy

The Auxiliary Data Conversion System

- **Setup kernels** are developed by ESS and are reviewed and iterated with the SGS and with the Instrument Teams when need be during the whole duration of the mission.
- **Time-varying kernels** are generated with the Auxiliary Data Conversion System (ADCS) and the source data is provided by the Flight Dynamics in terms of OEMs, AEMs and Housekeeping TM data.

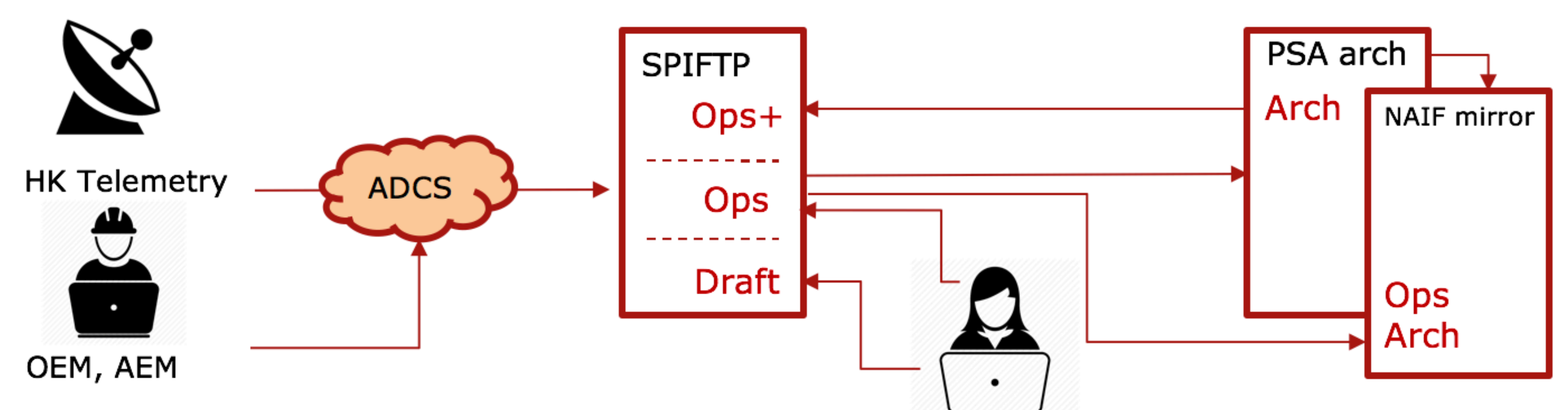
The **Auxiliary Data Conversion System (ADCS)** generates the **time-varying kernels** when the mission is in operations and provides up-to-date trajectory, attitude and orientation information to science operations engineers and scientists.



Kernel Production at ESA

The key element of using SPICE –after the Toolkit libraries- is **data**. Data files are called **kernels**. ESS is focused on producing high-quality kernels. How? SPICE Kernel Dataset consists of:

1. Set of Reference Frames of interest for geometry computations
2. FoV and boresight modeling for science payload
3. Study trajectory default orientation for S/C
4. Physical models for natural bodies of the mission
5. Predicted attitude and predicted/reconstructed trajectory
6. **OBT to UTC/CAL time conversion**
7. **Reconstructed trajectory and measured orientation for S/C**
8. Orientation of Solar Arrays and HGA (if applicable)
9. Position of scans or turn-tables or articulations of payload



ESS is focused on creating **Meta-kernels (MK)** which provide an easily managed listing of the real kernels that are to be used in any given mission scenario.

References

- [1] ESA SPICE Service Home Page: <http://spice.esac.esa.int>
- [2] NAIF Home Page: <https://naif.jpl.nasa.gov>
- [3] Acton C. (1996), *Space Sci.*, 44, 65-70

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