MOIS Student Edition and the Flying Laptop

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The Manufacturing and Operations Information System (MOIS) is designed for the preparation of Flight Operation Plans, automatic execution of operational and test procedures for satellites. It also features additional mission planning and schedule execution modules. MOIS has supported more than 80 spacecraft to date and is the standard software used at ESOC for ESA missions. The software is also used by a range of other international satellite operators such as DLR, CNES and ASI. In addition to operations it doubles as a tool to manage AIT/EGSE test procedures, allowing for easy transition between satellite manufacture and operations, and is used by major European satellite manufacturers including EADS-Astrium, Thales Alenia Space, OHB, Surrey Satellites in Europe as well as the US manufacturer Orbital Sciences Corp.

RHEA manages the MOIS software and offers a student edition free of charge for use on educational missions. This provides educational institutes with access to the latest professional software, and gives students valuable experience in the same tools used by industry and the major European space institutes.

A key feature of MOIS design is its flexibility; it currently supports a wide range of operational and test scripting languages including PLUTO, elisa, STOL, CGS, tcl/TOPE. The flexibility is further demonstrated by the range of satellite missions it supports. The system is scalable from the most complex deep space missions (Herschel-Planck, Bepi-Columbo), constellation missions (Galileo) down to the simplest microsatellites or individual instruments.

This paper sets out the capabilities of MOIS in more detail, using a existing student mission as a relevant case study:- The "Flying Laptop" is a microsatellite being built by the University of Space Systems at the University of Stuttgart. To support this mission, MOIS is combined with ESA's SCOS-2000 software and the system simulation infrastructure MDVE.

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I. What is MOIS?

MOIS is the pre-eminent procedure development, execution and automation platform system for spacecraft Assembly Integration and Test (AIT) and Mission Operations. In fact, MOIS is used as standard by the European Space Agency (ESA) at ESOC, as well as being widely used by European Operators and Satellite Prime Manufacturers.

All MOIS solutions are based on a core set of fully-integrated tools with open and well-defined interfaces – a software platform that allows simple customisation and integration into a wide variety of checkout, EGSE and mission control systems.

II. Why use MOIS for a University Spacecraft Project?

University satellite initiatives are universally subject to very challenging financial constraints, and so costs must be kept to a minimum. RHEA recognizes these limited budgets and offers the full product free of charge to European educational establishments for use on spacecraft projects. Furthermore, software is designed to minimize cost in the development and maintenance of AIT procedures throughout their lifecycle.

Using MOIS for university projects gives Students good skills in the same tools used in ESA and throughout European industry, and accustomed to the professional discipline for configuration control, reporting and so on, helping giving a good grounding for a professional career.

III. Main MOIS Features

Procedure Creation Tools

A selection of tools is provided for creation, editing and display of procedure structures through a graphical flow chart, tabular displays and target scripting languages (if any)

Enables the creation and development of procedures or timelines that may be viewed and worked on both in linearised form, showing steps and associated statements, and as a flow chart graphical display.. Step constructs, such as for defining conditions or loop controls, can be selected and dragged into the graphical display along with the connecting lines that define the overall structure. Changes to a procedure made in one tool are immediately reflected in the other.

The spacecraft database is used to insert telemetry and telecommand statements etc., or to select from a variety of functions and directives. Each statement's parameters are validated at insertion. The procedure can be executed manually or automatically within the mission control system, and also exported to one of several operations languages. The procedure layout is customised through templates and user-defined rules.

Test / Flight Manual Publisher

Makes the hard copy production of procedures and timelines as painless as possible by automating the printing of up to thousands of documents under configuration control. The main use is to generate a complete set of PDFs corresponding to a selected procedure directory structure, containing hyperlinks enabling quick navigation between PDFs. Additional configuration control information can be inserted at user request. Publisher also provides an overview of the procedure library using a tree diagram – an invaluable aid for library navigation and design.

Problem Reporting and Tracking

A centralised database of user-submitted system problem reports and their subsequent review and solution, thereby recording their full life cycle.

Reporting

The Reporter checks a selected set of procedures against the spacecraft database perform consistency checks, extract validation information or generate customised statistics.

TM/TC Database

MOIS may connect to existing (external) database, but it also has in internal Database Management Tool based on the SCOS-2000 Database format. Controls the creation, import or editing of the MOIS operational spacecraft database.

Function Editor

Provides a user-friendly interface to create and maintain functions and directives for use in procedure writing.

Function Editor maintains a database of customised functions and directives, either predefined or user-written, which may be added or edited. Functions may be written in various operations languages, or the Jython language may be used to produce generic implementations. The latter can be used by Validator/Test Harness, avoiding the need for an OL interface for each control system that MOIS may run under.

Procedure Execution Supervisor

MOIS provides a full run-time execution environment for automated procedure execution written in Java. This doubles up as a validation/debug environment.

The executor can run many procedures in parallel, connected to different control systems, simulators or MOIS Test Harness as required. .

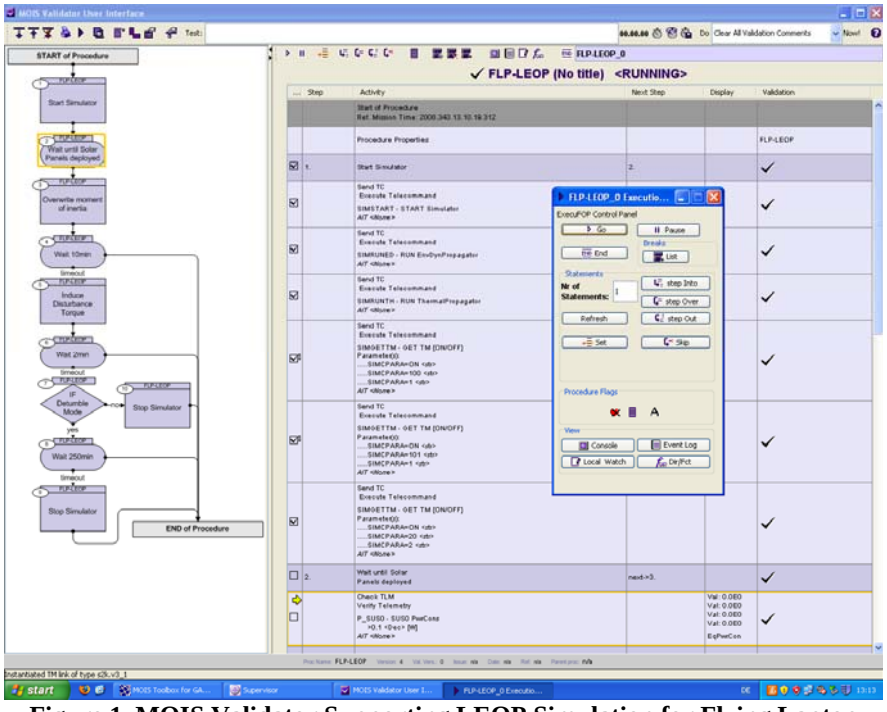

Figure 1. MOIS Validator Supporting LEOP Simulation for Flying Laptop

The Validator takes the hard work out of operational validation by simplifying the process. It can execute a procedure in three modes: manual (step-by-step validation under full user control), semi-automatic (using Test Harness with user control of parameter values) or automatic (using a control system running a simulator). Validator can display either in text view as produced by Writer, or graphically as infrom Flowcharter. Validation results are recorded for each individual statement and summarised at step and procedure level.

A **Test Harness** allows full testing without the need of a control system and spacecraft simulator, thereby enabling initial procedure validation and consequent resources optimisation before the resources (EGSE, control system, simulator) have been allocated.

Scheduler

Enables mission planning for satellite operations and station scheduling.

Scheduler integrates information on resources and constraints (e.g. flight dynamics events, operations requests, ground station availability for spacecraft passes) into the procedure development and execution environments, and generates conflict-free schedules with time-tagged commands for on-board execution.

IV. MOIS use for the Flying Laptop – University of Stuttgart

The small satellite Flying Laptop is the first satellite of the Small Satellites Program in Stuttgart. This mission shall establish the foundation for the required infrastructure as well as the expertise for the Small Satellites Program of the Institute of Space Systems (IRS), University of Stuttgart. The satellite is developed and build at the IRS and will be operated with the institutes' own ground station. The design, development, construction and future operation are primarily done by Ph.D. students and undergraduate students.

Flying Laptop will have the dimensions of 60x70x80 cm³ and a mass of 120 kg. It is three-axis stabilized and will orbit and survey the earth in a low polar orbit of approximately 700 km. The Flying Laptop shall be launched into orbit with an Indian PSLV as a secondary payload. The objectives of the Flying Laptop are the test and verification of new technologies, e.g. a reconfigurable FPGA onboard computer, a novel unfolding mechanism and a GPS experiment, as well as scientific earth surveillance.

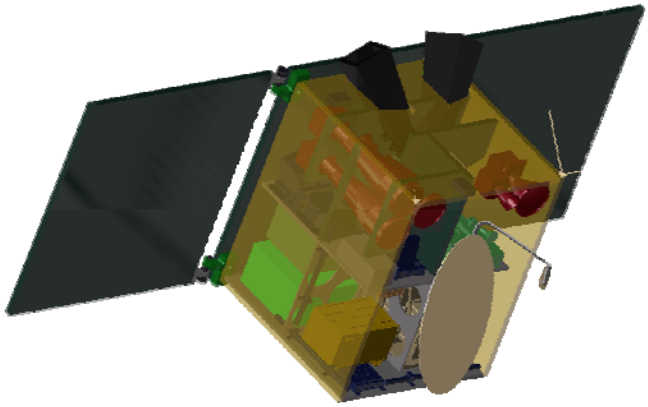

Figure 2. The microsatellite Flying Laptop, ©IRS

The Flying Laptop is currently between the end of phase B and the beginning of phase C. In 2012 a flatsat-model for functional verification will be put in operation. In parallel, the structure-thermal model will be built to verify the environmental capability. The launch is projected to be in early 2013. The lifetime of Flying Laptop shall be two years.

Figure 3. The Satellite Testbench ©IRS

MOIS forms part of a wider control and simulation architecture, It drives connected to SCOS-2000 (from ESA) connected to the on-board computer via a TM/TC front end (SSBV). EADS Astrium have provided a sophisticated real-time simulator developed by EADS Astrium (MDVE).

V. Conclusions

The Institute of Space Systems at the University of Stuttgart has shown that use of educational versions of professional tools such as MOIS leads to cost efficient and effective solution for the development of a university satellite.

References

Publications

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