

Integrating Model-Based Testing in the Space Industry

Service to LEIRIOS Technologies

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Outline

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- ❑ State of the Practice in Functional Testing
- ❑ LEIRIOS Test Generator
- ❑ ESA Support to LEIRIOS
- ❑ Share of Activities
- ❑ Test Generation Process
- ❑ Project Results
- ❑ Lessons Learned

Presentation of the Company

Commercial Aspects

- ✦ Spin-off from a CNRS & INRIA laboratory
- ✦ Recently Created (2003)
- ✦ Personnel (25):
 - 15 R&D Engineering
 - 6 Support & Services
 - 4 Sales
 - 6 Administration
- ✦ Location:
 - Besançon (R&D Centre)
 - Paris (Commercial)
 - Munich (German Market)

Field of Expertise

- ✦ Expertise in:
 - Model-Based Testing
 - Automatic Testing
- ✦ Leirios Test Generator
 - Formal B Models
 - UML Models
- ✦ Applications:
 - Smart Cards
 - Automotive
 - ...
 - Space ?

State of the Practice in Functional Verification

Verifying the compliance of a piece of software to its specification...

How to:

- Specify the tests (objectives)
- Master the complexity (generate **efficient tests**)
- Master the **number** of tests (stopping rule)
- Optimize the **functional test coverage**
- Manage **specification changes**
- Minimize **empiricism**



*Automated Test Generation
from a Model of the Specification*

Towards a fully automated test process...

- **Detection** of design/implementation faults
 - Automated generation of efficient test cases

- **Inputs:** requirements specification
 - Import UML models from widely used tools

- **Outputs:**
 - Coverage reports
 - Traceability from requirements to test cases
 - Test scripts generation to any execution environment

ESA Support to LEIRIOS

- ❑ Provide **expertise** in the applicability of ECSS Space Software Standards (ECSS-E-40, ECSS-Q-80)
- ❑ Apply the LEIRIOS Test Generator on a representative space software (**case study**)
- ❑ Provide feedbacks for improvement, empirical results on the **relevance of model-based testing** for the Space Industry.

Share of Activities

ESA



LEIRIOS Technologies

- ❑ Selection of the case study (AOCS software of the PROBA 2 mission)
- ❑ Design of the UML model
- ❑ Generation of test cases
- ❑ Evaluation of the effectiveness of the technology and dissemination of results

- ❑ Provide the technology (LEIRIOS Test Generator for UML/OCL)
- ❑ Provide dedicated training, support, and consultancy
- ❑ Provide feedbacks on results and implement modifications in LTG

Permanent cooperation between ESA and LEIRIOS to reach the study objectives

Test Generation Process

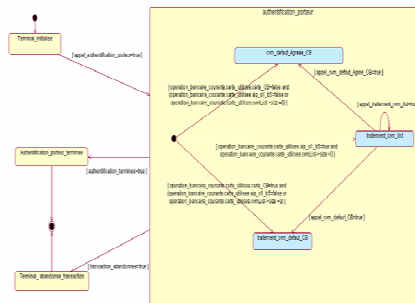


Functional Requirements

Functional Modelling



UML Model



Model Validation



LTG Model Animator

LEIRIOS Test Generator™

LTG Test Case Generator

Test Generation Criteria



Test Case Generation

Test Cases

Project Results

Corrective Improvements

- Corrective maintenance (bug removal)
- Better graphical interface
- Better documentation (user manual)

New Functionality

- Support of various modelling tools (for UML)
- Floating-point variables
- Concurrency (reactive systems)



Such technology can be used to automate the verification process of space software

Lessons Learned

- This type of project is essential to:
 - Improve technology transfer
 - Help SMEs to enter the space domain

- To be successful, it requires:
 - Relatively mature innovative technology
 - High cooperation with SMEs

The Space Industry can benefit of such project by getting mature and improved innovative technology