MATLAB and Simulink integrated in the DO-178c software certification workflow for a new Helicopter

MATLAB Expo 2021
Introduction

OBJECTIVE
• The aim of the presentation is to describe how the MATLAB and Simulink capabilities can be used in the validation and verification process to satisfy the DO-178c criteria for the software certification of a new Helicopter

CONTEXT
• Efficiency improvement of High Level Requirements (HLR) Test Cases / Test Procedures definition has been identified
  • Use of a Model Based approach
  • Improve convergence on test case maturity and coverage
  • Improve the way to apply the formal verification method
Contents

• Improvement expected
• Solution
• Tools
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Improvement expected
**Test Case elaboration**

**Current Process**

Test Cases inputs are manually defined
Test Cases outputs are computed via C code

RTRT tool is used to:
- Define Test Cases execution conditions
- Develop Test Procedures
- Compute expected outputs of test cases
- Execute tests on VMS EOC & compare outputs
- Compute code structural coverage

**Drawbacks**

High Level Test (HLT) C code like definition:
- Requires specific software skills for testing team
- No more adapted to system team way of working

**Improvement:**
The expected improvement is to automate the inputs definition and the expected outputs generation

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Solution
MATLAB & Simulink solution (1/3)

• The MATLAB & Simulink environment contains features for verification method improvement:

  – The requirements (behaviour and data) were developed in a model-based design using Simulink.

  – The test cases creation and execution conditions were developed with a “Test sequence” Simulink tool.

  – Saving of the test cases inputs and expected outputs is automated with MATLAB scripts.
MATLAB & Simulink solution (2/3)

The MathWorks tool suite is introduced to:
- Model HLR Requirement
- Model Test Cases execution conditions
- Mature and generate Test Cases inputs
- Generate Test Cases expected outputs

When Test Cases are mature & complete, Independent review is performed.

Test Cases are translated into Test Procedures

RTRT execute the test procedures & compare expected output, & compute structural code coverage.

Qualification add-on and toolkit was provided by MathWorks Consulting team at start of project.
Tools
MathWorks Tools

- The MathWorks tools used for the verification method improvement are:
  - MATLAB & Simulink R2017a

With additional toolboxes:

- Simulink Test
- Simulink Requirements
- Simulink Coverage
- Stateflow

With add-on:

- « Test Sequence » qualification toolkit developed and delivered by the MathWorks Consulting team
Results
MATLAB & Simulink results (1/2)

- The main Simulink model is made of a Test sequence block and a subsystem containing the design model (Run by script):
MATLAB & Simulink results (2/2)

• Co-simulation (Embedded software Vs Simulink model) can be done and displayed with graphical interfaces to check mismatch:

Imported embedded software C code as DLL
Advantages
MATLAB & Simulink advantages

**Early validation** of test cases maturity and coverage can be performed by using the MathWorks tool suite

- HLR Model Simulink can be simulated
- Co-simulation with embedded software:
  - Improve discussion between System Design Responsible and Vehicle System team,
  - Improve early identification of discrepancy between embedded software and HLR

*Nota*: In classical process, it was difficult to identify if failed result is due to scenario issue or « C code » issue.

HLT Test Case development performed with a **familiar tool** to Vehicle System Engineers allows:

- No specific software coding skill required
- HLR Model is reviewed by System Engineers

**Quick update** of models and scenarii at each requirement modification or update

All scenarii, coverage and procedure generation **run in one click**
Takeaways/Conclusion
Conclusion

• The MATLAB and Simulink capabilities can be used in the validation and verification process to satisfy the DO-178c criteria for the software certification for a new Helicopter.

• Proven efficiency for test model validation and therefore HLR maturity.

• This new process allows to accept more software changes with low validation and verification impact on the Host.
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