USING TTCN-3 IN AVIONICS TO TEST SAFETY-CRITICAL SOFTWARE

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Agenda

- The SUT: Flight Management System (FMS)
- Testing FMS with legacy system (Multitest)
- Migrating legacy test scripts to TTCN-3
- Testing FMS with TTCN-3
- Benefit of migrating to TTCN-3
- Summary
Flight Management System (FMS)

The FMS is a flight management computer embedded with Control Display Unit (CDU) and it provides several functions such as:

- Flight management
- Optimize navigation
- Calculate course to follow
  - Lateral Navigation (LNAV)
  - Vertical Navigation (VNAV)

FMS reads data from different sources (keyboard, navigation sensors, radio, etc.) This data is combined in aircraft navigation.
Flight Management System (FMS)
Testing FMS with legacy system (Multitest)

A simulator for each equipment is developed as multitest component to simulate the exchange of data.

Electronic Flight Instrument System (EFIS) flight deck instrument display

Inertial Reference System (IRS) Senses movement of the aircraft

Test System

Send stimulus (command) from CDU

Check response to CDU

SUT

CDU keyboard

Simulated Components Multitest Environment

Jig9000

CDU

AHRS

Efis

User Conference on Advanced Automated Testing
Migrating legacy test scripts to TTCN-3
Use a mature testing language and benefit from continuing advancement in test scripting tools.
Migrating legacy test scripts to TTCN-3

```xml
<project name="test name">
  <target name="target name">
    <verify description="step number">
      <interface>
        <!-- Actions Task (send) -->
      </interface>
    </verify>
    <!-- Verification Task (receive) -->
  </target>
</project>
```

- Test oracle (template)
- Test configuration (component)
- Test behavior (function)
Migrating legacy test scripts to TTCN-3

- TTCN-3 separation of concerns processing a response from the SUT

Abstract layer

Concrete layer

TTCN-3 execution tool

Abstract test suite
receive("my test oracle");
Setverdict(pass);

Data type

codec

Response message

test adapter

Generic matching mechanism

Abstract message

Abstract matching rule

outcome

System Under Test
Migrating legacy test scripts to TTCN-3
Migrating legacy test scripts to TTCN-3
Testing FMS using TTCN-3

Abstract Layer
(Migrated ttcn-3 module)

Concrete Layer

function check_Step_5() ... {

pressKey("LEGS");
editKey("YUL/H","1L");
pressKey("LEGS");
editKey("YMX/H","2L");
pressKey("EXEC");
pressKey("LEGS");
grabScreen();
}
Testing FMS using TTCN-3

Abstract Layer
(Migrated ttcn-3 module)

Concrete Layer

Receive

```
template cduPage a_Fly_LegsPageTemplate:= {
pageTitle:= "ACT RTE LEGS 1/1",
line_1:= {" 312$ ","YUL/h ",
" 13.0nm ",blank_field},
line_2:= {" 314$ ","YMX /h ",
" 23.5nm ",blank_field},
line_3:= {" THEN ","~~~~~~ ",
blank_field,blank_field},
line_4:= {"-- ROUTE DIS","CYMX ",
"CONTINUITY -:",blank_field},
line_5:= {blank_field,"----- ",
blank_field,blank_field},
line_6:= {blank_field,"{STBY RTE ",
blank_field," LEGS ETA}"},
scratchPad:= blank_scratchpad }
```
Testing FMS using TTCN-3

1. Deploy functionality on FMS with the same test input data for both systems.
2. Record output result for each system and compare for correctness.

Legacy code Functionality X

Migrated code Functionality X

Output

Legacy result

Output

Migrated result
Benefit of migration to TTCN-3

- Duplication of information is reduced
  - Common Test Oracle is reused via template
  - Common Test behavior is reused via functions
- Faster execution time comparing to legacy
  - Unlike legacy, one connection is opened and shared during the execution of test case
- Error detection at compilation time
  - Strong type checking of TTCN-3
- Fewer reading request to the SUT
  - Use of templates to specify structured values
Benefit of migrating to TTCN-3

- Requirements
  - HLR & LLR
- TDL Specification
  - Model-to-Model migration (software evolution)
  - Code-to-Model Transformation
- New Requirements
  - Models
  - generate
- Code-to-Code migration
- Ant/XML
- TTCN-3
- Ant, TTCN-3, other
Summary

- Initial experiments shown that TTCN-3 has several benefits over Multitest when testing the FMS. Testers need to learn TTCN-3 language to prepare test cases.
- Adopt a mature and standard testing language
- Use an industry-based testing methodology to benefit from continuing advancement in modeling and in test scripting tools.