GENEAUTO

Status of new Airbus case Studies

Presented by
Jean-Charles DALBIN
Airbus Operations SAS
&
Laurent DUFFAU
Airbus Operations SAS
Agenda

1/ OBSYS (EADS research demonstrator):
   - Primary Flight Control case study:
     - Part of laws function (using vector based controller)
     - Part of logics function (using state machines)

2/ AIRBUS internal research activities:
   - “Real life” Avionics case study:
     - Weight and Balance Backup Computation Function (Experimentation on a complete Simulink specification (equiv to 100 SCADE nodes)
   - Gene-auto evaluation to produce AP2633 code for simulation

3/ Feedback on Code Customization

4/ Global Status
OBSYS : Flight control laws function - Overview

- **Aim:**
  - Use a vector based approach for the laws function to enhance the capability of the design
  - Test the capability to generate certified code with the discrete vector based model, and compare it to the one from the current AIRBUS tools

- **Context:**
  - Part of flight control laws function (Flight Control Primary Computer A340-600)
  - Target cpu Intel 486
  - Multi-rate : 10 ms & 40 ms
  - Simulink model : Vectors, 30 blocks, 2 levels of hierarchy
OBSYS : Flight control laws function - Re-Design
### OBSYS : Flight control laws function - Status

<table>
<thead>
<tr>
<th></th>
<th>Generation (Gene-Auto without optimization tool) with Geneauto symbols</th>
<th>Generation (Gene-Auto without optimization tool) with AIRBUS backends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>Re-design part of laws function (25 SAO sheets) to a vector based Simulink (one model for C1, one model for C3)</td>
<td></td>
</tr>
<tr>
<td>Code Generation</td>
<td>OK</td>
<td>39 backends have been developed to optimize symbols</td>
</tr>
<tr>
<td>Compilation</td>
<td>OK + Link Gene-Auto source code with the other part of the design (SAO sheets)</td>
<td></td>
</tr>
<tr>
<td>Integration on target</td>
<td>Operation overflow detected after 9 steps of computation (cycles)</td>
<td>=&gt; Investigation on going</td>
</tr>
<tr>
<td>Functional verification on target</td>
<td>TO DO</td>
<td>TO DO</td>
</tr>
<tr>
<td>CPU Performance analysis</td>
<td>TO DO</td>
<td>TO DO</td>
</tr>
</tbody>
</table>
OBSYS : Flight control logics function - Overview

• **Aim:**
  
  ‣ Use state machines for the mode computation to split logics to enhance the capability of the design
  
  ‣ Test the capability to generate certified code with model using state machine, and compare it to the one from the current AIRBUS tools

• **Context:**
  
  ‣ Part of flight control logics function (Flight Control Primary Computer A340-600)
  
  ‣ Target cpu Intel 486
  
  ‣ Mono-rate : 40 ms
  
  ‣ Simulink & Stateflow model : 75 blocks, 3 levels of hierarchy, 5 states
Symbols Mrtrig & Bascr have been replaced by symbols Pulse + 1 automaton with 5 states.
## OBSYS : Flight control logics function - Status

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<th>Generation (Gene-Auto without optimization tool) with AIRBUS backends</th>
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<tbody>
<tr>
<td><strong>Design</strong></td>
<td>Re-design a part of logics function with state machine</td>
</tr>
<tr>
<td></td>
<td>(Mrtrig &amp; Bascr have been replaced by Pulse + 1 state</td>
</tr>
<tr>
<td></td>
<td>machine with 5 states)</td>
</tr>
<tr>
<td><strong>Code Generation</strong></td>
<td>OK</td>
</tr>
<tr>
<td><strong>Compilation</strong></td>
<td>OK</td>
</tr>
<tr>
<td><strong>Integration on target</strong></td>
<td>OK</td>
</tr>
<tr>
<td><strong>Functional verification on target</strong></td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>(same functional behaviour as SAO model reference)</td>
</tr>
<tr>
<td><strong>CPU Performance analysis</strong></td>
<td>=&gt; Cpu time consumption measured :</td>
</tr>
<tr>
<td></td>
<td>multiplied by 2</td>
</tr>
<tr>
<td></td>
<td>=&gt; Memory consumption measured : TBC</td>
</tr>
<tr>
<td></td>
<td>=&gt; Waiting for i486 model from Ait for WCET computation and analysis</td>
</tr>
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3/ Feedback on Code Customization

4/ Global Status
“Real-life” Avionics function Case Study

• **Aim:**
  - Evaluate the complete software application process using Simulink/Gene-Auto toolchain on a selected avionics function
  - Test the capability to generate certified code on a data flow Simulink design, and compare it to the one from the current SCADE tools used in AIRBUS

• **Context:**
  - **Weight & Balance Backup Computation function**
    - (CPIOM computer **A380**)
  - Target power PC 755
  - Mono-rate : 40 ms
  - Simulink model : 107 models, 197 blocks, 2 levels of hierarchy
### “Real life” Avionics function Case Study - Status

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<th>Generation (Gene-Auto without optimization tool) with AIRBUS backends</th>
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| **Simulink Model** | Original Simulink model split in 107 elementary models (for sequencing purpose)  
*Code generation performance to be checked on the complete original model (>several hours?)* |
| **Code Generation** | OK  
But some issues have been detected during backend development:  
Structured data, empty mask, order attributes  
⇒Trackers opened |
| **Compilation** | To Do |
| **Integration on target** | To Do |
| **Functional verification on target** | To Do |
| **Performance analysis** | To Do |
Gene-Auto benchmark for Simulation AP2633 code

Context:
Simulation models: hydraulics, engine…
- For Aircraft 0 (simulation + real equipment), Aircraft –1 (virtual equipment), OCASIME (desktop simulation)
- Host PC Linux, PC windows (for local verification)
- Simulink models provided by several system vendors

Aim:
- Replace RTW as much as possible…
  (lower licence costs, more flexible tool…)
- Customize Gene-Auto in order to produce AP2633 compliant source code without additional post-processing

Status: On-going
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Feedback on code customization with Gene-Auto

• Local customization (at block level)
  ‣ Call to external code by using `lib.xml`
    – call to a C function
    – TBC for macros
  ‣ Develop `backend`
    – use Macro instead of function (for using embedded symbol library)
    – compute constants (to reduce CPU consumption)
    – add instructions (ex: pragmas, data…)

• Global code customization (at model level)
  ‣ The development of an additional tool is on-going.
    This tool is placed between CodeGenerator and Printer.
    – add external dependencies (includes)
    – add instructions for verification tools (WCET tool…)
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Global status

• 16 Problem reports opened (Mantis tool)
• Good reactivity from Krates
• Sufficient level of maturity of Gene-Auto at this stage
• Toolset architecture (developers feedback):
  ▸ Several tools allow more flexibility (to add new tool…) and Model Driven Architecture gives a strong evolution potential

• To be Done:
  ▸ Solve the problem of access to data with separate models
  ▸ Optimize source code with Gene-auto optimizer and use of cache memory
  ▸ Analyse cpu consumption for part of flight control logics function (StateFlow)
  ▸ Look at structure of source code regarding certification issues

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