

Proving and improving worst-case execution times on the Alenia Aermacchi M-346

Alenia Aermacchi has built over 7,000 aircraft and supplied 2,000 trainers to more than 40 countries worldwide. A military transonic trainer aircraft designed for training combat pilots for front line fighter aircraft, the Alenia Aermacchi M-346 Master is powered by a digital flight control system.

An important part of the development of this system's software is the efficient capture and use of worst-case execution time data.



Challenge

In developing the flight control software, the challenge for Alenia Aermacchi was to simultaneously reduce the costs and improve the quality of worst-case execution time measurements.

Recognizing that manually determining execution times is expensive and time consuming, Alenia Aermacchi selected RapiTime because it was the only commercially available tool that could deliver WCET measurements, given the existing hardware / software architecture.

Alenia Aermacchi planned to use RapiTime to:

- reduce the effort required to carry out timing analysis on the flight control software;
- optimise code which powers the flight control system and reduce worst-case execution times; and
- compare the benefits of using RapiTime with established manual approaches.

The Challenge

- **To measure and improve the overall execution time of the flight control system on the Alenia Aermacchi M-346 Master**

The Solution

- **Use RapiTime to measure worst-case execution times, identify worst-case hotspots and optimize the appropriate code**

The Benefits

- **WCET determined with a high level of confidence and reduced effort**
- **Rapid identification of software bottlenecks, leading to 10% reduction in WCET**

Solution

Measuring worst-case execution times

RapiTime was first used to measure the execution time of short sub-paths between decision points in the code. This measurement is combined with static path analysis information to compute worst-case execution times and execution time variations.

Highlighting worst-case hotspots

Conventional code profiling techniques identify the lines of code that execute the most on *average*.

By contrast, Rapi**Time** identified worst-case hotspots in Ada sub-programs and even specific lines of source code from the point of view of their contribution to the overall worst-case execution time.

Once identified, hotspots were:

- stripped of code contributing heavily to worst-case execution times;
- provided with rewritten code.

Benefits

According to Alenia Aermacchi engineers working on measuring and improving the overall execution time of the M-346 flight control system, “The main advantage [of using Rapi**Time**] is the possibility to identify the software bottlenecks that can be subject to optimization”.



Without Rapi**Time** “The mandatory code optimization would have been done without the knowledge of where to concentrate the efforts”.

“With Rapi**Time** we discovered the possibility to reduce by 10% the time spent by a Computer Software Configuration Item”.

Next steps

Alenia Aermacchi are now exploring a number of options after using Rapi**Time**, including:

- Possible use of worst-case execution time information to aid DO-178B qualification;
- Selecting Rapi**Cover** to help meet code coverage measurement requirements.

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About Rapita Systems Ltd

Rapita Systems Ltd develops software tools to reduce the cost of measuring and optimizing the timing performance of large, real-time software systems, such as avionics applications.

Rapita Verification Suite (RVS), which includes Rapi**Time** and Rapi**Cover**, is the essential collection of on-target timing verification, optimization and code coverage measurement tools for real-time embedded systems. It is the only product on the market that can tell users exactly where to focus optimization effort to minimize worst-case execution time.

Using RVS, customers have cut the worst-case execution time of large scale, legacy applications by up to 50% with only a few days effort, and significantly reduced unnecessary testing and instrumentation overheads.

Our software supports Microsoft Windows (XP, 2000, Vista and Windows 7) and Linux.



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