



Faster and Cheaper Level A Software Certification With **SCADE**

Eurocopter: The World's Leading Helicopter Manufacturer

With 70% of its shares held by Aerospatiale Matra and 30% by Daimler-Chrysler Aerospace, the Franco-German group, Eurocopter (EC), is the world leader in civil helicopters and a large manufacturer of military helicopters. With four main sites and thirteen subsidiaries around the world, EC has delivered more than 11,000 aircraft to 1,700 clients in 132 countries.

By 1998, Eurocopter had 9,500 employees, and profits of 1,694 million Euro.

The Importance of Embedded Software

Embedded software developed by EC has become increasingly important in helicopter design. First appearing in Tiger mission computers, EC's embedded software was introduced in the NH90 (twin engine, multi-role naval and tactical transport helicopter in the 9 ton class), in Fly By Wire control computers, and in the HUMS (Health and Usage Monitoring System) on-board maintenance system for the Super Puma. EC-developed embedded software is now a vital component in autopilots, particularly in the latest EC civil range of helicopters.

Automatic Code Generation Is Nothing New for Eurocopter

In 1995, to determine the digital flight control specifications of the NH90 and generate "certifiable" software,

Eurocopter used a tool developed by Aerospatiale Airbus. This tool was subsequently replaced by SCADE™ (Safety Critical Application Development Environment).

The development of a commercial product to succeed the in-house tool proved beneficial, both in terms of productivity and in the quality of the results obtained.

SCADE Facilitates the Organization of the EC135 and EC155 Autopilot Project

Eurocopter's use of SCADE was formalized with their development of autopilots for the EC135 and EC155 civil helicopters, done in co-operation with the equipment manufacturer SFIM. To guarantee coherence in the development of the product range, this collaboration required precise formal specifications. By defining common rules for naming and structuring, SCADE made it possible to introduce, from the specification phase, detailed and complete information allowing unambiguous communication between the partners. Eurocopter developed and integrated the EC155 autopilot operational functions while SFIM developed the equipment management functions. Both Eurocopter and SFIM sites used SCADE as a specification and code generation tool. A key benefit in resulting in this type of technique is that it allows simulation on a host machine before integration into the target computer, specifications which are better validated and more complete.

The SCADE Qualifiable Code Generator Facilitates Software Certification: No Need for Unit Tests

Embedded software in aircraft must conform with the DO-178B standard defined by the RTCA/EUROCAE and applied by the civil aviation officials of each country. Autopilot software must conform to the most critical level: Level A. Previously, the verification of source code and testing of each module was a very laborious and costly activity (e.g. verification of coding rules, achievement of structural coverage). Now, the SCADE C code generator generates perfectly identified, well-calibrated and secure source code sequences.

In 1997, a pre-qualification process for the SCADE code generator was initiated. Acceptance of the procedure was dependent on the use of the tool in the frame of a DO-178B avionics software certification. In November 1998 and February 1999, the EC155 autopilot project used the first available results of the pre-qualification process for certifying the two initial versions with a limited certification credit for SCADE. The team nevertheless carried out unit tests and found no errors.

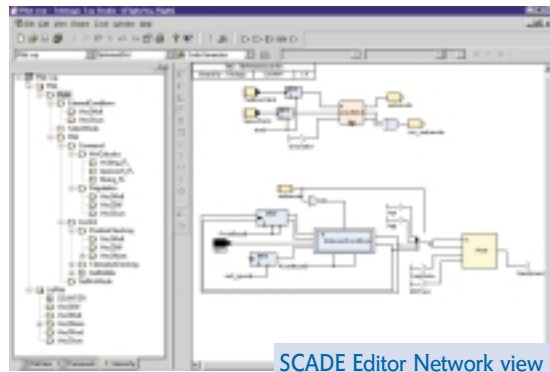
In early 1999, the CEAT (Centre d'Essais Aéronautique de Toulouse: Toulouse Aeronautical Test Centre) was given the task of checking the quality of civil aviation software by the Direction Générale de l'Aviation Civile (Directorate General for Civil Aviation) and carried out an initial audit on SCADE prequalification. Since then, the unit tests have proved unnecessary, as they are no longer needed for either for the EC155 or the EC135. However, the functional and integration tests remain.

Benefits and Future of SCADE With Eurocopter

The product has automatically generated 33,500 lines of C code corresponding to 450 SCADE nodes, while 13,000 lines for equipment management have been written manually. The immediate benefit in using SCADE has been the considerable shortening of the debugging loops. Integrating modifications in a new version has now become possible in 24 to 48 hours. Numerous benefits have been observed for this first project including ease of communication and debugging, fast integration of changes, etc. The cost of introducing this new technology has been largely compensated by the observed gains in productivity and lead time. Future projects will profit more completely by the gains in development time. Besides future autopilots, Eurocopter envisages using the product for developing functions which require large algorithmic processing. In addition, making the product and associated methods available to equipment manufacturers will shorten lead times and thereby reduce costs.

An Efficient Support

The first version of the code generator used in 1997 produced an unsatisfactory code in terms of performance at speed. The 25 and 100 ms cycles required for correct control of functions could not be maintained due to the complexity of the processes to be carried out. The resources required for adapting the code generator performances to Eurocopter demands have since been implemented. Today, the processor occupation rate does not exceed 50%. In addition, the code generator pre-qualification process has been accelerated to accommodate Eurocopter's scheduling constraints.



The Project Manager's Opinion

Jacques Doerflinger, Airborne software department manager at Eurocopter Technical Directorate in Marignane, supports this approach: "We shall benefit from the certification credit of SCADE code generator and no longer need to check all the code manually. SCADE enables the production of a complete and unambiguous specification and the generation of its associated embedded source code. The usual critical path is thus removed from software development and transferred to the specification and validation phases. Additionally, the reduction of the development cycle is accompanied by improved control of quality requirements."

SCADE: The Cost and time effective solution for safety critical software

SCADE enables you to automatically produce your safety critical real-time embedded systems and automates application code generation for increased productivity.

SCADE main features include:

- o Intuitive and familiar visual representation
- o Early detection of design errors using simulation
- o Readable, traceable and reliable C & Ada generated code
- o Functional testing and code coverage assessment
- o Automatic documentation generation
- o Component reuse support
- o Legacy code generation



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