Integrated Model-Based Design and Simulation of Critical Embedded Systems

ABSTRACT

Since the introduction of the fly-by-wire system in the Concorde and A320 civil aircraft programs, overall aircraft embedded systems complexity is continuously increasing. Current and forthcoming aircrafts highly depends on embedded avionics to operate. Computer innovation in these embedded avionics enabled us to improve flight safety, and the relation between the aircraft and environment, flying greener, cleaner, quieter, and, furthermore, being economically cheaper and sustainable for airlines. As the complexity grows due to continuous innovation in embedded avionics on aircrafts, Systems Engineering techniques currently employed to devise such systems are becoming insufficient to cope with existing requirements and dynamics in aircraft design, development, and production.

Two activities that suffer the most with the pressure when complexity increases are design and simulation of embedded avionics systems. Design concerns the development of avionics equipments, answering to stakeholders' requirements. Simulation concerns both the validation and refinement of designed equipment, and the development of aircraft simulators for training purposes. Despite the fact that design and simulation are very dependent of each other in order to prospect and to validate embedded avionics, respectively, current state-of-the-practice on Systems Engineering in AIRBUS put them somehow apart; not intentionally, but due to the lack of formalism and standardization when specifying design and simulation requirements, and when realizing them into concrete implementations. The specifications of design and simulation are currently performed in a textual document-centered approach, making very difficult the deployment of techniques to trace how design decisions constrain simulation, and how simulation requirements and results refine design.

To enable sustainable growth in complexity of forthcoming embedded avionics systems, while being economically viable, and continuously add innovation on these systems, this work proposes a Model-Based Systems Engineering approach to integrate design and simulation activities in the aircraft development cycle, adopting UML/SysML as specification language. By adopting a unified specification formalism to design and simulation, we can trace how design elements constrain simulation, and how simulation ones refine design, only by having them connected with UML/SysML language constructs. We have validated the approach with real design artifacts and simulation models from the A380 aircraft, showing a good scaling for complex models.

Keywords: Aircraft, AIRBUS, Code Generation, Eclipse, Metamodel, Model-Driven Engineering, Simulation, System Engineering, SysML, UML.