Thesis Abstract

On-board systems play a critical role in ensuring the safe and efficient operation of an aircraft. They include all the systems that perform a needed function for the aircraft, such as control or cabin air conditioning, as well as the systems that are needed by other systems, such as power generators and distributors. They represent a significant part of the overall aircraft design, directly influencing performance factors such as mass and fuel consumption. Their impact extends beyond the operational phase, affecting various stages throughout the aircraft life cycle (such as manufacturing, maintenance or disposal). The architecture of these systems is determined early in the design process, and it has a profound effect on the final product. Such architecture consists of various subsystems, components, and the connections among them. Given the huge number of possible feasible solutions, the architectural design space is often large and complex, and automation is essential to effectively explore it.

This Ph.D. research focuses on developing a methodology to evaluate the performance, maintenance, and certification aspects of on-board system architectures during early design phases. The proposed methodology enables the automated assessment of innovative system architectures by linking their design space model to a multi-objective and multi-disciplinary evaluation framework. This framework filters out non-certifiable architectures at an early stage, reducing the design space and saving computational time by preventing unnecessary evaluations.

Two application cases are shown. One assesses the three disciplines of interest for an innovative architecture concept of high-lift devices, comparing it to the conventional case and showing strong potential. The other example illustrates the roll control function of a flight control system. It demonstrates that the effective filtering of the design space successfully identifies the most promising architectures and uncovers valuable trade-offs. This process helps engineers in the decision making process during the conceptual design of on-board system architectures.