

Advanced, Adaptive, Modular, Distributed, Generic Universal FADEC Framework for Intelligent propulsion Control Systems

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Abstract— Advanced intelligent, robust propulsion controls and health management technologies are critical for improving the safety and maintainability of future propulsion systems. Propulsion system reliability could be considered to be critical for aircraft survival, and the key component of the turbine engine is the Full Authority Digital Engine Control (FADEC). Development of an innovative advanced FADEC is essential to a modern integrated, adaptive engine. As the turbine engines become more integrated with the airframe, their respective control systems must also be combined into integrated system intelligence. This combined system might also need to transmit vital system information to ground stations.

Today, each FADEC is unique and therefore is expensive to develop, produce, maintain, and upgrade for its particular application. Each FADEC is essentially a centralized system, with a redundant, central computer and centrally located analog signal interfacing circuitry for interfacing with sensors and actuators located throughout the propulsion system. In the future, it is desired to establish a universal or common standard for engine controls and accessories. This will significantly reduce the high development and support costs across platforms.

What is needed is a Universal FADEC (UF) Platform. This is a system of flexible process and product solutions that is fully independent and composable, and the chief purpose of such a system is to greatly improve engine reliability. Developing and implementing modern intelligent engine systems will also require the introduction of many additional sensors, actuators, and distributed processors to provide the advanced functionality. The term “UF” implies open system architectures with common or “universal” standardized inputs and outputs. Other desirable features for the UF system include the use of common and advanced materials, reusable software, and a reduced number of components. UF reliability (reduced risk of failure) may also be improved through the use of high-reliability modules and improved manufacturing processes. A decentralized/distributed multi-sensor system that is capable of fusing gathered data and using it as a basis for making decisions will provide greater robustness, timeliness and fault tolerance. Composability implies that modules that are developed by different teams at different times, or in parallel, can be made to integrate seamlessly.

The Air Force Research Laboratory initially recognized the need for a UF in May 2003, and began working with the FADEC manufacturers to explore the possibility of building a UF platform. The purpose of that effort is to produce an integrated, hybrid, distributed, modular, and generic framework for the intelligent and robust control and health management of the complex propulsion systems of the future. The incorporation of proven Commercial off the Shelf (COTS) technology into FADECs and the application of artificial intelligence and knowledge-based system for both software and hardware should provide the foundation for building the intelligent control system of the future. The presentation will review the current state of the UF platform for turbine engine controls and examine the issues, challenges and technology gaps that must be addressed in order to realize the vision for the next generation UF.