

AIRBUS FLY-BY-WIRE: A PROCESS TOWARD TOTAL DEPENDABILITY

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Abstract

This paper deals with the digital electrical flight control system of the Airbus airplanes. This system is built to very stringent dependability requirements both in terms of safety (the systems must not output erroneous signals) and availability. System safety and availability principles are presented with an emphasis on their evolution, on future challenges and on pilot aids.

1 Introduction

1.1 Background

The first electrical flight control system (a.k.a. Fly-by-Wire, FbW) for a civil aircraft was designed by Aerospatiale and installed on Concorde. This is an analogue, full-authority system for all control surfaces and copies the stick commands onto the control surfaces while adding stabilizing terms. A mechanical back-up system is provided on the three axes.

The first generation of electrical flight control systems with digital technology appeared on several civil aircraft at the start of the 1980's including the Airbus A310. These systems control the slats, flaps and spoilers. These systems have very stringent safety requirements (in the sense that the runaway of these control surfaces is generally classified as Catastrophic and must then be extremely improbable). However, loss of a function is permitted, as the only consequences are a supportable increase in the crew's workload.

The Airbus A320 was certified and entered into service in the first quarter of 1988. It is the first example of a second generation of civil electrical flight control aircraft, which is now a full family (A318, A319, A320, A321, A330, A340). The distinctive feature of these aircraft is that high-level control laws in normal operation control all control surfaces electrically and that the system is designed to be available under all circumstances.

This family of airplane has accrued a large and satisfactory service experience with more than 10000 pilots operating a Fly-by-Wire Airbus, and more than 40 million flight hours. Nevertheless, system architecture is permanently challenged to take benefit of technical progress and of this large in-service experience. Indeed, on top of the architecture level reached by A340^[1], A340-600, A380, and A400M are going steps further.

The A340-600 is the first significant change compared to the A320/A330/A340 baseline. It entered into service mid of 2002, introducing structural modes control, a full rudder electrical control and integration of autopilot inner loop with manual control laws. The full rudder electrical control is now part of all A330 and A340 definition.

A380 and A400M will be the first in-service aircraft with electrical actuation of control surfaces (a.k.a. Power-by-Wire). Additionally, new avionics principles are applied and a full autopilot and manual control integration is performed^[2].

A350 baseline is A380 functions and system. Other architectures are possible^[3]. The family of architectures we have designed has the merit of

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Dependable Computing - EDCC 2005 Mario Dal Cin, Mohamed Kaâniche, András Pataricza, 2005-03-31 It is always a special honor to chair the European Dependable Computing Conference EDCC EDCC has become one of the well established conferences in the field of dependability in the European research area Budapest was selected as the host of this conference due to its traditions in organizing international scientific events and its traditional role of serving as a meeting point between East and West EDCC 5 was the fifth in the series of these high quality scientific conferences In addition to the overall significance of such a pan European event this year's conference was a special one due to historic reasons The roots of EDCC date back to the moment when the Iron Curtain fell Originally two groups of scientists from different European countries in Western and Eastern Europe who were active in research and education related to dependability created a joint forum in order to merge their communities as early as in 1989 This trend has continued up to today This year's conference was the first one where the overwhelming majority of the research groups belong to the family of European nations united in the European Union During the past 16 years we observed that the same roots in all the professional cultural and scientific senses led to a seamless integration of these research communities previously separated artificially for a long time EDCC has become one of the main European platforms to exchange new search ideas in the field of dependability Dependable Computing--EDCC ..., 2005

Aerospace Actuators 1 Jean-Charles Maré, 2016-06-14 This book is the first of a series of volumes that cover the topic of aerospace actuators following a systems based approach This first volume provides general information on actuators and their reliability and focuses on hydraulically supplied actuators Emphasis is put on hydraulic power actuators as a technology that is used extensively for all aircraft including newer aircraft Currently takeovers by major corporations of smaller companies in this field is threatening the expertise of aerospace hydraulics and has inevitably led to a loss of expertise Further removal of hydraulics teaching in engineering degrees means there is a need to capitalize efforts in this field in order to move it forward as a means of providing safer greener cheaper and faster aerospace services The topics covered in this set of books constitute a significant source of information for individuals and engineers seeking to learn more about aerospace hydraulics Static Analysis of Software Jean-Louis Boulanger, 2013-02-07 The existing literature currently available to students and researchers is very general covering only the formal techniques of static analysis This book presents real examples of the formal techniques called abstract interpretation currently being used in various industrial fields railway aeronautics space automotive etc The purpose of this book is to present students and researchers in a single book with the wealth of experience of people who are intrinsically involved in the realization and evaluation of software based safety critical systems As the authors are people currently working within the industry the usual problems of confidentiality which can occur with other books is not an issue and so makes it possible to supply new useful information photos architectural plans real examples *Advances in Aeronautical Informatics* Umut Durak, Jürgen Becker, Sven Hartmann, Nikolaos S.

Voros,2018-05-10 The history of flight started with the pioneer era The introduction of mechanical controls including hydraulics then led to the second era Later with the utilization of computers and automation in aircraft we reached the third era Now we are moving towards the fourth era of flight namely Flight 4.0 which is characterized by smart and connected aircraft that extensively exploit emerging information and communication technologies Aeronautical informatics is advancing rapidly through the synergy between information and communication technologies and aeronautics Multi core avionic platforms wireless avionics networking service oriented architectures and IoT data sciences and semantic infrastructures are shaping systems to come Increasing autonomy requirements are challenging the community to investigate new ways to assure safety Modern software engineering methodologies and real time software techniques are altering the established development practice Universities are starting to align their aerospace engineering and computer science curriculums in order to address this synergy This book is a unique compilation of advancements in aeronautical informatics introducing the changing technology landscape of flight with respect to a new push in information and communication technology

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