Flying into the Modern World: Airplanes Upgraded to Meet Today's Industry and Consumer Demands for More Electronics

The world of aircraft electronics is growing and becoming ever-more important as manufacturers look for more ways to automate their systems. In fact, in a recent report by the Aircraft Electronics Association, it was found that worldwide aviation avionics sales were 6.9% higher than in 2012 at US$2.4 billion annually, 54% of which was for new aircraft and 46% for retrofits.[i] Increasing the electronics capabilities aboard and aircraft has many advantages. For instance, it can reduce pilot workload while enhancing mission capabilities. Electronics are also needed for increased situational awareness and avoiding obsolescence issues, as well as living up to the demands of passengers for greater functionality while inflight.

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Perhaps most importantly, new and changing regulatory requirement often involve the need for upgraded electronics systems on airplanes. And yet despite the enthusiasm for the use of electronics in aircraft, there are many issues yet to be ironed out. Issues of safety crop up frequently with concerns about data breeches and system controls, while others raise alarms about the added weight of increasing the amount of electronic hardware onboard. The following is a brief overview of some of the biggest issues faced by the industry as it grapples with how to improve functionality and comfort without compromising costs and security.

Challenges Faced in the Modernization of Aircraft Electronics with New Hardware

Within the world of airplanes, there's a huge variety shapes, sizes, ages, and configurations, and as such, common technologies as well as regulations have been difficult to develop in a way that meets the needs

of every type of aircraft. From a single engine sport aircraft to a massive Boeing machine, there is a lot of ground to cover.

Consider the fact that, if manufactured several decades ago during the analog era, an aircraft will need to undergo the integration of digital systems such as the replacement of AC-powered analog units with digital DC units, updating new data protocols with things like Avionics Full Duplex or switched Ethernet, MIL STD 1553 or ARINC 429 buses, and so on in order to meet modern standards. In most cases, when upgrading an aircraft with additional electronics systems, power usage also needs to be taken into consideration in order to avoid the need to upgrade generators or power bus bars which are costly to replace. Combining digital and analog systems would be simplified by plug and play options seen in other areas of the electronics industry, but these options have yet to be developed for aircraft, especially given the vast array of configurations.[ii]

Creating additional complexities for the industry is the fact that, throughout any upgrading process, regulators require that all changes meet safety standards, but these safety standards have not been well coordinated by and large. For instance, in Europe and the US, there are two sets of requirements for planes weighing up to 5,700 kg called the Special Federal Aviation Regulation No. 23 (CS-23) (for Europe) and Part 23 — Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes (for US). With aircraft representing technologies dating back 40 years within this single category, it's no surprise that the effort to regulate electronics across all variations has been great.[iii]

That said, the industry is making progress. In the US, they recently passed the Small Airplane Revitalization Act of 2013 which is set to come into effect December 15, 2015. The European Aviation Safety Agency in conjunction with regulators in Brazil, Canada, China and New Zealand are making efforts to adopt similar rulemaking in the near future. [iv]

Another development in the aircraft electronics regulation space is the FAA requirement for all US-registered aircraft to have automatic dependent surveillance-broadcast (ADS-B) systems installed by January 1, 2020. It will also be required in EU airspace starting 2017 for all aircraft over 5,700 kg or with a max cruise of over 250 knots (all new aircraft built from 2015 onward requires it as well). [v]

These systems, which determine an airplane's position via satellite navigation (broadcasting it periodically via radio frequency) in order to track it more accurately mid-flight and on the ground, are part of the Next Generation Air Transportation System (NextGen) and the Single European Sky ATM Research (SESAR). The aim of these new systems is to ensure better air traffic control in order to allow for a larger volume of planes and a more efficient routing of them. The systems are said to be low-cost replacements for conventional radar and will expand the level of monitoring throughout the globe.[vi]

Those that install these systems receive benefits such as the capability of flying overwater routes over the Gulf of Mexico, the New York Center, or Canada's Hudson Bay area. [vii]

Despite the benefits and the coming 2020 deadline, the FAA recently reported that of the 157,000 aircraft in need of this upgrade, only 3,500 planes have received it. In order to make the deadline, a total of 40 aircraft need to be modernized with the ADS-B systems daily between now and the deadline, but the current average is only 13 daily. To further complicate progress, the FAA has found that many of the completed installations have faults in that they are sending inaccurate ADS-B out position, velocity, and time information to ground infrastructure. [viii] This is just one hardware system that is creating challenges for the industry as they struggle to find a way to harmonize standards and systems for more electronic aircraft.

Coping with Software Upgrades for Aircraft Electronics

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In addition to the upgrading of electronic hardware aboard airplanes, there is a need for added software, which is a relatively new development. While older Airbus A320s and Boeing 737s contained only 30 pieces of software, today's Boeing 787s have over 500 software units loaded onto 800 to 900 locations on the aircraft. No doubt, managing all of these pieces of software poses a huge problem, and opens up aircraft to a variety of safety and security risks. [ix]

To overcome some of these software challenges, the industry is looking to loadable software systems, which are independently configured at the airplane level and include software and hardware parts (LRUs). With a permanent onboard loader or a portable onboard loader, the equipment allows upgrades to be installed safely when upgrade notifications are given through service bulletins, engineering orders, vendor notifications, service letters, or OEM specific communications. The goal is to ensure operators are able to quickly change and update functionality of commercial airplanes while reducing the need for extra hardware, modification time, and maintenance. Within such a system exists several checks and balances including guidelines for procurement and duplication, configuration and control, quality audits, and software library management, all of which combine to create a highly complex web of software integration. [x]

To simplify the process, many are turning to wireless solutions for managing loadable software configuration and control, but this brings with it many regulatory considerations as well. For instance, initial installations must receive OEM STC approvals as well as any local regulatory guidelines for software downloads to an aircraft. Additionally, there must be defined processes for providing full control of the software and validation of the configuration and of control following replacement.[xi] The industry is still wrestling with these issues as it adapts to the modern world.

Regulations have been drawn up in order to control the use of flight data monitoring information. Under the ICAO Annex 6 mandate, regional legislations have been implemented to manage flight data monitoring (FDM) programs. The Civil Aviation Authority (CAA) in the UK has developed the EU-OPS rules which regulate accident prevention and flight safety, retention of data for accident occurrences, reporting, installations, serviceability, and more.[xii] While the US doesn't yet require flight operational quality assurance (FOQA) programs for commercial operators, the US Department of Transportation FAA has created flight operational quality assurance circular to define FOQAs.[xiii] Obviously, as with electronic hardware used in aircraft, much more work is required to bring this issue into the modern age and to synchronize efforts across borders.

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Sources

[i] Thurber, M. (2014, April). *Aircraft Electronics Association Report: ADS-B and FDM among Top Issues for Operators*. Retrieved June 3, 2014, from AINonline: http://www.ainonline.com/aviation-news/aviation-international-news/2014-04-05/aircraft-electronics-association-report-ads-b-and-fdm-among-top-issues-operators

[ii] *Challenges involved in modernising an aircraft's avionics suite - See more at: http://www.newelectronics.co.uk/electronics-technology/challenges-involved-in-modernising-an-aircrafts-avionics-suite/56147/#sthash.qoqzyMe1.dpuf*. (2013, September 10). Retrieved June 3, 2014, from New Electronics: http://www.newelectronics.co.uk/electronics-technology/challenges-involved-in-modernising-an-aircrafts-avionics-suite/56147/

[iii] *Creating a New Generation of Aircraft and Pilots*. (2014, May/June). Retrieved June 3, 2014, from Standardization News: http://www.astm.org/standardization-news/provocative/creating-a-new-generation-of-aircraft-and-pilots-mj14.html

[iv] *Creating a New Generation of Aircraft and Pilots*. (2014, May/June). Retrieved June 3, 2014, from Standardization News: http://www.astm.org/standardization-news/provocative/creating-a-new-generation-of-aircraft-and-pilots-mj14.html

[v] *New Air Traffic Surveillance Technology*. (n.d.). Retrieved June 3, 2014, from Boeing: http://www.boeing.com/commercial/aeromagazine/articles/qtr_02_10/pdfs/AERO_Q2-10_article02.pdf

[vi] *New Air Traffic Surveillance Technology*. (n.d.). Retrieved June 3, 2014, from Boeing: http://www.boeing.com/commercial/aeromagazine/articles/qtr_02_10/pdfs/AERO_Q2-10_article02.pdf

[vii] Thurber, M. (2014, April). *Aircraft Electronics Association Report: ADS-B and FDM among Top Issues for Operators*. Retrieved June 3, 2014, from AINonline: http://www.ainonline.com/aviation-news/aviation-international-news/2014-04-05/aircraft-electronics-association-report-ads-b-and-fdm-among-top-issues-operators

[viii] Thurber, M. (2014, April). *Aircraft Electronics Association Report: ADS-B and FDM among Top Issues for Operators*. Retrieved June 3, 2014, from AINonline: http://www.ainonline.com/aviation-news/aviation-international-news/2014-04-05/aircraft-electronics-association-report-ads-b-and-fdm-among-top-issues-operators

[ix] *Best Practices for Loadable Software Management and Configuration Control*. (2013, June). Retrieved June 3, 2014, from IATA: http://www.iata.org/whatwedo/workgroups/Documents/loadable-software-management-configuration-control.pdf

[x] *Best Practices for Loadable Software Management and Configuration Control*. (2013, June). Retrieved June 3, 2014, from IATA: http://www.iata.org/whatwedo/workgroups/Documents/loadable-software-management-configuration-control.pdf

[xi] *Best Practices for Loadable Software Management and Configuration Control*. (2013, June). Retrieved June 3, 2014, from IATA: http://www.iata.org/whatwedo/workgroups/Documents/loadable-software-management-configuration-control.pdf

[xii] *Flight Data Monitoring*. (2013, June). Retrieved June 3, 2014, from CAA: http://www.caa.co.uk/docs/33/CAP739.PDF

[xiii] *Advisory Circular: Flight Operational Quality Assurance*. (2004, April 12). Retrieved June 3, 2014, from US DOT FAA: http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/40c02fc39c1577b686256e8a005afb0a/$FILE/AC120-82.pdf