Assessment of IMA in Civil Aircraft

CISEC

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Overview

• IMA Systems are the current standard for civil aircraft systems

• IMA System certification requirements are maturing

• IMA System definition and development is complex

• IMA Systems must still prove their lifecycle value
Integrated Avionics

Civil Aviation has leveraged integration for many years to reduce System Size, Weight, Power, and Cost
IMA Systems in Civil Aircraft

- Integrated Modular Architecture (IMA) based systems are the current standard for civil aircraft
  - Air Transport category aircraft
  - Regional category aircraft
  - Business aircraft

- IMA systems support multiple Air Transport Association (ATA) chapters across the aircraft systems
  - Avionics – Flight Displays, Navigation, Communications
  - Utilities – Power Control, Fuel Monitoring
  - Aircraft Functions – Braking and Steering
Civil Certification of Integrated Systems

• IMA Systems integrate many systems and functions that have traditionally been federated
  – Certification methods for federated systems is mature
  – Functional Technical Standard Orders (TSO’s) exist for many systems
    • Minimum Operational Performance Standards (MOPS)
    • Physical and logical interfaces defined

• IMA Systems stretched existing certification methodologies
  – Functional based TSO’s have limited applicability in IMA
    • Functional MOPS still valid, physical and logical interfaces usually not applicable
  – Methods of certification for integrated systems were immature
    • Modular TSO (C153) completed, utilization not consistent
    • Analysis of failures in shared resources not consistent
Certification Aspects for IMA Systems

• EUROCAE and RTCA developed DO-297 – Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations
  – “Guidance for Integrated Modular Avionics (IMA) developers, application developers, integrators, certification applicants, and those involved in the approval and continued airworthiness of IMA systems in civil certification projects”

• DO-297 Definition of IMA
  – IMA is a shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a platform that provides services, designed and verified to a defined set of safety and performance requirements, to host applications performing aircraft functions.

Guidance will improve the maturity of IMA system Development for Civil Certification
IMA System Complexity

- Systems that share resources are inherently complex
  - Physical Resources such as data buses / networks
  - Logical Resources such as data packets and messages
  - Temporal Resources such as data latency
- IMA systems are based on providing sets of shared resources that can be used by multiple functions within the system

- Impacts of integration of multiple functions
  - Fault impact drives high level of integrity and availability
  - System analysis becomes more complex
    - Analytical basis for all functions must be maintained
    - Functional interdependencies of shared resource utilization
    - System common cause analysis of shared resources
Complex IMA System Engineering

- System Engineering is vital to success of IMA
  - System Engineering methodology for complex system development
    - Requirements development and allocation
    - System decomposition, etc.
  - System analysis tools
    - Common cause analysis
    - Shared resource allocation and utilization analysis
  - System configuration tools
    - Certifiable configuration generation and management
  - System integration tools
    - Design and development tools
    - Laboratory integration and test tools
    - Aircraft integration and test tools

Actively managing system complexity through fundamental System Engineering
Aids in the development and certification of IMA systems
IMA Systems have High Value Expectations

• DO-297 summarizes the value proposition for IMA
  – Economic factors, including the needs to provide cost-effective upgrade paths, introduce new operational capabilities (e.g., CNS/ATM functions), fast and efficient maintenance, and to avoid premature obsolescence are the primary incentives for the IMA concept

• IMA Systems expectations
  – IMA Developer
    • Extensive amounts of reuse of hardware and software components across IMA systems
  – Functional Application Developer
    • Large sets of services will be made available with unlimited resources
    • Software will be reusable across multiple IMA systems
  – Aircraft Manufacturer
    • Commonality of aircraft components and reduced future impact to the airframe
  – Aircraft Owner / Airlines
    • Reduced lifecycle impact of change to aircraft functionality
IMA Lifecycle Value Questions to be Answered

• IMA Developer
  – The functionality of the IMA system continues to increase. What is the economic impact of providing a large set of physical resources and software services to the Application development community?
  – As functionality increases, technology must be upgraded. What is the impact of technology insertion of common components within the system?

• Functional Application Developer
  – IMA resources are not unlimited. What is the resulting impact to software portability across multiple IMA systems?
  – Aircraft functions are transitioning toward software solutions. Are these solutions more portable and maintainable than traditionally federated systems?
IMA Lifecycle Value Questions to be Answered

• Aircraft Manufacturer
  – Commonality of components increases the impact of change to the aircraft due to obsolescence, etc. Similarly, technology must be upgraded to support future functionality. Can IMA system components be changed without significant impact to the aircraft configuration?

• Aircraft Owner / Airlines
  – Functional requirements for the aircraft continue to change. Do IMA systems isolate changes to the system functionality from the infrastructure of the aircraft?
Incremental Certification of IMA Systems

- DO-297 defines tasks for the incremental acceptance of IMA systems in the certification process:
  - Task 1: Module acceptance
  - Task 2: Application software or hardware acceptance
  - Task 3: IMA system acceptance
  - Task 4: Aircraft integration of IMA system - including Validation and Verification (V&V)
  - Task 5: Change of modules or applications
  - Task 6: Reuse of modules or applications

Incremental certification and other questions will be answered in the near future as IMA systems have additional years of service.
IMA in Civil Aircraft Summary

- IMA systems are very successful in civil aircraft
  - Aircraft development and certification programs have completed
- IMA system certification is maturing
  - DO-297 provides guidance to improve the process
- Aviation Industry needs improved tools for IMA systems
  - Definition and analysis tools
  - Development and integration tools
  - Verification and validation tools
- Lifecycle value will be proven
  - Incremental changes to aircraft functionality
  - Incremental technology insertion to the infrastructure
  - Maintaining a certifiable configuration

IMA Systems will continue to dominate the civil aircraft market