

AADL-Based Toolset for IMA System Design and Integration

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ABSTRACT

The paper presents an AADL-based toolset for Integrated Modular Avionics (IMA) design and integration. It describes activities of IMA system designer and system integrator that are supported by the toolset as well as its current architecture and future directions of development.

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INTRODUCTION

Transition from federated avionics architecture to IMA is on the way. In federated architecture almost each avionic function (such as flight control, collision avoidance, navigation, communication, etc.) has its own core processor modules (CPM), sensors, actuators and communication channels between them. IMA architecture employs a shared computing platform that hosts multiple avionics functions of different criticality levels. The shared computing platform includes CPMs as well as data buses connecting CPMs with sensors and actuators. As an example, Figure 1 presents one of approaches to building IMA that is employed in Russian IMA program.

In Figure 1, the IMA platform includes CPMs, data concentrators, remote data concentrators and ARINC-664 (AFDX) [1] network components (green boxes). CPMs provide computing and memory resources and they can be extended with mezzanines (graphical processor units, mass storage, etc.). CPM resources are managed by ARINC-653 based Real-Time Operating System (RTOS) with the help of hardware specific device drivers.

Remote Data Concentrators (RDC) are responsible for exchange of information between sensors/actuators and IMA platform. They are typically placed out of avionics bay, close to sensors and actuators. Data concentrators connect CPMs with remote data concentrators and with avionic systems that are not allocated to IMA platform.

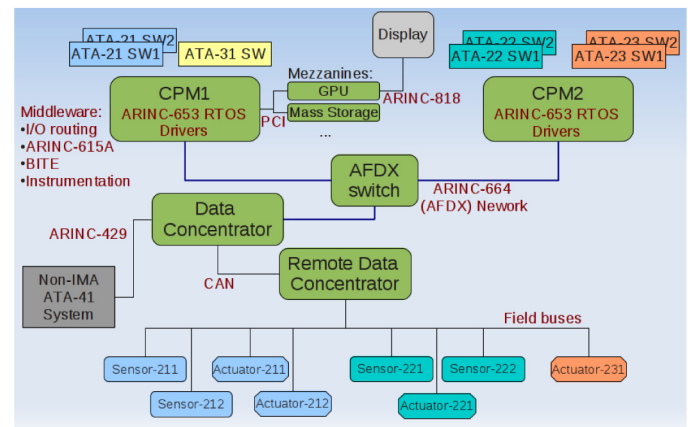


Figure 1. Example of logical structure of IMA platform

Communications between CPMs and data concentrators are based on ARINC-664 (AFDX) network. Data concentrators typically communicate with non-IMA avionics functions using ARINC-429 bus, while interactions with RDC are over ARINC-825 (CAN).

In addition IMA platform includes middleware components that provide services like I/O routing, data loading, BITE, instrumentation, etc.

Avionic functions allocated to IMA platform consist of software partitions (depicted as ATA-XX SW in Figure 1) and a set of sensors and actuators. All other required

resources are provided by IMA platform. Each software partition gets assigned to a CPM that provides computing and memory resources, communication needs are covered by proper configuration of AFDX network and other platform components.

IMA platform together with avionic functions allocated to IMA platform make up IMA system.

The transition to IMA leads to various consequences in avionics system design and system integration processes. New activities of IMA system design and system integration processes include but not limited to:

- Design an architecture of IMA platform and allocate resources required to all avionic functions assigned to IMA.
- Verify the design against all applicable requirements:
 - Verify consistency of resource allocation with requirements of avionic functions and with capacities of IMA platform components.
 - Verify absence of common cause of failure for segregation requirements identified within functional hazard assessment.
 - Verify absence of undesirable interferences between avionic functions.
- Maintain the design in consistency with changing requirements across all development cycle.
- Verify compliance of avionic function implementations with platform requirements.
- Develop configuration tables for all IMA platform components (ARINC-653 RTOS, I/O drivers, AFDX network switches and end-systems, middleware, etc.).
- Verify and qualify the configuration data.

Obviously these activities are complex enough, so tool support is required to achieve safety targets and to keep development time and cost at reasonable levels.

In the following we present a toolset aimed to automate IMA system design and system integration activities. Section 2 gives an overview of roles involved. Section 3 describes architecture models required for IMA design and integration. In section 4 we present details of the toolset, its current state and use cases supported. Finally, we conclude with future directions of development.

IMA SYSTEM GROUP

IMA system group (IMA-SG) is a dedicated group responsible for IMA platform design and integration. It includes the following roles:

- IMA System Designer
- ATA-XX Coordinator
- PCS Coordinator

• IMA System Integrator

IMA System Designer is responsible for a complete design of IMA platform. There is an ATA-XX Coordinator for each avionic function assigned to IMA platform and for each avionic function IMA platform communicates with. ATA-XX Coordinator is responsible for collaboration with ATA-XX supplier regarding:

- initial identification of ATA-XX requirements to IMA platform;
 - further change requests processing;
 - configuration of ATA-XX partitions.
- There is a PCS Coordinator for each platform component supplier, who is responsible for collaboration with the supplier regarding:
- initial identification of characteristics of the platform component;
 - further change requests processing;
 - configuration of the platform component.

IMA System Integrator is responsible for development of configuration tables for all IMA platform components.

There is IMA system verification group (IMA-SVG) as well that is responsible for verification of IMA platform design and IMA system configuration data. IMA-SVG can be either part of IMA-SG or an independent group.

IMA ARCHITECTURE MODELS

Design of IMA system starts with top level aircraft specification, IMA design standard and a list of ATA-XX systems allocated to IMA platform. It provides a first source of requirements to IMA design.

Then collaboration with ATA-XX system designer and platform component suppliers starts. Within the collaboration ATA-XX system designer provides:

- High Level Design
- Resource Requirements
- Interface Control Document
- Preliminary Safety Assessment

High Level Design defines ATA-XX system components (software partitions, sensors, actuators, etc.), connections between them, physical location limitations where applicable. Resource Requirements identifies computing, periodicity and memory requirements for software partitions, power requirements for hardware components, etc. Interface Control Document describes in details connections between ATA-XX components as well as connections with external systems. In final form it includes information about messages (size, frequency, structure, and semantics) and latency requirements including latency of multiconnection flows. The most