WINDOW OF OPPORTUNITY

Sysgo's vice president of marketing, Jacques Brygier discusses the next generation electronics platform opportunities on offer for avionics as currently defined in SCARLETT, a European FP7 joint research project with more than 40 European partners, and where Sysgo is helping to provide the software foundation.

The mechanical control of today's aircraft is increasingly being replaced by electronics, with their inherent weight, cost and sophistication advantages. The first electronic devices were based on a federal architecture where each function was equipped with its own housing, power supply, hardware and software.

The profound impact on weight, cabling and cost that came with the rising number of digital devices resulted in the concept of integrated modular avionics (IMA) in the early 90s. IMA replaced multiple 'boxes' with a smaller number of Core Processing and Input Output Modules (CPIOM) integrated into an avionics bay sharing the power supply and the communication connection.

The new concept has successfully been implemented into the Airbus A380 and will be reused in the A350 XWB, A400M, and Boeing's 787 Dreamliner. While the IMA approach has accomplished the goal of reducing weight and the number of parts significantly – Airbus reports a reduction of 50% in part numbers of processor units – it comes with some disadvantages in terms of scalability. The SCARLETT (SCAlable and ReconfigurabLe Electronics plaTforms and Tools) consortium is investigating an enhanced version of IMA – the second generation IMA2G – which puts more emphasis on flexibility by defining dynamic reconfiguration features. PikeOS Safe and Secure Virtualisation technology plays a major role in the new concept.

From IMA1G to IMA2G

The SCARLETT project has defined a leadtime reduction of 10 to five years as its main objective before a new aircraft enters service. Therefore innovations will be added to IMA1G starting with a more flexible hardware concept that separates input/output from computing modules and replaces the CPIOM by Distributed Modular Electronics components connected by AFDX.

Multicore CPUs will increase computing performance, and a software concept granting more independence between applications and the underlying platform will enable incremental certification.

New reconfiguration mechanisms will manage redundancy and resource allocation dynamically on platform level rather than statically on system level. As a result of the project, SCARLETT will provide a consistent tool chain for the entire development, integration, certification and maintenance process.

IMA2G aims at a maximum level of acceptance in the community and standardisation organisations so that the provided components and tools can be reused for different types of aircraft. To reach that goal, SCARLETT has gathered together all the major suppliers and airframers.

IMA2G requirements

The software requirements for IMA1G were defined in the ARINC standard 653 part 1. The software platform has to provide robust partitioning with protection of privileged services to be accessed by non-privileged services. A generic communication interface shall allow communication between applications on the same module and across module boundaries. The whole system should be supervised by a health monitoring concept which intercepts errors on module, partition and application level and handles them according to a pre-defined configuration setting.

The application programming interface (API) has to provide typical services required by multi-threaded applications like thread management, intra-partition communication and synchronisation, time management services and application level error handling.

IMAG2 will extend the existing services around ARINC 653 to manage platform reconfiguration. It also requires the availability of multiple APIs including open standards like POSIX, Java or Linux to support a wider range of applications.

Requirements for in-flight reconfiguration will be achieved either by multiple pre-defined configurations which are activated upon request through a commanded module reboot or by a concept allowing applications of a running module to be replaced without restarting the module. The SCARLETT project currently investigates whether multicore CPUs can be used in a deterministic, certifiable, and ARINC 653 compatible way.

Jacques Brygier: Vice president of marketing, Sysgo

PikeOS Safe and Secure Virtualisation (SSV)

The concept of PikeOS follows the IMA requirements and provides a capable, but small and flexible platform. PikeOS serves as a backbone in the SCARLETT project and builds the software foundation of various components ranging from the core processing modules, the remote data concentrator, and remote electronics to simulation environments.

PikeOS is built upon para-virtualisation technology. Based on a micro kernel, it provides a software interface to virtual machines – the so called Virtual Machine Monitor (VMM) – which is rich enough to implement a complete operating system on top, but which explicitly excludes all functionality which may compromise partitioning.

With APIs for POSIX, ARINC 653, Linux, OSEK, iTRON, Java, Ada etc, PikeOS satisfies the IMA2G demands for multiple API support. Contrary to other virtualisation concepts, para-virtualisation does not depend on specific virtualisation support from the hardware, thus it can be implemented on different CPU families. Up to 62 safely separated partitions can include applications and APIs of different levels of criticality.

All aspects of partitioning are covered in a way that application runtime environments run as user level code. Processor privilege levels are used to protect the critical domain from the user domain. The virtual machines communicate with each other and with I/O devices through ARINC 653 compliant communication ports, and can be individually stopped and restarted. All partitions are constantly checked on exceptional events by a health monitor system. PikeOS is a modular platform with a small code base of not more than 10,000 lines, making certification affordable.

Sysgo started with PikeOS when IMA came into use. The company's platform matched all requirements of the IMA concept and subsequently, has been implemented into today's aircraft. The SCARLETT project is the key of IMA2G, and as a member of the project Sysgo ensures PikeOS will meet the requirements for the development of next generation aircraft too.

Beyond IMA2G

One question overlooked by the IMA concept, but which has been asked by customers from the very beginning is what to do with the legacy code of the existing applications running in an aircraft?

PikeOS can be equipped with more operating system APIs, thus virtualisation may help to lower the porting and certification costs significantly. Most of these costs are caused by requirement, design and verification activities. If large portions of the application software can remain untouched the corresponding design artefacts and test cases remain valid as well. Porting an application by developing an appropriate porting layer can save a lot of development and verification effort compared to an application redesign for an ARINC 653 API.

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