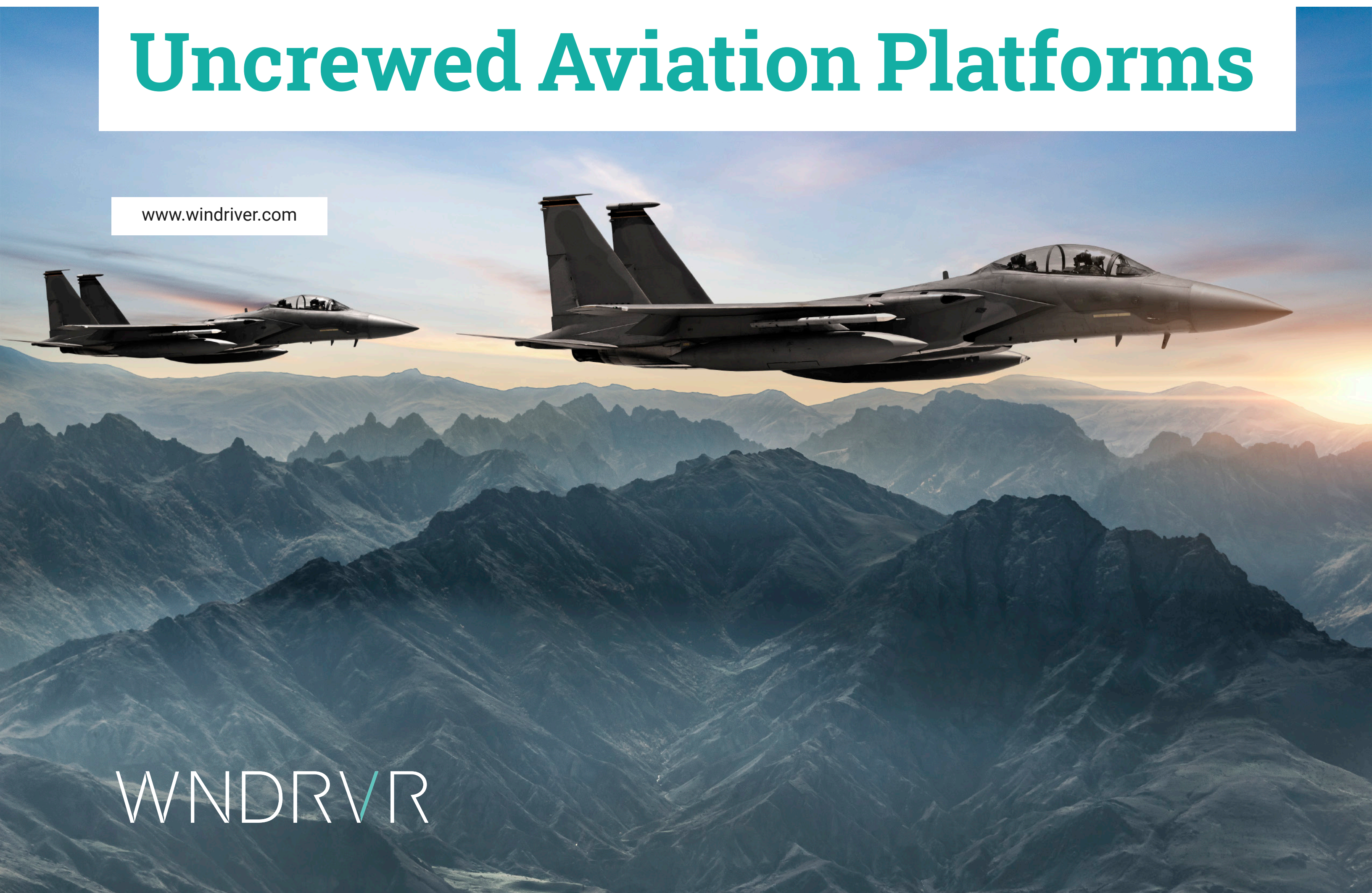
MOSA for Crewed and Uncrewed Aviation Platforms



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Executive Summary

Avionics systems professionals face the challenge of keeping pace with rapid technological evolution while balancing complex requirements with limited budgets. In today's digitally defined landscape, the traditional way of designing avionics systems as closed systems, with hardware and software tightly integrated and designed specifically for a particular aircraft, is proving unsustainable.

Where security, safety, and reliability are paramount, our mission is to enable our customers to realize the digital future with software-defined, mission-critical intelligent systems. The Modular Open Systems Approach (MOSA) and related standards and solutions have contributed to the increase in features and capabilities.

In this paper, we'll examine the ways in which MOSA benefits the avionics space, for both military and civilian applications, and enables faster development cycles, reduced costs, increased flexibility, and improved safety.

Advantages of a Modular Open Systems Approach

As the demand grows for innovative, efficient, and safe technology in avionics development, the implementation of MOSA has become a competitive game-changer. MOSA is not itself a standard but is a strategy for component acquisition and system design that prioritizes use of open standards–based technologies. The goal is systems that are flexible, competitive, and sustainable over their entire lifecycle.

MOSA provides a scalable path for building avionics systems, leading to increased efficiency. Cost-effectiveness is another advantage, as each system can be designed using standard components already available on the market. This eliminates the need for costly bespoke designs and ensures that components can be purchased in bulk from competitive vendors and used across multiple aircraft types, both military and commercial.

In complex environments, utilizing MOSA along with other technologies, such as integrated modular avionics (IMA), can further enable flexibility, affordability, and enhanced capabilities. IMA simplifies avionics software development by supporting an integrated architecture of application software that is portable across common hardware modules. Avionics systems can be designed as individual modules that can be swapped in and out as needed. Complexity management is also addressed, since each module is designed to operate independently, which simplifies the overall system design. IMA also allows use of standard interfaces, which makes it easier to integrate new modules with existing systems.

Figure 1. Multiple stakeholders across the Department of Defense are active in the MOSA ecosystem.

MOSA and FACE Conformance

To provide a common framework for integrating different avionics systems, standards such as the Future Airborne Capability Environment (FACE™) Reference Architecture have emerged. FACE supports MOSA because it backs the concept of integrated modular avionics.

> "The idea of integrated modular avionics came out of research that was done by the major suppliers over many years, and they came out with an open standard, the ARINC 653 standard, which is folded into the FACE environment. So FACE makes use of existing open standards."
>
> **— Alex Wilson,**
> *Director, A&D Industry Solutions*
> *Wind River*

Leveraging the FACE Conformance Program at Every Level

FACE Reference Architecture is comprised of five architectural segments:

1. Operating System Segment (OSS)
2. Input/Output Services Segment (IOSS)
3. Platform-Specific Services Segment (PSSS)
4. Transport Services Segment (TSS)
5. Portable Components Segment (PCS)

Each of these segments plays a specific role in the overall avionics system.

The Operating System Segment (OSS)

The OSS provides the foundation for the entire FACE Reference Architecture. Avionics professionals can use a variety of different OSS solutions to plug into the solution stack. Wind River® Linux is a popular choice, as it conforms to the FACE general purpose profile. Wind River Helix™ Virtualization Platform and VxWorks® 653 are other options that conform to safety-based profiles.

Input/Output Services Segment (IOSS)

The IOSS provides standardized interfaces for all the I/O capabilities of the avionics system. These can include sensors and displays through to communication systems and other peripherals. The IOSS allows avionics professionals to more easily integrate different I/O components into the system and ensure that they work together seamlessly.

Platform-Specific Services Segment (PSSS)

The PSSS provides the necessary software and hardware components to support the unique features and capabilities of a particular platform. For example, different aircraft may require different interfaces, protocols, and other components, depending on their specific design and requirements. The PSSS allows avionics professionals to more easily design and implement systems that are tailored to the specific needs of a particular platform.

The Transport Services Segment (TSS)

The TSS is responsible for correctly aggregating data from different parts of the system. The required operating system profile depends on the end use of the system. For example, building a display requires data to be aggregated and converted into a format that can be displayed on the screen.

The Portable Components Segment (PCS)

The PCS allows designers to integrate portable components that can be used across multiple avionics systems. A graphical display, again, is a good example of a portable component, because it can be implemented using a standard such as the ARINC 661 graphics server. By taking data from services and the OSS, designers can pass that data out to a display within the environment.

At the bottom of the FACE Reference Architecture are all the hardware interfaces, which must be designed and integrated to ensure that the avionics system is fully functional.

By adhering to the FACE Reference Architecture and using MOSA, avionics professionals can design and integrate avionics systems that are efficient, effective, and interoperable.

ENSURE FULL COMPLIANCE WITH THE FACE STANDARD

The FACE Conformance Program includes a variety of tools and resources, including test procedures, test tools, and a conformance registry.

MOSA for Crewed and Uncrewed Aviation: Tools at the Modeling Level

According to Fortune Business Insights, the global avionics market is projected to reach $75.81B by 2027, with a CAGR of 9.25% from 2019 to 2027, driven by the increasing demand for advanced systems in modern aircraft.[1] MOSA can help meet this demand by enabling the integration of new technologies, reducing development costs, and improving performance and reliability.

A MOSA design focuses on developing open and interoperable systems using modular, independent components that can be easily modified, replaced, or upgraded. With tools available at the modeling level, these approaches can be used in crewed and uncrewed aviation.

High-Performance Systems with Different Safety-Criticality Levels

MOSA enables the development of high-performance systems that can support different safety-criticality levels. Safety-critical systems are defined as systems whose failure could result in injury or loss of life, damage to property, or damage to the environment. Since safety is paramount in avionics, MOSA is useful because it helps mitigate risk by enabling the development of robust, reliable, and flexible systems.

To achieve the full benefits of MOSA, it is essential to verify and validate all components against the appropriate safety standards. Meeting standards such as DO-178C for software, DO-254 for hardware[1], and DO-297 for system architecture in airborne systems is essential for achieving certification and ensuring compliance with regulatory requirements.[2,3,4]

1. Fortune Business Insights, "Avionics Market Size, Share & Industry Analysis," August, 2020
2. RTCA, Inc., DO-178C: Software Considerations in Airborne Systems and Equipment Certification, 2012
3. RTCA, Inc., DO-254: Design Assurance Guidance for Airborne Electronic Hardware, 2010
4. RTCA, Inc., DO-297: Integrated Modular Avionics (IMA) Development and Certification Considerations, 2018

Airworthiness and Conformance to the FACE Standard Are Not the Same

There are critical factors that need to be considered when implementing MOSA in aviation — one of the most important being airworthiness.

The Federal Aviation Administration (FAA) defines airworthiness as the measure of an aircraft's suitability for safe flight. While it is often associated with airworthiness, it is important to note that the FACE standard does not mandate or specify a particular way of achieving airworthiness. Instead, it provides guidelines to build a safety-critical piece of avionics that can be adapted to fit different airworthiness requirements.

When building avionics systems using MOSA, it is essential that the system's features and attributes adhere to the safety profile, which defines the system's characteristics and requirements that help ensure safe and reliable operation.

The Growing Acceptance of Multi-Core Processors

Multi-core devices have become increasingly popular in avionics because they offer improved performance, reduced power consumption, and increased redundancy. However, their implementation requires careful consideration of avionics certifications and safety requirements.

Risk mitigation is a critical component of MOSA implementation; it requires strict adherence to guidelines to ensure that software safety testing conforms to safety and security guidelines. Wind River has been involved in this area of avionics for more than 20 years. VxWorks 653 and Helix Platform have gone through numerous safety processes over the years with different authorities, both military and commercial, covering different levels of safety and different operating environments. VxWorks Cert Edition is a platform for safety-critical applications that require DO-178C, IEC 61508, IEC 62304, or ISO 26262 certification evidence in the avionics, industrial automation, medical device, and transportation industries.

> "If you're having two applications on your final system running alongside each other at different levels of criticality, you don't want your lower-level maintenance tasks halting your highly critical flight control software."
>
> **— Alex Wilson,**
> *Director, A&D Industry Solutions*
> *Wind River*

For example, the Airbus A330 Multi Role Tanker Transport (MRTT), a military tanker with an application for automated air-to-air refueling, underwent safety certification following DO-178C Level A and CAST-32A requirements. Wind River supported Airbus with VxWorks 653 for achieving its certification milestone for automatic air-to-air refueling.

As the aviation industry evolves, MOSA is expected play a significant role in the development of innovative and safe avionics systems that enable no-fail operations, whether crewed or uncrewed. MOSA implementation in aviation will be critical to remaining competitive, flexible, and profitable.

MOSA and Next-Generation Technology in Avionics Systems Development

One of the significant developments in avionics systems is the move toward intelligent edge devices. Intelligent edge systems collect and process data at the edge, feeding it into a cloud-based environment for analytics.

The flexibility such systems bring supports incredible potential, allowing quick upgrades of applications and services on the system. Critical to the security of this approach is use of a DevSecOps environment.

> "In a DevSecOps environment, security is built in all through the process, from when we start designing our system to when we start developing the code, testing the code, releasing the code, deploying the code, and operating the code. Security is built into every stage of that whole lifecycle."
>
> **— Alex Wilson,**
> *Director, A&D Industry Solutions*
> *Wind River*

Containerization also plays a critical role in enabling intelligent edge capabilities, providing significant benefits to engineers. Containers offer a lightweight, portable, and scalable way to package applications and services, allowing faster deployment and simpler management. For example, the U.S. Air Force has shown that an F-16 with a container-based server can deploy containers on the aircraft even in flight. This ability offers a range of benefits, including updating and replacing at least some software applications without needing to take the aircraft offline. This is especially important for military aircraft, where downtime can have significant operational implications.

With the advent of embedded systems and the intelligent edge, avionics systems are evolving to offer sophisticated, high-performance capabilities with enhanced safety, security, and efficiency features. MOSA and related technologies and standards are all playing critical roles in enabling these next-generation capabilities. Avionics developers and engineers must leverage these advancements to deliver the most innovative and efficient avionics systems.