EMBRACING FACE FOR MILITARY AVIATION AGILITY

THE CHALLENGE

As military aircraft have become more sophisticated, so have onboard software systems. Avionics must advance to support evolving mission requirements, such as advanced weapons systems, sensor fusion, and artificial intelligence. Moreover, the shift from hardware-defined to software-defined systems has played a large role in increasing the complexity of onboard software.

In this environment, the software lines of code (SLOC) count of onboard systems has been doubling about every four years.[1] This exponential growth has produced unsustainable rises in complexity, cost, and development time. Making matters worse, most of this software comprises bespoke systems that cannot easily be adapted to other aircraft platforms. That lack of standardization and reusability limits the value of software assets by restricting where they can be used.

The first requirement of overcoming this lack of interoperability is to standardize the solutions themselves, so that they can be used across multiple war-fighting platforms. In addition to offering reusability, this approach also allows for software components from multiple providers to be more easily integrated, so that the best-fitting software components can be chosen for a given set of requirements and cost parameters. Software modularity allows for more rapid updating, to protect from fast-evolving vulnerabilities and to add new capabilities while in operation, for agile delivery of software at the speed of warfighter relevance.

The second requirement is to foster an ecosystem of solution providers willing to conform their software to the standards framework.

Next-generation military avionics systems must provide more advanced capabilities than ever before, while also controlling costs. Adopting standardization and open architectures is a critical step toward attaining that goal. In fact, recent market research finds that open architectures have become a standard requirement when upgrading military avionics, generating a reduction in unit cost of more than 70%.[2]

MILITARY AVIATION CHALLENGES

- Next-generation military avionics systems must provide more advanced capabilities than ever before. However, these increasingly complex requirements have led to unsustainable increases in software complexity, cost, and development time, and the resulting bespoke code has limited adaptability to other aircraft platforms. Onboard software systems for military aircraft must become standardized.
- To enable the benefits of such standardization, the industry must foster an ecosystem of solution providers willing to conform their software to the standards framework and open architectures.

WIND RIVER SOLUTIONS

- **VxWorks 653 Multi-core Edition:** This software is a safe, secure, and reliable real-time operating system (RTOS). It delivers an ARINC 653–conformant system with robust time and space partitioning for the latest hardware platforms to ensure fault containment and the ability to upgrade applications with minimal test and integration demands.
- **Wind River Linux:** With robust support for container technology, Wind River Linux delivers a rapid-fire means of loading and patching applications dynamically in an industrial automation system and across additive and adaptive manufacturing environments.
- **Wind River Helix Virtualization Platform:** This software platform supports virtualized frameworks in intelligent process control systems, spanning hybrid networks and multiple operating systems.

1 *Nathan Butt, 2018, Thesis (MS, Mechanical Engineering, Wright State University). "Development and Thermal Management of a Dynamically Efficient, Transient High Energy Pulse System Model." www.researchgate.net/publication/326997627_Development_and_Thermal_Management_of_A_Dynamically_Efficient_Transient_High_Energy_Pulse_System_Model.*

2 *Mobility Foresights, June 17, 2020. "Global Military Avionics Market 2020–2025." mobilityforesights.com/product/military-avionics-market.*

THE APPROACH

Integrated modular avionics (IMA) emerged in the 1990s as a standardization approach for reducing the cost and complexity of developing, integrating, and maintaining airborne software systems. This approach has dramatically reduced costs in the development of recent commercial aircraft, including the Airbus A380 and the Boeing 787 in the late 2000s. At present, the military avionics segment is working to emulate and improve upon those commercial successes for U.S. Department of Defense (DoD) aircraft.

The Open Group Future Airborne Capability Environment (FACE™) defines a standards-based reference architecture for that purpose. It is governed by the FACE Consortium (of which Wind River® is a Principal Member), which includes members from government, industry, and academia. The FACE reference architecture increases interoperability, portability across DoD hardware platforms, and component reuse by defining design principles such as standardized interfaces across modular software. It signals an end to the practice of creating single-use software for each aircraft model, replacing that approach with a common operating environment where software developers can, theoretically, create and deploy applications for use across any military aviation system.

A critical function of the FACE Consortium is to enable the software ecosystem built to support the FACE architecture. That enablement includes tools and processes to verify and certify conformance with the FACE technical standard. Once a software product receives its certification of FACE conformance, it is included in the FACE Registry, which was created for that purpose. These components are referred to as "units of conformance" (UoCs), and architects may choose several UoCs to include with a given avionics solution.

To achieve FACE conformance under the safety, safety-extended, or security profiles, avionics solutions must specify a partitioned operating environment to prevent interference between workloads. This requirement is particularly relevant for mixed-criticality systems as well as for isolation that minimizes disruption when replacing modular software components. Hardware-based isolation between processing cores must typically be augmented by software measures at the operating system (OS) and virtualization levels, which are provided by FACE-conformant products from Wind River.

Several Wind River products — including VxWorks® 653 Multi-core Edition, Wind River Linux, and Wind River Helix™ Virtualization Platform — have achieved FACE conformance, building a software foundation for avionics providers as they work to build their own FACE-conformant solutions. Accompanying tools enhance software quality and accelerate time-to-market. Wind River Workbench development suite, based on Eclipse, enables rapid development, testing, and debugging. Wind River Simics® simulates anything from a chip up to an entire system, automating software testing and eliminating hardware dependencies.

VxWorks 653 Multi-core Edition

The market-leading VxWorks 653 real-time operating system (RTOS) is in use aboard more than 80 civilian and military aircraft, including the Boeing 787 Dreamliner, the Airbus A400M, and the Northrop Grumman UH-60V Black Hawk avionics upgrade. It was the first product to conform to the FACE 2.1 Technical Operating System Segment Safety Base Profile, on March 15, 2017. VxWorks 653 Multi-core Edition is the platform of choice for FACE-conformant solutions that have strict safety and ARINC 653 time- and space-partitioning requirements across multi-core hardware. As a standards-based RTOS, VxWorks ensures portability across hardware and airborne platforms, reducing costs.

Wind River Linux

On July 29, 2020, Wind River Linux became the first and only Linux to achieve FACE 3.0 conformance for the General Purpose Profile of the Operating System Segment. This standards-based foundation — fully compliant with POSIX® 1003.1-2008 — facilitates accelerated development of reliable, high-performance, secure, FACE-conformant avionics systems. Built for a modern cloud-native development environment, Wind River Linux provides rich support for containers, including Kubernetes and Docker.

Helix Platform for Aerospace and Defense

A real-time embedded Type 1 hypervisor, Helix Platform is conformant to the FACE 3.0 Security and Safety Base profiles of the Operating System Segment. Based on the VxWorks product line, Helix Platform enables applications running on multiple OSes with mixed criticality and diverse certification requirements to be consolidated on the same hardware platform. In addition to being OS-agnostic, Helix Platform operates across a broad range of hardware, including CPUs from Intel, NXP, and Xilinx.

THE RESULT

Conformance with the FACE Technical Standard allows reuse of software components across different global military programs and aircraft. As a result, both defense contractors and military agencies can reduce procurement costs and avoid vendor lock-in. Wind River helps avionics developers integrate and deploy software faster, simplifying their paths to offering FACE-conformant products and participating in the growing FACE ecosystem.

VxWorks 653 Multi-core Edition, Wind River Linux, and Helix Platform are FACE-conformant and provide a robust Operating System Segment foundation for military avionics. They help overcome runaway development time and cost requirements. They also help prevent cybersecurity threats. This convergence of industry-leading technology with forward-looking industry standards promises a new era of expanded development efficiency and cost effectiveness for military avionics.

To learn more about VxWorks 653 Multi-core Edition, Wind River Linux, or Helix Platform, visit www.windriver.com or contact salesinquiry@windriver.com.

Wind River is a global leader of software for the intelligent edge. Its technology has been powering the safest, most secure devices since 1981 and is in billions of products. Wind River is accelerating the digital transformation of mission-critical intelligent systems that demand the highest levels of security, safety, and reliability.