



VxWorks® is the world’s most widely deployed real-time operating system (RTOS) that provides high reliability and determinism with low latency and minimal jitter. Built on a modern, upgradable, future-proof architecture, it helps rapidly address changing market requirements and technology advancements. VxWorks sets the standard for a scalable, safe, secure, and reliable operating environment for running mission-critical computing systems that demand the highest standards. It powers innovative products for aerospace and defense, rail, automobiles, medical devices, manufacturing plants, and communications networks that simply cannot fail.

VxWorks brings nearly 40 years of leadership and continuous innovation to support modern use cases. The latest releases enable such technologies as cloud convergence, bringing IoT connectivity with major cloud vendors, IT-like applications deployment, and an Open Container Initiative (OCI)–complaint container engine. As the leading RTOS for the intelligent edge, it integrates embedded system–optimized artificial intelligence and machine learning frameworks such as TensorFlow Lite and Python, industry automation with OPC-UA, and deterministic performance Time-Sensitive Networking support. It also packages the software source in a trustworthy, transparent Git repository; offers SBOM support; and includes mitigation processes to counter cybersecurity threats throughout the lifecycle.

VxWorks gives you the capability to deal with the most demanding time constraints while enabling modern use cases, using the latest available technology that powers the intelligent edge.

For more information, visit www.windriver.com/products/vxworks.

USE CASES

End-to-End Support for Application Deployment Through Containers and Orchestration

VxWorks is the first and only RTOS in the world to provide support for OCI containers. This enables the use of IT-like technologies to develop and deploy intelligent edge software better and faster, without compromising determinism and performance. Kubernetes provides management and orchestration of the VxWorks OCI containers.

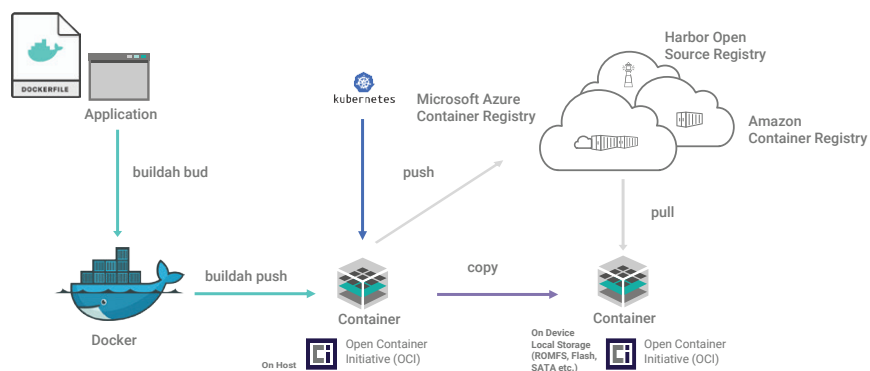


Figure 1. End-to-end workflow creating and distributing containers

Key outcomes:

- Simplifies application modularization through development and deployment
- Make software easier to deploy and run reliably when moved
- Enables software operation and management in the field
- Provides containerization with no impact on application performance
- Leverages an OCI-compliant container engine optimized for the mission-critical edge
- Containers managed and orchestrated across large deployments

Increase Developer Productivity with a Modernized RTOS Approach

VxWorks is the only RTOS to support C++17, Boost, Rust, Python, pandas, Time-Sensitive Networking (TSN) and more, as well as cloud IoT connectivity and an edge-optimized, OCI-compliant container engine – enabling you to use the languages, tools, and technologies you love most to innovate where it matters most.

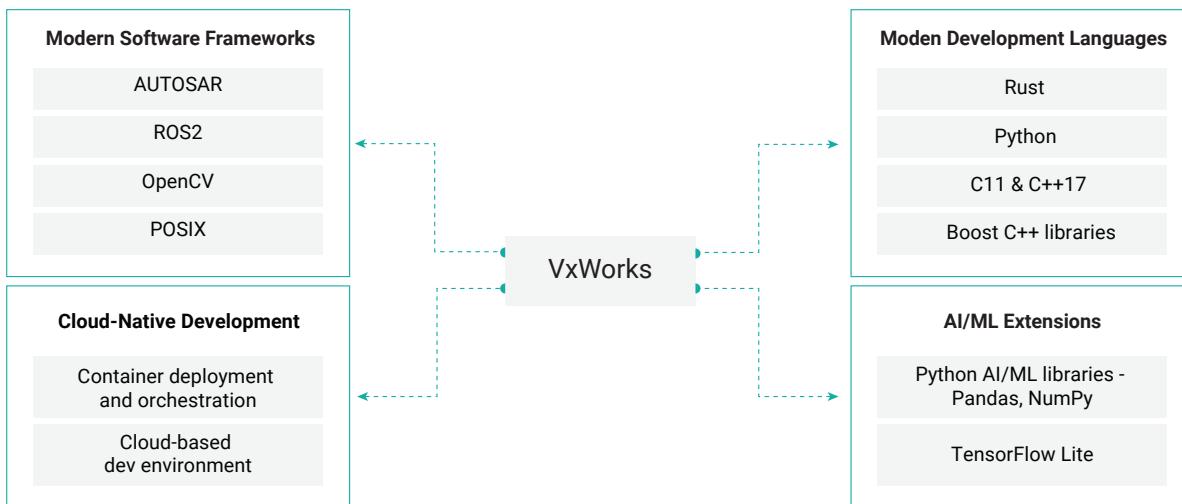


Figure 2. A complete set of tools for the modern developer’s journey

Key outcomes:

- Greater efficiency and portability with overall cost reduction
- Support for artificial intelligence/machine learning frameworks
- Complete developer toolset with intelligent automation solutions
- Comprehensive collection of board support packages
- Flexible development paradigm

Commercial Off-the-Shelf Solution for Safety-Critical Applications

VxWorks Cert Edition provides a commercial off-the-shelf (COTS) RTOS solution for delivering safety-critical applications that must achieve the highest and most stringent certification levels, such as RTCA DO-178C DAL-A and EUROCAE ED-12C software considerations in airborne systems, IEC 61508 ASIL-3 industrial functional safety, IEC 62304 Class C medical device safety, and ISO 26262 ASIL-D automotive safety. With VxWorks Cert Edition, you can take full advantage of the technological advances in microprocessors that VxWorks enables, while knowing you have a strong operating system foundation to meet the most demanding safety certification standards.

Key outcomes:

- Helps customers meet safety compliance requirements easily
- Enables safety use cases with reduced certification costs
- Optimized for specific hardware
- Written in lower-level languages such as C/C++
- Interacts directly with hardware (e.g., peripherals)
- Has a long lifecycle and stateful execution

CORE CAPABILITIES AND BENEFITS

- **Industry-leading RTOS**
 - Single and multi-core processor support with asymmetric multiprocessing (AMP) and symmetric multiprocessing (SMP)
 - Separated kernel and user space environments
 - Extensive POSIX® API support, including full POSIX PSE52-certified subset
 - Scalable, modular, and high-performance
 - State-of-the-art memory protection and management
 - Delivers the highest levels of performance when and where it is most needed
 - The first RTOS on Earth as well as on Mars, where reliability is a must

VxWorks Cert Edition	
Wind River Workbench	Toolchain
Debugger	VxWorks Simulator
VxWorks Cert Edition Binaries	VxWorks Cert Edition Buildable Source
Certified Network Stack*	Wind River Simics*
Certification Evidence*	
DO 178C DAL A Airborne Avionics Safety*	
IEC 61508 SIL 3 Industrial Functional Safety*	
ISO 26262 ASIL D Automotive Safety*	
IEC 62304 Class C Medical Device Safety*	

Partner Ecosystem*	
Certified Graphics	Ada
On-Chip Hardware Debugging	COTS Boards

Wind River Certification Services*	
Education Services and Installation	Platform Customization
System Design	Design Services
Hardware/Software Integration, Middleware, Application Software, & Board Support Packages (BSPs)	Customized Safety Certification Evidence Software

*Optional

Figure 3. VxWorks Cert Edition

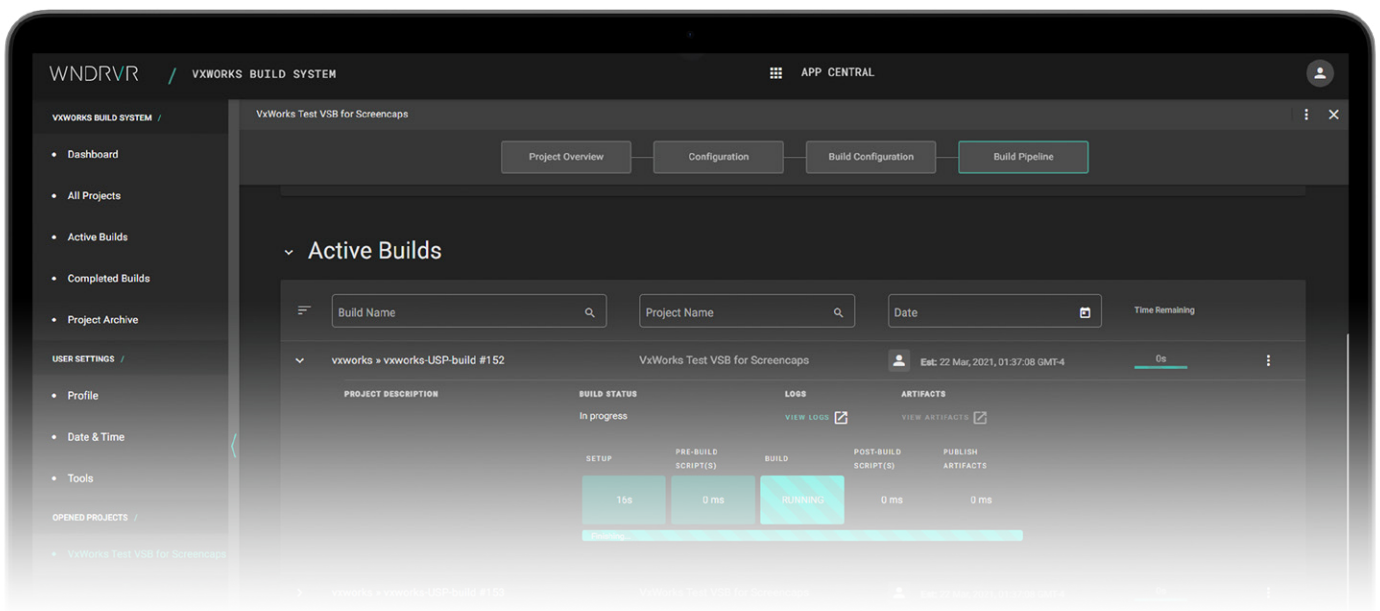


Figure 4. Platform development teams can create images of VxWorks quickly and efficiently using automation with cloud-native Wind River Studio

- Scheduling:
 - Priority-based preemption with optional round-robin
 - Time and space partitioning
 - Adaptive scheduling offering foreground and background threading
 - POSIX thread scheduling extensions (FIFO and sporadic)

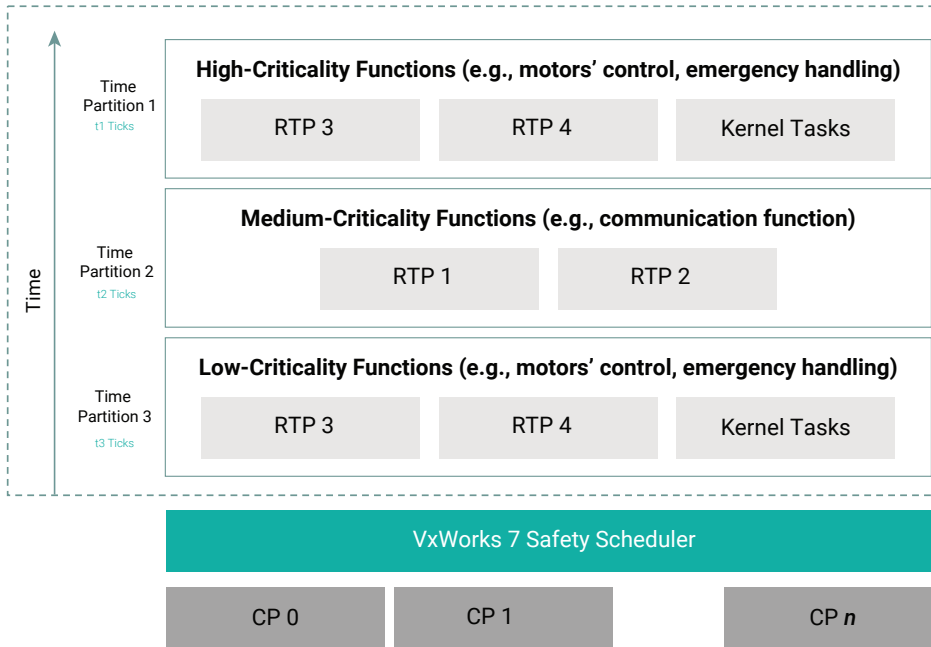


Figure 5. VxWorks safety scheduler

- Extensive processor and board support:
 - 32-bit and 64-bit CPUs
 - Broad spectrum of silicon architectures, including Arm®, Power Architecture®, Intel®, and RISC-V
 - More than 100 different boards supported



Figure 6. Broad and robust architecture and hardware support

- Capable of dealing with the most demanding time constraints:
 - Up to 10% reduction in atomic operations time
 - Network throughput on par with or better than Linux
 - Up to 30% reduction in time spent in spinlocks
 - Sub 3µs TSN interrupt response on selected Intel and Arm hardware
 - Over 2x improvement in entropy collection time

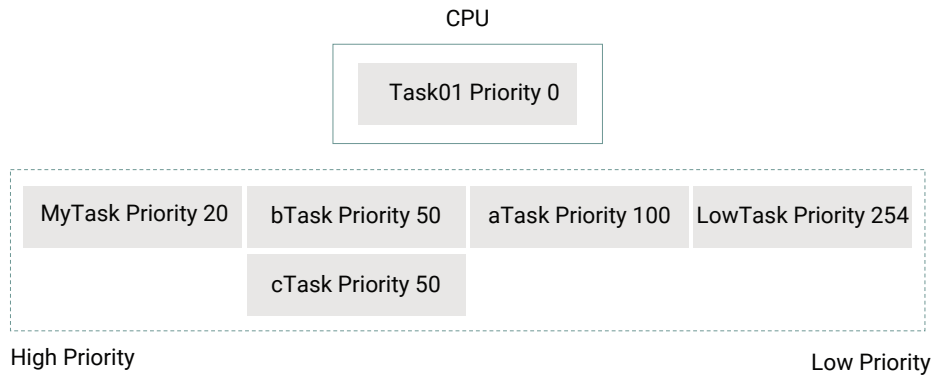


Figure 7. Direct interrupts and direct access to devices

KEY FEATURES

- Modern application development
 - C11 and C++17
 - Boost C++ libraries
 - Rust
 - Python
- Cloud integration
 - AWS IoT device SDK
 - Microsoft Azure IoT SDK
- AI/ML
 - NumPy
 - TensorFlow Lite
- Virtualization ready
 - VirtIO
 - KVM guest support
- Security
 - Secure boot (digitally signed image)
 - Secure ELF loader (digitally signed applications)
 - Secure storage
 - Encrypted container
 - Full disk encryption
 - Kernel hardening
 - Non-executable pages
 - Stack guard pages
 - Optional support for kernel page table isolation (KPTI)
 - Protection of code and read-only data
 - Stack smashing protection (SSP)
 - Address Sanitizer (ASAN)
 - CVE monitoring
 - Kernel Address Sanitizer (KASAN)
 - Security events
 - Built-in access controls
 - Advanced user management
 - Login policies
 - Password policies
 - Support for Active Directory/Lightweight Directory Access Protocol (AD/LDAP)
 - Cryptography
 - OpenSSL 3.x
 - FIPS 140-2
 - Arm TrustZone with OP-TEE support
 - TPM 2.0/TSS support
 - Network security protocols such as SSL, TLS, SSH, IPsec, IKE, GDOI, SCEP, etc.
 - Firewall
 - GE Digital® Achilles Level 2 certified for compliance with IEC 62443-4-2
 - NIST-conformant Security Requirements Guide (SRG)
 - NIST 800-53 mappings
- Networking
 - IPv4/IPv6 network stack
 - Time-Sensitive Networking (TSN)
 - IEEE 802.1Qbv
 - IEEE 802.1Qbu
 - IEEE 1588
 - IEEE 802.1AS

- Connectivity
 - USB (host, target, and OTG)
 - SocketCAN
 - OPC UA (open62541)
 - IEEE 1394
- File system
 - dosFs (FAT-compatible)
 - Fault-tolerant and certifiable highly reliable file system (HRFS) with configurable commit
 - Read-only ROM file system
 - NFS
- Lifecycle and management
 - OCI-compatible container engine (aligned with runc)
 - Docker Registry HTTP API V2
 - Docker Hub
 - Amazon ECR
 - Harbor
 - Kubernetes container orchestration
 - Wind River® Studio Conductor blueprints
- Multimedia
 - Software and hardware support for OpenVG™, OpenGL®, OpenGL® ES, Vulkan®
 - Image library (JPEG and PNG)
- Input device support (mouse, touch screen, keyboard, and others)
- PCM audio
- OpenCV
- Safety certifiable
- DO-178C DAL A
- Safety certifiable
 - DO-178C DAL A
 - IEC 61508 SIL 3
 - ISO 26262 ASIL D
 - IEC 62304 Class C
- Tooling
 - Industry-leading toolchain (LLVM, CMake)
 - Eclipse-based IDE
 - Visual Studio Code (desktop and cloud native)
 - Advanced debugger
 - Real-time system analyzer
 - System monitor
- Hardware simulation and emulation
 - VxSIM (x86 only)
 - QEMU (all architectures)
 - Wind River Simics®
- Application portability
 - POSIX®

STANDARDS AND CERTIFICATIONS

VxWorks Cert Edition is based on the proven standard commercial version of the VxWorks operating system and includes almost 900 kernel mode application programming interfaces (APIs) and more than 420 user mode APIs, all of which are fully deterministic and deployable under guidelines outlined in the DO-178C safety standards. They include cache, clock, event flag, interrupt, memory management, message queue, ring buffer, semaphore, signal, and task management calls, along with a wide array of C library functions.

Developers can also make use of object-oriented programming using the VxWorks Cert Edition C++ language subset, which includes basic C++ constructs such as classes, inheritance, namespaces, polymorphism, and virtual functions. User mode applications are supported with real-time processes (RTPs) to a safety-certifiable environment. The VxWorks Cert Edition RTP API subset allows applications to take advantage of memory protection, thus simplifying software integration between parallel development groups.

VxWorks Cert Edition delivers the highest levels of certification evidence for avionics, industrial, and automotive critical infrastructure. In all certification evidence packages, the fully hyperlinked content enables rapid traceability analysis of certification data. Certification evidence packages for VxWorks Cert Edition are optionally available for the following:

- DO-178C DAL-A and ED-12C airborne avionics safety
- IEC 61508 ASIL-3 industrial functional safety
- ISO 26262 ASIL-D automotive safety
- IEC 62304 Class C medical device software

PARTNER ECOSYSTEM / TECHNOLOGIES

The Wind River partner portfolio includes a large ecosystem of complementary third-party hardware and software solutions. The portfolio helps accelerate time-to-market and differentiate platforms with best-of-breed capabilities, while reducing development costs.

Visit our partner ecosystem at www.windriver.com/partners for a full list of our partners and their products.

WIND RIVER PROFESSIONAL SERVICES

The CMMI Level 3–rated Wind River Professional Services organization leverages years of system design and development expertise to work collaboratively with customer design and program teams. Professional Services interprets system requirements; architects platform options; and provides recommendations for meeting business, technical, and program goals.

For more information, visit www.windriver.com/services.

WIND RIVER EDUCATION SERVICES

Wind River offers instructor-led, on-demand, and mentored learning, including our anytime, anywhere access to online subscription-based e-learning.

For more information, visit www.windriver.com/studio/services/education.

WIND RIVER CUSTOMER SUPPORT

VxWorks is backed by our award-winning global support organization. We offer live help in multiple time zones, the on-line Wind River Support Network with multifaceted self-help options, and optional premium services to provide developers the fastest possible time-to-resolution.

For more information, visit www.windriver.com/services/customer-support.

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