VxWorks 7:
Where Real-Time Meets the Intelligent Edge

WNDRVR

Meet the Intelligent Edge

While the concept of edge computing has been around for years, the intelligent edge is a fairly new phenomenon. It refers to edge-based applications whose data processing is done at the source (i.e., at the edge) rather than hauled back to a central processing facility.

As you might imagine, intelligent edge applications tend to emphasize either real-time or near-real-time analytics — think manufacturing assembly lines, self-steering vehicles, healthcare monitoring devices, and so on.

This rise of the intelligent edge has grown in tandem with the number of sensors and connected devices (often referred to as the Internet of Things or IoT) that are deployed by various industries such as manufacturing, mining, transportation, aerospace, and defense. The more devices deployed at the edge, the more data generated at the edge — and the greater the need to process that data at the source to support real-time intelligence.

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The intelligent edge brings both new opportunities and new challenges for edge applications. Organizations need to be able to answer a specific set of questions when deploying intelligent edge applications, such as:

- Do we have the technology to support artificial intelligence and machine learning at the edge?
- Does our application require digital feedback loops to drive real-time decisioning?
- Is our application compliant with the latest security and certification requirements?
- Do we have a software bill of materials (SBOM) that addresses a wide variety of software from different vendors?
- Are we able to test our application at scale early in the development lifecycle?
- Can we deploy our application on a variety of different hardware vendor platforms?
- Is it simple to manage tasks such as remote configuration, policy automation, and automated updates?

Meet the Latest Version of VxWorks

First introduced almost 30 years ago, VxWorks® has continually evolved to meet the changing requirements of a modern, deterministic, real-time operating system (RTOS). Today, that means advanced security features, cloud-native capabilities (including container support), support for the latest programming languages, and integration with artificial intelligence (AI) and machine learning (ML) technologies. VxWorks 7 has undergone significant enhancements since it was released in 2014. In the last three years alone, our development team has added a host of new capabilities and features, many of them specifically designed to address the challenges of the intelligent edge.

2021

New Features

- Containers (OCI compliant)
- Microsoft Azure IoT embedded SDK
- AI/ML frameworks: Python 3.9, Pandas, TensorFlow Lite
- LLVM/Clang 12.0.0 upgrade

Performance Improvements

- Containers (OCI compliant)
- Microsoft Azure IoT embedded SDK
- AI/ML frameworks: Python 3.9, Pandas

Safety and Security Improvements

- Kernel address sanitizer (KASAN)
- Stack-smashing protection

2022

New Features

- Cloud AWS IoT Device SDK
- AWS Graviton2 EC2 support
- OCI container enhancements
- AI/ML Python and TensorFlowLite upgrade
- Harmonized LLVM/Clang 13.0.1 for all processor architecture support
- U.S. DoD Iron Bank–approved builder

Performance Improvements

- Gigabit network throughput improvement
- TSN hardware enablement
- OPC UA open62541 version 1.3.1

Safety and Security Improvements

- OpenSSL 3.0.5
- SBOM add-on

2023

New Features

- OCI container signing support
- VxWorks K8 orchestration
- AUTOSAR integration and MCAL layer
- LLVM 16 upgrade
- C++ Boost library 1.81 upgrade
- AI/ML digital feedback loop

Performance Improvements

- File system updates
- TSN profile, config, and advancements
- OPC UA enhancements

Safety and Security Improvements

- DO-178C DAL-A cert (Armv8 and Intel 64)
- ISO 26262 ASIL-D certification
- OpenSSL 3.1 upgrade and FIPS module
- SBOM enhancements

Figure 1. VxWorks 7: A history of innovation

Meet the Latest Version of VxWorks (cont'd.)

Artificial Intelligence/Machine Learning

In 2021, we added AI/ML frameworks to VxWorks 7 to support intelligent systems at the edge. Integration with AI/ML tools at the edge enables application developers to leverage real-time data processing, reduce latency, conserve network bandwidth, and create exciting new use cases for their business.

Open Container Initiative (OCI) Compliance

Also in 2021, VxWorks 7 became the first (and remains the only) RTOS to achieve OCI compliance. This means developers can use VxWorks 7 with Kubernetes orchestration to support agile software development processes, create portable applications with remote container management, and deploy smaller applications.

Container Registries

VxWorks 7 today works with a variety of leading container registries, including Amazon's Elastic Container Registry (ECR), Docker Hub, and Harbor. This allows developers to reuse applications effectively across their business.

Hardware and Software Support

In 2022, we added Amazon's Graviton EC2 processors to our list of hardware platforms that VxWorks 7 supports, giving our customers more freedom to explore deployment options in the cloud. At the same time, we expanded our SBOM to give customers a wider range of multi-vendor software options.

Kubernetes

In 2023, we introduced kubelets for VxWorks 7 that effectively brings Kubernetes to the intelligent edge. With the latest version of VxWorks 7, developers can create, deploy, and orchestrate containerized applications at the edge using Kubernetes.

Improved Performance

We're continually optimizing and enhancing the performance of VxWorks to run better, faster, and more reliably. Some of our most recent enhancements include improved performance for Time-Sensitive Networking (TSN) applications, better kernel performance, and faster performance for applications using the OPC Foundation's Unified Architecture.

Security Certifications

VxWorks 7 meets some of the world's most stringent security certifications, including DO-178C (for the defense and aerospace industries) and ISO 26262 ASIL-D (for the automotive industry). To date, Wind River® has completed testing for more than 600 separate safety certification programs. In addition, we continually review thousands of common vulnerabilities and exposures (CVEs) each year to ensure that VxWorks is secure against the latest threats.

Programming Languages

VxWorks 7 recently added support for new programming languages, including C++ 17 and Rust.

Considerations Before You Upgrade

It's not uncommon to find that systems with decades-long lifecycles (e.g., oil rigs, satellites) run an earlier version of VxWorks. While upgrading to VxWorks 7 has clear advantages, there are also some considerations to weigh before migrating your applications.

Architecture Support

We've updated the driver in VxWorks 7 to VxBus Gen 2, which is not only more efficient and more flexible than the earlier VxBus Gen 1 but also supports a wider range of hardware platforms, including those featuring Arm®, PowerPC, x86, and RISC-V processors. It's important to note, however, that the Gen 2 VxBus drivers are not backward compatible with the Gen 1 drivers found in VxWorks 5.x implementations. You can always find the hardware platforms that are supported by using the VxWorks BSP Query tool at bsp.windriver.com.

Updated APIs

VxWorks 7 uses a different compiler and API calls than VxWorks 6 and older versions. When upgrading, you need to ensure that your applications are compatible with the new compiler. For example, some of your legacy API calls may not be supported in VxWorks 7. In those cases, you may need to rewrite parts of your application, which can be time-consuming.

Updated Integrated Development Environment (IDE)

We updated the IDE in VxWorks 7 and fully integrated it with Wind River Studio Developer to allow developers to more easily share artifacts and build RTOS images in the cloud. If you use Studio Developer and Wind River Studio Operator together, you can do even more: Deploy software (and deploy software updates) across clusters of devices, create digital feedback loops, and create digital twins. This presumes, however, that your development environment can handle cloud-native workloads. If not, it can be a substantial investment to support those workloads, particularly if you're migrating from VxWorks 5. The migration from VxWorks 6 is easier, as you can still use Workbench (albeit an improved version) as your IDE in VxWorks 7.

User Authentication and Management

In VxWorks 7, we've replaced loginLib and IP-COM with improved authentication and user management tools. These improvements support more users and also work without a network stack — a noted drawback in previous versions of VxWorks.

Code Reusability for Certifications

The majority of applications running on VxWorks involve some kind of certification. If you're migrating to a newer version of VxWorks, it can be costly to recertify existing applications. To reduce those costs, we're creating reusable components that can be modularized and used when recertification is required.

Unlocking the Full Potential of VxWorks 7

If you're planning to upgrade to VxWorks 7, Wind River has published a series of migration guides that can help you complete the process. That said, no two migrations are exactly the same, and there will always be unique circumstances to consider. For that reason, many customers choose to engage with our customer success teams to help them achieve a quick, smooth migration.

VxWorks 7 is built to be the most modern RTOS on the market, meeting needs ranging from real-time intelligence support to cloud-native architectures. By focusing on continuous improvement and new features, we're able to provide customers with a future-proof RTOS that supports new services and new models for monetization. For example, by leveraging containerized workloads, VxWorks 7 users can add new functionality to their currently deployed devices or take advantage of a new generation of connected devices. In addition, the enhanced SBOM in VxWorks 7 can help reduce software licensing costs and even monetize maintenance streams.

Let's consider how real-time intelligence at the edge with VxWorks 7 impacts different industry use cases. Recently, we announced a solution with Airbus using VxWorks 7 to support in-flight refueling. The solution can detect the receiving aircraft, including such details as its shape and even the fuel receptacle itself, and allow the planes to connect in flight with a high degree of accuracy. Similar use case examples include real-time lane detection in automobiles, predictive failure in manufacturing lines, or thermal imaging for mining operations.

The potential uses aren't relegated to new solutions only. By upgrading to VxWorks 7, developers can add new or update existing functionality to already-deployed devices — even devices that have been in service for decades. Or you could ship new devices with built-in features that could be activated remotely, based on different pricing models. With VxWorks 7, the only thing limiting what you build is your imagination.

If you're ready to discover what VxWorks can do for your business today, talk to your Wind River representative and ask about the latest VxWorks 7 features, read the datasheet at www.windriver.com/themes/Windriver/pdf/vxworks-7-datasheet.pdf, or visit us online at salesinquiry@windriver.com.

Why Partner with Wind River Professional Services?

Advantages include:

- 40 years of embedded software experience
- 24/7 managed services and global support
- Customization options
- Dedicated premium support
- A variety of e-learning courses

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 intelligent transformation of mission-critical edge systems that demand the highest levels of security, safety, and reliability.