WIND RIVER

Wind River Platform for Automotive Devices, VxWorks Edition 3.6

Table of Contents

Target Applications and Devices 2
- Vehicle Control Systems 2
- Security Control Systems 2
- Navigation Systems 2
- Digital Dashboard Displays 2
- Telematics Systems 2
- Entertainment Systems 3
- Intelligent Transportation Systems ... 3

New in Platform for Automotive Devices, VxWorks Edition 3.6 3

Included in Platform for Automotive Devices, VxWorks Edition 3

The Real-Time Operating System: Vxworks 3
- Symmetric Multiprocessing 3
- Compatibility 4
- State-of-the-Art Memory Protection .. 4
- VxBus Framework 5
- Message Channels and TIPC 5
- Memory Management 5
- Error Management 6
- Processor Abstraction Layer 6
- Operating System Scalability 6
- File Systems 7
- Wind River Network Stack 7
- Wind River PPP (PPP, PPPoE) 8
- Wind River USB 9

Middleware Technology 9
- Security 9
- Management 11
- Distributed Messaging and Services 13
- Bridging and Routing 13
- Graphics and Local User Interface ... 14
- Connectivity 14
- Wireless 15

Wind River Workbench Development Suite 15
- Wind River Workbench 3.0 16
- Eclipse 16
- Project System 16
- Build System 16
- Indexed-Based Global Text Search-and-Replace 16
- Wind River Compiler and Wind River GNU Compiler 16
- Workbench Debugger 17
- VxWorks Simulator 17
- VxWorks 6.x Kernel Configurator ... 17
- Host Shell 17
- Kernel Shell 18
- Run-Time Analysis Tools 18

Optional Add-Ons 18
- Wind River VxWorks 6.6 SMP 18
- Wind River Device Management . 19
- Wind River Workbench, On-Chip Debugging Edition 19
- IPL Cantata++ for Wind River Workbench (Formerly Workbench Unit Tester) 20

Technical Specifications 20
- VxWorks 6.6 20
- Workbench 3.0 20
- Optional Add-Ons 20

Architectures, Hosts, and Board Support Packages 21
- Supported Target Architectures .. 21
- Supported Hosts 21
- Board Support Packages 21

Partner Ecosystem 21

Professional Services 22
- Installation and Orientation Service 22

Education Services 22
- Personalized Learning Program ... 22
- Public Courses 22
- Onsite Education 22

Support Services 23
- Support for Platform for Automotive Devices, VxWorks Edition 23

Electronics and software—driven by increasingly feature-rich infotainment content, advanced automotive connectivity, body electronics, under-the-hood control systems, and security monitoring systems—now account for close to 40 percent of a car's development costs. This is changing how automotive manufacturers do business.

Auto manufacturers are accustomed to building and releasing parts based on a bill of materials (BOM), but there is no similar concept for software yet. In addition to keeping projects on schedule and on budget, manufacturers must think about how to license, support, and upgrade the complex software packages essential to the success of their products. On the other end, their customers expect security, networking, interoperability, small memory footprint, and power management to function flawlessly.

Wind River Platform for Automotive Devices, VxWorks Edition provides telematics, information, navigation, and entertainment system developers with a Device Software Optimization (DSO) solution that combines VxWorks, the industry's leading commercial-grade, real-time operating system; Wind River Workbench, the premier open device software development suite; and essential multimedia and connectivity middleware.

Platform for Automotive Devices addresses the challenges automotive developers face by offering more choice, greater flexibility, and a comprehensive partner ecosystem to facilitate tighter product integration. The platform is backed by Wind River's 25 years of device software industry experience, a world-class support organization, customer education to help jump-start projects, and a specialized professional services team.

Development Suite

Wind River Workbench

Software Partners

Bluetooth	Advanced Flash Support	Automotive Application Framework
Browsers	OSGi	Speech Recognition and Text-to-Speech
Databases	IEEE 1394	2-D Graphics and GUI Builder
Haptics	Java	3-D Graphics and OpenGL

Additional Middleware*

Wireless Ethernet	Mobile IPv4/IPv6	RIP/RIPng	Media Library
SSL & SSH	IPSEC & IKE	NAT	Firewall
RADIUS Client	802.1X, 802.11i	Security Libraries	Web Svcs-SEC
SNMP v1/v2/v3	Web Server	CLI/MIBway	Learning Bridge
XML/SOAP	Web Svcs-Interop	DCOM	CAN/OPC

Base Middleware**

TIPC	Distributed Shared Memory	USB 1.1, 2.0
dosFs	Flash Support (TrueFFS)	Highly Reliable FS
IPv4/IPv6 Network Stack		PPP

Operating Systems

VxWorks/VxWorks SMP

Hardware Partners

Reference Designs, Semiconductor Architectures

Services

Education Services and Installation	Platform Customization
System Design	Design Services
Hardware/Software Integration	

Figure 1: Platform for Automotive Devices, VxWorks Edition components

* Included in VxWorks industry-specific platforms: See documentation for exact contents of each platform

** Included in all VxWorks platforms

Target Applications and Devices

Platform for Automotive Devices is well-suited for the development of applications that require high reliability, low power consumption, and a small memory footprint, such as the following.

Vehicle Control Systems

Traditionally included in the under-the-hood category of automotive electronics, vehicle control systems add and automate critical capabilities for vehicle operation or passenger safety. Examples are powertrain, engine management, power steering, environmental controls, advanced braking systems (ABS), and crash and airbag sensors.

Security Control Systems

These devices manage the access control and anti-theft systems in vehicles, including alarms, window and door entry, keyless entry, and immobilizers.

Navigation Systems

This includes all devices that provide real-time navigation services in a vehicle. They may be onboard, where map data resides on a DVD or another type of mass storage, or off-board, where the system connects to a server through a gateway to receive map data, then performs route calculations. Speech technology can be used to deliver turn-by-turn driving instructions.

Digital Dashboard Displays

Advanced display technologies are spurring rapid innovation in dashboard systems with digital graphics screens. These systems make configurable, context-sensitive information available to the driver, provide enhanced safety features, and allow automotive manufacturers a high-visibility opportunity for product differentiation.

Telematics Systems

This broad term encompasses any computing device in a vehicle that can communicate with a system outside the vehicle. In current usage, it typically covers the subset of devices with a hands-free cell phone module via Bluetooth, a GPS module, and a communications module for sending the vehicle

location and data, such as diagnostics information, to an outside system for fleet management. In the consumer automotive market, safety and security devices such as GM's OnStar are the best examples of telematics systems. In the transportation industry, vehicle tracking systems best illustrate this market segment.

Entertainment Systems

This includes all devices designed to play audio and video content in a vehicle, where content can be analog radio, digital radio, digital satellite radio, CDs, MP3s, DVDs, games, and so on. Entertainment systems are considered a subsegment of automotive infotainment systems.

Intelligent Transportation Systems

If not properly managed, enhanced vehicle features—including cellular, entertainment, telematics, and navigation systems—can contribute to driver distraction factors and higher accident rates. Intelligent transportation systems leverage sensor, wireless, and machine vision technologies to allow a car to sense its surroundings, communicate with other vehicles, and react to critical conditions. These systems enable the car to respond to perceived danger with proper warnings or automatic vehicle maneuvering to avoid accidents. In addition, as wireless-equipped cars become real-time traffic probes, they will be able to communicate with the roadside infrastructure to improve traffic management.

New in Platform for Automotive Devices, VxWorks Edition 3.6

The latest release of Platform for Automotive Devices, VxWorks Edition includes updated and enhanced run-time components in VxWorks, as well as industry-specific middleware technologies. These components can also be used with VxWorks symmetric multiprocessing (SMP) to exploit the capabilities of the latest multicore processors. The Wind River Workbench 3.0 development suite includes enhancements to the Workbench core and improved VxWorks and SMP platform support, on-chip debugging, and diagnostics tools. Wind River Device Management tools (add-on products to our VxWorks-based platforms) provide a powerful, enterprise-wide infrastructure that enables development, test, and field engineering teams to collect and aggregate data to diagnose and repair faults in running software at every phase in the device life cycle.

This release also includes Wind River Advanced Networking Technologies, providing significant performance, scalability, and feature improvements to the networking capabilities of the platform. Systems using older versions of the networking components (prior to Wind River VxWorks platforms 3.5)—including the Wind River Network Stack, Mobile IPv6, PPP, IPsec, IKE, Firewall, NAT, and RADIUS Client—may require a migration effort to the new versions of these components. Detailed migration requirements are available in the Programmer's Guide for each component.

Version 3.6 of Platform for Automotive Devices introduces the following new features, functionalities, and enhancements:

- Broad and deep networking functionality
  - 802.11n/Wi-Fi wireless support
  - Enhanced IPv4 and IPv6 mobility
    - Authentication, authorization, and accounting
    - RADIUS Key Exchange
    - MOBIKE (IKEv2)
    - Addressing extensions for mobility
    - DHCPv6
- Robust security
  - Advanced Encryption Standard (AES)
- Network management
  - Management Configuration Editor (MCE) enhancements
  - IP MIB
  - SNMP integration with Wind River Network Stack 6.6
- Workbench run-time analysis tools
  - System Viewer
  - Workbench Memory Analyzer
  - Workbench Performance Profiler
  - Workbench Data Monitor
  - Code Coverage Analyzer
  - Function Tracer
- Support for all architectures in Platform for Automotive Devices, VxWorks Edition 3.5

Included in Platform for Automotive Devices, VxWorks Edition

The Real-Time Operating System: VxWorks

VxWorks is the industry-leading, commercial-grade device software operating system. Its high determinism, high performance, modular scalability, and small footprint make more than 350 million devices worldwide run faster and more reliably. The next generation of VxWorks adds powerful new features and a focus on multiprocessing, openness, performance, reliability, and interoperability.

With VxWorks 6.6, companies can do the following:

- Optimize developer productivity through open standards
- Leverage the power of multicore silicon to deliver higher performance and more capable devices
- Increase reliability through memory management unit (MMU)-based memory protection
- Accelerate time-to-market through enhanced error management
- Seamlessly migrate existing VxWorks-based IP and other existing IP, including open source
- Continue to deliver products that rely on the core attributes of VxWorks, including high performance, high reliability, high determinism, low latency, and modular scalability

Complementary solution elements include the integrated, Eclipse-based Wind River Workbench development suite, extensive middleware components, comprehensive processor and board support package (BSP) support, expert professional services, and the DSO industry's largest partner ecosystem of hardware, software, development tools, middleware, and applications providers.

Symmetric Multiprocessing

VxWorks 6.6 offers support for symmetric multiprocessing (SMP) as an optional add-on product, VxWorks 6.6 SMP. The VxWorks SMP configuration allows the operating system to use multiple processors in a single system. At the same time, it maintains the same key RTOS characteristics of performance,

small footprint, high reliability, and determinism as the uniprocessor configuration of VxWorks.

The VxWorks SMP-enabled platforms allow customers to do the following:

- Deliver higher performance, multicore-powered products with reduced risk and development investment
- Speed time-to-market by using commercially available and supported run-time platforms and developer tools for multiprocessing
- Increase productivity by using the same development environment and process available for uniprocessor development by using the SMP extensions to existing development tools
- Enable a flexible design approach using Wind River's expertise and broad technology support for multiprocessing

VxWorks SMP introduces the following key features:

- **Multitasking:** Allows true concurrent execution of tasks and handling of interrupts.
- **Concurrent task scheduling:** Manages the concurrent execution of tasks on different CPUs.
- **Mutual exclusion:** Provides specialized mechanisms for mutual exclusion between tasks and interrupts received simultaneously on different CPUs. Because SMP systems allow for truly concurrent execution, the uniprocessor mechanisms for disabling (masking) interrupts and for suspending task preemption in order to protect critical regions are inappropriate for—and not available in—an SMP operating system.
- **CPU affinity:** Provides the ability to assign specific tasks or interrupts to a specific CPU. By default, any task can run on any of the CPUs in the system, which generally provides the best load balancing. However, this capability may be useful for cases where the designer wishes to assign a task or interrupt to a specific processor resource.
- **Binary and API compatibility:** Maintains substantial commonality between the binary code and the APIs used for both the uniprocessor and symmetric multiprocessing configurations. The differences in the API's are a small number of routines, accounting for APIs not suitable for an SMP system or that are not relevant to a uniprocessor system. This allows applications that use the subset of APIs defined for SMP to have binary compatibility with a VxWorks uniprocessor configuration.
- **VxWorks SMP simulation capability:** Allows development of SMP applications to begin without physical hardware. The VxWorks Simulator provides default SMP system images to develop and test the API's use in the applications. SMP simulators are provided with the standard uniprocessor VxWorks installations as an introduction to the SMP product.
- **Broad multicore hardware compatibility:** Provides support for the leading multicore silicon available on the market, giving customers a choice in functionality for their specific device requirements.

Compatibility

VxWorks 6.x and VxWorks SMP are designed to ease migration from VxWorks 5.5. To that end, the kernel of VxWorks 6.x supports the VxWorks 5.5 kernel operating environment. Most BSPs, drivers, and kernel applications developed for or ported to VxWorks 5.5 will run in the VxWorks 6.x kernel. By default, the VxWorks 6.x kernel builds like that of VxWorks 5.5. VxWorks 6.6 is also backward-compatible with all previous versions of VxWorks 6. VxWorks SMP is API-compatible with the uniprocessor versions of VxWorks (with a few exceptions).

The VxWorks product documentation includes information about the following:

- Migrating VxWorks 5.5 kernel applications to the current kernel and user modes
- Porting BSPs and drivers
- Migrating code to VxWorks SMP
- Changes in networking and security technologies from VxWorks platforms 3.4 to the current release

In addition, VxWorks 6.x provides increased support for open standards. This promotes compatibility between open source applications and VxWorks 6.x, with the following improvements:

- Increased POSIX compliance, including certified conformance to IEEE Std. 1003.13-2003 PSE52 and full support of JTRS SCA AEP 2.2.2, eases porting of open source and third-party software to VxWorks.
- The standard process-based programming model reduces the learning curve for programming new applications on VxWorks 6.x.
- Support for IPv6 enables development of next-generation networked devices.
- Standard sockets-based and modular-message channels provide a common Interprocess Communication (IPC) interface.
- Support of the open source, industry-standard TIPC (Transparent Interprocess Communication) protocol extends messaging to tasks in multiprocessor systems with heterogeneous operating systems.

State-of-the-Art Memory Protection

VxWorks 6.x enables manufacturers to increase their device reliability through MMU-based memory protection. VxWorks introduces process-based, user-mode application execution in addition to its traditional kernel-mode execution. The kernel is protected from user-mode applications running in VxWorks real-time processes (RTPs). User-mode applications are also protected from each other.

Features of memory protection include the following:

- MMU-based memory protection provides isolation of the kernel from user-mode applications and of applications from each other, increasing device reliability.
- The standard, process-based programming model simplifies application development.
- Support of RTPs on MMU-free processors reduces device cost by enabling the use of low-cost processors.
- The ability to use RTPs with the MMU enabled during development, and with the MMU disabled during deployment, speeds development and maximizes device performance. This feature is not available for VxWorks SMP.
- VxWorks' preemptive, priority-based global task scheduler ensures real-time deterministic behavior.
- The ability to create private or public objects in the kernel and in RTPs offers flexibility to use objects that are protected from manipulation, or that can easily be shared among kernel and process tasks.
- The extensible system call interface enables application developers to employ custom-developed kernel services from user-mode execution.
- Support for shared libraries among RTPs improves code efficiency and reusability, as well as speeding code development and debugging.

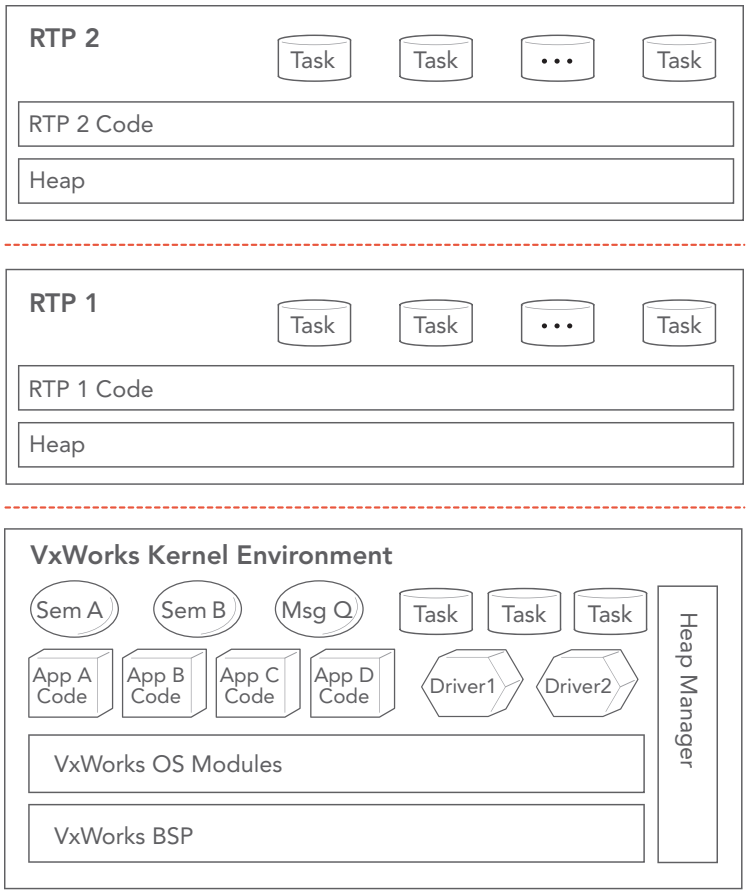

Figure 2: VxWorks kernel environment and two RTPs

VxBus Framework

VxWorks 6.6 introduces the VxBus framework, which device drivers plug into and coordinate device-related operations between device drivers, the BSP, and the VxWorks kernel. It provides a formal interface between device drivers and hardware. It also provides a uniform set of APIs that can be used by higher-level features such as file systems, network stacks, power management frameworks, and so on. VxBus provides the following:

- Device discovery mechanisms
- Common infrastructure between devices, middleware, and the OS
- Support for different bus topologies

These features allow device drivers to be decoupled from the BSPs they ship with. In turn, this allows drivers to work with minimal or no modifications on many BSPs. The task of writing BSPs for VxWorks is made simpler with the VxBus framework.

Message Channels and TIPC

With memory protection comes the challenge of segmentation of applications into protected memory spaces. Message channels are a new connection-orientated, bidirectional messaging mechanism introduced in VxWorks 6.0 that allow tasks to communicate across memory boundaries and complement traditional communication mechanisms provided in VxWorks.

Tasks located in different processes or in the kernel can establish connections with each other independent of their locations. Communication can take place between one task in a process and another in the kernel, or between tasks in separate processes, or between tasks in the same process. In VxWorks 6.1 and later, message channels use the open source, industry-standard Transparent Interprocess Communication (TIPC) protocol to extend messaging to tasks in multiprocessor systems that can run VxWorks, Linux, or any other operating system that supports TIPC. The VxWorks 6.6–based platforms support TIPC version 1.7.

Features of TIPC 1.7 include the following:

- Open-standard TIPC
  - High-speed, reliable message-passing service
  - Location transparency with logical address and internal address translation table
  - Lightweight, connectionless, or connection-orientated communication modes
  - No message losses
  - No message duplicates
  - Uninterrupted message sequence order
  - Reliable multicast messaging
- OS independence, with interoperability between VxWorks and Linux
- Scalability from single processor to multicore to cluster of nodes
- Extensible framework for failover
- Suitable for systems where short, real-time critical transactions are performed
- Complements traditional Wind River intertask communication methods
- Multicluster network topology support

Memory Management

Although VxWorks 6.x provides MMU-enabled memory protection, it continues to use the non-overlapped addressing model in all earlier versions of VxWorks. The non-overlapped memory model promotes backward-compatibility with legacy VxWorks code and provides the following benefits:

- High determinism and low latency are maintained by not requiring memory to be mapped in or out, and by eliminating unnecessary cache flushes.
- Address pointers are unique, enabling reuse of existing VxWorks drivers and applications, as well as simplifying new driver and application development.
- Support for both MMU-enabled and MMU-free processors gives device manufacturers more flexibility to choose processors that fit their capability and budget requirements.
- Memory translation tables are not required, saving memory space and improving memory access performance.

Other VxWorks 6.x memory management enhancements include the following:

- **Automatic resource reclamation:** Maximizes memory availability and helps prevent memory leaks, improving device robustness

- **Improved memory allocation using a "best-fit" algorithm:** Reduces memory fragmentation and achieves near deterministic memory allocation/free performance
- **User-mode heap and memory partition support:** Enables RTPs and user-mode execution
- **Developer-replaceable user-mode heap allocator:** Maximizes system design flexibility
- **Heap instrumentation for heaps and memory partitions in both the kernel and RTPs:** Assists in diagnosing common memory problems by detecting and reporting memory errors
- **Tight integration with error management:** Maximizes reliability and minimizes time-to-market
- **Compiler-assisted code instrumentation:** Improves static code analysis of memory errors

Error Management

Wind River provides an error management framework to help customers isolate, diagnose, and correct error conditions encountered during development and testing. With this framework, customers can manage failures, minimizing the need to reproduce the failure in order to diagnose the device. The error management framework includes memory error detection and error reporting technology and provides a foundation for debugging device software out of the box, and is extensible to enable customers to design reliable devices.

Error management capabilities are available in both the kernel and in RTPs, and include the following:

- ISR and task stack overrun and underrun detection
- Code corruption detection
- Null pointer usage detection
- Heap block overrun and underrun detection
- Heap usage tracking and leakage detection
- RTP error detection
- API support for kernel application errors
- API support for user-defined application errors
- Customizable error-handling policies
- Comprehensive error records with common headers, key OS information, hardware information, and user-defined optional string
- User-defined memory storage of error records
- Integration and coordination with Wind River Device Management tools

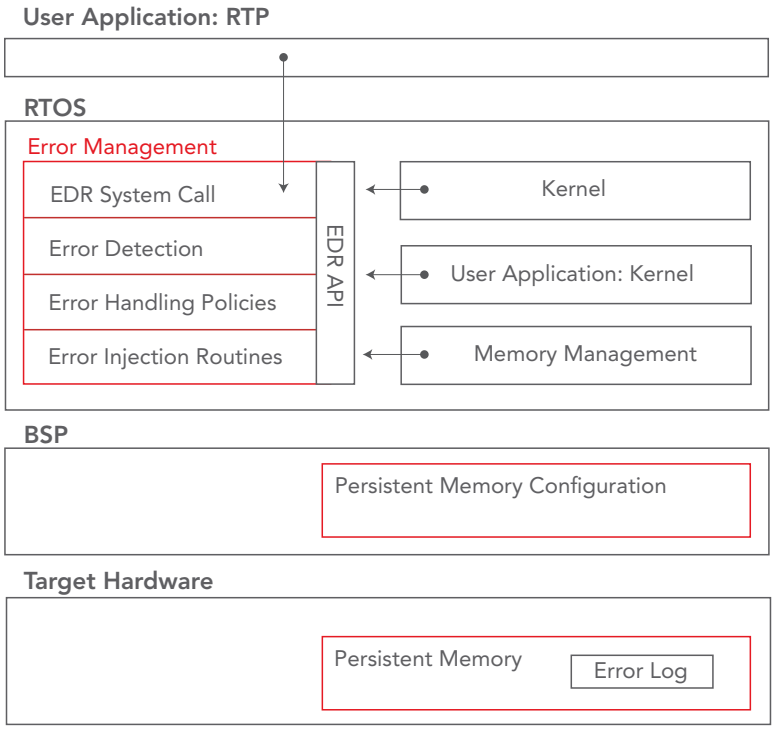

Figure 3: Error management

Processor Abstraction Layer

With VxWorks 6.x, the Processor Abstraction Layer (PAL) provides the capability to extend OS support to similar architecture families with relatively less effort than earlier versions of VxWorks required. An architecture-specific PAL defines the functional interconnects for each architecture family, and, to a degree, abstracts the functionality of that hardware feature from the operating system. While this is transparent to the application, the presence of a PAL for an architecture family facilitates the quick adoption of processor variants, improving time-to-market for VxWorks 6.x customers. In VxWorks 6.6 the PAL also supports VxWorks SMP for the supported SMP-capable processors.

Benefits of the Processor Abstraction Layer include the following:

- Faster processor ports within an architecture family give VxWorks 6.x customers more design options and shorter time-to-market for new processors.
- Easier application migration across architectures provides better flexibility for product life cycle management.
- Increased systematic testing of common PAL components increases quality.

Operating System Scalability

VxWorks versions 6.2 and later include improved scalability through the use of predefined configuration profiles. The functionality provided by the profiles varies, enabling customers to build OS images that fit their functionality, footprint, and performance constraints. Note that for all profiles, the actual compiled image size depends on the specific processor, architecture, and configuration, such as whether the cache is enabled or disabled.

The Minimal Kernel Profile, the smallest default configuration, provides microkernel functionality in a footprint between 36KB and 100KB, depending on proces-

sor family and which components are included. This kernel is fully static (no dynamic memory allocation), and semaphores and watchdogs are optional capabilities.

The Basic Kernel Profile includes all the functionality of the Minimal Kernel Profile with dynamic memory allocation and other features added to achieve a VxWorks image size of approximately 150KB.

The Basic OS Profile builds on the Basic Kernel Profile, adding functionality such as the I/O system and coprocessor support to provide an approximately 250KB footprint.

Each profile provides a default configuration that may be configured further by enabling or disabling individual components, allowing for faster and easier optimization of the OS to meet specific device requirements.

File Systems

VxWorks includes a FAT-compatible file system called dosFs. VxWorks versions 6.2 and later also include a new file system framework that enhances the capabilities, performance, and reliability of VxWorks-based file systems.

Features of the file system framework include the following:

- Support for multiple file systems, removable media, and automatic file system detection
- Cache write-through option for dosFs, ensuring data is committed to the file system, enhancing reliability
- Improved CheckDisk for dosFs uses the "clean bit," allowing the file system to skip CheckDisk for improved boot-up performance
- Unicode filename support

The transaction-based highly reliable file system (HRFS) provides complete power-safe reliability (except for the case where a write action is interrupted). In VxWorks 6.6, HRFS is enhanced to support configurable commit policies, which allow finer control and better file system performance without sacrificing reliability.

Wind River Network Stack

Wind River Network Stack is a critical component of the Wind River Advanced Networking Technologies portofolio, which provides advanced networking protocols, security, wireless, and mobility capabilities for markets such as wireless infrastructure, network infrastructure, and consumer devices.

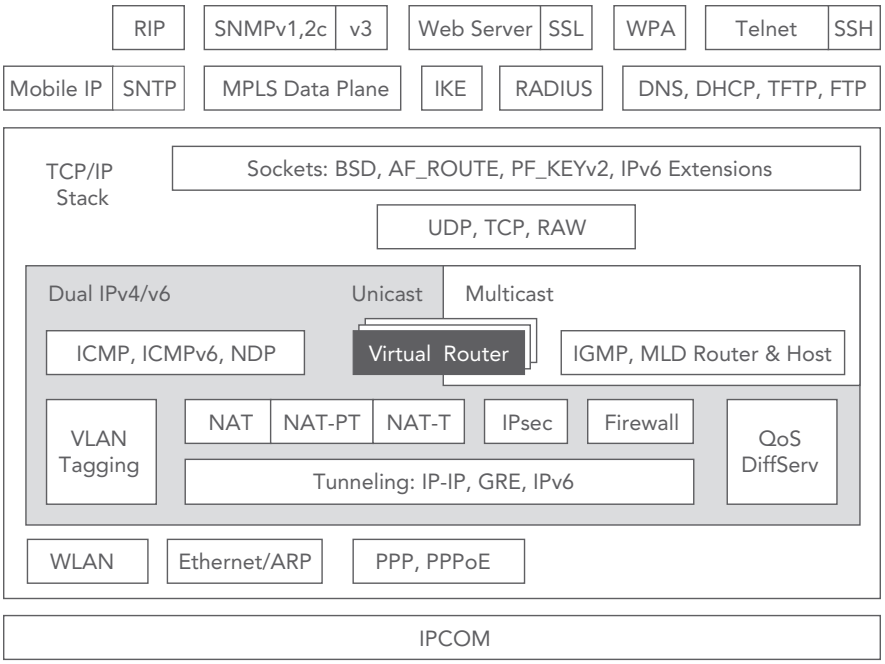

Figure 4: Wind River Network Stack and related components

The Wind River Network Stack is a full-featured IPv4/IPv6 dual stack specifically designed for next-generation device software applications. It provides rich networking features with high-performance, scalable implementation, and a small footprint. It conforms to relevant industry standards and provides a clean code structure for easy integration and faster implementation. In order to ensure high quality, conformance to standards, and interoperability with other network devices, the Network Stack has undergone extensive third-party testing and external test lab validation. As a result, the Network Stack is one of the first few TCP/IP stacks in the industry to receive the "IPv6 Ready" Phase II logo.

The Wind River Network Stack provides the following:

- Full integration with the VxWorks operating system, development tools, device management products, and peripheral networking protocols and utilities
- Clear and structured code to ease configuration and maintenance
- Robust security, including AES and 802.1X
- Flexible configuration options to optimize required memory resources
- IPv6 implementation along with enhanced IPv6 utilities and applications
- Performance enhancements to the stack for improved forwarding and end-to-end performance
- Optimized, high-performance implementation
- Advanced mobility functionality for IPv4 and IPv6

Figure 4 depicts how the Wind River Network Stack is integrated with all the relevant networking technologies, including mobility, security, and network management.

Features of the Wind River Network Stack include the following:

IPv4/IPv6 Dual Stack

The Network Stack offers greater flexibility in configuring the stack to support IPv4 and/or IPv6. The stack may be built for IPv4 only, for IPv6 only, or for both protocol versions.

Highly Scalable

The Network Stack may be deployed in a variety of different configurations. The memory footprint is minimized when unused modules, protocols, or features are deselected at build time. The stack can be compiled to be both small and robust.

MPLS Data Plane Support

Multiprotocol Label Switching (MPLS) brings the speed of layer 2 switching to layer 3. It allows routers to eliminate the complex lookup process based on the destination IP address, and to make forwarding decisions based on the contents of a simple label. In addition to speed, MPLS offers two key advantages: it supports Quality of Service (QoS) and virtual private networks (VPNs).

The MPLS data plane support provides the following benefits:

- MPLS over Ethernet devices
- Generic MPLS labels
- IPv4 and IPv6 over MPLS
- Label stacking
- Common label operations
- Delivery of PDUs to the Network Stack
- Ingress, transit, or egress node

QoS and DiffServ

Differentiated Services (DiffServ) is a standards-based priority mechanism for organizing different quality of service (QoS) categories. The Network Stack includes DiffServ for egress traffic as a built-in feature of the dual-mode IPv4/IPv6 stack. It supports the following Internet Engineering Task Force (IETF) standards:

- **RFC 2474:** Definition of the differentiated services field (DS field) in the IPv4 and IPv6 headers
- **RFC 2475:** An architecture for differentiated service
- **RFC 2597:** Assured forwarding PHB group
- **RFC 2598:** An expedited forwarding PHB
- **RFC 2698:** A two-rate three-color marker

Policy-Based Routing

Policy-based routing in the Wind River Network Stack makes it possible to base the route lookup decision on more than just the destination address. With policy-based routing enabled, each virtual router (stack) can look up the destination in one or more forwarding information bases (FIBs). The virtual router looks up the packet information in a policy database to determine which FIB to use. If no matching entry is found, the default FIB is used.

Equal Cost Multipath (ECMP) Routing

Implementing ECMP routing enables network load-sharing by using multiple paths to the same destination. The Wind River Network Stack includes two different algorithms, both defined in RFC 2991 Multipath Issues in Unicast and Multicast next-hop selection, that can be used to select which routes to use when two or more routes have an equal cost. ECMP routing also means that if a certain network path becomes unavailable, the flow of packets will be switched rapidly to an alternative path.

Virtual Router Redundancy Protocol (VRRP)

Using the VRRP implementation in the Wind River Network Stack allows a higher availability default path without the configuration of dynamic routing or router discovery protocols on every end host. You can configure VRRP to provide redundancy and load-sharing by defining multiple routers as default gateways and sharing traffic between them. VRRP support is currently defined for IPv4 only.

GRE and IPIP Tunneling

- Generic routing encapsulation (GRE) to tunnel IPv4 or IPv6 packets over IPv4
- Generic tunnel interface (GIF) to tunnel IPv4 and/or IPv6 packets in a point-to-point tunnel between two IPv4 hosts or IPv6 hosts

Routing Engine

The Wind River Network Stack contains a high-performance routing engine that uses highly optimized Radix trees that allow both static and dynamic routes. A standard BSD routing socket interface enables the use of standard routing daemons, and also allows for dedicated routing devices to cooperate with the TCP/IP stack.

Virtual Routing

The Wind River Network Stack also supports full virtualization with multiple independent routing tables, used in virtual routers. This means that one Network Stack can act as multiple routers, enabling a massive reduction in router hardware. The virtual routing support includes a number of BSD socket extensions to manage the additional routing tables.

Networking Applications

The Network Stack has implemented a large number of security and networking applications, including SSH, SSL, IKE, RADIUS, PPPoE, RIP, SNMP, SNTP, Telnet, FTP, TFTP, DHCP, HTTP, DNS, Mobile IP, and so on. Some of these protocols are available only in Wind River's market-specific platforms.

IPv4 and IPv6 Autoconfiguration

Wind River Network Stack supports both IPv4 and IPv6 autoconfiguration.

Wind River Mobile IPv4/IPv6

An increasing number of consumers are taking advantage of wireless technology when accessing the Internet. This offers significant benefits but also means that the connection is lost whenever a user moves to a new network. Mobile IP provides an efficient, scalable mechanism that allows users to roam seamlessly among wireless networks. Using Mobile IP, applications such as Internet telephony, media streaming, and virtual private networking can be supported without service interruption when users move across network boundaries.

Wind River Mobile IP products are compliant with WiMAX Forum standards for mobility in WiMAX networks, as well as the 3GPP2/3GPP standards for 3G cellular networks. In addition, these products implement fast handover ("make-before-break") for the support of Voice over Internet Protocol (VoIP) and other real-time applications.

The Wind River Network Stack includes support for the following:

- Mobile IPv4 mobile node
- Mobile IPv4 home agent
- Mobile IPv4 foreign agent
- Mobile IPv6 mobile node
- RADIUS Key Exchange and accounting
- Mobility addressing extensions
- MOBIKE (IKEv2)

Wind River PPP (PPP, PPPoE)

Wind River PPP is a source-code product written in C with an object-oriented design. With Wind River PPP, you can implement a dynamically configured PPP stack for diverse remote access applications. These applications can have a variety of network interface types,

network stack types, link speeds, numbers of PPP connections, control protocols, framing techniques, and so on.

PPPoE (PPP over Ethernet) is a protocol standard for opening and running PPP sessions using Ethernet as a virtual driver. The specification can be used by multiple hosts on a shared Ethernet to open PPP sessions to multiple destinations via one or more bridging modems. It is intended to be used with broadband remote access technologies that provide a bridged Ethernet topology, when access providers wish to maintain the session abstraction associated with PPP (RFC 2516).

Features of Wind River PPP include the following:

- Complete RFC 2516 implementation (server mode)
- MD5 integrity protection against denial-of-service attacks
- Unlimited PPPoE interfaces
- Multiple Ethernet interfaces handled
- Highly portable function API

Wind River USB

Wind River USB enables developers to quickly incorporate standard universal serial bus (USB) connectivity in VxWorks-based embedded devices and their attached peripherals.

Wind River USB 2.4 supports version 2.0 of the USB specification, providing support for the universal host controller interface (UHCI), the open host controller interface (OHCI), and the enhanced host controller interface (EHCI), and currently incorporates low-speed (1.5Mb/sec), medium-speed (12Mb/sec), and high-speed (480Mb/sec) data rates. All four USB modes of data transfer are available with Wind River USB: control, interrupt, bulk, and isochronous. These data transfer modes enable simultaneous transmission of asynchronous and isochronous data. Asynchronous data is typically error-rate-critical, while isochronous data is typically used in multimedia applications, such as real-time audio or streaming video.

Host-class drivers provided with Wind River USB allow developers to connect a wide range of peripherals, from the most common to the most advanced. Out-of-the-box-class drivers included in the product support keyboard and mouse human interface devices (HIDs), printers, speakers (audio-isochronous), mass storage devices (bulk-only and control-bulk-interrupt), and communications devices (END and ACM). The mass storage and communications-class drivers enable developers to establish USB connections between embedded devices and advanced peripherals, such as Ethernet networks, modems, digital cameras, and portable storage devices.

Starting in VxWorks 6.6, Wind River USB has been integrated under the VxBus device driver framework.

Middleware Technology

Security

Wind River security components enable developers to include security features in their devices for Ethernet-based wired and wireless connectivity.

Wind River IPsec and IKE

Wind River IPsec is a scalable implementation of IPsec, as specified by the IETF. It provides authentication, data integrity, encryption, and replay protection of any network traffic on the IP layer. It is implemented as a tightly integrated software module for the Wind River Network Stack for both IPv4 and IPv6 operations. Wind River IPsec is interoperable with other IPsec implementations and conforms to the IPsec RFCs, as specified by the IETF.

Features of Wind River IPsec 6.6 include the following:

- Tunnel and transport mode in any security association (SA) combination
- Support for AH and ESP modes
- IP in IP tunneling
- Bypass/apply/discard IP packet filtering with both input and output selectors
- Support for IPsec monitoring MIB
- Key and SA management with PF_Key Management API v2 with openbsd extension
- Support for all required authentication transforms and encryption algorithms
- Validated with Common Cryptography Interface (CCI)
- Interoperability tested with popular IPsec and IKE products
- Integrated and validated with optional security coprocessors, demonstrating significant performance improvement over software processing
- Virtual Private Network Consortium (VPNC) certification for basic and AES interoperability

Wind River IKE is a scalable implementation of IKE versions 1 and 2, as specified by the IETF, and it provides for secure key exchange for IPsec.

Features of Wind River IKE 6.6 include the following:

- Support for IKE v1 and IKE v2
- NAT traversal of ESP packets over UDP
- Integration with Wind River Network Stack
- Authentication based on X.509 certificates and preshared secrets (passwords)
- Passive and active establishment of IPsec connections
- Secure, interoperable communication with other IPsec endpoints
- Plug-and-play integration with Wind River IPsec
- Flexible and powerful policy-based configuration
- Support for tunnel and transport IPsec connections
- VPNC certification for IKE v2 interoperability

Wind River Wireless Security

Wind River Wireless Security is a suite of security protocols that includes supplicant and authenticator for the 802.1X protocol. The Wireless Security authenticator is integrated with the Wind River RADIUS Client, Wind River Learning Bridge, and Wind River Wireless Ethernet Driver, providing all the core functionality for typical authenticator products, such as wireless access points. Both supplicant and authenticator can be used in the same product, allowing greater flexibility and a range of application support. Multiple EAP (Extensible Authentication Protocol) types are supported. Integration with Wind River SNMP is included to interface with the 802.1X MIB.

Features of Wind River Wireless Security 2.4 include the following:

- 802.1X
- Wi-Fi Protected Access (WPA/WPA2)
- 802.11i
- Temporal Key Integrity Protocol (TKIP)
- AES
- Preshared keys
- Multiple EAP types

- Full integration and testing with Wind River Wireless Ethernet Driver (station and access point modes), easily portable to other wireless driver solutions
- Support for both authenticator and supplicant modes
- Support for wide range of encryption and hashing algorithms

Wind River Firewall and Wind River NAT

Wind River's solution for implementing a firewall within a device is based on Wind River NAT and Wind River Firewall. Wind River NAT is a full-featured implementation of the industry-standard Network Address Translation Protocol (NATP) for use in routers, firewalls, DSL and cable modems, and residential gateways. A device running Wind River NAT can connect an entire department or a small office to the Internet using a single global IP address. Address mapping effectively conceals the size and topology of the private network from the outside, providing a basic level of security.

Wind River NAT supports the two most widely used NAT modes. Basic NAT performs one-to-one mapping of private IP addresses to a pre-allocated block of external IP addresses. The more commonly used NATP maps port numbers, as well as IP addresses. NATP allows multiple private addresses (up to 64,000 address/port combinations) to be multiplexed on a single public address, offering the full benefit of address conservation and security.

NAT provides basic security by blocking all incoming connection requests that don't map to recognized address translations.

Wind River Firewall supplies a powerful filtering engine that allows device manufacturers to optimize their software to provide advanced features that protect valuable data. This engine is ideally suited to a wide range of products, including SOHO routers, broadband access devices, and small to medium-sized enterprise devices.

Features and functions of Wind River Firewall 6.6 include the following:

- Packet filter type firewall
- Easy to integrate and use
- ipfilter compatible rule syntax
- Shell commands or firewall rule files to configure a firewall
- Flexibility to filter on almost any protocol parameter
- High performance
- Support for stateful firewalling
- Support for logs and statistics
- ANSI-compliant C source code

Wind River Cryptography

Wind River Cryptography is a collection of cryptographic modules that can be used in developing secure applications. It consists of widely used algorithms as provided in openssl 0.9.8. It is also used by other components requiring access to crypto functions. Wind River Cryptography includes an implementation of X.509 digital certificates. Digital certificates can be used by a wide variety of other components, such as Wind River IPsec and IKE, Wind River Wireless Security, Wind River Web Server, and Wind River Web Services. Wind River Cryptography uses the Cryptography Libraries API, which is defined in the Wind River Cryptography Libraries for VxWorks 6 Programmer's Guide 6.6.

Included algorithms are AES, DES, triple DES, Blowfish, CAST, RC2, RC3, RC5, RSA, Diffie-Hellman, DSA, Elliptic Curve, MD2, MD4, MD5, MDC2, SHA, SHA1, RIPEMD, X.509 and X.509v3, HMAC-MD5, HMAC-SHA, and HMAC-RIPEMD. Symmetric cipher modes ECB, CBC, OFB, and CFB are also available.

Wind River Security Libraries

Starting with VxWorks 6.6, cryptographic services are provided by the Wind River Cryptography component. The Wind River Security Libraries are also included for backward-compatibility with prior versions of VxWorks . This includes a library of cryptographic algorithms, the Common Crypto Interface (CCI), used by other components requiring access to crypto functions, and the Crypto Provider Interface (CPI), which supplies a mechanism for developers to add other crypto libraries or hardware-based crypto functions.

Wind River SSL and SSH

Wind River SSL is a client server technology used to secure any higher layer protocol that uses sockets. A typical application is to secure HTTP connections (HTTPS) for e-commerce.

Security is provided by the following:

- Privacy, using data encryption
- Authentication, using digital certificates
- Message integrity, using message digests

Features of Wind River SSL 6.6 include the following:

- SSLv2, SSLv3, and TLS (RFC 2246) support
- HMAC-SHA-1 and HMAC-MD5
- DES, 3DES, and AES
- RSA public-key cryptography
- Implementation of OpenSSL APIs to allow for easy porting of existing applications
- Support of Transport Layer Security Extensions (RFC 3546)

The Wind River SSH (Secure Shell) protocol creates a secure terminal connection between an SSH client and an SSH server. This means embedded systems can communicate at the application level over a connection that is encrypted and provides data integrity and replay protection. This effectively eliminates eavesdropping, connection hijacking, IP spoofing, and other network-level attacks.

In addition, embedded SSH provides several secure tunneling capabilities that may be used to create VPNs. A variety of authentication methods is also supported.

Features of Wind River SSH 6.6 include the following:

- SSH server mode
- SFTP client support
- SSH versions 1.5 and 2.0
- Port forwarding
- Terminal connections and SFTP connections
- Integration with RADIUS Client

Wind River RADIUS Client

Wind River RADIUS Client is a full-featured implementation of the industry-standard remote authentication dial-in user protocol. Wind River RADIUS Client supports a complete set of functions for authentication, accounting, and security, and it has been verified against several commercial RADIUS servers, ensuring compatibility with a wide range of applications.

Wind River RADIUS Client 6.6 allows the network to determine whether a user is allowed access (authentication). Authentication is also used to determine that a message has not been fabricated or altered in transit. Authorization determines which network resources a user may access, and the accounting functions provide a record of usage. Wind River RADIUS Client also adds support for RFC 2865 and RFC 2866.

Management

Wind River provides a scalable, unified, small-footprint management framework that enables creation of web-based, CLI-based, or custom management interfaces to manage networked elements. It consists of a management backplane, which acts as a conduit for data-handling between management interfaces (consumers) and manageable elements (producers). The scalable framework can have any type of consumers and any type of producers.

Wind River Management Backplane interfaces with a CLI agent, Wind River CLI; an embedded web server, Wind River Web Server; and an SNMP implementation, Wind River SNMP (Simple Network Management Protocol). In addition, the framework comes with a full-featured, Windows-based developer tool (GUI), Wind River Management Integration Tool (WMIT). This tool eases the development of management interfaces by bringing all the framework components together.

In addition to WMIT, Management Configuration Editor (MCE) is a simplified Eclipse plug-in to help with development of CLI- and Web-based management interfaces. MCE is integrated with Wind River Workbench and may be run on any host that Workbench supports. Developers may choose WMIT, MCE, or a combination of the two to develop a desired management interface.

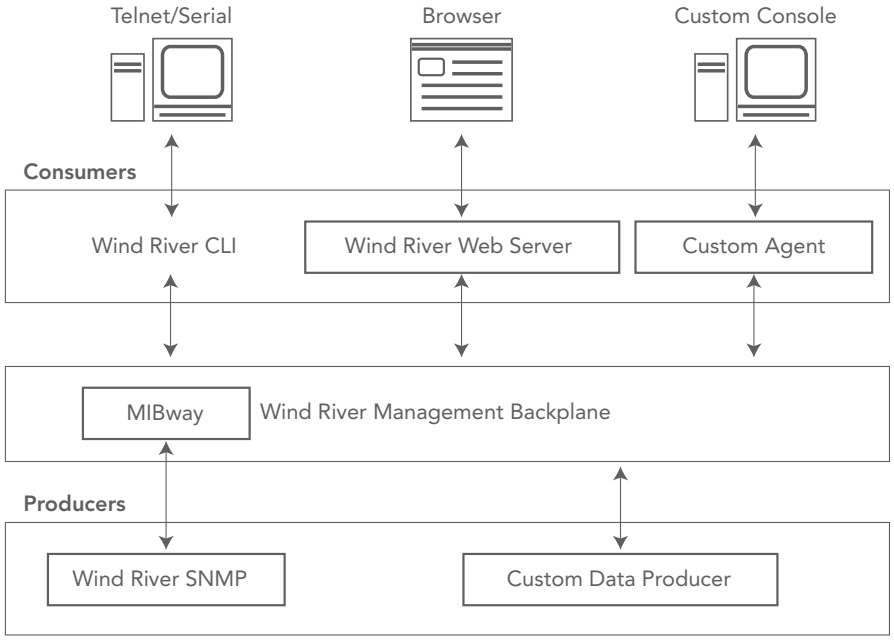

Figure 5: Wind River network management architecture

Wind River SNMP

SNMP is designed to facilitate management and configuration of networked devices. Wind River SNMP is a highly portable, memory-efficient, standards-compliant implementation of SNMP specifically designed for original equipment manufacturers (OEMs) and system integrators who require full compliance with SNMP standards in a fast, small SNMP agent. This complete solution for integrated SNMP design and implementation includes a full management information base (MIB) development platform. It is composed of SNMP v1/v2c/v3 and AgentX.

Features of Wind River SNMP 10.2 include the following:

- Bilingual SNMP agent supporting SNMPv1/v2c protocols
- Asynchronous support
- SNMP v3 security
- SNMP notifications
- "Target" and "Notify" MIBs
- SNMP proxy
- SNMP v1/v2/v3 coexistence
- AgentX module
- MIB compiler
- Compact, interoperable, standards-based configuration
- Integration with Wind River Network Stack
- Portable design and implementation

Wind River Web Server

Wind River Web Server is a scalable, secure, small-footprint commercial embedded web server. In addition to the functionality of a standard web server, it provides all the functionality needed to quickly create a browser-based management interface. Specifically designed for embedded systems, Wind River Web Server is HTTP 1.0 and 1.1 compliant and supplies SSL hooks to provide a secure transaction mechanism. The Wind River Management Integration Tool is a GUI tool that accelerates the process of creating and configuring a custom web-based management interface or a standalone web server by generating more than 70 percent of the required embedded code for such an application. The web-based management interfaces with a scalable backplane that interacts with SNMP through Wind River MIBway or with any custom manageable data.

Features of Wind River Web Server 4.7 include the following:

- HTTP 1.0/1.1 compliant web server
- Bidirectional CGI layer
- LiveControl
- Visual integration tool
- GZIP/PKZIP compression
- Support for HTML, DHTML, CSS, JavaScript, and XML
- Drop-in support for SNMP objects
- Bundled SMTP email alerts
- User time-out sessions
- HTML/query string processing
- Bidirectional gateway for tying management objects to HTML pages, email alerts, and JavaScript libraries
- File-based uploads (RFC 1867)
- Server Side Includes (SSI)
- Secure authentication (basic base64 encoding and digest authentication)
- SSL hooks verified with OpenSSL
- Wind River SNMP inheritance through MIBway
- In-depth tutorial and sample code that steps through API usage, development tools, and best practices

Wind River CLI

Wind River CLI includes a full-featured command shell and development tools that enable users to build either the standard "craft" style interface or a custom interface to manage a networked device. CLI commands can be executed on a device through either an RS-232 or a Telnet connection. The Wind River Management Integration Tool is a GUI tool that accelerates the process of creating and configuring a custom web-based management interface or a standalone web server by generating more than 70 percent of the final embedded CLI code for such an application. CLI interfaces with a scalable backplane, which interacts with SNMP through MIBway or directly with any custom manageable data.

Features of Wind River CLI 4.7 include the following:

- Complete CLI management solution
- High-speed generation of command tree, handler functions, and individual commands
- Drop-in, prebuilt commands
- Telnet server
- Secure communication over SSH
- With MIBway, instant reflection of SNMP MIBs in the command line
- Same architecture as Wind River Web Server
- Command completion
- Context-sensitive help
- Command history
- Intermediate mode handling
- Parameter handling, verification, and grouping
- Negate commands (e.g., to restore defaults)
- Support for simultaneous Telnet sessions and serial ports
- Common command libraries
- Security parameters defined by object, command, or session
- Fully reentrant ANSI C code
- In-depth tutorial and sample code that steps through API usage, developed tools, and best practices

Wind River MIBway

Wind River MIBway enables developers to automatically leverage all SNMP objects for reuse in command-line and web-based management interfaces, with zero additional engineering effort required. Wind River MIBway provides an SNMP inheritance library to access data objects already instrumented for the Wind River SNMP agent. This makes it possible to leverage the thousands of developer hours already invested in writing MIB variables and code in a schema that is both flexible and scalable for future device management requirements.

Benefits of Wind River MIBway 4.7 include the following:

- Instant leverage of all existing SNMP code
- Reduction in development cost by cutting down months of coding and testing to days
- Creation of powerful, feature-rich web and command-line interfaces
- Separation of application logic from interface design
- Embedded code that handles SNMP-specific queries from Wind River Management Backplane
- Single-click integration with Wind River SNMP
- In-depth tutorial and sample code that steps through API usage, development tools, and best practices

Wind River Management Integration Tool

The Wind River Management Integration Tool is a Windows-based GUI that enables users to build web-based or CLI-based management applications by incorporating features to set project options, configuration options, build options, and resource constraints settings, and automate code generation. It provides an MIB compiler to facilitate Wind River SNMP users, as well as a simple HTML editor as a miscellaneous tool.

Management Configuration Editor

Management Configuration Editor (MCE) is an Eclipse plug-in integrated with Wind River Workbench to help develop management interfaces. This tool is provided in addition to WMIT, so developers may use MCE on any host that supports Wind River Workbench (whereas WMIT is supported only on Windows). MCE functionality in this version of Platform for Automotive Devices is limited when compared to that of WMIT. WMIT and MCE will coexist until all necessary functionality is available in MCE and customers have completed migration to MCE.

Wind River HTTP Client

Wind River HTTP Client is a library of client-side functions required to interact with an HTTP server. Using the functions provided, developers can write simple applications for transferring files (using GET and POST methods) with URL syntax.

Features of Wind River HTTP Client include the following:

- Conformance with HTTP 1.1 specification
- Support for GET and POST methods
- Support for cookies
- Support for direct and proxy server requests
- Secure HTTP communication with HTTPS

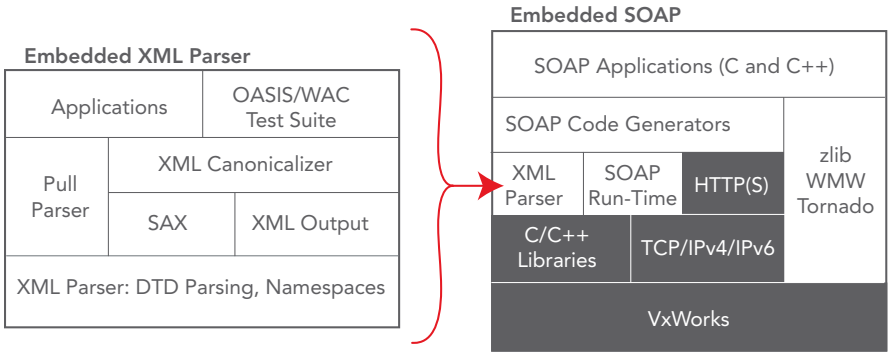

Figure 6: Wind River Web Services

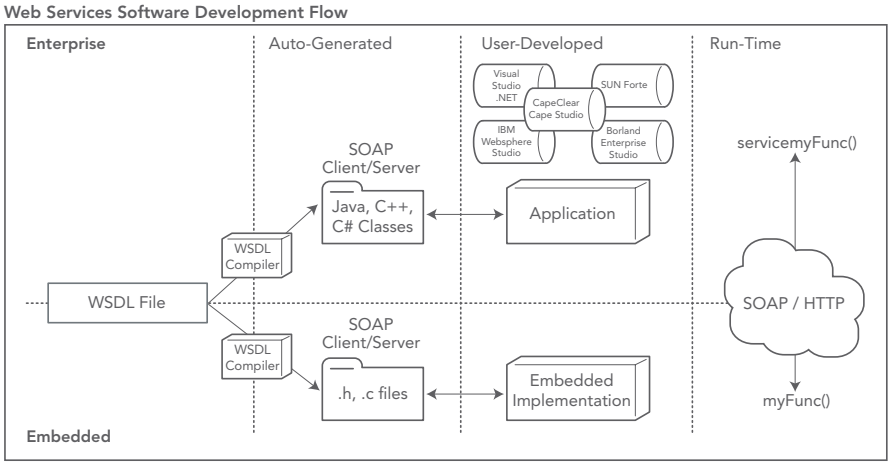

Figure 7: Web Services software development flow

Distributed Messaging and Services

Wind River Web Services

Wind River Web Services enable distributed applications running on a variety of platforms to communicate and interoperate seamlessly in a manner conforming to Web Services standards. They allow developers to create interoperable Web Services applications (clients and servers) by providing the fundamental building blocks: XML, SOAP, WSDL, and GUI-based compiler tools for Web Services intermediate code generation and compilation. Wind River Web Services are standards-compliant and specifically tuned for embedded systems applications.

Features of Wind River Web Services 1.5 include the following:

- WS-Security
- WS-I Basic Profile 1.0 conformance
- Clear and structured code and documentation for ease of configuration and maintenance
- Standards-conformant: XML 1.0, SOAP 1.2
- Communication through use of SOAP messages with any system supporting Web Services, including Microsoft .NET or Apache Axis
- Graphical WSDL compiler tool integrated into Wind River Workbench

Wind River DCOM

Wind River DCOM, an implementation of Microsoft's DCOM, scaled for device software development, provides the foundation for management protocols such as OLE for Process Control (OPC).

Wind River DCOM enables application distribution between VxWorks-based devices and non-real-time devices, such as desktop computers. It allows developers to seamlessly integrate device software applications with Windows applications running, such as data analysis, database storage, and graphical user interface. Wind River DCOM provides a compact, performance-focused solution targeted specifically for the strict requirements of devices.

Features of Wind River DCOM 2.3.6 include the following:

- Small footprint
- Source-compatible with Win32 SDK COM and DCOM API
- Object Template Library that provides convenience methods for DCOM application developers
- IDL compiler (compiling IDL files into Wind River DCOM application classes)
- GUI wizard for creating DCOM interfaces

Bridging and Routing

Wind River Learning Bridge

Wind River Learning Bridge is a basic implementation of a transparent, layer 2 Ethernet learning bridge that learns the network topology by analyzing the source address of incoming frames from all attached networks. The learning bridge attaches above the MUX layer as a SNARF network service type, and it includes two mirror END drivers used to bridge traffic destined for a stack located on the same machine as the bridge.

Wind River Learning Bridge 1.3.3 includes a station cache: a basic database that stores the relationship between MAC addresses and the ports from which it sees frames associated with those MAC addresses. Forwarding decisions are based on this cache. Both source and destination MAC addresses are used to build the cache database, and a cache-aging algorithm removes inactive entries. Learning Bridge is used by the Wind River Wireless Security Authenticator.

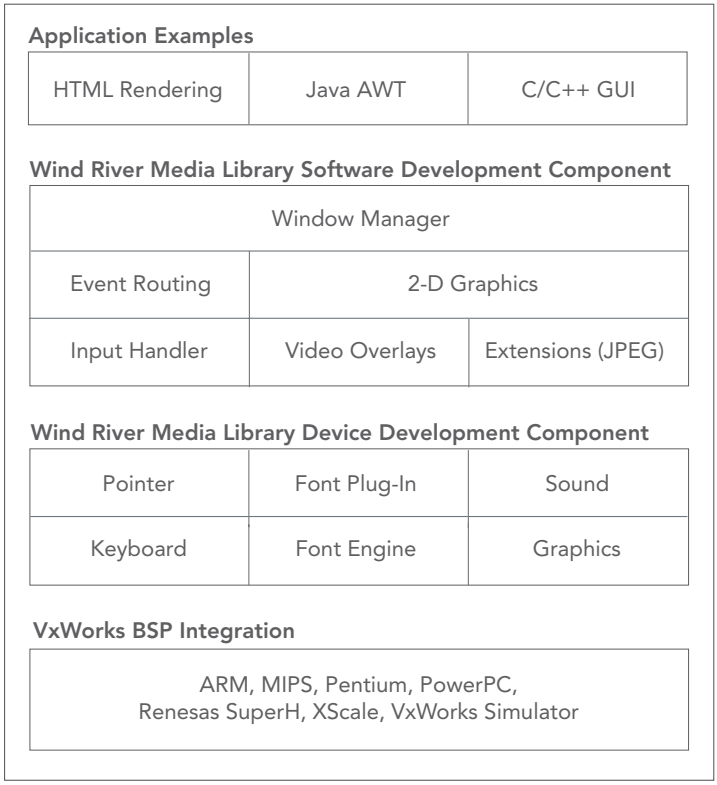

Figure 8: Wind River Media Library

Graphics and Local User Interface

Wind River Media Library

The scalable Wind River Media Library facilitates and speeds GUI development locally within a device. The library consists of a software development component and a driver development component that together provide a hardware abstraction layer for graphics, video, audio, and input devices.

The software development component is used for developing hardware-independent applications for a variety of platforms. It includes a comprehensive API for 2-D graphics, window management, region management, text display, color management, video overlay support, alpha blending, and JPEG image support. The 2-D API allows hardware-accelerated features to be used in a hardware-independent manner. The integrated window manager and input event routing facilities enable multiple applications to share one screen. For example, native C/C++ applications and Java-based applications can execute simultaneously while sharing the input and output device. The event service handles input events and routes them to specific applications, and it controls cursors for pointer devices, such as touch screens, mice, and remote controls.

The device development component is used for implementing drivers. It interfaces directly with the application's target hardware devices, including graphics chips, video controllers, LCD displays, audio chips, keyboards, and touch screens, and it provides a rich set of reference drivers for common hardware configurations. This component includes generic frame buffer rivers for 1-, 4-, 8-, 16-, and 32-bit color modes, which allow developers to bootstrap new drivers quickly and support any graphics device easily. The graphics driver framework provides both a native Media Library interface and an XFree86 driver interface, enabling development on the most current graphics hardware in the market. Media Library also includes an integrated FreeType font engine, which supports TrueType fonts and enables faster GUI application development. Finally, the driver development component is extensible, so it can accommodate the specific hardware functionalities of a device.

New features of Wind River Media Library 5.1 include the following:

- FreeType font engine v2.3.2
- Screen rotation support
- VxBus support
- Additional XFree86 resolutions
- Virtual input support
- Shared data library (optional) for kernel applications
- X.org drivers support
  - Added Intel 9xx support

Additional features of Wind River Media Library include the following:

- Multiple display functionality
- Video overlay enhancements
- Drawing surface extensions, including support for OpenGL
- Menu and button widgets
- Timers
- Touch screen calibration support
- RTP support for local bus graphics devices
- XFree86 driver support

Connectivity

Wind River CAN

Wind River CAN 1.5.5, an implementation of the Controller Area Network (CAN) protocol for VxWorks embedded targets, provides developers with a standardized interface to one or more CAN devices. The product supports many of the popular CAN controllers in use today, such as Philips SJA1000, Intel 82C157, and Motorola TouCAN. In addition, the Wind River CAN API is independent of the target architecture and the I/O mechanism used to access the CAN controller. This standardized interface greatly simplifies programming CAN hardware and allows applications to be ported quickly to new target architectures with minimal or no changes to user application source code. Additional protocols, such as CANopen (available from Wind River partner IXXAT) and DeviceNet, are integrated on top of this standard interface.

Wind River OPC

Wind River OPC, our implementation of the OLE for Process Control (OPC) specification for the VxWorks RTOS, is a non-proprietary technical specification that defines a set of standard interfaces based on Microsoft's OLE/COM technology. The OPC standard protocol enables interoperability between automation/

control applications, field devices, and business/office applications by allowing clients and servers from different vendors to speak the same standard language. OPC streamlines development of device interfaces, increased connectivity, and interoperability between custom applications and allows applications to access subsystem data easily. The Wind River OPC implementation is designed specifically to support devices with high-performance and small footprint requirements.

Wind River OPC 3.1.5 support includes the following:

- OPC Data Access Server 2.05A specification
- OPC Alarms and Events 1.1 specification
- OPC Data eXchange 1.0 specification
- Interactive sample OPC client
- Optimization for real-time devices
- Integration with development tools

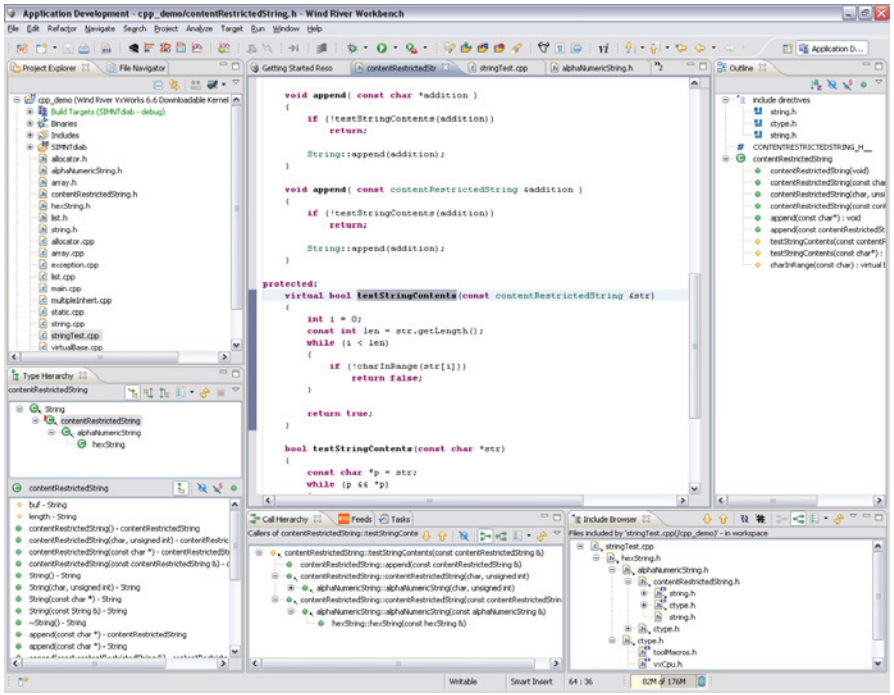

Figure 9: Wind River Workbench

Wireless

Wind River Wireless Ethernet Driver

Wind River Wireless Ethernet Driver provides access point and station-side support for the industry-standard 802.11a, b, and g protocols. The drivers come with direct support for Atheros AR500x and Broadcom BCM43xx chipsets. 802.11n is supported in the Broadcom driver. A fully abstracted hardware interface layer provides ease of portability to other wireless chips. The driver supports multiple hardware interfaces on the same target, allowing for more advanced applications. The driver can be used in a wide variety of target hardware platforms. A standard IOCTL application interface is provided for user configuration and control. Wireless security is provided through preintegration with the Wind River Wireless Security protocol, supporting the 802.1X, WPA, and 802.11i standards, and Wind River Wireless Ethernet Driver facilitates management of spectrum regulation differences between different countries through 802.11d support.

The security implementation includes preshared keys and TKIP (Temporal Key Integrity Protocol). A range of encryption and hashing algorithms is available to give developers flexibility in trading off security level versus performance.

Features of Wind River Wireless Ethernet Driver 2.3 include the following:

- Supports multiple modes: 802.11a, b, g
- Supports country-specific spectrum regulations through 802.11d
- Supports Wi-Fi Protection Access (WPA) and 802.11i for security
- Supports multiple service set identifiers
- Directly supports Atheros AR500x chipsets
  - AR5001X, AR5002, AR5004, AR5005
- Directly supports Broadcom BCM43xx chipsets
- Ports easily to other chipsets
- Supports both access point and station side
- Supports multiple hardware instances on the same target
- Features user configuration and control through use of IOCTL controls
- Features industry-standard application interface format: ioctl (descriptor, function, value)
- Extends easily to support new features and customer requirements
- Maps directly into the 802.11MIB
- Features extensive debugging/logging support and show routines
- Configures through command line or Wind River Workbench
- Integrates with Wind River Wireless Security protocol: 802.1X

Wind River Workbench Development Suite

Wind River Workbench is a collection of Eclipse-based tools that accelerates time-to-market for developers building devices with VxWorks. Workbench offers the only end-to-end, open standards–based collection of tools for device software design, development, debugging, test, and management. Through its powerful combination of capabilities, integration, and availability, Workbench enables organizations to standardize on a common environment for device software development, helping developers, project teams, and enterprises improve their effectiveness.

Workbench offers the following:

- Best-in-class capability at each phase of the development process, including hardware bring-up, firmware development, application software development, advanced visualization, system diagnostics, and test
- Broad availability to support increased standardization across projects
  - Multiple-target OS support, including support for VxWorks 5.5, VxWorks 6.x, and Linux
  - Target processor support for ARM, ColdFire, Intel Architecture/Pentium, MIPS, PowerPC, Renesas SuperH, and XScale processors

- Plug-in architecture enabling additional target OS, target processor, and target connection support to be added
- Extensible framework, based on Eclipse, to seamlessly integrate third-party and in-house plug-ins for total customization and scalability

Workbench addresses the challenges individual developers and project teams face by increasing productivity, enabling collaboration between hardware and software developers, and meeting diverse development needs across an enterprise. The development suite is backed by Wind River's 25 years of device software industry experience, a world-class support organization, and a specialized professional services team.

Wind River Workbench 3.0

This version of the platform features Workbench 3.0, which includes significant new capabilities in support of increased development team productivity:

- General Workbench enhancements
  - Increased APIs and compatibility with Eclipse plug-ins
  - Migration to CDT 4.0.1 Editor, Target Management, and Device Debugging views from Eclipse
  - Performance and scalability enhancements for large application support
  - New Getting Started Resources
  - New Host OS support
  - Based on Eclipse 3.3.1 framework
- VxWorks platform enhancements
  - SMP support (includes Debugger, run-time analysis tools, and VxWorks Simulator)
  - System Viewer SMP task-to-core and timing analysis
  - Significant improvements in instrumented kernel size with System Viewer
  - Code Coverage Analyzer and Function Tracer (formerly CoverageScope and TraceScope), now included in all VxWorks platforms
- On-chip debugging enhancements
  - VxWorks SMP support
  - NAND flash support
  - Flash development kit
  - Updated processor support
  - Workflow enhancements
- Lab and Field Diagnostics enhancements
  - Persistent Sensorpoints after reboot
  - Programmatic Sensorpoint API with scripting capability
  - Enhanced security between site manager and devices
  - Upgradeable agent to enable update of deployed devices
  - Support for Emerson MicroTCA
  - MIPS and ARM support

Workbench includes the following features:

Eclipse

Because of its openness, capability, and strong community support, Eclipse was chosen as the framework for the Wind River Workbench development suite. The Eclipse 3.3.1 framework supplies the necessary infrastructure to graphically and functionally integrate the components of Workbench. Open, extensible, and backed by a strong community of commercial and open source developers, the Eclipse framework provides developers using Workbench with a wide range of additional integrated functionalities.

Eclipse-integrated capabilities are provided by commercial development tool providers (such as IBM, Hewlett-Packard, and Borland) and an active developer community. As a result, developers have access to a wide range of value-added plug-ins from third-party and in-house sources that can be used to extend the capabilities of Wind River Workbench. Examples include Eclipse-integrated configuration management systems and editors, which offer simple plug-in integration with Wind River Workbench through standard Eclipse interfaces.

More information on Eclipse and available third-party plug-ins is available from the Community Projects and Plug-Ins section of the Eclipse website, www.eclipse.org.

In many cases, users will need to validate the utility and compatibility of these plug-ins with Wind River Workbench.

Workbench 3.0 includes useful new features from the Eclipse CDT project, many of which were developed and contributed by Wind River for the benefit of Wind River customers. In earlier versions of Workbench, Wind River provided these features independently, but with the migration of these capabilities to CDT 4.0, this functionality is now available in the open source project. Notable among the features provided by CDT 4.0 are the editor, the source code parser, and the indexer.

Project System

The Workbench Project System allows developers to organize and manage the primary components in a device software development project, including source files and target systems. By design, Workbench enables users to manage multiple projects simultaneously.

Build System

The Workbench Build System specifies the tools, options, and parameters to use when building device software projects, enabling you to set build parameters easily from the project level down to the individual file level. The Build System allows for use of simple global build-setting, fine-grained control at the level of an individual file, and everything in between.

Indexed-Based Global Text Search-and-Replace

The Search view provides high-speed text search-and-replace features based on project settings. The searches can operate on text or regular expressions and can find matches within context (such as comments, literal text, source code, etc.). The resulting replacements can be previewed individually or accepted for all occurrences.

Wind River Compiler and Wind River GNU Compiler

Wind River Compiler is the default C/C++ compiler configured for building the VxWorks 6.x kernel, libraries, BSPs, and applications in Wind River Workbench. This compiler's optimization capabilities are based on and extend the industry-hardened Diab compiler technology, and it produces robust, tight, fast-executing code.

Wind River Compiler includes the following:

- Superior optimization technology to generate fast, compact, high-quality code
- 100 percent compatibility with the latest ANSI C++ specs (ISO/IEC 14882:1998(E) C++ standard) and the ANSI C spec (X3.159-1989)
- Standards conformance (ANSI and EABI) for maximum tool interoperability
- Complete control of code and data memory allocation
- Position independent code (PIC) and position independent data (PID) support
- Proven performance with VxWorks

Wind River Compiler also supports run-time error-checking that detects and corrects hard-to-find problems, such as memory leaks and out-of-bounds pointers, to aid in producing higher-quality code.

Wind River GNU Compiler is based on the Free Software Foundation (FSF) distribution of the GNU compiler. Wind River has modified an off-the-Net version of the compiler specifically for use with VxWorks 6.x. The primary areas of modification deal with support for RTPs and shared libraries.

Wind River GNU Compiler includes the following:

- cpp, the C preprocessor
- GCC, the C and C++ compiler
- id, the programmable static linker
- as, the portable assembler
- Binary utilities

Both compilers are included and supported as part of Wind River Workbench for VxWorks 6.x.

Workbench Debugger

The Workbench Debugger provides more capability than the GNU debugger (GDB) or other basic source-level debuggers. Our debugger was designed to provide simultaneous, side-by side debugging of device software running in multiple contexts that may be different tasks, different real-time processes, or different processors. These capabilities can be extended further with Wind River's on-chip debugging solutions. In combination, these tools provide the necessary functionality for hardware bring-up, device driver/BSP debugging, kernel debugging, and application software debugging.

VxWorks Simulator

VxWorks Simulator 6.6, formerly known as VxSim, is a complete prototyping and simulation tool for VxWorks 6.x applications. Starting in VxWorks 6.6, VxWorks Simulator now supports simulation of SMP systems, up to a maximum of 32 CPUs on any supported host. It enables you to develop and test significant portions of your application earlier in the development cycle, before hardware is available. It can also lower your development cost by allowing developers to share fewer hardware targets by enabling host-based development. The simulator is fully integrated into the Wind River Workbench development environment as a target connection, allowing complete configuration and debugging control through standard interfaces.

VxWorks Simulator is a native application that has been ported from the VxWorks 6.x operating system to accurately implement the sophisticated features of VxWorks 6.x, including SMP, RTPs, memory protection, file systems, and UNIX-style networking (TCP/IP, rlogin, etc.). The simulator also provides network simulation capabilities that let you create complete simulations of complex networks consisting of multiple IPv4, IPv6, or other protocols, subnets, and routing systems.

The simulator runs on your chosen host workstation, decreasing the need for evaluation hardware early in the development cycle. It also provides easy access to the host operating system API, so you can use the host facilities and peripherals in your simulation. For instance, a PCI card used in your final system can be installed on the host machine, then accessed by the simulator.

VxWorks 6.x Kernel Configurator

VxWorks 6.x Kernel Configurator is a graphical utility that simplifies and accelerates the task of selecting the operating system components that must be included in a bootable VxWorks image. A command-line utility, vxprj, supplies the ability to perform a kernel build within scripts used as part of automated builds. The configurator is backward-compatible with Tornado 2.2 and VxWorks 5.5. Starting in VxWorks 6.6, the kernel configurator allows the creation of SMP projects as well, on any supported SMP target.

When creating a new bootable kernel image, Workbench analyzes available kernel components, as well as BSP and compiler selections. The configurator displays a summary of key configuration data, such as the number of selected components or data and text size. A bundle selector allows users to quickly and easily include or exclude dedicated configuration bundles composed of multiple components from a kernel image. Sample configuration bundles provided with the configurator include components needed for POSIX compliance, real-time process development, or error management.

Selecting kernel components individually gives you greater flexibility and control over your VxWorks image. VxWorks 6.x Kernel Configurator analyzes component dependencies and highlights conflicts when components are required, but not selected, or if components are incompatible with one another. An autoscale feature analyzes the entire VxWorks image and removes unused kernel components that may increase the size of a bootable image unnecessarily.

It is also possible to include custom component definitions for specialized purposes or from third parties—the configurator verifies whether component selections are valid and free of conflict.

Host Shell

The Host Shell, formerly known as WindSh, provides a command-line interface that allows you to download application modules and invoke both VxWorks 6.x and application module subroutines. This facility has many uses:

- Interactive exploration of the operating system by calling any VxWorks routine and API
- Debugging and monitoring processes
- Prototyping

The following are new to VxWorks 6.x:

- Interactive exploration of VxWorks 6.x RTPs
- Interactive development by calling any application (RTP) routines
- VxWorks 6.x application (RTP) and kernel testing
- Error management support through output of error dumping; the ability to turn on/off error management on a per-task or per-RTP basis
- Message channels (IPC) support through text dump of the message traffic

The Host Shell executes on the development host, not the target, but it enables you to spawn tasks, look at RTPs, read from or write to target devices, and exert full control over the target. The Host Shell receives your commands, executes them locally on the host, and dispatches requests to the target server for any

action involving the symbol table or target-resident programs or data.

Because the shell executes on the host system, you can use it with minimal intrusion on target resources. As with other VxWorks 6.x tools, only the target agent is required on the target system. Therefore, the Host Shell can remain available at all times—you can use it to maintain a production system, as well as to experiment and test during development. Since you do not need to rebuild the VxWorks 6.x image, the Host Shell is useful on targets with restricted memory, and permits system mode debugging, which is critical to debug device drivers and interrupt handlers.

Kernel Shell

The VxWorks 6.x Kernel Shell, formerly known as the Target Shell, runs within the VxWorks 6.x kernel and provides direct access to VxWorks 6.x through a console or a network connection, such as Telnet. The Kernel Shell provides similar capabilities to those provided by the Host Shell; it is often used when control or visibility into system status is needed outside a development environment. Starting in VxWorks 6.6, the kernel shell works with VxWorks SMP. The task information display now includes the CPU/core on which tasks run.

Run-Time Analysis Tools

Workbench contains powerful and dynamic visualization tools for device software applications. They provide developers with visibility into the entire platform: application code, third-party libraries, and the operating system. You can monitor variables, optimize performance, and find memory problems—all while the system is still running.

System Viewer

System Viewer provides detailed analysis and graphical visualization of VxWorks 6.x system events, revealing the complex interactions of tasks, interrupts, and system objects of an application executing on a target. Context changes are clearly shown, as are system events such as semaphores, message queues, signals, tasks, timers, and user events. System Viewer allows device software developers to detect anomalous behavior quickly, then understand the cause and effect by reviewing the complete history of events leading up to the problem, including error management events from VxWorks 6.x.

Performance Profiler (Formerly ProfileScope)

Profiling is critical for real-time systems. Once you understand performance bottlenecks, it becomes easier to optimize application code. Performance Profiler is a dynamic execution profiler that provides detailed function-by-function performance analysis, specifying individual routines within the program that are consuming the CPU cycles. Performance Profiler pinpoints inefficiencies and shows how performance changes over time.

Memory Analyzer (Formerly MemScope)

Ensuring optimal use of memory is a critical activity in device software design. In many applications, memory usage is not fully understood, and a large portion of available memory is wasted. Systems can run for days before failing due to noncharacterized memory leaks. Memory Analyzer is an instant memory analyzer that provides greater visibility into memory usage. Without any special compilation or instrumentation, you can monitor available memory, detect leaks that occur due to system calls or third-party libraries, and even watch leaks as they happen.

Data Monitor (Formerly StethoScope)

This real-time graphical monitoring tool is used to examine variables, data structures, or memory locations in your system. You can watch any set of variables, see peak values and out-of-range settings you would otherwise miss, trigger collection on specific events, change variables while your program runs, and save collected data to disk. Data Monitor presents this live analysis of your program without stopping or slowing your code.

Code Coverage Analyzer (Formerly CoverageScope)

Code Coverage Analyzer enables analysis of code to determine which code segments are executed during testing. Visibility into the execution of individual statements, decisions, and conditions enables you to create more thorough test scenarios, ensuring delivery of higher-quality devices. It also becomes easy to identify and remove code that is never executed, thus preventing future problems and reducing your overall memory footprint.

Function Tracer (Formerly TraceScope)

Function Tracer traces code execution in real-time by providing function call sequences as your code executes. Included with the function call displays are the provided parameters, as well as the returned values, to allow you to identify when function behavior and execution timing change.

Optional Add-Ons

Wind River VxWorks 6.6 SMP

VxWorks 6.6 offers support for symmetric multiprocessing (SMP) as an optional add-on product, VxWorks 6.6 SMP. Multiprocessing systems include two or more processors in a single system. SMP is a variant of multiprocessing technology in which one instance of an operating system controls all processors and memory is shared. SMP differs from asymmetric multiprocessing (AMP) in that an AMP system has a separate instance of an operating system executing on each processor (and each instance may or may not be the same type of operating system).

The VxWorks SMP configuration allows a single instance of the operating system to use multiple processors in a single system. At the same time, it maintains the same key RTOS characteristics of performance, small footprint, high reliability, and determinism as the uniprocessor configuration of VxWorks.

The VxWorks SMP–enabled platforms allow customers to do the following:

- Deliver higher performance, multicore-powered products with reduced risk and development investment
- Speed time-to-market by using the commercially available and supported run-time platforms and developer tools for multiprocessing

- Increase productivity by using the same development environment and process available for uniprocessor development by using the SMP extension to existing development tools
- Enable a flexible design approach using Wind River's expertise and broad technology support for multiprocessing

VxWorks SMP introduces the following key features:

- **Multitasking:** Allows true concurrent execution of tasks and handling of interrupts.
- **Concurrent task scheduling:** Manages the concurrent execution of tasks on different CPUs.
- **Mutual exclusion:** Provides specialized mechanisms for mutual exclusion between tasks executing, and interrupts them being received simultaneously on different CPUs. Because SMP systems allow for truly concurrent execution, the uniprocessor mechanisms for disabling (masking) interrupts and for suspending task preemption in order to protect critical regions are inappropriate for—and not available in—an SMP operating system.
- **CPU affinity:** Provides the ability to assign specific tasks or interrupts to a specific CPU. By default, any task can run on any of the CPUs in the system, which generally provides the best load balancing. However, this capability may be useful for cases where the designer wishes to assign a task or interrupt to a specific processor resource.
- **Binary and API compatibility:** Maintains substantial commonality between the binary code and the APIs used for both the uniprocessor and symmetric multiprocessing configurations. The differences in the APIs are a small number of routines, accounting for APIs not suitable for an SMP system or that are not relevant to a uniprocessor system. This allows applications that use the subset of APIs defined for SMP to have binary compatibility with a VxWorks uniprocessor configuration.
- **VxWorks SMP simulation capability:** Allows development of SMP applications to begin without physical hardware. The VxWorks Simulator provides default SMP system images to develop and test the API's use in the applications. SMP simulators are provided with the standard uniprocessor VxWorks installations as an introduction to the SMP product.
- **Broad multicore hardware compatibility:** Provides support for the leading multicore silicon available on the market, giving customers a choice in functionality for their specific device requirements.

The following are supported processors:

- ARM11 MPCore (ARMv6)
- Broadcom BCM1480
- Cavium OCTEON CN38XX
- Freescale MPC8641D, MPC8572
- Dual-Core Intel Xeon processor LV
- Intel Core Duo T2400
- Raza XLR 732

Wind River Device Management

Wind River Device Management consists of two interoperable products that create a powerful, enterprise-wide infrastructure to enable development and software quality assurance (SQA) engineers to streamline the SQA process, and field engineering teams to streamline the support process. Benefits include faster time-to-market, higher-quality products, and the ability to rapidly and remotely diagnose and repair software defects in deployed devices. This leads to lower support costs, increased system uptime, and improved customer satisfaction. Both products are available for VxWorks 5.5 and VxWorks 6.x, as well as for Wind River Linux 1.x and 2.0.

Wind River Lab Diagnostics

Wind River Lab Diagnostics is an enterprise-class server application that enables engineers to comprehensively test applications and resolve issues encountered in test labs. It allows companies to greatly enhance productivity by streamlining system integration, software verification, and product validation, spreading the test load across distributed teams, enabling fact-based diagnostics of multiple devices, and eliminating time-consuming instrumentation-build-test cycles. Lab Diagnostics also enables manufacturers to "design in" supportability, which eases and speeds issue resolution in deployed devices. This standalone product is interoperable with Wind River Workbench and is sold as an add-on to Wind River platforms. For more information, see the Wind River Lab Diagnostics product note.

Wind River Field Diagnostics

Wind River Field Diagnostics is a scalable, field diagnostics system that enables support engineers to securely collect and manage deployed device data to diagnose and correct software faults. Field Diagnostics is a secure, enterprise-wide infrastructure that includes a site-installed application for onsite device data collection and diagnostics, as well as an enterprise application to manage data aggregation, analysis, and archiving from worldwide deployments. It links device manufacturers with device users through a secure data exchange infrastructure. With Field Diagnostics, device manufacturers can improve uptime, streamline support and maintenance operation, reduce support costs, and increase service revenue. This standalone product is interoperable with Wind River Workbench and is sold as an add-on to Wind River platforms. For more information, see the Wind River Field Diagnostics product note.

The following are new in Lab and Field Diagnostics 2.2:

- Persistent Sensorpoints after reboot
- Patchpoint technology that enables software upgrades on deployed devices
- Enhanced security between site manager and devices
- Upgradeable agent to enable update of deployed devices

Wind River Workbench, On-Chip Debugging Edition

The Workbench development environment provided with Wind River platforms can be enabled for on-chip debugging. Wind River's on-chip debugging capability, along with Wind River ICE, Wind River Trace, or Wind River Probe hardware, provides access to significant additional capability within Workbench.

In the early stages of hardware and software development, a robust connection to the microprocessor through its run-control port is essential. Workbench On-Chip Debugging provides connectivity between the host development environment and the target device via the JTAG or on-chip debugging interface of the microprocessor residing on the device. The on-chip debugging interface of most microprocessors enables full

control of the microprocessor itself, access to core and peripheral registers, and access to on-chip switch fabrics and memory controllers, along with access to external buses and many devices attached directly to the bus. In addition, some microprocessors support either internal or external trace buffers, allowing developers to capture information about the exact code that runs on the target and when.

On-chip debugging provides developers with complete system-level control of their environment at all times, enabling more efficient and effective hardware bring-up, firmware development, and device driver and BSP generation. On-chip debugging can also be a useful alternative to agent-based debugging in applications where serial, Ethernet, or USB interfaces are not available, or in environments where agent instrumentation of the OS is not desired.

Extended Workbench capabilities offered through the on-chip debugging connection include the following:

- On-chip debugging target connection manager
- On-chip debugging command shell
- On-chip debugging console
- Flash programming
- Hardware and memory diagnostics
- Configuration options
- JTAG editor
- Extensions to Register view, including the following:
  - Bit-level register details
  - Additional peripheral register support for most processors
- On-chip debugging user's perspective within Workbench
- Wind River Trace (may require additional hardware, to be purchased separately)
- Firmware update
- Cache Memory view
- Statistical performance analyzer (PFA)
- On-chip debugging reset and download/launch
- VxWorks 5.5, VxWorks 6.x, Linux, and ThreadX OS awareness via JTAG

For more information, see the Wind River Workbench, On-Chip Debugging Edition product note.

IPL Cantata++ for Wind River Workbench (Formerly Workbench Unit Tester)

IPL Cantata++ for Wind River Workbench, available for VxWorks 5.5 and VxWorks 6.x based platforms, is a set of tools that allows developers greater efficiency in completing unit testing, integration testing, and code coverage analysis on the tests. The integration of IPL Cantata++ with Workbench places these capabilities within easy reach. IPL Cantata++ increases software quality, decreases time-to-market, and reduces support costs through better, faster, more automated testing in the development life cycle.

Technical Specifications

VxWorks 6.6

- VxWorks 5.5, 6.0, 6.1, 6.2, 6.3, 6.4, and 6.5 compatibility
- Kernel scalability using scaled OS configuration profiles
- State-of-the-art memory protection
- Memory management
- Error management
- Message channels IPC, including support for multiprocessor and multi-OS messaging using TIPC
- Improved POSIX compliancy, including full support for JTRS SCA AEP 2.2.2 and certified conformance to POSIX IEEE Std. 1003.13-2003 PSE52
- Dual-mode IPv4/IPv6 network stack
- Power management framework, with CPU power management
- TrueFFS (flash file system)
- dosFs (FAT-compatible file system)
- Highly reliable file system (HRFS) with configurable commit points
- High-speed interconnect framework with PCI and local bus support
- VxMP 2.3.4
- Wind River TIPC 1.7.3
- Wind River Network Stack 6.6
- Wind River PPP 6.6
- Wind River USB 2.4
- Wind River IPsec and IKE 6.6
- Wind River Crypto 6.6
- Wind River Security Libraries 1.4
- Wind River SSL 6.6
- Wind River SSH 6.6
- Wind River RADIUS Client 6.6
- Wind River Firewall 6.6
- Wind River NAT 6.6
- Wind River Wireless Ethernet Driver 3.0
- Wind River Wireless Security 2.4.1
- Wind River OPC 3.1.5
- Wind River DCOM 2.3.6
- Wind River CAN 1.5.5
- Wind River CLI, Web Server, MIBway 4.7
- Wind River SNMP 10.2
- Wind River Learning Bridge 1.3.3
- Wind River Media Library 5.1
- Wind River Web Services 1.5

Workbench 3.0

- Eclipse
  - Eclipse platform 3.3.1
  - C/C++ Development Tooling (Eclipse CDT project) 4.0.1
  - Target Management/Remote System Explorer (Eclipse DSDP-TM project) 2.0
  - Device Debugging (Eclipse DSDP-DD project) 0.9
- Project System
- Build System
- Index-based global text search-and-replace
- Wind River compilers
  - Wind River Compiler for VxWorks 5.6
  - Wind River GNU Compiler 4.1.2
- Debugger
  - Target debug agent for VxWorks
- Shell environments
- VxWorks Kernel Configurator
- Run-time analysis tools
  - System Viewer
  - Performance Profiler (formerly ProfileScope)
  - Memory Analyzer (formerly MemScope)
  - Data Monitor (formerly StethoScope)
  - Code Coverage Analyzer (formerly CoverageScope)
  - Function Tracer (formerly TraceScope)

Optional Add-Ons

- VxWorks 6.6 SMP optional add-on product (support for leading-edge multicore processors and boards)
  - ARM11 MPCore (ARMv6)
  - Broadcom BCM1480
  - Cavium OCTEON CN38XX
  - Freescale MPC8641D, MPC8572
  - Dual-Core Intel Xeon processor LV
  - Intel Core Duo T2400
  - Raza XLR 732
- Wind River Device Management
  - Wind River Lab Diagnostics 2.2
  - Wind River Field Diagnostics 2.2
- Wind River Workbench, On-Chip Debugging Edition
- IPL Cantata++ for Wind River Workbench 3.0 (formerly Workbench Unit Tester)
- Datalight FlashFX Pro version 3.17 for NAND flash memory support

Architectures, Hosts, and Board Support Packages

Supported Target Architectures

- ARM
  - ARM9
  - ARM11
  - ARM MPCore
- ColdFire
  - ColdFire V2
  - ColdFire V3
  - ColdFire V4e
- Intel
  - Pentium family (Pentium, Pentium Pro, Pentium II, Pentium III, Pentium 4, Pentium M)
  - Xeon LV
  - Core
- Intel/Marvell XScale
  - IXP4xx
  - IXP2xxx
  - PXAxxx
- MIPS
  - MIPS 4Kx
  - MIPS 5Kx
  - MIPS tx49xx
  - MIPS24Kx
  - BCM SB1 (1250, 1125, 1122, 1121)
  - BCM SB1a (1480, 1455, 1280, 1255, 1155)
  - Cavium OCTEON CN3XXX
  - Cavium OCTEON CN5XXX
  - RM9000GL
  - VR55xx
  - Raza XLR
- PowerPC
  - PowerPC 40x
  - PowerPC 44x
  - PowerPC 60x
  - PowerPC 7xx
  - PowerPC 8xx
  - PowerPC 52xx
  - PowerPC 74xx
  - PowerPC 82xx
  - PowerPC 83xx
  - PowerPC 85xx, 8572
  - PowerPC 86xx, 8641d
  - PowerPC 970
- Renesas SuperH
  - SuperH-4
  - SuperH-4A

Supported Hosts

- Windows XP Professional, Service Pack 2
- Windows Vista (Business and Enterprise)
- Red Hat Enterprise Linux 4, Update 5
- Red Hat Enterprise Linux 5*
- Red Hat Fedora Core 7
- SUSE Desktop Linux 10, Service Pack 1
- SUSE Linux/openSUSE** 10.2
- Solaris 9***
- Solaris 10

** Both 32-bit and 64-bit versions are supported. For 64-bit version, only x86-64 is supported. IA-64 (original Intel Itanium architecture) is not supported.*

*** SUSE Linux has been renamed to openSUSE.*

**** GTK only (Solaris 9, update 9/05)*

Board Support Packages

Platform for Automotive Devices, VxWorks Edition supports a wide variety of board support packages on the target architectures listed previously. For a complete list of available BSPs, please visit the Board Support Packages section of the Wind River website at www.windriver.com/products/bsp_web/index.html.

Partner Ecosystem

Wind River's world-class partner ecosystem assures tight integration between our core technologies and those of the premier hardware and software companies we've chosen to complement our solutions. Our partners help extend the capabilities of Wind River's development and run-time platforms by offering out-of-the-box integration and support for key technologies in the fast-moving automotive market. Our customer support team is trained to troubleshoot partner technologies in use with Wind River products, making ours the most comprehensive and best supported partner ecosystem in the DSO industry.

Our automotive hardware partners include the following:

- ARM
- Freescale
- Intel
- MIPS
- Renesas
- Seagate
- Texas Instruments

Our automotive software partners include the following:

Technology	Partner
NAND flash support	Datalight
Graphics and GUI builder	Tilcon, PSA
3-D graphics and OpenGL	ALT Software, Seaweed Systems
3-D graphics acceleration and optimization	3DVU
Graphics development framework	Altia, 3SOFT
Music database	AMG, Gracenote
Java VM	aicas, Apogee, DDC-I, Esmertec, Aonix, Skelmir
IEEE1394	VividLogic
HTML-based UI (browser)	Access, Espial, Opera
Haptics	Immersion
Input method	Agfa, Bitstream, Zi
Speech recognition and text-to-speech	Asahi Kasei, Conversay, Fonix, Nuance
Model-based development	ILogix, IBM
OSGi	ProSyst
Data management	ENCIRQ, Solid
Automotive application framework	Lectronix
Wireless telemetry	Airbiquity
GPS	Trimble

Professional Services

Wind River Professional Services, a CMMI Level 3–certified organization, enables you to reduce risk and focus on development activities that add value and differentiate your design. As part of our comprehensive DSO solution, Wind River offers industry-specific services practices, with focused offerings that help you meet strict market deadlines while keeping development costs down. Our experienced team delivers device software expertise that solves key development challenges and directly contributes to our clients' success.

Backed by our commercial-grade project methodology, Wind River Professional Services include the following:

- Requirements discovery and definition
- BSP and driver optimization
- Software system and middleware integration
- Application and infrastructure development
- Hardware and FPGA design for prototyping or market-ready systems

Typical projects range from two to four man-weeks for driver and BSP implementation, to one man-month to one man-year for hardware design or extensions to an existing software solution, to multi-man-year programs that bring customer concepts to reality through design, creation, and system test and verification.

Professional Services has extensive experience with automotive platform design, including safety critical systems and navigation/infotainment systems. Professional Services has implemented both hardware and software solutions for the automotive industry and continues to work with standards organizations to establish the next-generation platforms for consumer devices in automotive infrastructure.

Installation and Orientation Service

Proper installation and orientation of Platform for Automotive Devices means you won't waste time solving easily avoidable problems before you can begin your next development project. Wind River offers an Installation and Orientation Service to ensure your project starts on time and without hassle by delivering the following:

- **Onsite installation:** Guided install on your hardware and host platform, along with a sample build process, demonstrations, and examples of customizations
- **Hands-on orientation:** Architecture, development file system, adding open source packages, porting drivers, addressing design issues
- **Advice:** Introduction to Wind River support channels and processes, additional services, project review, and consultation

The Wind River Installation and Orientation Service will expedite your path to productivity, allow you to rest assured that we have eliminated a common source of user error, and help you realize all of the platform's potential.

Education Services

Education is fundamentally connected not only to individual performance, but also to the success of a project or entire company. Lack of product knowledge can translate into longer development schedules, poor quality, and higher costs. The ability to learn—and to convert that learning into improved performance—creates extraordinary value for individuals, teams, and organizations. To help your team achieve that result, Wind River offers flexible approaches to delivering product education that best fits your time, budget, and skills development requirements.

Personalized Learning Program

Wind River offers a unique solution to minimize the short-term productivity drop associated with the process of adopting new device software technology, and to optimize the long-term return on investment in a new device software platform. The Wind River Personalized Learning Program delivers the right education required by individual learners to accomplish their jobs. The program identifies work-related skill gaps, generates development plans, materials, and learning events to address these skill gaps, and quantifies the impact of the development activities for each individual user.

This programmatic, focused, and project-friendly approach to skills development results in a significant increase in the personal productivity of your team, improved efficiency in the processes they employ, and faster adoption of the technology you have purchased. The Personalized Learning Program deliver improved business performance; customers have reported a return on investment ranging from 18 percent to 80 percent over a traditional training approach.

Consult your local Wind River sales representative for more information on the Personalized Learning Program.

Public Courses

Wind River's public courses are scheduled for your geographical convenience. They are conducted over one to five days, using a mixed lecture and interactive lab classroom format that leverages the experience of Wind River instructors and other course participants. Courses provide a fast, cost-effective way for students to become more productive in Wind River technology.

Benefits of public courses include the following:

- A conceptual introduction that orients students to the subject matter
- A selective examination of the details, focusing on the most commonly used areas, or on areas with which users tend to be least familiar
- Personal guidance and hands-on application of individual tools and course concepts
- The chance to grasp device software concepts, as well as the fundamental issues involved in real-time design
- The knowledge needed to develop device drivers, perform hardware porting, or develop applications
- Answers to specific questions about topics addressed in the course

Please consult your local Wind River sales representative for course schedules and fees.

Onsite Education

If you have a large project team or a number of new users, you may benefit from custom onsite education. Instructors will consult with you and, based on the

workshop series curriculum, determine which topics should be included and emphasized. This type of education offers an opportunity for one-on-one discussions with our instructors about your specific project needs, technical requirements, and challenges—all in the comfort of your own office.

Advantages of onsite education:

- Your entire team gains a common knowledge base
- Onsite education helps ensure that knowledge and skills will transfer from the classroom to your workplace
- Use of your location saves employees travel expenses and time away from the office

Consult your local Wind River sales representative for further information about onsite education.

Support Services

Wind River Customer Support, a Support Center Practices (SCP)–certified organization, provides support for all Wind River VxWorks platforms. Your subscription to Platform for Automotive Devices includes full maintenance and support, delivered through Wind River's Online Support (OLS) website and our worldwide technical support team. While under subscription, customers receive both maintenance updates and major upgrades.

Support for Platform for Automotive Devices, VxWorks Edition

Visit Wind River Online Support at www.windriver.com/support for fast access to product manuals, downloadable software, and other problem-solving resources. OLS offers a comprehensive knowledge base with a robust search feature for locating product information and manuals by keyword, author, published date, document type, language, and solution category.

Additional support features, including proactive email alerts covering particular technologies, platforms, or product patches and technical tips for common problems, are available for all customers on subscription. OLS visitors can also access a community of developers to discuss their issues and experiences.

Support on modified or unsupported configurations is best effort–based. Wind River Customer Support will try to reproduce the problem on a supported configuration. If the problem can be validated, Wind River will provide a fix that will be tested on a supported configuration. Wind River Professional Services can provide support for boards or host operating system versions that are not supported by the standard product, as well as for customized versions of the source code or additional nonstandard packages.

Customer Support will provide bug fixes following the process outlined in Wind River's Customer Support User's Guide (CSUG), available at www.windriver.com/support/resources/csug.pdf.

Customers with a valid support or subscription agreement are eligible for all updates and major upgrades to Platform for Automotive Devices, VxWorks Edition free of charge. If customers cannot update to a new version but need critical parts of the update applied to an older version of the product, Wind River Professional Services can be engaged to backport the required functionality on a case-by-case basis.

If you cannot find the information you need through Online Support, please contact our global support team for access to the industry's most knowledgeable and experienced support staff.

North America, South America, and Asia/Pacific

support@windriver.com
Toll-free tel.: 800-872-4977 (800-USA-4WRS)
Tel.: 510-748-4100
Fax: 510-749-2164
Hours: 6:00 a.m.–5:00 p.m. (Pacific time)

Japan

support-jp@windriver.com
Tel.: +81 3 5778 6001
Fax: +81 3 5778 6003
Hours: 9:00 a.m.–5:30 p.m. (local time)

Europe, the Middle East, and Africa

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Nordic tel.: +46 8 594 611 20
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UK tel.: +44 1793 831 393
UK fax: +44 1793 831 808
Hours: 9:00 a.m.–6:00 p.m. (local time)

WIND RIVER

Wind River is the global leader in Device Software Optimization (DSO). We enable companies to develop, run, and manage device software faster, better, at lower cost, and more reliably. www.windriver.com

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