Wind River Platform for Automotive Devices, VxWorks Edition

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.

**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:

**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 offboard, 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 like 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 3.5**

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. The Wind River Workbench 2.6 development suite includes enhancements to the Workbench core and improved VxWorks 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 features the integration of 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—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 3.5 of Platform for Automotive Devices introduces the following new features, functionalities, and enhancements:

- Improved networking functionality
  - Increased throughput and end-to-end performance
  - Enhanced scalability
  - MPLS data plane framework support
  - Quality of Service (QoS) and Differentiated Services (DiffServ)
  - Mobile IPv4 suite and Mobile IPv6 Mobile node
  - Policy-based routing
  - Equal Cost Multi-Path (ECMP) routing
  - Virtual Router Redundancy Protocol (VRRP)
  - GRE and IPIP tunneling
  - Multicast proxy
  - OS-agnostic design
- **IPCOM**: an OS abstraction layer for VxWorks
- Enhanced security
  - New Wind River SSH
  - High-performance IPsec and IKE
  - IKEv2
  - Scalable implementation
  - Support for NAT-Traversal (NAT-T)
- Network management additions
  - New Workbench tool: Management Configuration Editor (MCE)
  - HTTP client libraries
  - CLI over SSH
  - SNMP integration with Wind River Network Stack 6.5
- Support for all architectures in Platform for Automotive Devices, VxWorks Edition 3.4

1MPLS Data Plane support provides only the necessary framework to work with Wind River’s partner MPLS solutions. It does not include a complete MPLS solution.
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 openness, performance, reliability, and interoperability.

With VxWorks 6.5, companies can:
- Optimize developer productivity through open standards
- Increase reliability through 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 BSP support, expert professional services, and the DSO industry’s largest partner ecosystem of hardware, software, development tools, middleware, and applications providers.

Compatibility

VxWorks 6.x was 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 6.5 is also backward compatible with all previous versions of VxWorks 6.

A set of migration guides in the VxWorks product documentation describes migrating:
- BSPs and drivers
- VxWorks 5.5 kernel applications to the VxWorks 6.x kernel and user mode
- VxWorks AE applications to VxWorks 6.x user mode
- From Tornado and SNiFF+ projects to Wind River Workbench
- From networking technologies in VxWorks 6.4 and VxWorks Edition 3.4 platforms to those in VxWorks 6.5 and VxWorks Edition 3.5 platforms

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 2.2.1, eases porting of open-source and third-party software to VxWorks
- 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:
- MMU-based memory protection provides isolation of the kernel from user-mode applications and of applications from each other, increasing device reliability
- Standard, process-based programming model simplifies application development
- Support of RTPs on MMU-less 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
- VxWorks’ preemptive, priority-based global task scheduler ensures real-time deterministic behavior
- 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
- 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

Message Channels and Wind River 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 TIPC protocol to extend messag-
ing to tasks in multiprocessor systems that can run VxWorks, Linux, or any other operating system that supports TIPC.

Features of Wind River TIPC 1.5 include:

- Open-standard Transparent Interprocess Communication (TIPC)
  - High-speed, reliable message-passing service
  - Location transparency with logical address and internal address translation table
  - Lightweight, connectionless, or connection-oriented 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

- Support for both MMU-enabled and MMU-less 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:

- Automatic resource reclamation: maximizes memory availability and help 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

**Memory Management**

Although VxWorks 6.x provides MMU-enabled memory protection, it continues to use the non-overlapped addressing model used 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

**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, 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:
- 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

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.

Benefits of the Processor Abstraction Layer include:
- 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, 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 of less than 100KB down to 36KB. 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 like 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:
- Support for multiple file systems, removable media, and automatic file system detection
- New transaction-based highly reliable file system (HRFS) that provides complete power-safe reliability, except for an interrupted write action
- Cache write-through option for dosFs ensures 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

Wind River Network Stack
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 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:

- 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
- 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

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:

**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 removed. The stack can be compiled to be both small and robust.

**OS-Independent**

The Network Stack is integrated with Wind River’s VxWorks platforms and Wind River Workbench, and it provides a high level of performance with the VxWorks OS and network drivers. In addition, it enables developers to easily reuse the same network stack across multiple OS environments with the appropriate OS interface layers.

**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

**Quality of Service (QoS) and Differentiated Services (DiffServ)**

The Network Stack includes DiffServ for egress traffic as a built-in feature of the dual-mode IPv4/IPv6 stack. It supports the following 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 Multi-Path (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, etc. Some of these protocols are available only in Wind River’s market-specific platforms.

IPv4 and IPv6 Autoconfiguration
The Wind River Network Stack supports both IPv4 and IPv6 auto-configuration.

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.

Mobile IP support requires a mobile node in each mobile device, and it provides an efficient and scalable mechanism for mobility within the Internet. Mobile IP is designed to help organizations easily enable their customers to benefit from seamless mobility between different networks.

There is a Mobile IP protocol home agent in each mobile device’s home network. Optionally, a foreign agent may be present in the network the device is visiting. Both home agents and foreign agents normally reside within routers in their network. When a mobile device visits another network, IP datagrams destined for the device are intercepted by its home agent and tunneled to the visited network using a temporary IP address. If there is a foreign agent on the visited network, it receives the tunneled packets, unpacks them, and forwards them to the mobile node; otherwise, the mobile node itself receives the tunneled packets and unpacks them. Finally, the mobile node reinserts the original datagrams into the stack, resulting in a transparent operation using only the original IP addresses.

Replies to the originating host can either be sent directly from the mobile node to the host, or tunneled back to the home agent, which in turn unpacks and forwards the replies to the host.

The Wind River Network Stack includes support for:
- Mobile IPv4 mobile node
- Mobile IPv4 home agent
- Mobile IPv4 foreign agent
- Mobile IPv6 mobile node

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:
- 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 2.3 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.

**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. Figure 5 depicts how Wind River IPsec and IKE are integrated with the Wind River Network Stack.

Features of Wind River IPsec 6.5 include:
- Tunnel and transport mode in any 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

**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 Protocols) 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:

- 802.1X
- Wi-Fi Protected Access (WPA)
- 802.11i
- Temporal Key Integrity Protocol (TKIP)
- Pre-shared keys
- Multiple EAP (Extensible Authentication Protocol) types
- Fully integrated and tested 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
- Wide range of encryption and hashing algorithms supported

**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 NAPT maps port numbers, as well as IP addresses. NAPT 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 6.5 include:

- 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 Security Libraries**

Wind River Security Libraries is a collection of cryptographic modules that can be used in developing secure applications. This includes the Common Crypto Interface (CCI), a library of crypto algorithms (encryption and hashing). Source code for CCI is included in the distribution. CCI is used by other components requiring access to crypto functions. The Crypto Provider Interface (CPI) supplies a mechanism for developers to add other crypto libraries or hardware-based crypto functions.

Wind River Security Libraries also 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 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:

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

Features of Wind River SSL 1.3 include:

- SSLv2, SSLv3, and TLS (RFC 2246) support
- HMAC-SHA-1 and HMAC-MD5
- DES, 3DES, and AES
- RSA Public Key Cryptography
- Implements OpenSSL APIs to allow for easy porting of existing applications
- Supports 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 Virtual Private Networks (VPNs). A variety of authentication methods is also supported.

Features of Wind River SSH 6.5 include:

- SSH server mode
- SFTP client support
- SSH versions 1.5 and 2.0
- Port forwarding
- Terminal connections and SFTP connections
- Integrated 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 1.4 allows the network to determine if 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. 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.

Wind River SNMP

The Simple Network Management Protocol (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 MIB development platform. It is composed of SNMP v1/v2c/v3 and AgentX.

Features of Wind River SNMP 10.2 include:

- Bilingual SNMP agent supporting SNMPv1/v2c protocols
- Asynchronous support
- SNMPv3 security
- SNMP notifications
- “Target” and “Notify” MIBs
- SNMP proxy
- SNMP v1/v2/v3 coexistence
- AgentX module
- MIB compiler

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 secure transaction mechanism. The Wind River Management Integration Tool is a graphical user interface (GUI) tool that accelerates the process of creating and configuring a custom Web-based management interface or a stand-alone Web server by generating more than 70% 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 4.6 include:

- 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 Command Line Interface (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 stand-alone Web server by generating more than 70% 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 4.6 include:
- 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, development tools and best practices

Wind River MIBway

Wind River MIBway enables developers to automatically leverage all Simple Network Management Protocol (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 4.6 include:
- Instant leverage of all existing SNMP code
- Reduction in development cost by cutting down months of coding and testing to days
- Enables creation of powerful, feature-rich Web and command-line interfaces
- Separates application logic from interface design
- Embedded code 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 (WMIT) 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, 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. MCE and WMIT 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:
- 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

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.
Wind River Web Services are standards-compliant and specifically tuned for embedded systems applications. Features of Wind River Web Services 1.4 include:

- 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
- Facilitates communication through use of SOAP messages with any system supporting Web Services, including Microsoft .NET® or Apache Axis

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 include:

- 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 includes a station cache: a basic database that stores the relationship between MAC addresses and the ports from which it sees frames associated with that MAC address. 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.

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...
Wind River Platform for Automotive Devices, VxWorks Edition

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 touchscreens, 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 5.0 include:

- Multiple display functionality
- Video overlay enhancements
- Drawing surface extensions, including support for OpenGL
- Menu and button widgets
- Timers
- Enhanced touchscreen calibration support
- Additional driver configuration option types
- Improved RTP support for local bus graphics devices
- Upgraded XFree86 driver support

**Connectivity**

**Wind River CAN**

Wind River CAN 1.5, 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 support includes:

- 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

**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. Designed to work with any wireless chipset, the drivers come with direct support for Atheros AR500x chipsets. A fully abstracted hardware interface layer provides ease of portability to other wireless chips. The driver directly supports any PCI card that uses an Atheros AR500x chipset, and also 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 pre-shared keys, TKIP (Temporal Key Integrity Protocol), and Michael Countermeasures. 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:

- 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
- Can be ported easily to other chipsets
- Supports both access point and station side
- Supports multiple hardware instances on the same target
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:

- 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 enables additional target OS, target processor, and target connection support to be added
- An 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 2.6

This version of the platform features Workbench 2.6, which includes significant new capabilities in support of increased development team productivity:

- **General Workbench enhancements**
  - Installation as a plug-in for your existing Eclipse environment
  - CDT compatibility
  - Improved Welcome page
  - Enhanced user-defined builds
  - JDT now included
  - Based on Eclipse 3.2.1 framework
- **VxWorks platform enhancements**
  - Minimal kernel layer debug via on-chip debugging
  - Support for C++ applications on VxWorks 5.5
  - Improved performance of VxWorks image projects
  - Enhanced kernel object viewer
- **On-chip debugging enhancements**
  - Linux user-mode debugging
  - Updated processor support
  - Scripting enhancements
  - 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 Framework**
  - Because of its openness, capability, and strong community support, Eclipse was chosen as the framework for the Wind River Workbench development suite. The Eclipse 3.2.1 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 (CM) 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, among other resources:

- [www.eclipse.org](http://www.eclipse.org)
- [www.eclipse-plugins.info/eclipse/index.jsp](http://www.eclipse-plugins.info/eclipse/index.jsp)
- [www.eclipseplugincentral.com](http://www.eclipseplugincentral.com)

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

- **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.

- **Editor**
  - The Workbench Editor provides state-of-the-art editing capabilities, including a number of performance-enhancing features, such as code completion, parameter hinting, and syntax highlighting for source files, that serve to speed the development process and make the edit-compile-debug cycle less frustrating and less prone to error.
Source Code Analyzer
The ability to quickly and completely understand code written by someone else—or to assess the impact of a change under consideration—is vital to development productivity. Wind River Workbench source-code analysis capabilities enable this function. Integration of these capabilities into the editing and debugging functions of Workbench speed both code creation and debugging.

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, board support packages, 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:
• 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:
• cpp, the C preprocessor
• GCC, the C and C++ compiler
• ld, 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 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 6.5, formerly known as VxSim, is a complete prototyping and simulation tool for VxWorks 6.x applications. 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 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 necessary quantity of both evaluation hardware typically purchased for early development and final target hardware. 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.

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 if 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 mod-
ules 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

New to VxWorks 6.x:

- Interactive exploration of VxWorks 6.x real-time processes (RTPs)
- Interactive development by calling any application (RTP) routines
- VxWorks 6.x application (RTP) and kernel testing
- Runtime 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 helps with debugging drivers.

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.

Wind River System Viewer

System Viewer, formerly known as WIND@VIEW, 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 like 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.

Wind River ScopeTools

ScopeTools are 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.

Three ScopeTools are included with Workbench: Wind River ProfileScope, Wind River MemScope, and Wind River StethoScope. For an additional cost, Wind River TraceScope and Wind River CoverageScope are optionally available for VxWorks 6.x in the “Wind River ScopeTools for Test and Validation” package. (For more information, see “Optional Add-Ons,” below.)

Wind River ProfileScope

Profiling is critical for real-time systems. Once you understand performance bottlenecks, it becomes easier to optimize application code. ProfileScope 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. ProfileScope pinpoints inefficiencies and shows how performance changes over time.

Wind River 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 non-characterized memory leaks. MemScope 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.

Wind River 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. StethoScope presents this live analysis of your program without stopping or slowing your code.

Optional Add-Ons

Wind River Device Management

Wind River Device Management consists of two interoperable products that create a powerful, enterprise-wide infrastructure to enable development, test, and field engineering teams to collect and aggregate data about—as well as diagnose and repair faults in—running software across the entire device life cycle. Benefits include faster time-to-market for 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 1.4 and 1.5.

Wind River Lab Diagnostics

Lab Diagnostics is a root-cause analysis system that enables development and test teams to dynamically instrument, isolate, diagnose, and correct defects in running software in a highly collaborative environment. Lab Diagnostics is a secure, enterprise-class server application for data aggregation and storage. It allows companies to greatly enhance productivity by streamlining test and QA, spread-
New in Lab and Field Diagnostics 2.1:

- 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

**Wind River Field Diagnostics**

Wind River Field Diagnostics is a scalable, remote diagnostics system that enables support engineers to securely collect and manage deployed device data to diagnose and correct faults in running software. Field Diagnostics is an enterprise-wide infrastructure that includes a site-installed application for 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 service 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.

**Wind River ScopeTools for Test and Validation**

ScopeTools are 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. In addition to the standard tools included with the platform, two other tools are available as options for VxWorks 5.5 and 6.x platforms:

**Wind River TraceScope**

TraceScope 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.

**Wind River CoverageScope**

CoverageScope 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.

**Wind River Workbench On-Chip Debugging**

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 ran 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:

- On-chip debugging target connection manager
- On-Chip Debugging Command Shell
- On-chip debugging console
- Flash programming
- Hardware and memory diagnostics
- CF options
- JTAG editor
- Extensions to Register view, including:
  - Bit-level register details
  - Additional peripheral register support for most processors
- Combined Register view with Agent views and perspectives
- 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
- Linux, VxWorks 5.5, VxWorks 6.x, and ThreadX OS awareness via JTAG
  - All hosts
  - All targets with BSP available

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 Cantata++ with Workbench places these capabilities within easy reach. 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 6.5
- VxWorks 5.5, 6.0, 6.1, 6.2, 6.3, and 6.4 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 compliance, including full support for JTRS SCA AEP 2.2.1 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)
- High-speed interconnect framework with PCI and local bus support
- VxMP 2.3
- Wind River TIPC 1.5
- Wind River Network Stack 6.5
- Wind River PPP 6.5
- Wind River USB 2.3
- Wind River IPsec and IKE 6.5
- Wind River Security Libraries 1.3
- Wind River SSL 6.5
- Wind River SSH 6.5
- Wind River RADIUS Client 6.5
- Wind River Firewall 6.5
- Wind River NAT 6.5
- Wind River Wireless Ethernet Driver 2.3
- Wind River Wireless Security 2.4
- Wind River OPC 3.1
- Wind River DCOM 2.3
- Wind River CAN 1.5
- Wind River CLI, Web, MIBway 4.6
- Wind River SNMP 10.2
- Wind River Learning Bridge 1.3
- Wind River Media Library 5.0
- Wind River Web Services 1.4

Workbench 2.6
- Eclipse 3.2.1 framework
- Project System
- Build System
- Editor
- Source Code Analyzer
- Wind River compilers
  - Wind River Compiler for VxWorks
  - Wind River GNU Compiler
- Debugger
- Target debug agent for VxWorks
- Shell environments
- VxWorks Kernel Configurator
- Wind River System Viewer (system event visualization)
- Wind RiverScopeTools
  - Wind River StethoScope (data analysis)
  - Wind River MemScope (memory analysis)
  - Wind River ProfileScope (performance analysis)

Optional Add-Ons
- Wind River Device Management
  - Wind River Lab Diagnostics
  - Wind River Field Diagnostics
- Wind RiverScopeTools for Test and Validation
  - Wind River TraceScope (execution trace analysis)
  - Wind River CoverageScope (test coverage analysis)
- Wind River Workbench On-Chip Debugging
- IPL Cantata++ for Wind River Workbench (formerly Workbench Unit Tester)

Supported Hosts
- Red Hat Enterprise Linux (Workstation 4, update 3; Workstation 3, update 6)
- Solaris 2.8, 2.9
- SUSE Linux 9.3, 10
- Windows 2000 Professional, Windows XP

Board Support Packages
Platform for Automotive Devices, VxWorks Edition, supports a wide variety of board support packages on the target architectures listed above. 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.

Architectures, Hosts, and Board Support Packages

Supported Target Architectures
- ARM
  - ARM9
  - ARM11
- ColdFire (requires Service Pack 1 for VxWorks Edition 3.3 platforms)
  - ColdFire V4e
- Intel
  - Pentium family (Pentium, Pentium II, Pentium III, Pentium 4, Pentium M)
- Intel XScale
  - IXP4xx
  - IXP2xxx
- MIPS
  - MIPS 4Kx
  - MIPS 5Kx
## 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:

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

Our automotive software partners include:

- Professional Services
- Technology Partner

### 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:

- 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

### Technology Partner

- NAND flash file system: Datalight
- Power-failure-safe file system: Datalight
- Graphics and GUI builder: Tilcon, PSA
- 3-D graphics and OpenGL: ALT Software
- 3-D graphics acceleration and optimization: 3DVU
- Graphics development framework: Altia, 3SOFT
- Music database: Gracenote
- Java VM: aicas, Apogee, Esmertec, iIEEE1394: 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
- Bluetooth: Stonestreet One
- Model-based development: ILogix, IBM
- OSGi: ProSyst
- Data management: ENCIRQ, Solid
- Automotive application framework: Lectronix
- Wireless telemetry: Airbiquity
- GPS: Trimble

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.

### 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:

- On-site 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. Personalized Learning Programs deliver improved business performance—customers have reported a return on investment ranging from 18 to 80 percent over a traditional training approach.

Please consult your local Wind River sales representative for more information on Personalized Learning Programs.

**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:

- 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.

**On-Site Education**

If you have a large project team or a number of new users, you may benefit from custom on-site 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 on-site education:

- Your entire team gains a common knowledge base
- On-site 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

Please consult your local Wind River sales representative for further information about on-site 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.


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)

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Hours: 9:00 a.m.–6:00 p.m. (local time)