

WIND RIVER

Wind River Platform for Industrial Devices, VxWorks Edition

Industrial and medical devices are becoming more complex, but quality cannot be compromised. As open standards promise seamless data exchange between simple sensors, controllers, and enterprise and ERP systems, the demand for network connectivity increases. Internet connectivity allows new levels of remote management, but also calls for increased levels of security.

More powerful processors are being considered to drive intelligence to devices, but at a rise in hard costs. Because real-time performance requirements for robotics and medical devices are nonnegotiable, manufacturers are cautious about incorporating new technologies into proven systems. Balancing the need for increased speed, greater efficiency, and lower cost with an acceptable level of risk defines the challenge for many providers.

Wind River Platform for Industrial Devices meets this challenge with a Device Software Optimization (DSO) solution that combines VxWorks, the industry's leading real-time operating system; Wind River Workbench, the premier open device software development suite; and essential security, device management, and connectivity middleware, including drivers and protocols for connected devices on the factory floor, wireless peripherals, and other devices within the network infrastructure. Support includes CAN, DCOM, OPC, USB, Wi-Fi, and IPv4/IPv6. The platform offers an extensive suite of security protocols to protect network data and delivers a high-reliability solution.

The platform is rigorously tested and backed by Wind River's 25 years of device software industry experience, a world-class support organization, a comprehensive partner ecosystem, and a specialized professional services team.

Development Suite

Wind River Workbench

Partner Software

Fail-Safe File System	HTML-Based UI (Browser)	Fieldbus Solutions
CANopen Stack	CIFS/Samba	OS Coresidency
NAND Flash File System	2-D Graphics and GUI Builder	3-D Graphics and OpenGL
NDDS Stack		JavaVM

Middleware

CLI	Firewall	SNMP v1/v2/v3	XML/SOAP
RADIUS Client	IPSec & IKE	RIP/RIPng	Web Server
802.1X, 802.11i	SSL/TLS	USB 2.0 Host/Device	
DCOM	OPC	CAN	
IPv4/IPv6 Network Stack			Media Library
TIPC	NAT	Bridging	dosFs
802.11 WLAN	PPP	Ethernet	Flash FS

Operating System

VxWorks

Hardware

Reference Designs, Semiconductor Architectures
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Services

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

Figure 1: Platform for Industrial Devices, VxWorks Edition, components

Target Applications and Devices

- Industrial automation
 - PLCs, CNCs, robotics, smart sensors, drives, HMIs
- Medical devices
 - CTs, X-ray, MRI controllers, imaging devices, patient monitoring, instrumentation, blood/DNA analyzers, dialysis equipment, pacemakers, wireless cardiac monitors, defibrillators
- Test and measurement
 - Oscilloscopes, fiberoptic and network testers, spectrum analyzers, data acquisition systems
- Building automation
 - HVAC controllers, elevators, fire and security systems, ticket delivery systems
- Power control and distribution
 - Power generator controllers, sensors and actuators, distribution monitoring and control equipment
- Transportation
 - Train/subway/tram and shipping controllers, railway automation, port signaling systems

New in Platform for Industrial Devices, VxWorks Edition 3.4

The latest release of Platform for Industrial Devices, VxWorks Edition 3.4, includes updated and enhanced run-time components in VxWorks, as well as industry-specific middleware technologies. The Wind River Workbench development suite has been updated to version 2.6, with several enhancements to the Workbench core and improved VxWorks platform support, on-chip debugging, and diagnostics tools. As add-on products to our VxWorks-based platforms, Wind River Device Management tools enable engineering teams to collect and aggregate data for diagnosis and repair of faults in running software throughout the device life cycle.

Version 3.4 of the platform introduces the following new features, functionalities, and enhancements:

- Improved POSIX compliance
 - VxWorks 6.4 is the first RTOS to achieve certified conformance to POSIX IEEE Std. 1003.13-2003 PSE52 in user mode

- VxWorks 6 certification profile
 - API subset for applications seeking DO-178B and IEC 61508 certifications
- Support for all architectures in Platform for Industrial Devices, VxWorks Edition 3.3, plus new board support:
 - ARM 946 (mrvl_db88f5181_mpu)
 - Freescale PowerPC CDS8548 (cds8548)
 - Intel Allagash (Pentium 4 PC)
 - MIPS BCM91480 (sb1480_0_mips64, sb1480_1_mips64)
- Graphics
 - Multiple display support
 - OpenGL support
- Wind River Workbench 2.6
 - See the “New in Wind River Workbench 2.6” section of this product note for details

Included in Platform for Industrial 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 6.4, 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 6.4 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
- Migrating VxWorks 5.5 kernel applications to the VxWorks 6.x kernel and user mode
- Migrating VxWorks AE applications to VxWorks 6.x user mode
- Migrating from Tornado and SNIFF+ projects to Wind River Workbench

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

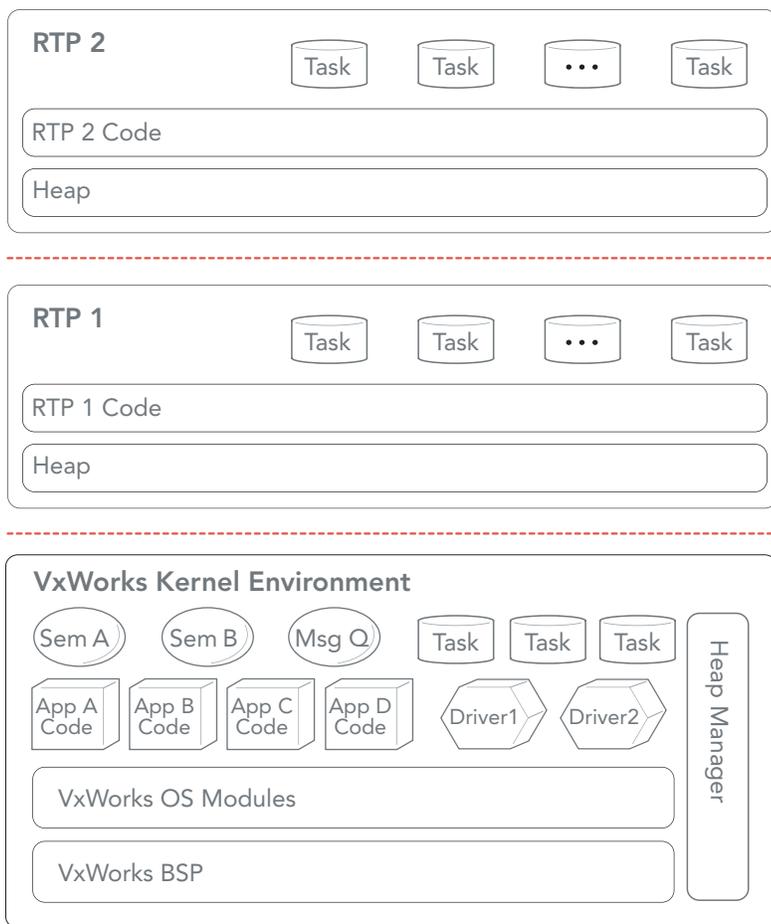


Figure 2: VxWorks kernel environment and two RTPs

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 messaging 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-orientated communication modes
 - No message losses
 - No message duplicates
 - Uninterrupted message sequence order
- 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
- Reliable multicast messaging

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
- 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

User Application: RTP

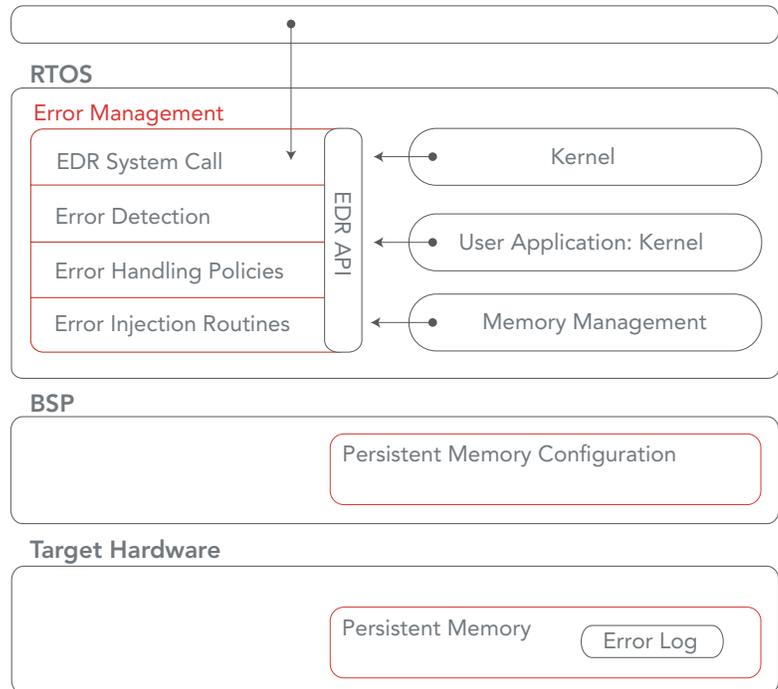


Figure 3: Error management

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

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 utilizes 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, an integral part of VxWorks, is a high-performance, scalable, dual-mode IPv4/IPv6 network stack based on a port of the KAME/FreeBSD TCP/IP release. Wind River has invested significant effort and engineering resources into optimizing the TCP/IP stack for typical constraints found in device software environments. Our network stack has a clean code structure for easy integration and faster implementation. Extensive testing against third-party test suites and external test lab validation ensures high quality, standards conformance, and interoperability with other network devices. The Wind River Network Stack is among the first few TCP/IP stacks in the industry to receive the “IPv6 Ready” Phase II logo.

Benefits of Wind River Network Stack 3.1 include:

- Full integration with the VxWorks operating system, development tools, device management products, and peripheral networking protocols and utilities
- Clear and structured code for ease of configuration and maintenance
- Flexible configuration options to optimize required memory resources
- IPv6-enabled and enhanced utilities/applications
- Several performance enhancements to the stack for improved forwarding and end-to-end performance
- Several applications running on one or multiple RTPs
- Optimized, high-performance implementation from the leader in device software networking

Features of Wind River Network Stack 3.1 include:

- Support for TCP, UDP, IPv4, and IPv6

- BPF devices for packet monitoring
- Fast IP forwarding
- IPv6 jumbograms
- ICMP
- IGMP versions 1 and 2 host
- ARP, Neighbor Discovery
- Proxy ARP client
- RARP
- NDP
- Router solicitation
- Router advertisement
- ICMP redirects
- RIP and RIPng
- DNS client
- Tunneling devices, gif, and stf
- fastUDPLib, a fast UDP-based communication API (faster than sockets)
- Sockets in the following domains:
 - IPv4 Internet communications domain (AF_INET)
 - IPv6 Internet communications domain (AF_INET6)
 - Routing communications domain (AF_ROUTE)
 - Local domain sockets for Interprocess Communication (AF_LOCAL)
 - ZBUF sockets (zero-copy sockets)
 - RPC protocol, version 2
 - Remote access support: RSH, FTP, TFTP, rlogin, Telnet IPv4 server and client, Telnet IPv6 server and client
 - NFS, versions 2 and 3
 - BOOTP (boot images only)
 - DHCPv4, server, client, relay agent
 - DHCPv6, server, client, relay agent
 - Prefix delegation option
 - DNS option
 - NTP option
- SNMP (updated with RFC 2030)
- Ping, Ping6
- IPv4 auto-configuration to enable UPnP
- IPv6 auto-configuration
- Standard MIB II instrumentation
- Enhanced routing table manager
 - Route table support for multiple same-destination routes
- UNIX-like network stack configuration and monitoring utilities
 - ifconfig: Configure a network interface
 - netstat: Report network status

- routec: Manually edit the route table
- Sysctl/sysctl: Set and get network stack configuration parameters
- Improved NFS client caching mechanism to significantly improve performance
 - Efficiency improvements to server-side writing/reading operations
 - Improvements to dosFs seeking speed

Wind River Network Stack 3.1 features available only in Wind River market-specific platforms include:

- Support for SCTP
- Mobile IPv6—Mobile Node and Home Agent
- Port-based, socket-based, and subnet-based VLAN tagging library support
- IGMPv2 up-calls to support a routing protocol
- IGMPv3 host
- Multicast Listener Discovery, version 2 host, proxy router
- Two virtual instances of the stack
- Enhanced QoS framework (ALTO implementation)
 - Packet scheduling disciplines supported:
 - Priority queuing
 - Class-based queuing
 - Queue buffer-management discipline supported:
 - Random Early Detection (RED)
 - QoS support also includes Explicit Congestion and control of outgoing packet flow through a token bucket regulator mechanism

Wind River PPP (PPP, PPPoE, ML-PPP, RAF)

The Wind River PPP 2.2 component provides a set of PPP implementation modules you can plug into a remote access framework. Using this framework, you can create one or more PPP stack instances. Using a PPP stack instance, you can create and manage a PPP connection with a remote peer. Bundled with Wind River PPP are modules that provide support for PPP over Ethernet connections, as well as modules that provide support for PPP multilink functionality. Using this multilink functionality, you can bundle multiple parallel point-to-point links into a single virtual high-bandwidth pipe.

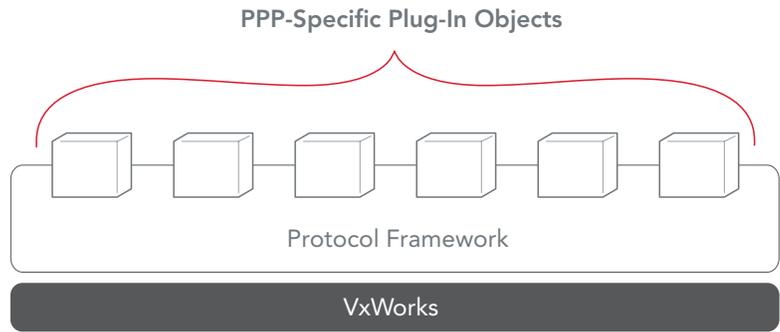


Figure 4: PPP component—protocol framework

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.

Features of the Wind River PPP 2.2 implementation include:

- Multiple framework instances
- Multiple network type support
- Multiple driver type support
- Multiple PPP framing support
- Unlimited PPP connections
- Dynamic configuration of the stack
- Configuration profiles
- Multilink (ML-PPP, PPPoE, and RAF support)

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 and IKE are Wind River's implementation of IPsec and IKE, as specified by the IETF. They provide for authentication, data integrity, and encryption of any network traffic on the IP layer. IPsec and IKE support IPv4 and IPv6, a powerful management API, and a flexible hardware interface for encryption acceleration.

Functional elements of Wind River IPsec and IKE 4.0 include:

- IPsec protocols
- Internet Key Exchange Protocol (IKE)
 - Dynamic negotiation of security associations
 - Keeps security information “current” by tracking key expiry
 - Automatically renegotiates between peers
 - ISAKMP defines framework for negotiations
 - Packet formats, retransmission timers, message construction requirements
 - Oakley protocol (partial) and SKEME protocol for key exchanges
 - Negotiate symmetric session key per Diffie-Hellman algorithm
 - Main mode and quick mode
 - Perfect forward secrecy (PFS)
 - Predefined Groups I and II with 768- and 1024-bit modules
- Security Association Database (SADB)
 - Contains Security Associations (SAs) used by IPsec for inbound and outbound traffic
 - One-way relationship from sender to receiver
 - Two-way traffic requires two separate SAs
 - Four security association types
 - Transport mode, tunnel mode, bypass, discard
 - Specifies and provides mutually agreed-upon security services
 - IPsec protocol and mode
 - Encryption algorithm
 - Encryption key
 - Security associations expire after preset time and kilobytes
 - Support for combination of SAs and ordering of SAs
- Security Policy Database (SPD)
 - Defines policies (filter rules) to be applied to IP packets
 - Bypass
 - Discard
 - Apply (transport or tunnel mode)
 - Filter characterized by selectors based on:
 - Source/destination IP address (also subnet masks and address ranges)

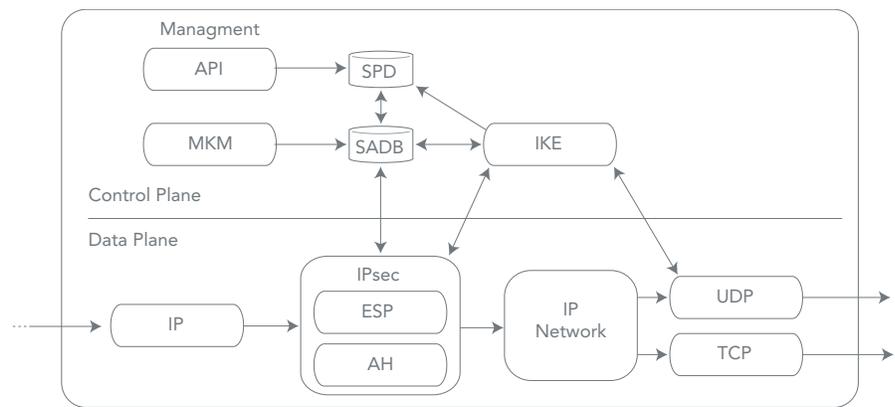


Figure 5: Wind River IPsec and IKE

- Protocol
- Source/destination port address
- Separate policies for inbound and outbound traffic
- Separate policies per interface
- Support for ordering policies
- Manual Key Manager (MKM)
 - Pre-shared encryption and authentication keys
 - Management API to SADB
 - Configurable protocol and port selectors
 - Manual creation of security associations
 - Require the actual encryption and/or authentication keys to be entered by the administrator
- Crypto Provider Interface (CPI)

Statistics are gathered and logged extensively, giving developers access to a vast array of information on created or attempted security sessions. This can be used to monitor potential network problems, as well as determine potential network threats and attacks.

IPsec supports the standard Authentication Header (AH) and Encapsulation Security Payload (ESP) functions, as defined by the IETF. Both tunnel and transport mode are supported, with an application interface to allow the user to support other tunneling protocols. IKE main mode and quick mode are supported, allowing for dynamic negotiations of security associations. The Oakley protocol is used for key exchanges between negotiating peers.

Wind River IPsec and IKE can use a broad suite of encryption and hashing algorithms, allowing developers to make the

necessary tradeoffs between the strength of the security algorithm and system performance.

Features of Wind River IPsec and IKE 4.0 include:

- Functionality to enable and enforce use of security policies on a network
- Suite of multiple protocols for:
 - Packet tunneling (VPN)
 - Data hashing
 - IP packet encryption
 - Data origin authentication
 - Data integrity
 - Data confidentiality
 - Replay prevention
- Various IP header and payload encryption options
- Support for tunnel and transport modes
- Fully featured and standards-compliant implementation
- Interoperability tested with popular IPsec and IKE products
- IPv6 support
- Management API to add, view, delete SAs and SPs
- CPI: Crypto Provider Interface
- Generic interface for optional hardware encryption accelerators

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 2.3 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 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 NAT is configurable through use of Wind River SNMP, CLI, or Web interfaces. Wind River NAT can be used in conjunction with Wind River IPsec and IKE software, and is also fully integrated with Wind River Firewall.

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 2.1 include:

- IP packet filter
 - Rules can be specified at four different points in the IP stack
 - Rules grouping: Rules can be *and'ed* or *or'ed* together
- Stateful packet inspection keeps the state for TCP, UDP, and ICMP echo packets
- MAC address filter
 - Source or destination MAC address can be filtered
 - Specific MAC address (or range) can be allowed or rejected
- NAT and IPsec integration and interoperability, IPsec pass-through
- Keyword search can be used for URL filtering, content filtering, intrusion detection, etc.
- Filter criteria based on the following parameters:
 - MAC address (source or destination)
 - Interface (source and/or destination)
 - IP address (source and/or destination)
 - Port number (source and/or destination)
 - Protocol type
 - Packet size
 - Header length
 - IP fragment flag
 - ICMP type
 - ICMP code
 - TCP flag
 - Time of day

- Packet processing
 - Forward (allow) the packet
 - Drop (deny) the packet silently or drop by sending back ICMP error message or TCP reset
 - Enter log information
 - Reassemble fragments before filtering
 - API for user-defined processing enables URL blocking, content filtering, virus scanning, and so on
 - Logging: Write log to specified memory space and to SyslogServer (RFC 3164)
 - Non-volatile storage
 - Web configuration with sample HTML pages

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). 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

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 1.2 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)

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 includes standard MIB support, which is integrated with Wind River SNMP, and it is also integrated with the Wind River Wireless Security component to enable authentication of the supplicant. Wind River RADIUS Client 1.4 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 Consumer and any type of Producer.

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.

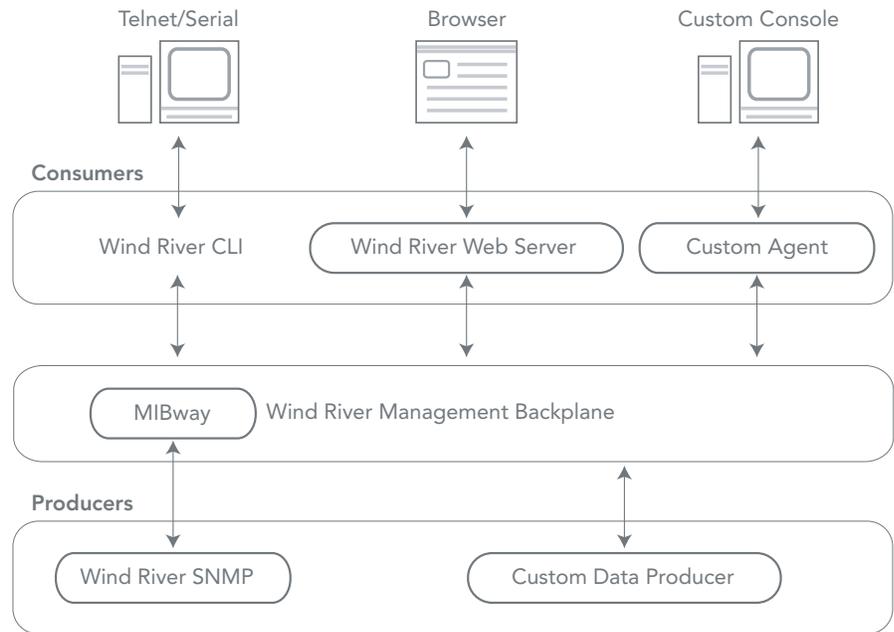


Figure 6: Wind River device management architecture

This tool eases the development of management interfaces by bringing all the framework components together.

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 10.1 include:

- Bilingual SNMP agent supporting SNMPv1/v2c protocols
- Asynchronous support
- SNMPv3 security features
- SNMP notifications
- "Target" and "Notify" MIBs
- SNMP proxy
- SNMP v1/v2/v3 coexistence
- AgentX module
- MIB compiler
- Compact, interoperable, standards-based configuration

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 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 4.5 include:

- HTTP 1.0/1.1 compliant Web server
- Bidirectional CGI layer
- LiveUpgrade
- 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 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 4.5 include:

- Complete CLI management solution
- High-speed generation of command tree, handler functions, and individual commands
- Drop-in, prebuilt commands
- Telnet server
- 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

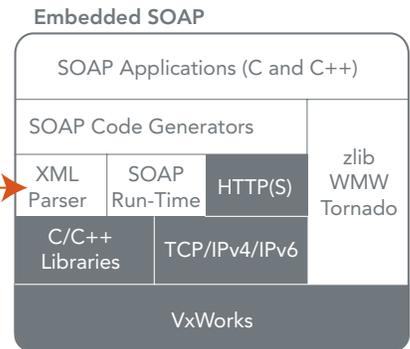
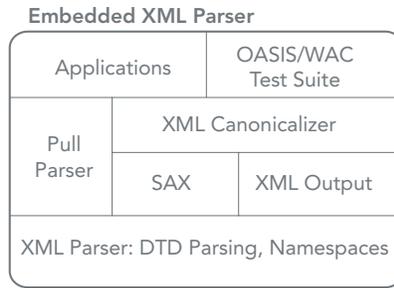


Figure 7: Wind River embedded XML parser and SOAP

- 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 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.

Features of Wind River MIBway 4.5 include:

- Instantly leverages all existing SNMP code
- Cuts months of coding and testing down 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 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.

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.

Web Services Software Development Flow

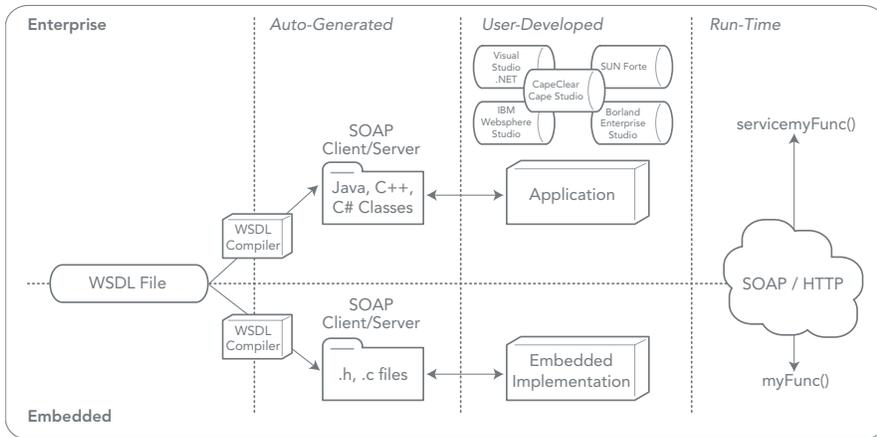


Figure 8: Web Services software development flow

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
- 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 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 caching 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

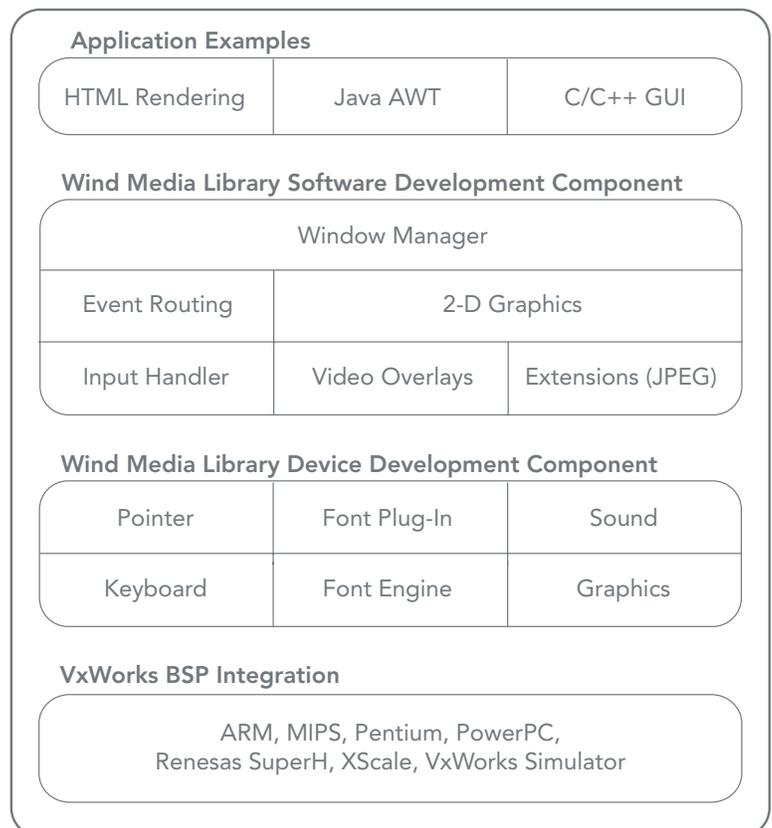


Figure 9: Wind River Media Library

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 touchscreens, and it provides a rich set of reference drivers for common hardware configurations. This component includes generic frame buffer drivers 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 in Wind River Media Library 5.0 include:

- Multiple display functionality

- Video overlay enhancements
- Drawing surface extensions, including support for OpenGL (from partner ALT software)
- 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

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 the Atheros AR500x wireless chipsets. A fully abstracted hardware interface layer provides ease of portability to other wireless chips. The driver directly supports any PCI card that uses the 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 the developer 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
- User configuration and control through use of IOCTL controls
- Industry-standard application interface format: ioctl (descriptor, function, value)
- Extends easily to support new features and customer requirements
- Maps directly into the 802.11MIB
- Extensive debugging/logging support and show routines
- Configuration through use of command line or Wind River Workbench
- Integrated 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:

- 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.

New in Wind River Workbench 2.6

Workbench 2.6 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
 - Updated processor support
 - Scripting enhancements
 - Workflow enhancements
- Diagnostics enhancements
 - Enhanced VxWorks 6 core generation
 - Enhanced command line workflow
 - Programmatic Sensorpoint API
 - Sensorpoint libraries
- New optional capabilities (available for an added fee)
 - Lab Diagnostics for VxWorks 5.5 and 6.x

Wind River Developer Network

Developers can now access code samples, video tutorials, community-provided tips, and other information online via the Wind River Developer Network. This new resource is a Web-based repository of community and Wind River knowledge about how to get the most from VxWorks and Wind River Linux solutions using Workbench. The Developer Network is accessible through a link in the Workbench Welcome screen, or at www.windriver.com/developers/workbench.

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
www.eclipse-plugins.info/eclipse/index.jsp
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 GCC. Wind River has modified an off-the-net version of GCC 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.

Wind River Debugger

The Wind River 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 6.4, 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 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

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

- 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 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 applications that create a powerful, enterprise-wide workflow and information flow 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 more thoroughly tested products, in addition to the ability to rapidly and remotely diagnose and repair software defects in deployed devices, leading to lower support costs, increased system uptime, and higher customer satisfaction. Both products are available for VxWorks 5.5 and VxWorks 6.x.

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, spreading the test load across distributed teams, enabling fact-based diagnostics of multiple devices, and eliminating unnecessary 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, remote diagnostics system that enables support engineers to securely collect and manage deployed device data to diagnose and correct faults. Field Diagnostics is an enterprise-class application that includes a site configuration for on-site device data aggregation and diagnostics, as well as an enterprise configuration for device data aggregation from worldwide deployments and remote diagnostics. It links device manufacturers with device users through a secure device data exchange infrastructure. With Field Diagnostics, device manufacturers can improve device uptime, streamline service operation, reduce service cost, 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.

Wind River Workbench Unit Tester

Workbench Unit Tester, available for VxWorks 5.5- and VxWorks 6-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 Unit Tester with the Workbench development suite places these capabilities within easy reach. Unit Tester 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 6.4

- VxWorks 5.5, 6.0, 6.1, 6.2, and 6.3 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 2.2.1 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
- Wind River Network Stack 3.1
- Wind River PPP 2.2
- Wind River USB 2.3

Workbench 2.6

- Eclipse framework
- Project System
- Build System
- Editor
- Source Code Analyzer
- Wind River compilers
 - Wind River Compiler for VxWorks
 - Wind River GNU Compiler
- Wind River Debugger
- Host Shell
- Kernel Shell
- VxWorks Kernel Configurator
- Wind River System Viewer
- Wind River ScopeTools
 - Wind River StethoScope
 - Wind River MemScope
 - Wind River ProfileScope

Optional Add-Ons

- Wind River Device Management
 - Wind River Lab Diagnostics
 - Wind River Field Diagnostics
- Wind River ScopeTools for Test and Validation
 - Wind River TraceScope
 - Wind River CoverageScope
- Wind River Workbench On-Chip Debugging
- Wind River Workbench Unit Tester

Architectures, Hosts, and Board Support Packages

Supported Target Architectures

- ARM Architecture
 - ARM9
 - ARM11
- ColdFire Architecture (requires Service Pack 1 for VxWorks Edition 3.3 platforms)
 - ColdFire V4e
- Intel Architecture
 - Pentium family (Pentium, Pentium II, Pentium III, Pentium 4, Pentium M)
- Intel XScale Architecture
 - IXP4xx
 - IXP2xxx
- MIPS Architecture
 - MIPS 4Kx
 - MIPS 5Kx
 - MIPS tx49xx
 - MIPS24Kx
 - BCM SB1 (1250, 1125, 1122, 1121)
 - BCM SB1a (1480, 1455, 1280, 1255, 1155)
 - RM9000GL
 - VR55xx
- PowerPC Architecture
 - PowerPC 40x
 - PowerPC 44x
 - PowerPC 60x
 - PowerPC 7xx
 - PowerPC 8xx
 - PowerPC 52xx
 - PowerPC 74xx
 - PowerPC 82xx
 - PowerPC 83xx
 - PowerPC 85xx
 - PowerPC 86xx
 - PowerPC 970
- Renesas SuperH Architecture
 - SuperH-4
 - SuperH-4A

Supported Hosts

- Red Hat Enterprise Workstation 3, 4
- Solaris 2.8, 2.9
- SUSE Linux Desktop 9.3, 10
- Windows 2000 Professional, Windows XP

Board Support Packages

Platform for Industrial 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.

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 industrial 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 industrial hardware partners include:

AMCC	Intel
Ampro	Kontron
ARM	MEN (Mikro Elektronik)
congatec	MicroSys
Freescale	MIPS
GE Fanuc	Renesas
IBM	TQ Systems

Our industrial software partners include:

Technology	Partner
Fail-safe file system	Datalight
NAND flash file system	Datalight
2-D graphics and GUI builder	PSA, Tilcon
3-D graphics and OpenGL	ALT Software
CIFS/Samba	Visuality Systems
HTML-based UI (browsers)	Access, ANT, Espial, Opera
Fieldbus solutions	HMS, IXXAT, Softing, Woodhead (Applicom, SST)
Industrial Ethernet, CANopen stack	IXXAT
NDDS stack	RTI
JavaVM	aicas, Apogee
OS co-residency	KUKA Controls

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
- Legacy application and infrastructure migration

Installation and Orientation Service

Proper installation and orientation of Platform for Industrial 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.

Education Credits

Platform for Industrial Devices includes 16 education credits per subscription seat per year, offering customers the chance to get product development off to a quick start by transferring product knowledge from our technology experts to yours. Customers may redeem education credits for Personalized Learning Programs, public courses, or on-site education. Unused education credits expire one year after they are issued.

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 Industrial 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 Industrial 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 Industrial 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. to 5:00 p.m. (Pacific time)

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UK fax: +44(0) 1793 831 808
Hours: 9:00 a.m. to 6:00 p.m. (local time)



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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