

# VxWorks SBC Support

## VxWorks Board Support Packages and Enhanced Support Packages

### Features

- Extensive support for the embedded industry's most popular real-time operating system
- Fully featured, standard board support package (BSP) for all operating system vendor-defined functions
- Enhanced support package (ESP) provides many extra functions not defined by the operating system vendor, including continuous test
- BSPs / ESPs available for all GE Intelligent Platforms SBC families. Includes PowerXtreme, PowerXpress, EmPower, PowerPact and XtraPower, all based on PowerPC, plus INTraXtreme and INTraPact based on Intel architectures
- All Wind River 'platforms' supported, for Workbench / VxWorks 6.x and Tornado / VxWorks 5.x

VxWorks on GE Intelligent Platforms' single board computers (SBCs) creates a partnership between the leading real-time software system in the marketplace and the leading COTS hardware platforms in the defense arena, giving users an unprecedented choice of compatible hardware and software modules to facilitate optimum system integration.

GE offers five PowerPC-based SBC families and two Intel-based families, all with comprehensive VxWorks support and aimed at different application areas. Each family features a common architecture approach, facilitating technology insertion, and the best Deployed Test software for COTS systems in the industry. In addition to progressive strategies for obsolescence management, GE supports defensive strategies including configuration control, component health checks, and component buy-ahead and storage.

GE is the COTS supplier of choice for mission-critical applications based on either standard VxWorks 5.x, or VxWorks 6.x with enhanced memory protection and error-trapping.

### Real-Time Operating Systems from Wind River

Real-time operating systems for device software play an integral role in how manufacturers develop, deploy and market their devices. Over the past twenty years and more, Wind River Systems has delivered and supported the industry's most significant real-time operating systems. Wind River operating systems have been used as the foundation for a broad range of devices across multiple markets, from set-top boxes, cameras and planes to NASA's Mars Rover.

VxWorks and pSOS, two of the most influential real-time operating systems, have been

deployed in millions of devices worldwide. Wind River customers continue to rely on VxWorks, the world's leading real-time operating system, to provide the solid, deterministic, small-footprint, high-performance characteristics needed to successfully develop and deploy their products better, faster, at lower cost and more reliably.

Real-time operating systems from Wind River include VxWorks 5.x and VxWorks 6.x. VxWorks 5.x is the most established and most widely deployed device software operating system in the embedded market.

### VxWorks 6.x

The next generation of VxWorks adds powerful new features and a focus on openness, performance, dependability and interoperability. With VxWorks 6.x, 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 IPs, including open source

Continue to deliver products that rely on the core attributes of VxWorks, including high performance, reliability, determinism, low latency and scalability.

### Compatibility

One of the central goals of VxWorks 6.x was to ease migration from VxWorks 5.5. To that end, the kernel of VxWorks completely supports the VxWorks 5.5 kernel operating environment – most BSPs, drivers, and kernel applications developed for or ported



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to VxWorks 5.5 will run in the VxWorks 6.x kernel, with only a recompilation required. By default, the VxWorks 6.x kernel builds as that of VxWorks 5.5.

VxWorks 6.x also provides increased support for open standards. This promotes compatibility between the operating system and open-source applications, with these improvements:

- Increased POSIX compliance facilitates easier porting of open-source and third-party software to VxWorks
- Standard process-based model reduces the learning curve for programming new applications on VxWorks 6.x
- Support for IPv6 enables development of the next generation of networked devices
- Standard sockets-based and modular message channels provide a common communications interface

## State-of-the-Art Memory Protection

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

While VxWorks 6.x provides MMU-enabled memory protection, it continues to use the

non-overlapped address space used in all earlier versions of VxWorks. The non-overlapped memory model promotes backward compatibility with legacy VxWorks code and provides high determinism with low latency.

## Error Management

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

## Generic Hardware Support

Differing hardware platforms are supported under VxWorks via a board support package (BSP). The BSP contains a set of functions isolating the operating system from low level hardware specifics, such as timers / interrupt structure / VME interface plus drivers to isolate peripheral devices such as network / serial / USB and others.

VxWorks BSPs have a fixed interface and style defined by Wind River Systems (WRS), which can be verified by hardware vendors using a Validation Test Suite (VTS) supplied

by Wind River. This approach allows wide hardware platform support while giving a guarantee of seamless operation with the operating system. The precise BSP definition is aligned to each particular (major) operating system version, for example VxWorks 5.x, VxWorks 6.x, VxWorksAE653.

BSPs delivered by GE for the required hardware family are separate items from the main operating system, which is purchased direct from Wind River and ships with a full Integrated Development Environment (IDE).

## BSP and ESP

A GE BSP is engineered for “vanilla” standard usage and functionality with VxWorks, including out-of-the-box operation. An enhanced support package (ESP) provides functional extensions to the BSP, allowing drivers and applications access to hardware functionality not included within the standard BSP definitions made by the operating system vendor.

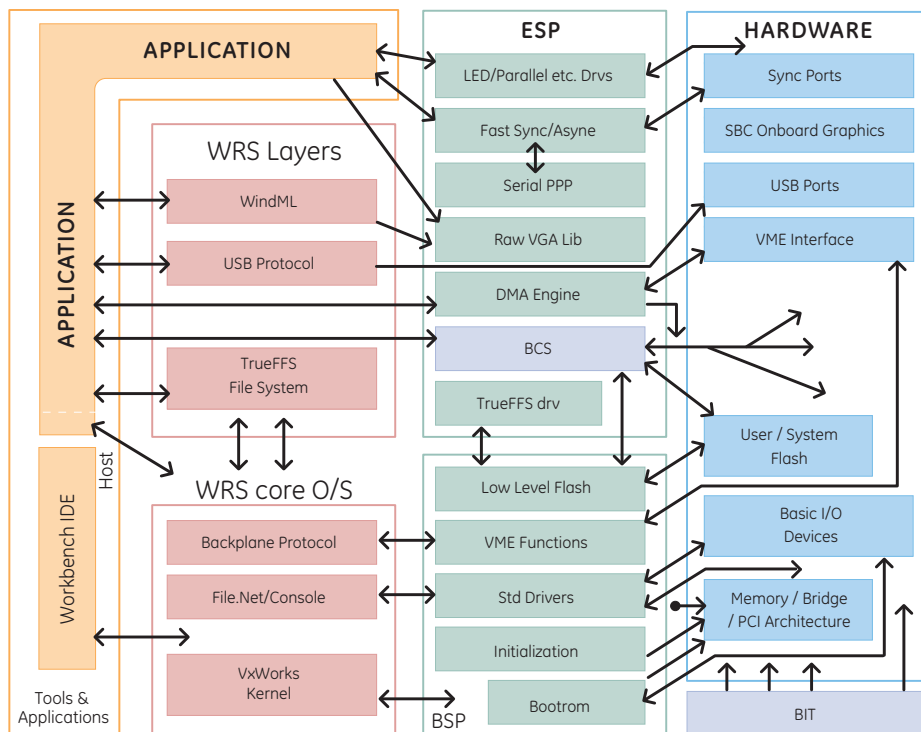
BSPs operate via Wind River-defined interfaces. The ESP necessarily operates via GE-defined interfaces. The diagram below illustrates the BSP/ESP concept, and typical paths from the operating system and application to hardware functional blocks via the BSP and ESP. [BIT and BCS are Deployed Test firmwares.]

## GE Intelligent Platforms Maintenance Agreements

BSPs and ESPs for each SBC family are supplied by GE under a Maintenance Agreement, renewable annually if desired, which provides expert support and the distribution of regular updates. This allows users to be constantly up-to-date with changes to accommodate new hardware revisions (e.g. to combat device obsolescence), or operating systems changes originating from Wind River that may impact the BSP or ESP, together with new features and any solutions for bugs reported from the field.

Users who have already completed application testing and have frozen for production need not implement any software upgrades received unless a particular issue is deemed important, but these may still be useful regarding planned technology refreshes or work on new projects.

The part numbers for ‘BSP only’ maintenance, or ‘BSP/ESP’ maintenance, are given in table 1 below, with entries per hardware family. Note: an ESPZ includes extra multi-processing options; an ESPC includes extra communications-orientated



options. GE Maintenance Agreements are tailored to match the major versions and bundles in which Wind River Systems offers VxWorks. Historically, Wind River's Tornado IDE with VxWorks 5.x was the company's main product. At a later date, these were both bundled with various middlewares in market-orientated 'platforms', featuring differing content and capability. Wind River's newer Eclipse-based Workbench IDE, together with VxWorks 6.x, is offered as a parallel stream, also bundled within equivalent 'platforms'.

For each GE SBC family, a single Maintenance Agreement covers hardware support matching all VxWorks 5.x-based releases (whether delivered from Wind River with 'platforms' Tornado for whichever platform, or with the pre-platforms 'legacy' Tornado).

A separate Agreement covers equivalent SBC hardware support matching all VxWorks 6.x releases (delivered from WRS with 'platforms' Workbench for whichever platform).

## VxWorks Platforms

As noted previously, VxWorks is bundled in Wind River 'platforms', the primary foundation for device software applications. These include tightly integrated middleware run-time technologies: networking, security, management, and graphics. Each platform includes an end-to-end, integrated development suite, tightly aligned partner ecosystem, industry-specific professional services and training, together with worldwide technical support. Available platforms include those listed below.

- General Purpose Platform (GPP), VxWorks Edition
- Platform for Automotive Devices (PAD), VxWorks Edition
- Platform for Consumer Devices (PCD), VxWorks Edition
- Platform for Industrial Devices (PID), VxWorks Edition
- Platform for Network Equipment (PNE), VxWorks Edition
- Platform for Safety Critical ARINC653
- Platform for Safety Critical DO-178B

BSPs and ESPs delivered under any of the Maintenance Agreements that list platform support in Table 1 above will install over the Wind River platform software (excluding the Safety Critical platforms, see top right).

Only selected GE boards are supported for VxWorks AE653 (delivered by Wind River in Platform Safety Critical ARINC653). Note that BSPs delivered by GE for this VxWorks

PowerX	6U VME SBCs, Including PowerXpress and PowerXtreme
PPCBSP-TOR1M	For Platforms & Legacy Tornado VxWorks 5.x, BSP only, on all PowerX boards to PPC7D
PPCBESP-TOR1M	For Platforms & Legacy Tornado VxWorks 5.x, BSP & ESP, on all PowerX boards to PPC7D
PXBSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all PowerX boards from PPC7A
PXBESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all PowerX boards from PPC7A
EmPower	Comms orientated 6U VME EP1A, plus PMCs PMCQ1, EPMCQ2, PrPMCQ2
EPBSP-TOR1M	For Legacy Tornado VxWorks 5.x, BSP only, on all EmPower boards
EPBESP-TOR1M	For Legacy Tornado VxWorks 5.x, BSP & ESP, on all EmPower boards
NOTE:	Contact GE Intelligent Platforms for Fast Async, HDLC, 1553 & PCIT Comms-modules partnumbers, for VxWorks 5.x
EPBSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all EmPower boards
EPBESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all EmPower boards
NOTE:	EmPower ESPC = ESP + Fast Async, HDLC, 1553 & PCIT Comms-modules, for VxWorks 6.x
XtraPower	6U VME Dual Processor SBCs. Note: a 'BSP only' option is not available for XtraPower
XPBESPZ-TOR1M	For Legacy Tornado VxWorks 5.x, BSP & ESPZ, on XtraPower PPCM1
XPBESPZ-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESPZ, on all XtraPower boards
NOTE:	ESPZ = ESP + Multiprocessing support through P0 PCI or StarFabric
PowerPact3	3U cPCI SBCs
IMPBSP-TOR1M	For Platforms (IMP1A / 2A) & Legacy (IMP1A only) Tornado VxWorks 5.x, BSP only
IMPBESP-TOR1M	For Platforms (IMP1A / 2A) & Legacy (IMP1A only) Tornado VxWorks 5.x, BSP & ESP
PP3BSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all PowerPact3 boards
PP3BESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all PowerPact3 boards
PowerPact6	6U cPCI SBCs
PP6BSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all PowerPact6 boards
PP6BESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all PowerPact6 boards
IntraXtreme	6U VME Intel based SBCs
IXTBSP-PTR1M	For Platforms Tornado VxWorks 5.x, BSP only, on IntraXtreme IXT2A
IXTBESP-PTR1M	For Platforms Tornado VxWorks 5.x, BSP & ESP, on IntraXtreme IXT2A
IXTBSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all IntraXtreme boards
IXTBESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all IntraXtreme boards
IntraPact6	6U cPCI Intel based SBCs
IP6BSP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP only, on all IntraPact6 boards
IP6BESP-WBV1M	For Platforms Workbench VxWorks 6.x, BSP & ESP, on all IntraPact6 boards

**TABLE 1** BSP/ESP Maintenance Agreement Numbers for GE SBC Hardware Families

version (which is certifiable to DO-178B) are also 'functional only', i.e. not engineered for certification. However, GE's partner Ultra Electronics Datal can provide expert engineering services for the purpose of delivering certifiable BSP code and associated process evidence. Please contact GE or Datal for further information on this topic. No standard support is offered for Wind River's older certifiable release, VxWorks-178, which is delivered in Platform Safety Critical DO-178B, but inquiries on this topic may be made to GE.

## Additional GE Intelligent Platforms Support with VxWorks

In addition to BSPs and ESPs for GE SBCs, VxWorks support is also available for a wide range of peripheral hardware products offered by GE Intelligent Platforms including 1553, Fibre Channel, StarFabric, Graphics, DSP product, Gigabit Ethernet extensions/switches, ADC/DAC solutions and more. Please visit [www.ge-ip.com](http://www.ge-ip.com) for details.

In addition to highly configurable built-in test (BIT) firmware, running at initialization

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and intrusive to obtain the highest coverage, GE offers a non-intrusive test suite that does not disturb the functioning of the COTS operating system. Tailored to run with VxWorks, this provides background test coverage and also lets the application invoke specific tests. Known as Background Condition Screening (BCS), it is delivered as part of the VxWorks ESP. Main BCS features and tests are:

- Downloadable or linkable to the VxWorks operating system image
- Launched from shell or application
- Static configuration via .h file
- Dynamic configuration via interactive menu
- Configurable thread priority and other parameters
- Error log in Flash and visual indication
- Call-back menu for immediate invocation of individual tests, in addition to running tests in background mode
- Logs and scrubs single bit errors
  - Comprehensive main memory test. By dedicating small segments per bank for exclusive BCS usage, and in conjunction with ECC circuitry, all failure modes throughout all the memory can be detected without destructive action outside the BCS segments
  - System and user background Flash checksumming
  - NVRAM checksum
  - PCI bus error condition monitoring
  - Preset PCI configuration verification
  - Temperature monitoring
  - Temperature throttling (on supported hardware)
  - Network connectivity
  - SCSI connectivity
  - Bus memory probing
  - Real-time clock test
  - Global hardware register verification
  - Tests of 8250-compatible COM port devices
  - Altivec and FPU tests
  - Custom tests can be integrated

<p><b>PowerX</b> is a range of single board computers which benefit from the significant engineering investment made by GE Intelligent Platforms in the PowerPC processor family since 1994. All PowerX boards are software compatible and maintain standard, open market interfaces that allow customers to protect application investments through a clearly defined technology insertion strategy. PowerX covers a broad range of environmental requirements from benign industrial to fully rugged, through two distinct streams. <b>PowerXpress</b> is a range of SBCs specifically designed to meet the needs of systems in sheltered defense environments, typically found in naval, ground-based and vetronics applications. The PowerXpress range offers leading edge performance, with real cost benefits resulting from its sharp focus on the sheltered COTS market. <b>PowerXtreme</b> SBCs - available in five air- and conduction-cooled levels - deliver the same exceptional performance as the PowerXpress range but also offer full rugged survivability. Designed explicitly for operation in the harshest environments, PowerXtreme boards incorporate state-of-the-art design and manufacturing techniques to guarantee operation in the most demanding of defense and aerospace applications.</p>
<p><b>EmPower</b> is a range of cost-effective boards based on embedded PowerPC technology and targeted at communications applications requiring combinations of fast serial, MIL-STD-1553 and Ethernet channels. An appropriate mix of hardware and software modules from the EmPower range can satisfy a wide range of system requirements, avoiding the expense and extended lead time of custom- or tailored products. All family members, in both 6U (EP1A) and PMC form factor (PrPMCQ2, EPMCQ2 and PMCQ1) are offered across a wide ruggedization spectrum for use in environments ranging from industrial to defense and aerospace applications.</p>
<p><b>XtraPower</b> architecture combines the processing power of two traditional SBCs within a single 6U VME slot. Loosely coupling two fully independent processor nodes (each with its own bridge/memory/Flash) across a fast internal bus, provides the system architect with cost-effective, high-bandwidth processing units optimized for real-time. Standard VxWorks multiprocessing mechanisms are maintained between nodes, providing legacy application compatibility in '1 for 2' SBC replacement, or 'built-in system redundancy' scenarios. GE's raw DMA is provided for maximum bandwidth transfers between nodes and the PPCM2 SBC also features an off-board StarFabric connection. XtraPower SBCs are also offered to full rugged specifications.</p>
<p><b>PowerPact</b> single board computers are designed for demanding applications with restrictive dimensional requirements. <b>PowerPact3</b> complies with the 3U CompactPCI format. SBCs in this family pack high PowerPC-based performance into a small space (the IMP2A SBC features a 7448). Core I/O functions are also provided, and a PMC slot plus an optional carrier card allows for functional expansion. <b>PowerPact6</b> SBCs conform to 6U CompactPCI, but otherwise have a similar specification to PowerXtreme boards, the CP1A being close to 'a PPC7D without VME'.</p>
<p><b>INTraXtreme</b> combines GE's industry leading ruggedization technology with Intel's popular Pentium M processors, packaged in a 6U VME form factor. With the Pentium M's new micro-architecture now offering a real alternative to PowerPC in the embedded market, INTraXtreme SBCs (starting with the IXT2A) capture true PC performance, ruggedized to meet the demands of harsh environment defense and aerospace applications.</p>
<p><b>INTraPact</b> offers Pentium M processors in a 3U CompactPCI format for space- or weight-constrained applications, while for applications requiring extensive I/O capabilities, INTraPact6 offers higher function in a 6U CompactPCI format and is also based on Pentium M processors. With two PMC sites and an addition plug-on AFIX (Additional Flexible Interface Xtension) module, <b>INTraPact6</b> offers the most flexible range of I/O solutions available in the rugged SBC market space.</p>
<p>Deployed Test firmware, Configuration Control, plus other software and services for critical program support, are available on all SBCs.</p>

**TABLE 2** A summary of GE Intelligent Platforms' SBC families

## About GE Intelligent Platforms

GE Intelligent Platforms, a General Electric Company (NYSE: GE), is an experienced high-performance technology company and a global provider of hardware, software, services, and expertise in automation and embedded computing. We offer a unique foundation of agile, advanced and ultra-reliable technology that provides customers a sustainable advantage in the industries they serve, including energy, water, consumer packaged goods, government and defense, and telecommunications. GE Intelligent Platforms is a worldwide company headquartered in Charlottesville, VA and is part of GE Home and Business Solutions. For more information, visit [www.ge-ip.com](http://www.ge-ip.com).

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Global regional phone numbers are listed by location on our web site at [www.ge-ip.com/contact](http://www.ge-ip.com/contact)

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