

SDR-3000 Series

Software Defined Radio Transceiver Platform

6U
cPCI



Benefits

- Ultra high performance wireless processing engine
- Industry standard form factors allow easy integration with third party components
- Industry standard software APIs help preserve your software investment
- Data flow optimized for software defined radio
- Designed to meet high availability requirements
- Modular design addresses multiple software defined radio applications
- Allows optimal partitioning of algorithms across FPGAs and signal processors
- Available as Integrated Development Systems (IDS) for rapid development
- Available as a variety of MILCOM rapid-prototyping and deployment platforms that include an integrated fast tuning RF front-end

Applications

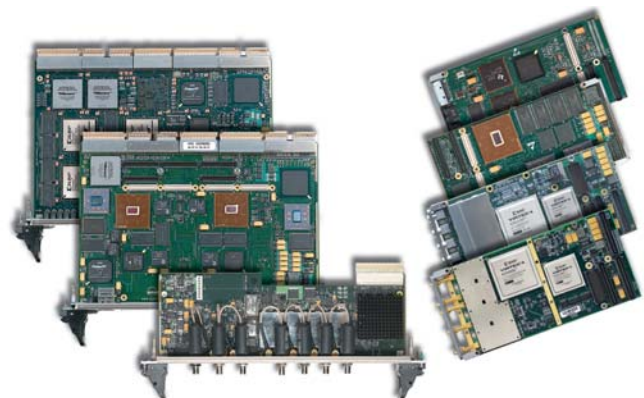
- Military communications (JTRS) including wireless prototyping, wireless test and measurement
- Wireless intelligence and surveillance
- Electronic warfare
- Beam forming and Smart Antennas

Description

SDR-3000 is designed specifically for the implementation of high-performance and/or high-density software defined radios. SDR-3000 supports hundreds of simultaneous transmit and receive channels, each with an independent air interface protocol. Virtually any air interface can be supported by SDR-3000, making it ideally suited for defense programs such as software defined military communications programs and signals intelligence applications.

Features

- 6U CompactPCI®-based architecture
- Combines Xilinx® Virtex-II FPGAs and Freescale™ MPC7410 PowerPC™ G4s, and optionally TI TMS320C64X DSPs, in a single system
- Supports IF sampling rates up to 213.33 MSPS
- Supports 2-4 ADC channels and 2-4 DAC channels per slot
- *flexFabric™* - Serial RapidIO™-based switched fabric connects all boards with deterministic, low latency 320 MB/s data paths
- Supports up to 1000 simultaneous transmit and receive communication channels per chassis
- Includes optional Software Communications Architecture (SCA) core framework
- Supplied with full CORBA support (TAO)
- Supports the Wind River® VxWorks® RTOS on every PowerPC node
- Supports Spectrum's *quicComm™* API for high-performance interprocessor communications and board setup/control
- Supports VSI/Pro, a VSIPL-compliant vector and image processing library optimized to the PowerPC G4
- Supports *quicWave™* for PowerPC, a set of wireless application building blocks



SDR-3000 family comprised of 6U CompactPCI carriers and a variety of Enhanced PMC (ePMC) and XMC modules. Configurations based on your application requirements.

Hardware

The SDR-3000 hardware consists of a series of 6U cPCI-based boards including:

- PRO-3100: a front-end processing board supporting four user-programmable Xilinx Virtex-II FPGAs
- PRO-3500: a signal processing board supporting two Freescale PowerPC G4 processors, up to two additional G4 or 'C64X processors, and/or additional Spectrum and third party XMC/PMC modules
- TM1-3300: an analog I/O board supporting four 80 MHz ADCs and four 160 MHz DACs
- TM1-3350: an analog I/O board supporting two 213.33 MHz ADCs and two 213.33 MHz DACs

For detailed information, please see the individual component datasheet.

All boards are designed for use in high availability applications and are hot-swappable.

In order to achieve optimal data flows, the following standard interconnects are used:

- All FPGAs and G4 processors are connected via *flexFabric*, a serial RapidIO-based switched fabric that allows virtually any data flow to be achieved when working with high-data rate front-end processing.
- All processing boards (PRO-3100 and PRO-3500) are connected via a PICMG 2.16 switched Ethernet backplane, allowing simple network integration, efficient integration of development tools, and an efficient data path for lower speed payload data.
- Both the PRO-3100 and PRO-3500 have standard cPCI interfaces, allowing simple integration with any third-party cPCI boards, and an efficient control path that is independent from the data path.

These concepts are illustrated in Figure 1.

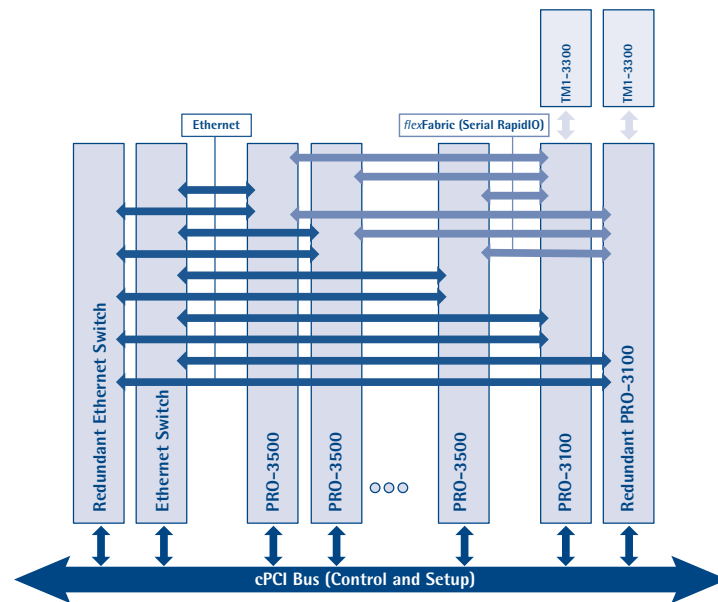


Figure 1. Example SDR-3000 Configuration (high availability)

[PRO-3100]

The PRO-3100 is a cPCI board with four user-programmable Xilinx Virtex-II FPGAs, and is ideal for very high data rate front-end processing. These can support:

- Up to 160 narrowband down converter channels of 2 MHz bandwidth or less, or
- Up to 40 wideband channels of 40 MHz or less

The PRO-3100 contains a user-programmable embedded IBM PowerPC 405GP controller to offload system control from the FPGA processors, which can then be dedicated to signal processing. It also provides a seamless network interface.

The following summarizes the external interfaces on the PRO-3100 board:

- TM1 interface supporting up to 1280 MB/s full-duplex I/O
- *flexFabric* interface – supporting up to six 320 MB/s full-duplex switched fabric links
- PICMG 2.16 compliant switched Ethernet
- 66 MHz, 32-bit PCI via cPCI backplane

[PRO-3500]

The PRO-3500 is a signal processing engine with two Freescale PowerPC G4 processors, and support for two ePMC or XMC modules. Up to two additional G4s or additional I/O can be supported via additional ePMC/XMC modules or third party PMC/XMC modules.

The PRO-3500 contains a user programmable embedded PowerPC 405GP controller to provide networking support, and to offload system control from the PowerPC G4 processors, which can then be dedicated to signal processing.

The following summarizes the external interfaces on the PRO-3500 board:

- *flexFabric* interface – supporting up to two 320 MB/s full-duplex switched fabric links
- PICMG 2.16 compliant switched Ethernet
- 66 MHz, 32-bit PCI via cPCI backplane
- ePMC/XMC module sites: ePMC modules are PMC modules that are equipped with Solano link ports to move high-speed data to the PRO-3500 via an additional connector. Four dedicated, full-duplex 200 MB/s data paths between the PRO-3500 and the ePMC module are supported. For more information on the PRO-3500, please see the PRO-3500 datasheet. Spectrum modules currently supported on the PRO-3500 include:
 - ePMC-PPC: Dual G4 MPC7410 PowerPC™ processing module with AltiVec™ support for floating-point applications
 - ePMC-8311: Includes two Texas Instruments TMS320C6416 DSP-based multiprocessing engine
 - XMC-3311: Single Xilinx® Virtex-4™ FPGA providing dual input 12-bit A/D converters and a single output 14-bit D/A converter running at up to 213.33 MSPS
 - XMC-3321: User programmable Xilinx Virtex-4 FPGA with two 14-bit A/D converters sampling at 96.0 MSPS and two 14-bit D/A converters sampling at 192.0 MSPS

For more information on the supported ePMC and XMC modules, please refer to the respective datasheets.

[TM1-3300]

The TM1-3300 is a 6U x 80 mm cPCI transition module supporting four 80 MHz ADCs and four 160 MHz DACs, for interfacing to any off-the-shelf RF front-end unit with an analog IF, or a baseband signal interface.

[TM1-3350]

The TM1-3350 is a 6U x 80 mm cPCI transition module supporting two 213.33 MHz ADCs and two 213.33 MHz DACs, for interfacing to any off-the-shelf RF front-end unit with an analog IF, or a baseband signal interface.

[*flexFabric*]

All signal processing devices, including FPGAs, G4's and 'C64X's, are connected via *flexFabric*, a serial RapidIO-based switched fabric that allows virtually any data flow to be achieved when working with high data rate front-end processing. *flexFabric* supports the following specific features:

- *flexFabric* - Serial RapidIO-based switched fabric connects all boards with deterministic, low latency data paths that can sustain payload data rates of 320 MB/s (full-duplex). A wide variety of application-specific topologies can be created using different backplanes and backplane overlays.
- Packet switches are built into the PRO-3100. This allows use of passive backplanes, eliminating the backplane as a single point of failure in high availability systems.

[Ethernet]

Both the PRO-3100 and PRO-3500 support 100 Mbps Ethernet via either of:

- PICMG 2.16 compliant CompactPCI Backplane
- Front panel RJ45 connectors

In addition, Gigabit Ethernet is supported via a Critical I/O XGE PMC module installed on the PRO-3500.

[Digital Mass Storage]

Mass storage of up to 144 GB at data rates of up to 200 MB/s can be supported via the ePMC site of the PRO-3500. A typical use is to capture raw data from one of the I/O interfaces.

Software

SDR-3000 features a standards-based software stack, providing performance, code portability, and allowing choice with respect to which components are used in an application.

[TAO CORBA]

CORBA (Common Object Request Broker Architecture) is an industry standard means of developing distributed, multiprocessor, multi-OS, multi-vendor software systems.

Every PowerPC processor in the SDR-3000 platform is supplied with an Object Request Broker, or ORB, to facilitate CORBA development if required. Although different variants of CORBA are commercially available from various vendors, Spectrum selected the TAO open-source ORB due to its ideal combination of level of industry adoption, performance and price.

Although TAO CORBA is supplied as standard, its actual use is completely optional, and software applications can be built on the VxWorks and *quicComm* layers.

[VxWorks and Tornado]

VxWorks, from Wind River Systems, is the leading real-time operating system in the embedded marketplace. The SDR-3000 series product line supports VxWorks on both the G4 processors as well as the on-board embedded controllers (405GPs).

Features of the VxWorks RTOS include:

- Scalable, high-performance wind® microkernel
- Advanced networking support
- File system and I/O management

VxWorks is bundled with the Tornado II development toolset from Wind River Systems, also available from Spectrum. The package available from Spectrum includes:

- Windows XP development environment
- C/C++ compiler
- Editor, debugger, simulator, launcher, browser
- The VxWorks operating system
- A choice of the supplemental development tools, including WIND®VIEW, VxSim, StethoScope, TraceScope, MemScope, ProfileScope, Real-time Visualisation Pack, CoverageScope, CodeTEST and Visual SlickEdit

[quicComm]

quicComm is Spectrum's high-performance library for all board-level functions. These include:

- High-performance interprocessor communication: *quicComm* provides high-level software links and signals between all processors allowing a simple, yet extremely powerful programming model
- Booting functions for PowerPCs, user programmable FPGAs and 'C64X DSPs
- Flash programming tools for both the PRO-3100 and PRO-3500
- Control of all I/O not covered by the operating system (e.g. control of digital radio hardware)

quicComm is available on all generations of *flexComm* products released since 2000, and will be available on all future generations, allowing maximum code portability and reducing the learning curve.

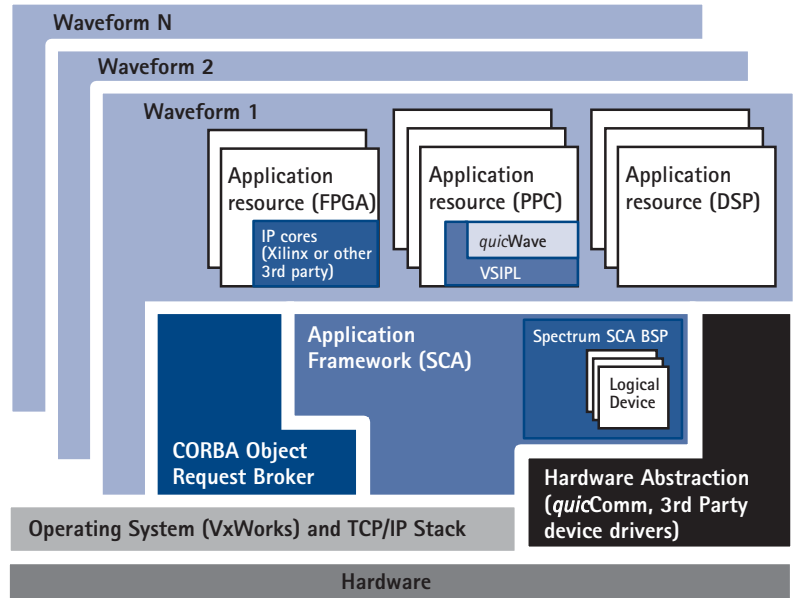
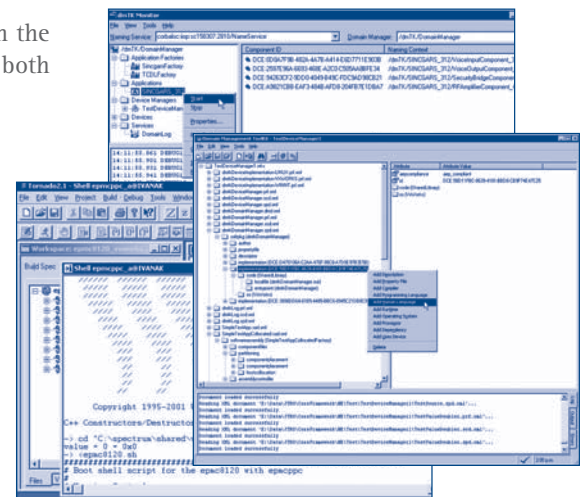


Figure 2. SDR-3000 Software Stack



[Software Communications Architecture (SCA)]

The SCA is an open specification sponsored by the Joint Tactical Radio System (JTRS) program and adopted by the Software Defined Radio (SDR) Forum. It specifies software, hardware, security, and networking architecture requirements for open, programmable SDR systems with flexible, re-programmable communication capabilities.

Specifically, the SCA specifies a common framework to build-up, configure, connect and tear down distributed, embedded radio applications while maximizing waveform portability.

Spectrum has partnered with Harris Corporation to provide a mature, fully functional SCA core framework, in conjunction with Spectrum’s SCA board support package (BSP), which implements those portions of the SCA core framework specific to the SDR-3000.

For full details, please see the Harris dmTK and Spectrum SCA BSP datasheet.

[VSI/Pro]

Spectrum has partnered with Verari Systems to bring you VSI/Pro®, a vector and image processing library, specifically optimized to the PowerPC G4. VSI/Pro contains optimized functions for common signal processing tasks such as FFTs, FIR filters, dot products and trigonometric/algebraic functions. Full details of VSI/Pro can be found at www.verarisoft.com.

The library is fully compliant with the VSIPL API standard, as published by the VSIPL forum, maximizing code portability via an efficient programming interface. For further details on the VSIPL forum, please see: www.vsipl.org.

[quicWave for PowerPC]

quicWave for PowerPC is a library of building blocks for the development of wireless modems (waveforms). These building blocks can be combined with user-defined and other *quicWave* blocks to create a complete PowerPC-based wireless application.

quicWave for PowerPC is built on top of the VSIPL industry standard interface for signal processing functionality. This allows the library to be optimized to the PowerPC G4 Altivec engine simply by linking with VSI/Pro.

For full details, please see the *quicWave* for PowerPC datasheet.

[FPGA Cores]

RF Engines Ltd. (www.rfel.com) provides individual intellectual property (IP) cores and integrated turnkey designs for digital RF signal processing in FPGAs and ASICs as appropriate to speed development. RF Engines provides off-the-shelf IP cores that are highly optimized in terms of speed, power, and size compared to cores available from other major FPGA vendors. Available cores include pipelined FFT, tunable PFT, half-band filters, highly optimized FIR filters, windowing and CORDICs.

Spectrum routinely develops custom cores for clients when these are otherwise unavailable. If you have such a requirement, please contact your Spectrum sales representative.

[Basic Package vs. Optional Extras]

Developers can use as much or as little of this software stack as they choose. The following table illustrates which components are supplied as part of the basic SDR-3000 package vs. optional extras.

Basic SDR-3000 Software Package	Optional Extras
VxWorks BSPs for all applicable hardware <i>quicComm</i> for all hardware <i>quicWave</i> for PowerPC TAO CORBA (use is optional)	Tornado/VxWorks (specific components required unless already purchased) Xilinx ISE (required unless already purchased) VSI/Pro SCA Core Framework (dmTK and SCA BSP) FPGA IP Cores

SDR-3001 and SDR-3002 Integrated Development System

In order to allow customers to begin developing immediately with minimal risk, Spectrum has made the SDR-3001 and SDR-3002 Integrated Development Systems available. The SDR-3001 and SDR-3002 IDS includes:

- One complete board set
 - SDR-3001 IDS: PRO-3100, PRO-3500, TM1-3300
 - SDR-3002 IDS: PRO-3100, PRO-3500, TM1-3350
- A rackmount CompactPCI chassis
- 3-slot *flexFabric* passive backplane, allowing a level of system expansion
- Tornado and VxWorks board support package
- *quicComm* software
- *quicWave* component libraries for PowerPCs
- TAO CORBA
- Windows XP development PC with all software tools installed and tested
- All necessary cables and documentation



SDR-3001 Integrated Development System

Other hardware and software can be integrated into the

SDR-3001 or SDR-3002 IDS according to your needs. These include but are not limited to:

- Tornado II / VxWorks 5.5
- FPGA cores for Virtex-II FPGAs
- VSI/Pro
- Additional PRO-3100, PRO-3500, TM1-3300 or TM1-3350 boards

Rapid-Prototyping and Deployment Platforms

Spectrum offers a series of rapid-prototyping and deployment platforms for those targeting military communications and public safety programs. The platforms integrate high-performance, fast tuning transceivers with a high performance modem providing a COTS "RF to Ethernet" signal processing solution.

[Military Communications Platforms]

To provide a COTS SCA-enabled integrated black-side signal processing solution, Spectrum has integrated an RF transceiver from Digital Receiver Technology, Inc. A comprehensive data flow example from the RF input through the entire signal processing chain and back out the RF output is provided, giving project teams a valuable starting point for development.



SDR-3000 MRDP MILCOM Rapid-Prototyping and Deployment Platform

Platform	Hardware Included
SDR-3000 MRDP Two-slot solution	PRO-3100, PRO-3500, TM1-3300, DRT2110 RF front-end
SDR-3500 SMRDP Single-slot solution	PRO-3500, XMC-3311, DRT2110 RF front-end

Various MILCOM platform configurations. For more information and to purchase the DRT2110, please visit <http://www.drtd.com>.

All systems include Spectrum's *quicComm* and SCA board support package, Harris SCA Core Framework, Wind River VxWorks Real-Time Operating System, TAO CORBA and data flow examples. For complete details, please see the respective datasheets.

[Public Safety Cross Band Communications Platform]

Spectrum's Public Safety Cross Band Communications Platform uses SDR technology to enable interoperable communications across multiple radio frequencies allowing first responder services to share critical information.



The RF Transceiver Subsystem is provided by TRL Microwave Technology Inc., a designer and manufacturer of microwave components and systems since 1987. The RF Transceiver Subsystem consists of two spectral ranges:

- TRL TR4575 operating in the Ultra High Frequency (UHF) band between 350-800 MHz
- TRL T4965 operating in the public safety band of 4.9 GHz

Both transceivers offer simplex capabilities at their respective RF frequencies, and communicate with the IF and baseband signal processing subsystem using a 70 MHz IF.

For more information, please see the Public Safety Cross Band Communications Platform datasheet.

Platform	Hardware Included
Public Safety Cross Band Communications Platform	PRO-3500, XMC-3321, XMC-3321, TRL TR4575, TRL T4965

Services

[Customer Training]

Spectrum's training workshops are designed to get your team up and running in the shortest time possible by using a combination of lectures and at least 60% hands-on experience with your system. Experience thus far has shown this service to be an invaluable tool that generates significant cost savings and reduces risk for Spectrum customers.

The standard SDR-3000 training consists of three days with a Spectrum Applications Engineer working with actual hardware. An additional three day course covers the dmTK and SCA BSP is available. Alternatively a five day course is offered covering both SDR-3000 and the SCA components. Training typically consists of:

- Descriptions of over-all system functions and data paths
- Demonstrations of the Development Tools
- Training on how to run and rebuild software examples
- Formal training modules (presentations and hands-on)

Should you have any specific areas that need to be covered in greater detail, these can be requested ahead of time (recommended), or at the training.

Training can be done either at Spectrum's headquarters in Burnaby, B.C., Canada or at the customer site.

For complete detail, please see the training datasheet

[Custom Application Development]

Spectrum's Application Engineering Services (AES) can assist development of your custom application software. The scope of these services are tailored to customers' needs, ranging from complete subsystem development to support for SCA operating environment and waveforms. Spectrum's AES team partners with customers' internal application development engineers to augment their development resources.

For more information, please see the Application Engineering Services datasheet.

Specifications (assumes 1xPRO-3100, 1xPRO-3500, 1xTM1-3300 or TM1-3350)

[general]	Form Factor	6U CompactPCI	
	I/O	4 x A/D channels, 14-bit, 80 MHz, 4 x D/A channels, 14-bit, 80 MHz (with 2x interpolation to 160 MSPS), or 2 x A/D channels, 12-bit, 213.33 MHz, 2 x D/A channels, 14-bit, 213.33 MHz	
	Processors	4 x user programmable Xilinx Virtex-II FPGAs (XC2V6000 or XC2V3000) 2 x Freescale PowerPC MPC7410 G4 on PRO-3500, plus additional 2 G4s or 'C64Xs via ePMC sites PowerPC 405GP embedded controllers on both PRO-3100 and PRO-3500	
[buses]	Host	CompactPCI bus: 32-bit/66 MHz	
[external interfaces]	<i>flexFabric</i>	<i>flexFabric</i> Serial RapidIO switched fabric for interboard communications. Six 320 MB/s links are supported on the PRO-3100 while two are supported on the PRO-3500.	
	ePMC	Dual 33 MHz, 32-bit PMC sites with Solano enhanced capability	
	Ethernet	10/100 BaseT Ethernet supported via either: PICMG 2.16 packet switched backplane or front panel Gigabit Ethernet supported via Critical I/O XGE PMC module installed on the PRO-3500	
	Serial port	RS232 ports of embedded controllers are routed to the front panels of the PRO-3100 and PRO-3500	
	User-defined I/O	Sixteen user-defined pins from each Virtex-II FPGA routed to front panel	
[performance]		Please consult individual board datasheets for block diagrams:	
	Peak Data Transfer Rates	Between TM1 interface and each Virtex-II FPGA	640 MB/s bidirectional or 1280 unidirectional
		Between Virtex-II processors	376 MB/s
		From PRO-3100 to other boards via <i>flexFabric</i>	320 MB/s per link
		Virtex-II to embedded controller	10 MB/s
		Between PowerPC G4s via Solano	200 MB/s
		PowerPC G4 to network via GigE PMC module	50 MB/s
[software]		<i>quicComm</i> , TAO CORBA, VxWorks, VSI/Pro, <i>quicWave</i> for PowerPC	
[environmental]	Temperature	Operating temperature range of 0 to 45 °C	
	RoHS	Please see component level datasheets for RoHS compliance or contact Spectrum Sales	
[quality]	MTBF	100,118 hours	
[ordering information]		You should contact your Spectrum Sales Representative for specific ordering information. You can expect to cover the following items:	
	Development PC	Minimum specifications: 2.5 GHz Pentium-IV processor, 512 MB SDRAM, Windows XP	
	Hardware	Configurations can be constructed from a combination of chassis, PRO-3100, PRO-3500, TM1-3300, TM1-3350, and <i>flexFabric</i> backplane. Optional configurations with various ePMC, XMC and/or RF front-ends are available.	
	SDR-3000 Base Software and Documentation	Includes <i>quicComm</i> software for all SDR-3000 series boards, plus <i>quicWave</i> , VxWorks BSP's and ACE/TAO CORBA. Licensed on a per site, per project basis.	
	Tornado/VxWorks	Tornado/VxWorks is ordered on a development seat basis (per developer) under Wind River's Enterprise Licensing Model. All pricing includes first year maintenance, while run-time licensing applies (per processor) for production systems only.	
	SCA Core Framework	The SCA core framework comprises Harris dmTK and Spectrum's SCA BSP. The dmTK is licensed on a per developer basis while the SCA BSP is licensed on a per project, per site basis.	
	VSI/Pro	VSI/Pro is ordered on a development seat basis and is optional. Run-time licensing applies (per processor), for both development and production systems.	
	Xilinx ISE	Xilinx ISE is recommended for FPGA development, and can be ordered from Spectrum as an option. ModelSim PE with both VHDL and Verilog licenses is required to use the supplied simulation environment.	
	Training	Initial SDR-3000 and SCA orders require compulsory training, either at Spectrum's headquarters or at your site. Options include: SDR-3000 training (3-days), SCA training (3-days) and combined SDR-3000/SCA training (5-days).	
	FPGA IP Cores	FPGA IP cores are licensed to the device type and must be purchased for each instantiation of the core on an FPGA.	
[custom configurations]		For custom configuration options, please contact Spectrum Sales	