SPECTRUM SIGNAL PROCESSING BY VECIMA

SDR-4800 Embedded Radio Modules

Customized Rugged Software Defined Transceiver Modules for Rapid Deployment

Preliminary

Custom

flexComm

A family of radio modules based on reconfigurable System-On-Chip (SoC) and Embedded RF technologies that can be customized for integration into defense, civil or commercial radio products.

Your Challenges	Spectrum's Solution
Do you face any of these challenges in your radio development program?	Spectrum's SDR-4800 Family of Embedded Radio Modules can help you overcome your challenges:
• A short development schedule to hit your deployment window.	• Spectrum's architecture is designed specifically for rapid optimization and delivery. Save up to four man-years of hardware and software development effort when you let Spectrum supply the RF-to-Ethernet module for your radio solution.
• The need to reduce development and hardware costs to maximize return on investment while building a technically compliant solution.	• Spectrum has invested in the base radio technology so your in-house engineering can focus on waveform and feature development.
• Significant constraints on size, weight, and power.	• Spectrum can help select the appropriate space and power saving SoC and Embedded RF technologies to meet your application constraints.
• The need to support existing Defense and Commercial Satellite Communications (SATCOM), Cellular, Data Link, and Tactical Military Communications (MILCOM) waveforms.	• Spectrum's SDR-4800 architecture is based on reference designs for many of the latest Tactical MILCOM, SATCOM and Commercial Waveforms such as SINCGARS, HAVEQUICK, INTELSAT, UHF SATCOM, and INMARSAT BGAN.
• The need to deploy your radio or wireless system in a harsh environment.	• All SDR-4800 radio modules are designed in accordance with ANSI VITA47 ECC3 for extended temperature, shock, vibration, and humidity.
• Require a radio module that will be cost-effective to build in low to medium production volumes (hundreds to thousands per year).	• Spectrum offers different models for bringing your radio module subsystem to deployment in a cost-effective manner, ranging from manufacturing to technology licensing options.

Description

The *flex*Comm™ SDR-4800 product family offers commercial-off-the-shelf (COTS) hardware, software and services to deploy field-ready integrated radio modules into defense and commercial wireless systems. The core SDR-4800 radio architecture is based on reconfigurable System-on-Chip (SoC) and Embedded RF technologies to create an integrated RF-to-Ethernet radio module that reduce size, weight and power when compared to more traditional COTS solutions. All SDR-4800 radio modules are designed to address the needs of both benign and harsh operating environments, and support conduction-cooling, extended temperature range, and increased shock and vibration immunity.

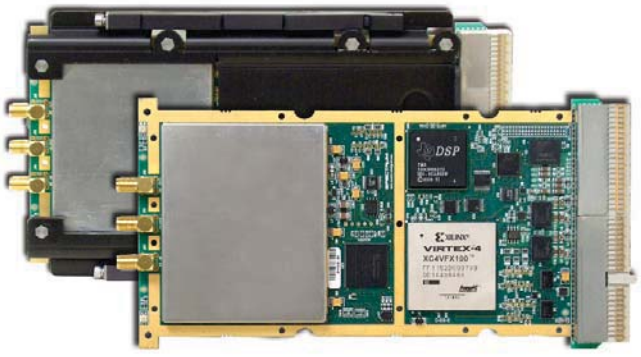

Figure 1. SDR-4800 family of embedded radio modules

The SDR-4800 can be tailored for a variety of deployments in MILCOM, SATCOM, and commercial applications. For example, its ability to support multiple MILCOM and Data Link waveforms give it the flexibility to be deployed in various targets, such as mobile or fixed base stations, Humvees, combat ships, fighter planes, and unmanned aerial vehicles (UAVs) (see Figure 2).

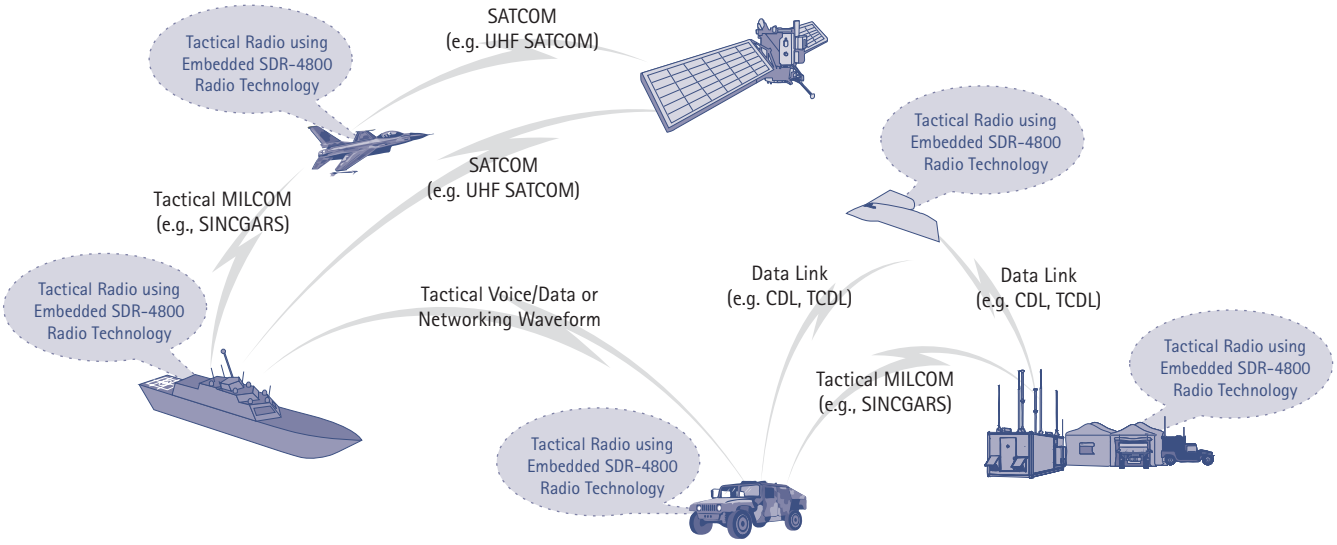

Figure 2. SDR-4800 embedded radio technology in deployment

The foundation of your specific SDR-4800 radio module solution is a base architecture built on a core set of modular hardware and software components that enable rapid optimization of performance, size, weight, power, cost and ruggedization characteristics. By allowing Spectrum to build your radio modem solution according to your specific requirements, you can allocate your resources and budget towards application critical development.

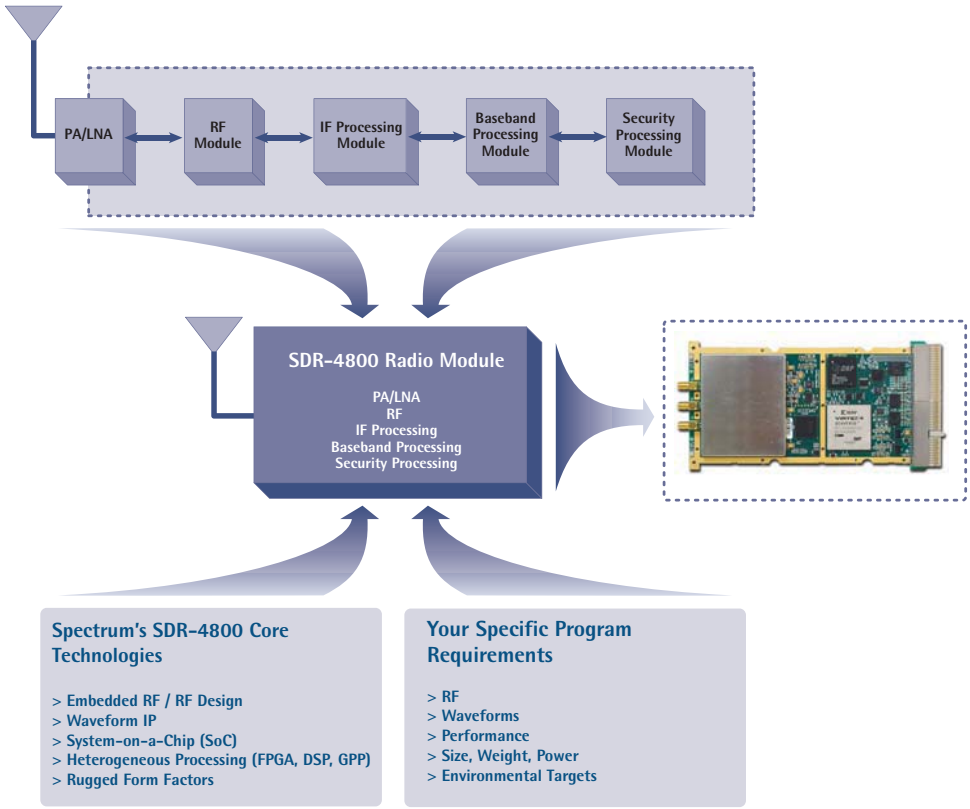

Figure 3. SDR-4800 tailors Spectrum's core technologies to meet your program needs, reducing your traditional radio architecture into a single embedded radio module

Tailor a Field-Ready Solution for Your Radio Program

Spectrum's architecture leverages SDR technologies and expertise to rapidly build a deployable radio module to meet your specific application and waveform needs when integrated as part of your overall system. Spectrum will work with your in-house engineering team to select the most appropriate technologies to get you to demonstration or deployment. This allows your team to focus on delivering the high-value feature sets of your product or solution, thereby minimizing technical risk and accelerating your time-to-market or deployment.

For example, you have a frequency agile application that requires RF to Ethernet functionality on a licensed RF band. Spectrum will work with you to define your RF conversion needs, select the appropriate level of processing, and incorporate the appropriate rugged characteristics. The result of this activity is an application specific module for your program.

The following table provides customizable options for tailoring the SDR-4800 embedded radio module.

Core Processor	Xilinx® Virtex-4™ FX SoC with Two Embedded PowerPC™ 405 Processors			Xilinx® Virtex™-5 FXT SoC with Two Embedded PowerPC™ 440 Processors		
RF/Analog	L-Band SATCOM, L-Band Terrestrial	UHF SATCOM, UHF Terrestrial		VHF	HF	Custom
Modem Co-Processor	TI C6455 DSP	Virtex-4 LX or SX	Virtex-5 LX, LXT, or SXT	Freescale	ASIC	Other
External Interfaces	10/100/100BT Ethernet		PCI	Serial	USB	
Form Factors	3U CompactPCI	AdvancedMC	MicroTCA	VPX	Custom	
Operating System	Green Hills® INTEGRITY®		Wind River® VxWorks® 5.5 or 6.x	Linux		

Table 1. Possible Options for Customized SDR-4800 Radio Module Components

[Meeting Your Waveform Requirements]

The SDR-4800 family is based on reference designs for Military Communications (MILCOM), Satellite Communications (SATCOM), and Data Link waveforms. Your SDR-4800 can be tailored to support one or more of the following waveforms shown in Table 2. Please contact Spectrum sales with your specific waveform requirements.

Waveform	RF Frequency Band	Supported Data Rates	Modulation Schemes
SINCGARS	VHF (30 - 88 MHz)	16 kbps	FM
HAVEQUICK	UHF (225 - 400 MHz)	16 kbps	AM, FM, PSK
UHF SATCOM	UHF (225 - 400 MHz)	64 kbps	FSK, BPSK, QPSK, 8PSK, 16QAM
INTELSAT Business Services	L-Band (800 MHz - 2.4 GHz) IF	16 kbps – 8.4 Mbps	BPSK, QPSK
Common Data Link (CDL), Tactical Common Data Link (TCDL)	L-Band (800 MHz - 2.4 GHz)	200 kbps - 10.71 Mbps	BPSK, QPSK
STANAG 7085	L-Band (800 MHz - 2.4 GHz)	200 kbps - 10.71 Mbps	OPQSK
WiMAX 802.16d (Subscriber Mode)	2.3 - 2.7 GHz	0.5 - 2 Mbps	BPSK, QPSK, 8PSK, 16QAM
DVB-S2	L-Band (800 MHz - 2.4 GHz)	16 kbps – 10.71 Mbps	QPSK, 8PSK, 16APSK, 32APSK
DVB-RCS	L-Band (800 MHz - 2.4 GHz)	16 kbps – 10.71 Mbps	QPSK, 8PSK, 16APSK, 32APSK
INMARSAT BGAN	L-Band (800 MHz - 2.4 GHz)	Up to 492 kbps	QPSK, 16QAM

Table 2. Waveforms that can be supported with SDR-4800 variants

[Example Application-Specific SDR-4800 Variants]

Spectrum offers a series of application-specific radio module concepts that have been architected to meet requirements for SATCOM, Data Link and Tactical MILCOM applications. Spectrum can rapidly tailor any of these following application-specific concepts. Contact Spectrum for further technical information on any of the following variants, and discuss your specific application requirements.

	SDR-4800 for L-Band SATCOM	SDR-4800 for L-Band Data Link	SDR-4800 for UHF SATCOM
Primary FPGA Processor	Virtex-4 FX100	Virtex-4 FX100	Virtex-4 FX100
Primary Co-Processor	TI C6455 DSP	NONE	TI C6455 DSP
Integrated RF	L-Band (800 MHz - 2.4 GHz)	L-Band (800 MHz - 2.4 GHz)	UHF (225 - 400 MHz)
Environmental/ Rugged	-40C to 70C VITA47 ECC3	-40C to 70C VITA47 ECC3	-40C to +70C VITA47 ECC3
Form Factor	3U CompactPCI	3U CompactPCI, MicroTCA	3U CompactPCI, VPX
Performance	High - Up to 32APSK	High - Up to 32APSK	Medium - CPM/up to 16QAM
Power	< 12 watts	< 10 watts	< 12 watts

Table 3. SDR-4800 Application Specific Variants

Radio Module Overview

Every SDR-4800 radio module is based on a core architecture shown in Figure 4, that was developed to meet the processing and I/O requirements of a wide range of tactical MILCOM and SATCOM waveforms.

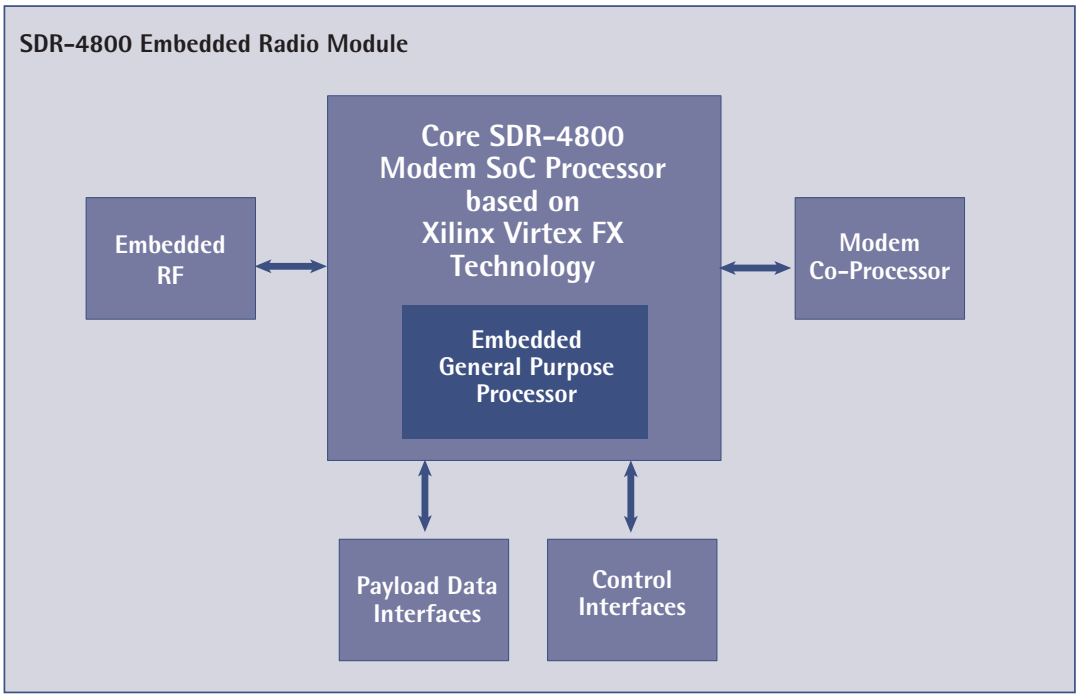

Figure 4. SDR-4800 base architecture using Xilinx Virtex FX System-on-Chip (SoC) technology

[Core Modem Processor – Xilinx Virtex Field Programmable Gate Array (FPGA) System-On-Chip]

At the heart of the architecture is the Core Modem Processor that is implemented using Xilinx Virtex FX FPGA System-On-Chip technology. The SDR-4800 is roadmapped for the Virtex-5 FXT and will be available after the part is released by Xilinx. In addition to FPGA processing resources, the Virtex-5 FXT FPGA will contain an embedded IBM PPC440 core. The embedded PPC440 processor is intended for modem control and staging of network payload data. The PPC440 connects to dedicated high-speed and low-speed peripheral buses. These buses connect to peripherals, memory, and Gigabit Ethernet.

Today, the SDR-4800 is offered with the Virtex-4 FX FPGA with an embedded IBM PPC405 core.

[Modem Co-Processor - Digital Signal Processor, FPGA, ASIC and/or PowerPC]

Depending on the radio waveform or application requirements, a secondary modem co-processor may be required to supply additional resources for PHY and/or MAC layer processing functions. As a result, various co-processor options have been designed into the architecture to rapidly implement solutions that include one of the following processing technology devices.

- Xilinx Virtex-4 FPGA or Virtex-5 (after it is made available by Xilinx)
- Texas Instruments C64x Digital Signal Processor
- Freescale/P.A. Semi PowerPC
- Other ASIC-based co-processors (e.g. LDPC decoder/encoder, security device, etc.)

[Embedded RF]

Spectrum's embedded RF solutions reduce the number of system components by integrating amplifier and conversion stages into the SDR-4800, hence reducing the size, weight and power of the overall system. Spectrum's RF front-end designs utilize proven analog technologies in the area of analog converter chips, discrete RF designs, and embedded RFIC chips. Example RF front-end solutions include:

- L-Band SATCOM front end covering 800 MHz - 2400 MHz
- UHF SATCOM front end covering 225 MHz to 400 MHz
- UHF Terrestrial front end covering 225 MHz to 400 MHz
- HF/VHF (3 - 30 MHz, 30 - 88 MHz)
- Customer specific RF

[Form Factor]

Spectrum can tailor your SDR-4800 radio module in the form factor of your choice while still maintaining all required performance requirements of the design. This includes custom form factors and industry standard form factors such as 3U CompactPCI, VPX, and MicroTCA.

[Operation in Harsh Environments]

In order to meet the needs of a diverse set of fielded radio applications, each radio module is designed to support conduction cooling and extended temperatures through the use of industrial-temperature-range components. Embedded stiffening and thermal mechanical structures are employed to provide increased shock and vibration immunity.

For protection against high levels of humidity and other environmental contaminants, your SDR-4800 radio module can be conformally coated with a protective sealant. Software readable temperature sensors are included to monitor temperature on hot components. The SDR-4800 product family is designed to operate under the conditions for air-cooled and conduction-cooled environments specified by VITA47.

Software Operating Environment – Tools to Accelerate Radio Application Development

SDR-4800 product family features a standards-based software operating environment as shown in Figure 5. The software stack provides high performance, code portability, and choice with respect to which components are used in an application.

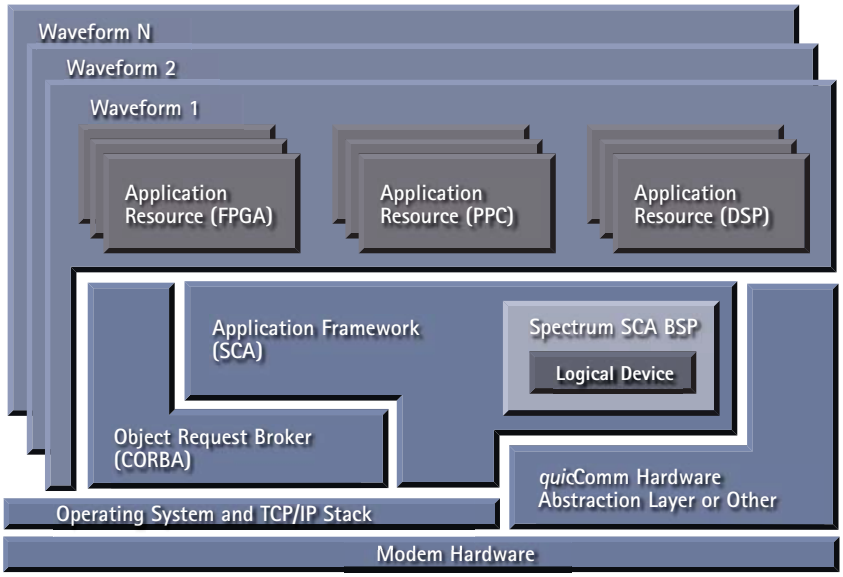

Figure 5. SDR-4800 radio module software operating environment

[Operating Systems]

The embedded PPC405/PPC440 processors support multiple operating systems including Green Hills® INTEGRITY® real-time operating system (RTOS) and the Wind River® VxWorks® RTOS. Both of these operating systems are designed for use in embedded systems that require deterministic operation and maximum reliability.

Customizations including support for other real-time operating systems (such as Linux) can also be supported.

[Standards-Based Application Programming Interfaces]

Accelerate waveform porting or integration activities on your SDR-4800 radio module using standards-based Application Programming Interfaces (APIs) and tools to allow for quick integration and porting of waveform components. Using a "wrapper"-like approach, Spectrum provides a standards-based interface between the application space of the processing elements and the underlying hardware (Figure 6).

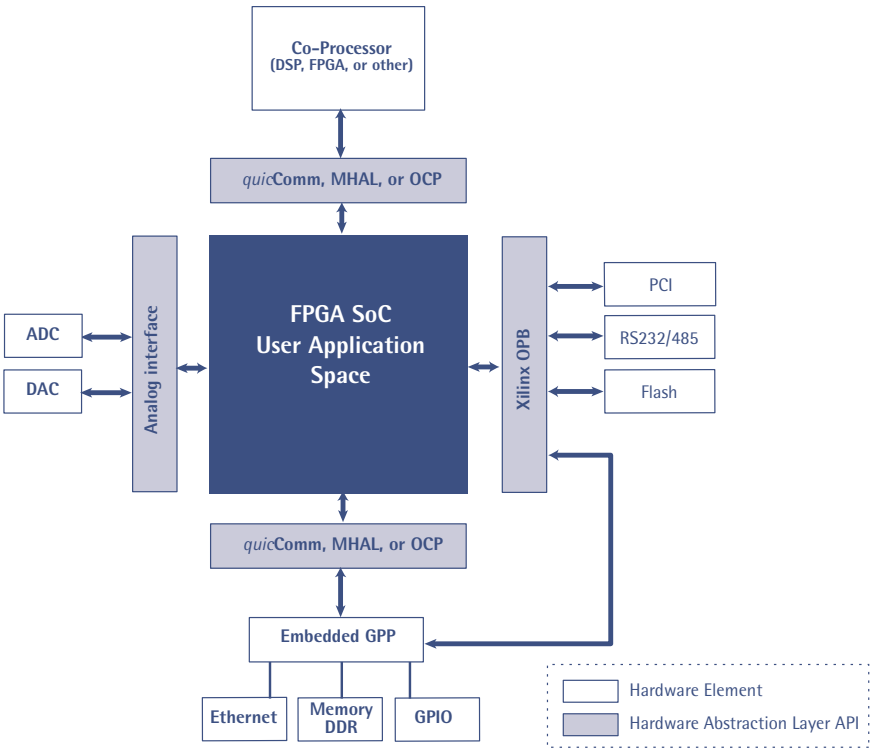

Figure 6. Hardware abstraction layer on the FPGA SoC

[Embedded General Purpose Processor]

The SDR-4800 software application-programming interface on the embedded General Purpose Processor is provided via Spectrum's *quic*Comm SDK. *quic*Comm software abstracts the underlying hardware providing users with basic transport level access and control of the hardware. This software includes a board support package for control and data handling which:

- Allows configuration and control of the data links between primary FPGA user application space and secondary processor (FPGA, DSP, PowerPC, etc.)
- Initiates and manages data transfers
- Manages interrupts
- Enables dynamic loading on a processor without affecting other processors

For example, the *quic*Comm API provides built-in functions that can parse bit files and load the images into the User Application Space of the Primary Modem Processor. The API function gives the user the flexibility to load (only), load and execute the current image, or execute a previously loaded image. For standalone operations, the image can be pre-loaded into Flash and the User FPGA automatically programmed at boot on power up.

[Other HAL Options for FPGA and DSP]

The SDR-4800 also supports other hardware abstraction layer (HAL) options depending on your program needs and other open industry standard API for use on the Embedded GPP, DSP or FPGA. Industry-standard Application Programming Interfaces (APIs) that can be supported include:

- Modem Hardware Abstraction Layer (MHAL) –Standard for Application Programming Interfaces (API) released by the U.S. Joint Program Executive Office (JPEO) for the JTRS program to abstract the modem hardware and radio operating environment from the waveform application.
- Open Cores Protocol (OCP) – A common open standard for FPGA IP core interfaces facilitating efficient development of System-On-Chip designs that incorporate 3rd party or custom FPGA cores.
- eXpressDSP – Texas Instruments software and development tool suite that includes a set of standard application programming interfaces that is supported by hundreds of 3rd party algorithm providers and system integrators.

[DSP Debug and Compile Tools]

Spectrum builds on TI's proven eXpressDSP™ software tools to provide multiprocessing tools and configuration utilities that enable application developers to work at a system level. SDR-4800 radio modules utilizing TI DSP processors support TI Code Composer Studio™ Development Tools.

[FPGA Tool Flow]

Although other tools can be used, the SDR-4800 is designed to support the Xilinx ISE Foundation tool flow. ISE is an integrated programmable logic design environment that includes schematic capture, power analysis tools, physical synthesis for FPGAs, advanced Place and Route Algorithms, and COREgenerator, a graphical interactive design entry tool that is used to create high-level modules. Xilinx System Generator, Xilinx AccelDSP and Synplicity SynplifyDSP tools can also be used to design and simulate FPGA-based algorithms within the MATLAB/Simulink environment from The MathWorks.

[Waveform Intellectual Property (IP)]

Spectrum has teamed with industry leaders in waveform technology to provide a selection of key waveforms and waveform components that are pre-ported for use on Spectrum's modem solutions. IP components for the physical layer implementation of the following waveforms are available from Spectrum.

- Wideband Networking Waveform (WNW) OFDM
- SINCGARS
- UHF SATCOM

The availability of waveform IP components allows Spectrum to deliver highly integrated radio modem solutions.

[Software Communications Architecture (SCA)]

The SDR-4800 supports the Communications Research Centre (CRC) Canada's implementation of the SCA core framework. The SCA is an open specification sponsored by the U.S. Department of Defense Joint Tactical Radio System (JTRS) program. It specifies software, hardware, security, and networking architecture requirements for open, programmable Software Defined Radio (SDR) systems with flexible, re-programmable communication capabilities. The SCA specifies a common framework to build-up, configure, connect, and tear down distributed, embedded radio applications while maximizing waveform portability. The SCA core framework is available as an option.

[SCA Development Tools]

The SDR Development Toolset from CRC is a complete platform-independent set of software tools for creating, modifying, and operating an SCA-based Software Defined Radio. The tools:

- Provide template based, portable, POSIX/CORBA compliant code generation for resources and devices
- Represent SCA applications graphically
- Implement real-time model validation
- Provide model re-factoring capabilities
- Allow reverse-engineering of models for existing components
- Minimize code memory footprint using the Component Development Library

The SCA Development Toolset is available as an option. Please contact Spectrum Sales for more information.

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. This service to be an invaluable tool that generates significant cost savings and reduces risk for Spectrum customers.

[Custom Application Development]

Spectrum's Application Engineering Services (AES) can assist in the development of your waveform or custom application software, including U.S. Department of Defense and ITAR-controlled projects. The scope of these services are tailored to the customers' needs, ranging from complete SDR-4800 subsystem development to support for SCA operating environment and waveforms.

[Product Lifecycle Support]

Product Lifecycle Support: Obsolescence management service and extended warranty plans minimize the impact of obsolescence and maximize your return on investment.

[Ordering Information]

Each SDR-4800 radio solution must be tailored to your program's needs. Spectrum will work closely with your team to understand your program and technical requirements.

Please contact Spectrum today. Email sales@spectrumsignal.com or call 1.800.663.8986 (North America) or 604.421.5422.

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