WHITE PAPER

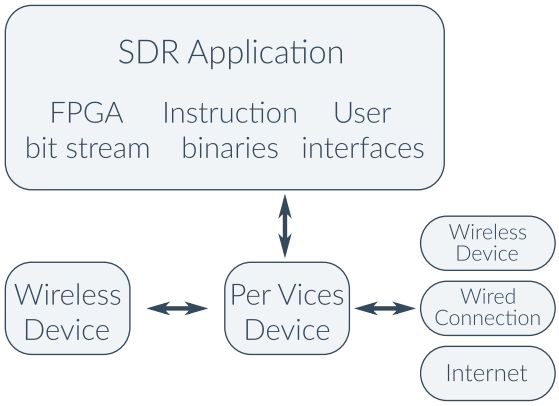
Per Vices Corporation

High Performance SDR for Radar Systems and Spectrum Monitoring & Recording

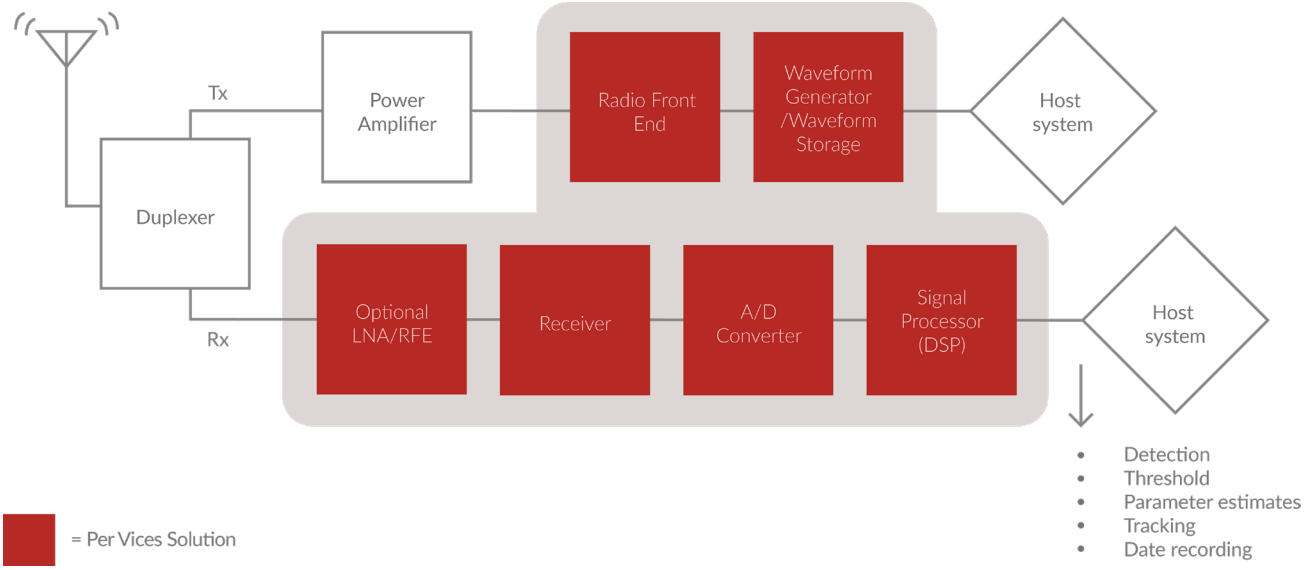
INTRODUCTION

Over the last several decades, there has been a lot of buzz around software defined radio (SDR). SDR are radio platforms that replace traditionally analog components for programmable digital components. With the recent advancements in SDR technology such as ease of integration, higher speeds and reliability, they have become an important consideration for radar systems. The ease of maintenance and set up of SDR's allow for seamless integration into any system. With the huge increase in radio traffic and the implementation of 5G, spectrum monitoring is an integral part of enforcing compliance with radio traffic regulations, both as a matter of national security, and for ensuring uninterrupted transmissions across all parts of the spectrum. A system providing flexibility, dynamic functionality, and ability to adapt and keep up with the exponential growth in technology is needed. Per Vices combined radio and storage solution provides real-time spectrum monitoring and recording and enables easy integration for clients, as a COTS solution. A large RF spectrum coverage and user adjustable bandwidth, combined with technology for seamless data capture, make detecting events quick and accurate. Multiple channels allow you to capture a wide amount of data, and tune into specific parts of the spectrum for further analysis and higher data fidelity. Combined with multiple options for data storage, Per Vices Cyan and Storage and Playback Solution is the top-of-the-line solution on the market for mission-critical spectrum monitoring and recording applications.

SDR USE IN RADAR SYSTEMS



RADAR BLOCK DIAGRAM



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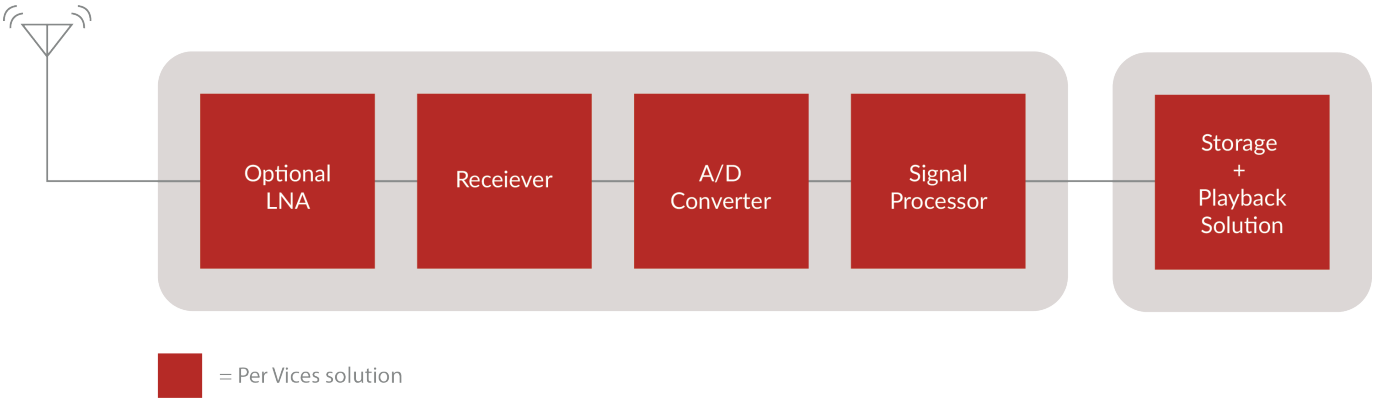
USE IN SPECTRUM MONITORING APPLICATION



SYSTEM ARCHITECTURE

The radar block diagram displayed (above) shows a typical set up for a radar system where SDRs are incorporated. By integrating SDRs into your system, you have a fully integrated product that contains both the transmit and receive functionality required with the phase coherency and stability needed. The setup involves either a single or multiple host systems with the ability to send arbitrary waveforms or trigger pre-stored waveforms, on the SDR, with the output to either a single or multiple 50Ω SMA connections. This can be directly connected to your required power amplifier and transmitted. With the same SDR, you can also receive the reflected data, over multiple receive SMA ports, with optional increased low noise amplification, and convert the RF data into the digital domain. The FPGA on the SDR can further perform additional DSP or pass the data through to a host system for further analysis with your radar software.

The system architecture shows a typical network for spectrum monitoring and recording. Everything starts with the radio chain. With Cyan, this offers 1 to 16 independent radio chains, each offering adjustable bandwidths up to 1GHz, where the higher bandwidth would be useful for wideband monitoring and a narrow bandwidth would be used for better SNR for specific signal analysis. The data is sent to the FPGA which allows for real-time analysis and streaming. It is also possible to upconvert and/or downconvert the signal if desired. Following any other DSP performed using the FPGA, the data is sent over 4 x 40Gbps ports to a Recording and Playback Solution where the ability to process the data from a greater number of channels allows for better IODT, geolocation and mapping with the use of software. The more channels, the more accurate geolocation positioning is, therefore allowing you to deploy resources to a location with confidence and save valuable time by not having to extensively search and approximate a signals' location.

TRADITIONAL VS. SDR

Traditional Platforms	SDR Based Platforms
Single application, would need to create a new platform for each applications	The same hardware can be implemented into many systems, developing code is inexpensive, and simpler than creating a new platform
Performance cannot be improved	SDRs can be tweaked, and different algorithms can be implemented to support newer standards
Limited frequency range	SDRs can be operated at multiple frequency bands simultaneously
Narrow bandwidth	SDRs offer very high bandwidths or can be adjusted in software for higher fidelity

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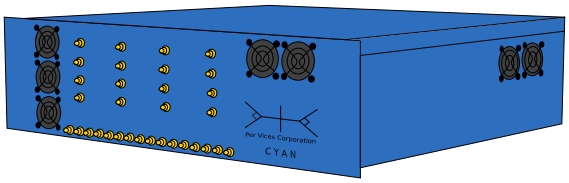
TECHNOLOGY FEATURES



PER VICES STOCK PRODUCT

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FIRMWARE

- Real-time data capture and analysis
- Supports 4x40Gbps data transfer
- Digital Up-Conversion and Down-Conversion done on platform
- Uses 8b10b encoding for in-band communication through control words
- On board data storage and transmission of arbitrary waveforms
- Signal processing can be handled using FPGA

SOFTWARE

- Can be tuned and configured remotely
- Open architecture for ease of use and upgrading
- Lossless data transfer from SDR to host system for an easy-to-deploy solution
- Support for latest Linux kernal drivers, mitigates large operating system induced latencies on most operating systems
- Can be managed remotely with numerous options for debugging and troubleshooting

HARDWARE

- Can operate at different frequency bands simultaneously with many independent radio channels
- Flexible radio front end for tuning to a wide frequency range
- High bandwidth for capturing as much data as possible
- Supports beam forming with control of multiple transmission ports
- Preliminary filtering through RF ADC's allows direct downsampling increasing reliability and reducing cost
- Can operate at different frequency bands simultaneously, such as L band (1-2 GHz) S band (2-4 GHz), and C band (4-8 GHz)

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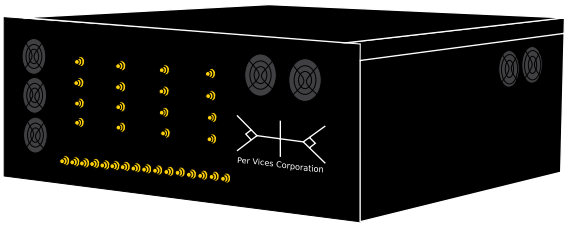

PLATFORM FOR CUSTOMER SPECIFIC APPLICATION

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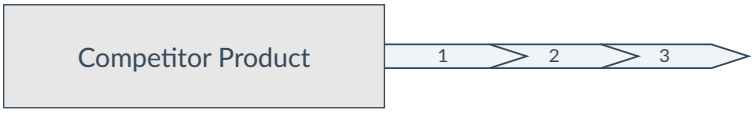
TECHNOLOGY READINESS LEVELS

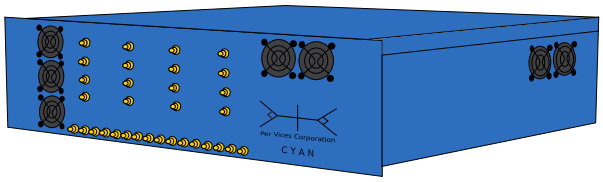
1. Basic Research
2. Tech Formulation
3. Proof of Concept
4. Lab Validation
5. Simulated Validation
6. Prototype System
7. Pilot System
8. Qualified System
9. Operational System

Technology Readiness Levels (TRLs) were established by NASA, and are used by government institutions and companies globally to enable uniform discussions of technical development and maturity across different technologies. Per Vices makes the only customer-validated SDR platform that supports manufacturers from ideation through full production.



The closest alternative to Per Vices products lacks flexibility, reliability and performance that customers require to develop wireless systems past the initial testing and Proof of Concept phase.

Customers Switch To Per Vices For:



- Maximum flexibility - the ability to continuously update requirements and specifications as the design is refined.
- Easy integration - built-in connectors and tools that securely link harwdare, data feeds, etc. into broader system design.
- Extensible performance - powerful, modular, software-driven features ramp up platform capabilities as needed. Per Vices products take you right from basic research all the way to the operational system phase on the TRL scale.

COMPETITIVE MATRIX

	Per Vices SDR	Component Providers	Application Specific SDR Providers	Test & Measurement Equipment Providers	Hobbysit SDR Providers
Integrated Platform	Yes		Yes	Yes	Maybe
Full Customizable	Yes	Yes			
Production Performance	Yes		Yes	Yes	
Software IP Support	Yes	Yes			Yes
Maintenance Support	Yes		Yes		

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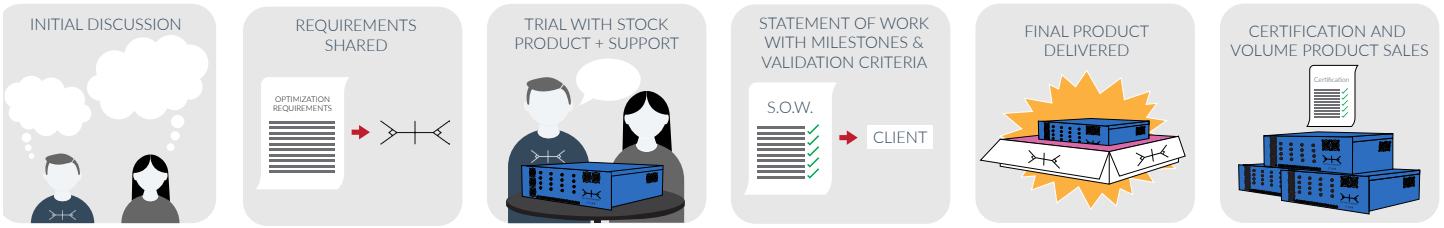
MAJOR DIFFERENCES

Traditional hardware-defined radios, with specialized analog signal processors, are single purpose and difficult to modify. In contrast, Software Defined Radios (SDRs) have more flexible signal processing components that are designed to run on high-speed embedded systems. Each SDR Application is an arrangement of the field-programmable gate arrays (FPGAs) on the radio working in place of the hardware components. Changing the SDR application changes the FPGA layout allowing the SDR to change it's internal behaviour as if it had a whole different set of circuitry!

TECHNICAL SPECS

Our Crimson and Cyan products can be a valuable component of any radar system. The products possess a very high receive sensitivity of -87 dBm, and the units impart very little noise to the system with a noise figure of 3.1 dB. The products also showcase their sensitivity through their dynamic range with an SFDR of 47 dB. This performance is not limited to a small operating range either, our products can have an operating frequency of anywhere from near DC to 6GHz and can be extendedbeyond up to 18GHz. This allows for flexibility across any radar band without sacrificing performance. These specifications allow for the optimal performance that can be expected from our products.

PER VICES COLLABORATIVE PROCESS



KEY POINTS

Per Vices is focused on delivering high-quality radios that are more commercially applicable - even for use in mission critical infrastructure. The application of our SDRs can have a tremendous impact on your radar system, increasing sensitivity and data throughput. With Cyan and Crimson, you can design a reliable, long lasting radar system that is easy to configure and update to suit your evolving needs.

WORKING TOGETHER

Please contact us at solutions@pervices.com to learn more about how we can help you. Following our initial discussion, our team will support you throughout the whole process, from a trial with a stock product, to developing out specific requirements for a statement of work, all the way to the volume integration and certification stage. Our engineers work with you each step of the way to ensure it's a smooth and easy integration of our product into your systems.

More information is available at www.pervices.com.
If you have any questions, please contact us at solutions@pervices.com.