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FPGA with Protocol Awareness & Onboard Processing RT Application

caseSTUDY: TCS009

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ABOUT INL

INL is part of the U.S. Department of Energy's complex of national laboratories. The laboratory performs work in each of the strategic goal areas of DOE: energy, national security, science and environment. INL is the nation's leading center for nuclear energy research and development. Their 890-square-mile laboratory includes unparalleled assets such as a utility-scale electric power grid for improving grid reliability and security; a wireless communications user facility (WNUF) available for commercial and government-sponsored research; and key capabilities for performing cyber and control system research, explosives impact analysis, armor development and radiological training.

INL Wireless National User Facility (WNUF) has unique capabilities which enables federal, industrial, and academic researchers to accelerate technology deployment of advanced wireless communication technologies to address national challenges within the National Broadband Plan for national defense, public safety, infrastructure security, communications interoperability, and spectrum utilization.

These are some of the Wireless/Cellular technologies being redefined at WNUF:

WNUF
leading the way in

Communications Interoperability

Infrastructure and Cyber Security

RF Spectrum Utilization

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PROBLEM

Working on the leading edge of emerging wireless technologies, WNUF must utilize test tools that are not readily available on the market. This requires them to define their own test tools via FPGAs. However, most FPGAs do not provide adequate flexibility when it comes to Input/Output (I/O) Protocol Awareness, and therefore, are not fast enough with onboard processing and real-time analysis.

CURRENT APPLICATION

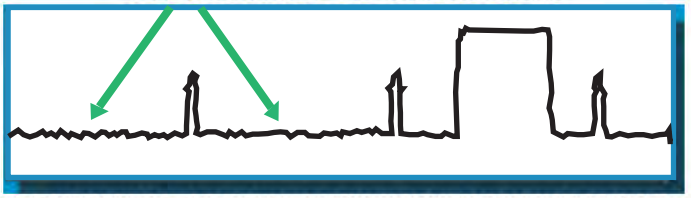
The solicitation went out to find the tests WNUF required to research, design, and test Cognitive Radio Networks (CRN), also referred to a "Smart Radio Networks". CRNs are an innovative approach to wireless engineering in which radios are designed with an unprecedented level of intelligence and agility. CRN radios have the ability to monitor, sense, and detect the conditions of the operating environment, and dynamically reconfigure their own characteristics to best match evolving present conditions.

CONVENTIONAL RADIO VIEW OF UNLICENSED RF SPECTRUM

RF SPECTRUM APPEARS AS A WALL OF INTERFERENCE

RF test instruments like a Spectrum Analyzer display how conventional radios view the RF Spectrum as congested and essentially unusable with heavy interference.

COGNITIVE RADIO VIEW OF THE SAME UNLICENSED RF SPECTRUM



RF SPECTRUM APPEARS AS WINDOWS OF OPPORTUNITY

WNUF required test tools that would enable their researched and designed Cognitive Radios to identify "unused gaps" in the congested RF Spectrum.

MINIMUM TECHNICAL REQUIREMENTS

- Reconfigurable FPGA
- FPGA O/S Windows
- I/O Bidirectional Channels (100 min)
- Logic Levels (LVDS, LVTTL min)
- Data Rate (500Mbits/sec min)
- Form Factor PXI/PXIe
- Bus PXIe
- LabVIEW environment
- Availability of an array of Adapter Modules

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TEVET SOLUTION

TEVET engaged directly with the engineering team at WNUF and conducted a full gap analysis to gain further insight into test challenges WNUF was facing and the requirements customers may have in the future.

Determining factors of the gap analysis for identifying the best FPGA COTS solution included selecting an OEM that offered a product that met the minimum technical requirements and that offered a full array of Programmable FPGA solutions as well as other PXI/PXIe solutions. In the end, TEVET concluded that National Instruments offered the best overall solutions.

Front View (without I/O Adapter)

Side View with Xilinx Kintek-7 Programmable FPGA

PXIe-7975R
NI FlexRIO FPGA Module for PXIe

- Xilinx Kintex-7 Programmable FPGA
- PCIe Gen 2x4 Interface to Host Controller
- NI I/O Adapter Modules or Custom Adapter Modules
- Logic Levels 1.2V, 1.5V, 1.8V, 2.5V, 3.3V, LVDS, LVTTL
- MAX Digital I/O Rate 1Gbits/s
- Form Factor PXI/PXIe
- Bus PXIe
- LabVIEW Programmable

The NI PXIe-7975R is part of National Instruments Award Winning line of products in the category of Programmable Logic (Electronic Design News, Innovation Award Winner). FlexRIO combines the latest high-performance ADCs and DACs with powerful, user-programmable FPGAs to help you push the limits of measurement and control. As sampling requirements for frequency and resolution continue to increase, implementing your algorithm on FPGA for real-time processing becomes essential.

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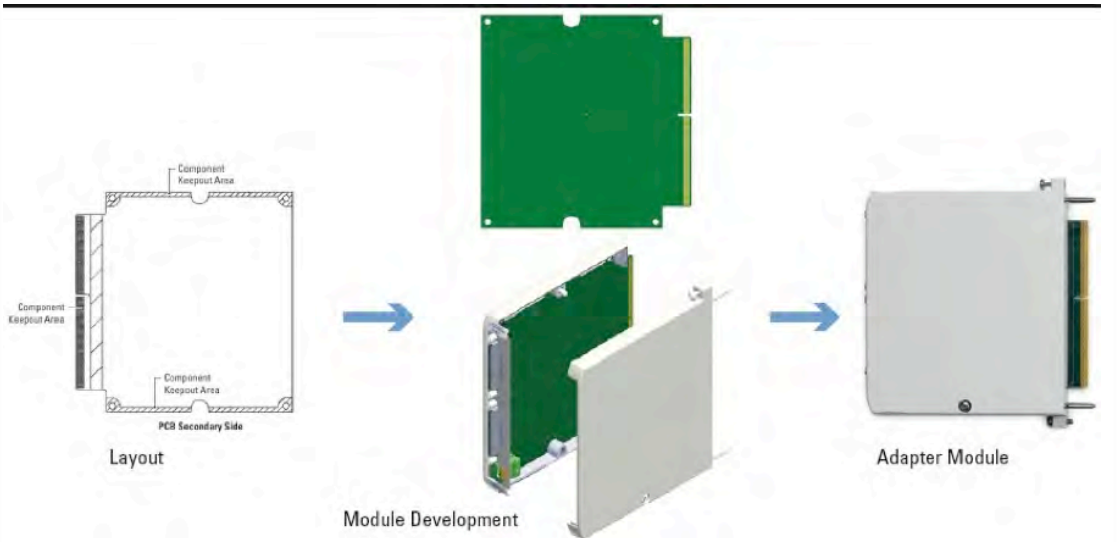
NI-FlexRIO line offers these advantages:

- Graphical System Design
- IP Libraries and HDL Code Reuse
- Rapid Algorithm Development
- I/O Protocol Awareness
- FPGA Onboard Processing in Real Time
- Full line of NI FlexRIO Adapter Modules
- Functionality with 3rd Party Adapter Modules
- NI FlexRIO MDK Adapter Module for end-user customization with your own PCB with design tools



FlexRIO MDK Adapter Module enables end-user custom I/O designs