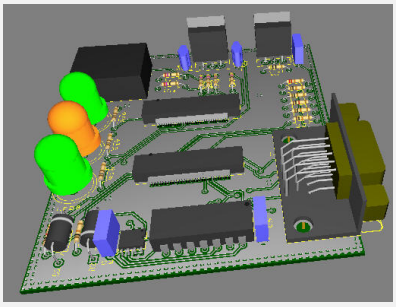
Rapid Design of a Military Communications System Using NI Technologies



Circuit design layout of our custom C-series module, modeled using NI Ultiboard

"Using CompactRIO, Multisim, and Ultiboard to prototype the design, we successfully prototyped the complete communications system in a month."

- Lionel Girod , STeP

The Challenge:

Developing an autonomous system to sample, digitize, and transmit audio signals over an Ethernet network to improve communication throughout a naval fleet of military boats.

The Solution:

Using the NI CompactRIO design platform to deploy a remote system that acquires audio signals, and NI Multisim and Ultiboard to define an application-specific custom I/O module to transmit over the communications user datagram protocol (UDP).

Author(s):
Lionel Girod - STeP

STeP, a National Instruments Alliance Partner based in France, specializes in creating test and automation systems using NI products. The company focuses on real-time and FPGA-deployed applications to quickly develop flexible and adaptable systems across multiple industries. With in-depth knowledge of NI products, including NI LabVIEW, DIAdem, and Multisim, STeP rapidly deploys test and data management systems for customers throughout France and Europe.

Improving Communication

A military group recognized our expertise in automation systems and asked us to develop a system that would improve the group's current communications system. Its legacy, analog-based system for communicating wideband signals, such as sonar, was important for military watercraft to effectively navigate through waters as a group. We proposed a digital solution to modernize the system for quicker and more accurate communication. The military group decided to use an Ethernet digital backbone, but it could not interface the analog signal acquisition, such as sonar and audio, to the digital network.

Our customer clearly stated that the new system needed to automatically acquire audio signals from various sources and transmit them via UDP, a protocol used to transmit signals through networked computers. Because of its universal nature that allows more users to receive data, UDP data transmission is preferred over more restrictive and specific protocols such as TCP/IP or SNMP in certain military applications. By implementing UDP and using an IP multicast technique, we can send a single packet of data, in this case audio signals, throughout an Ethernet network, and then the network can replicate and send the data to multiple recipients.

Within one month, we defined and prototyped a system that not only interfaced to the equipment acquiring wideband audio signals but also transmitted the data to the rest of the naval fleet via a new generation IP network.

Design Tools

To deploy a system that appropriately transmits data, we selected CompactRIO. The military clearly described the thermal and size requirements for this application, and the rugged and compact nature of CompactRIO helped us implement an effective application deployment. Using LabVIEW and the LabVIEW Real-Time Module, we quickly designed and deployed the underlying system architecture and algorithm onto the CompactRIO prototyping platform. Because the application responded to a continuous audio signal broadcast, we needed LabVIEW Real-Time to ensure real-time system responsiveness.

While LabVIEW Real-Time provided tremendous flexibility and easy-to-use design tools to design critical elements of the platform, there was no existing support for the data transmission over the universal UDP protocol in multicast mode within the software. Thus, we created a custom C Series module to facilitate the necessary data transfer over this protocol, which our customer required.

The system digitized the acquired audio signal, which was originally analog, via the NI 9239 C Series 24-bit analog input module. LabVIEW Real-Time appropriately processed the signal and then directly transferred the data to the custom module, which broadcasted it over a UDP multicast mode. This flexible architecture permitted a real-time, effective system.

As specialists in automation and test, this was our first experience with circuit design. However, the NI electronics design platform provided tools to quickly capture and prototype the module. The ease of use of NI Multisim helped us implement the schematic circuit capture, and NI Ultiboard was useful for the layout with the power and flexibility to address the module customization.

An Adaptable Design

Throughout the custom module development, it was important to create a modular design for future customization to a wide variety of designs. Our ultimate goal was to develop a design that not only could meet the military needs, but was also flexible and applicable to future deployments, such as protocols other than UDP. For example, this module is flexible enough to use to design an Ethernet POWERLINK CompactRIO module.

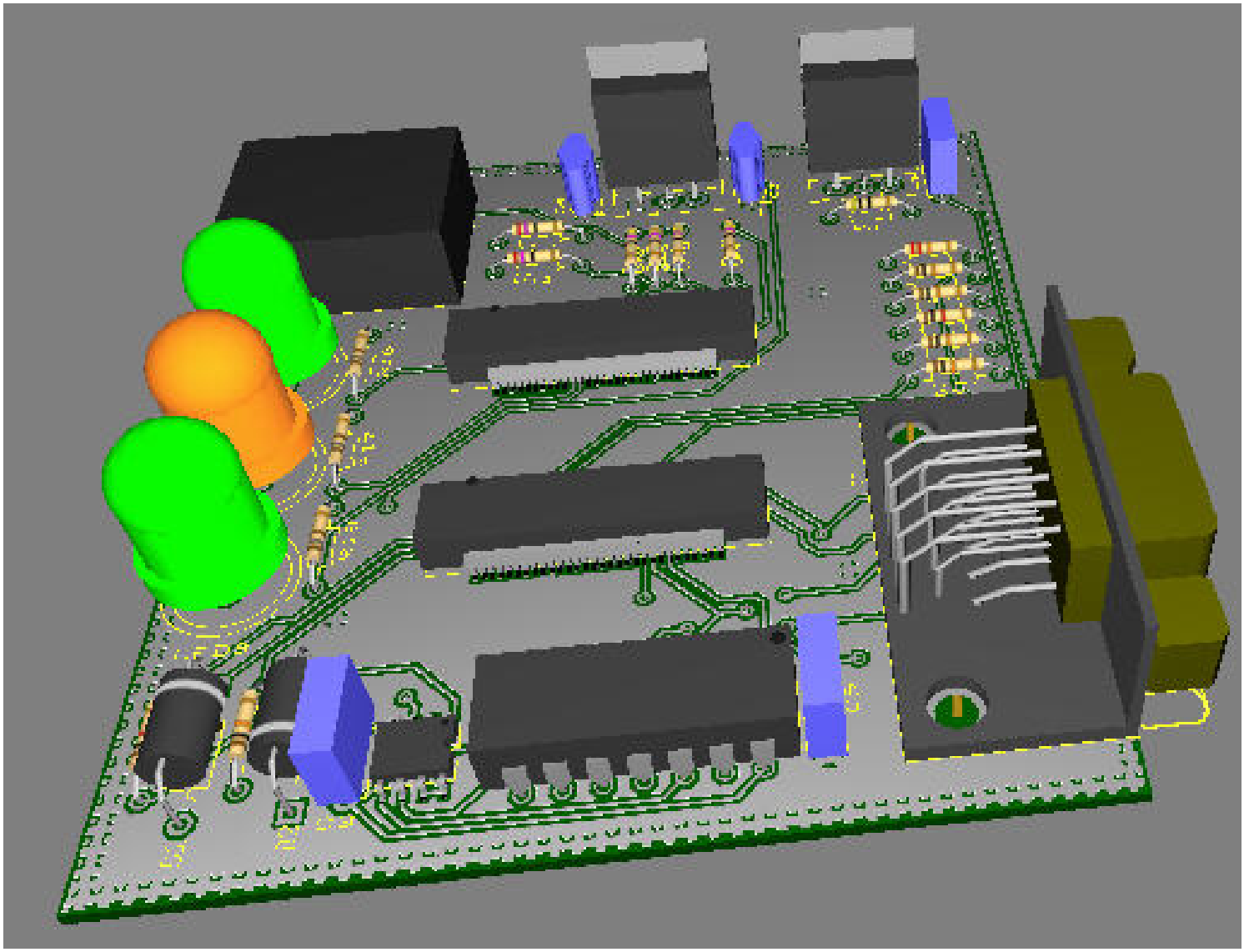
We designed the C Series module to include an embedded processor to apply firmware and quickly change the performance and characteristics of the design. Ultimately, we used the Analog Devices Blackfin digital signal processor (DSP) to create the flexible architecture. By changing the code deployed on the chip, we greatly broadened the communication protocols in which this custom C Series module could interface.

The Results

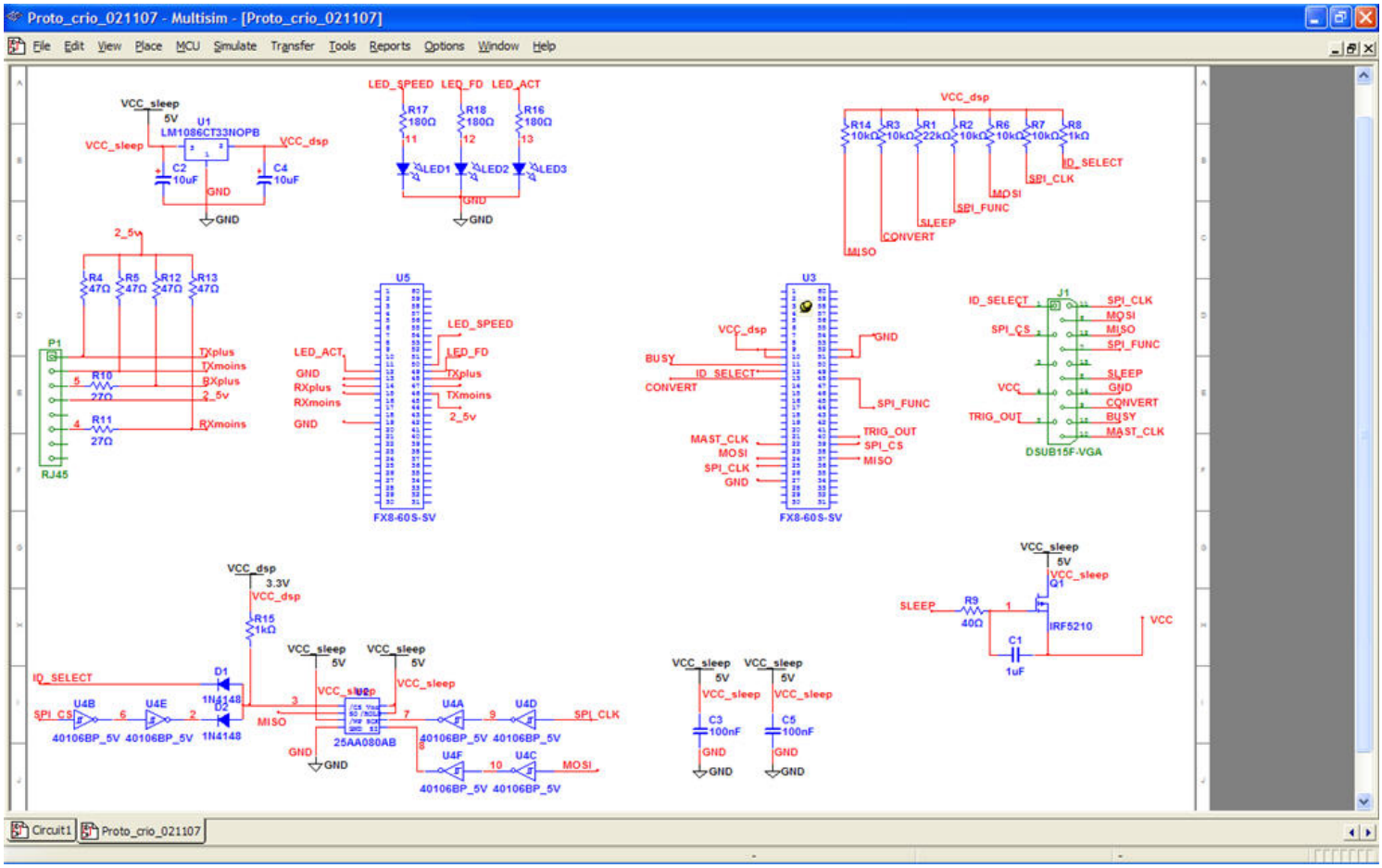
Using CompactRIO, Multisim, and Ultiboard to prototype the design, we successfully prototyped the complete communications system in a month. We delivered more than 10 major communications systems to our customer on time with successful system implementation. Due to the modular nature of the design, we programmed 30 additional systems for various future applications.

Author Information:
Lionel Girod

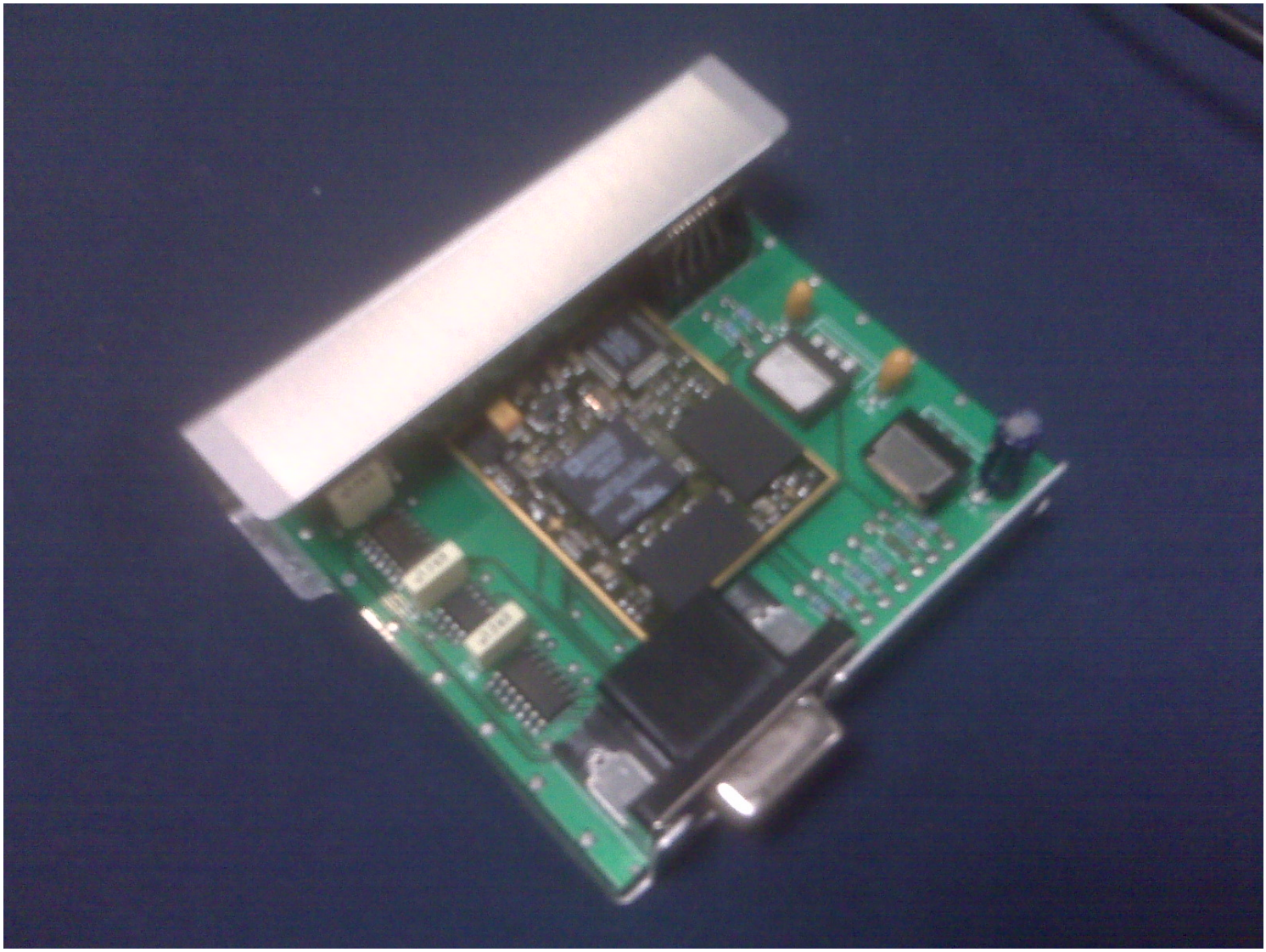
STeP
41 Rue des métiers, ZAC des Playes
83140 SIX FOURS LES PLAGES
France



Circuit design layout of our custom C-series module, modeled using NI Ultiboard



The C-series circuit board schematic, design using NI Multisim.



The actual circuit board designed for our C-series module.


STp
STp
Ethernet POWERLINK cRIO module
ST4P
41 rue des métiers- ZAC des plaines
93 140 SIX FOURS
FRANCE

The final deployed custom C-series module.