Digital signal processing (DSP) customers solutions

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Lyrtech Inc
Lyrtech Commitments and capabilities

Digital signal processing (DSP) runs the engines of today’s technology. Cell phones, MP3 players, car airbag sensors, and state-of-the-art medical diagnostic tools are just some of the sophisticated devices that are made possible through today’s high-speed digital signal processors.

Lyrtech has established 20 years’ leadership expertise in designing systems based on Digital Signal Processing technology. Lyrtech has three major offerings: DSP development platforms, engineering turnkey solutions, and DSP embedded products.

DEVELOPMENT PLATFORMS

The SignalMaster, Lyrtech’s line of development platforms, plays a vital role in the quality and feasibility of DSP technologies. Based on our own intellectual property as well as hardware and software from industry-leading partners, these off-the-shelf tools help technology manufacturers fast-track innovative products while holding down initial development costs. What’s more, the platforms are an important factor in Lyrtech’s growth and diversification strategy. We’re developing this line of products at the same time as our engineering and development services, and we’re concentrating our marketing efforts on high-growth niche markets such as wireless digital telecommunications and audio/video equipment. The key differentiators behind the SignalMaster line of products are:

- DSP and FPGA integration on the same board-level solution
- DSP+FPGA hardware-in-the-loop co-simulation and real-time implementation capabilities of TheMathWorks Simulink and System Generator models
- On-board unique Ethernet JTAG tool for debugging and communication through a LAN/WAN
- Access to multiple I/O interfaces (VIM-2, GPIO, Codec) and access to a large number of pre-packaged compatible I/O modules
- Access to all required low-level drivers and system-level toolboxes for use within Simulink for HOST, DSP-FPGA board-level solutions and I/O modules
- Access to reference designs for rapid development

The SignalMaster line of products includes PCI, cPCI and stand-alone DSP boards, high-performance DSP processors together with Xilinx’s VIRTEX series of high-density FPGAs. All products are also tightly integrated with MATLAB®, SIMULINK, and the RealTimeWorkshop (from The MathWorks, Inc.) system level simulation tools, as well as Xilinx’s System Generator Simulink-based FPGA design tool. Lyrtech’s platforms are targeted at offering demanding users in the embedded, communications and audio/video processing communities the tools they need in order to rapidly come up with solutions to their design challenges.

By combining industry-leading DSP and FPGA chips - along with a wide variety of add-on, high-speed data acquisition modules - in a single pipelined architecture, Lyrtech’s systems make it possible to simplify designers’ tasks. Data-intensive, repetitive signal processing functions (e.g., filters, FFTs, intense memory access, etc.) can thus be implemented in the beginning of the processing pipeline within an FPGA while the DSP remains free for Code/Math-intensive signal processing functions, or the ‘intelligent’ core of the application (e.g., compression, encryption, etc.).
Based on our long-standing DSP expertise and resulting intellectual property, we've devised competitive turnkey solutions that enable OEM customers to bring innovative products to market faster. We're positioned for revenue streams through the sale of technology licenses — and resulting royalties — and also by supplying components and marketing rights for the final products. By choosing a turnkey solution, OEM customers also benefit through cost-of-scale savings: easier component integration in complex products, shorter development cycles, and easier fulfillment. The engineering turnkey services are based on a solid and efficient project management infrastructure and on a highly competent engineering team. The engineering turnkey services supply organizations worldwide across a broad range of sectors as aerospace/defense, automotive/transport, industrial, and telecom to name a few.

**The Engineering Turnkey Process**

- Assign the right Lyrtech expert to the application.
- Analyze the requirements and define the needs.
  - Key driver: IP (intellectual property) developed over multiple projects enables faster solutions to complex challenges, innovative design approaches, and faster time-to-market.
- Provide input and innovative ideas in the design stage.
  - Key drivers: insight into architecture-specific CPUs, memory and power optimization.
- Provide high level prototyping, modelization, and solution validation.
  - Key drivers: expertise in DSP and FPGA processor architectures; long-term experience with TI’s Code Composer Studio and Analog Device’s Visual DSP++.
- Finalize hardware design
- Manage the manufacturing lifecycle
- Deliver after-sales support

**The Simulink environment allows a developer to quickly create a valid test bench to verify hardware functionality early in the design process**

**Integrate legacy C/VHDL code and create new IP in a graphical model**

**Generated code for both DSP and FPGA is portable to lower-cost, lower power devices (Fixed-point TMS320C6x TI DSPs and Xilinx Spartan FPGAs)**

**Speed up implementation through Simulink-based DSP and FPGA code generation**
DSP EMBEDDED PRODUCTS

For more than 10 years now, Lyrtech has provided hands-on expertise in digital signal processing to major aerospace and defense research centers around the world including the Development and Research Defense Canada centers (DRDC). And we’re now extending the experience gained in defense applications to the automotive, consumer electronic, and industrial control sectors.

Past experiences

Lyrtech’s broad industry and DSP/FPGA expertise has assisted clients worldwide with custom consulting projects. Following is snapshots of just a few of these projects where clients have leveraged Lyrtech’s in-depth knowledge in order to meet their specific objectives.

Brian Jones, RICE UNIVERSITY

“I’m impressed by Lyrtech’s vision. Their hardware/software development platform enables a smooth transition from host to DSP/FPGA. By working on the host, I can quickly develop and debug new algorithms, using Simulink’s graphical features with Microsoft’s Visual C++ debugger. Then, I can quickly move that algorithm from the host to the DSP/FPGA using the Lyrtech's Gateway blocks. I appreciate the ability to develop where it's easy, and then implement in a low-power, standalone environment.”

Scott D. Briles, LOS ALAMOS NATIONAL LABORATORY

“The availability of Commercial-of-the-shelf (COTS) and modular systems, as well as Lyrtech Hardware in the Loop (HIL) product mindset, oriented our choice toward their high performance system. Compared to other solutions, Lyrtech's solution is way ahead! Using their integrated solution, we will be able to better focus on our customers' needs and requirements, significantly reduce time and costs and lowering overall project risks.”

Adnan Al-Adnani, PANASONIC-UK

“After using the demo system, I can appreciate how easy it is for software development and rapid prototyping.”
A) Los Alamos National Laboratories

The Challenge
To develop a proof-of-concept prototype that uses modulated reflectance to reduce power requirements for battery-dependent wireless devices. Like any proof of concept, time was of the essence. The proof of concept had to insure that the functional model was appropriate for high-end FPGAs.

The solution
Use MATLAB and related Lyrtech’s software toolbox to build and validate a rapid prototype of the modulated reflectance-based technology using Lyrtech’s SignalMaster and AdacMaster II products.

The decision time was reduced by 70%. Time to market was also reduced significantly since access to already existing development platform was available. Another benefit was that the data collection and analysis was accessible from a single environment.
B) Communication Research Laboratory (Yokosuka, Japan) User Story

The Challenge

The CRL (Communication Research Laboratory), a governmental-based research institution attached to the Ministry of post and Communication in Japan, in collaboration with researchers from the TAO (Telecommunication Advancement Organization, Yokosuka, Japan) and Matsushita, wished to have a system to conduct airborne research on array antennas. Array antennas are multiple element antennas which allow higher band-with wireless communication.

The requirements for the system were:

- 16 high-speed (0-10 MHz) high-precision (14 bit) channels.
- Data-logging of data snapshots (or frames) of up to 4K sample
- Simulink-based acquisition process.

The system would be mounted on a helicopter to conduct experiments.

The solution

Lyrtech supplied such a system to CRL, which was used in experiments conducted in summer of 2002. Figure I shows the overall system and it’s mounting on a Kawasaki BK117 Helicopter.

The experiment permitted to acquire experimental data in the context of evaluating DOA (Direction of Arrival) algorithms. These algorithms are a basic function of array antennas while allowing estimating the angular direction of the other transmitting system. This value is used to “beamform” the antennas pattern in order to point electronically and have maximum gain in the direction of the other system, which can be mobile. Continual evaluation of the DOA then allows tracking the mobile.

Figure 1 – CRL System
C) Okayama University

The Challenge
The customer requirement consisted in developing a real-time FPGA-DSP based multi-channel control system for a neural network robotic system. There needed to be 16 channels acquired at 1 kHz. One particularity was that overall processing needed to be done at 1 kHz within the 1 msec sample time. Very fast FPGA processing was desired while high-ratio over sampling would be used to supply data to the FPGA process. In addition, the overall process would have to be Simulink-based (Real-Time Workshop for DSP target and Xilinx’s System Generator for FPGA target), either in term of modeling or real-time execution.

The solution
The proposed solution was based on a SignalMaster with a third party (Diamond Systems) 16 channel analog PC-104 I/O card. The card was inserted on the General purpose Pentium class processor bus, which would run the Diamond driver card. An interrupt-driven background acquisition process would acquire the data, and transfer it to the DSP, which would then transfer it to the FPGA for fast processing.

D) ITT - Aerospace and Communication division

Project Title: Active remote sensing

The Challenge
ITT’s ARS team had to develop a proof-of-concept prototype of active remote sensing system using a passive hyperspectral imager that can detect, locate and track a gas plume under real environmental conditions. ITT has been working on developing algorithm for DSP/FPGA target system using MATLAB/Simulink. They were looking for a complete hardware-in-the-loop system to verify algorithm on real hardware.

The solution
Using Lyrtech DSP/FPGA based development platform fully integrated to Simulink, they were able to run their algorithm in real-time. It also allowed them to generate optimized C and VHDL codes using software tools from third party to target TI DSP and Xilinx FPGA. The result was so concluding that the complete solution was a proof-of-concept itself. They saved over 70% of time in their development cycle.
E) British Navy - DAPSIII

The Context

The AN/AAR-47 MWS is a passive Missile approach Warning System that is installed on modern transport aircraft and helicopters. The system is designed to provide warning of Surface to Air Missiles (SAMS) and pass information to countermeasure systems.

The AN/AAR 47 MWS consists of four sensors, a central processing unit and a control indicator, as shown.

Lyretch has been involved in the development of the DAPS (Digital Acquisition and Playback System) for nearly 20 years. The DAPS System is used to record optical sensor signals and threat declaration data from the AN/AAR-47 Missile Warning System and perform signal playback of real or synthetic signal data to the AN/AAR-47 MWS Computer Processor (CP).

The DAPS is used, among other things, to identify the signatures of signals that trigger false alarms on the AN/AAR-47 MWS system.

A newer generation of the DAPS system, the DAPS III, was recently designed by Lytech to overcome the limitations of its predecessors and introduce new features.

The Challenge

A newer generation of the AN/AAR47 sensors is now being commercialized by its manufacturer. This newer generation of sensors offers additional threat detection information on laser-guided missiles and is based on a new communication architecture that is a radical departure from the original communication protocol. Support of the newer generation of sensors was required by scientific teams who need to remain at the leading edge in the development of countermeasure systems.

The new serial communication protocol operates at the limit of the bandwidth offered by the serial communications link. The DAPS III System is designed to “tap” communications exchanges with up to six of the newer generation sensors at a time, demanding fast response and very high bandwidth support. The DAPS III system had to meet the challenge of supporting and emulating serial communications performed by high-cost dedicated hardware.

The predecessor of DAPS III was designed as a EISA card designed to be operated on a PC equipped with an EISA-Bus. PC Platforms equipped with EISA-Bus being obsolete, it was getting more difficult to find equipment able to support the original DAPS platform. Our clients wanted a platform that would run on newer hardware architectures and remain current as architectures evolve, by providing some form of hardware-independence.

Some field tests require that the DAPS III be placed in remote locations. In those circumstances, the bulk of a PC-based setup is sometimes undesirable. Comparative testing may require that multiple DAPS system operate in parallel to acquire a single threat event. Operation in parallel of multiple DAPS systems may be required in those circumstances.
The DAPS III was designed to support newer versions of the AN/AAR-47 sensors AND to also support the legacy AN/AAR47 MWS system and sensors. This means that the DAPS III system can simultaneously acquire data from up to six Pulse Count (legacy) and six Message Count (newer) AN/AAR-47 sensors, and acquire communications between the Computer Processor and Control Indicator for both types of systems.

The DAPS III system is designed against obsolescence, as a stand-alone Internet Appliance. Communications between the host computer and the DAPS III unit is done through standard Ethernet protocols. The DAPS III units acquire data autonomously on-board, using a removable disk. Data can rapidly be transferred to the host PC for analysis, either through the Ethernet link or a commercially available PC removable disk reader. The DAPS III can run in a stand-alone configuration, without any host PC intervention. The large storage available for acquired data being sufficient for multiple runs in field tests.
The MathWorks System-level Communication demo

The MathWorks, producer of MATLAB and Simulink, which are industry leading system-level and DSP design tools, wished to showcase in partnership with Lyrtech their products on a DSP and FPGA based communication system development.

The requirement consisted in being able to acquire and transmit RF signals between 0.5 and 29MHz.

Solution:

The SignalMaster DSP/FPGA architecture was a suitable choice. Using the onboard Audio Codec, the customer was able to transmit music and voice from a CD player.

The TI DSP was used for Audio processing (reverb, compression), AM modulation/demodulation and AGC (Automatic Gain Control). A Xilinx Virtex-II was also used for passband processing of data (frequency translation, high-speed DDS, CIC and FIR filtering).

An high-speed AD/DA add-on module was also used to interface the antenna. One particularity of the system is the truly software radio nature of the system where no front-end RF IC were used. This demo will be showcased, notably, during fall 2003’s Programmable World events.

AM/FM demodulation

The customer wished to conduct DSP/FPGA-based communication system development. The requirement consisted in being able to acquire signals at 10-20 MHz range, perform AM or FM demodulation and downsampling, transmit base band data to a DSP for further processing and output in a sub 100KHz codec for audio output.

Solution:

The SignalMaster DSP/FPGA architecture was a suitable choice. One particularity of the system is that base-band clocks were non-standard, e.g. 48 or 44.1 KHz multiples and features a completely end-to-end synchronous approach.


3. Telephony Training System - LAB-VOLT

Lytech supplies to Lab-Volt (Québec) on an OEM basis the basic DSP/FPGA board for LabVolt’s Telephony Training System (TTS). The system allows students to study the operation of modern telephone networks and digital private automatic branch exchanges (PABX). The TTS is built upon the Reconfigurable Training Module (RTM). This module, which uses state-of-the-art digital signal processor (DSP) technology, can be programmed to act as different parts of a telephone network. Interface cards that students install in the RTM allow connection of real analog and digital telephone sets and trunk lines.

- The Matlab/Simulink environment and the TI, Xilinx tools are used to develop the Lab-Volt telephony applications at a system level.
- The RTM is the main telephony module into which the SignalMaster SBC6x is installed, and it accepts the telephony interface daughtercards for analog line interfaces, digital line interfaces, etc. and the RTM will be used for future telecom/wireless interfaces that are to be developed.

4. Alter speech signals in real-time: University of California in San Francisco

The 'C67x-based SignalMaster is used to alter speech signals in real-time. UCSF researchers use this in experiments where they alter how subjects hear their own speech, and look at how they change their speech production in response to the altered feedback.

These experiments are part of a general research program looking at the role of auditory feedback in speech production.

5. Yamaha PC audio Chipsets

LYRtech chosen for its world-class digital audio expertise, collaborated to design of OPL3-SA and derivatives (DS1 chips):

- Embedded on Intel, Acer & Toshiba motherboards
- Over 100 Million units sold
- Innovative use of high-level tools
  - FPGA development / ASIC retargeting
• Reduced development time
• Facilitates communication on an international development team

**6** TI DA610 Home Theatre OEM Board for Texas Instruments - Sony

- Designed for Texas Instruments, based on the C6711 DSP technology architecture.
- Concept demonstration of a plug-in Home Theatre Processor board, using SONY receivers as a compatibility reference:
  - Design while chip was still under development
  - Integrated Home Theatre processing software: Dolby / DTS /AAC
  - Demonstrated a low-cost/high integration of the DA610 in a compact, 2 layers board