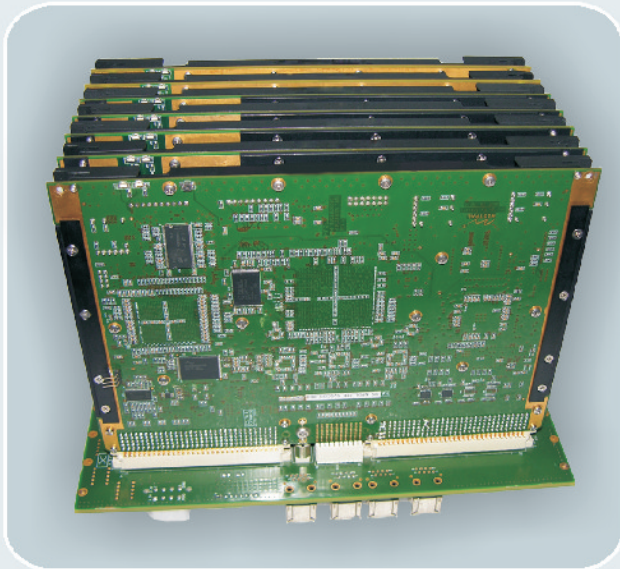# Multi-channel Data Acquisition and Processing System

Introduction

This case study is a showcase of Mistral's capability in the design, system integration and deployment of a network-based high-performance multi-channel Data Acquisition & Processing System intended for Naval Applications.

> A complete Distributed Data Acquisition System capable of providing high configurability, high accuracy data acquisition

The Customer

The customer is a leading Defense Organization from India involved in Research and Development.

The Requirement

The customer approached Mistral to develop a multi-channel Data Acquisition and processing System capable of providing high configurability, high accuracy data acquisition. The system had to be designed with a modular approach to make the system compatible for use in various naval projects. The design also needed to achieve precision synchronization of sampling clocks in the networked system. The following were some of the key requirements of the system to be built:

- Data Acquisition system on a customized backplane supporting
  - 128/256 channel system
  - Synchronization of all the channels
- Transmitter system on a customized backplane to act as a data simulator
- Control Interface - Run time re-configurable data acquisition receiver and transmitter systems
- Multiple System Synchronization
- System supporting high throughput ports for data transfer
- System needed to operate in an Air tight environment.

Solution Provided

Mistral offered a network-based solution for the multi-channel Data Acquisition and Processing System. The system provides 128-channel acoustic data acquisition developed using 24-bit Delta Sigma ADC. The system supports Dual Redundant Gigabit Ethernet for transmitting the acquired data and one dedicated management port (Gigabit Ethernet) for system configuration and diagnostic purpose. Synchronization capabilities allow all channels of multiple processing units to sample synchronously.

Key Features

- Virtex-5 FPGA used for data acquisition and data transfer over gigabit Ethernet
- Supports up to 128 channel using four 32 channel, 120KSPS, 24-bit Delta Sigma ADC cards

- High-speed serial link protocol used for data communication between ADC and Controller cards
- Dedicated slots for each ADC card to accommodate pre-amplifiers and filters as per customer's need
- Supports manual and automatic gain control (-40 to +80dB)
- Supports Digital Down Conversion and Digital Up conversion for high frequency signals <100dB+ dynamic range
- Fully Differential Sensor and Test Input channels
- Highly configurable system that supports programmable sampling rate, channel numbers, Ethernet packet transmission parameters, etc.
- Dual redundant configurable FPGA based GbE Port of data transmission
- Dedicated management port for system configuration and system health monitoring
- 64MB on-board memory support
- FPGA based synchronization scheme designed for multi-system synchronization.
- Conduction-cooled System Design
- Built-in test feature with programmable data patterns
- Operating Temperature Range: -20°C to +70°C.

The Challenges

- Maintaining the required optimal temperature within the Data Acquisition systems was a considerable challenge as these are closed units. The team needed to design a conduction-cooled system that dissipates 170Watts of power
- Typically, Data Acquisition systems capture only the strong signals. The team had to design a very high Dynamic Range ADC card, which would allow the system to acquire even weak signals
- The system had to provide for Multi-Gigabit Serial Connectivity interface for management and data interface
- The entire designing had to be done to meet the stringent Environmental and EMC requirement defined for Naval Applications

- Precision sampling synchronization had to be achieved across multiple systems
- Designing customized backplanes that was flexible to handle both the Receive and transmit systems
- Designing the various boards to ensure the signal integrity of the high speed serial interface as well as gigabit Ethernet data for communication between the boards over the backplane
- Developing the firmware for complete functionality while ensuring flexibility to accommodate future upgrades.

Key Achievement

- Mistral's team built a complete Data Acquisition System solution from concept to deployment, meeting the challenges in the process
- The team also successfully built a customized mixed-signal Backplane that carries both Gigabit Serial lanes and sensitive sensor signals
- Achieving Multiple System synchronization to ensure data acquisition is synchronized within the acceptable timeline
- Developing a conduction cooled system that is able to transfer heat efficiently to the chassis and maintaining the temperature of the cards within acceptable limits
- Building of the UDP Core and being able to achieve better than 600mbps data throughput
- Mistral developed the complete VxWorks BSP and test application software for the system.

Customer Benefits

- The customer leveraged Mistral's proven expertise in development of data acquisition systems
- The feature-rich & highly configurable architecture of the multi channel Data Acquisition and Processing system provides the customer with a quick-turn around
- The flexibility of the system allows the customer to be able to use it in various other programs.