



Radar Controller and Processing Unit (RCPU)

Introduction

The Radar Controller and Processing Unit (RCPU) is a radar sub-system providing resources for Radar Signal Processing, Radar Data Processing, Radar Controller Functions and Radar Data Recording.

The RCPU consists of the following line-replaceable units (LRUs)

- ▶ Signal Processor Unit (SPU)
- ▶ Data Processor and Controller Unit (DPCU)
- ▶ Radar Data Recorder Unit (RDRU)
- ▶ Power Distribution and Control Unit (PDCU)

This Case Study highlights Mistral's expertise in the architecture and design of the signal processing unit for the radar sub-system to meet the requirements of data processing.



“ This case study showcases Mistral's expertise in the architecture and design of the Signal Processing Unit for the RCPU to meet the data processing requirements. ”

The Customer

A leading Defense Lab selected Mistral to design, build and integrate a system capable of functioning as a Radar Signal Processor.

The Requirement

The customer's requirement was to design and integrate a solution that meets their overall functional and performance criteria; while adhering to the longevity, product lifecycle management and integration norms. The solution had to meet the following requirements:

- ▶ Equipment mechanical dimension constraints: 1500mm x 550mm x 474mm (Width x Depth x Height)
- ▶ Radar Signal Processor:
 - 6U VPX COTS product based on PowerPC
 - Support for sFPDP based communication
 - High-speed communication channels between boards
 - Power supply unit consisting of DC to DC converter modules and a filter module to cater to the system needs of +3.3v, +5v, +12v and -12v.

Solution Provided

Mistral is a professional design services company with extensive experience in embedded hardware and software development for Mil-Aero applications. This capability, in conjunction with partnerships with leading embedded solution providers like Curtiss-Wright and Wind River Systems, enabled Mistral to provide a complete solution to meet the customer's specific requirements. Mistral developed a system comprising of the following components:

The RCPU enclosure was made of light; non-ferrous material to withstand and sustain the extreme environmental conditions that it will be exposed to.

The RCPU enclosure consists of the following:

- ▶ Signal Processor (SP) LRU
- ▶ Data Processor (DP) LRU
- ▶ Wide Band Recorder (WBR) LRU
- ▶ Power Distribution & Control Unit LRU
- ▶ Connectors in the right side panel of RCPU enclosure
- ▶ Liquid cooling Mechanism for the LRUs inside the RCPU enclosure
- ▶ Isolated platform for the LRUs to negate the Vibrations and shocks from the RCPU enclosure
- ▶ Power status indicators of the LRUs.

The Signal Processing LRU consists of:

- ▶ Liquid cooled Chassis for conduction cooled VPX boards
- ▶ Customized VPX backplane
- ▶ Customized Power Supply Unit consisting of DC to DC converter modules and a filter module to cater to the system needs of +3.3v, +5v, +12v and -12v
- ▶ Customized Front Connectors Panel to connect signals from VME64x boards
- ▶ Radar Signal Processor based on five 6U VPX COTS based Quad Dual Core PowerPC Processor boards, each having an XMC site
- ▶ VPX Fire Blade Ethernet Switch to communicate with external sub-systems and intra board communication
- ▶ XMC site populated with sFPDP card.

Design Services and System Integration:

Mistral was involved in the design and development of the entire system from the initial phase of system architecting, to component selection, system engineering and validation. The solution offered included:

- ▶ System Design
 - System Study with report generation to ensure all the operational environmental conditions and performance requirements were met. This included the complete 3D computer modeling of the system, system power consumption calculations, system cooling calculations, system structural analysis, system thermal analysis and external/ internal cable harness
- ▶ Hardware Design
 - Design and development of:
 - VME Based IO translation card
 - VME based GPS and Clock module
 - Seven Slot VPX backplane
 - Sandwich board
 - Front panel IO connector PCBs
 - Complete cable harness design
- ▶ Integration
 - Integration of all boards within the system; and establishing functional capabilities of base card, inter- and intra-system communication, HA validation, GigE network establishment, Inter Processor Communication with inter- and intra-system dependencies
 - Integration and testing of COTS and custom designed hardware
 - Integration of drivers, BSP, DSP libraries and system monitoring programs provided by our solution partners

- ▶ Verification and Validation
 - Design and validation of ATR for a high-power application, with thermal management
 - Rugged systems adherence to ground based application - All boards supplied cater to the requirements of JSS55555 and MILSTD416E.

The Challenges

- ▶ The design of the cooling system for a complex system like the RCPU was a challenge. This was addressed by using liquid-cooled cold plates as an ideal high-performance heat transfer solution
- ▶ Designing and fabrication of seven slot VPX backplane with full mesh fabric connection between five slots while maintaining high level of signal integrity
- ▶ Conformance to environmental conditions including thermal management, structural rigidity, EMI/EMC conformance.

Key Achievements

- ▶ Incorporation of liquid cooling in the side walls of the LRUs to provide an effective cooling system. This is one of the first designs wherein Liquid Cooled Cold Plates were used for cooling the LRUs
- ▶ Various key elements of the system were built indigenously at Mistral, This includes, the seven slot VPX backplane, VME based Translation IO card, Sandwich backplane for I/O termination, Front Panel IO boards, Cable Harness creation and routing plan for the same
- ▶ Customization of GPS module for VME form factor. Mistrals design team adapted a non-standard COTS module to conform to the VME form factor by designing a board that will host the GPS module without any modification to the original GPS module
- ▶ Complete integration of the LRUs that used two industry standard bus architectures VPX and VME. The system realized with two different operating platforms (Linux and VxWorks)
- ▶ Establishing optical links for sFPDP and Fiber Channel and Gigabit ethernet network for external and internal network
- ▶ Designed an intelligent power distribution box that will regulate optimum power supply to the units and regulates temperature sensors to prevent over heating
- ▶ The system designed to withstand solar radiations, Vibration and shocks that the unit might receive during transportation and operation of the Radar, Operation of the system in extreme weather conditions like rain, snow, high humidity and high temperature environments like desert
- ▶ Provided the end user with complete software development tools on Linux and VxWorks operating systems, also provided optimized signal processing libraries for SP LRUs
- ▶ System designed meets requirements of JSS 55555 and MIL STD 416E Specifications.

Customer Benefits

- ▶ A multi-vendor selection of best-of-breed sub-systems was made available as an integrated system through a single system integrator; who not only provided the solution but would also provide support and maintenance for the coming years
- ▶ Shortens customer's end-to-end product development cycle and ensured on-time deployment schedule
- ▶ A fully integrated deployable solution, thoroughly verified and certified for deployment, and compliant with functional and environmental standards was made available.



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