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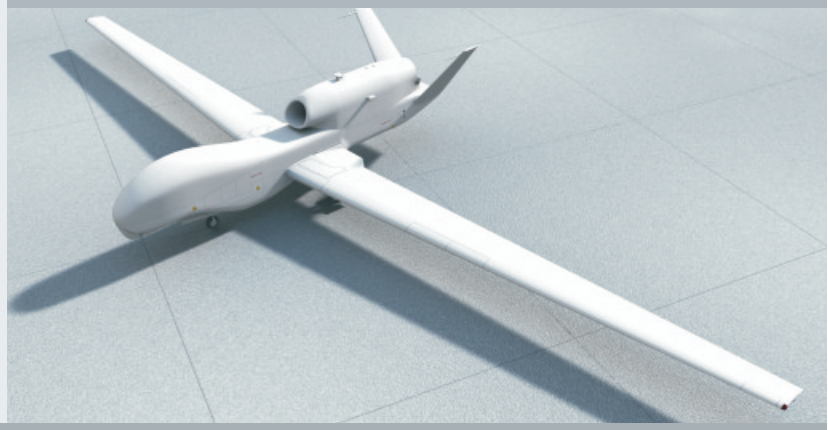


Design and Development of High-Definition, Rugged Digital Video Recorder

Introduction

Digital Video recorders are employed in several demanding defense and homeland security applications like Airborne Video recorder systems, Real time Data acquisition systems, Telemetry systems and Video surveillance systems & security solutions. They are expected to be rugged, small, lightweight systems capable of multi-channel HD video recording with playback.

This case study showcases Mistral's expertise in designing a flexible and easily upgradeable Video recording & processing solution with high resolution and frame rate for defense and aerospace applications.

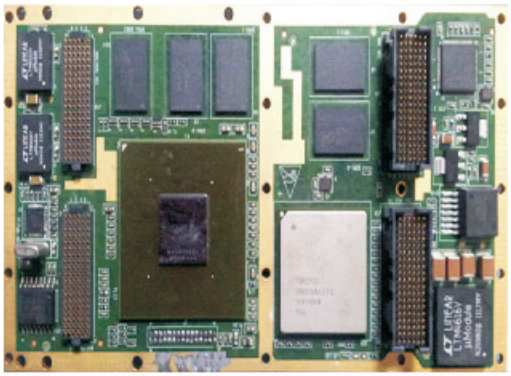
> "This case study showcases Mistral's expertise in designing a flexible and easily upgradeable Video recording & processing solution with high resolution."

The Customer

The customer is a privately held company with business activities in the telecommunications, defense and contract manufacturing domains. These include sales and support of wireless communication, radar and communication systems, design and manufacture of identification friend or foe (IFF) systems, microwave tactical data links and flight management systems for unmanned aircraft systems (UAS).

The Requirement

The customer approached Mistral to design and develop a Digital Video Recorder (DVR) solution for airborne applications. The unit would have to prove reliable and long term (8- 10 hrs) functionality under the most severe conditions. For the current application, the Digital Video Recorder units had to be fitted at three locations - Remote Station, Ground Station and Viewing Station.



The solution provided had to meet the following requirements:

- A small form factor, High definition Video processing Engine supporting HD-SDI, HD and SDI formats
- Conduction based Cooling system to protect against external and internal heat generated
- MIL-STD-810F qualification for temperature & vibrations
- MIL-STD-461D/MIL-STD-462D for EMC.

The DVR unit mounted on the UAV (remote station) was expected to capture and encode multiple UAV cameras inputs (HD-SDI, HDI, SDI). The encoded data had to be converted to Analog signals before being transmitted to the ground station. The DVR unit in the ground station had to decode the received signal to display for immediate viewing. The same data had to be also sent via Ethernet to the Viewing station where the captured data would be studied in detail and stored for future reference.

The DVR had to perform Encode, Decode and Transcode operations for the following video compression formats: H.264, MPEG2, MPEG4 SP/ASP in 1080p video resolution

Solution Provided

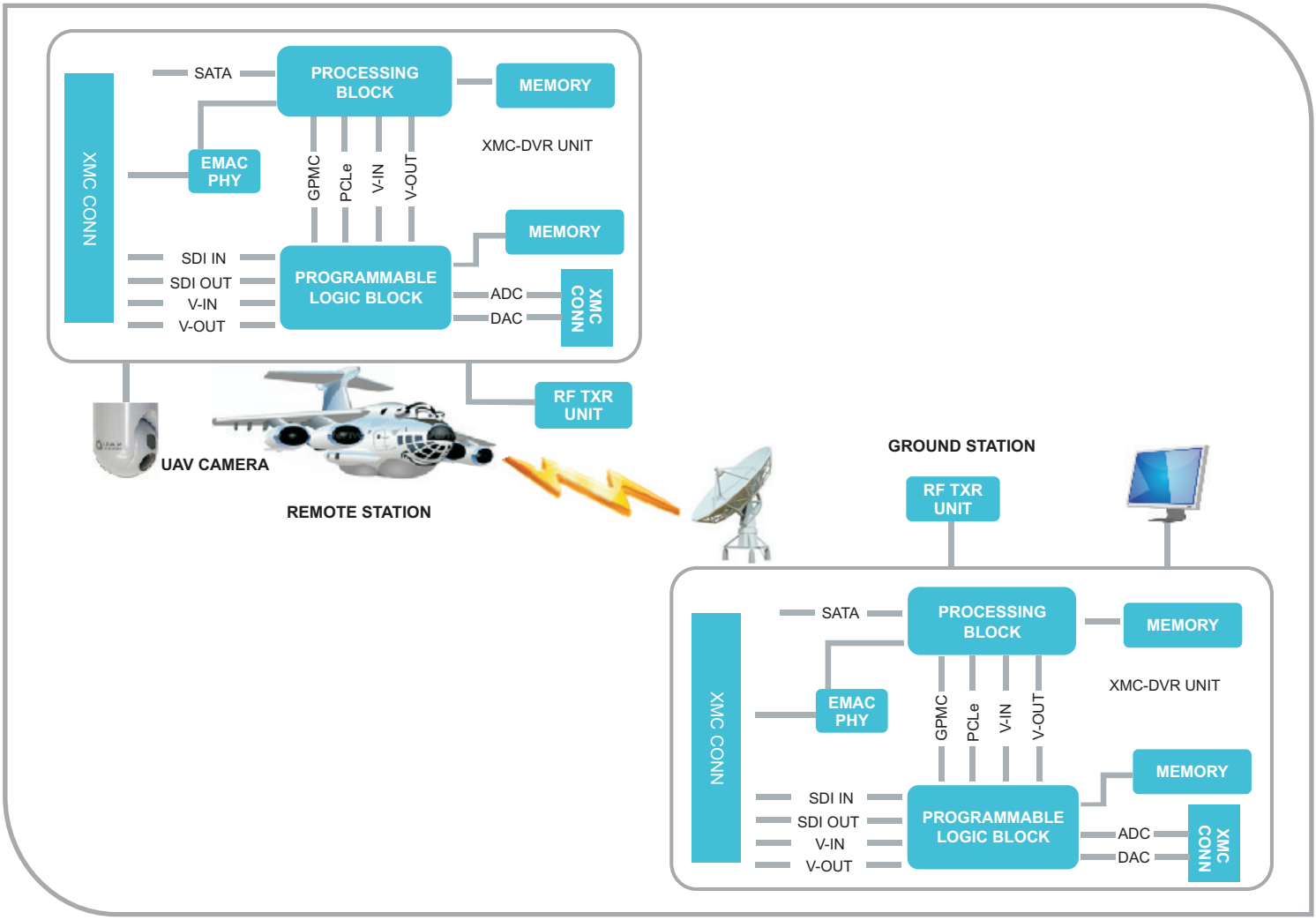
To meet the customer's small form factor requirement for the DVR, Mistral provided an XMC based video processing unit based on TI's DM8168 Video processor & Arria II FPGA from Altera. The compression/decompression and encoding is performed by the processor and the FPGA is the transceiver. The FPGA video input on the Remote station DVR unit receives raw video from the UAV camera & transmits it to the processor. The Processor encodes the video along with other flight data parameters and packetizes the data for transmission. The FPGA interfaces with the host processor through PCIe and receives the packetized data which is sent to the RF link over DAC interface.

The FPGA in the Ground station DVR unit receives the RF signal which is demodulated and retrieved using ADC. For decoding, the data is packetized and sent to the processor over the PCIe link where the video, audio & flight parameters is separated from the packet. The Video bit stream is further processed for storing using SATA interface & for displaying using HD-SDI out interface.

The team at Mistral worked on the design, development and verification of Hardware and firmware, system analysis for thermal & mechanical constraints, integration and validation of TI media framework and pre-qualification tests for MIL STD compliance.

Key features of the system are provided below:

- Hardware
  - TI's DaVinci Processor for High speed, multiple video inputs Altera Arria II FPGA
  - Dual 10/100 Ethernet interface
  - 1GByte DDR3 SDRAM
  - SATA interface
  - PCIe interface
- Software
  - U-Boot, Linux kernel
  - Linux device drivers for SATA, PCIe, Ethernet, Audio, Video inputs and outputs



- FPGA
  - 3G-SDI, HD-SDI and SD-SDI video Interface
  - DDR3 Interface
  - PCI Express 1.0 Interface
  - Remote System Upgrade

The Challenges

Hardware Implementation

Cooling System: With a large amount of heat being generated both internally and externally, it became important to protect the system from damage. Mistral's team fitted the unit with a Thermal and Conduction cooling system to address this challenge.

Small Form Factor: Considering the application of the unit as well as the various functions of the processor, the size of the unit had to be compact and light-weight. To address this challenge, Mistral used an ultra small XMC form factor design.

MIL standard compliance for Temperature & vibration

FPGA Implementation:

Video Format Analysis and Dynamic SD video conversion: As the unit had 6 camera ports which could detect different camera inputs, it was necessary to enable auto analysis and dynamic generation of the requested video format to the processor. Mistral had to design the unit with FPGAs that would facilitate different video interface support to the system.

Soft Modem Logic: As it would be easy for external sources to intercept critical data while being transmitted, Mistral had to implement soft modem logic on the FPGA for advanced security. This would make it difficult to interpret the data being shared between the stations.

Compatibility and Auto detection of 3G-SDI,HD-SDI and SD-SDI

Auto RX Clock: To further enhance security and to make it difficult for data interpretation by external sources, Mistral programmed the FPGA with Auto RX clock generation for UART with respect to the Baud rate.

Remote Factory Firmware Upgrade: With the UAV being constantly in motion, regular upgrading of firmware was a challenge. Mistral enabled the option of remote factory firmware upgrade on the FPGA which could be controlled and upgraded from a ground system.

Key Achievements

- Achieved XMC dimension in a 16 layer PCB.
- Built the XMC-DVR unit to withstand severe temperature conditions with an operational temperature between -20 deg C to +65 deg C.
- Obtained 8 to 16 bit conversion of SD video for processor compatibility.
- Enabled AUTO Generation of requested video resolution to the Processor.
- Achieved AUTO Recover FPGA firmware which enabled upgrade remotely.
- With less overhead, Mistral was able to achieve 2 Gbps PCIe throughputs.

Customer Benefits

- Leveraged Mistral's expertise of small form factor development and received a lightweight, XMC form factor solution.
- The entire system comprised a compact unit, integrating both interface and conferencing, thereby, saving on BoM and production cost for the customer.
- Mistral being a single source for hardware and software expertise offered the client an end-to-end solution with a quick-turn around and with no compromise on quality.

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