vadatech Ltd.
THE POWER OF VISION

SOLUTION BRIEF

Dense FPGA Processing Engine

High Bandwidth Interconnects And Powerful FPGAs Provide Dense Sensor Processing Engine

Overview

FPGA-based processing is often used in airborne sensors, where space and weight are at a premium. This Solution Brief describes one such processing platform supplied by VadaTech. In this application, multiple sensor inputs are fed into a highly connected FPGA cluster and the result output over Ethernet. Being a mil/aero application, it was originally assumed that the most appropriate platform would be VPX, but in this instance a MicroTCA solution provided both size and cost benefits.

Requirement

The processing unit is required to house up to five Virtex-6 FPGAs (e.g. XC6VSX475T), each supported by a large local memory. Since there is a large amount of data sharing between the FPGAs, they need to be interconnected by high-bandwidth links capable of supporting raw data rates up to 25Gbps. Data input will be via FMCs, to allow the specific sensor interfaces to be implemented.

While the data rate from the processor is reduced as a result of the processing carried out, it is still substantial, and two 10GbE ports are to be used to provide an aggregate raw output rate of up to 20Gbps. A host GPP is used to carry out post processing and to manage data flow onto the network. A quad-core QorIQ processor is selected for this, the P4080, since it provides strong processing capability and includes hardware acceleration for networking tasks.

The space envelope is severely constrained and the

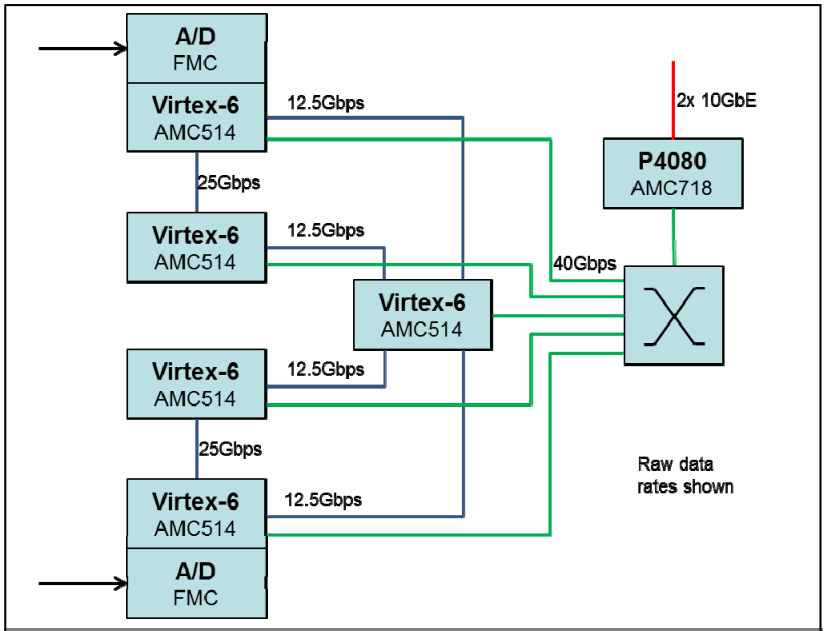

Figure 1: Processing Architecture

Figure 2: VT899 6-Slot Chassis

complete processor sub-system cannot exceed 7U in height. To be compatible with the air platform systems, the processor must have front-to-back airflow, with any necessary plenums fitting within the height constraint.

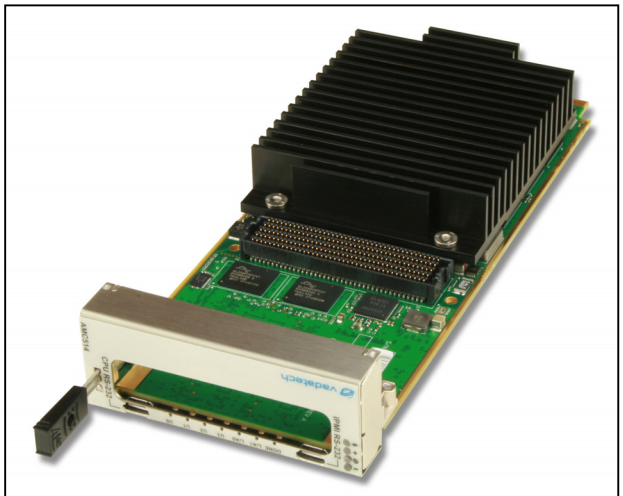

Figure 3: AMC514, Virtex-6 FPGA with FMC site

Solution

VadaTech provided a solution based on MicroTCA architecture, giving all the benefits of an open standard COTS solution in a package only 5” wide and 9” deep.

As well as base (GbE) and switched fabric (PCIe, SRIO or XAUI) interfaces, the MicroTCA standard incorporates an ‘extended options’ region that supports high-speed point-to-point connections. The chassis used in this system, the VT899, uses these pins to provide data paths between AMC slots capable of supporting up to 25Gbps raw bandwidth. (See Figure 4.) These pins are routed to Aurora connections on the Virtex-6 FPGAs housed on AMC514 modules. The connectivity provided lends itself to a high-bandwidth processing pipeline where a level of data reduction happens in the initial processing stage. VadaTech offers backplane customisation for the VT899, allowing other processing architectures to also be supported.

Table 1: VT899 Features	
5” x 7U x 9” deep	Compact
Supports full-size AMCs (6 single– or 3 double-width)	Supports up to 80W dissipation per AMC , depending on environment
26-layer high-speed back-plane	Highly connected between AMC sites
No active components on backplane	Reliable and serviceable
Front-to-back airflow	Suitable for aircraft installation
Optional integrated mains power supply	Ease of use

The VT899 supports up to six full-height AMCs. Five of these slots have the high-speed point-to-point connections, but not the sixth. This final slot is used to house the host processor, in this instance an AMC718, which is based on the QorIQ P4080 processor. All FPGA slots are connected to the host processor via the PCIe switch incorporated into the MCH, which provides x8 connection to each slot.

Innovation

Dissipating heat from power-hungry FPGAs can be a challenge. The VT899 supports full-height AMCs to allow for larger heat-sinks than would be possible with mid-height

modules. In addition, the AMCs are titled by 5°; this small tilt assists airflow in the entry and exit plenums and is vital in fitting the required thermal performance into a 7U chassis. Failure to incorporate this innovation would require the chassis size to increase to 8U for equivalent cooling performance.

The chassis incorporates redundant carrier locator and FRU information devices, enhancing reliability. Unusual for MicroTCA chassis but common for VadaTech units, the backplane contains no active components.

Other features of the VT899 - JTAG Switch Module to ease FPGA programming and optional integrated AC power supply - make the chassis particularly useful for development.

The AMC514 supports a range of Virtex-6 FPGAs, allowing users to balance processing power against cost and thermal constraints. The module also has an optional P1020 integrated into the unit. This on-board 'host' makes the module very versatile, supporting intelligent FPGA load and initialisation functionality. This can significantly reduce the workload on the system host and improve system boot times.

The MCH used in this system, the UTC002, is unique on the market in providing two front-panel 10GbE connections. In this configuration, this feature allows the customer to achieve a very well-structured data flow, as shown in Figure 1. The two ports can be channel-bonded together to support data rates up to 20Gbps (raw).

Applicability

Dense FPGA-based processing is used in a broad range of commercial and defence applications, being common in;

- Image reconstruction and analysis
- Radar/sonar
- Network security
- Medical (tomography)

The example shown here is just one such application where processing density is particularly important, coupled to the ability to support custom interfaces for sensor input.

Table 2: AMC514 Features	
Xilinx Virtex-6 FPGA	Highly capable FPGA processing resource
VITA-57 FMC site	Flexible I/O with broad range of COTS products available
Choice of FPGA and speed	Optimise price/performance per application
Up to 4GB DDR-III memory	Large, fast on-board data
Optional P1020 processor	Local intelligent

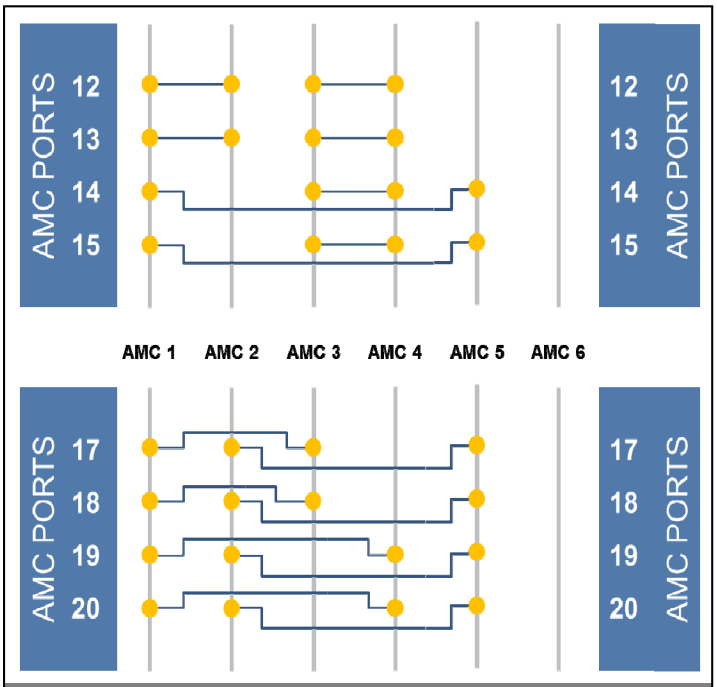

Figure 4: AMC Extended Connectivity

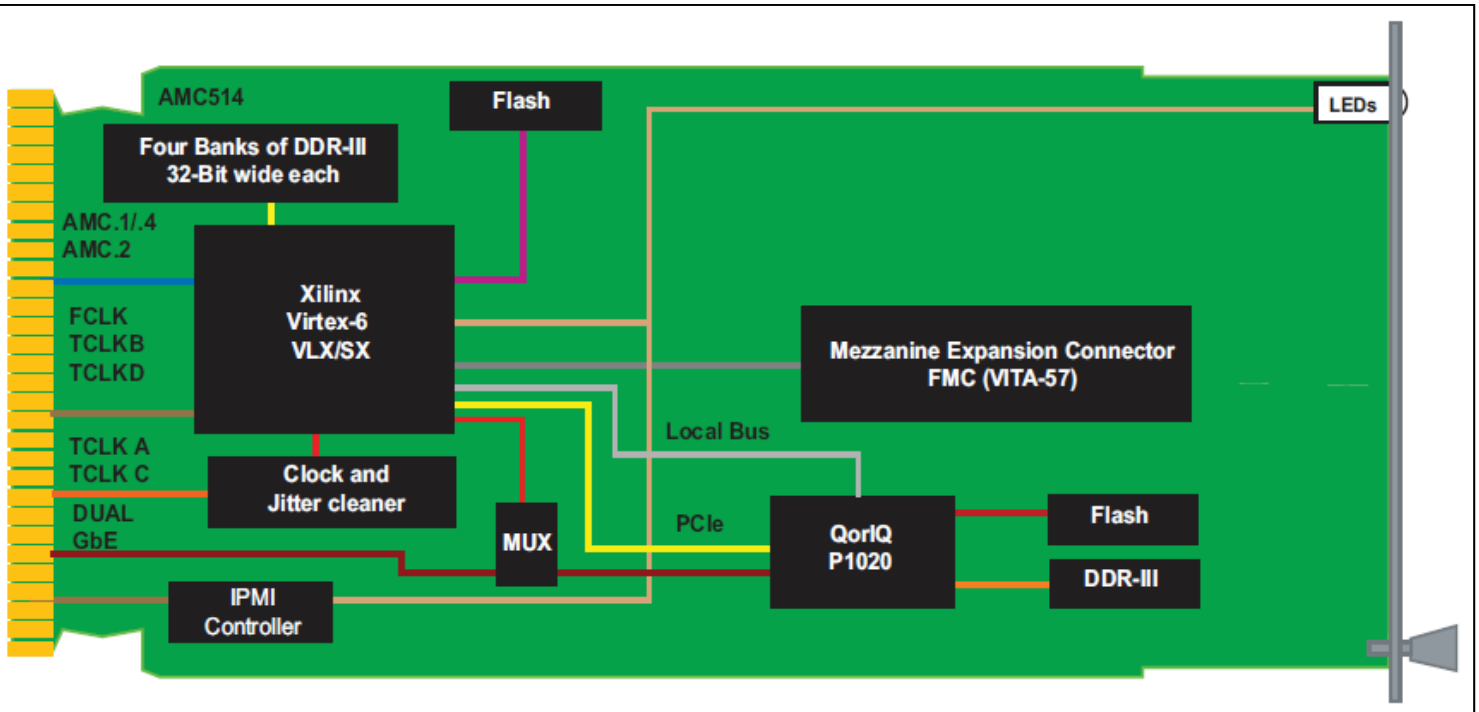

Figure 5: AMC514 Block Diagram

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