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A Service-Oriented Platform for embedded monitoring systems in the Belle II experiment.

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uSOP is a general purpose single board computer designed for deep embedded applications in control and monitoring of detectors, sensors, and complex laboratory equipment. In this paper, we present its deployment in the monitoring system framework of the ECL endcap calorimeter of the Belle2 experiment, presently under construction at the KEK Laboratory (Tsukuba, J). We discuss the main aspects of the hardware and software architectures tailored on the needs of a detector designed around CsI scintillators.

Summary

uSOP is a Service-Oriented Platform designed for deep embedded applications in controls and monitoring of detectors, sensors as well as complex research instruments. It is a single board computer (Fig.1) with a Eurocard 3U form factor. It is based on the AM3358 (1 GHz ARM Cortex A8 processor), equipped with standard microSD flash memory card reader, USB and Ethernet interfaces. On-board RAM and solid state storage allows hosting a full LINUX distribution including GNU compilers, tools, libraries, a window system, as well as documentation and software frameworks for specific user tasks. The board supports SPI, I2C, JTAG and UART interfaces, all of them galvanically isolated and each equipped with a separate supply to power remote sensors and

acquisition resources like ADCs, DACs, digital I/O expander, optocouplers. Non-isolated digital I/Os allow the user to benefit from the Programmable Real time Units (PRU) available in the processor and from the sophisticated event capture and timer peripherals.

Aiming at embedded applications, uSOP has been designed to offer resilient, low maintenance performance in harsh, limited access environment. The most critical system-level operations can be performed remotely by means of a specific LAN connection operated independently by the main processor. Such an approach allows the user to reset and power cycle the board, to flash the operating system on the storage unit and/or boot from the network, to redirect the system console on the LAN in order to troubleshoot hardware and software issues.

The Belle II experiment is presently being installed at SuperKEKB e+e- collider in Tsukuba (Japan). The detector is designed to operate at a peak luminosity 40 times higher with respect to the former Belle experiment. Following the original Belle design, the Electromagnetic Calorimeter is divided in a barrel and two anular endcap regions. CsI(Tl) was chosen as the scintillation crystal material in all regions, due to its high light output at an affordable cost. The two endcaps are made of 2112 CsI(Tl) crystals, arranged in 32 sectors.

CsI(Tl) scintillator light yield does change with temperature (about 0.3%/℃ at 20℃) and crystals are strongly hygroscopic and they can be severely deteriorated by long time exposure at high humidity levels. Each sector is equipped with three thermistors and an active humidity probe for a total of 128 analog channels (96 themistors and 32 Rh probes). In the BelleII slow-control framework, temperature and relative humidity will be monitored by a uSOP-based system.

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