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uSOP: a microprocessor-based Service-Oriented Platform for Control and Monitoring

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We present a Service-Oriented Platform (uSOP) designed for deep embedded applications in controls and monitoring of detectors, sensors as well as complex research instruments. uSOP is a single board computer based on the AM3358 1 GHz ARM Cortex A8 processor and it is equipped with standard uSD, 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, 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 on board power grid has been segmented in order to provide the cleanest supply to the acquisition peripherals. The noisy digital domains are powered with high-efficiency Point-Of-Load switching regulators while linear regulators decouple the more demanding high-speed I/Os like USB and Ethernet. Thermal shutdown, over-current and short-circuit protection are guaranteed by design for safe operation in hazardous area. The PCB design has been tailored to achieve EMI immunity, including ground planes and rings to shape the current return paths.

In this contribution we present and discuss the main aspects of the hardware and software design of uSOP, including details of the EPICS framework porting and application design. We show the tests done with state-of-art Delta-Sigma 24-bit ADC acquisition modules designed for this platform, assessing the noise level, ease of software development, CPU and network loading. uSOP is the backbone of the control system of the endcap electromagnetic calorimeter of the Belle2 experiment, presently under construction at the KEK Laboratory (Tsukuba, J). We present our experience in the design and deployment of this demanding control infrastructure.

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