National Instruments' CompactRIO-Based Control, Monitoring, and Interlock Systems

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National Instruments' CompactRIO (cRIO)-based control, monitoring, and interlock system for detectors can be used either as the primary or as the backup system. This note describes the layout of a cRIO system and shows how it differs from EPICS-based systems.

The cRIO system's hardware architecture, Fig.1, consists of a chassis, I/O and relay modules, power supply, a reconfigurable FPGA, and an embedded controller, which can be programmed in LabVIEW, C/C++, or Java.

FIG. 1. cRIO system inside National Instruments chassis.

Typically, monitored detector signals are voltages, currents, ramp rates, temperatures, humidities; purities, flow rates, and pressures of fluids; and vacuum levels.

Signal levels are *controlled* by setting limits. If *monitored* signal values are outside set limits, corrective action is taken to adjust the signals to be within limits, or the instrumentation is powered off, i.e. *interlocked.*

A cRIO system, Fig. 2, obtains signals via *hardwired* connections to detector sensors and instrumentation, which in turn are hardwired to the detector (red lines). cRIO systems can be configured to send process variables to EPICS via Ethernet (black lines), using the standard cRIO/EPICS interface.

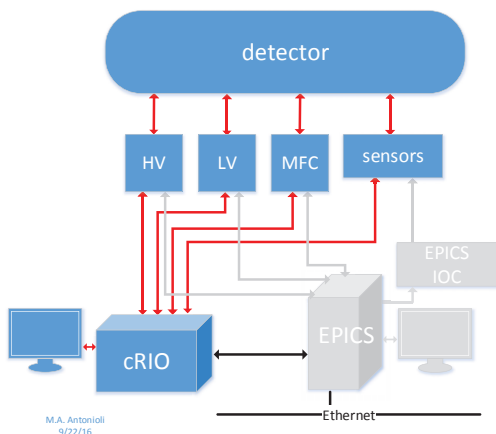EPICS systems can obtain signals from the cRIO, Fig. 2, or via either a hardware or software EPICS IOC, bypassing the cRIO, Fig. 3. The disadvantage of this system is its dependency on the network. Network error probability should be taken into consideration when designing control, monitoring and interlock systems.
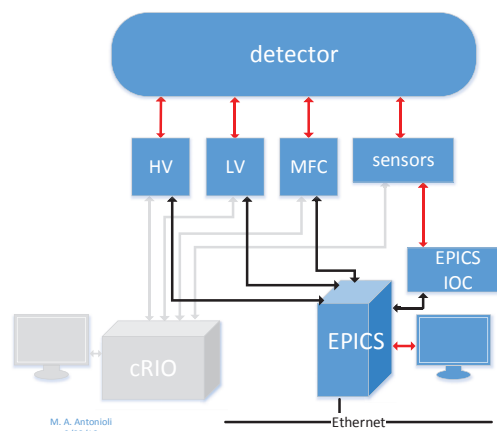

FIG. 3. Block diagram of an EPICS control, monitoring, and interlock system. Red lines indicate hardwiring and black the Ethernet.

cRIO systems do not require network connectivity. It is this feature that makes cRIO control, monitoring, and interlock systems invaluable.

The Detector Support Group uses both EPICS and cRIOs, usually with the EPICS system as the primary and the cRIO as the backup, Fig. 4.

FIG. 2. Block diagram of a cRIO control, monitoring, and interlock system. Red lines indicate hardwiring and black the Ethernet.
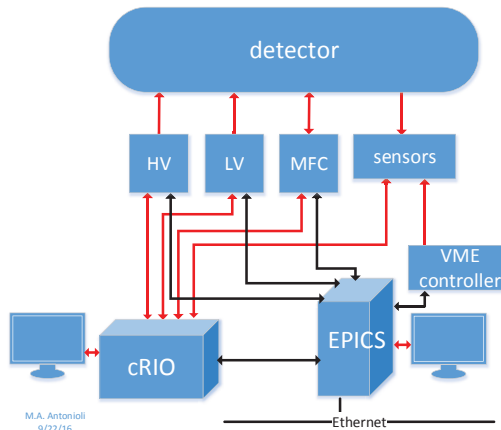

FIG. 4. Typical control, monitoring, and interlock system, using both a cRIO and EPICS.