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Integration of advanced data acquisition applications using FPGA-based FlexRIO devices in ITER's CODAC Core System

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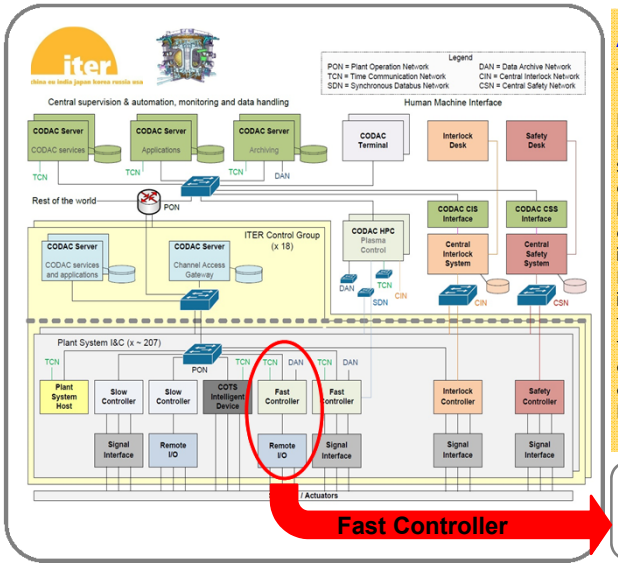


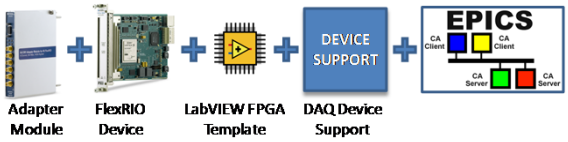
ABSTRACT

The aim of this work is to present the development and integration of advanced data acquisition (DAQ) applications using Reconfigurable Input Output (RIO) FPGA-based devices in ITER's Control, Data Access and Communication (CODAC) Core System (CCS). CCS is the software distribution built by the ITER Organization for the developers of plant system controls. Compared with traditional DAQ systems, the use of Reconfigurable Input Output (RIO) devices drives a methodology change of the design model and brings the system designer the capability to fully customize the functionality with a high performance and a reconfigurable architecture. National Instruments (NI) FlexRIO devices are part of ITER Catalog of I&C products for Fast Controllers [1] developed using PCIe/PXIe technology. The integration of this hardware with EPICS [2][3] is relying on the common interface that the Nominal Device Support (NDS) supplies. NDS is a software layer that provides a device handling standardization in CODAC, simplifying the development of EPICS device support. The design methodology proposed in this work covers: a) modeling in LabView-FPGA the behavior of the DAQ hardware b) exporting the functionalities for interacting with the hardware to ITER's CODAC Core System (CCS) [4] c) the creation of the low level communication interface to the device using the NDS abstraction layer and the connection with the corresponding EPICS records and d) the built of the main software element of EPICS, the Input/Output Controller (IOC). DAQ example using FlexRIO PXIe796x devices with digital I/O (6581) adapter module is presented as basic use case of integration with ITER's CCS.

- **PXIe form factor for Fast Controllers.**
- **Totally integrated with EPICS.**
- **Simplifies the design of high performance DAQ systems based on fully reconfigurable FlexRIO.**

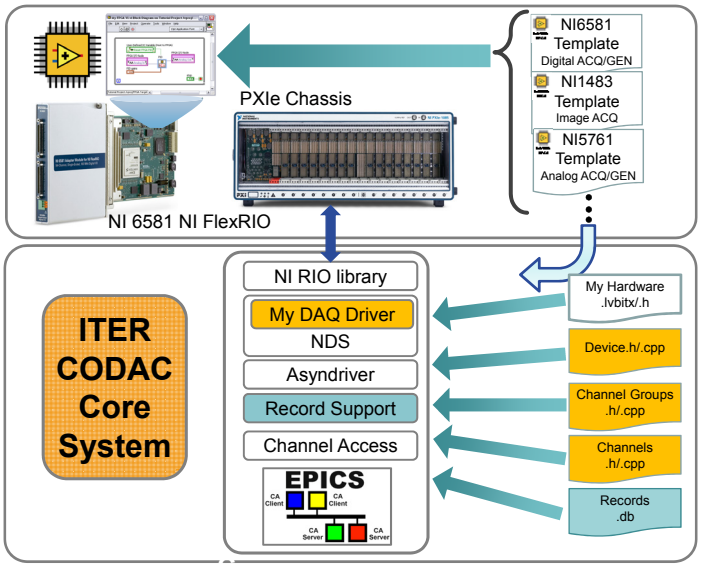
Choose FlexRIO HW from ITER Catalogue for Fast Controllers

Product	Description
NI-5761R	14-bit 200MS/s Digitizer
NI-6581	54-channel Digital I/O adapter module
NI-1483	Cameralink Adapter module
PXIe 7961	FlexRIO device (FPGA module)
PXIe 7966	



We have elaborated templates and examples that accelerate the development time. Complete integration examples, i.e. Digital DAQ 8-bit@100MHz

Digital DAQ	Description	Features
Adapter Mod.	NI-6581	100MHz Max. Clk. Rate 54 digital I/O channels
PXIe FPGA	NI PXIe 796X Devices	Fully Reconfigurable LabVIEW Template
Device Support	Complete Device Suport Based on NDS	8-bit Acquisition@ 100MS/s
CA EPICS Client	Example BOY Interface (GUI)	Complete Device Control



HARDWARE RELATED STEPS

1. Explore given templates.
2. Add extra input output controls.
3. Add particular preprocessing hardware to the device (FPGA) under development.
4. Compile and generate the bitstream.

SOFTWARE RELATED STEPS

5. Shape the device from specifications.
    1. Number of Channel Groups and Channels.
    2. Type of channels.
6. Modify template for particular management of the acquired data.
7. Add new records to provide extra device functionalities through EPICS.
8. Test the custom DAQ system with GUI-Based BOY interfaces given.

CONCLUSIONS

- **Start off building your custom DAQ system with FlexRIO-Based Templates.**
- **Available for all hardware defined in ITER catalog for PXIe form factor Fast Cotrollers.**
- **Reduce development time simplifying the design, implementation and integration complexity.**
- **Templates covering the full design cycle of FlexRIO based DAQ systems with CODAC Core System and EPICS.**
    - **LabVIEW-FPGA templates.**
    - **Device Support templates using NDS abstraction layer.**
    - **Record Support templates to control the device through EPICS.**