



NIDays09

WORLDWIDE GRAPHICAL SYSTEM DESIGN

CONFERENCE

How to Get a Jump Start Using CompactRIO

Agenda

- Introduction to CompactRIO
- CompactRIO Scan Engine
- Data transfer and variables
- Scan Engine benchmarks
- 1131 Function blocks
- Combining FPGA & Scan Mode programming models
- Deterministic Distributed I/O

NI CompactRIO Embedded Architecture

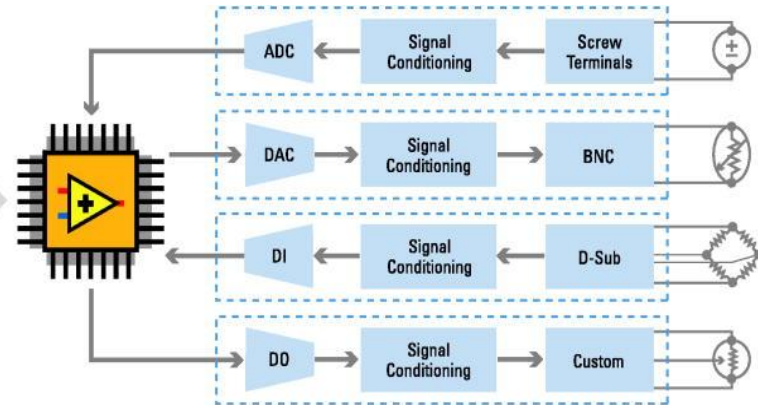
Real-Time Processor **Reconfigurable FPGA**



I/O Modules



PCI Bus



Extreme Ruggedness

- -40 to 70 °C temperature range
- 50 g shock, 5 g vibration

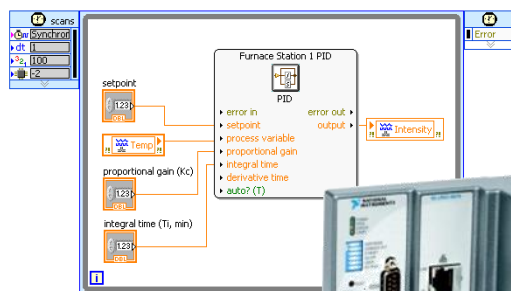
Low Power Consumption

- 9 to 35 VDC power, 7 to 10 W typical

- **I/O Modules** with built-in signal conditioning for connection to sensors/actuators
- **Reconfigurable FPGA** for high-speed and custom I/O timing, triggering, and control
- **Real-time processor** for deterministic, stand-alone operation, logging, and analysis

New programming model for CompactRIO

- Easier programming of CompactRIO with CompactRIO Scan Mode
- Work with new monitoring and maintenance tools
- No time-consuming FPGA re-compiles necessary



Check out the
Try It Yourself Demo
Station
in the expo area

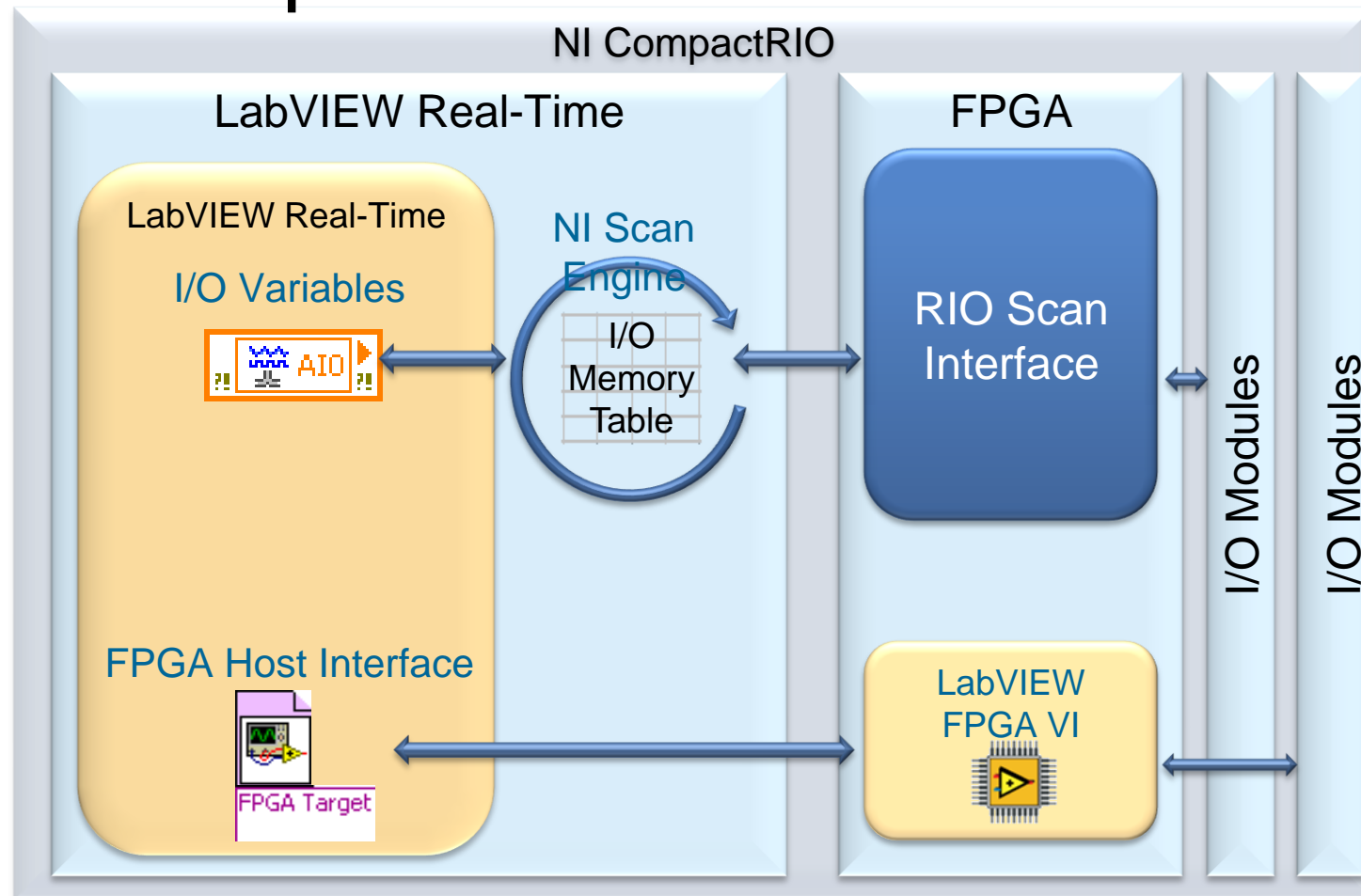
DEMO 1

CompactRIO Scan Mode in the LabVIEW Project

Distributed system manager

Creating a simple CompactRIO Scan Mode VI

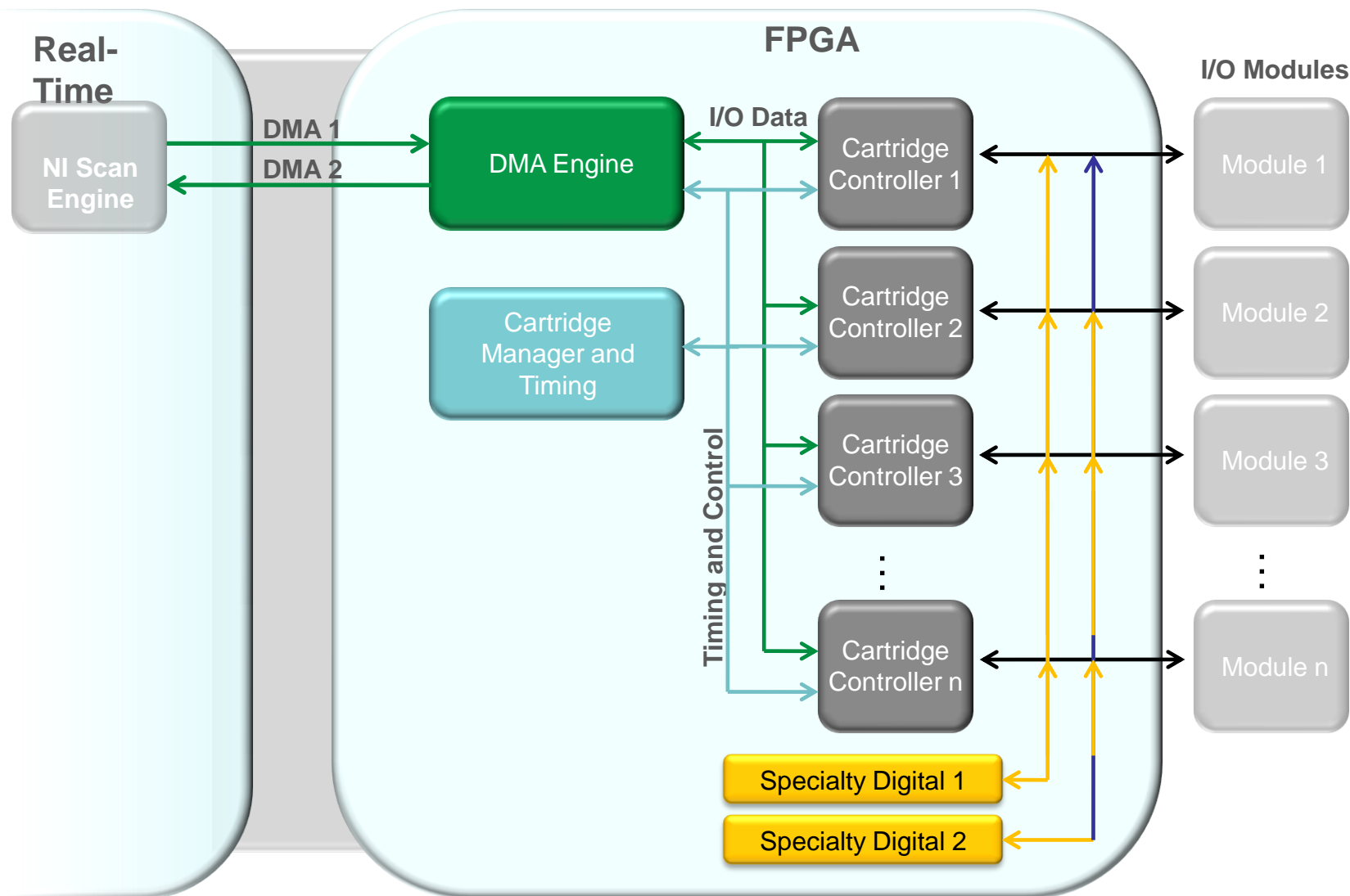
New LabVIEW 8.6 Programming Model for CompactRIO



What Is the RIO Scan Interface?

- Prebuilt bit file for the FPGA
 - No FPGA programming/compile needed
 - LabVIEW FPGA not required
- Direct single-point I/O access to LabVIEW Real-Time Module
 - Automatic module detection
 - Supports most modules

What Is in the RIO Scan Interface?



The Cartridge Controller

Cartridge
Controller

- A “soft core” 8-bit microcontroller
- Allows “no-compile” support for different modules
 - Module Identification
 - Module read-write (single point)
 - Supports “standard” modules – similar to compactDAQ

Cartridge Manager

- Controls the hardware scan timing
 - Synchronization of the module reads/writes
 - Synchronization with the RT code
 - 500 nS jitter for IO updates

Specialty Digital

- Add specialty digital functionality to any C Series digital I/O module (8 channels or less)
- No programming required
- Supports high-speed counter, PWM, and quadrature encoder
- Each block can be used for one module in any slot

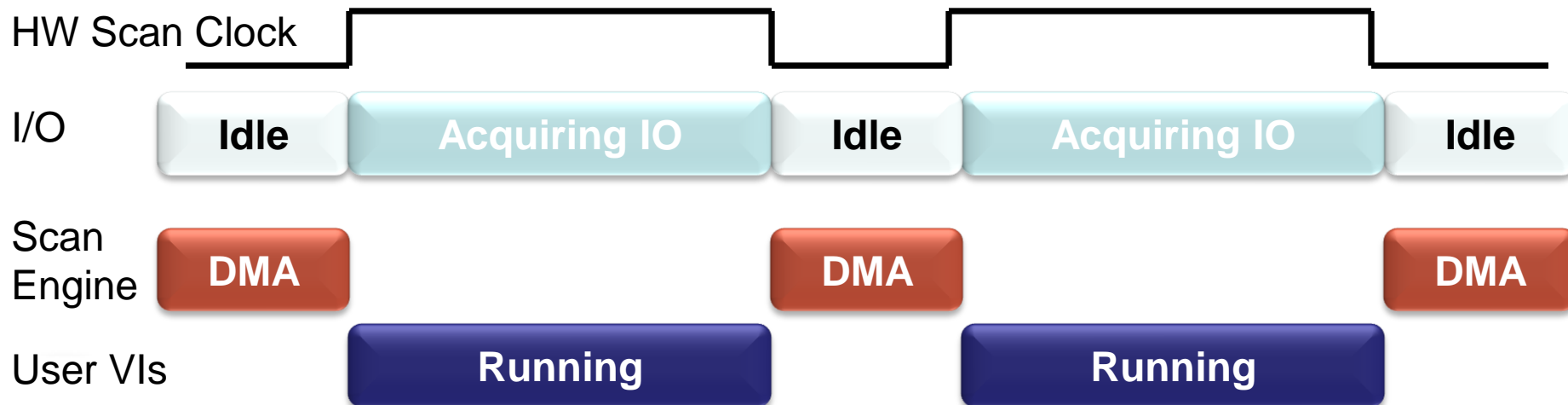


DEMO 2

Configuring specialty digital functionality

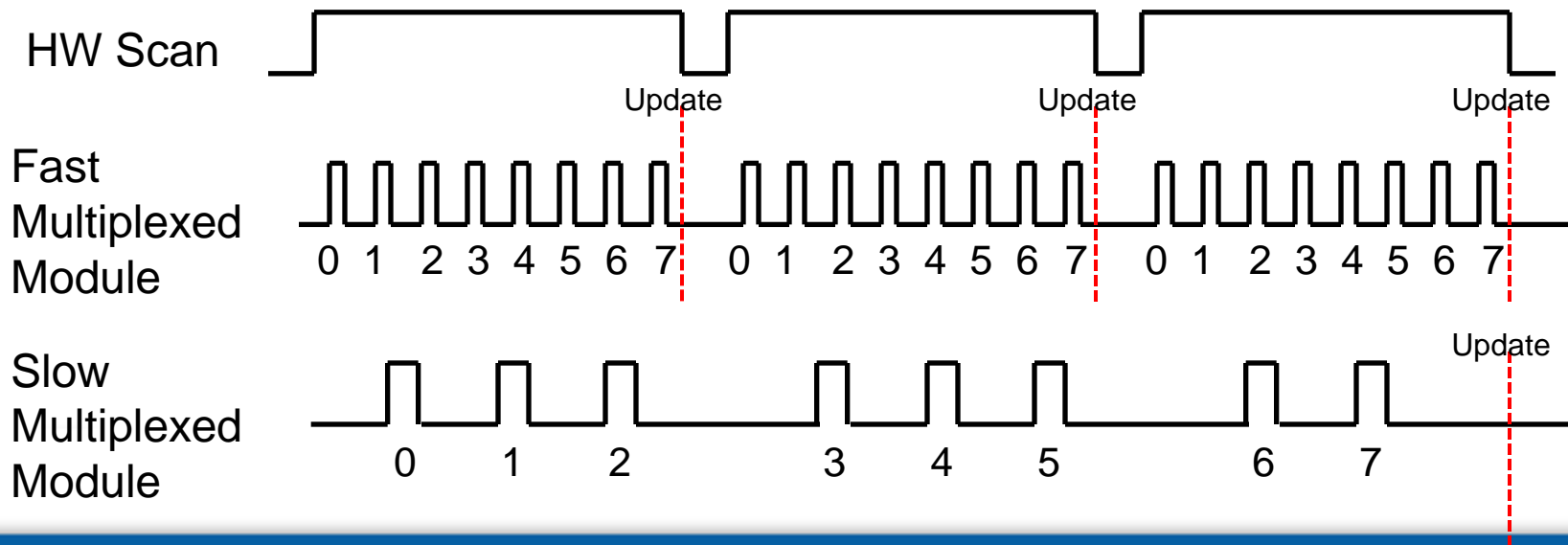
Timing Overview

- HW Scan: A hardware clock controls IO conversions
- SW I/O Scan: SW synchronized to collect data from the IO during non-covert times

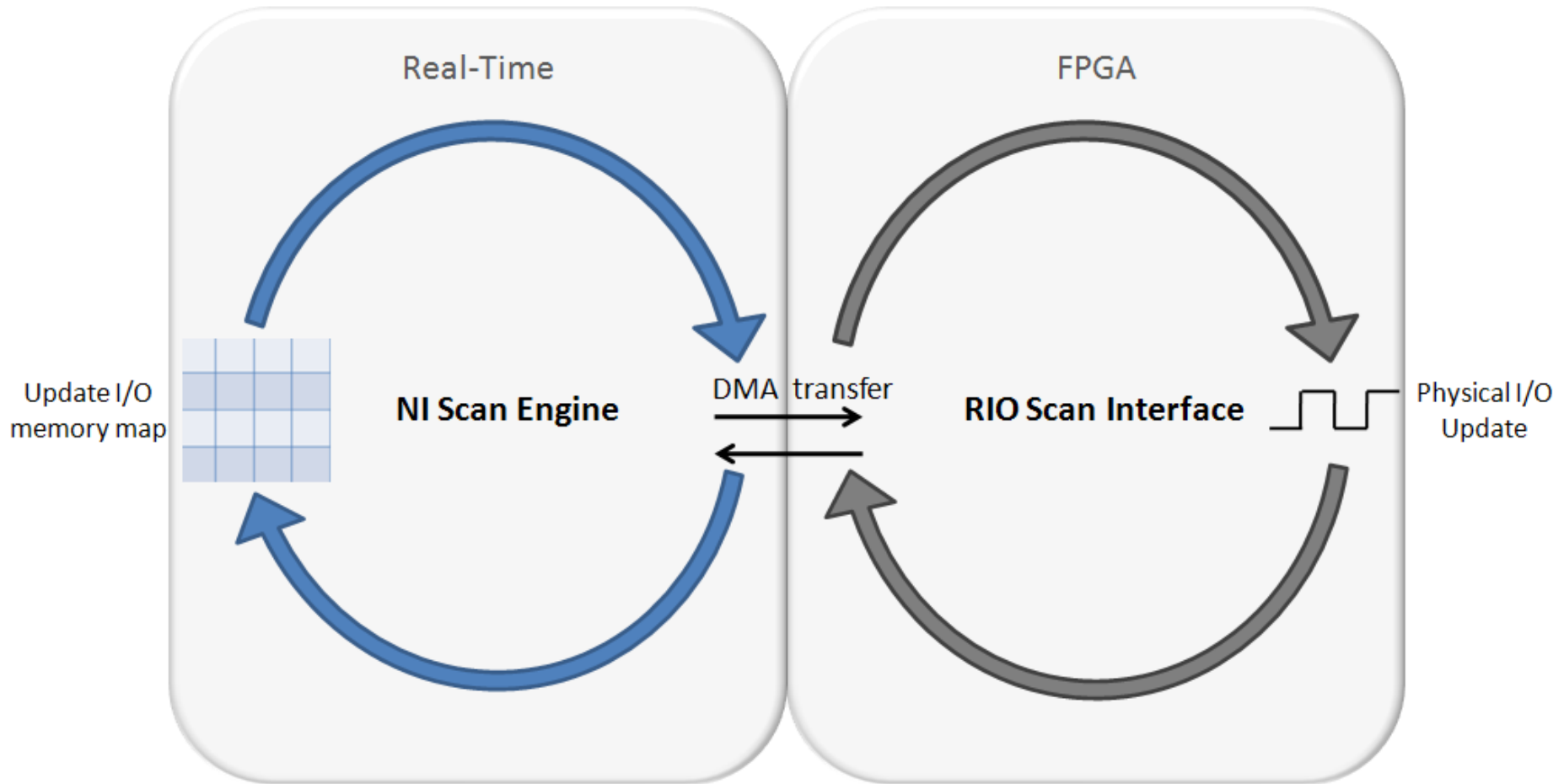


Input Module Conversion Timing

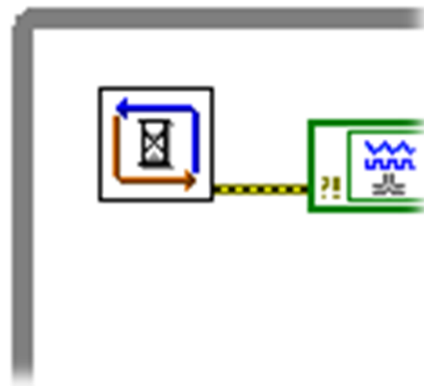
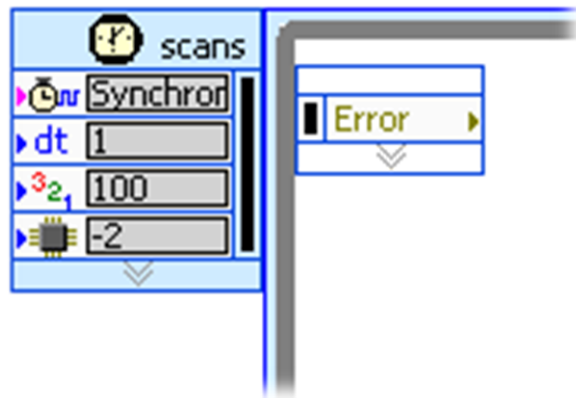
- Modules update during the HW Scan
- All points passed to RT after the scan
- Slower modules update when all channels have been read



I/O Data Transfer to NI Scan Engine



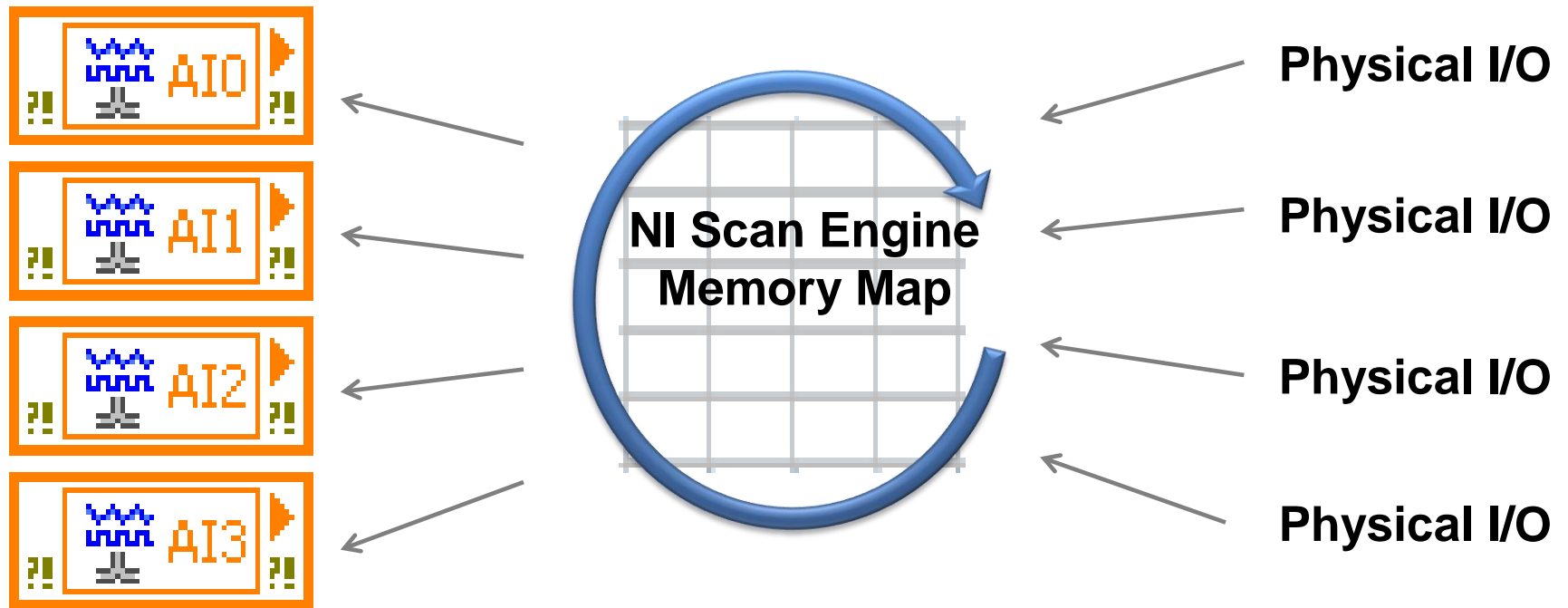
Synchronizing to the NI Scan Engine



- Timed loop
- Synchronize to NI Scan Engine timing source

- While loop
- Synchronize to Scan Engine.vi

I/O Variable Access



I/O Variable Network Publishing

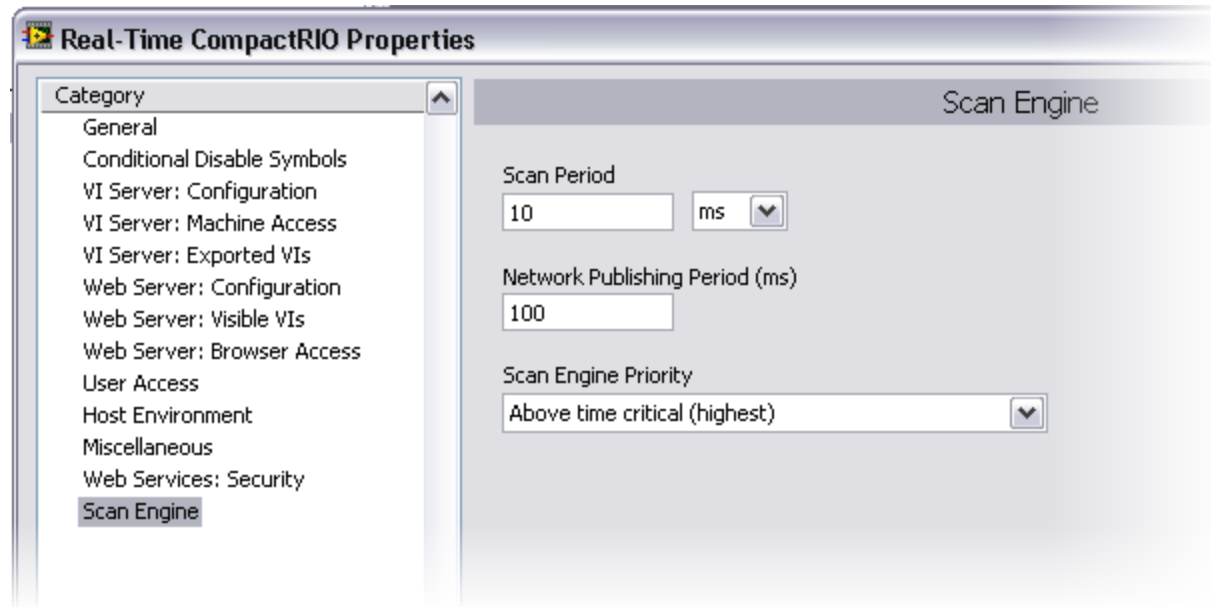


- Out-of-box I/O without programming
- I/O variable and alias publishing
- Published by NI Scan Engine
- Configurable update rate
- Not yet supported on touch panel
- Binds to shared variables for additional features



NI Scan Engine

- Configured from CompactRIO controller properties

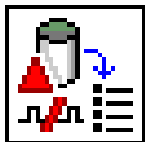


- Runs above time-critical priority by default

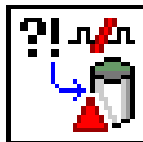
Faults

- NI Scan Engine error reporting tool
- View and clear in system manager
- Access programmatically with Fault Vis
- Important to monitor faults if you lower the NI Scan Engine priority

Get fault list



Set fault



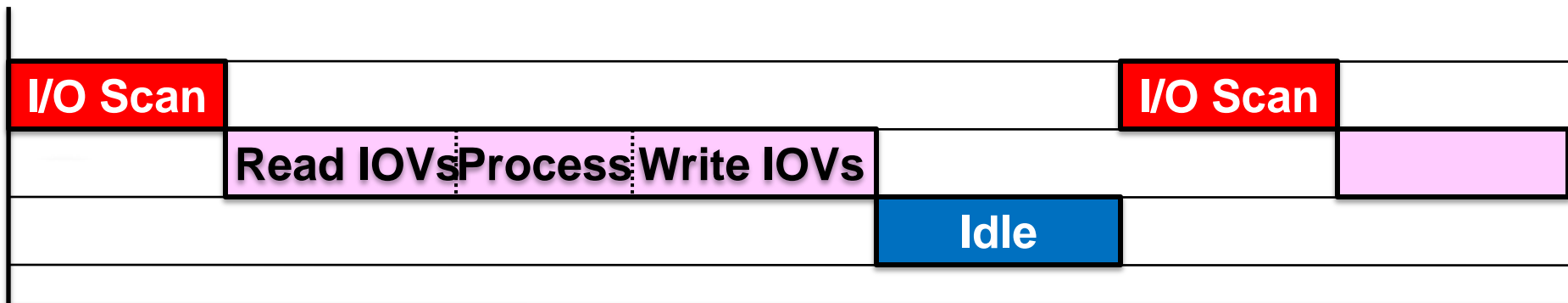
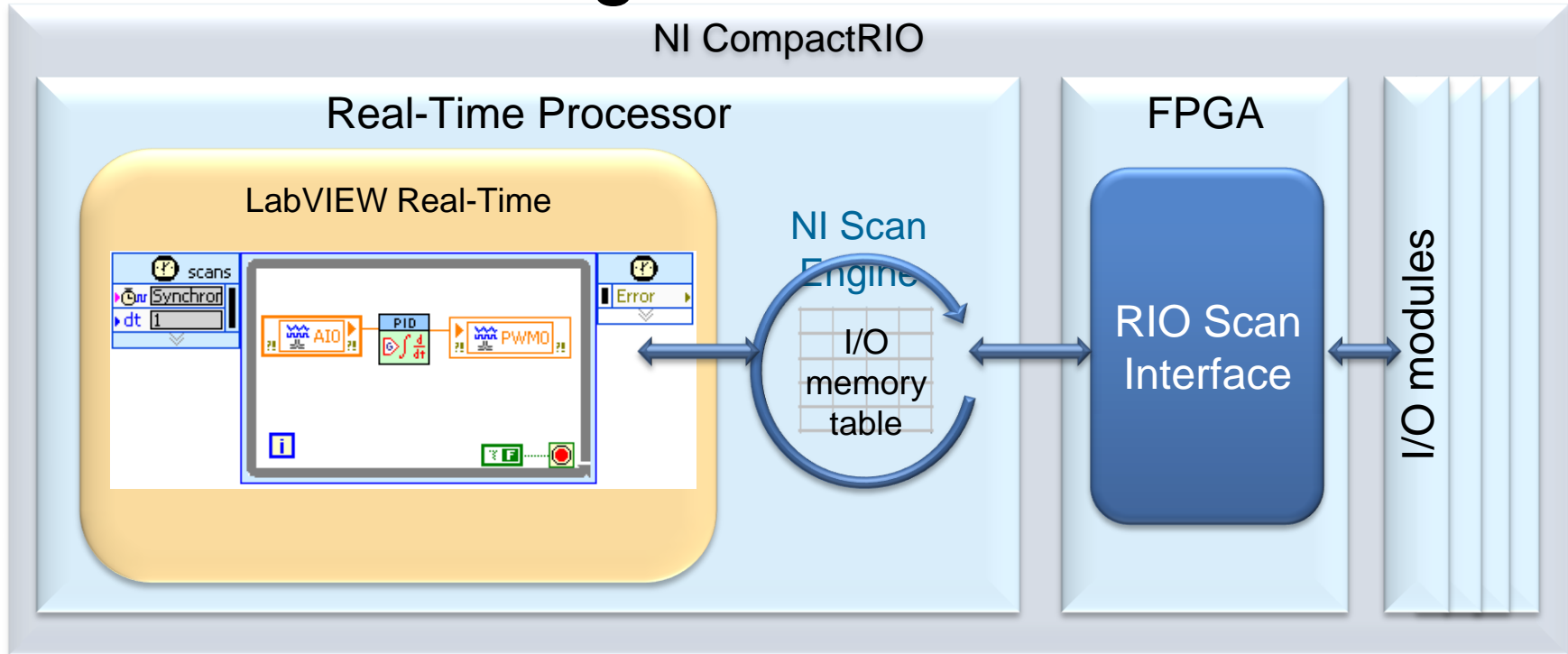
Clear fault



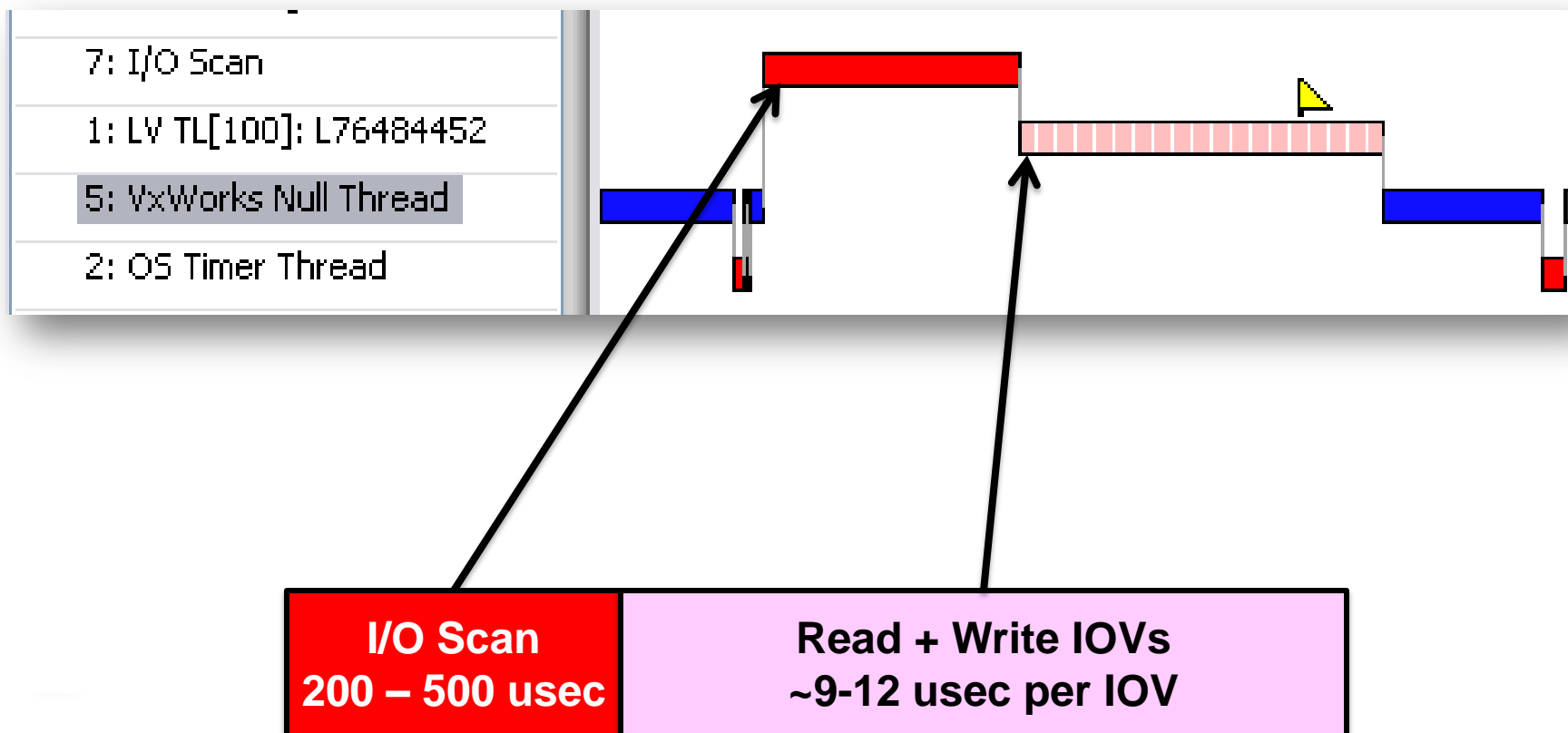
Clear all faults



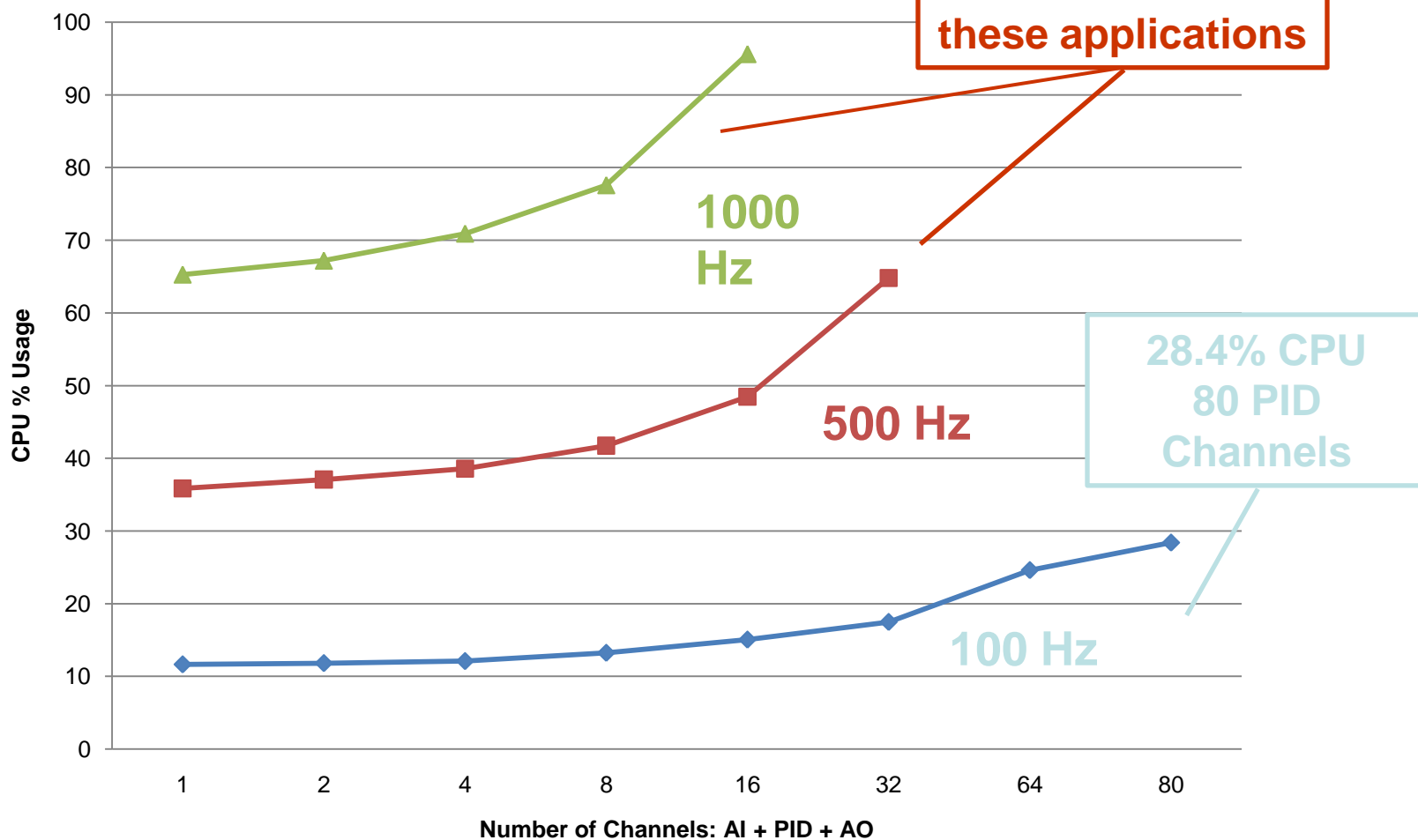
Benchmarking Scan Mode



Scan Engine Benchmarks



CPU Usage Benchmark



New LabVIEW 1131 Function Blocks

Accumulate and Collect



Accumulate



Collect Boolean Array



Collect Numeric Array



Totalize

Bistable/Flip-Flop



RS Bistable



SR Bistable

Timing



Count Down



Count Up



Count Up Down



Pulse Timer



Elapsed Timer



Retentive Timer On



Timer On Delay



Timer Off Delay

Edge Detection



Edge Detect



One Shot Rising



One Shot Falling

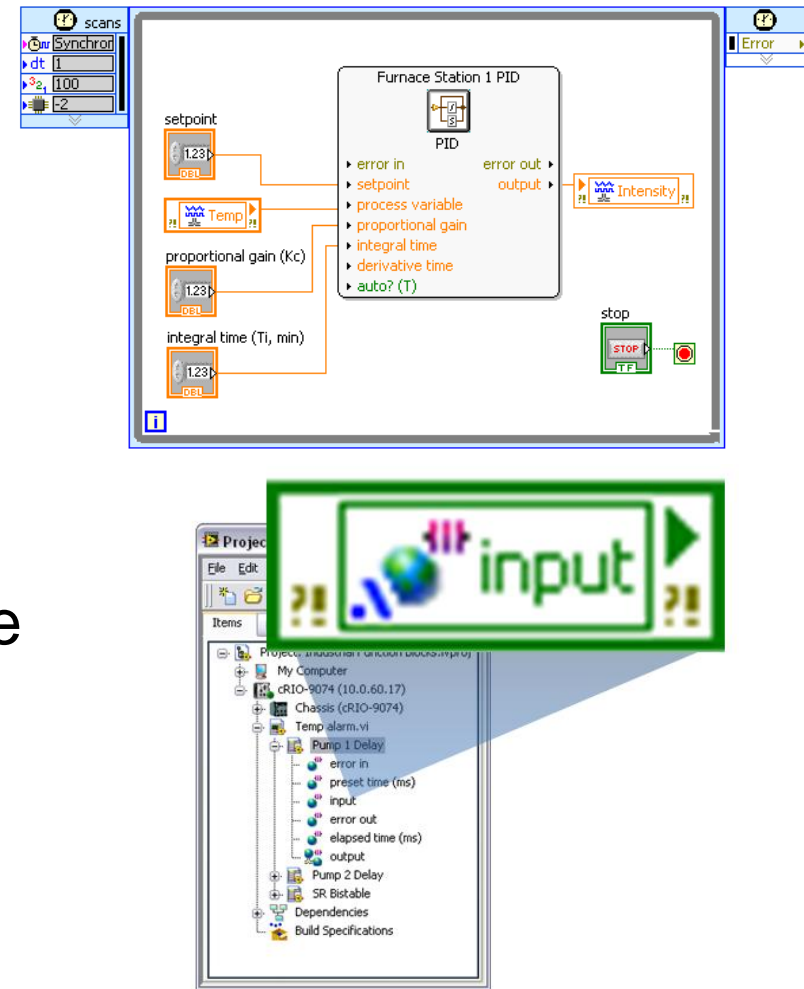
Control



PID

LabVIEW Function Blocks

- Familiar industrial functions based on IEC 61131-3 standard
- Designed for real-time control
- Network-published shared variable parameter values
- Install with LabVIEW Real-Time Module
- Also runs on Windows OS
- LabVIEW Project integration



DEMO 3

Creating an I/O alias

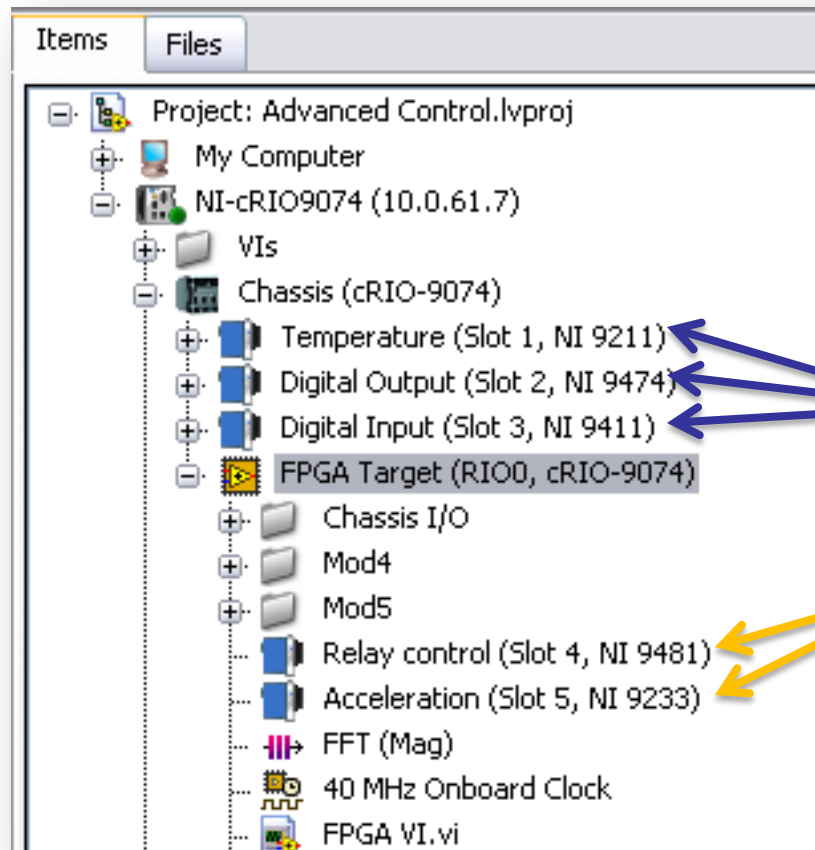
New LabVIEW function blocks

Hardware Support for CompactRIO Scan Mode

- Controller/Chassis Support
 - ✓ VxWorks controllers – NI 901x, NI 9022
 - ✓ 2M gate chassis – NI 9103, NI 9104, NI 9073, NI 9074
 - ✗ PharLap – NI 900x
 - ✗ Less than 2 M gate chassis – NI 9101, NI 9102, NI 9072
 - ✗ NI Single-Board RIO
- Module Support
 - ✓ Most AI, AO, DI, DO modules;
 - ✓ NI 9233, 9234 DSA modules
 - ✗ NI 9235, 9236 DSA
 - ✗ NI 985x CAN
 - ✗ NI 987x serial
 - ✗ NI 9505 motion drive
 - ✗ Custom/third-party modules

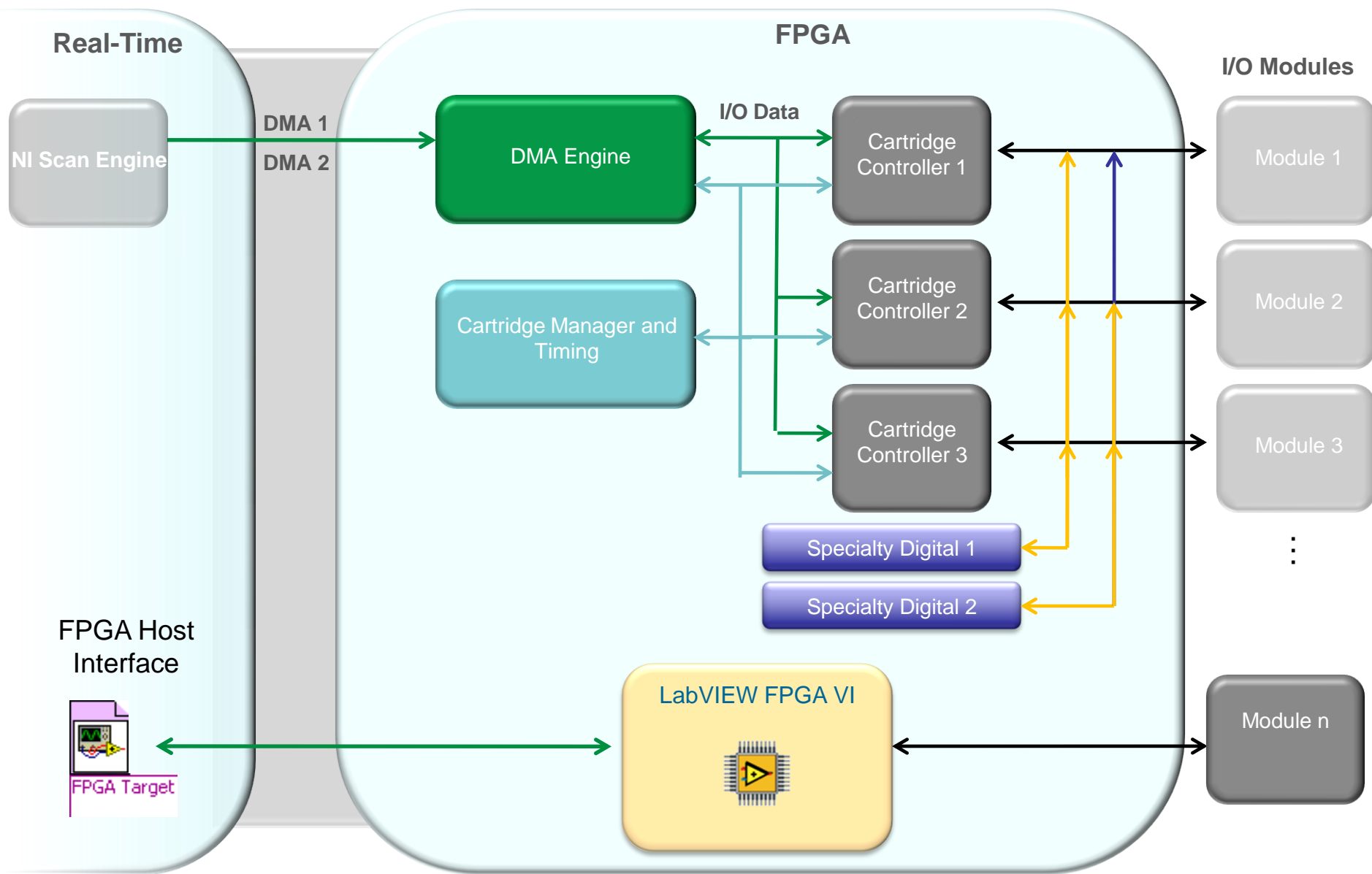
Use LabVIEW FPGA

Combining CompactRIO Scan Mode with LabVIEW FPGA Mode



- Add FPGA to project
- Drag modules to FPGA
- Requires compiler
- CompactRIO Scan Mode modules
- LabVIEW FPGA Mode modules
- No synchronization yet

RIO Scan Interface with LabVIEW FPGA



Notes on using LabVIEW FPGA with RIO Scan Interface

- RIO Scan Interface uses 2 DMA channels (1 left)
- FPGA code and CompactRIO Scan Mode code are not synchronized
- Less space left on the FPGA
- Compile times are longer

DEMO 4

Adding the FPGA target

Using LabVIEW FPGA and CompactRIO Scan Mode

Deterministic Distributed I/O

LabVIEW
Real-Time
Module



Smart Camera

CompactRIO

PXI



Compact FieldPoint

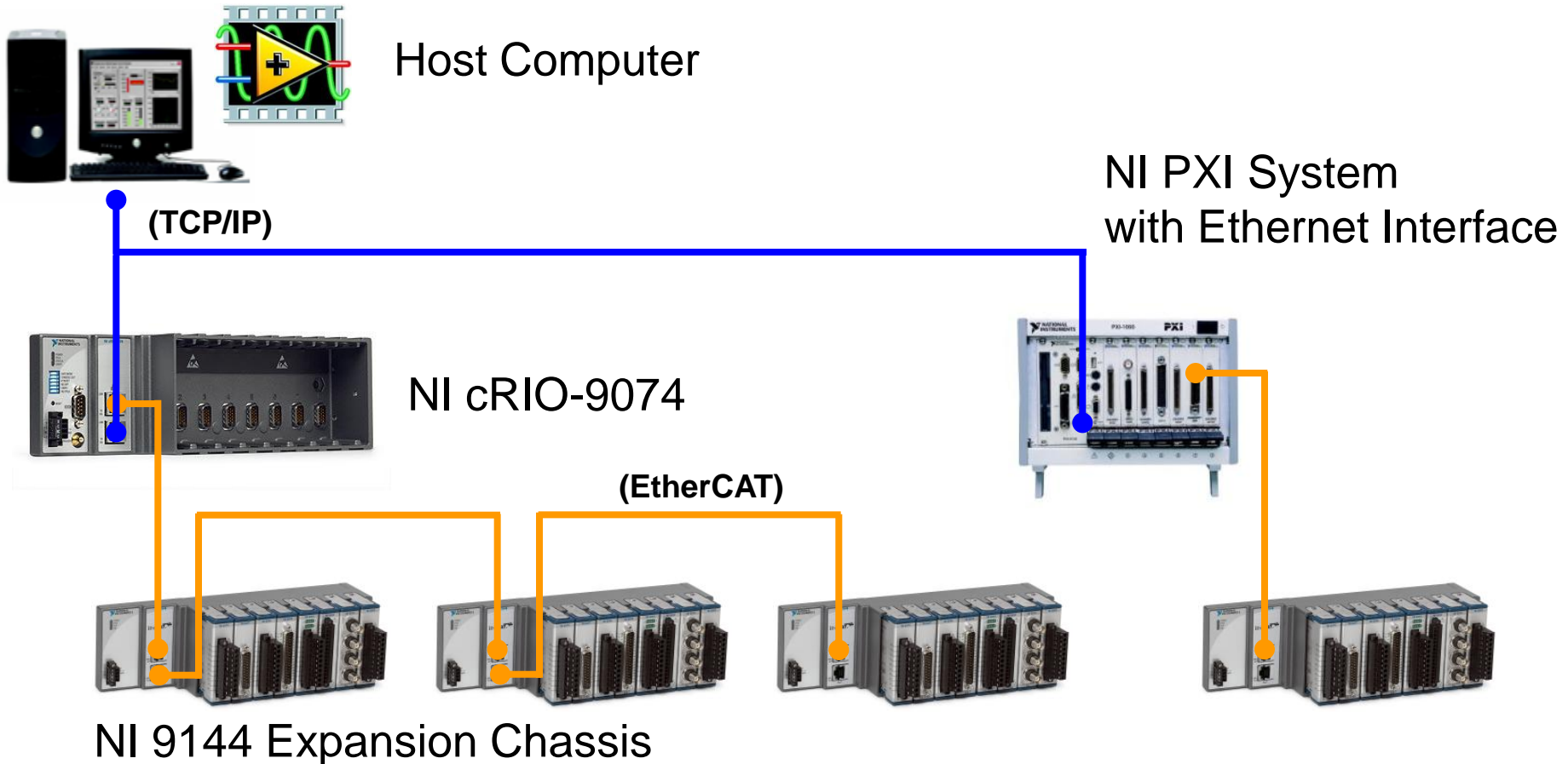


NI 9144 Expansion Chassis

- High-speed distributed I/O with tight synchronization
- Real-time expansion for NI CompactRIO and PXI platforms
- Easy drag-and-drop API with LabVIEW



NI System with Deterministic Distributed I/O



NI 9144 Expansion Chassis

2 Ports for
Daisy-Chaining



Rugged Chassis

- -40 to 70°C
- 9-30V Input
- Hazloc
- Shock/Vibe

8 Slots for
C Series
Modules

DEMO 5

Deterministic Ethernet

How to Learn More



From rapid
prototyping to low-
cost deployment
with LabVIEW
embedded tools

Try-It-Yourself
demo station:
Using CompactRIO
Scan mode and
function blocks

Online:

- ni.com/compactrio
- <http://www.ni.com/distributedio/>