Industrial Embedded Platform for Monitoring and Control
Industrial Embedded = Innovative embedded monitoring and control applications that are often deployed in an industrial environment.
## Industrial Embedded Applications by Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Embedded</th>
<th>Advanced Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy: Renewables &amp; Electrical Power</strong></td>
<td>Smart grid analyzer, solar monitoring, condition monitoring for wind turbines</td>
<td>Power inverter control, HIL, Simulation</td>
</tr>
<tr>
<td><strong>Energy: Oil &amp; Gas</strong></td>
<td>Leakage detection, pump monitoring</td>
<td>Drilling &amp; Fracturing control</td>
</tr>
<tr>
<td><strong>Industrial Automation</strong></td>
<td>MCM, machine vision</td>
<td>Specialty machine control, multi-axis motion control, industrial robotics</td>
</tr>
<tr>
<td><strong>Life Sciences &amp; Research</strong></td>
<td>Medical diagnostics &amp; monitoring, Research instruments</td>
<td>Medical device control, laser control, medical imaging, service robots</td>
</tr>
<tr>
<td><strong>Automotive &amp; Transportation</strong></td>
<td>In-vehicle logging, condition monitoring (trains, planes, ships)</td>
<td>RCP, HIL, dynamic ship positioning</td>
</tr>
</tbody>
</table>
The Industrial Embedded Landscape

PC
+ Open Software
+ Open Networking
+ Powerful Processing
- Not very rugged
- Unreliable OS

PLC
+ Highly reliable
+ Industrial networks
- Not very fast I/O
- Inflexible SW

Custom Design
+ Totally flexible
+ Highest Performance
- Not easy to develop
- Not easy to maintain
The Industrial Embedded Landscape

- PC or SBC
- PLC
- NI industrial embedded Platform
- Custom Design
NI Industrial Embedded Platform

Supporting Products & Services

- Vision
- Motion
- Industrial buses, communication
- HMIs
- WSN
- LabVIEW
- LabVIEW Real-Time LabVIEW
- Proc
- FPGA
- I/O
- 3rd-Party Products

Services and Training
Alliance & Design Partners

IP for control, analysis, comm, ...

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NI RIO Technology Platform

- **LabVIEW**: LabVIEW Real-Time, LabVIEW FPGA
- **Application IP**: Signal Processing IP, Control IP, Third-Party IP
- **Middleware**: Driver APIs, Device Drivers, I/O Drivers
- **Processor**: I/O
- **FPGA**: I/O, Custom I/O

CompactRIO & Single-Board RIO:
- Value
- Ultra Rugged
- Performance

PXI/PC:
- High Performance
Introduction CompactRIO platform for Control and Monitoring
The CompactRIO System

Processor + Backplane + I/O = CompactRIO System
The CompactRIO System

- **Real-Time Processor**: For reliable measurement, analysis, connectivity & control
- **Reconfigurable FPGA**: For high-speed and custom I/O timing, triggering, and control
- **I/O-Modules**: With built-in signal conditioning for connection to sensors/actuators

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

**Low Power Consumption**
- 9 to 35 VDC power, 7-10 W typical

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2011 Top 40 cRIO/sbRIO Customers by Application Type

- 50% Monitoring
- 50% Monitoring & Control

Source: australia.ni.com/techsym
IE RIO Customer **Technical** Requirements

- **Dynamic monitoring**
  - High-speed, high-quality, and specialty analog measurements
  - Dynamic analysis & signal processing

- **Advanced control**
  - High-speed analog control
  - Custom control algorithms

- Often, the engineering team has considered custom hardware
IE RIO Customer Business Requirements

- **Areas of Innovation**
  - Energy, Medical, Mechatronics, and Robotics
    - Solving NEW Problems
    - Prototyping is critical

- **Smaller Design Teams**
  - Domain Experts (scientists/engineers)
  - No established tools or way of doing things

- **Volume, price or timeline doesn’t justify custom**
  - 10s – 100s of machines/devices per/year
  - Expensive machines/devices (NI hardware cost represents less than 10% of total cost)
  - Need fast time-to-market
IE Case Study - Pipeline Welding

Application:
- Automating the welding process of large pipes
- Controlling motor speed and oscillation of the welding head

Reasons for Choosing NI:
- Speed and customization of CompactRIO
- Complex signal processing and control
- Ability to control design and update system themselves

Competition: Custom hardware
IE Case Study – Solar Power Monitoring & Control

Application:
- Monitoring DC output power from distributed PV arrays
- 2.5MW DC to AC power inverter with redundant control

Reasons for Choosing NI:
- Analog measurements and analysis
- Ability to monitor and control
- NI field support (field and NIC)
- Ability to prototype quickly with RIO
Monitoring and Control Demo

- Solar Tracker
- Weather Station Monitoring
New cRIO 2011
CompactRIO Platform

Value
- 266 MHz – 400 MHz
- -40 to 70 C
- Spartan FPGA

Ultra Rugged
- 533 MHz – 800 MHz
- -40 to 70 C
- Virtex 5 FPGA

Performance
- Up to 1.33 GHz Dual-Core
- 0 to 55 C
- Virtex 5 or Spartan 6 FPGA

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NEW! High-Performance Multicore CompactRIO

- Dual-Core 1.33GHz Processor
- Spartan-6 LX150 FPGA
- 2GB DDR3 RAM
- CPU Expansion Module
- USB & Serial Connectivity
- 32GB cFast Storage
- MXI-Express for C Series Expansion
- VGA Graphics
- Gigabit Ethernet
- 8 Slots of C Series IO
- Specifications for cRIO-9082

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Multicore CompactRIO Benchmarks

- **5x Improvement**
  - 64 Channel PID: 69 us
  - 22 Channel PID: 14 us

- **22x Improvement**
  - 32 Channel FFT: 18,986 us
  - 32 Channel FFT: 873 us

- **11x Improvement**
  - Streaming to TDMS: 33 MB/s
  - Streaming to TDMS: 3 MB/s

**cRIO-9024** vs **cRIO-9082**
NI cRIO-9075/6 Details

- Small footprint
  - First 4-slot cRIO
- Low power input at 9-30 VDC
- Spartan-6 FPGA
- Ideal for high volume and OEM deployments

<table>
<thead>
<tr>
<th>Model</th>
<th>Processor</th>
<th>Operating Temp</th>
<th>Memory</th>
<th>Storage</th>
<th>FPGA</th>
<th>USB</th>
</tr>
</thead>
<tbody>
<tr>
<td>cRIO-9075</td>
<td>400 MHz</td>
<td>-20 to 55</td>
<td>128M</td>
<td>256M</td>
<td>LX-25</td>
<td>No</td>
</tr>
<tr>
<td>cRIO-9076</td>
<td>400 MHz</td>
<td>-20 to 55</td>
<td>256M</td>
<td>512M</td>
<td>LX-45</td>
<td>Hi-Speed (x1)</td>
</tr>
</tbody>
</table>

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Wireless Sensor Networks
Wireless Application Areas

Environmental Monitoring

Resource Monitoring

Industrial Measurements

Air/Climate

Water/Soil

Indoor Monitoring

Power Monitoring

Solar Monitoring

Wind Farm Monitoring

Structural Health Monitoring

Machine Condition Monitoring

Process Monitoring

WSN 1.0

WSN (after 1.0)
Low-Power. Reliable. Wireless Sensor Networks

• **Low-power:** Up to 3 year life with 4 AA batteries and 3 samples per minute

  • **Reliable:** Mesh routing and outdoor range up to 1000 m

• **Wireless Sensor Networks:** Remote, deployable wireless monitoring systems
NI 9795: WSN C Series Gateway
“Wireless I/O for CompactRIO”

- WSN Moves “On-Platform”
- Elegant Integration with CompactRIO
  - API already similar
- Easily combine wired & wireless measurements
  - Augment existing solutions with WSN
- One gateway per chassis at release (36 nodes)
- Chassis must support RSI
NEW! NI 9795: WSN C Series Gateway

- Remote data acquisition
- Easily combine wired & wireless measurements

- Wireless Sensor Array
- Battery-powered, outdoor capable
- Up to 300m range

- Drag-and-drop variable API
- Web Services for remote data
- Programmable Nodes
WSN-3214: Strain/Bridge Completion Node

- Developed in collaboration with industry and research leaders
- Ideal Solution for Wireless SHM
  - Bridges, Buildings, Tunnels, Dams, Equipment
  - Civil Engineers, Maintenance technicians, Construction, Oil/Gas/Energy
- 4 Channels, Full/Half/Quarter bridge
  - Internal excitation
  - High speed, High resolution modes
- 2 DIO channels
- Onboard processing of WFM data with LabVIEW WSN
WSN-3230 (RS-232) & WSN-3231 (RS-485)

- Autonomous wireless interface to serial sensors and instruments
  - Adds support for thousands of devices
- Many different applications
  - Environmental monitoring
  - Control board interface
  - Solar inverter monitoring
- Programmable ONLY
  - “Programmable Sensor/Instrument Control”
DEMO: Integrating Wireless Sensor Networks with CompactRIO
Vision

NI Smart Camera
New High-Performance Smart Cameras

7 New High-End Smart Cameras

- Powerful processing with 1.6GHz Intel® Atom® (Z530)
- Rugged, industrial design with IP67 housing and M12 connectors (NI’s first product like this!)
- Variety of image sensors including color and high resolution (up to 5MP)
- Real-Time operating system
<table>
<thead>
<tr>
<th>Display Resolution</th>
<th>PowerPC 400 MHz</th>
<th>PowerPC 533 MHz</th>
<th>PowerPC 600 MHz</th>
<th>1.6 GHz Intel ATOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>VGA 640 x 480</td>
<td>NI-1712</td>
<td>NI-1732</td>
<td>NI-1752</td>
<td>NI-1772/NI-1772C</td>
</tr>
<tr>
<td>SXGA 1280 x 1024</td>
<td></td>
<td></td>
<td>NI-1754</td>
<td>NI-1774/NI-1774C</td>
</tr>
<tr>
<td>UXGA (2MP) 1600 x 1200</td>
<td></td>
<td></td>
<td></td>
<td>NI-1776/NI-1776C</td>
</tr>
<tr>
<td>5MP 2500 x 2000</td>
<td></td>
<td></td>
<td></td>
<td>NI-1778</td>
</tr>
</tbody>
</table>
x86 Smart Camera Features

- Intel ATOM (x86) processor
- IP67 Housing & Lens Cover (water-proof, dust-proof)
- Industry standard mounting holes
- M12 Connectors
- Power & I/O (4 in, 4 out)
- Gigabit EtherNet
- USB & VGA
- Heat Sink For power dissipation
- Includes Vision Builder software
NEW! High-Performance Multicore CompactRIO

- Dual-Core 1.33GHz Processor
- Spartan-6 LX150 FPGA
- 2GB DDR3 RAM
- CPU Expansion Module
- USB & Serial Connectivity
- 32GB cFast Storage
- Gigabit Ethernet
- 8 Slots of C Series IO
- Now compatible with GigE Vision Cameras

Specifications for cRIO-9082

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NI Industrial Embedded Value Proposition

National Instruments Focus in Embedded Industry

“Long Tail” Monitoring & Control Options

- High-sensitivity monitoring
- Advanced control
- Fast Time-to-Market
- Low-to-medium volume

Build versus Buy

Hybrid Design Approach
- Custom
- Standard
- Commercial-off-the-shelf

NI RIO Empowers Smaller Design Teams

NI Technology Partner Advantage
- Processor
- Bus
- FPGA
- IP
- I/O

NI Embedded Advantage
- OEM experience with many industries
- Extreme stability
  - 35-year track record of strong growth and profitability
  - No one industry/customer represents >15% of our revenue
- Global manufacturing facilities
- Focus on industry standard form-factors, technologies
- NI Product Life Cycle Management
  - Products designed with stable components and technologies
  - Manufacture most products for 10+ years
  - Automated product change notification (PCN) system

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