Deploying and Customizing NI LabVIEW Embedded Technologies
Agenda

• Customizing Embedded Systems
  ▪ Custom I/O with NI C Series
  ▪ NI Single-Board RIO Daughter Cards
• User Interface Options
• Custom Hardware with ARM Microcontrollers
LabVIEW Targets for Embedded Design

- NI CompactRIO
- NI Single-Board RIO
- NI FlexRIO
- Touch Panel PCs
- Microprocessors/controllers
  - ARM, ADI Blackfin
  - Any 32-bit Microprocessor
- PC/104, SBC, PC, or PXI
  - LabVIEW/LabVIEW Real-Time
  - Windows Mobile/CE/XP/Xpe
  - Linux
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CompactRIO</th>
<th>NI Single-Board RIO</th>
<th>LabVIEW Embedded Module for ARM Microcontrollers</th>
<th>LabVIEW Embedded Module for ADI Blackfin Processors</th>
<th>LabVIEW µProcessor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Development Risk/Effort</strong></td>
<td>Integrated software and hardware</td>
<td>Integrated software and hardware</td>
<td>User responsible for integration</td>
<td>User responsible for integration</td>
<td>User must define and code for all hardware integration</td>
</tr>
<tr>
<td><strong>Power/Size</strong></td>
<td>7 to 15 W typical</td>
<td>7 to 10 W typical</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
</tr>
<tr>
<td><strong>FPGA</strong></td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td><strong>Available I/O</strong></td>
<td>COTS modules, Third-party, custom modules</td>
<td>110 digital I/O lines, COTS modules, Third-party, custom modules</td>
<td>Some on-chip I/O</td>
<td>Custom I/O</td>
<td>Custom I/O</td>
</tr>
<tr>
<td><strong>I/O Integration</strong></td>
<td>Built-in driver software</td>
<td>Built-in driver software</td>
<td>Some software drivers</td>
<td>Some software drivers</td>
<td>User responsible for drivers</td>
</tr>
<tr>
<td></td>
<td>CompactRIO</td>
<td>NI Single-Board RIO</td>
<td>LabVIEW Embedded Module for ARM Microcontrollers</td>
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<tr>
<td>---------------------</td>
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<td>---------------------</td>
</tr>
<tr>
<td>Maturity</td>
<td>Industry-proven</td>
<td>CompactRIO architecture</td>
<td>Fewer users</td>
<td>Fewer users</td>
<td>Few users</td>
</tr>
<tr>
<td>Processing Power</td>
<td>667 MHz Power PC Virtex-5 FPGA</td>
<td>400 MHz Power PC Spartan 3 FPGA</td>
<td>Performance varies</td>
<td>Performance varies</td>
<td>Depends on processor</td>
</tr>
<tr>
<td>Ratings and Certification</td>
<td>Shock/vibration, temp, CE, UL, Same components as CompactRIO</td>
<td>Various</td>
<td>Various</td>
<td>Various</td>
<td></td>
</tr>
<tr>
<td>Tech Support</td>
<td>One source</td>
<td>One source</td>
<td>More difficult to troubleshoot</td>
<td>More difficult to troubleshoot</td>
<td>More difficult to troubleshoot</td>
</tr>
<tr>
<td>Software Toolkits</td>
<td>LabVIEW Control Design and Simulation, LabVIEW Statechart</td>
<td>LabVIEW Control Design and Simulation, LabVIEW Statechart</td>
<td>Limited toolkits</td>
<td>Limited toolkits</td>
<td>Limited toolkits</td>
</tr>
</tbody>
</table>
NI Reconfigurable I/O Deployment Options

LabVIEW

PXI RIO

PCI RIO

CompactRIO

NI Single-Board RIO

AUTOMATED TEST

PC-BASED

INDUSTRIAL

BOARD-LEVEL
Using the CompactRIO Module Developer Kit to Create Your Own C Series Module

Resellers
- NI alliance product distribution
- Vertical market suppliers

Users
- Research/teaching
- Hobbyists
- Vertical systems suppliers (VAR)
- **MDK Base $995 USD**
  - Installer EULA for internal use only
  - Access to private forum support on ni.com
  - Sample module shells with connectors

- Certification to CompactRIO electrical specification testing $1,295 USD

- **MDK Developer Suite $2,995 USD**
  - Installer EULA and required signed distribution agreement
  - Access to product support engineering and private Web forum on ni.com
  - Sample module shells with connectors
  - Certification to CompactRIO electrical specification testing
What Is Inside Most C Series Modules?

- I/O Connector
- LED
- I/O Circuitry
- Isolation
- ID
- EEPROM
- 15-Pin DSub
Get Free PCB Templates and Dimensions

- Use NI Multisim to simulate your analog circuits
- Use NI Ultiboard for board layout
- Use third-party tools such as PCB123 and small order board services
Customization Options for NI Single-Board RIO

- Online resource templates for schematics and layout within Ultiboard
Embedded Displays
Range of Embedded Displays

- **Serial LCD**
  - Text/Only
- **Serial LCD**
  - Text/Graphics/Digital Interface
- **VGA LCD**
  - Text/Graphics/Digital Interface
- **Programmable HMI**

- **7 Seg Text Only**
- **Programmable HMI**

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Display Hardware Considerations

• **Screen size** required for effective representation of user interface
  ▪ 6 in., 12 in.

• **OS** support for HMI functionality
  ▪ Windows CE, Windows XP Embedded, other, none

• **Memory** reliability and size
  ▪ Solid state, rotating disk

• **Safety ratings** depending on operating conditions
  ▪ NEMA, IP 65

• **Run-time licenses** for software that runs on the HMI hardware
  ▪ Built-in, separate purchase, free
Simple Low-Cost LCD Displays

• Most primitive
  ▪ Text-only displays
  ▪ Some incorporate user input via buttons

• Use cases
  ▪ Device status
  ▪ Primitive menus and user configuration
  ▪ Debugging

• Serial: many different serial microprocessors
• Digital: two dominant (98% market)
  ▪ HD44780 (FPGA IP available at ni.com/ipnet)
  ▪ LM018L
Serial LCDs

- 50+ serial display options
  - Alphanumeric and graphics
  - LCD and VFD
  - $30 to $200 USD
  - Extended temperature available
  - LabVIEW drivers for some modules
Reach Inc.
SLCD Controller Board

- Color touch screen through serial port
- Serial communication interface and API library
- Outputs to “many” QVGA LCD displays (320 by 240)
- Upload bit maps and overlay text with serial commands
Use LabVIEW Web Services for HMIs

- Standard http protocol
- Firewall friendly
- No run-time engine required
- Multiple connections
- Desktop or real time
- Custom clients

Web Server

Request

Response

Web Clients

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LabVIEW Touch Panel Module

• Add-on to LabVIEW for building programmable HMIs
  ▪ Ability to deploy to Windows CE and XPe HMI hardware
  ▪ Target NI and third-party touch panels

• Familiar LabVIEW development environment
  ▪ Rich user interface
  ▪ Advanced control and analysis
  ▪ Ability to use programming structures
Methone
NI Single-Board RIO and Intel Atom PC Module Adapter

- Methone is an adapter board combining NI Single-Board RIO and a COM Express Intel Atom PC aingle-board computer
- Methone attaches directly to NI Single-Board RIO allowing FPGA digital I/O and/or Ethernet communication
- Run LabVIEW for Windows, Linux, or any other PC-based application on the COM Express PC module

The Methone adapter includes:
- COM Express PC Module connector
- 26-pin connector to NI Single-Board RIO FPGA with IEEE1284 and GPIO
- Three double USB connectors
- 1G Ethernet connector with magnetics
- VGA connector
- JILI flat panel connector (option)
- Two RS232 D-sub9
- SATA connector for 2,5” hard drive
- Keyboard/mouse connector
- Line in/out connector
- 12 V DC input connector powers both NI Single-Board RIO, COM, and Methone

Included software:
- NI Single-Board RIO FPGA interface to COM Express Module
Robin COM Express™ Module

Robins are embedded COM Express™ computer modules based on the Intel® Atom™ Z530 (1.6 GHz) and Z510 (1.1 GHz) processors and the Intel® US15W

Robin Z530

- Intel® Atom™ Z530 (1.6 GHz)
- Hub US15W
- MPEG2/HD/H2.64 Decoder
- 512 MB on-board DDR2
- 2 Gbyte SSD Solid State Disk
- PCI Express 1 (optional +1)
- GLAN
- HD-Audio
- SATA
- USB 480Mbit 7x
- MicroSD Slot onboard
- SDIO 3x
- VGA/TV out
- LPC
- LVDS
- SMB
- I²C
- GPIO 8x
- optional SDVO
- WinXP, XPE, Vista, CE5/6, WePOS, Linux, VxWorks
- Type 1 COM Express™ Pin out

www.toradex.com

Coming soon: New Robin with 1 Gbyte Ram 4 Gbyte SSD
ADIS1620X
Programmable Accelerometers/Inclinometers

**Performance**
- Accurate to 0.1°
- Non Linearity: 0.1% of FS
- 14-bit digital data

**Programmability**
- Digital Filtering
- Sample Rate
- Dual Alarms

**Ease of Use**
- No Additional Motion Test Required
- SPI Interface
- AutoNull to System Axis
- Embedded Temp Sensor Included
- Digital Self Test

**Dual Axis, Dual Mode Horizontal or Vertical Mount**
**Dual Axis, Horizontal Mount**
**Vertical Mount Inclination Only**

**Applications**
- Platform Control, Stabilization, and Alignment
- Tilt Sensing, Inclinometers, Leveling
- Motion/Position Measurement
- Monitor/Alarm devices (security, medical, safety)
- Navigation
- Robotics

<table>
<thead>
<tr>
<th>Range</th>
<th>Sensitivity</th>
<th>Shock Survivability</th>
<th>Supply</th>
<th>Turn-on Time</th>
<th>Package</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>±30°, ±180°</td>
<td>0.025°/LSB</td>
<td>3500 g</td>
<td>3.0 to 3.6V</td>
<td>150ms / 2.5ms</td>
<td>9.2mm LGA</td>
<td>-40°C to +125°C</td>
</tr>
</tbody>
</table>
Using Methone as a Display Front End

Development PC
- LabVIEW Real-Time
- LabVIEW FPGA
- LabVIEW Touch Panel

- Ethernet
- Shared Variables
- NI Single-Board RIO Digital I/O
- Set Motor Speed
- Motor On Acknowledgement

- Real-Time Motor Control
- NI FPGA IPNet
- ADI MEMS Inclinometers

- VGA
- LVDS
- Touch Panel

Windows XP OS
NI Real-Time OS + FPGA

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Demo
LabVIEW Embedded Module for ARM Microcontrollers

- More than 260 supported processors
- Integrated drivers for analog, digital, and communications
- Desktop simulation support for software development
ARM Development Environment

Development Software

LabVIEW Development Environment
Keil µVision – Compiler and Linker

Programming and Debugging

Hardware

RTX RTOS
RL-ARM (Drivers)

ARM Processors
Elemental I/O
- Simple API for Analog, Digital, and PWM
Timed Loop
• Multithreaded programming
Peripheral Drivers
• TCP/IP, UDP, Serial, Display, I²C, SPI, File System
Integration with KEIL µVision

- Cycle-accurate simulation
- Advanced debugging
**Inline C Node**

- Combine graphical and text code in one diagram
How It Works

C Code Generation

My VI.vi

C Code Generation

My_VI.c
How It Works

Keil µVision

My_VI.c

Run

My_VI

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Deployment to Hardware

Download JTAG USB

Run

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Real-Time Debugging

Debugging via TCP, Serial, JTAG
Development Kit

• Included
  ▪ LabVIEW
  ▪ LabVIEW Embedded Module for ARM Microcontrollers
  ▪ ULINK2 USB/JTAG Adapter
  ▪ Evaluation Board

Learn more at [ni.com/arm](http://ni.com/arm)
Where to Get More Information

Product Information

• ni.com/compactrio
• ni.com/singleboard
• www.prevas.com/sbRIO_methone.html
• ni.com/arm

Displays

• http://zone.ni.com/devzone/cda/tut/p/id/7426

Design Resources

• http://zone.ni.com/devzone/cda/tut/p/id/2727