

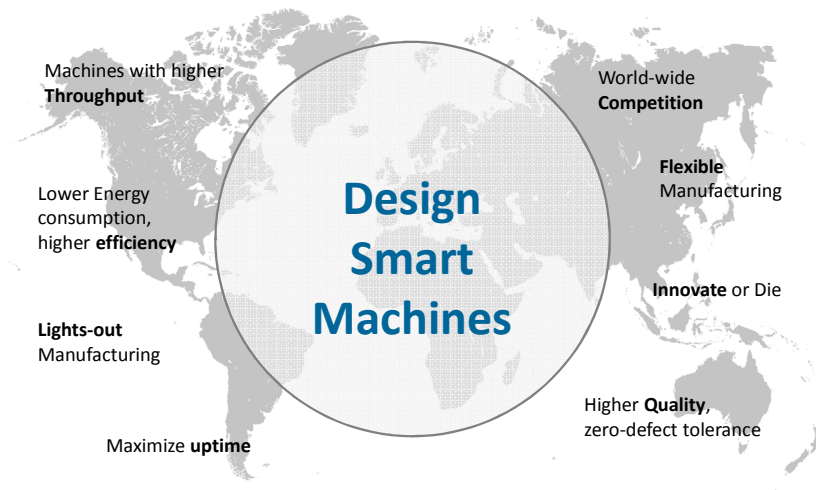
Strategies for Designing State-of-the-Art **Machine Control** Systems

NI Embedded Control & Monitoring Technology Day

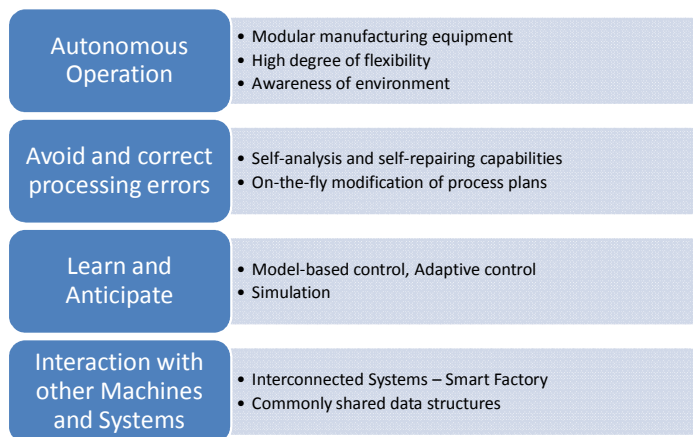
Agenda

- The world of machine builders
 - Trends
 - Key Concerns
 - Smart Machines
 - Design Challenges
 - Relevant Technologies
 - NI's value proposition
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The world of machine building



What is a Smart Machine



Design Challenges for Smart Machines

- Information about the environment, machine process and condition
 - Integration of different tasks within one controller
 - Networking and data storage
 - High-performance control systems
 - Time-to market pressure
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Application example: Wafer processing

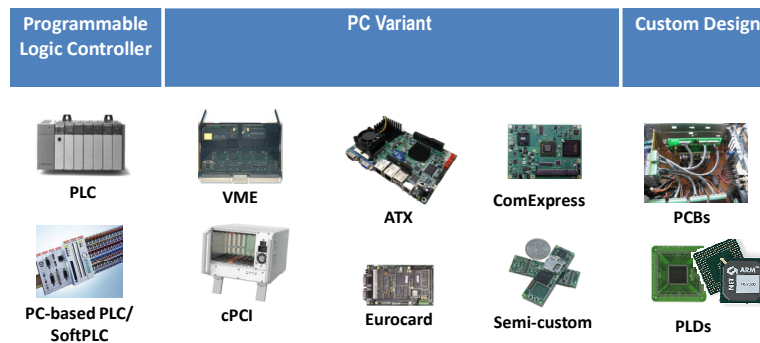
- New challenges:
 - New materials and thinner wafers require mechanical dicers to operate at lower speed
 - Wafer polishing machines need to take increasing temperatures and during the process into considerations
 - Opportunities for innovative machine builders:
 - Implementing a different cutting process leveraging laser technology
 - Adding measurements to the control loop to monitor the polishing process
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Key Technologies for Smart Machines

- Embedded Control and Monitoring Systems
 - Software Design Tools
 - Analog and specialty I/O
 - Machine Vision
 - Complex multi-axis Motion
 - Higher-efficiency and higher performance motors
 - Shift from mechanical to electrical components
 - Analysis and Signal Processing
 - Advanced Control IP and Simulation
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Embedded Control and Monitoring Hardware

Embedded Control and Monitoring Options



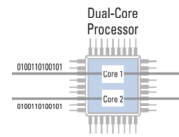
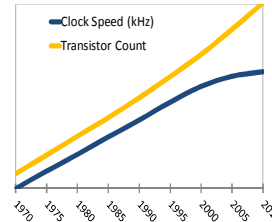
Machine Controller Trends

- OEM Machine Builder and End User relationship is changing
 - OEMs get more responsibility
 - Increased performance requirements
 - Multi-controller solutions
 - Increased importance of services offering
 - Customizable off-the-shelf solutions
 - Leveraging latest technologies
 - High-Level Software Tools
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Embedded Multicore Processors Technology

Faster processors → Multicore processors

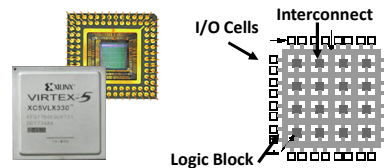
- Physics limits maximum clock speed for processors
- Combine two or more independent cores into a single IC
- Simultaneously execute multiple computing tasks
- Software Development tools need to support parallel execution



Programmable Logic Devices (PLD)

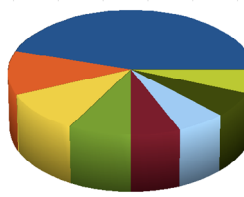
- **High Reliability** – Designs become a custom circuit
- **High Determinism** – Runs algorithms at deterministic rates down to 25 ns
- **True Parallelism** – Enables parallel tasks and pipelining
- **Reconfigurable** – Create new and alter existing task-specific personalities
- **IP Protection** – Source-Code can't be extracted from Bit stream

Software programmable
Hardware components like
FPGAs are widely used in the
industry



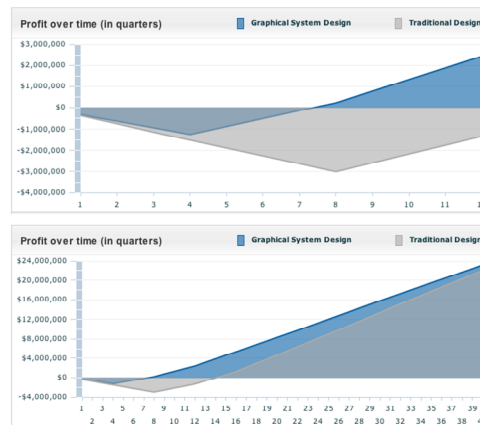
The Complexity of Custom Design

- Hardware and software costs
- Mechanical components (nonelectronic)
- EDA development tool costs
- Design specification and component selection
- Prototyping
- Hardware design
- Hardware test and verification
- Software development
- Software test and verification
- Mechanical design
- Manufacturing setup and tooling
- Manufacturing test
- Compliance and environmental engineering
- Documentation, training, and customer support
- Inventory management and EOL issues
- Sustaining engineering
- Opportunity cost

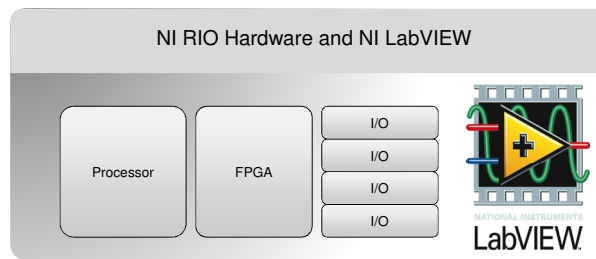


NI Build vs. Buy Online Calculator

- Designed for engineering management and decision makers
- Teams can get to market 50% faster with COTS
- Teams can use 20% less resources with COTS
- COTS is 4X hardware cost of custom
- www.ni.com/buildvsbuy



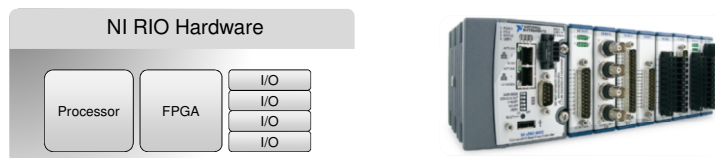
Hybrid Design Approach



Platforms that offer custom design features
with commercial off-the-shelf (COTS) productivity

NI RIO Technology

Off-the-Shelf Platform with Custom Capabilities



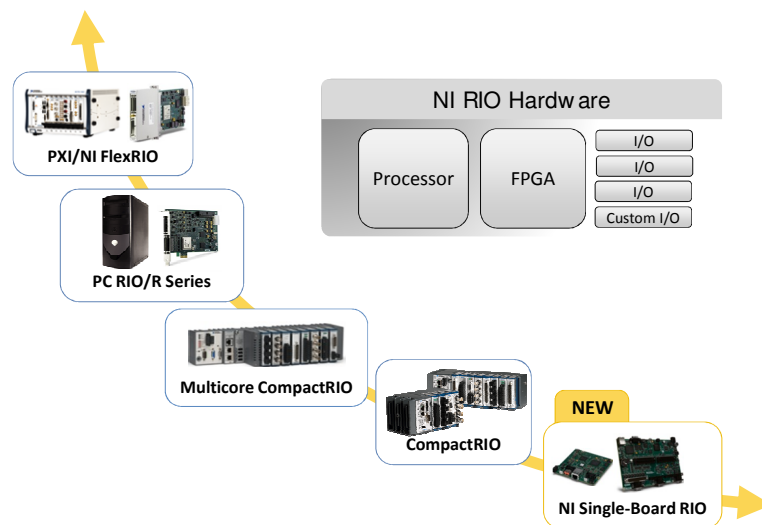
- Standard architecture through design, prototype & deploy
 - Standard software tool-chain across technologies and platforms
 - Integrated FPGA for custom processing, timing and control
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Scalability of NI RIO platform

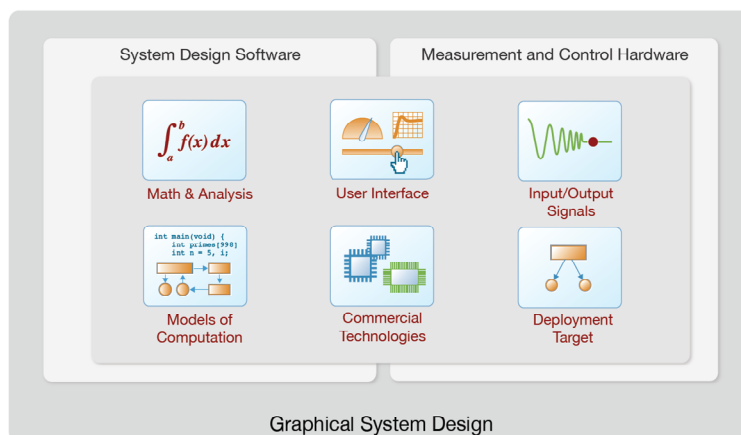
- 1.33 GHz Intel Dual Core i7 processor
 - Integrated HMI via VGA Graphics
 - Ability to deploy with LabVIEW Real-Time or Microsoft Windows Embedded Standard 7
 - Extensive connectivity and expansion options
 - MXI Express, dual Gigabit Ethernet, serial, USB



- 400 MHz Freescale PowerPC processor
 - RIO architecture on a single board
 - LabVIEW Real-Time OS
 - Xilinx Spartan-6 FPGA
 - RIO Mezzanine Card (RMC) connector
 - Boards with different I/O options available
 - Cost optimization for OEM applications



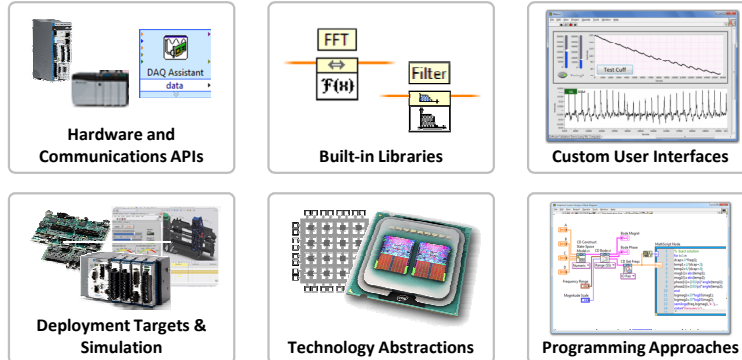
Software Design Tools



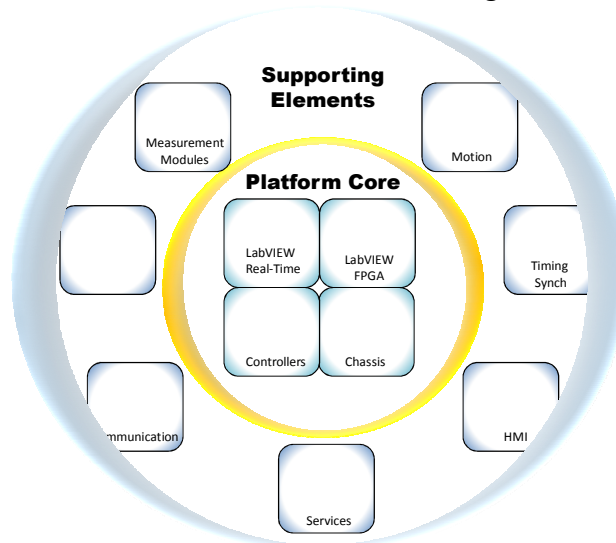
NI graphical system design provides a **reconfigurable software and hardware platform** for **faster** development of **any system that needs measurement and control**.



A Highly Productive Graphical Development Environment for Engineers and Scientists



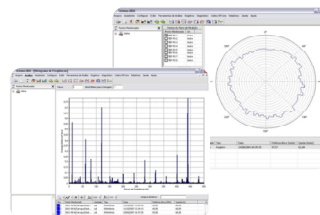
Embedded Control and Monitoring Platform



Analog and specialty I/O

Benefits of Analog and Specialty I/O

- Bring performance measurements in the control loop
 - Force Feedback Application
 - Specialty Sensors
- Condition Monitoring
 - Process monitoring
 - Machine Condition Monitoring
- Add quality inspection



Measurement Modules

7 Years | 100+ Modules

Accelerometer	Thermocouples	Motor Drive
Strain Gauge	4 to 20mA	Drive Interface
Load Cells	Isolation	Frame Grabber
Digital I/O	RTD	Ind. Communication
Microphone	Resistance	Encoder Input

and many more...



Custom I/O

CompactRIO C Series MDK 2.0

- Over 50 3rd-party modules to date
- Easier to develop 3rd-party modules
- Improved integration of 3rd-party modules within LabVIEW



RIO Mezzanine Card (RMC) for NI Single-Board RIO

- Enables customization for application specific I/O
- Ideal for embedded OEMs & Partners



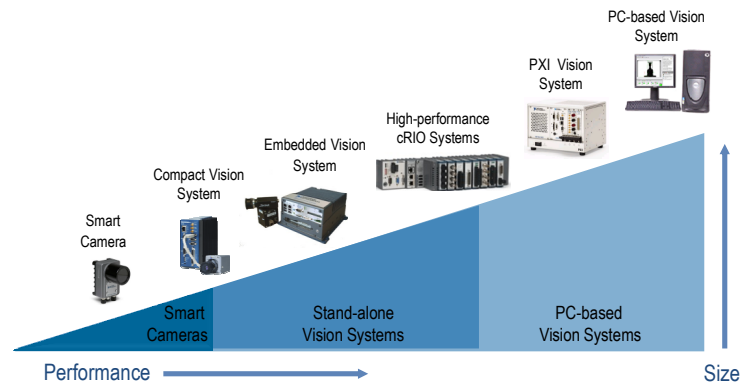
Machine Vision

Benefits of Machine Vision

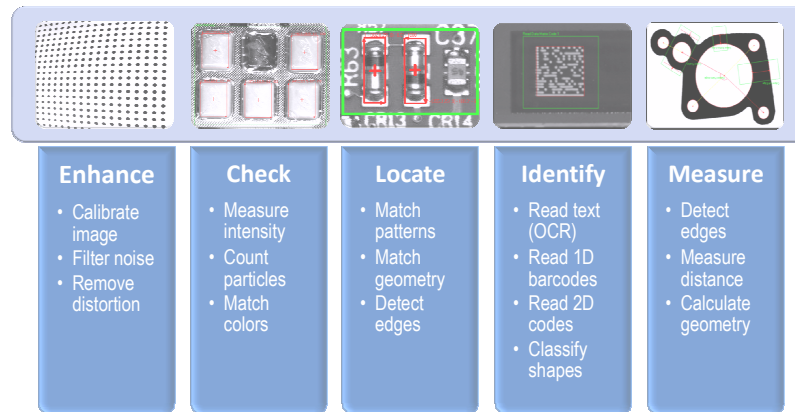
- High-speed sorting
- Traceability & identification
 - Bar code reading
 - OCR, Data matrix grading
- Web inspection
- robot or motion system guidance
 - Pick & Place
- Packaging inspection
- Defect Detection
- Etc.



NI Vision Products



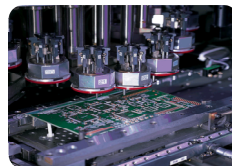
Software Libraries



Motion Control

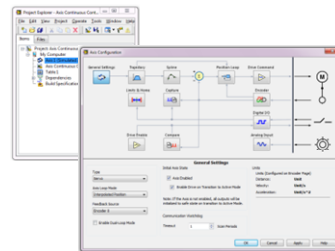
Benefits of Motion Control

- Abstracts the complexity of controlling motors
 - Trajectory generation
 - Supervisory control
 - Multi-axis synchronization
 - Advanced Motion Features
- Customization capabilities
- Simulation
- Integration with other automation tasks

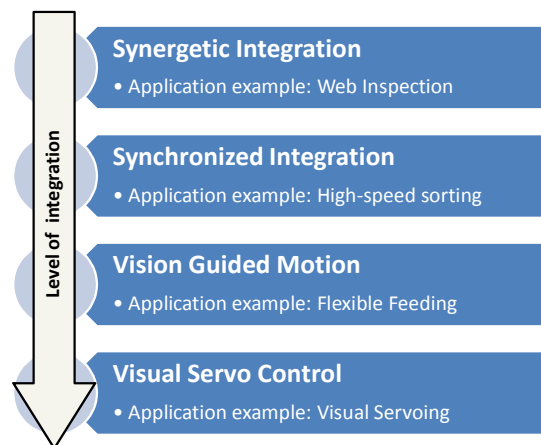


NI Motion Products

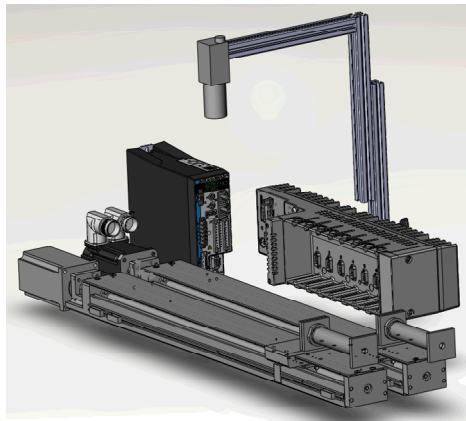
- Comprehensive Drive and Motor Offering
 - Best in Class performance
 - Stepper, Brushed Servo, & Brushless Servo options
 - Power and size ranges for industrial to embedded
- LabVIEW NI SoftMotion Module
 - Open Motor Control IP
 - Trajectory Generator
 - Supervisory Control
 - Open motion control APIs
 - Integrated Hardware Configuration



Advanced Motion-Vision Integration



Demo



Signal Processing, Analysis & Math

Benefits of Signal Processing, Analysis & Math

Machine Condition Monitoring

- Increase uptime
- Reduce spare parts and repair time
- Lengthen maintenance cycle
- Stop unscheduled outages
- Prevent catastrophic failure
- Avoid injury and environmental harm

Process Monitoring

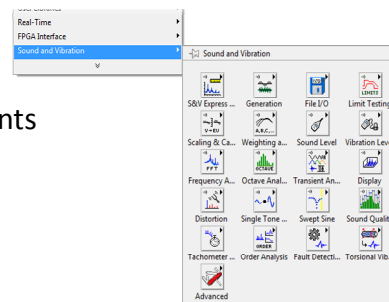
- Reduce scrap and raw material use
- Increase product quality
- Increase production output
- Optimize machine performance and efficiency

Advanced control

- Bring additional information in the control loop
- Force Feedback
- Vibration suppression

Extensive library of signal processing and analysis functions

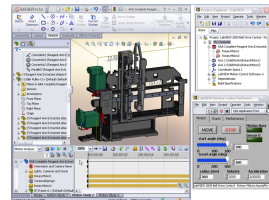
- Vibration Measurements
- Tachometer Analysis
- Order Analysis
- Limit Testing



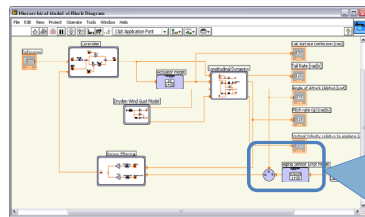
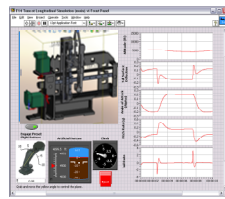
Advanced Control IP and Simulation

Virtual Prototyping

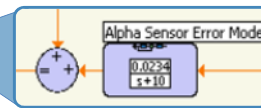
- Design your motion application using NI LabVIEW and NI SoftMotion
- Validate the motion profiles using DS SolidWorks
- Optimize the design before building a physical prototype
- Identify design issues across mechanical/electrical boundaries
- Visualize realistic machine operation



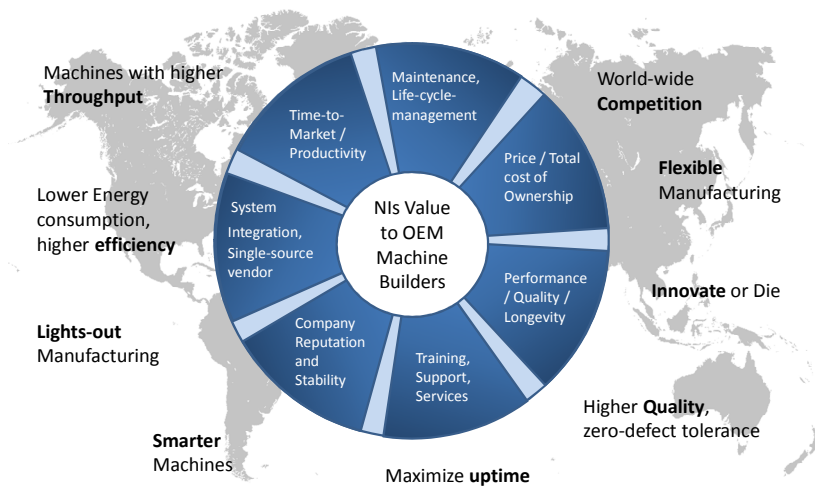
Dynamic System Simulation & Control

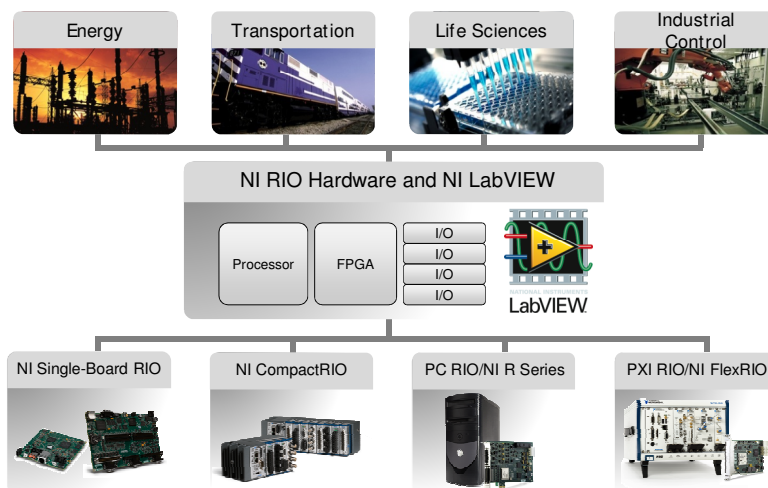


- Simulation of dynamic systems
- System Identification
- PID and Fuzzy Logic Control
- Simulation Interface
- Real-time implementation for rapid control prototyping or hardware-in-the-loop simulation



National Instruments Value Proposition





**Thank you for attending the
NI Embedded Control & Monitoring
Technology Day**

**For more information, please visit
www.ni.com/embeddedsystems**

