Outline

- Introduction to National Instruments
- Control Applications in LabVIEW
- Our Verification Tools Today
- Our Verification Tools Tomorrow
INTRO TO NATIONAL INSTRUMENTS
Corporate Background

- Leaders in Computer-based Measurement and Automation
- Long-term Track Record of Growth and Profitability
- $677 M Revenue FY 2009; $202 M Revenue in Q4 2009
- More than 5,000 employees; operations in 40+ countries
- R&D Investment: 16% of Annual Income
- *Fortune’s* 100 Best Companies to Work For: 12 Consecutive Years
National Instruments in Academia

- 110 Countries
- Adopted in 6,000+ universities worldwide
- Used in all engineering and science disciplines
Diversity of Industries

Telecom

Automotive

Semiconductors

Electronics

Computers

ATE

Military/Aerospace

Advanced Research

Petrochemical

Food Processing

Textiles
CONTROL APPLICATIONS IN LABVIEW
What is LabVIEW?

Front Panel

Block Diagram
What is LabVIEW?

- Distributed Intelligence
- Multiple Programming Models
LabVIEW is a Programming Language

• Graphical Programming (often called ‘G’)
  • Data types
  • Structures (i.e. loops, case, event handling)
  • Standard functions (i.e. File I/O)
• Reuse external code
• Compiles to machine code
• Automatic multithreading
Dynamic System Simulation & Control

- Both signal flow and .m file development
- Single environment for:
  - Simulation of dynamic systems
  - Real-time implementation for rapid control prototyping or hardware-in-the-loop simulation
Deployment Curve

System Flexibility and Price

Number of Systems Deployed

13
Tough Real-Time Challenges

Large Telescope Mirror Control
Tokomak Plasma Control
Wind Turbine Sound Source Characterization
CERN Hadron Collider
Early Cancer Detection
Structural Monitoring
ESO - ELT – Primary Mirror (M1) Control

984 MIRRORS

3,000 ACTUATORS

6,000 SENSORS

3k x 6k MATRIX

1 MILLISECOND
High Speed & High Precision Control with Real-Time & FPGA

Scanning Probe Microscope w/ PLL

Ultrastable Atomic Force Microscope

Nanoimprint Lithography

Precision Servo-Hydraulic Control
Biomedical Design

Controlled pacifier

Robotic rehabilitation

Closed-loop control of anesthesia

Breast tumor treatment device
OUR VERIFICATION TOOLS TODAY
Hardware in the Loop

ABS ECU Hardware

Actuator Software Model

Solenoid Signals

Vehicle Motions

CarSim

Brake Forces/Torques

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LabVIEW Unit Test Framework Toolkit

- Validation
- Dead code identification
- Identify behavior-modifying changes
NI VeriStand

• Test sequence creation & reuse
• Dynamic pass/fail analysis
• Real-time stimulus generation
• Event alarming & response
NI VeriStand
High-Level Design Models

- Data Flow
- C Code
- Textual Math
- Simulation
- Statechart

LabVIEW™
Graphical System Design Platform

- PC/Mac/Linux
- PXI
- CompactRIO
- FlexRIO
- Custom

ni.com
OUR VERIFICATION TOOLS TOMORROW
Analyzing LabVIEW Code

• G in its current state is very expressive

• G can be ‘pruned’ to achieve greater analyzability

• Enables tools to accelerate V&V and certification
Future Work

• Definition of an analyzable subset of G

• Refinement of LabVIEW Statecharts

• Development of formal verification tools

• Collaboration with YOU