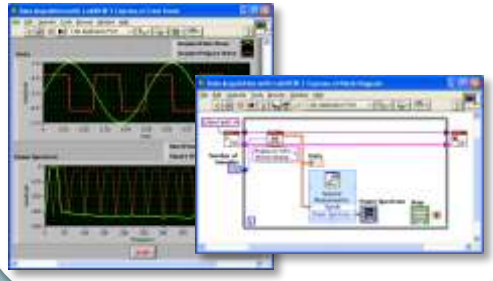
NI Days 2009

Stockholm, Sweden

What We Do

Low-Cost Modular Measurement and Control Hardware

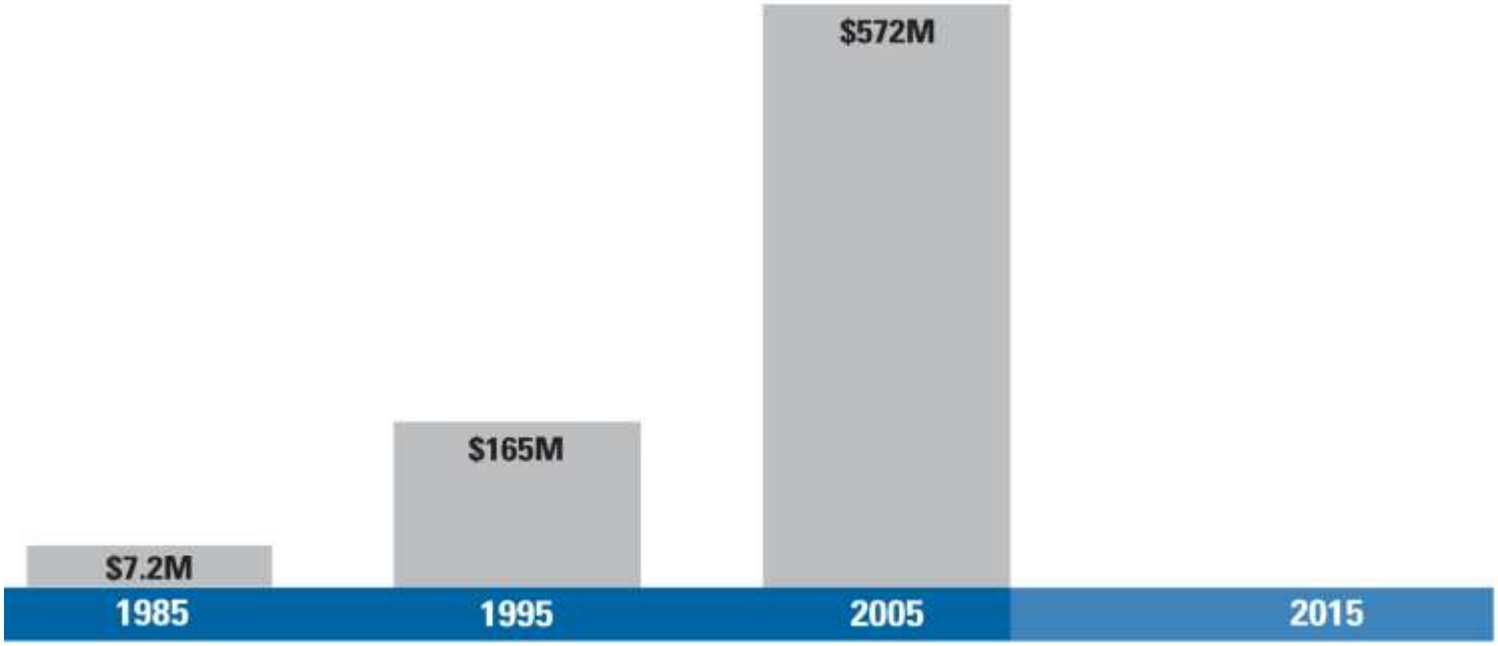
Productive Software Development Tools



Highly Integrated Systems Platforms

Used By Engineers and Scientists for Test, Design and Control

NI: Decades of Innovations



First Decade

1985: Self-financing with GPIB

Second Decade

1995: Virtual Instrumentation with GPIB, NI LabVIEW, and DAQ

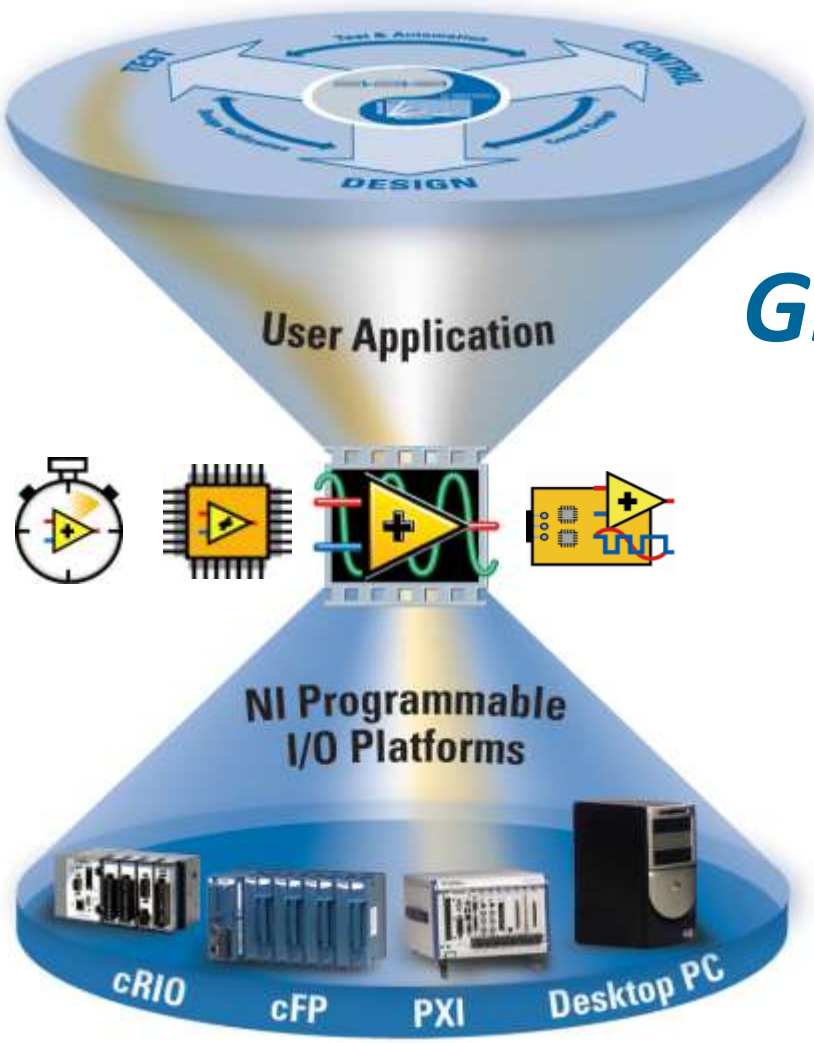
Third Decade

2005: Measurement and Automation (Modular Instruments and systems – PXI, FieldPoint, and CompactRIO)

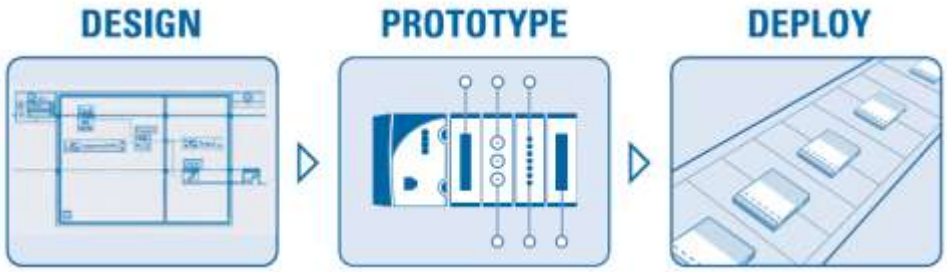
Fourth Decade

2015 : Test & Measurement and Graphical System Design

Virtual Instrumentation *Evolved …*



Graphical System Design



Charles Schroeder

R&D Section Manager, FPGA-based products for Test

- As a section manager in research and development, Charles Schroeder is responsible for the business strategies, architectures, and product development of test products that combine cutting-edge measurement technologies with user programmable FPGAs.

- Schroeder joined NI in 1993 and has held several positions in the company. He began his career as a hardware design engineer and has since held R&D leadership positions in several product areas.

- In his current role, he is working to combine his knowledge of customer applications and needs with his deep understanding of FPGA technologies to re-write the “rules” of the test industry, allowing test customers to define their own measurement hardware through the programming model of LabVIEW FPGA.

- Schroeder is a co-holder of several patents and an author of several technical papers. He has both Bachelor’s and Master’s degrees in Electrical Engineering from Texas A&M University.

Leveraging Technologies to Solve the Next Generation of Engineering Challenges

Charles Schroeder

R&D Section Manager

NIDays 2009

Engineering Grand Challenges


Make solar energy economical


Provide energy from fusion


Develop carbon sequestration methods


Manage the nitrogen cycle


Provide access to clean water


Restore and improve urban infrastructure


Advance health informatics


Engineer better medicines


Reverse-engineer the brain


Prevent nuclear terror


Secure cyberspace


Enhance virtual reality


Advance personalized learning


Engineer the tools of scientific discovery

Source: www.engineeringchallenges.org

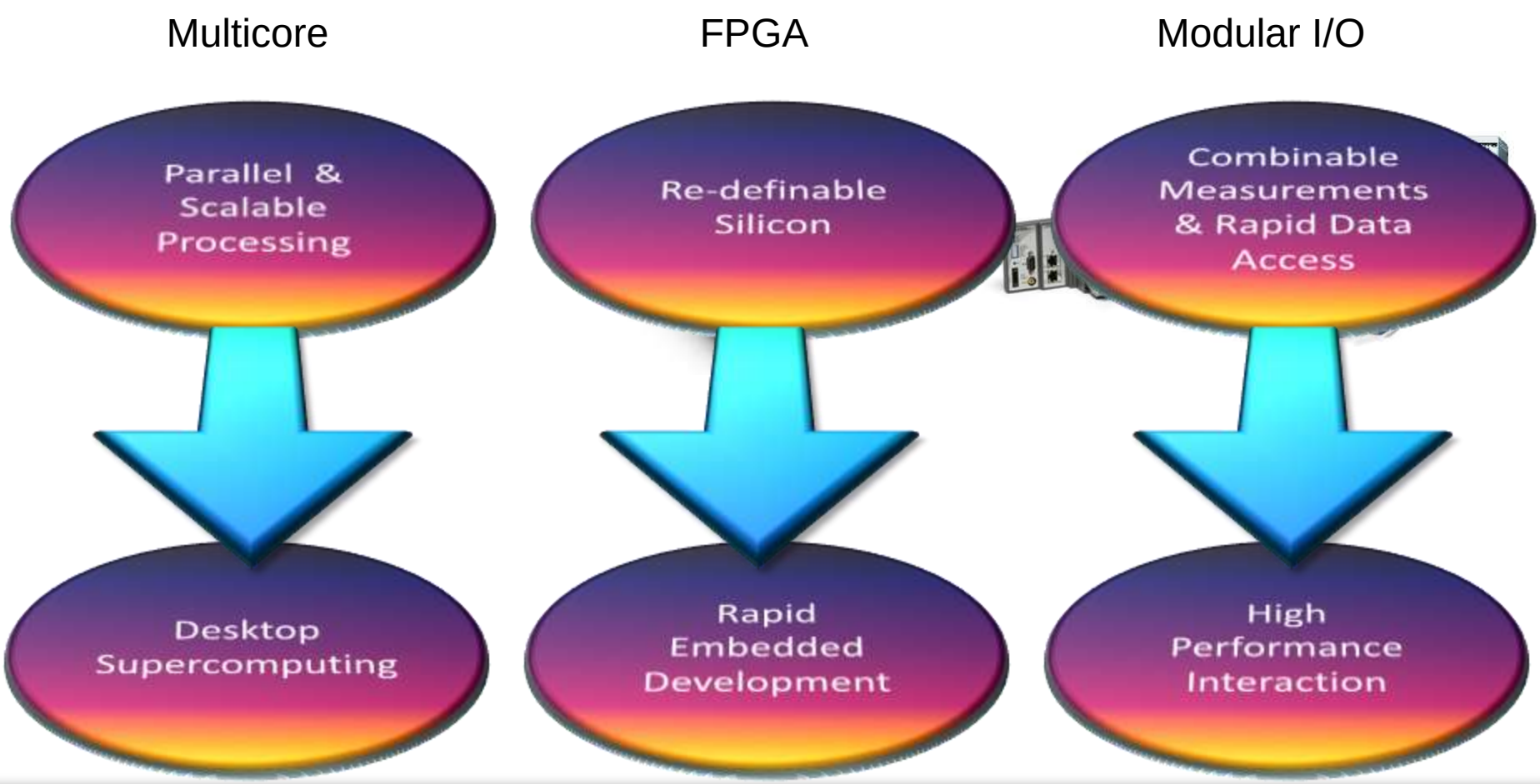
Today's Technology: Core Value

Multicore

FPGA

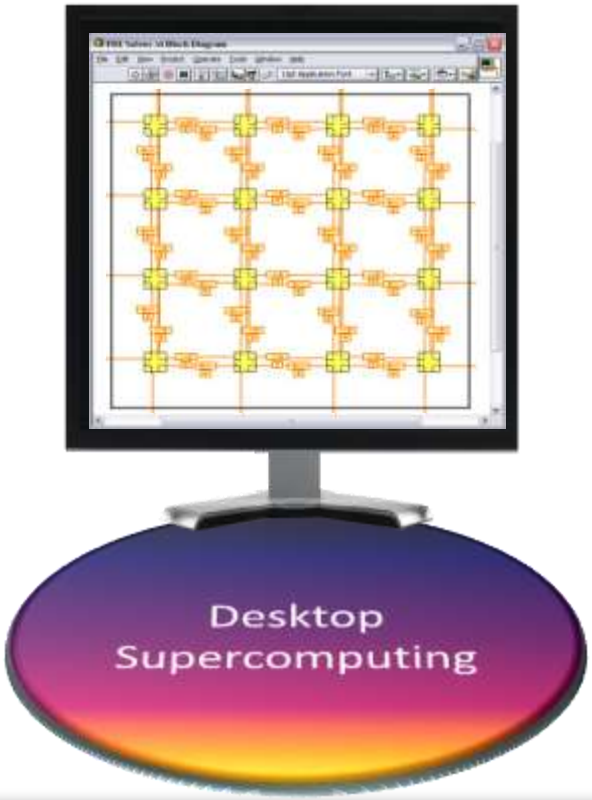
Modular I/O

Today's Technology Potential

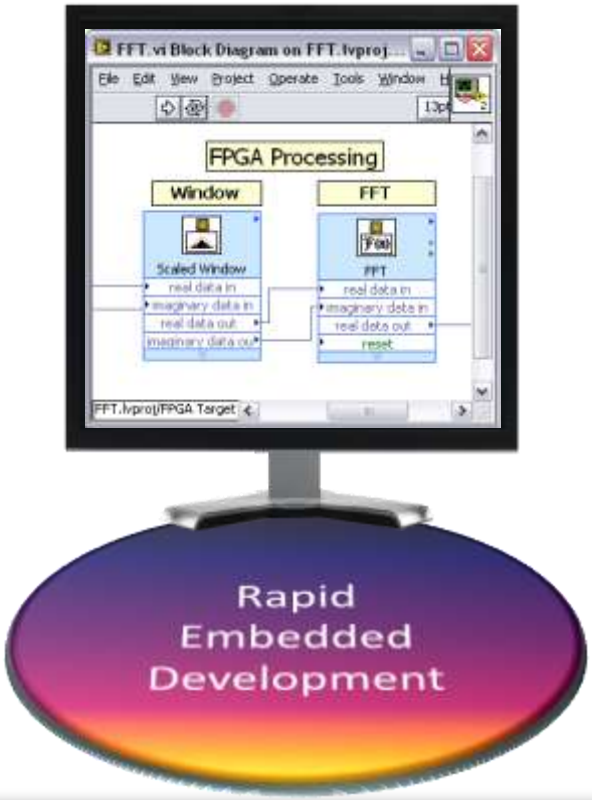


Access through Graphical Programming

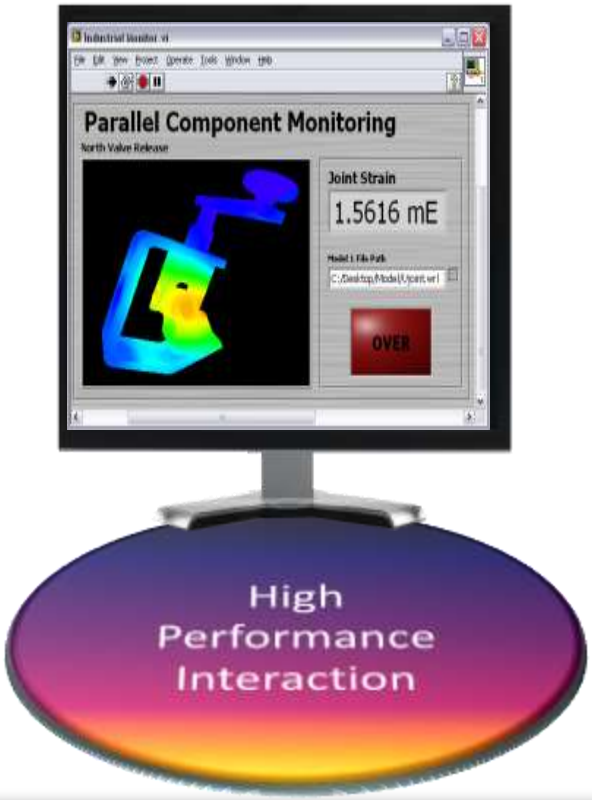
Multicore



FPGA



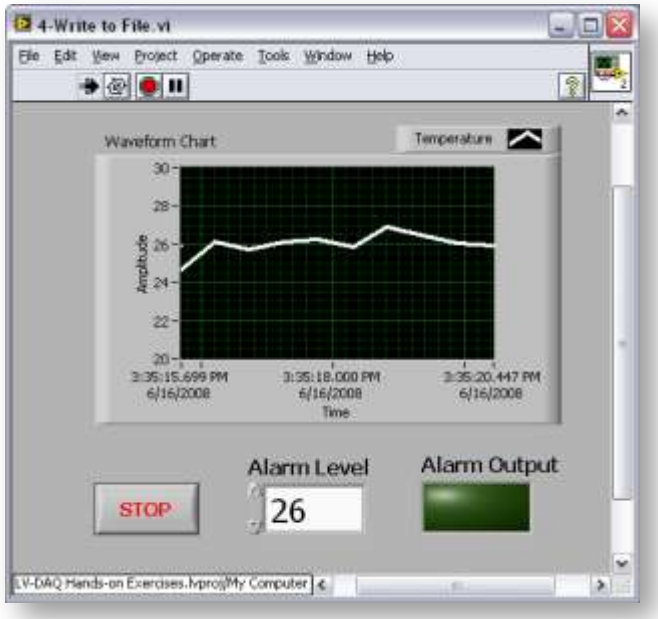
Modular I/O

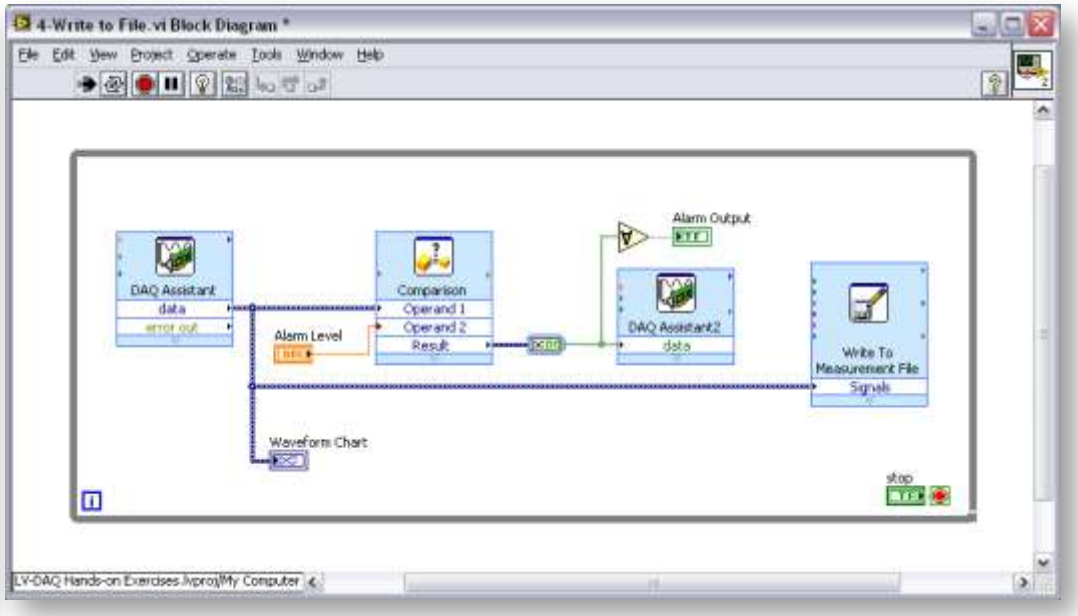


Graphical Programming:

Simplifying Design of Complex Engineering Systems

- Symbolic
- Dataflow
- Hierarchical
- Interactive
- Inherent User Interface



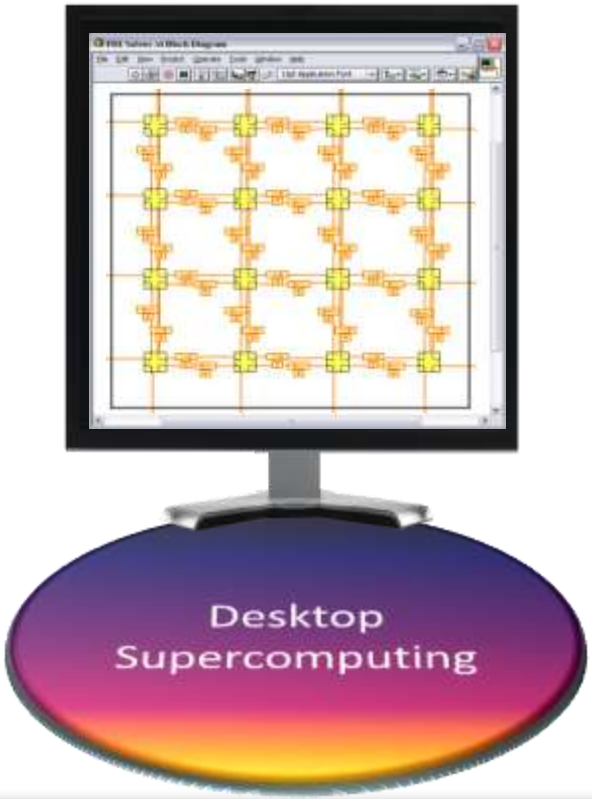


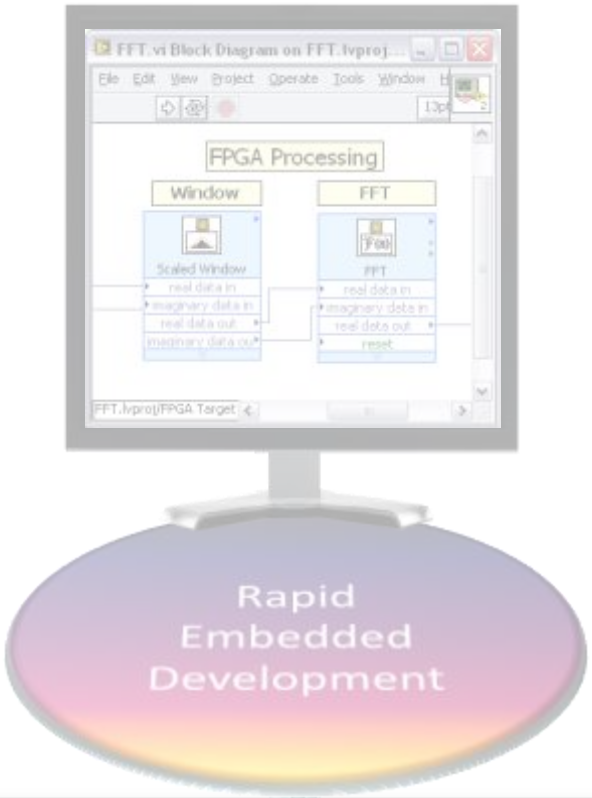
Access through Graphical Programming

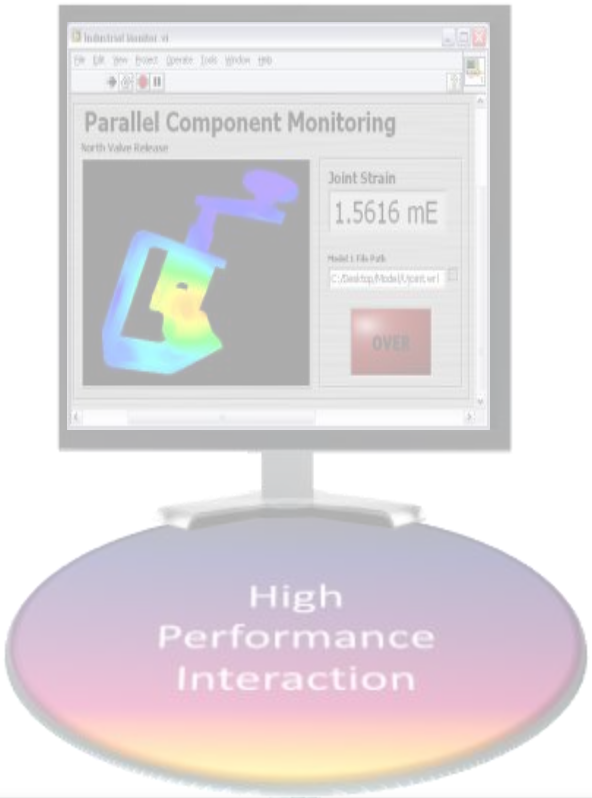
Multicore

FPGA

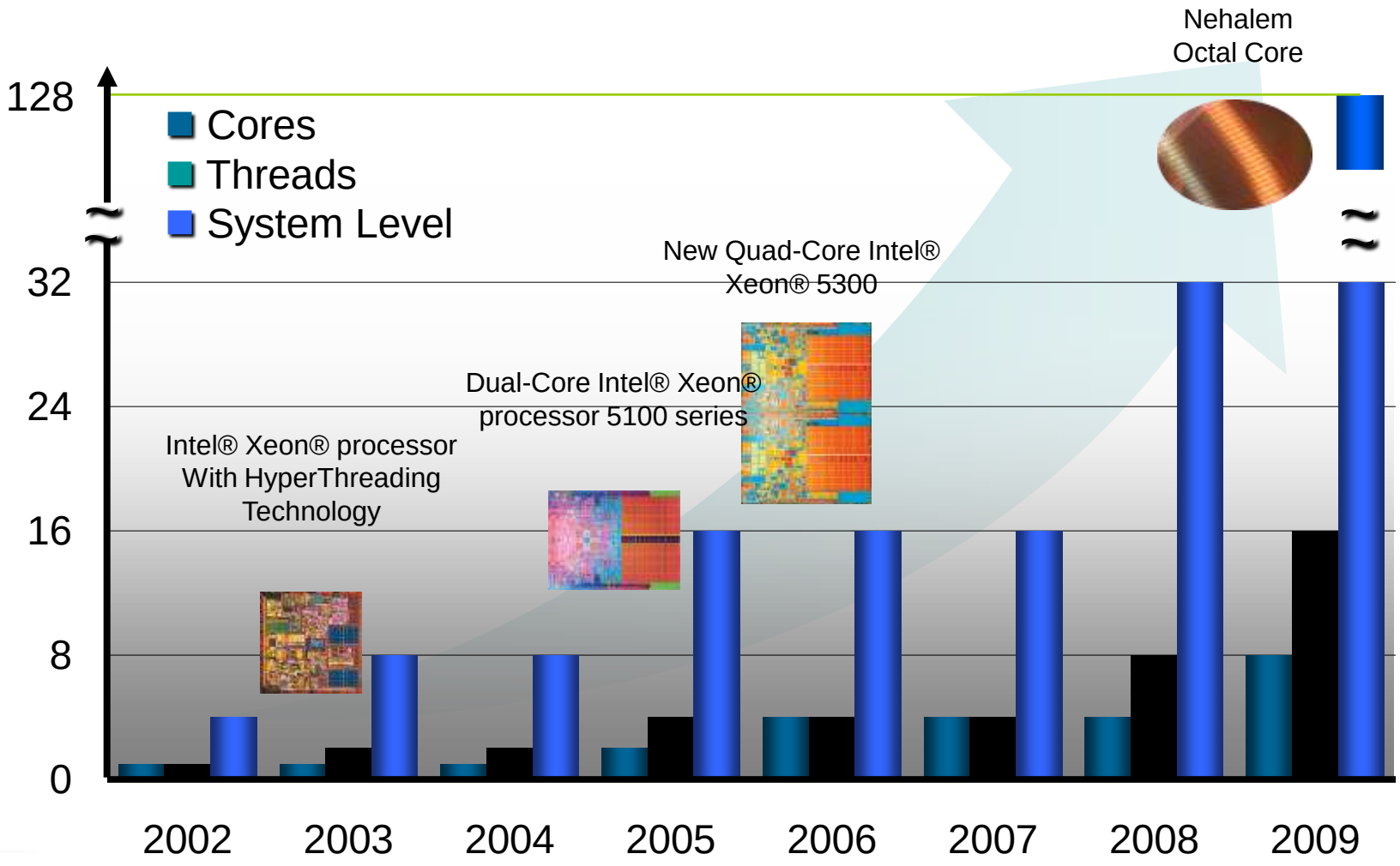
Modular I/O





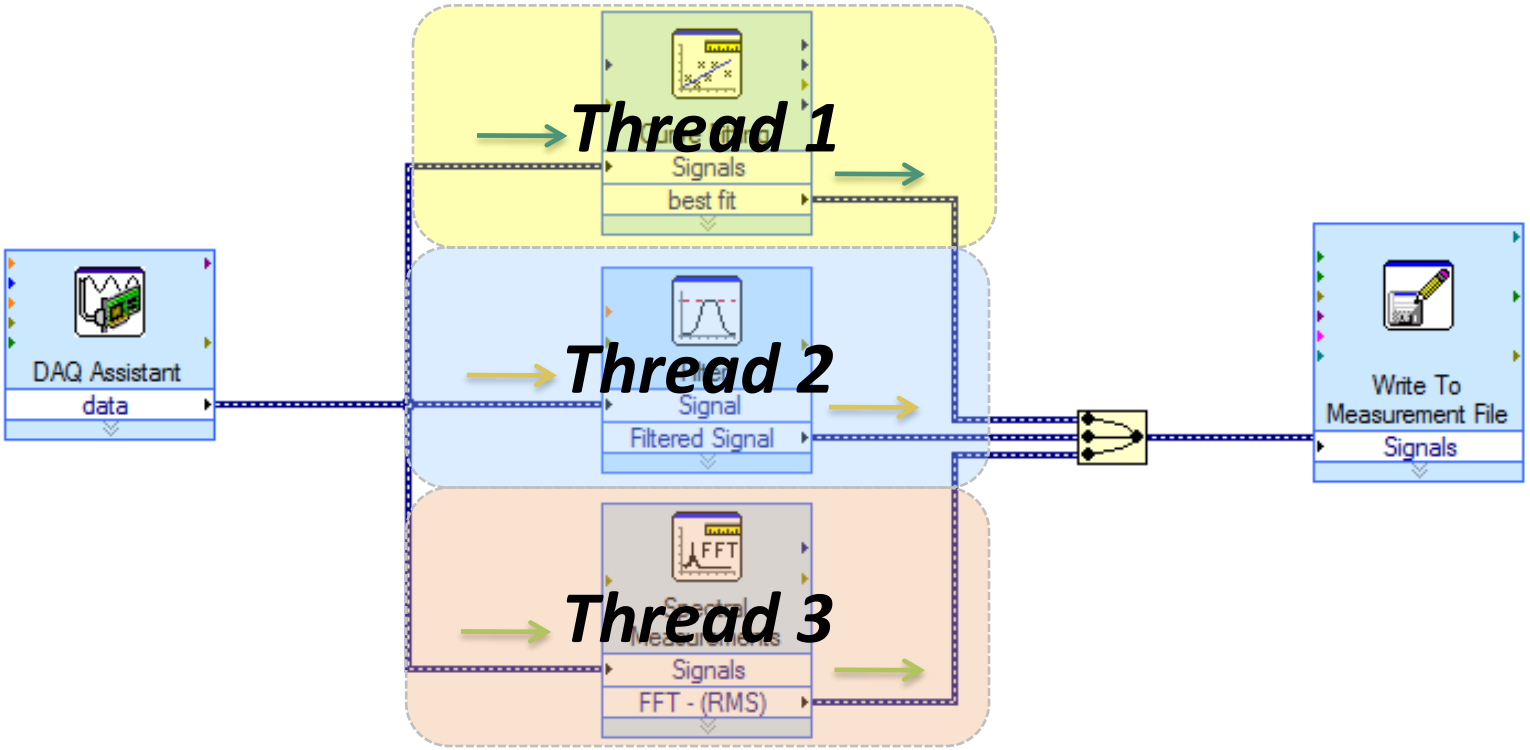


Multi-core: Scalable Parallel Processing



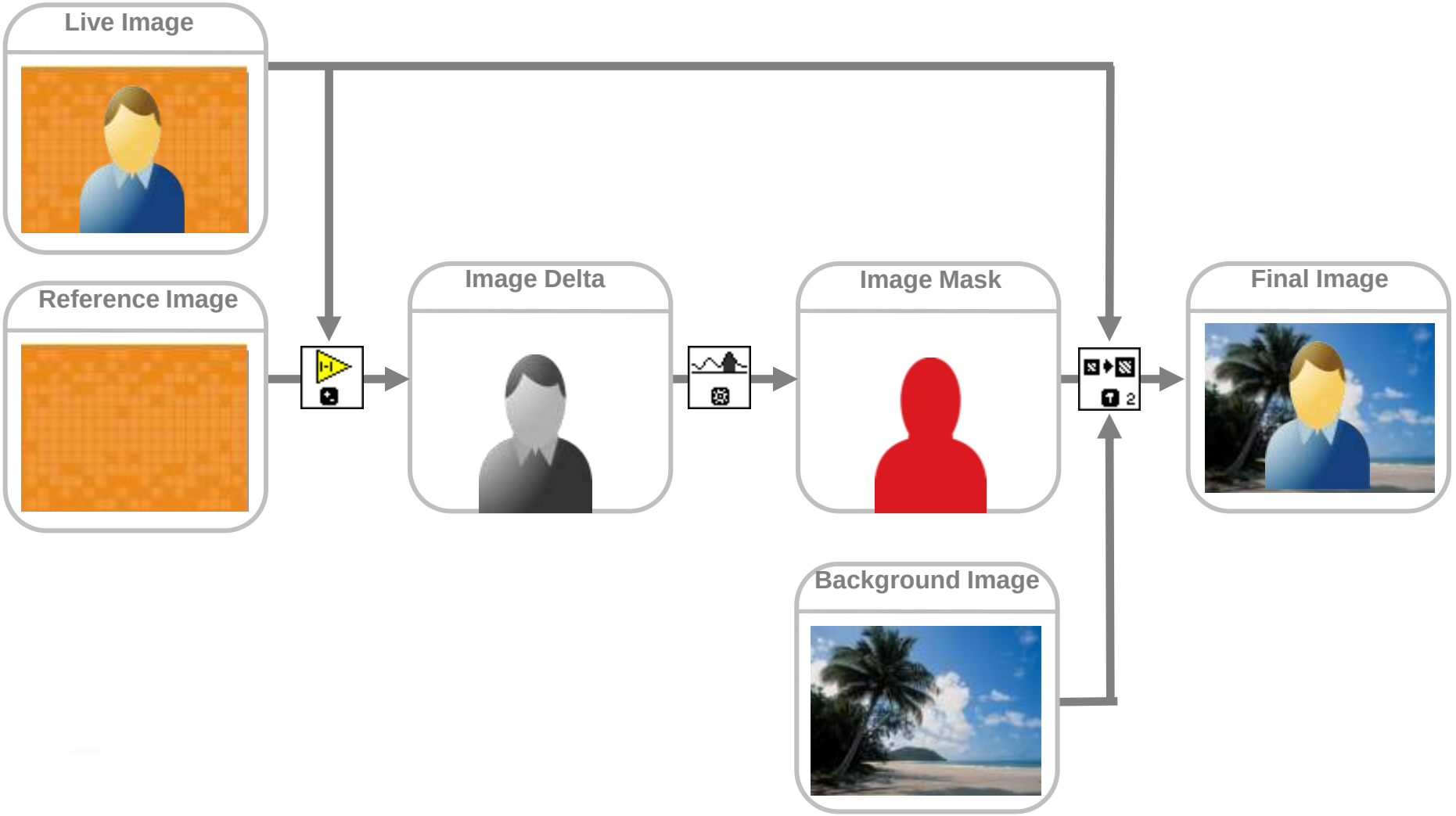
Courtesy: Intel Corporation

Realizing the Potential:
Inherent Access to Automatically Scalable Parallelism

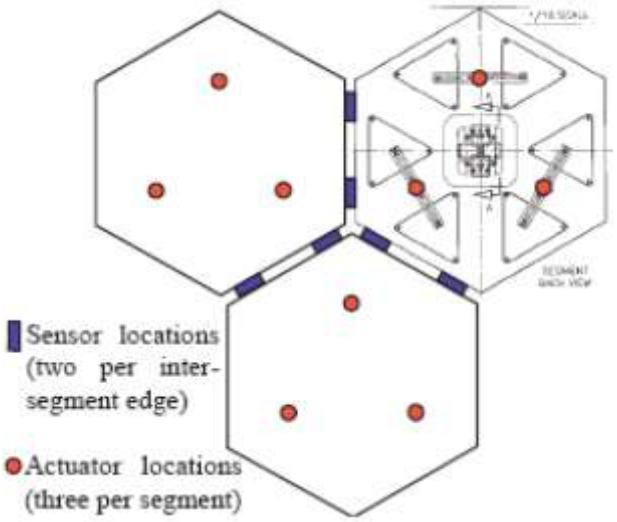


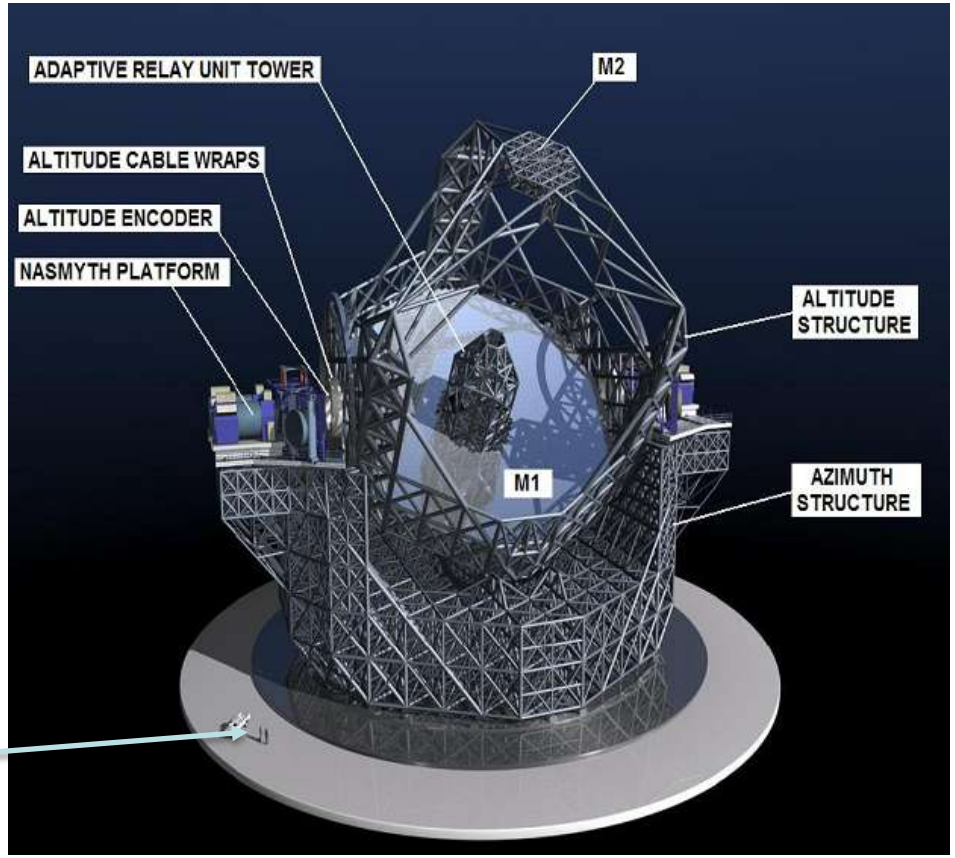
10 Year Anniversary of Multithreading

Demo: The LabVIEW Green Screen



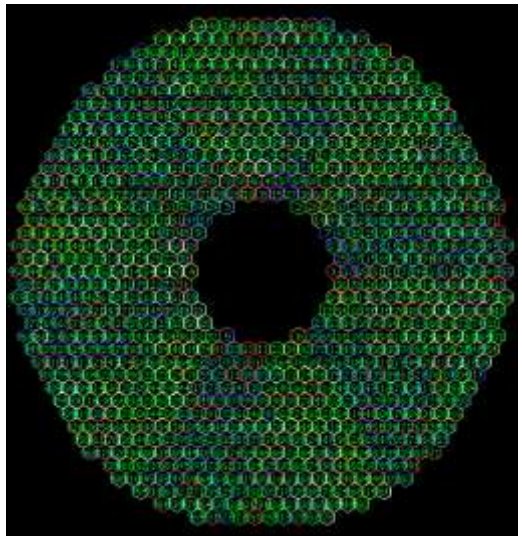
1 Case study I – Extremely Large Telescope



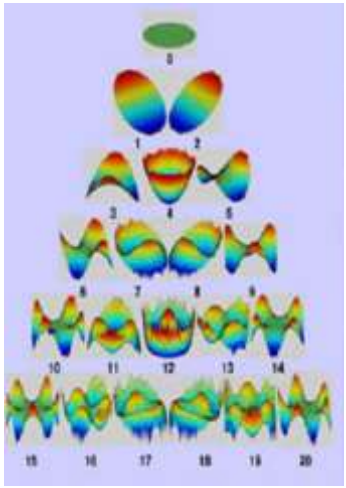


Physicists are getting smaller these days!

1 Case study I – Extremely Large Telescope

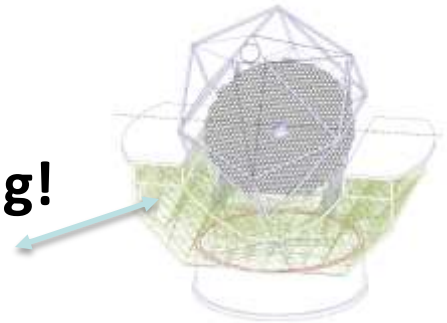


M1 – mirror
984 hexagonal mirrors
6 sensors/3 actuators each
1 ms



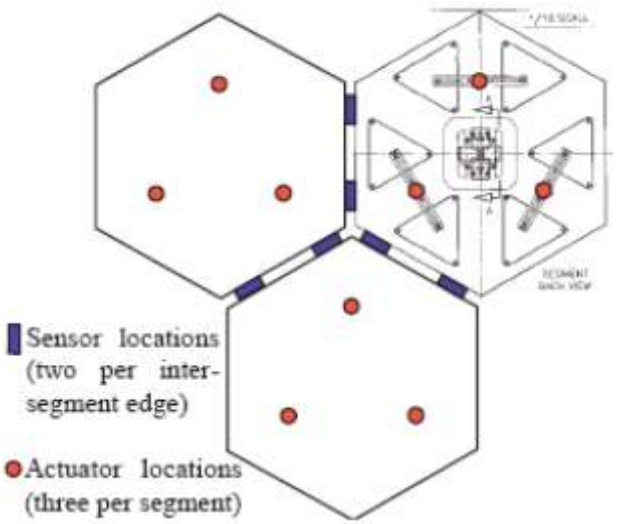
Fight the modes!
Translates into large matrix operations (3K-by-3K)

Shaking!



1 Case study I – Extremely Large Telescope

Sensors **break all the time** (actually, every other night)



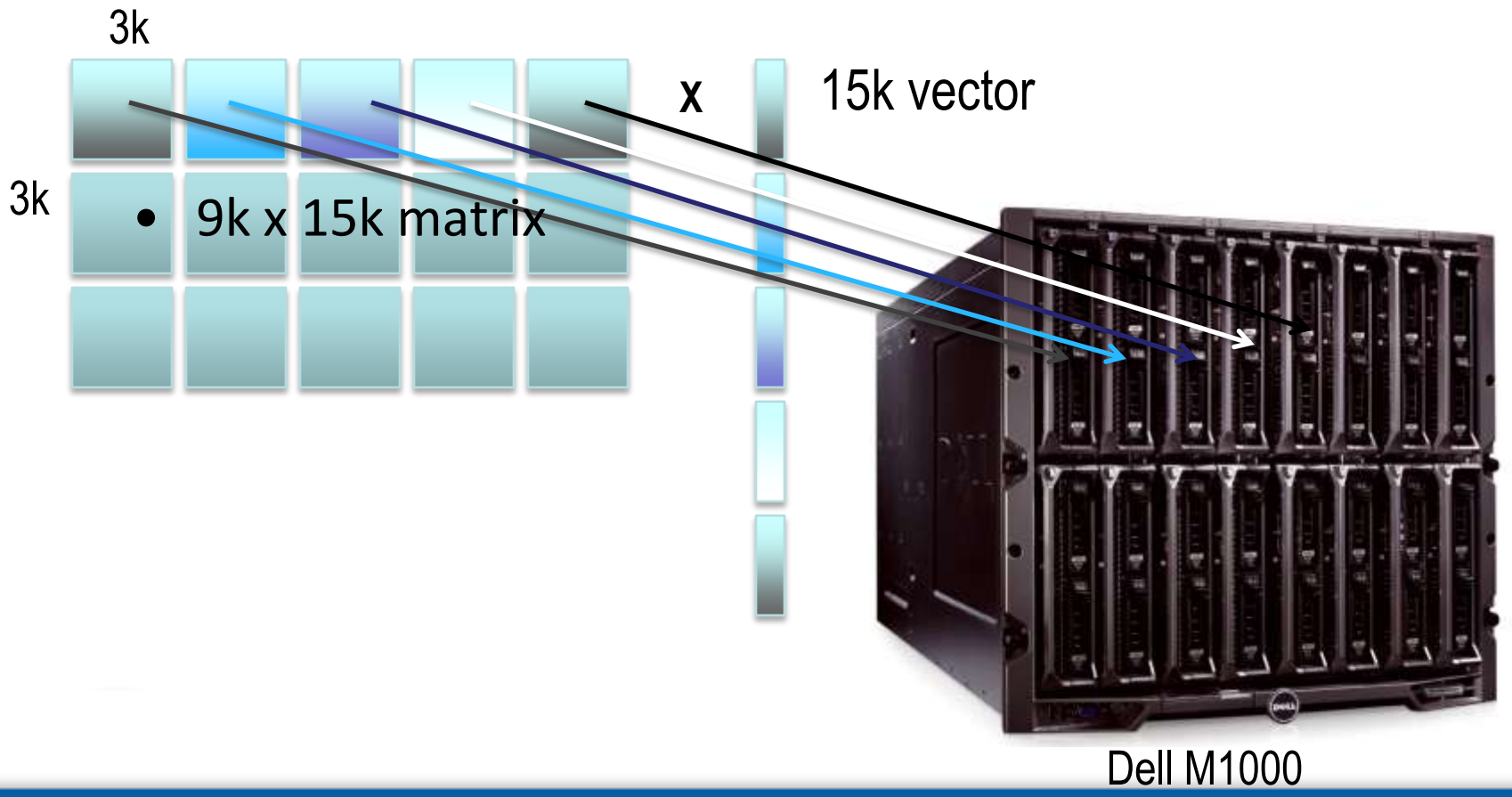
$$pinv(newIM) = (newIM^T newIM)^+ newIM^T$$
$$= ((IM - e_i a_i^T)^T (IM - e_i a_i^T))^+ (IM - e_i a_i^T)^T$$
$$= (IM^T IM - a_i a_i^T)^+ (IM^T - a_i e_i^T)$$

$$(IM^T IM - a_i a_i^T)^+ = (IM^T IM)^{-1} + \frac{(IM^T IM)^{-1} a_i a_i^T (IM^T IM)^{-1}}{1 - a_i^T (IM^T IM)^{-1} a_i}$$
$$= (IM^T IM)^{-1} + \frac{b_i b_i^T}{1 - a_i^T b_i}$$

$$pinv(newIM)ES = ((IM^T IM)^{-1} + \frac{1}{1 - a_i^T b_i} b_i b_i^T)(IM^T - a_i e_i^T)ES$$
$$= (IM^T IM)^{-1}(IM^T \cdot ES) - (IM^T IM)^{-1} a_i \cdot es_i +$$
$$\frac{b_i^T (IM^T \cdot ES) - (a_i^T b_i) \cdot es_i}{1 - a_i^T b_i} b_i$$

Requires to recalculate pinv of 3K-by-3K matrix in 100 ms
→ Sherman Morrison

1 Adaptive Optics
Distributing LabVIEW computations

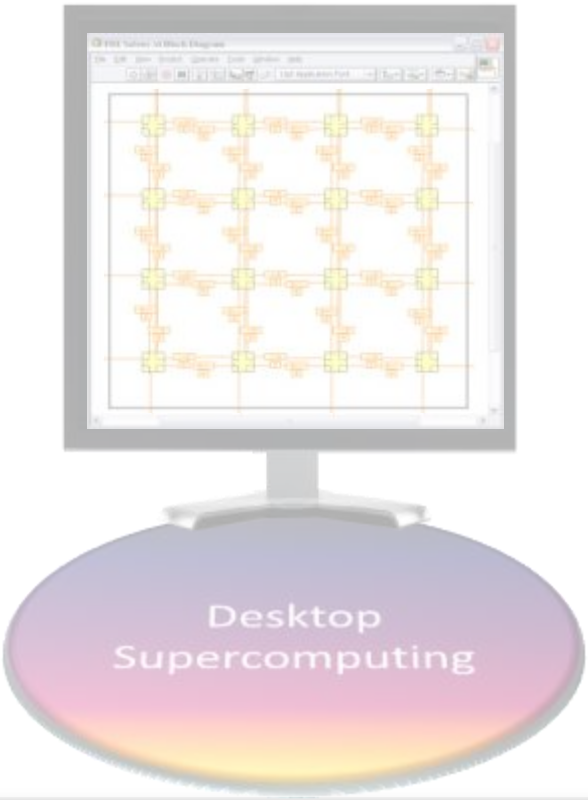


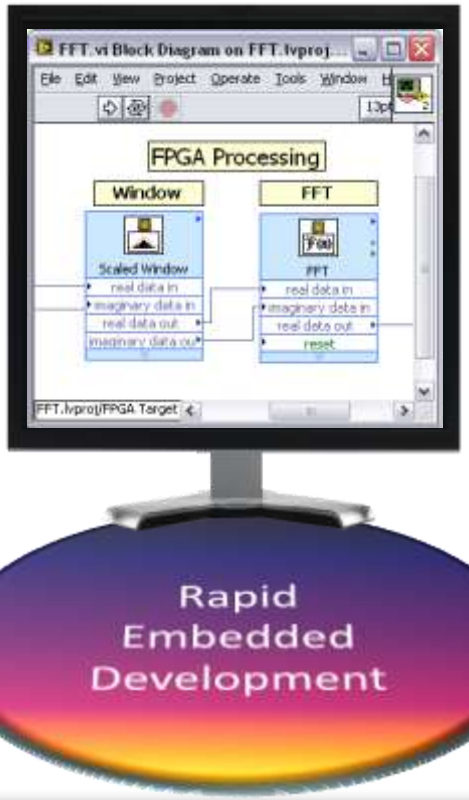
Access through Graphical Programming

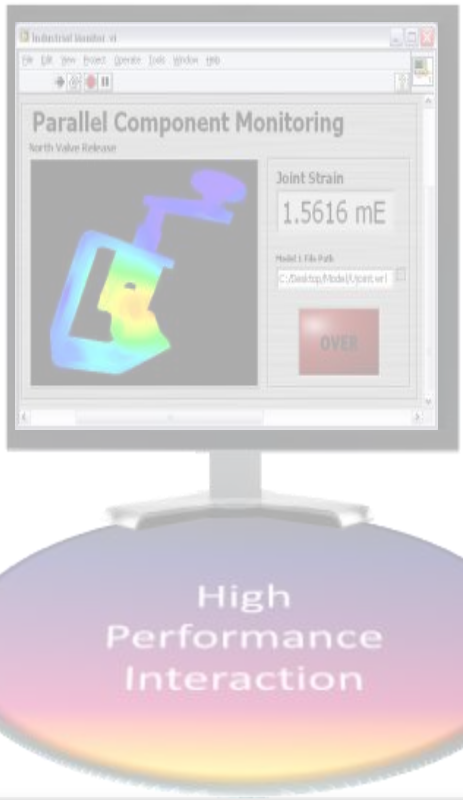
Multicore

FPGA

Modular I/O







Desktop Supercomputing

Rapid Embedded Development

High Performance Interaction

Advances in FPGA Technology

Size

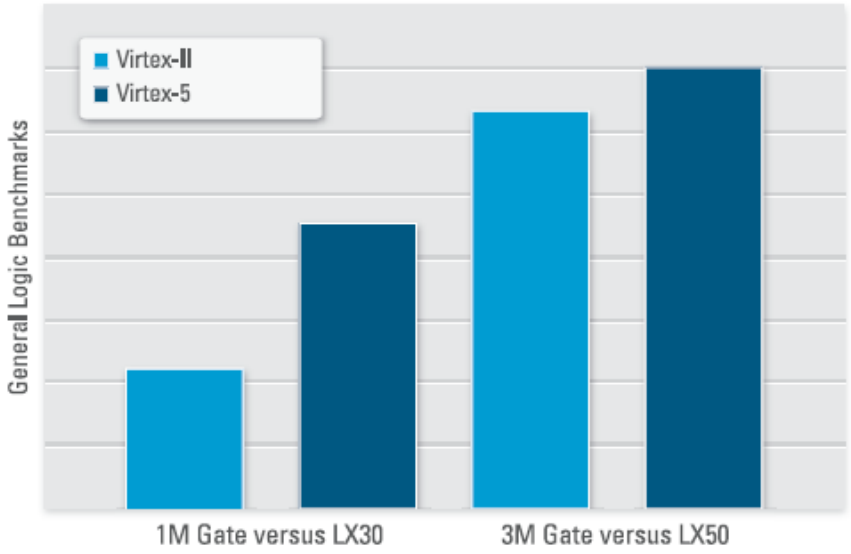


Figure 1. General logic benchmarks show that Virtex-5 FPGAs offer larger sizes when compared to Virtex-II FPGAs.

Speed

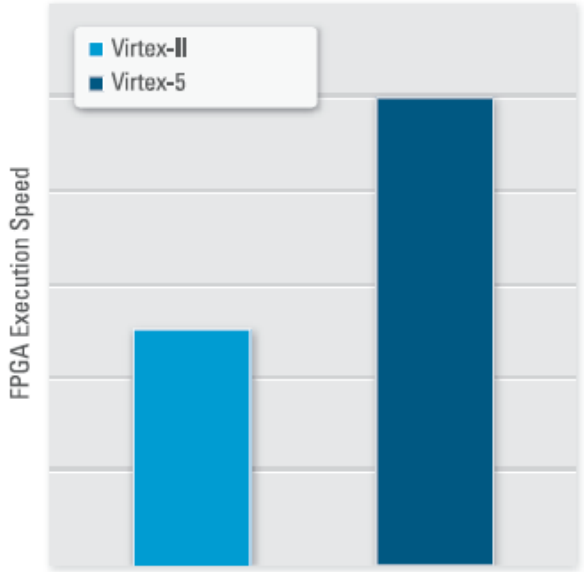
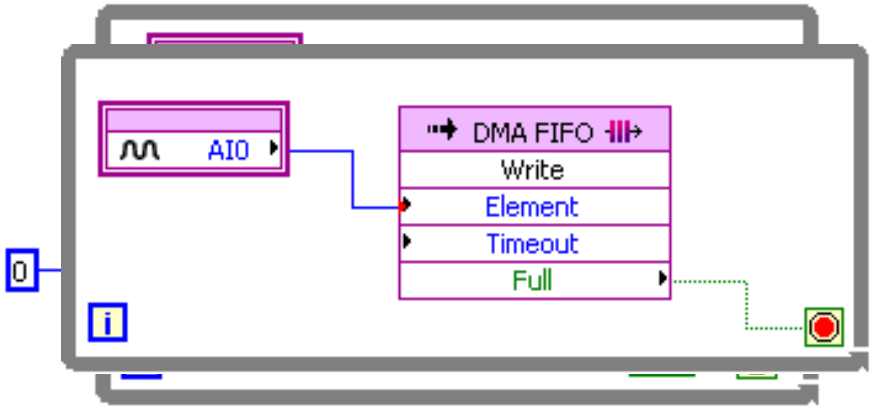


Figure 2. Execution speed benchmarks show that Virtex-5 FPGAs feature faster processing capabilities when compared to Virtex-II FPGAs.

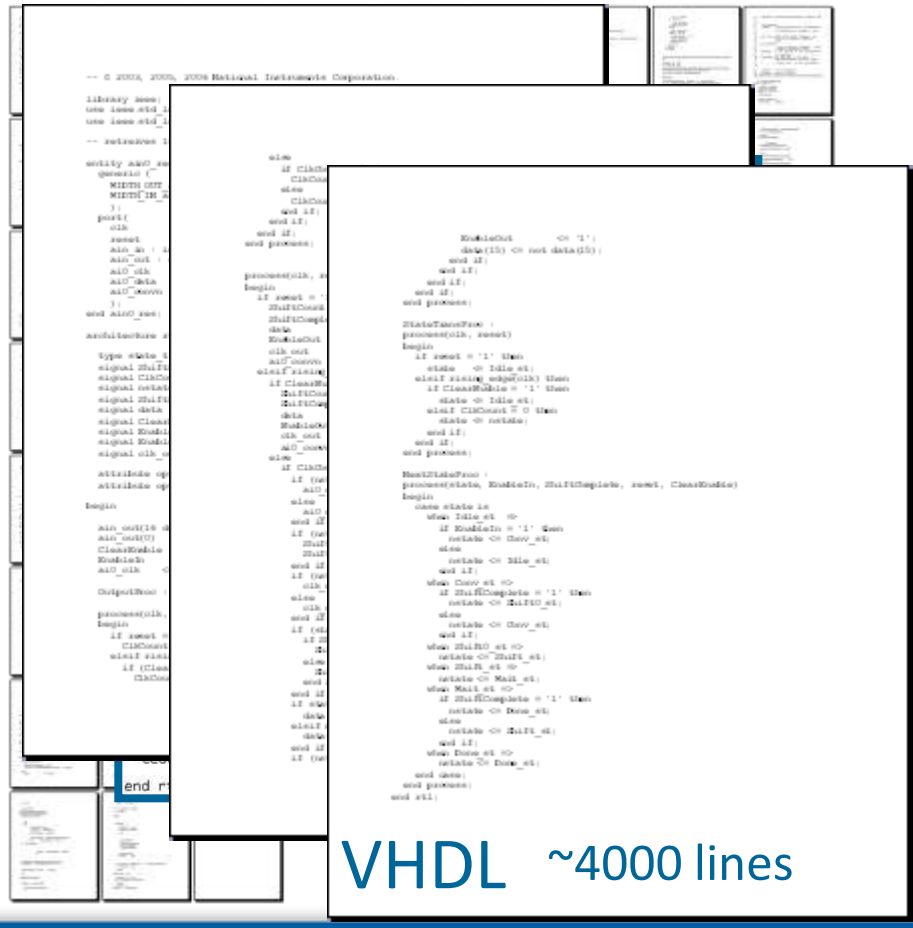
Realizing the Potential

Simplifying Access to FPGAs

Counter | **Analog I/O** | **I/O with DMA**



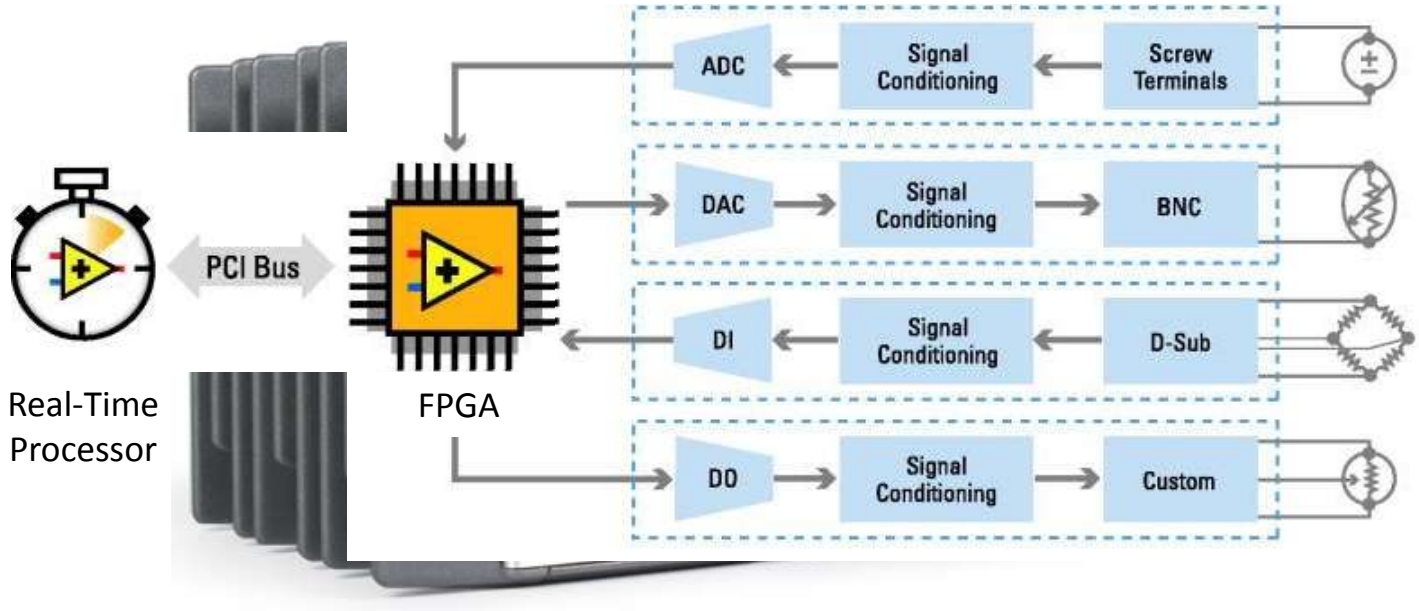
LabVIEW FPGA



VHDL ~4000 lines

NATIONAL INSTRUMENTS

Blending Technologies for New Architectures
CompactRIO



- **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
- **Real-time processor** for reliable measurement, analysis, connectivity, and control

Blending Technologies for New Architectures
FlexRIO

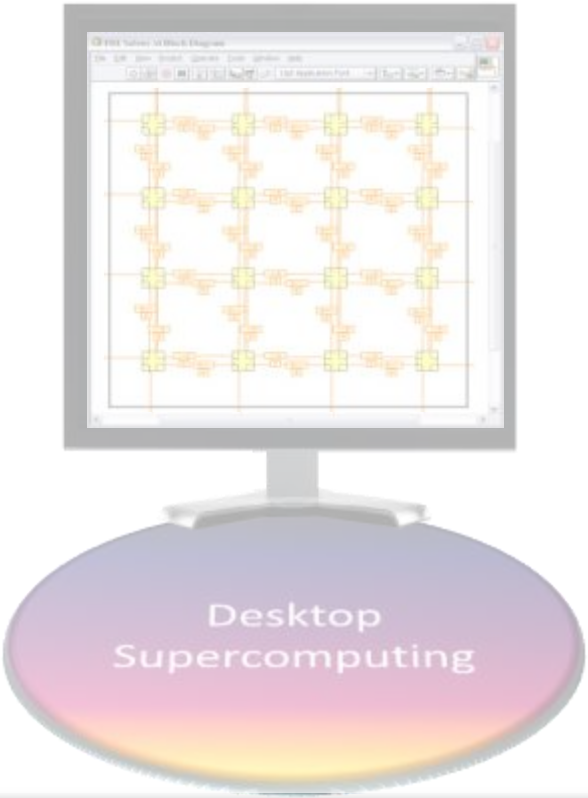
NI FlexRIO Adapter Module
- Interchangeable I/O
- Customizable by users
- Adapter Module Development Kit

NI FlexRIO FPGA Module
- Virtex-5 FPGA
- Up to 132 channels
- Up to 128 MB of DDR2 DRAM

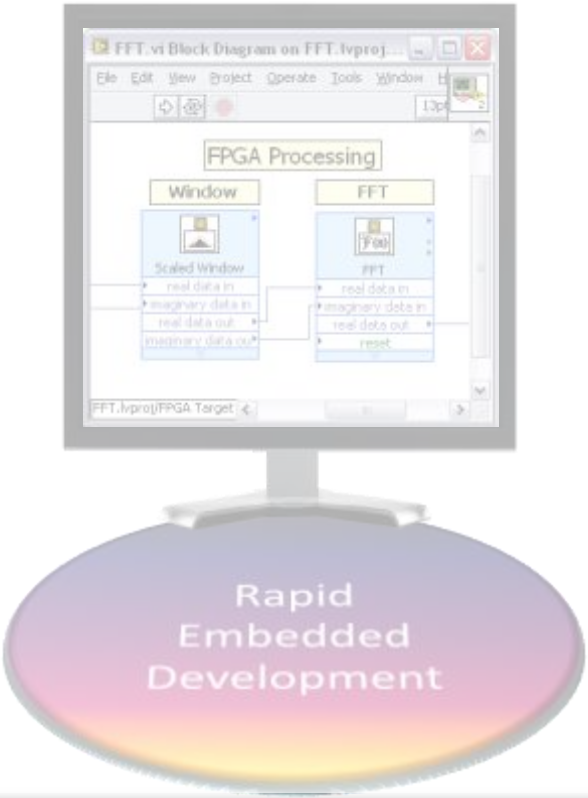
Introducing NI FlexRIO

Access through Graphical Programming

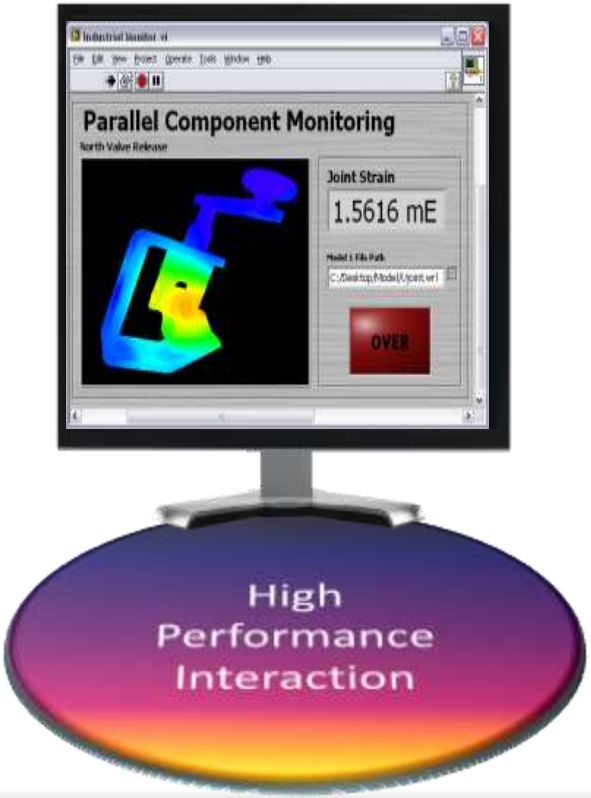
Multicore



FPGA



Modular I/O



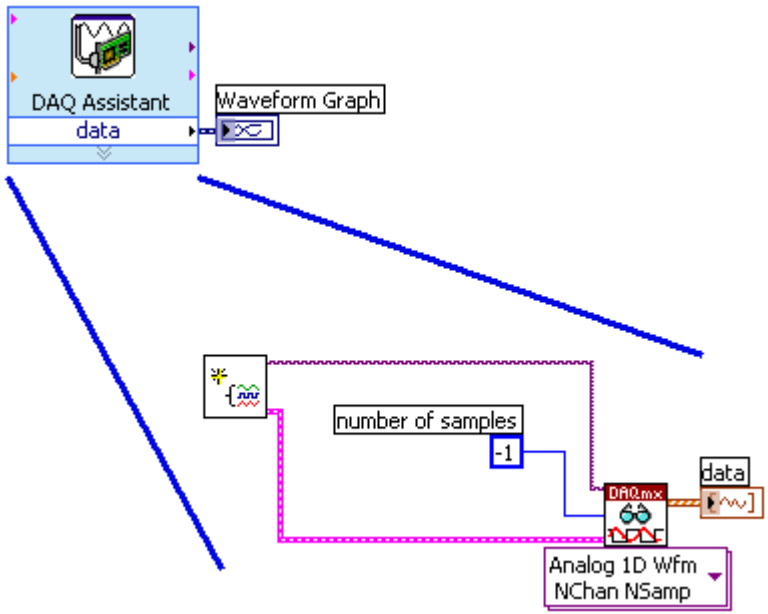
Modular I/O:
Combinable Measurements & Rapid Data Access

- Combinable Measurements
  - Mix and match I/O to meet exact requirements
  - Access to leading edge measurement technology
- Rapid Data Access
- ge latest bus technologies
- l synchronization
- integrated through a single, unified software language

Realizing the Potential

Uniform Access to All Functionality

- Common APIs
- Measurement and Automation Explorer
- Simplifying Wizards
- Low Level Access



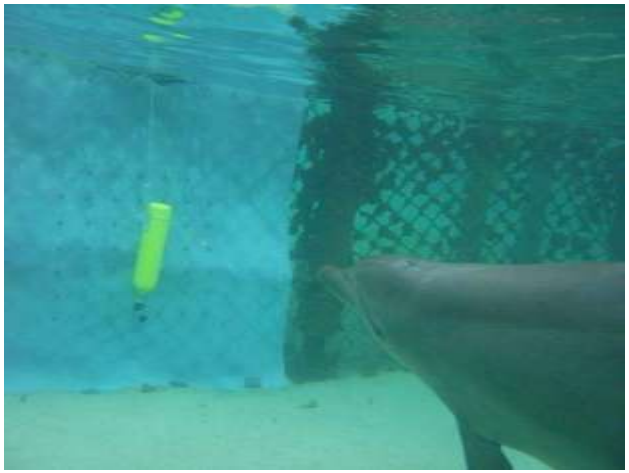
Case Study – The Dolphin sonar project

- ELVIS II
  - Echo Location Visualization Interface System

• Lund University in collaboration with Kolmarden wild animal park

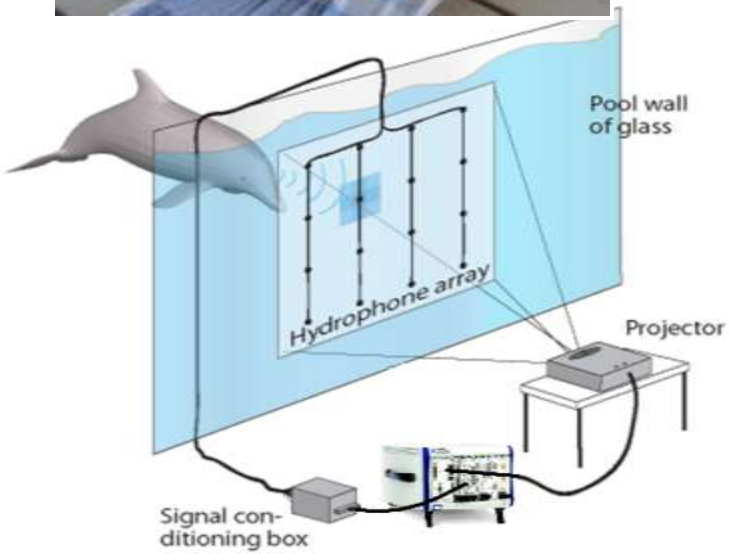
• PhD Student Josefin Starkhammar as developer

• LabVIEW and 47 channel PXI system for digitizing and visualizing dolphin sonar



Project Objectives and Principle

- Learn more about dolphin behavior, cognition, sonar skills and intelligence
- Better understand the dolphin echolocation skills to be able to develop equipment for ultrasonic diagnostics and non-destructive testing of materials
- 47 simultaneously sampling hydrophones
- Triggers on arbitary hydrophone in array
- Fast data streaming to disc
- Real time visualization of measurements
  - Allows to develop an acoustically operating touch screen



C Series Modular I/O Platform

More than 60 Measurement modules

C Series Modular I/O Platform

More than 60 Measurement modules

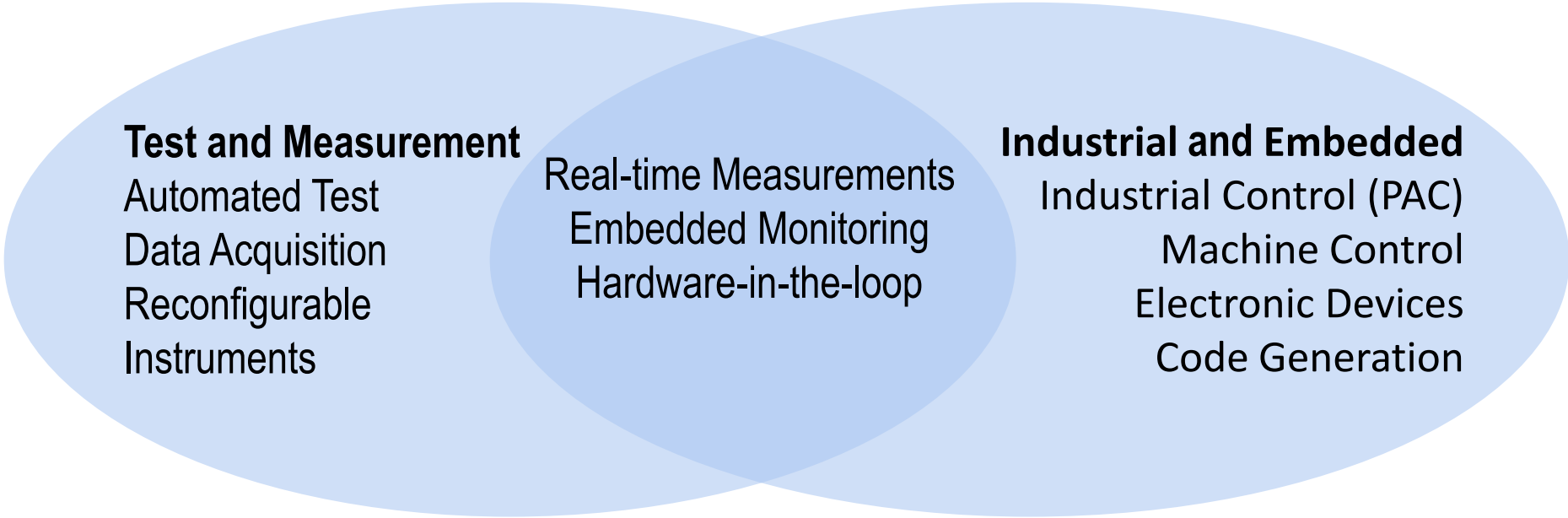
Introducing Wi-Fi Data Acquisition

- IEEE 802.11b/g radio
- 10/100 Base-T/X Ethernet
- NI-DAQmx driver
- DC powered (9-30 VDC)
- C Series module support
  - NI 9211 (4-ch thermocouple)
  - NI 9215 (4-ch SSH ±10V inputs)
  - NI 9234 (4-ch IEPE accelerometers)
  - NI 9237 (4-ch strain gauges)
  - NI 9219 (4-ch universal inputs)

The Engineering Design Transformation

National Instruments Vision

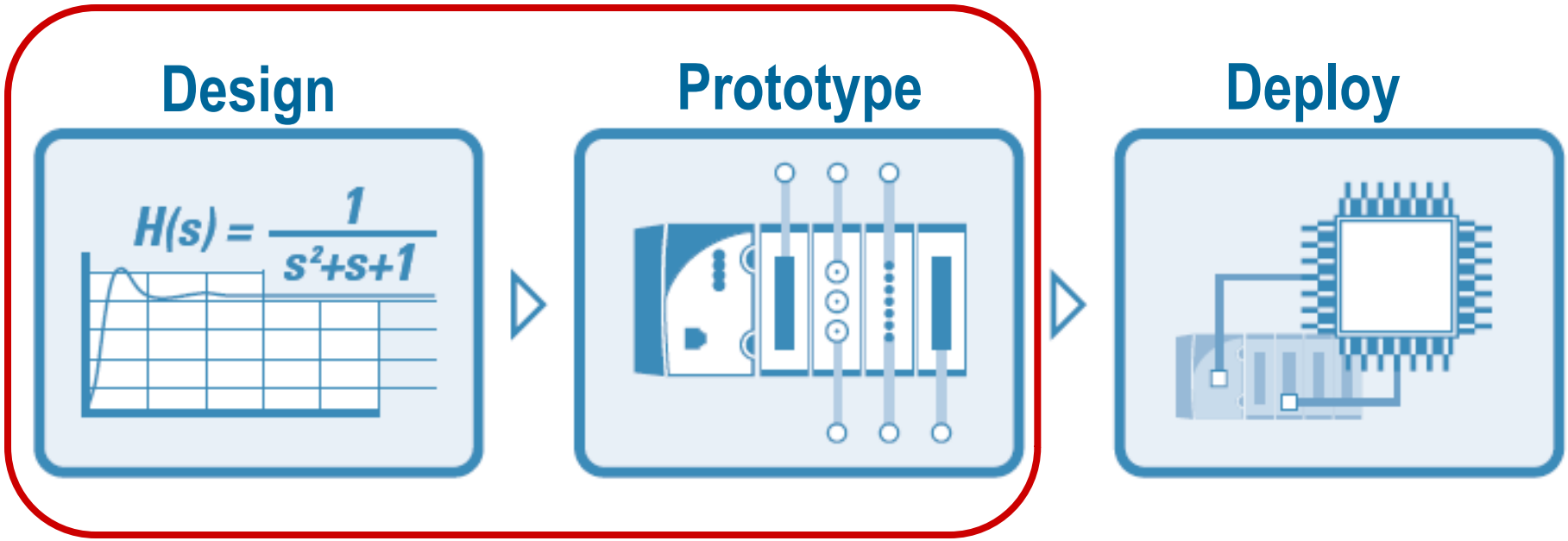
Graphical System Design



"To do for test and measurement what the spreadsheet did for financial analysis."

"To do for embedded what the PC did for the desktop."

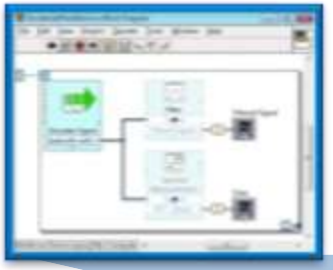
Graphical System Design



Algorithm Engineering

Models of Computation

Dataflow

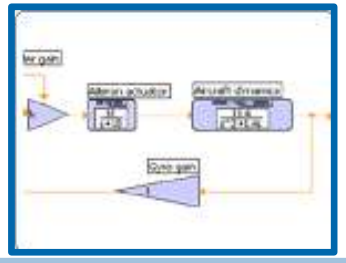


C / HDL Code

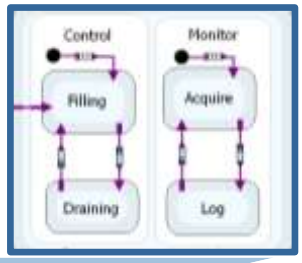
Textual Math

```
1 c = 0.285 + 0.013i;
2 [X Y] = meshgrid(x, y);
3 z = X + i*Y;
4 for k=1:30
5     z = z.^2 + c;
6 end
```

Simulation



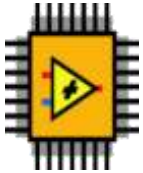
Statechart



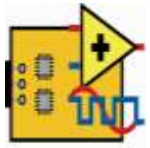
LabVIEW Desktop

LabVIEW Real-Time

LabVIEW FPGA



LabVIEW MPU/MCU



Personal Computers

PXI Systems

CompactRIO

Single-Board RIO

Custom Design

Training and Certification

Together, the National Instruments training and certification programs deliver the fastest, most certain route to increased proficiency and productivity using NI software and hardware.

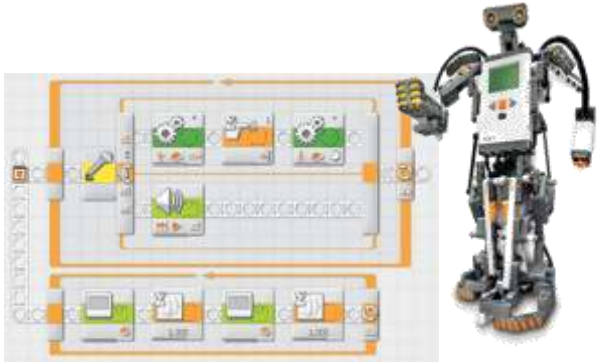
NI Training: Build Your Knowledge
NI training helps you build the skills to more efficiently develop robust, maintainable applications. We provide several training options including classroom, self-paced, online, or on-site training at your facility.

NI Certification: Validate Your Expertise
NI certification confirms your technical growth and skill. This professional certification is ideal for differentiating yourself from the competition and making your own informed hiring and outsourcing decisions.

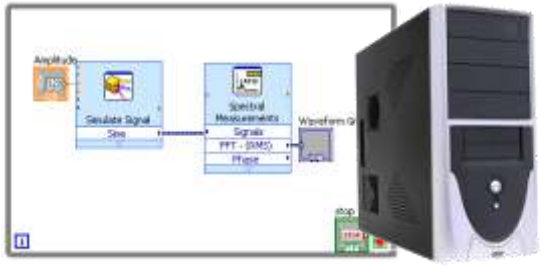
Visit **ni.com/training** to learn more

Graphical System Design:
From Kindergarten to Rocket Science

LEGO® Education WeDo Loop

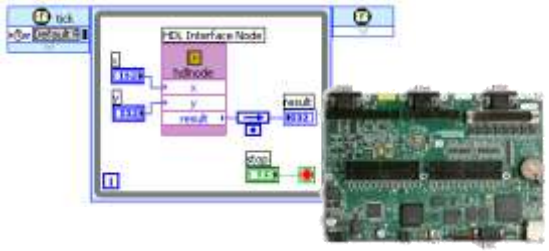


LEGO MINDSTORMS® NX T Loop

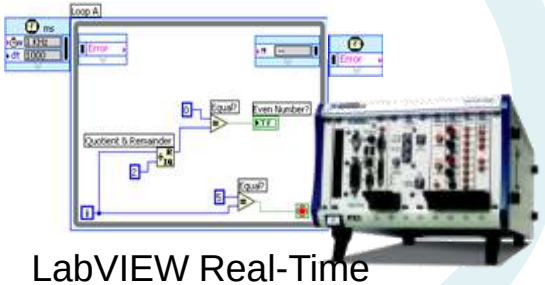


LabVIEW While Loop

LabVIEW Simulation Loop



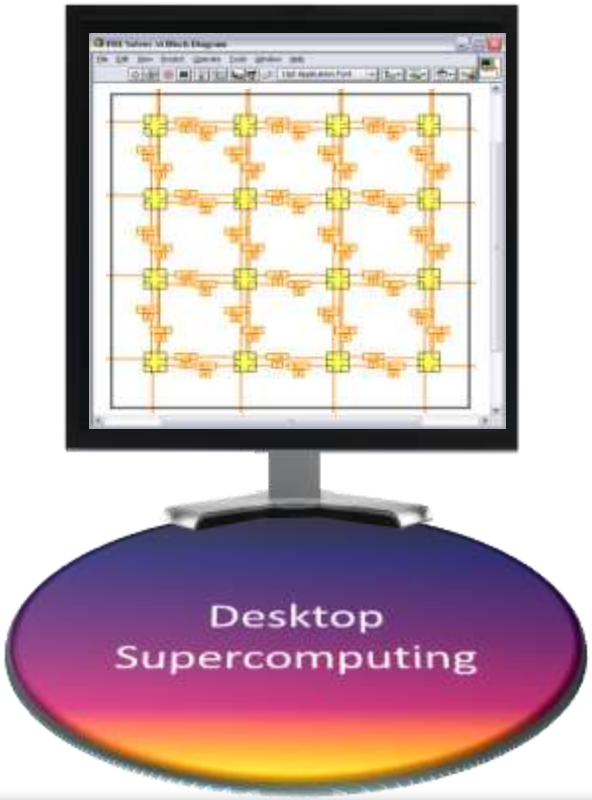
LabVIEW FPGA
Single-Cycle Timed Loop



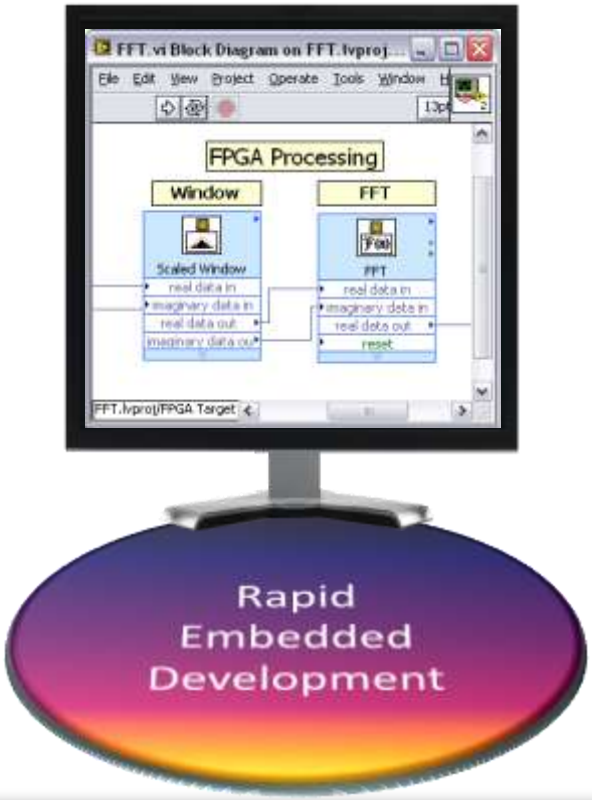
LabVIEW Real-Time
Timed Loop

Graphical System Design in Practice

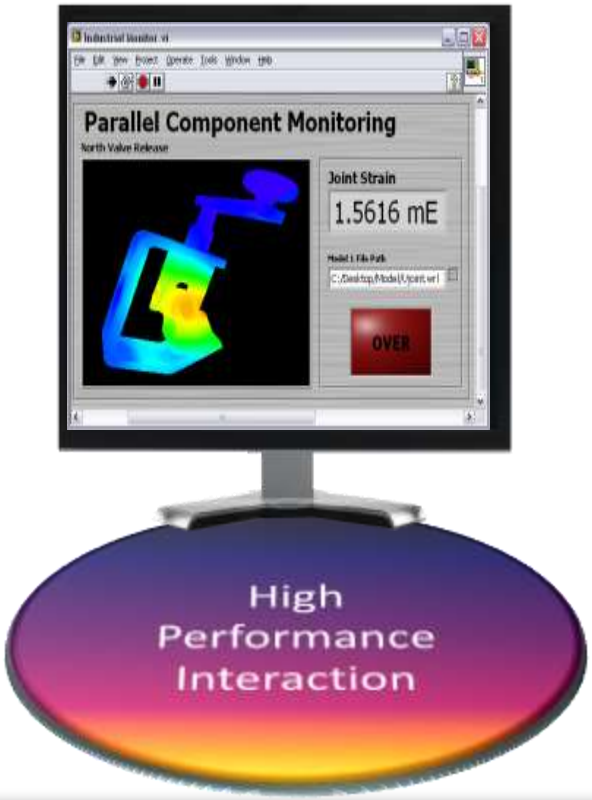
Multicore



FPGA



Modular I/O



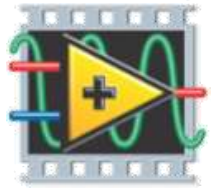
RF and GPS Production Testing

- **Application**
  - Automate production testing of 3.5GHz satellite transceivers and GPS tracking modules
- **Requirements**
  - Maximize production throughput while minimizing footprint and cost

RF and GPS Production Testing

- **Technology**
  - PXI
  - Panel PC
- **Software Access**
  - LabVIEW
  - TestStand
  - NI Switch Executive
  - PXI
- **Graphical System Design in Practice**
  - Simulates GPS satellite signals over-air
  - Performs mixed signal and RF measurement
  - 32 ch 50MHz digital pattern generation
  - 16 bit 250KS/s analog measurement
  - Parallel testing allows 2 module tested at once


Multicore


LabVIEW

Wind turbine HIL Testing

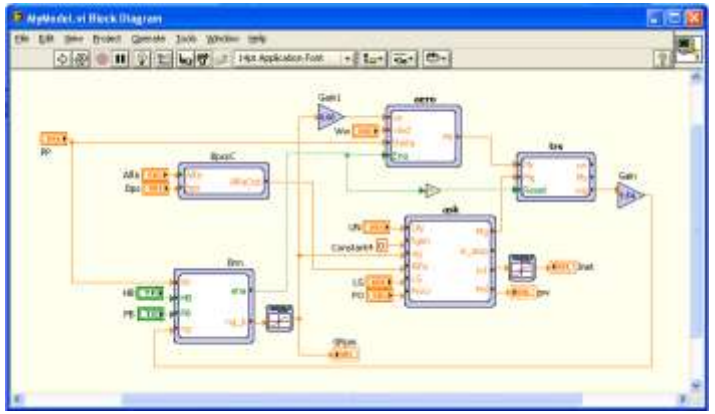
SIEMENS

Siemens Wind Power
Denmark

Designed a HIL test system that simulates the effects of wind, pitch and blade position to test turbine controller

Software - *LabVIEW*

- Control Design and Simulation
- Real Time
- FPGA



Hardware - *PXI*

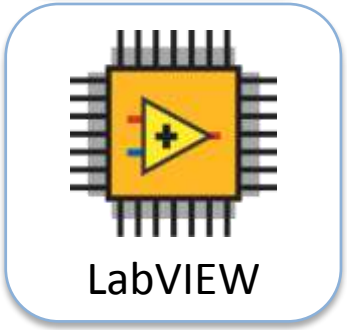
- Real Time OS
- Multicore
- FPGA
- Analog I/O

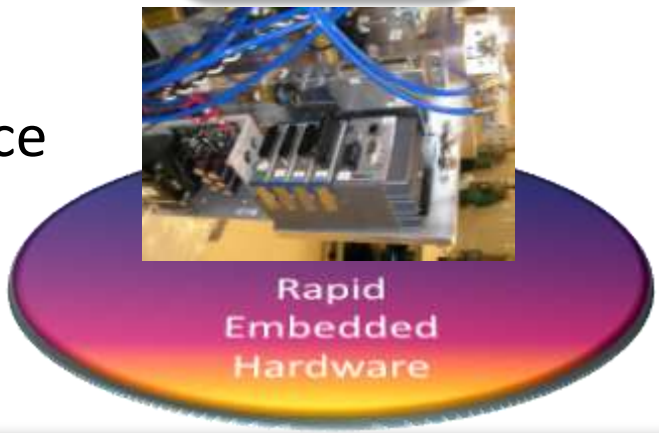
Tumor Treatment Medical Device

- **Application**
  - Design of medical device for treatment of breast tumors
- **Requirements**
  - Real-time ultrasound-guided control system
  - No room for firmware errors
  - Develop prototype in four months
  - Strict regulatory guidelines (Class II)
  - FDA approval
  - EMC certification

Tumor Treatment Medical Device

- **Technology**
  - CompactRIO
  - Panel PC
- **Software Access**
  - LabVIEW
  - LabVIEW FPGA Module
  - LabVIEW Real-Time Module
- **Graphical System Design in Practice**
  - Nearly painless tumor elimination device
  - Outpatient treatment that takes 10-20 minutes, no stitches
  - Working prototype in just weeks





Engineering Grand Challenges


Make solar energy economical


Provide energy from fusion


Develop carbon sequestration methods


Manage the nitrogen cycle


Provide access to clean water


Restore and improve urban infrastructure


Advance health informatics


Engineer better medicines


Reverse-engineer the brain


Prevent nuclear terror


Secure cyberspace


Enhance virtual reality


Advance personalized learning


Engineer the tools of scientific discovery

Source: www.engineeringchallenges.org

Partner Introductions

National Instruments
Technical Symposium 2008

Columbia

- Columbia has delivered testfixtures and Interface solutions from Virginia Panel corporation for the Nordic market since 1977.
- Columbia designs fixtures for function- and in-circuit test of all types of electronic units – on component- and board level as well as subsystems and finished product.
- Development of all fixturetechnics: vacuum, pneumatic or mechanical. The fixtures are built standalone, direct connected to the testsystem or integrated in the production line fully automatic.
- Knowledge, modern machine park and the best suppliers of material has made Columbia leading in the Scandinavian market.
- Columbia is agent for Virginia panel Corporation. VPC supplies reliable Interface solutions for any type of test platform, VXI,PXI,LXI,SCXI, Rack&Stack etc.

VPC Virginia Panel Corporation

COLUMBIA

Cool Engineering

COOL ENGINEERING

THE ART OF TESTING

member of the Etteplan group

- COOL Engineering's business idea is to offer services regarding testing mainly for the automotive industry.

- We **are specialised in climate testing,** simulation, evaluation, analysing and presenting the results. We are able to execute tests in our **in house laboratory** or in our contractor's test-rigs.

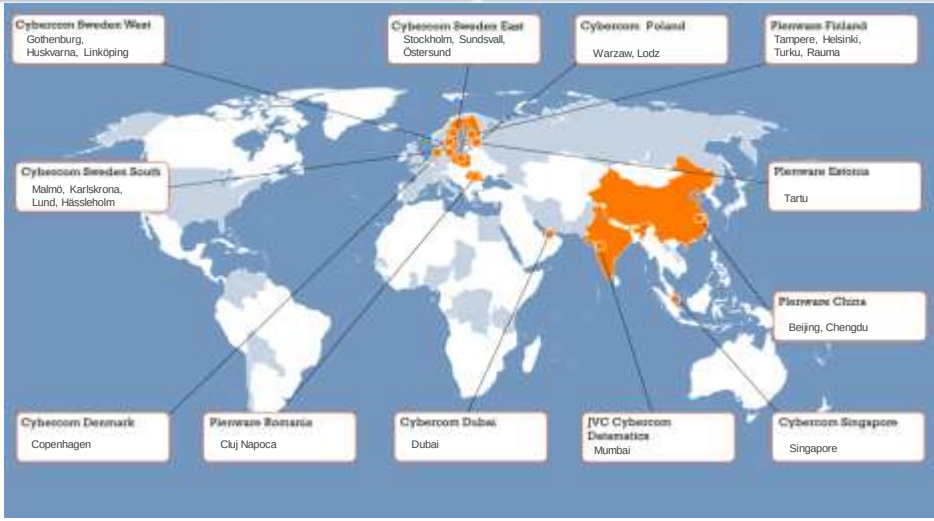
- We also perform **engine tests in our own engine test rig**, such as aging of catalysers.

- COOL Engineering develops and markets our own test equipments. Our company possesses the expertise in areas such as mechanical design, electrical design, software programming.

- We deliver "turn key equipment" with the right quality, delivered at the right time.
Cool Engineering develops software for data acquisition systems in a ***LabView™*** based user interface. Cool Engineering is an *Alliance Partner of National Instruments*.

Cybercom

Cybercom – “Local presence Global reach”



- **Cybercom is a high-tech IT consultancy with global delivery capability for turnkey solutions as well as specialist competence**
- **Well established within: Telecom, Industry, Media, Bank & Finance, Retail, Public**
- **A decentralised organisation to shorten decisions time with 26 offices in 10 countries**
- **2000 employees mainly within Europe and Asia**
- **Business Unit dedicated to test. Long experience in Test Methods, Tools and Test Systems**

CYBERCOM GROUP

DSE
Test Solutions

When test really matters…

DSE A/S
Area Sales Manager:
Rene Skovgaard Madsen

Referencer

- ABB Robotics
- Peltor
- Cefar
- Autoliv Electronics
- Ascom Tateco
- SEM (Opcon)

Specification, development and production of test solutions and fixtures.

Endevo

Endevo

<flander>

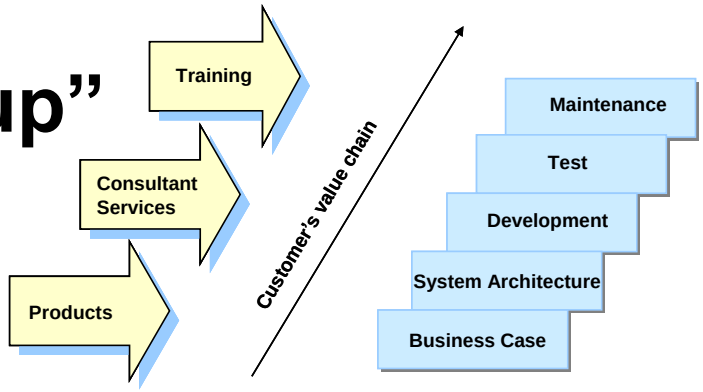
Endevo
Part of Flander Group

NATIONAL INSTRUMENTS
Alliance
MEMBER

Enea

“The power of the Enea group”

- Full Spectrum Services for the Customers value chain



Business Case

Project management

Audits

Mentorship

Pre-studies

Roadmaps

System Architecture

System Architecture HW & SW

Platform Architecture

Usability

Development

Embedded design & implementation SW

Embedded Design HW

FPGA design

Communication Design

Test & Validation

Test System Design

Test and Verification

Test Process Design

Test Management

Support & Maintenance

Trouble Report Handling

New requirement implementation

Cost Reduction HW

CM

ENEA

Espotel

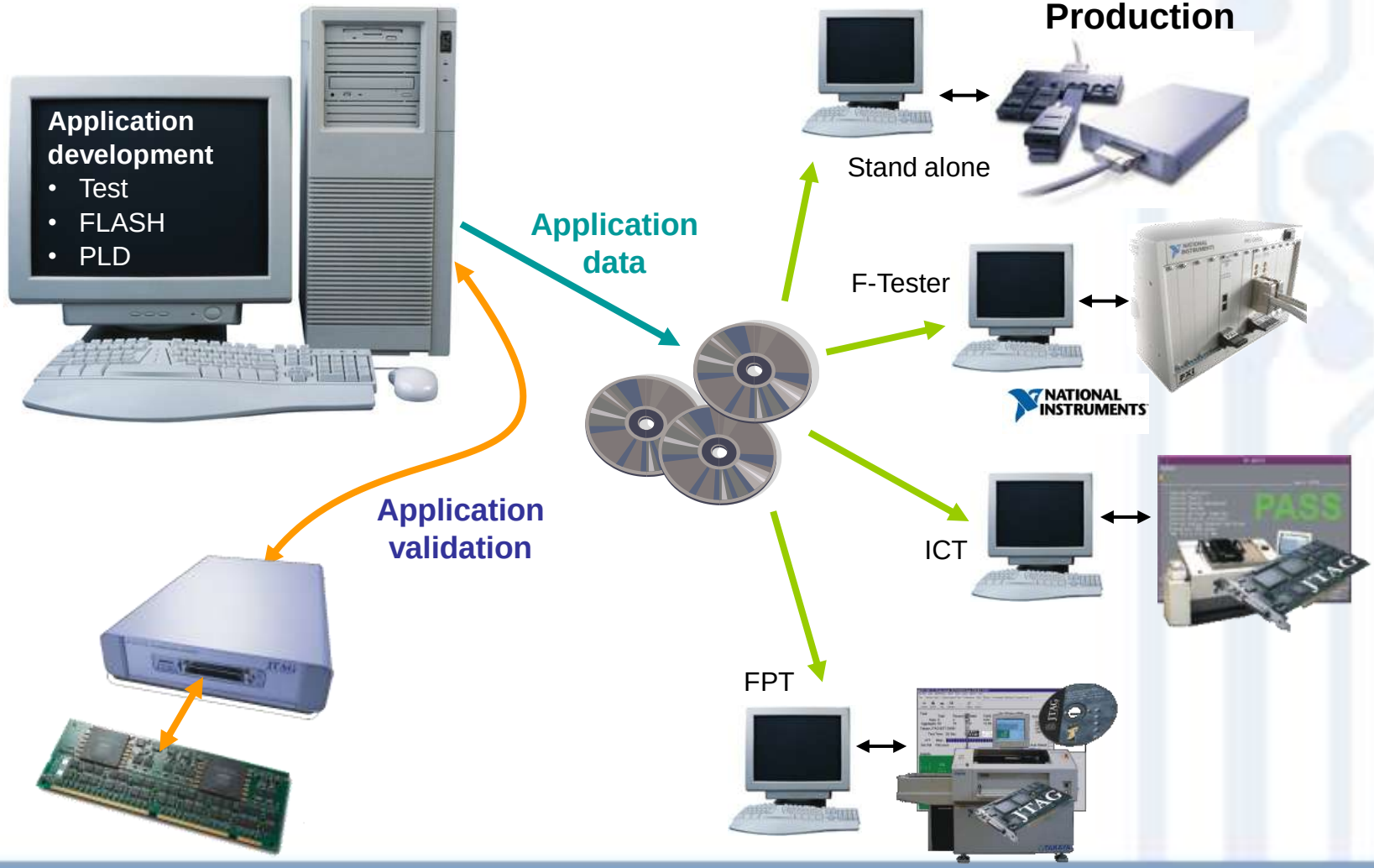
ESPOTEL

Twenty Years of Embedded Design

- Annual sales 21.2 M€ (2008)
- 230 employees at 7 locations in Finland
- Leading Finnish R&D services company in the field of embedded systems.
- Full-service design house, delivers system design, electronics design, mechanics design, embedded software design, industrial design and test systems
- Test Systems Division:
  - R&D Test Automation
  - DfT, Test Specifications
  - Testers: Mechanics, Electronics, Software
  - Test System Platforms
  - SPC software, Six-Sigma know-how

JTAG

One development environment for all test methods



Prevas

Key expertice

xMove

Complex test solutions for electronic control units, used in automotive and other industry.

Application areas:
- Functional test
- Hardware In the Loop (HIL) test
- Repair test

HSDH-RT

High **S**peed **D**ata **H**andling - in **R**eal **T**ime
Complex solutions for telecom, defence and data applications.

Application areas:
- Simulators in general
- High speed data
- RF simulations and analyses

Large RT-Systems

Real Time systems used in control, measurement and test applications for a number of industries.

Main caracteristics:
- Real Time
- Gbps data rate
- >20 interconnected computers
- Handling >2000 signals
- Scalable
- Distributed

The Göteborg design centre

-Engineering expertise in: LabVIEW, LabVIEW-RT, Multicore etc.
-Engineering expertise in: HW-design, FPGA, RF, interface design etc.

Scandinavia's largest integrator of embedded electronics
Founded 1985, 550 employees, ISO 9001:2000

Virinco

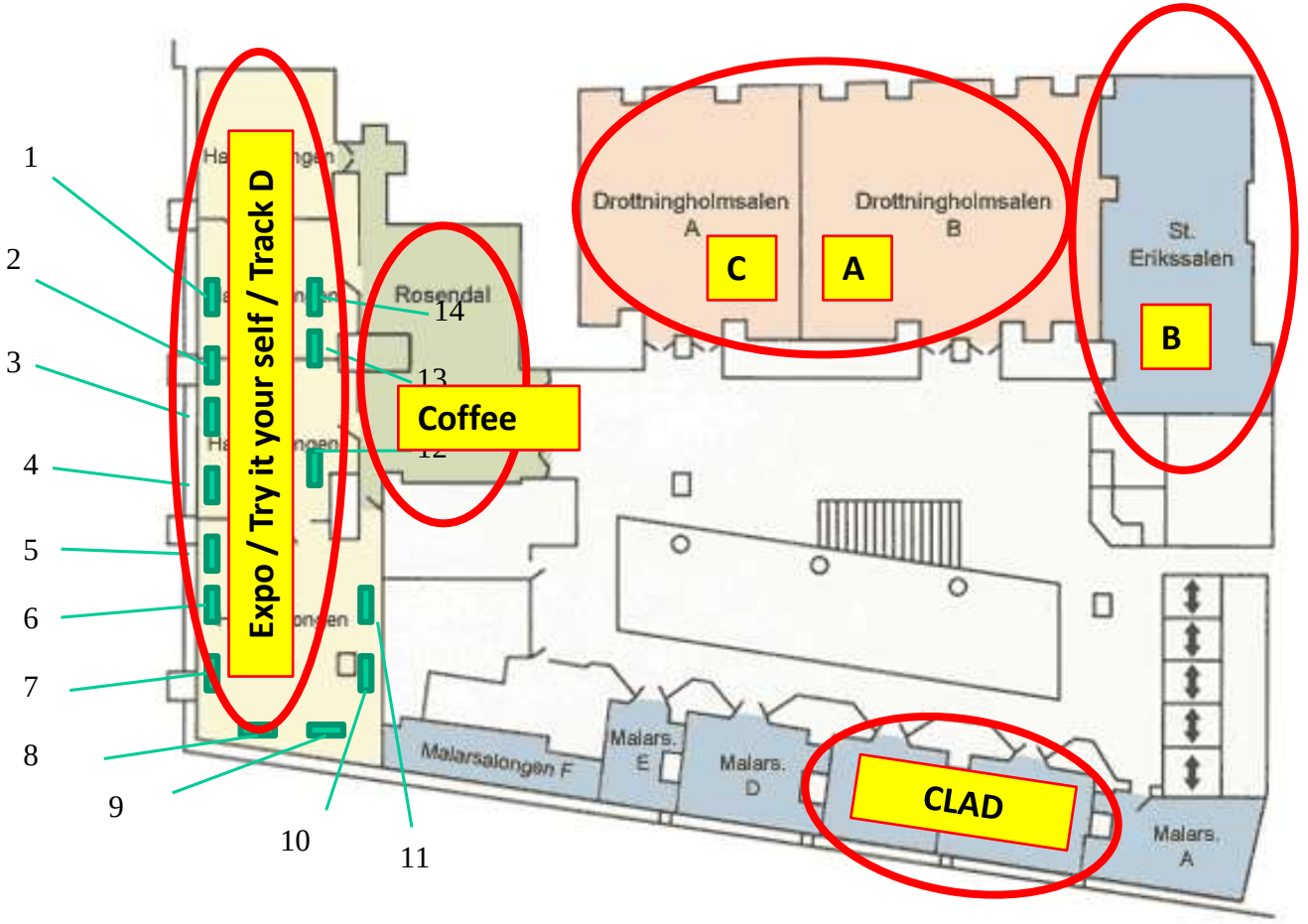
eWATS

the best loop for product improvement

proudly developed by virinco

Announcements

1. Prevas
2. Cybercom
3. Enea
4. VPC
5. JTAG
6. Espotel
7. Endevo
8. NI
9. NI
10. NI
11. NI
12. Cool Engineering
13. DSE
14 Virinco



Time	Duration	Track A Drottningholmsalen B	Track B St. Erikssalen	Track C Drottningholmsalen A	Track D Hagasalongen 4
8:30 - 9:30	1:00	*Registration, Exhibition, CLAD exam (Mälarsalongen B,C)*			
9:30 - 11:00	1:30	Keynote - Charles Schröder			
11:00 - 11:30	0:30	*Break and Exhibition*			
11:30 - 12:30	1:00	Sound and Vibration Applications - ***Sören Petersen***	Trends in Wireless Test: Benefits of Software Defined Instrumentation for MIMO-OFDM tests - ***Carsten Watolla***	Benefits of FPGA technology - **Ashwani Singh**	Endevo ENEA
12:30 - 13:30	1:00	*Lunch and Exhibition*			
13:30 - 14:25	0:55	Tips and Tricks to improve signal quality in data acquisition systems - ***Björn Beckman***	Recording RF Signals Off of the Air: Advanced Techniques and Applications - ***Leif Johansson***	How to get a jump start using CompactRIO - ***Espen Ringnes***	Espotel Practical Programming of ARM micro-controllers Lund University
14:25 - 14:30	0:05				
14:30 - 15:25	0:55	Seeding the future of test with reconfigurable instruments -***Charles Schroeder***	Introduction to Software Engineering for LabVIEW Applications - ***Pelle Steen***	From rapid prototyping to low-cost deployment with LabVIEW embedded tools - ***Jimmie Adolph***	Designing a flexible measurement and control system for research applications Stockholm University Cybercom
15:25 - 15:45	0:20	*Hot Chair Interview, Break and Exhibition*			
15:45 - 16:40	0:55	How to test embedd... control ... [Pr... Prevas] - ***Aku Wi...***			...NCO
16:40 - 17:00	0:20	*Expo / Wrap-Up / Prize draw / Drink & Snacks*			

2nd CLAD exam
Mälarsalongen B,C

Announcements

- Encourage you to do ”Try –it your-self” demos:
  - Algorithm Engineering
  - Measure DAC characteristics with PXI and MI
  - Tempreature Control with NI CompactRIO
  - Measure Vibrations, Analyze Signals and Build Reports
  - NI Smart Camera with Vision Builder for Automated Inspection
  - Connect Model- Based Design to Real-World I/O

Announcements

- Lunch : Vegetarian / Allergies.
- Return your Feedback forms during the day and claim your collector items
- In expo area at the end of day:

  Expo / Wrap-up / Snacks and Drinks / Lottery