

A decorative pattern of hexagons in various colors (yellow, orange, green, purple, brown) arranged in a honeycomb-like structure, primarily concentrated on the left side of the slide.

NIDays09

WORLDWIDE GRAPHICAL SYSTEM DESIGN
CONFERENCE

From Rapid Prototyping to Low-Cost Deployment with LabVIEW Embedded Technology



What is an “Embedded System?”

“A specialized computer system that is part of a larger system or machine.”

Webopedia

“...an embedded system performs pre-defined tasks, usually with very specific requirements. Since the system is dedicated to a specific task, design engineers can optimize it, reducing the size and cost of the product.”

Wikipedia

Let's Play...Find the Embedded Products

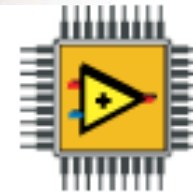
R Series



PXI



ARM, Blackfin



LabVIEW
FPGA



LabVIEW
Real-Time



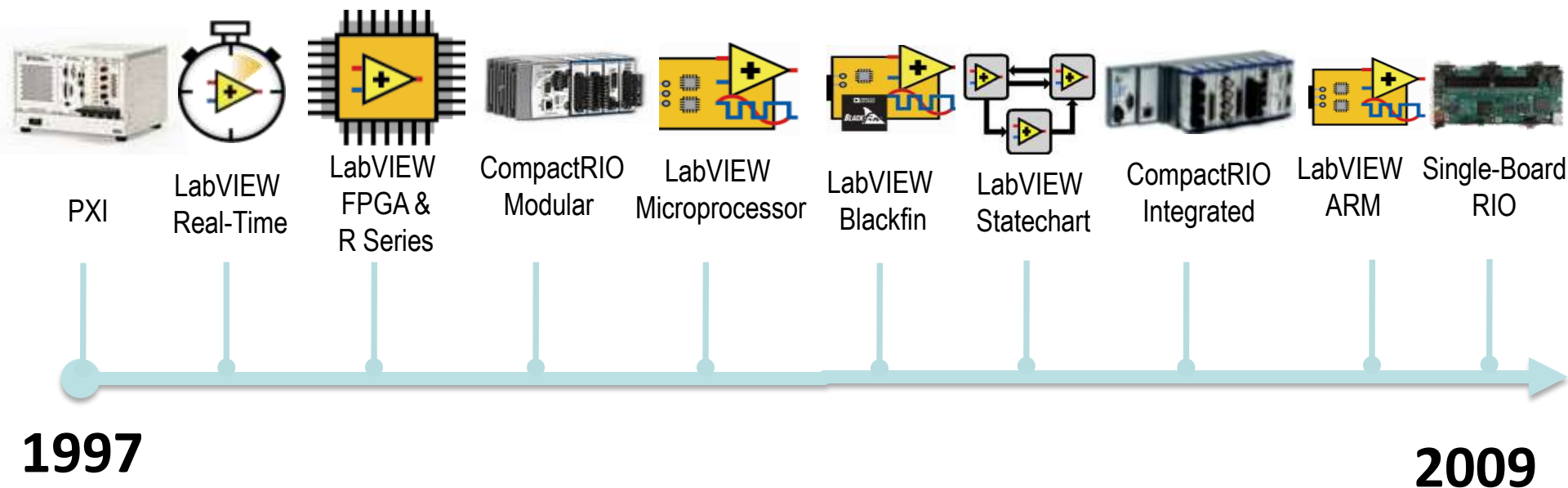
CompactRIO

Touch-Panel



Single-Board RIO

NI for Embedded Design: Today

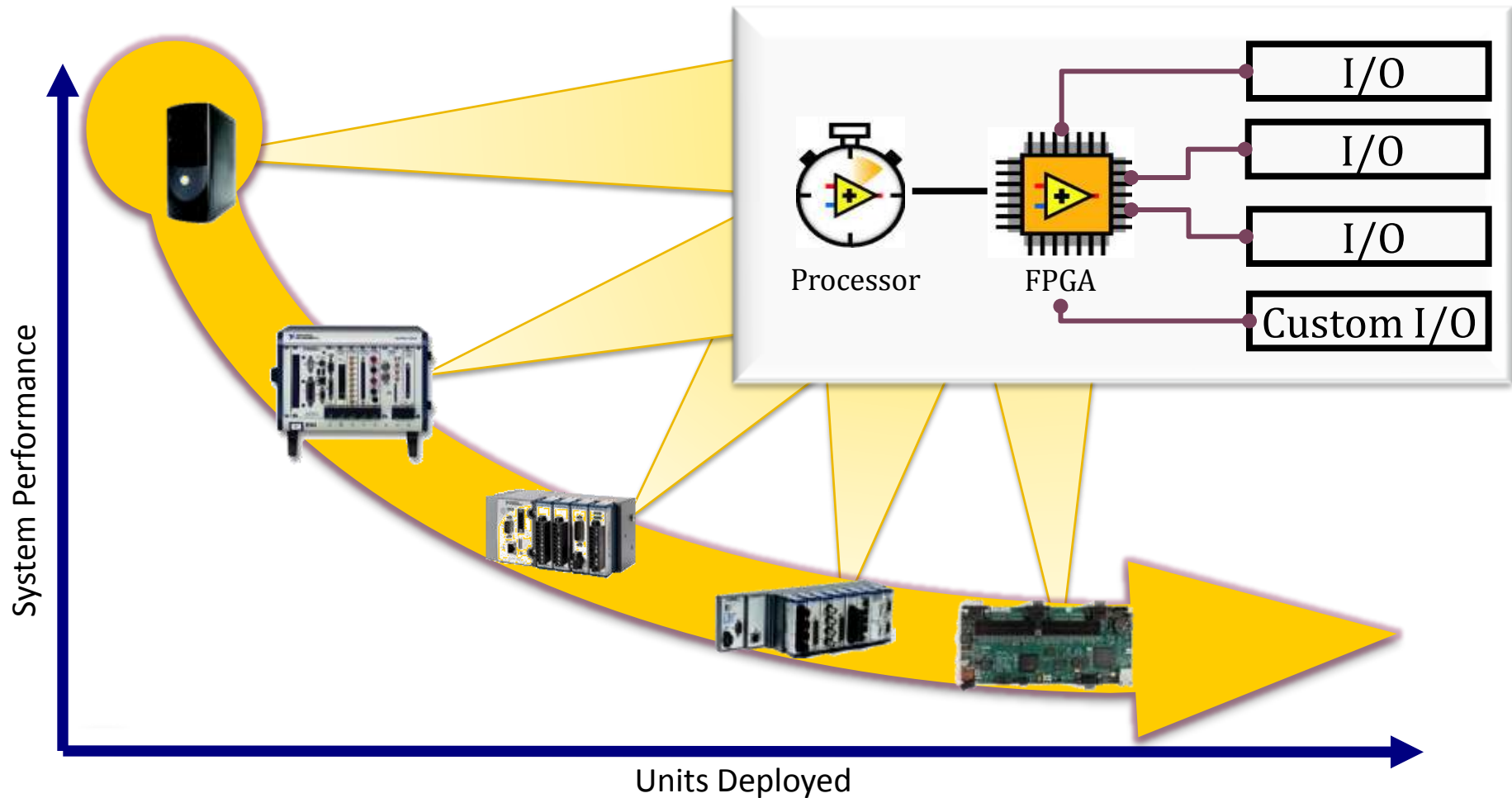


Agenda

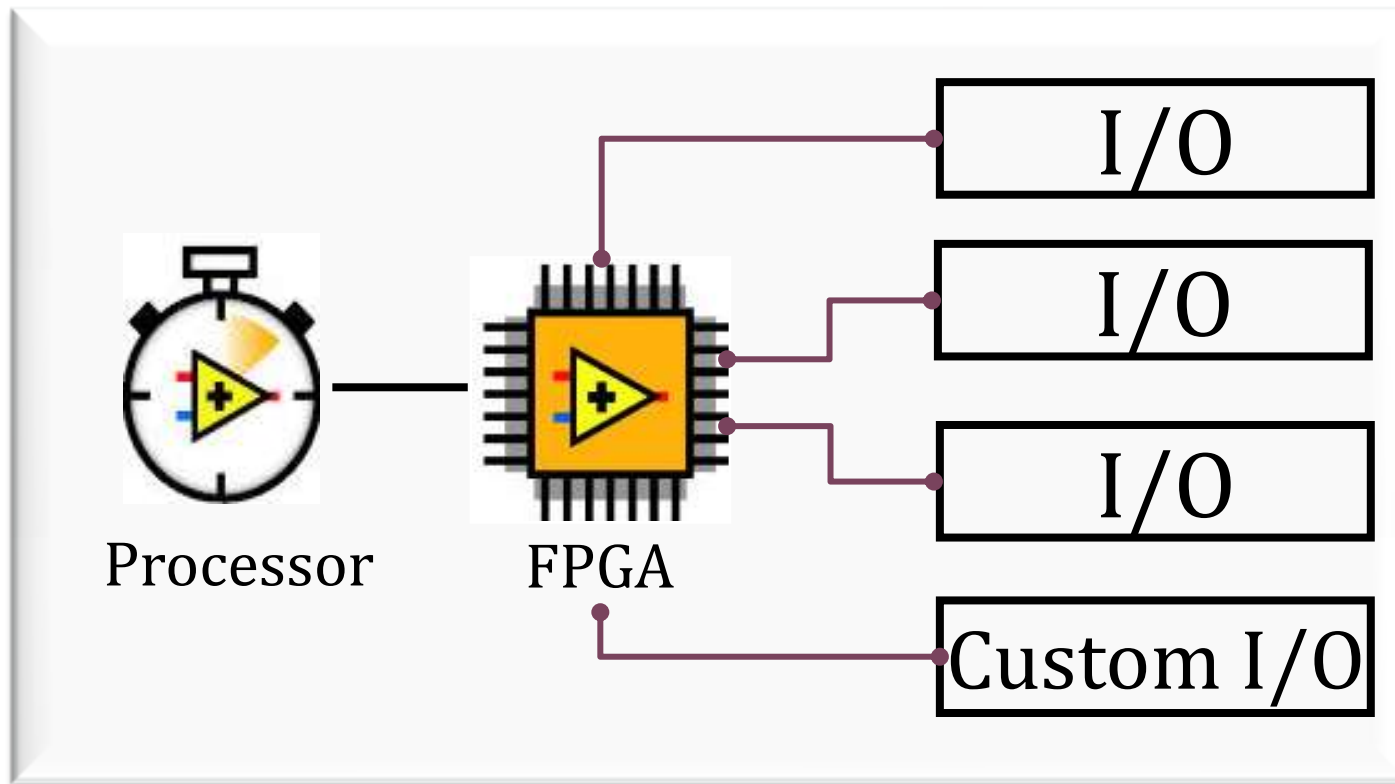
- The Deployment Curve
- Example Designs
- Recommendations
- LabVIEW Embedded Platform

LabVIEW and RIO Hardware Platform

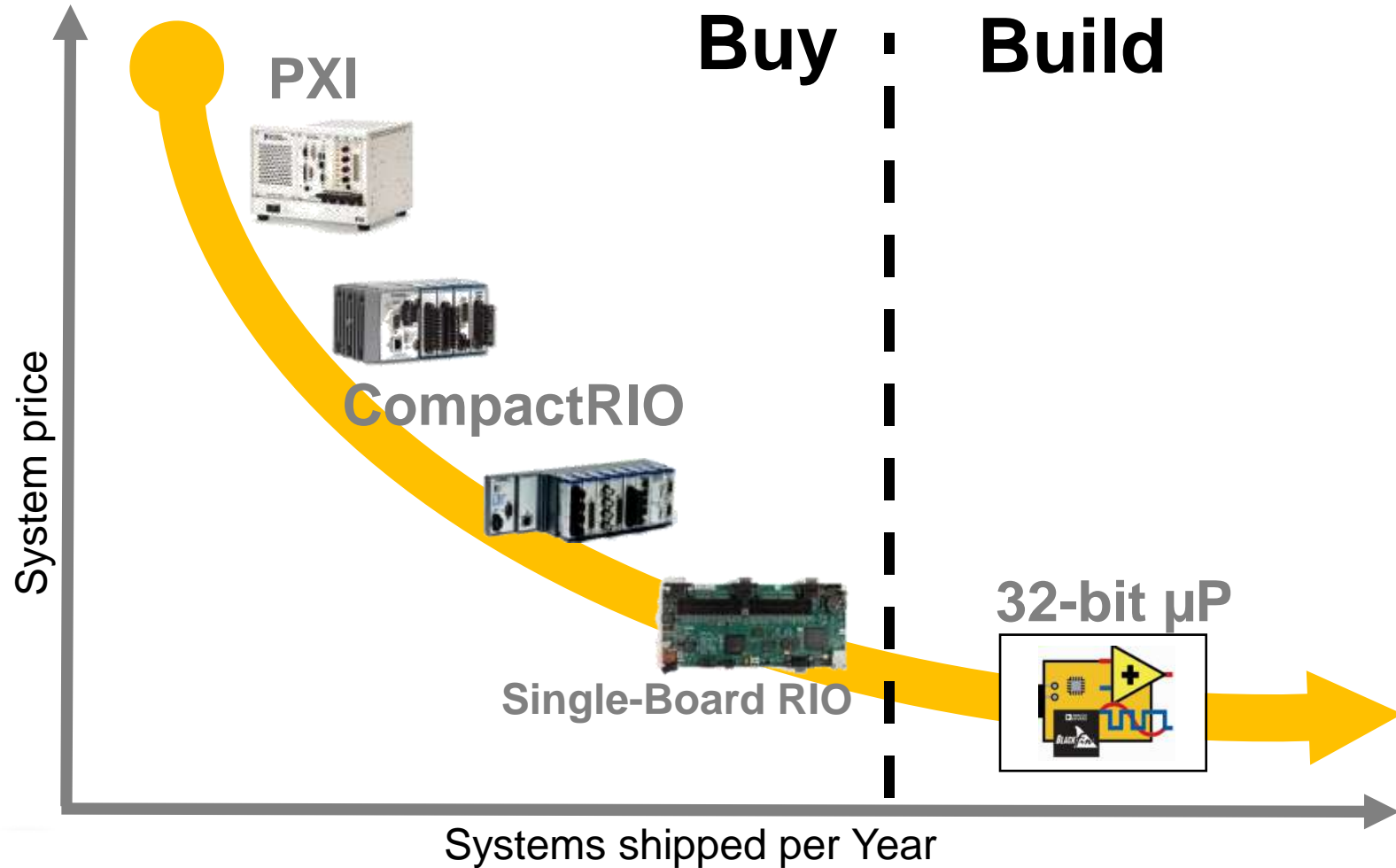
Standard Embedded Architecture, Standard Design Software



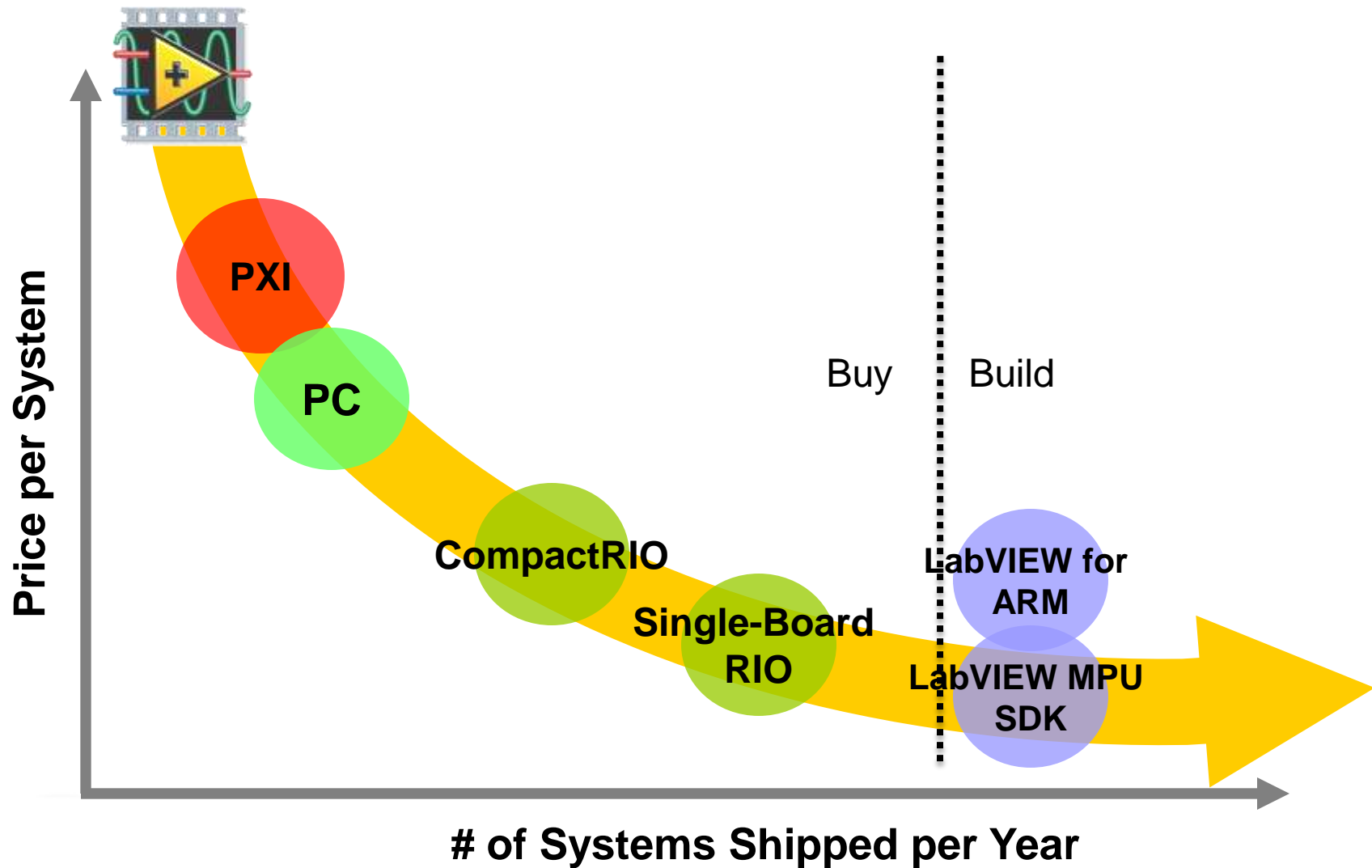
Reconfigurable I/O (RIO) Architecture



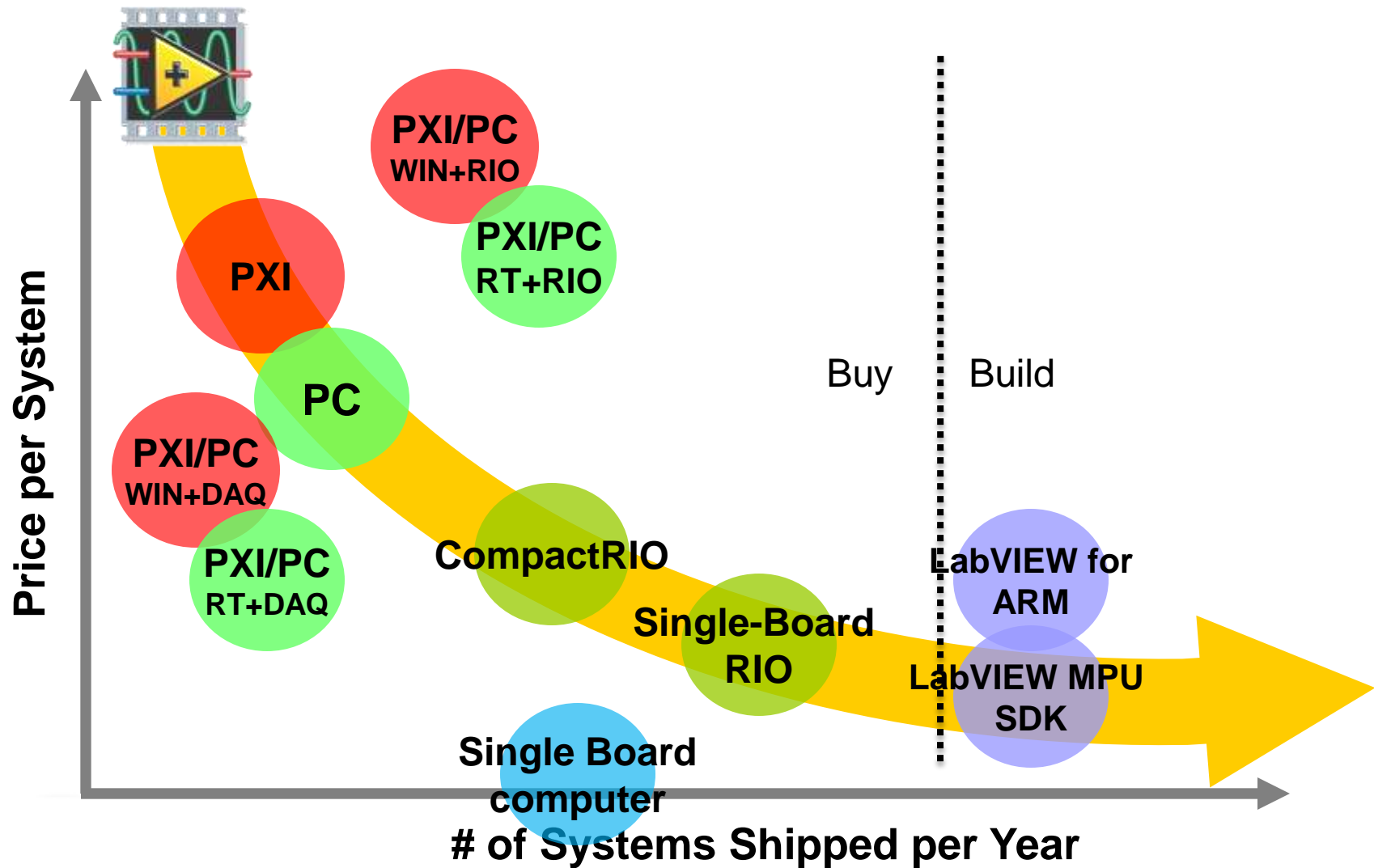
National Instruments “Deployment Curve”

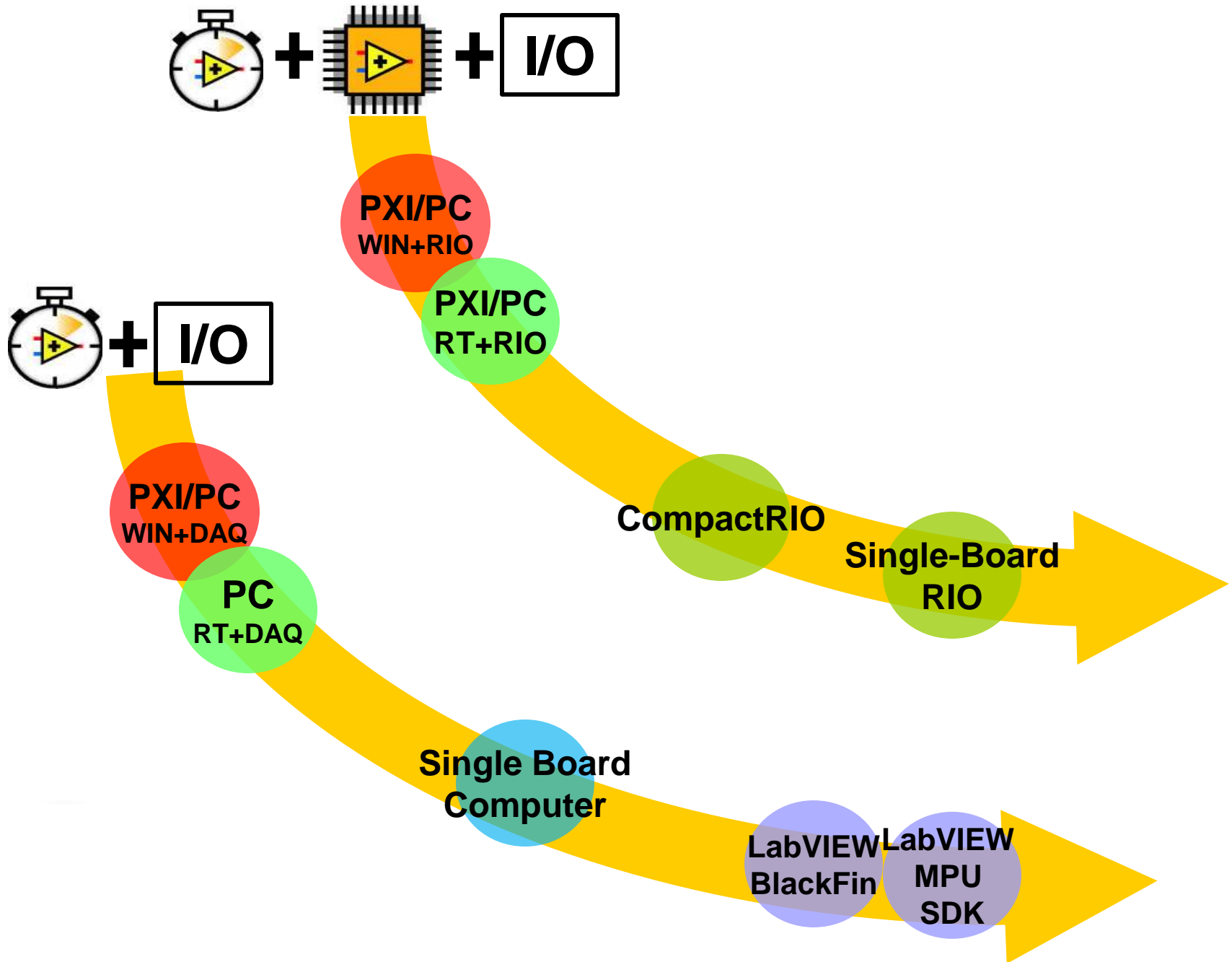


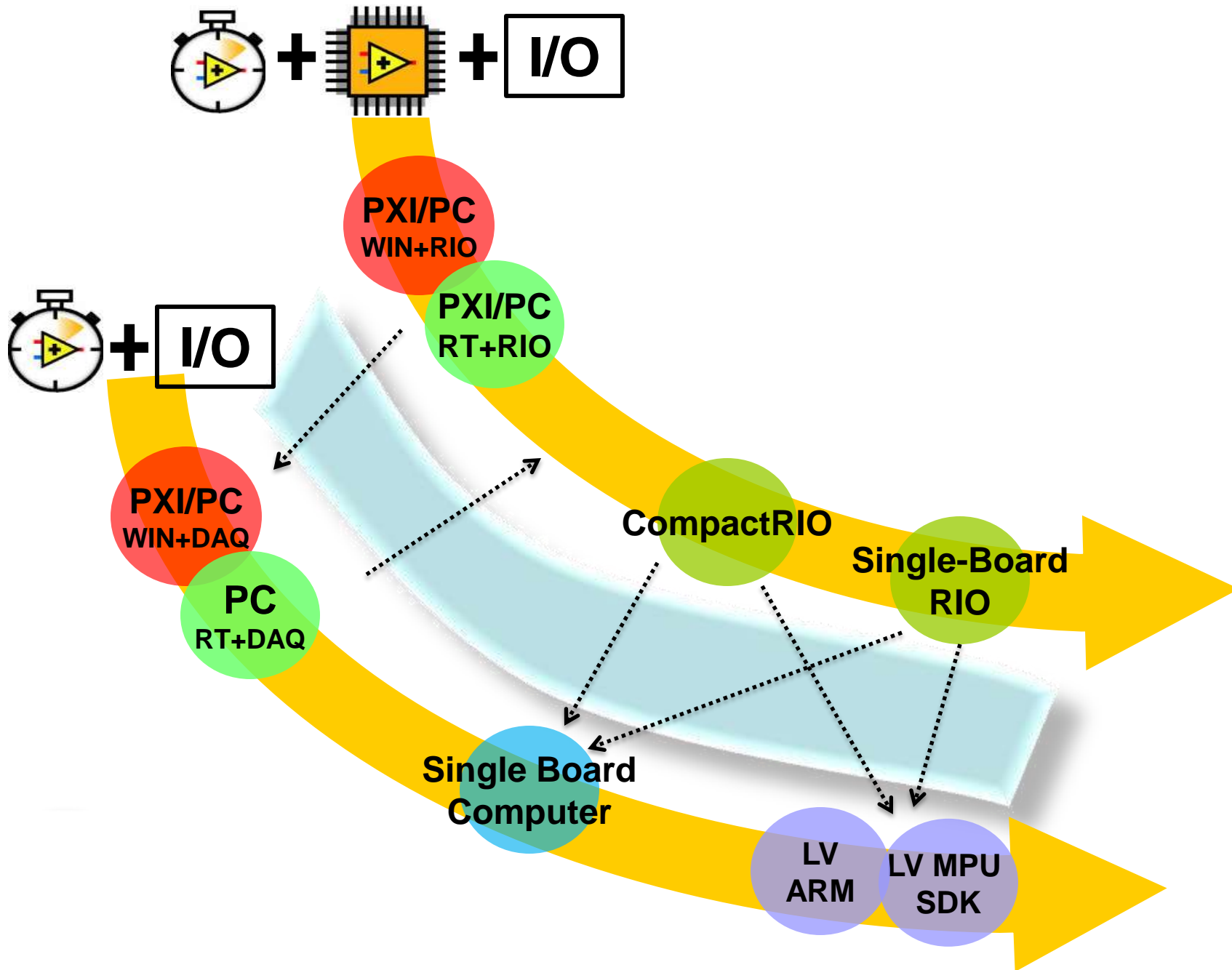
NI Deployment Curve



NI Deployment Curve

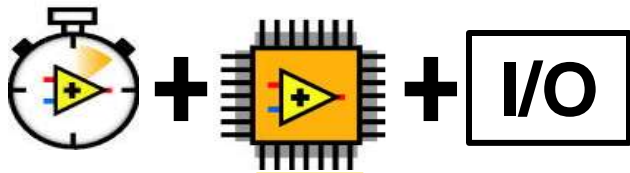






Processor + FPGA = Reconfigurable I/O (RIO)

RIO Deployment Curve



PXI/PC
WIN+RIO

PXI/PC
RT+RIO

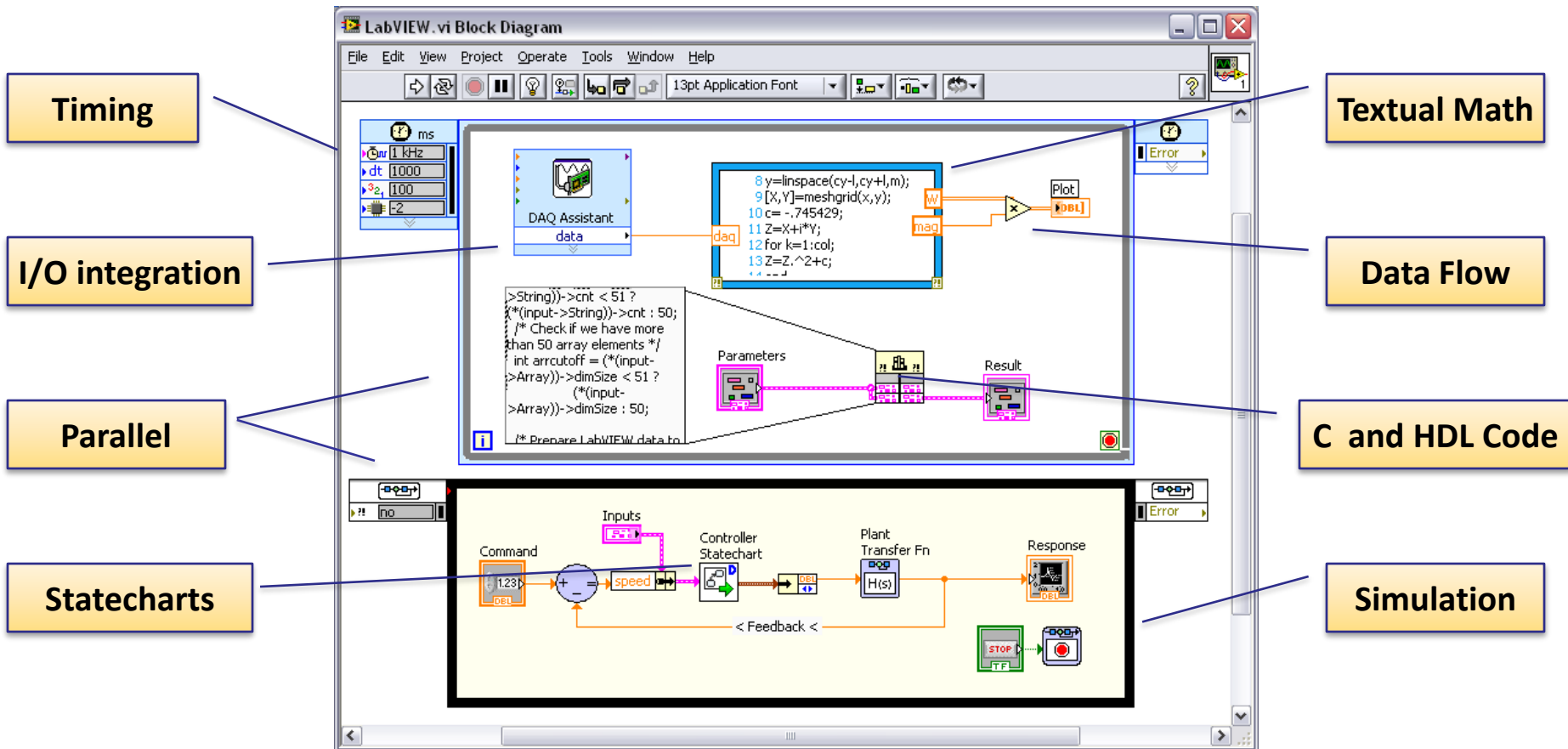
CompactRIO

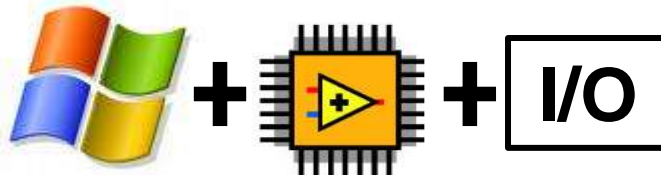
Single-Board
RIO

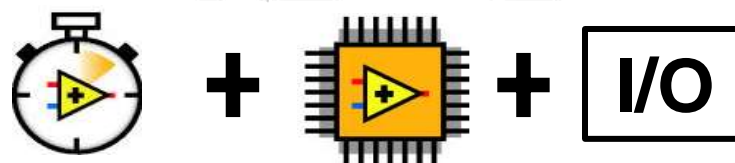
Custom

- Maximum software reuse

LabVIEW: Graphical Embedded Software

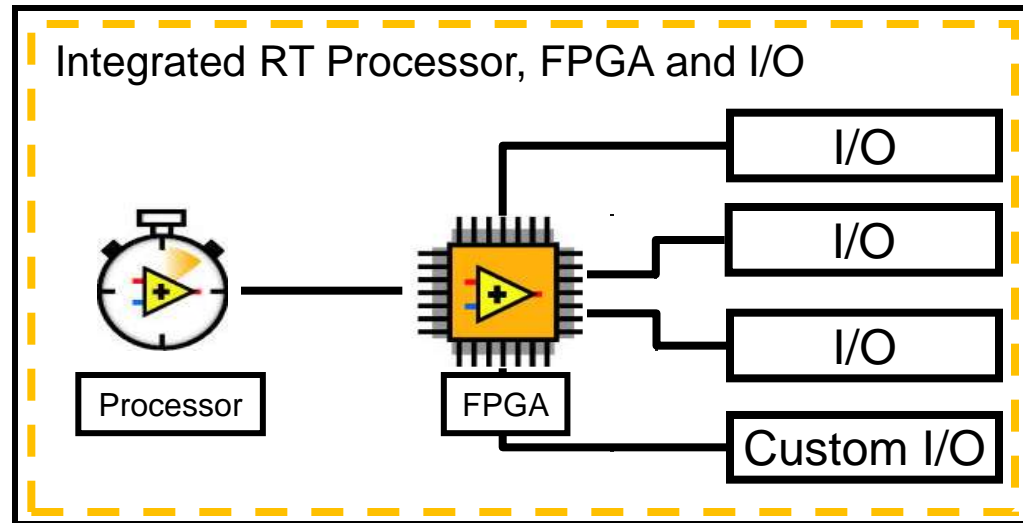






Single-Board RIO

- Embedded device and machine I/O, processing and control
- FPGA customization and performance
- Lowest cost RIO product for high volume machines and devices



Single-Board RIO

Networking/Peripherals

10/100 Ethernet port
RS232 Serial port

Real-Time Processor

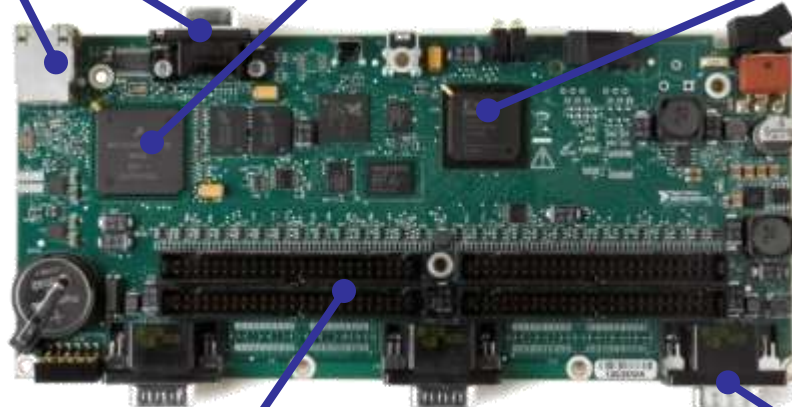
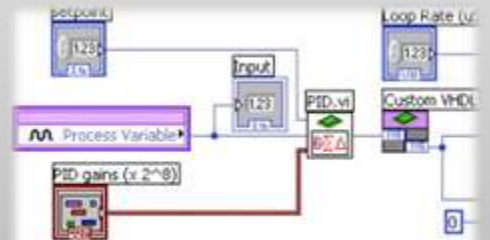
400 MHz processor for floating-point control, analysis, and logging

Reconfigurable FPGA

Customized timing and processing of I/O

LabVIEW

- Graphical software for rapid development
- Program processor, FPGA and I/O with one tool
- Integrate existing C/VHDL



Small Size, Low Power

21 x 9 cm. (8.2 x 3.7 in.)
19-30 VDC power, (7-10 W typ.)

Expansion I/O

Connect up to three C Series modules for additional I/O (strain, TC, comm., motion, etc...)

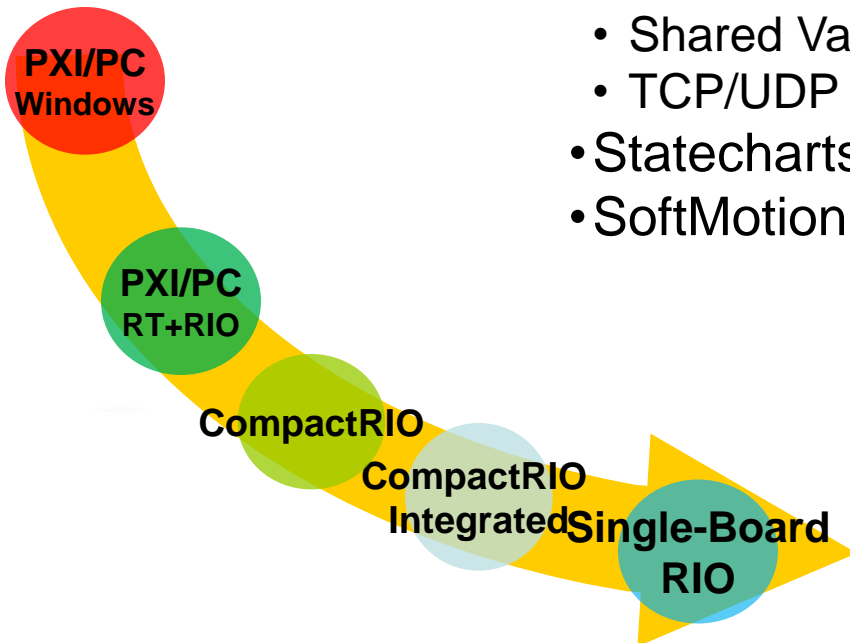
Onboard Analog and Digital I/O

110 DIO, Up to 32-ch AI, up to 4-ch AO,
Up to 32-ch of 24 V DIO

Processor + FPGA = Reconfigurable I/O (RIO)

RIO Deployment Curve

- Control Design
 - Control Design and Simulation
 - System ID
 - SIT
 - PID Control
- Algorithm Engineering
 - MathScript
 - Digital Filter Design
 - LabVIEW Analysis
 - FPGA IP
 - Sound and Vibration
 - Order Analysis
 - Modulation
- Communication
 - Shared Variables
 - TCP/UDP
- Statecharts
- SoftMotion
- Enterprise
 - Database Connectivity
 - Internet Toolkit
- C Code Integration
 - Call Library Node
 - Inline C Node
- Debugging
 - Execution Highlighting
 - Execution Trace
 - Desktop Execution Trace
 - VI Profiling
- I/O
 - Serial
 - CAN
 - Vision
 - USB DAQ
 - Motion

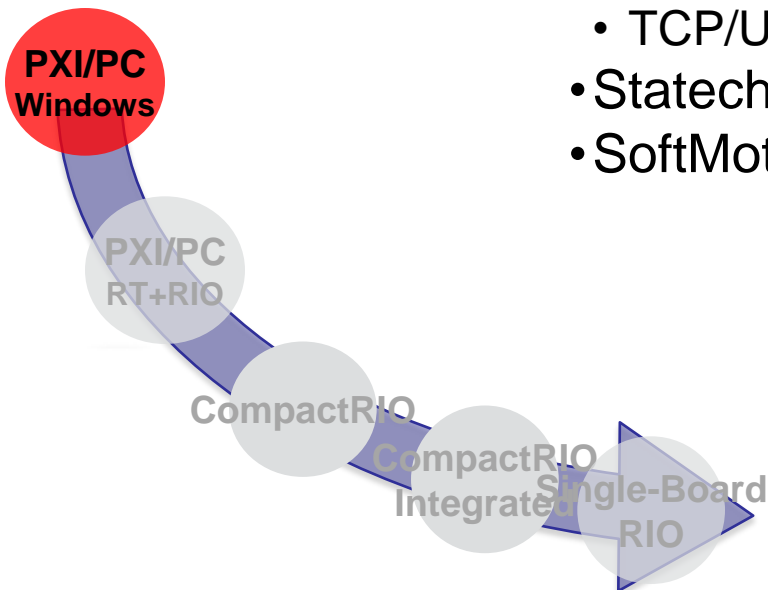


Processor + FPGA = Reconfigurable I/O (RIO)

RIO Deployment Curve

PXI/PC Windows

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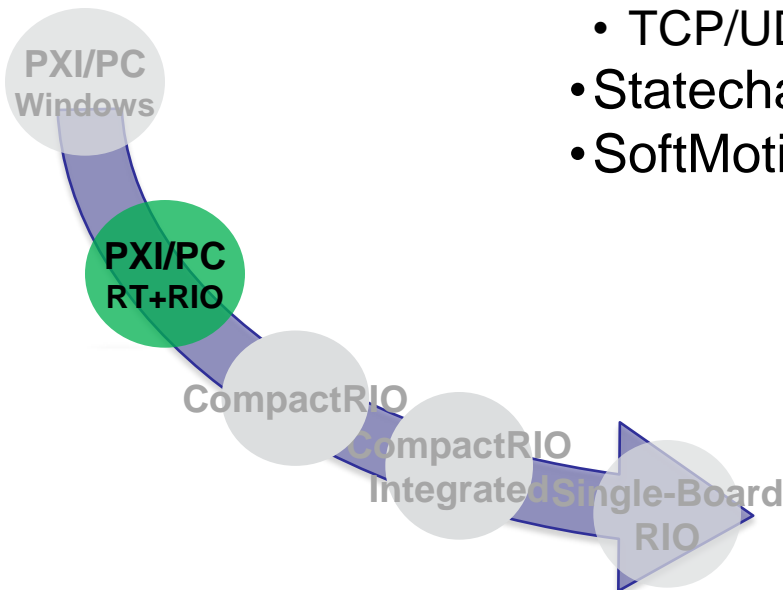


Processor + FPGA = Reconfigurable I/O (RIO)

RIO Deployment Curve

PXI/PC Real-Time

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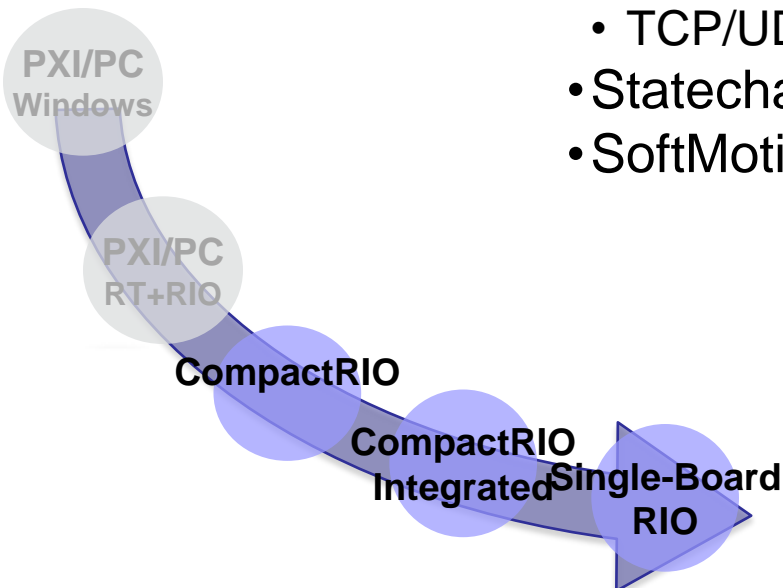
Processor + FPGA = Reconfigurable I/O (RIO)

RIO Deployment Curve

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CompactRIO

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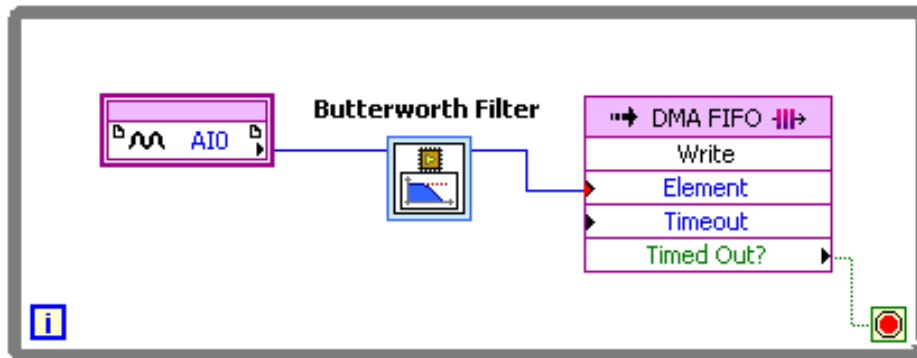


LabVIEW FPGA Code Abstraction

Counter

Analog I/O

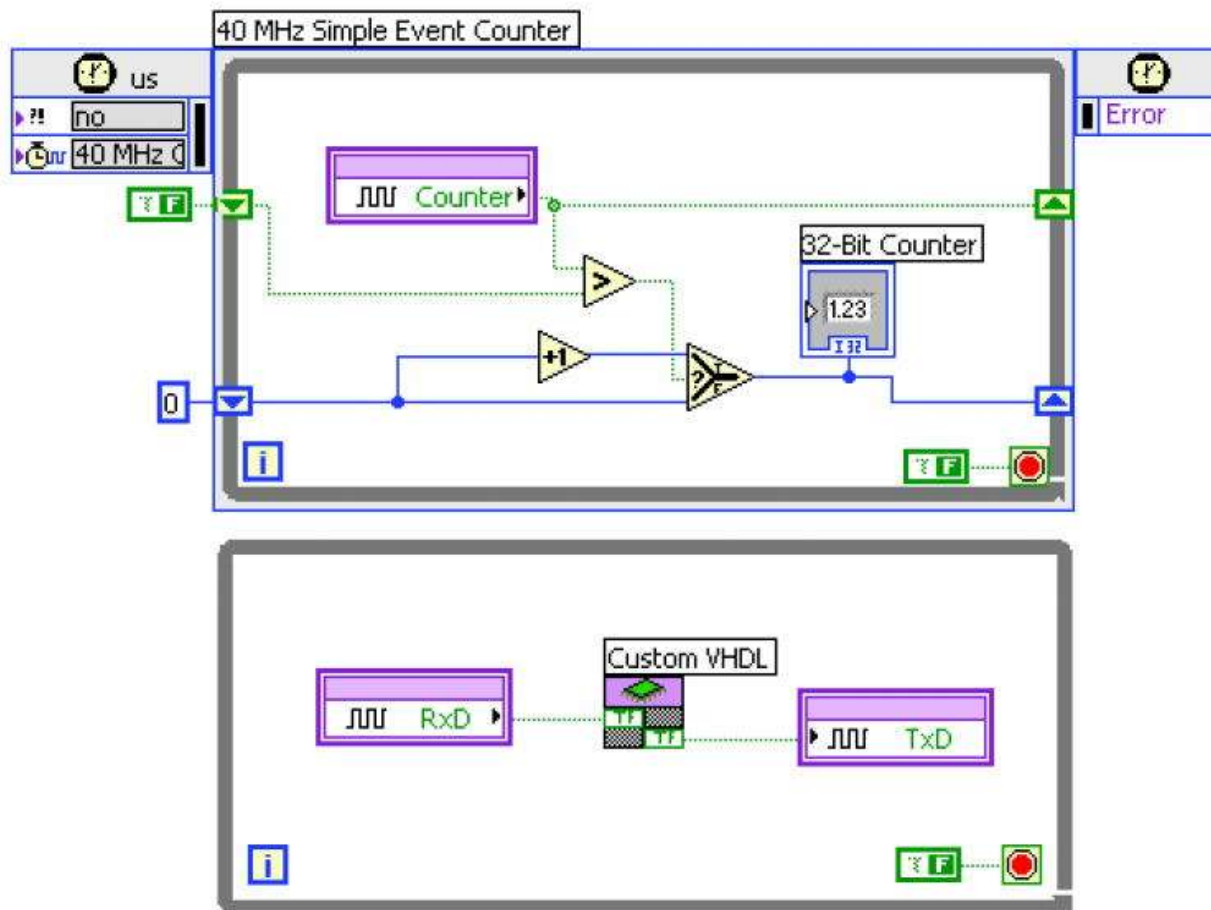
I/O with DMA



LabVIEW FPGA

[illegible]

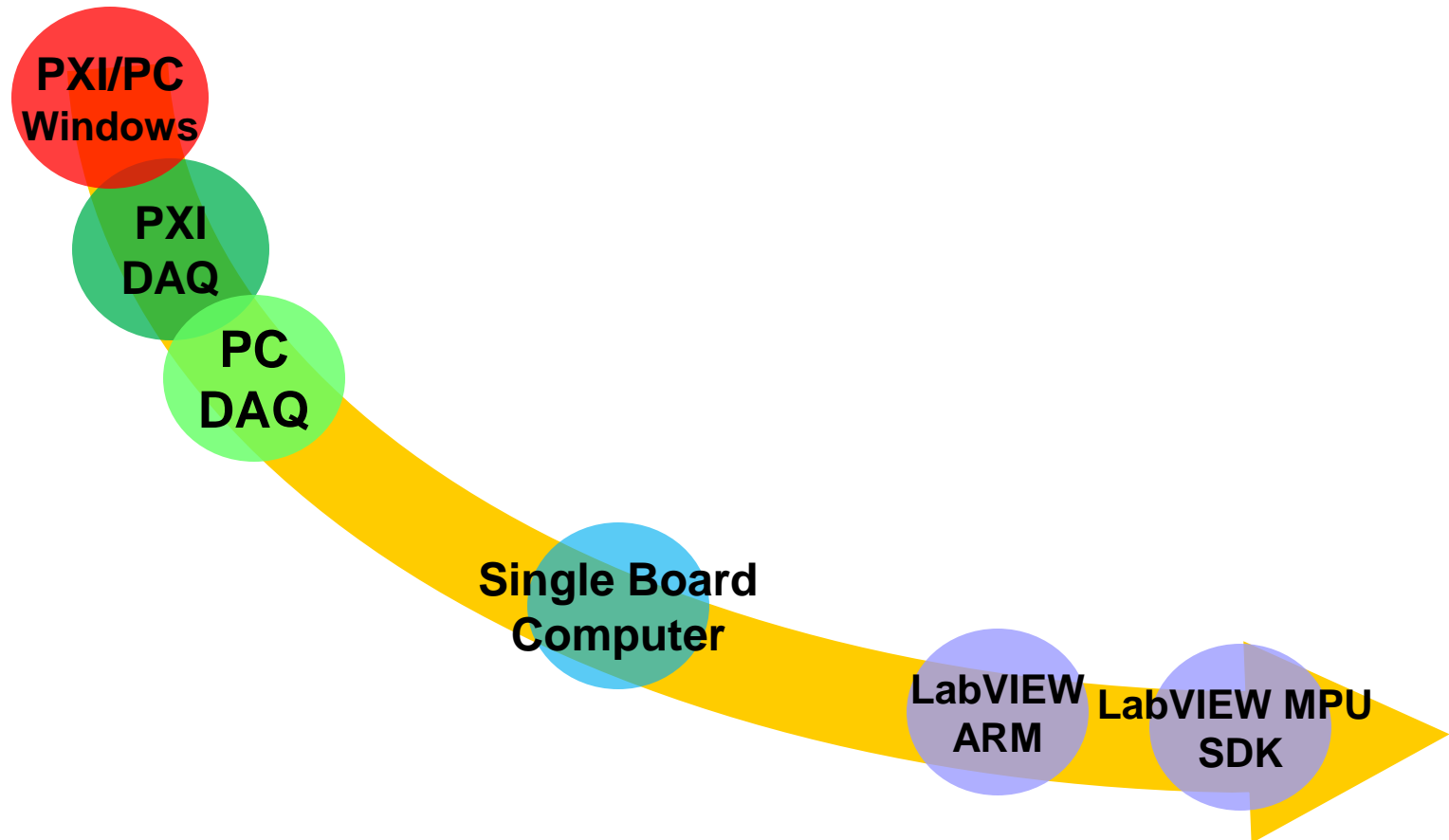
VHDL ~4000 lines



Program an FPGA: No HDL knowledge required

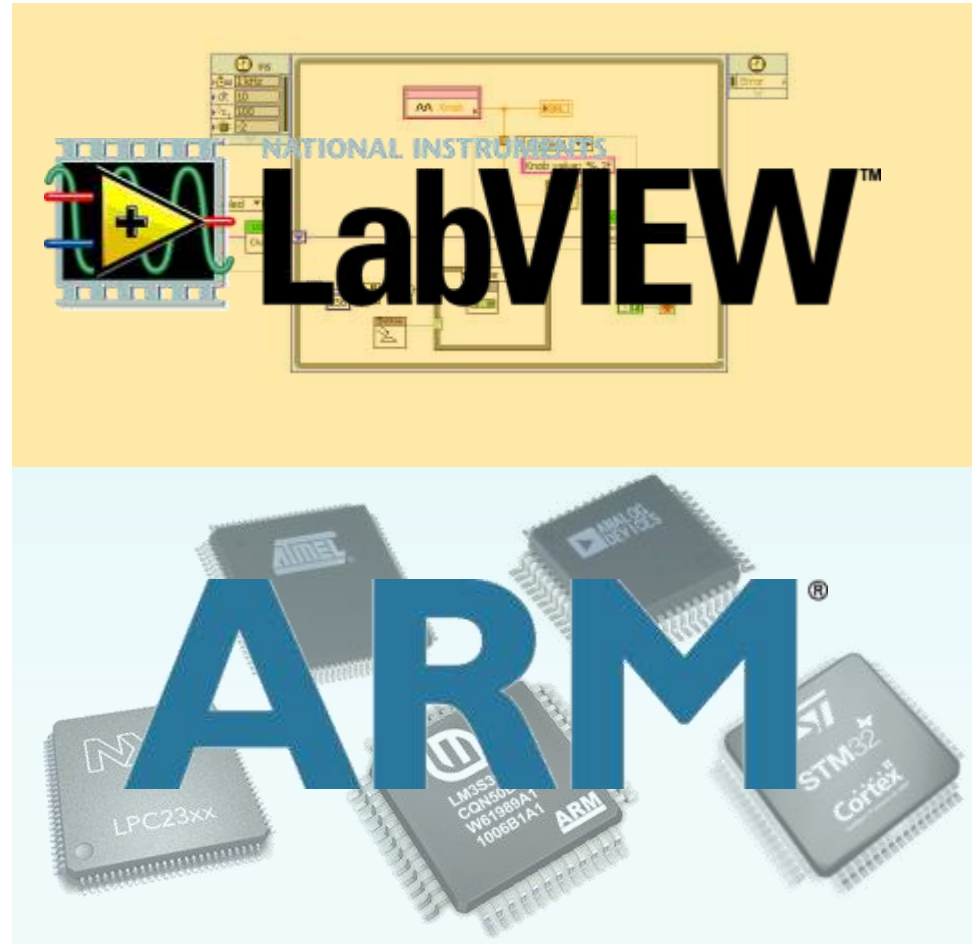
DEMONSTRATION

Processor/MPU+IO Architecture Curve

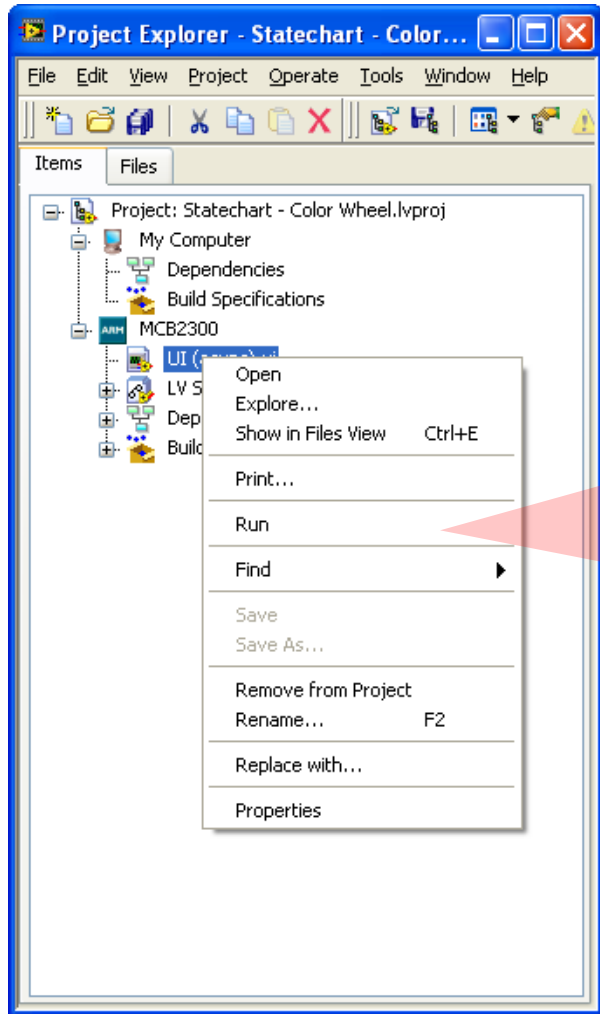


LabVIEW Embedded Module for ARM® Microcontrollers

- Over 260 supported processors
- Integrated drivers for analog, digital, and communications
- Desktop Simulation support for software development



Generating C Code



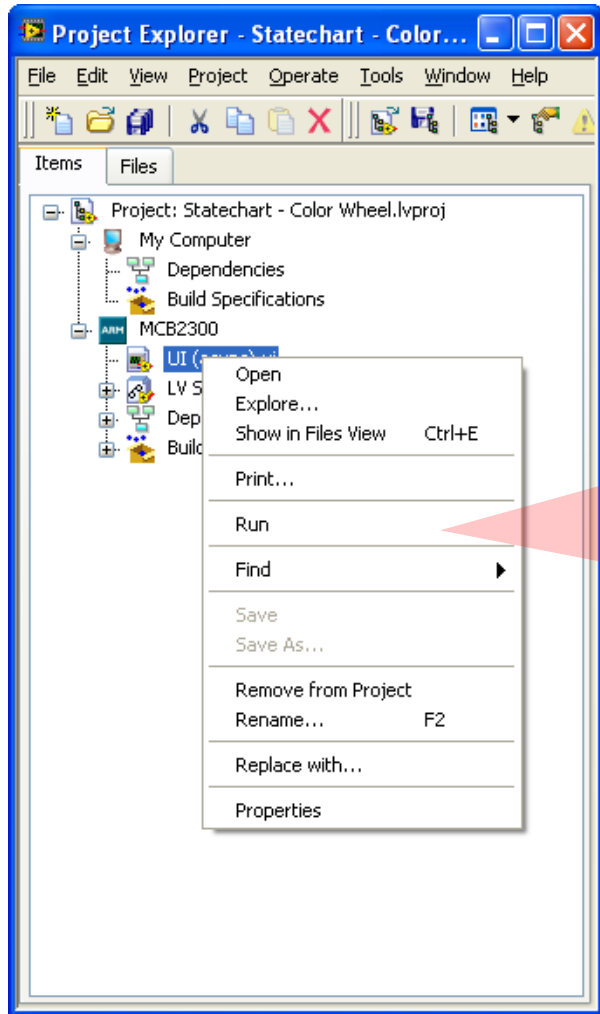
Run

My VI.vi

C Code Generation

My_VI.c

Compile and Link

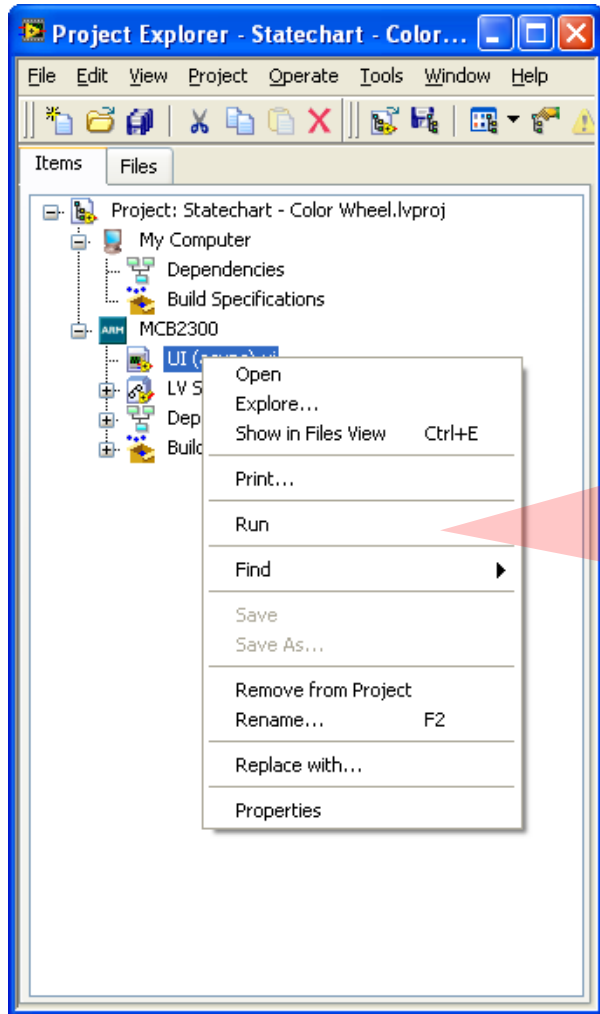


My_VI.c

Keil uVision

My_VI

Deployment to Hardware

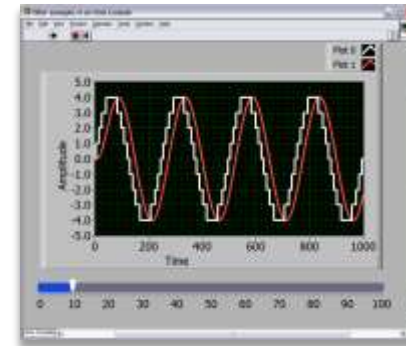
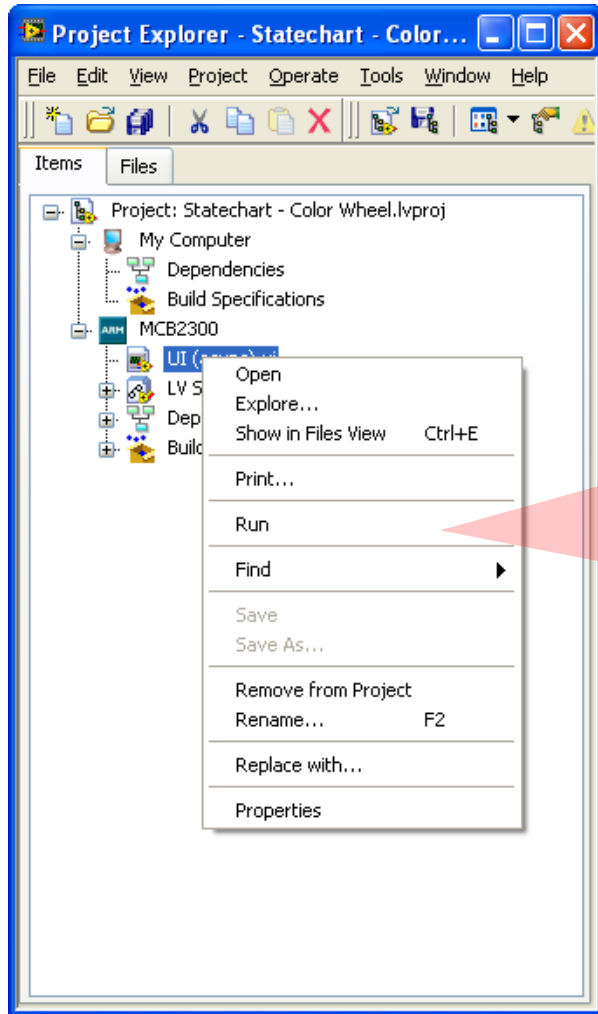


My_VI

**Download using
ULINK2**



Real-time Debugging

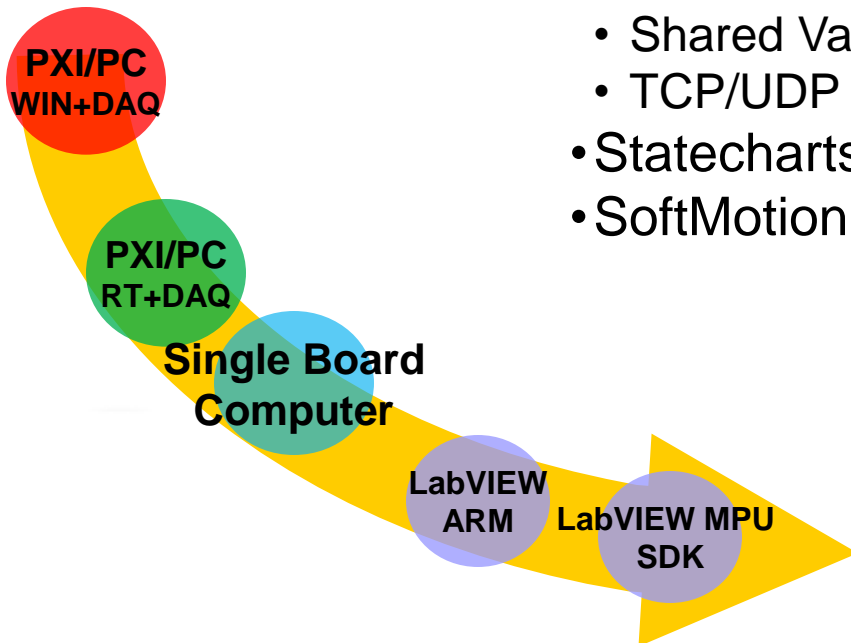


**Debugging via
ULINK2, TCP,
Serial**



Processor/MPU+IO Architecture Curve

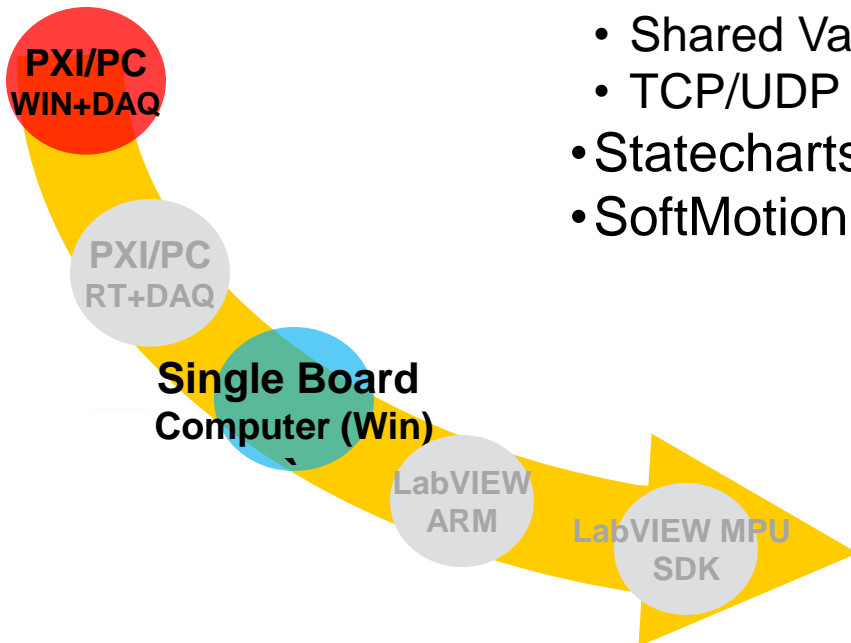
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Processor/MPU+IO Architecture Curve

PXI/PC/SBC Windows

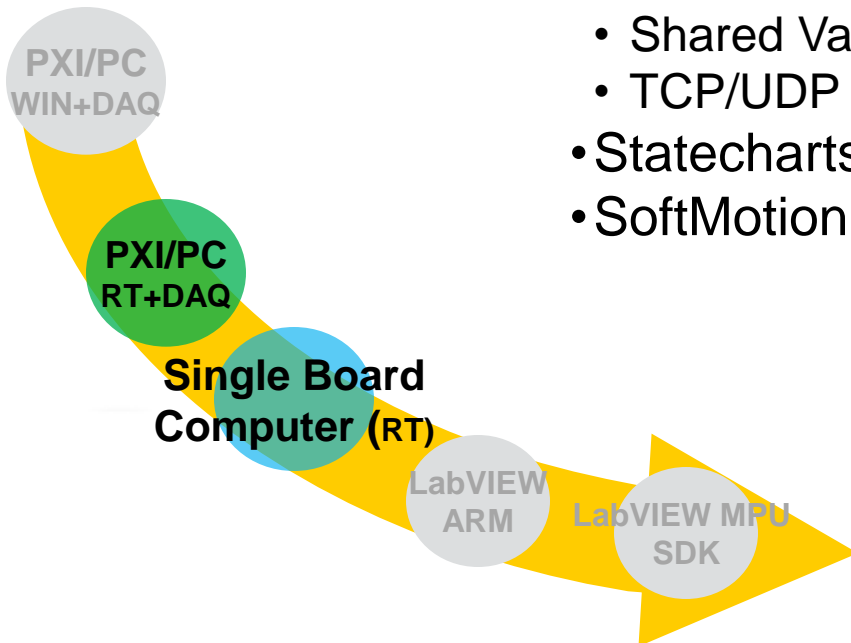
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Processor/MPU+IO Architecture Curve

PXI/PC/SBC Real-Time

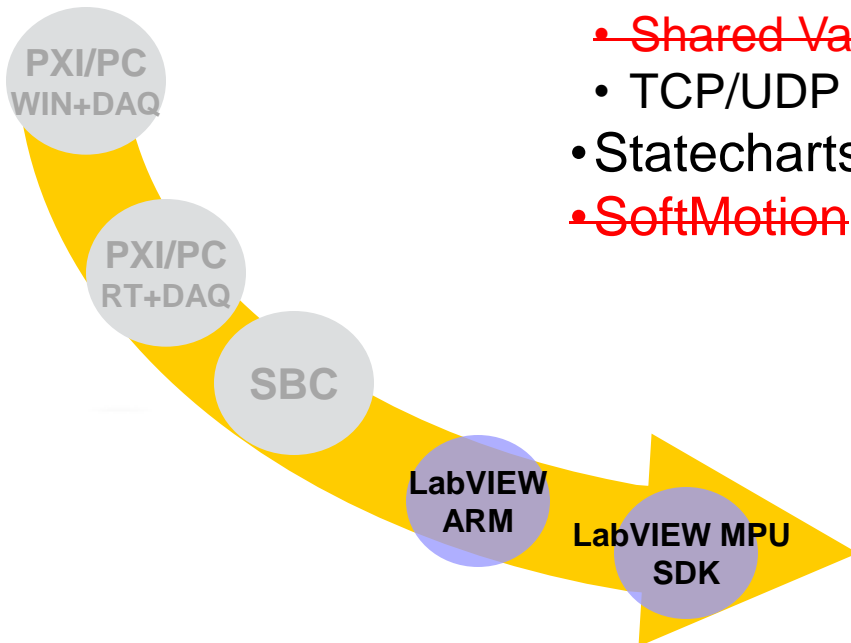
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Processor/MPU+IO Architecture Curve

ARM/BlackFin/MPU SDK

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Agenda

- The Deployment Curve
- Example Designs
- Recommendations
- LabVIEW Embedded Platform

Sanarus Medical: Embedded Medical Device



"NI played a fundamental part in achieving our goals. Our product design, prototype, and eventual deployment timelines were met because of the graphical system design platform from NI." – Jeff Stevens, Sanarus

Optimedica: Embedded Instrumentation

"By programming in LabVIEW FPGA, we were able to vary the timing and power of each pulse to optimize for speed and precision." – Michael Wiltberger, Optimedica



FedEx: Embedded Control System



"We were able to rapidly prototype our system for FedEx with LabVIEW and CompactRIO and create a final deployed solution with NI Single-Board RIO – all in under a year." – Ventura Aerospace

KCBioMediX: Embedded Instrumentation



“With National Instruments LabVIEW and NI CompactRIO, we were able to reduce our development cost by \$250,000 ...from 4 months to 4 weeks”
Dave Stalling,
KCBioMediX

Recommendations

How big is your design team?

Answer	Processor + FPGA + I/O	Processor + I/O
1-10	✓	
10 or more		✓

Does your team have embedded experience?

Answer	Processor + FPGA + I/O	Processor + I/O
Yes		✓
No	✓	

Device Level Questions

What I/O are you going to need?

Answer	Processor + FPGA + I/O	Processor + I/O
High speed, digital, analog	✓	
SPI, I ² C, Communications, Digital		✓
Simple Standard I/O		✓

Are there size, weight, power consumption issues?

Answer	Processor + FPGA + I/O	Processor + I/O
Yes		✓
No	✓	

Project Level Questions

How many devices are you going to make?

Answer	Processor + FPGA + I/O	Processor + I/O
0-500	✓	
500-1000		✓
More than 1000		✓

What is the schedule for this project?

Answer	Processor + FPGA + I/O	Processor + I/O
Months	✓	
Years		✓

**LabVIEW
Real-Time**



**LabVIEW
FPGA**



**LabVIEW
Touch
Panel**



**LabVIEW
for ADI
Blackfin**



**LabVIEW
for ARM**



LabVIEW Embedded Technology

**Real-Time
Processor**

FPGA

Industrial HMI

Microprocessor

Microcontroller



TRY IT

LabVIEW Embedded Platform Evaluation Kit