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Embedded Software Quality Challenge

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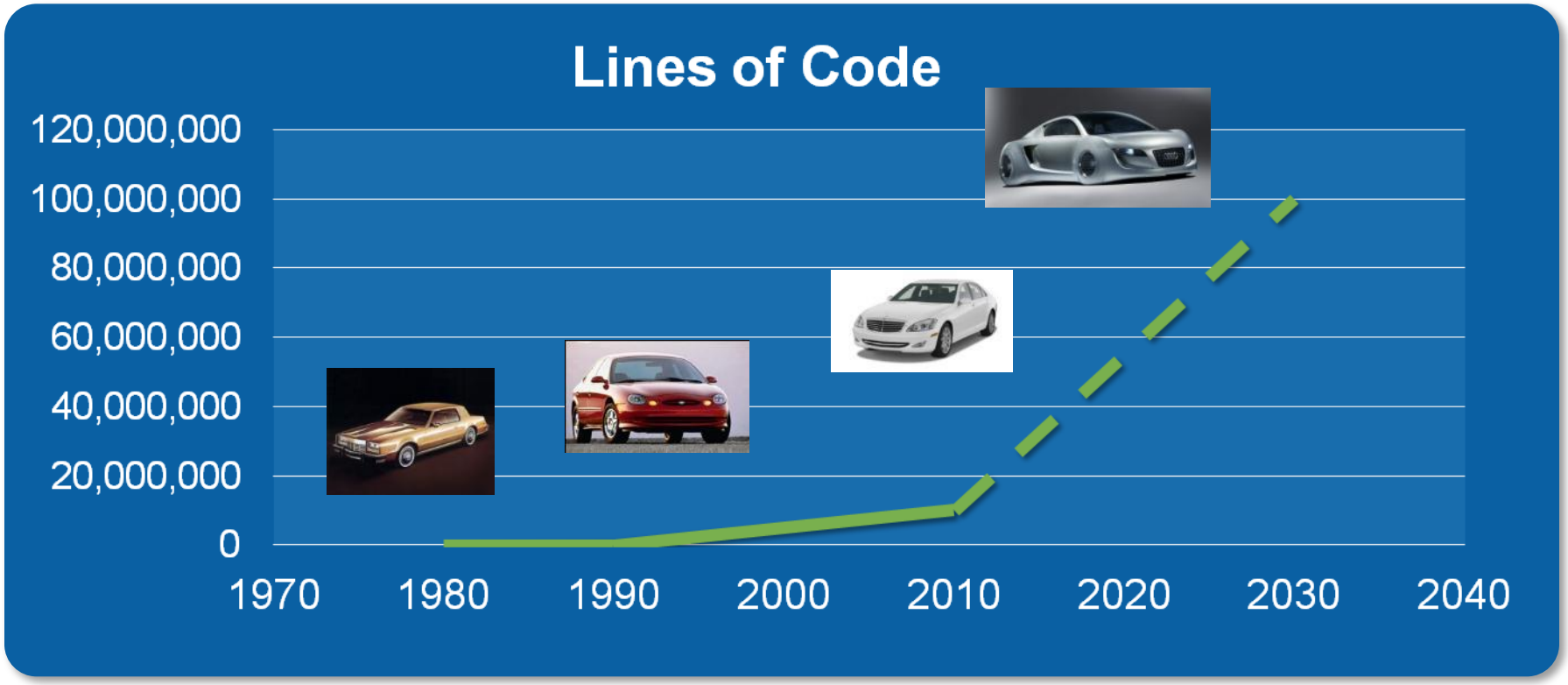
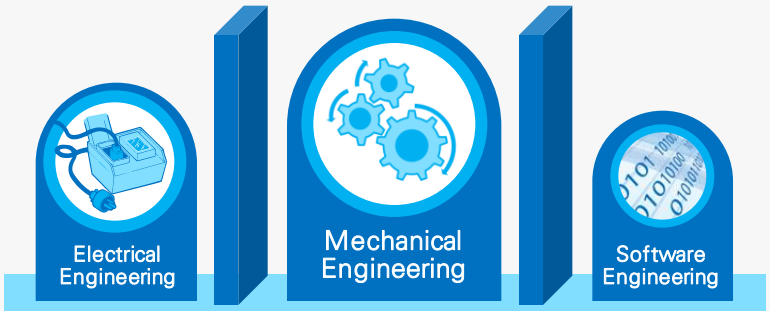
Embedded Software Quality Challenge



The complexity is growing at an increasing pace

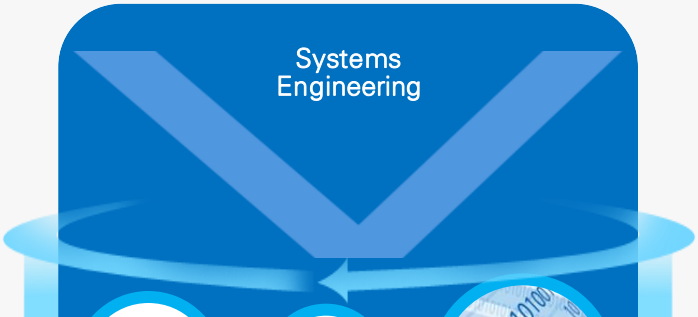
Smarter Products Require New Technology

Traditional Product & Systems Development



- Focused on CAD/CAM and BoM
- Slower to react to change
- Silos of engineering disciplines

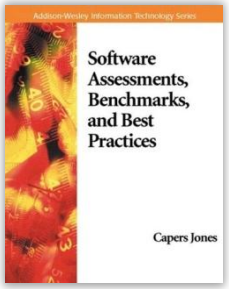
Next Generation Product & Systems Development



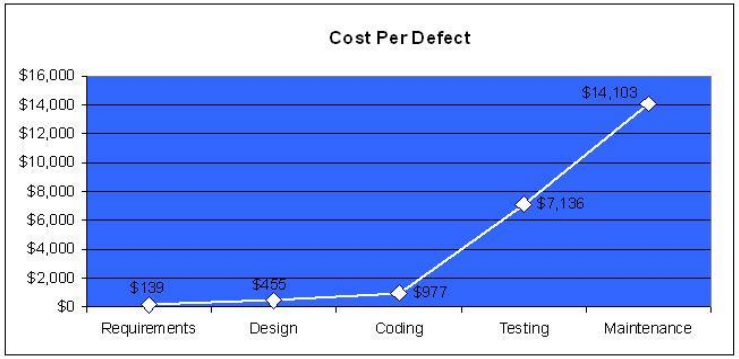
- More focus on software and electronics
- Responsive to change
- Systems engineering methods optimize product designs and engineering collaboration

Managing the Cost of Software Errors

	Smart Washing Machine	Commercial Aircraft	Luxury Automobile
			
Lines of Code	100k	6.5 Mil	10 Mil
	10-20 defects produced per 1,000 lines of code*		
Defects	1k – 2k	65k - 130k	100k – 200k



…a bug which costs $1 to fix on the programmer's desktop costs $100 to fix once it is incorporated into a complete program, and many thousands of dollars if it is identified only after the software has been deployed in the field.



* The Economists.May 16th, 2010. *Tech.View: Cars and software bugs. www.economist.com*

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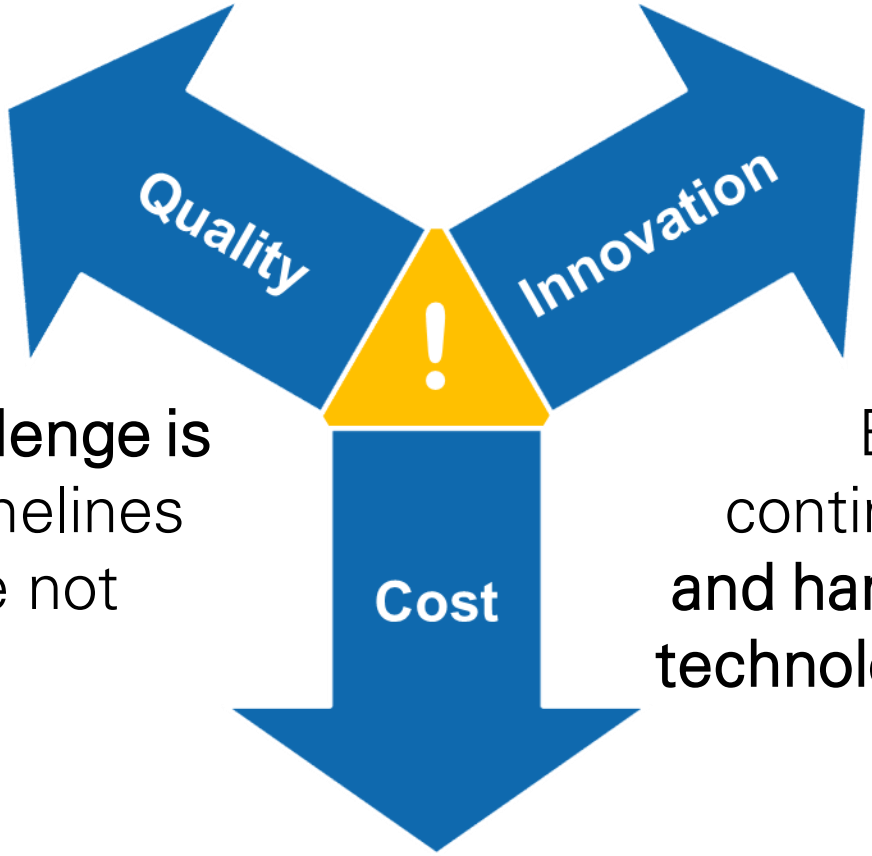
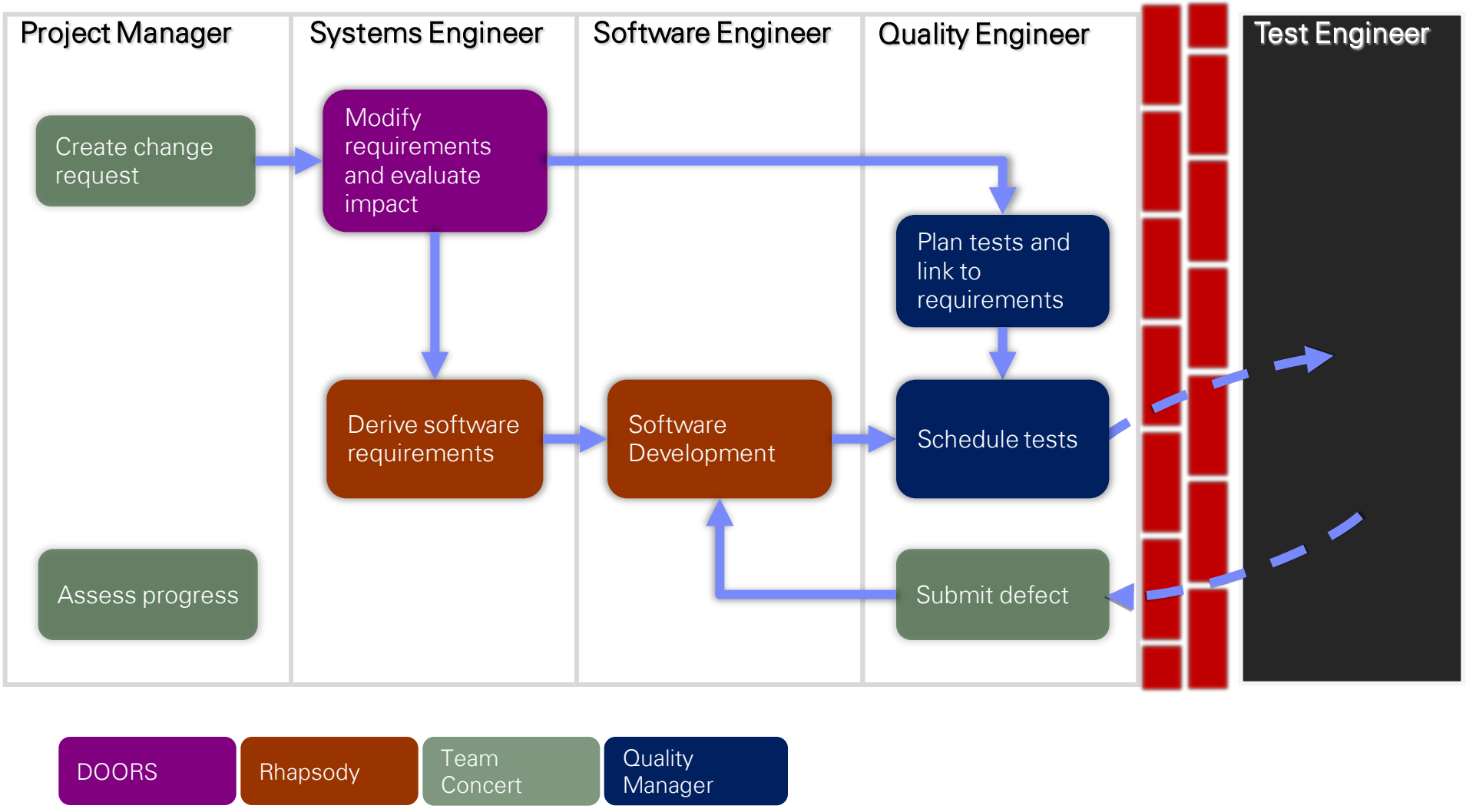
Diverging Challenges

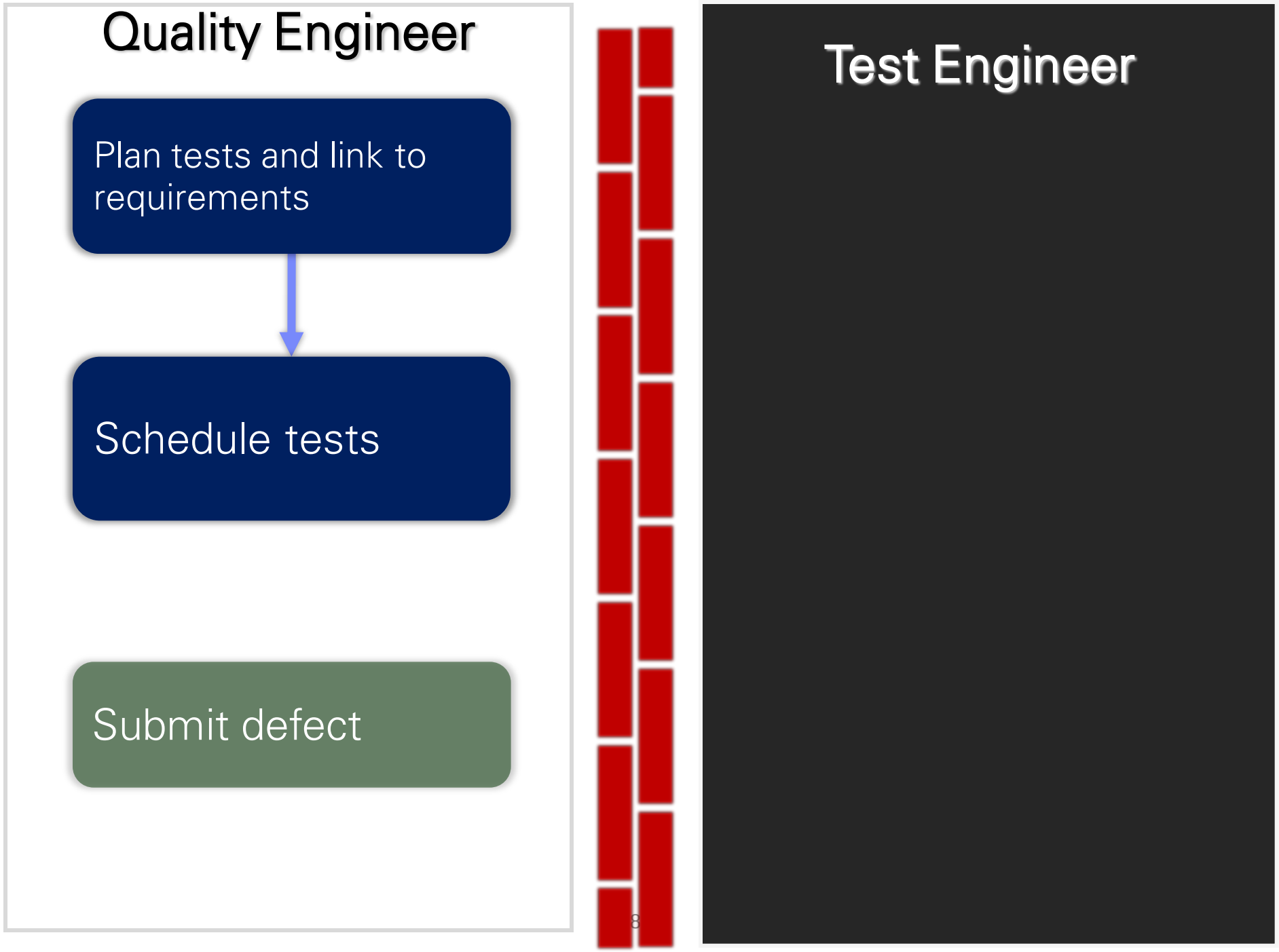


The **quality challenge is growing**, but timelines and budgets are not increasing proportionally

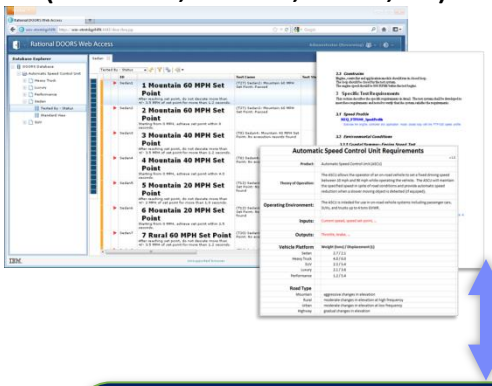
Engineers must continue to **innovate and harness the latest technologies** to remain competitive

Traditional Development Process



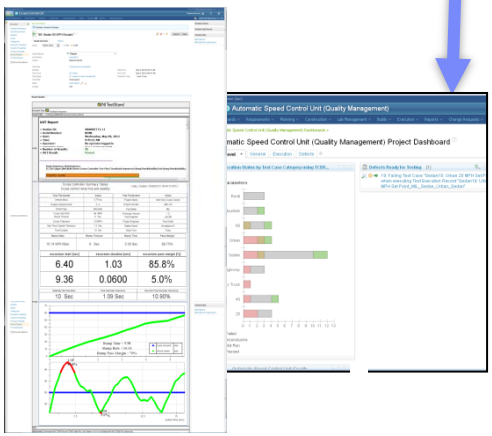

Quality Engineer
Plan tests and link to requirements
Schedule tests
Submit defect
Test Engineer

Requirements Documents
(DOORS, .docx, .xlsx, …)



IBM Rational Quality Manager

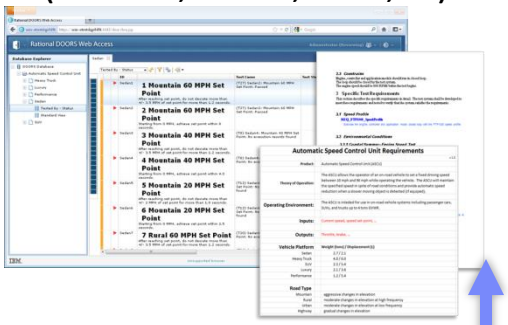
Test Plans	Execution Records
Test Cases	Requirement Links
Test Schedules	Quality Dashboards



Execution Records, Defect Management, Test Plan Documentation

Test Engineer

Requirements Documents
(DOORS, .docx, .xlsx, …)



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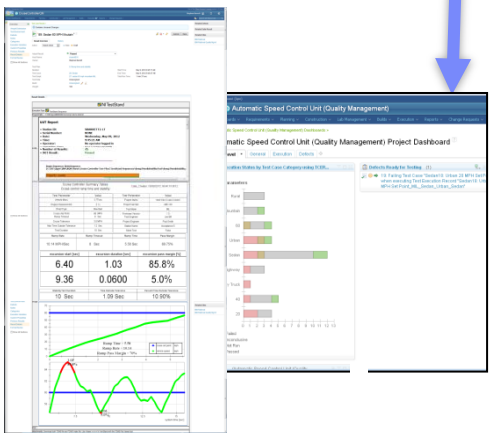
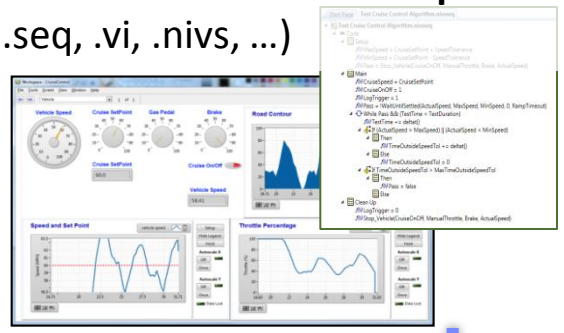


Execution Records, Defect Management, Test Plan Documentation

National Instruments Test Components
(.seq, .vi, .nivs, …)



NI TestStand

Sequences	Execution Records
Parameter Files	Requirement Links
Code Modules	Quality Dashboards

Test Results
(.html, .pdf, .tdms, .jpg, …)

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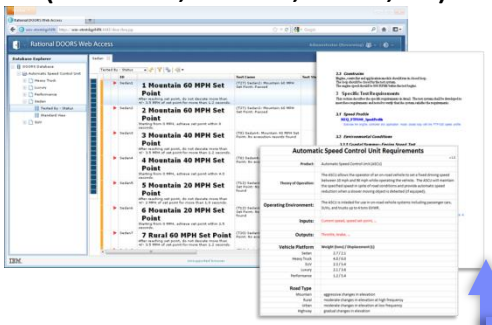
Requirements Documents
(DOORS, .docx, .xlsx, …)



National Instruments Test Components
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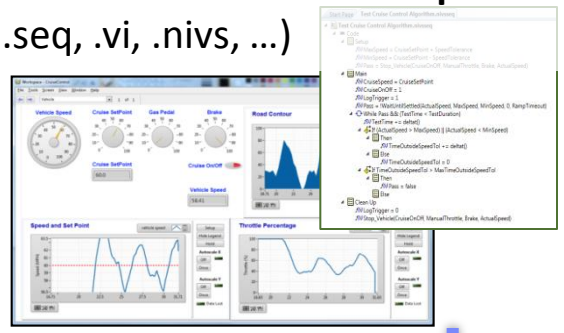

National Instruments Test Integration Adapter for IBM Rational Quality Manager

IBM Rational Quality Manager

Test Plans	Execution Records
Test Cases	Requirement Links
Test Schedules	Quality Dashboards

NI TestStand

Sequences	Execution Records
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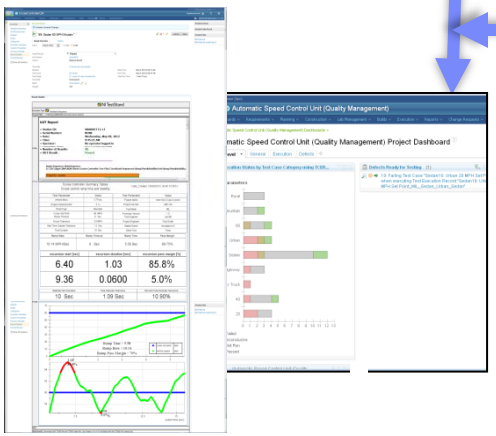
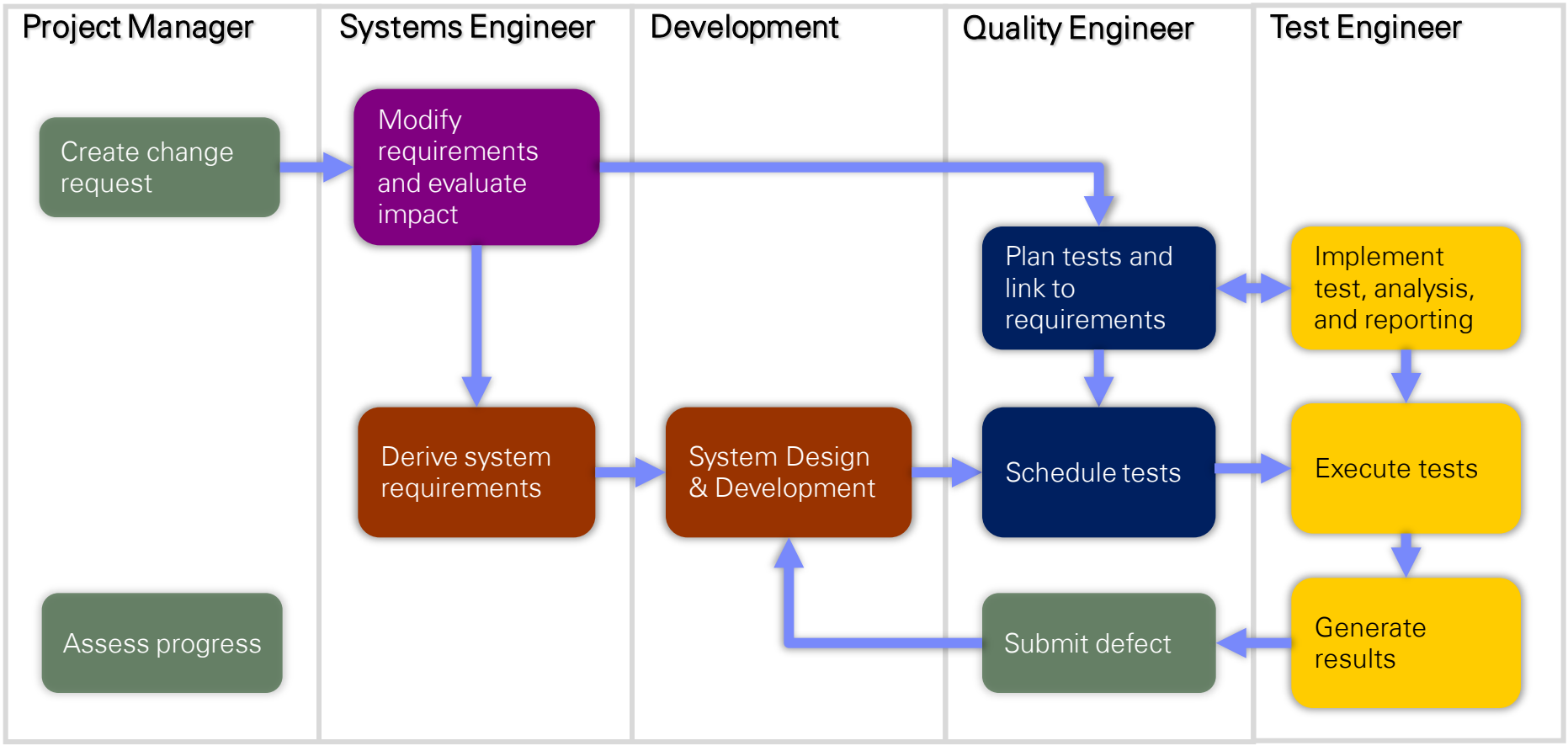


Execution Records, Defect Management, Test Plan Documentation

Test Results
(.html, .pdf, .tdms, .jpg, …)

Next Generation Development Process



DOORS | Rhapsody | Team Concert | Quality Manager | NI TestStand | LabVIEW | NI VeriStand | DIAdem

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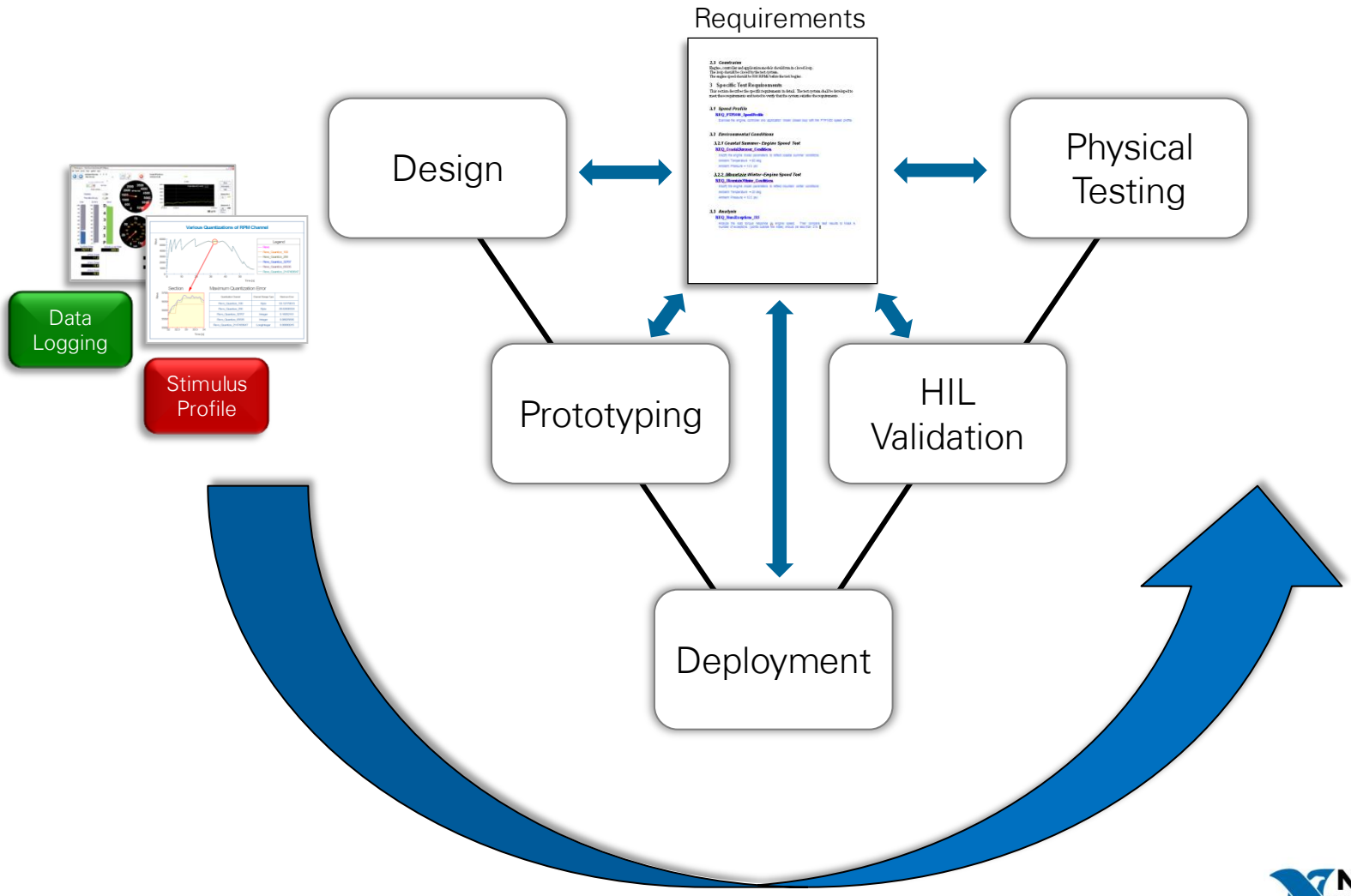
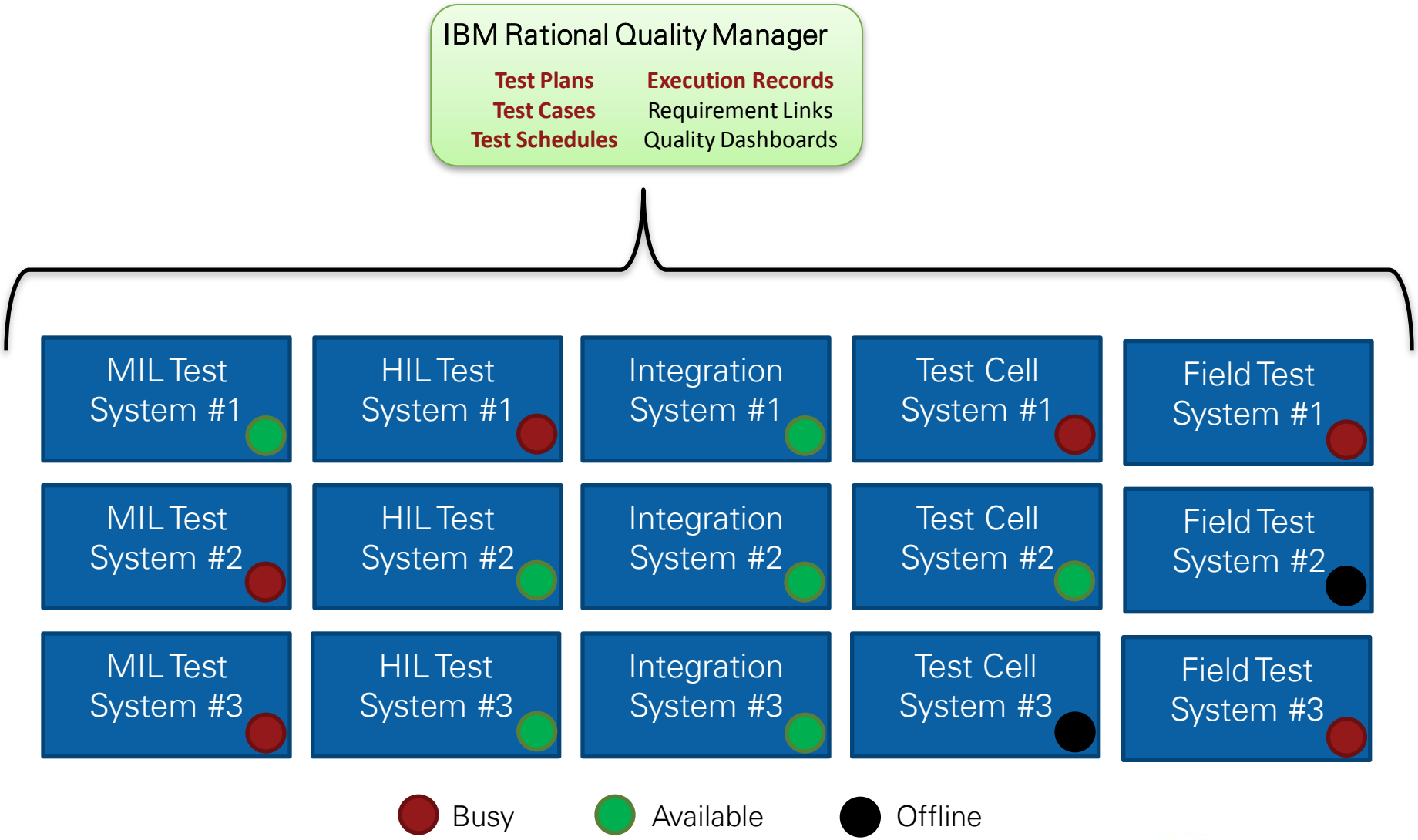
Consistency and Efficiency throughout the Process



Test Asset Management and Automation

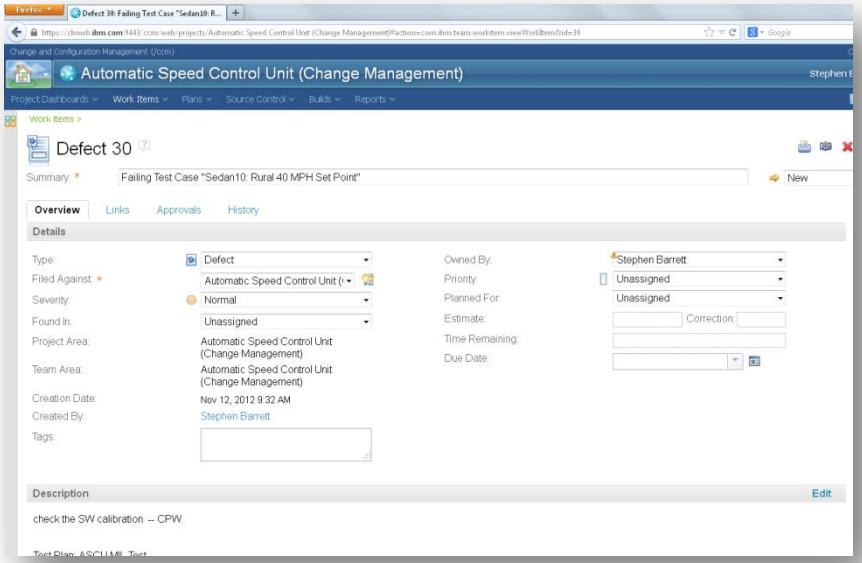


Defect Management

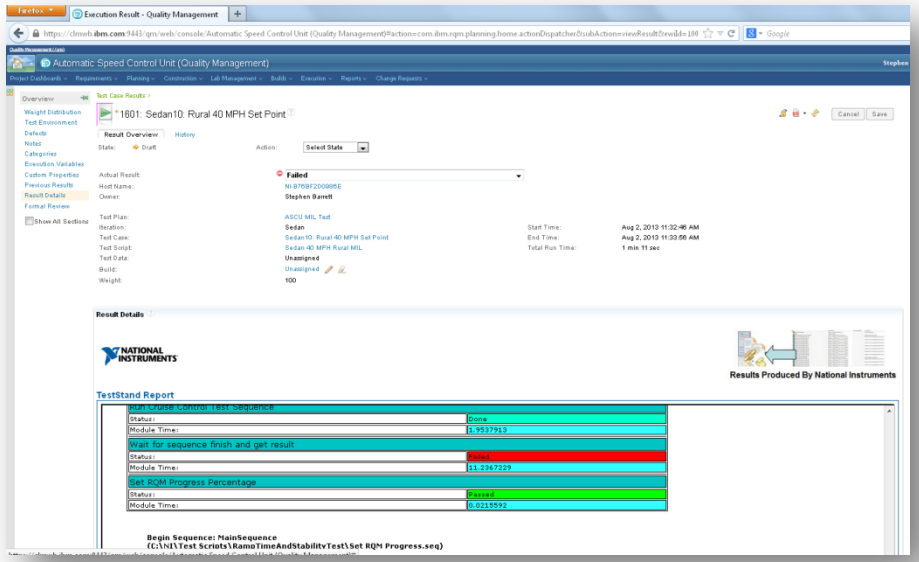
IBM Rational Quality Manager

Test Plans	**Execution Records**
Test Cases	**Requirement Links**
Test Schedules	Quality Dashboards

Defect Resolution Collaboration



Defect Results and Verification Items



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Project Documentation and Tracking

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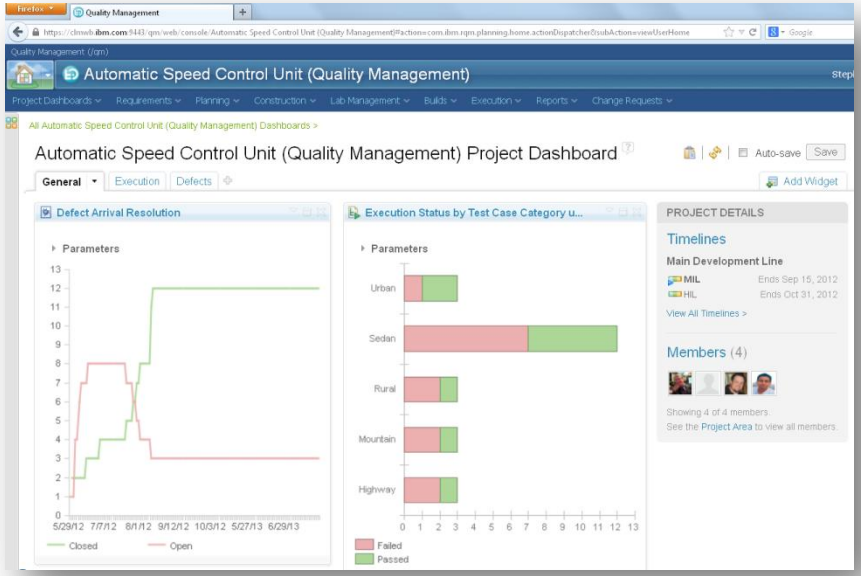
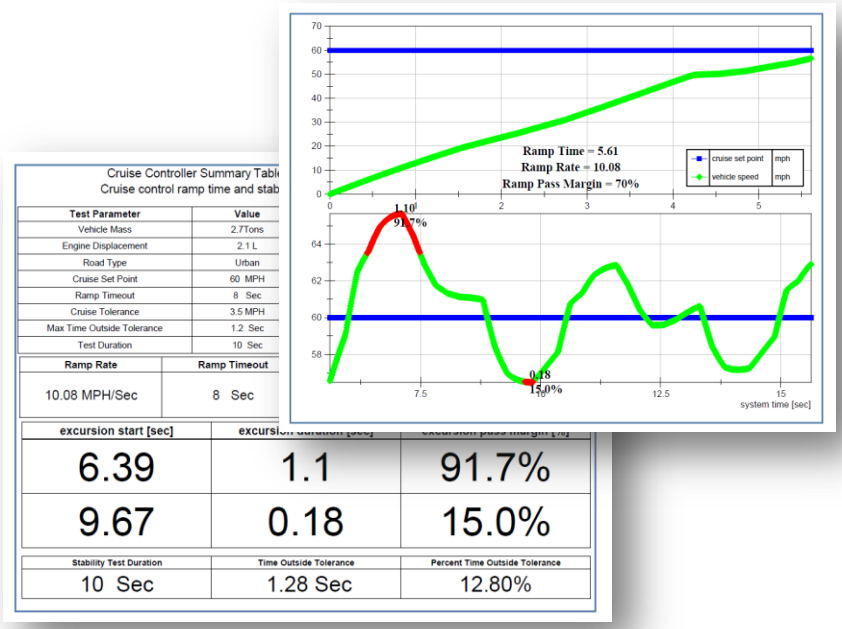
Test Plans	Execution Records
Test Cases	Requirement Links
Test Schedules	Quality Dashboards

Project Dashboards



Test Results



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Breaking the Quality Management Silos with Enhanced Collaboration and Traceability

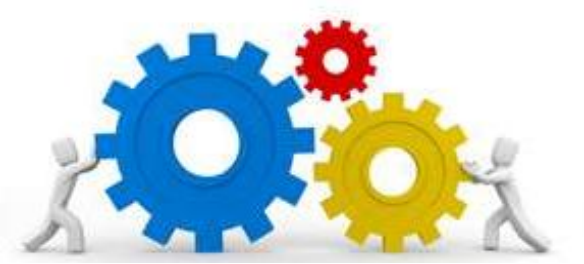
IBM Rational and National Instruments are teaming together to provide an **end-to-end quality management solution**.

Traceability all the way to test and back with **Collaboration** between ALL teams, including test

- Test components and assets linked to and managed with quality plan test cases
- All test results available to all teams and linked to test cases and requirements

Promotes quality and test consideration from the outset, not an afterthought, **reducing cost and risk** of identifying and correcting defects

Enables **test component re-use** throughout project phases and between projects providing operational efficiency and accuracy



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Questions?

Trends in Advanced Powertrain & In-Vehicle RF Communications Research

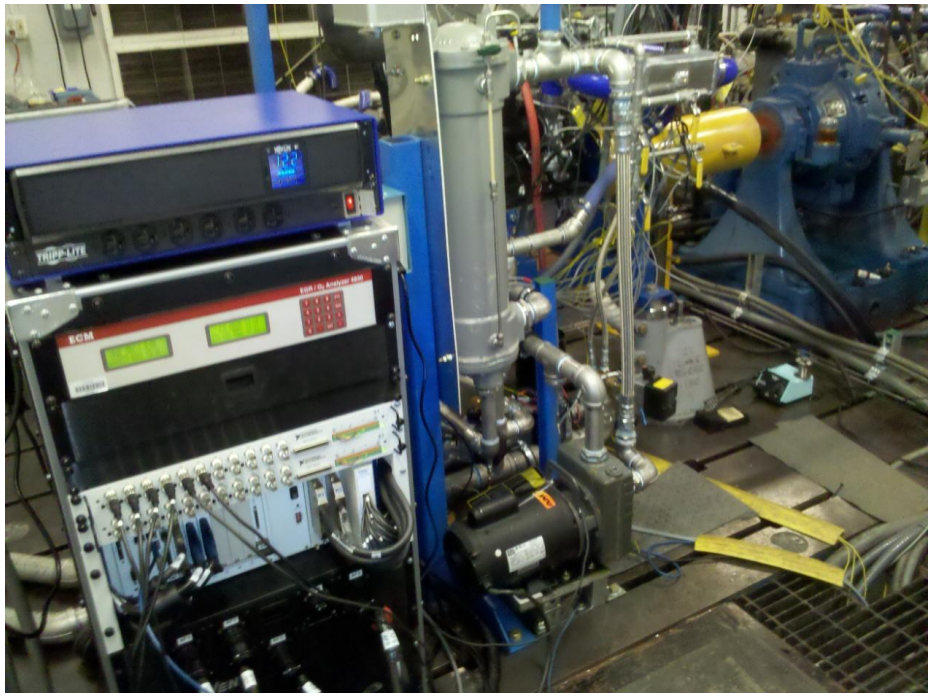
- Fast
- Parallel
- Connect math to real world quickly
- Interactive, integrated systems (complexity)

Advanced Powertrain Trends

- Fuel efficiency
- Fast control of traditional technologies
  - Fast analysis
  - Fast decision making
  - High speed I/O
- Electrification

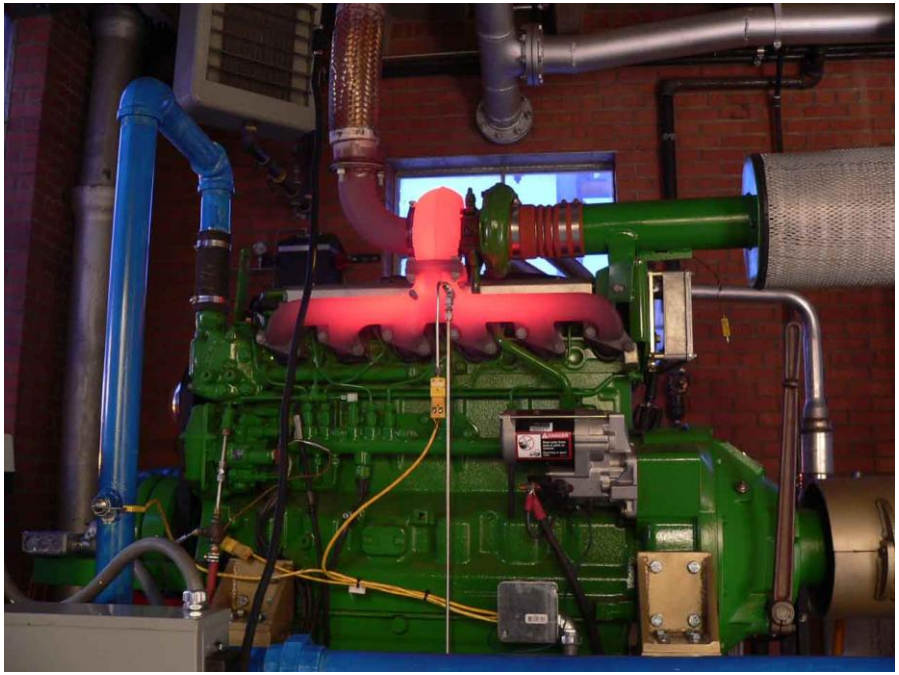
Oak Ridge and Argonne National Labs

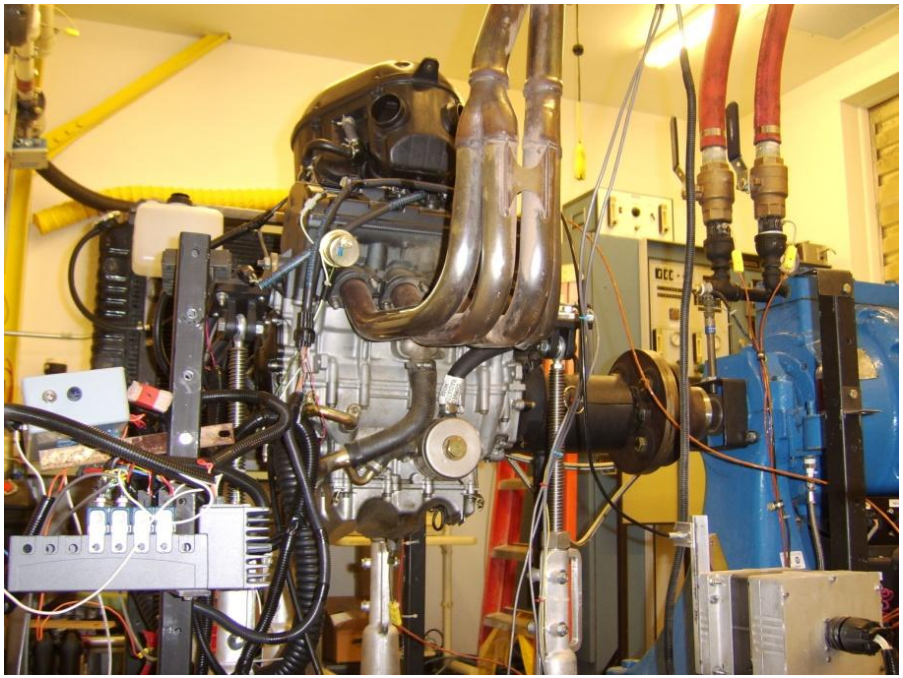
Full authority engine control system with DCAT combustion analysis for same-cycle and next-cycle control



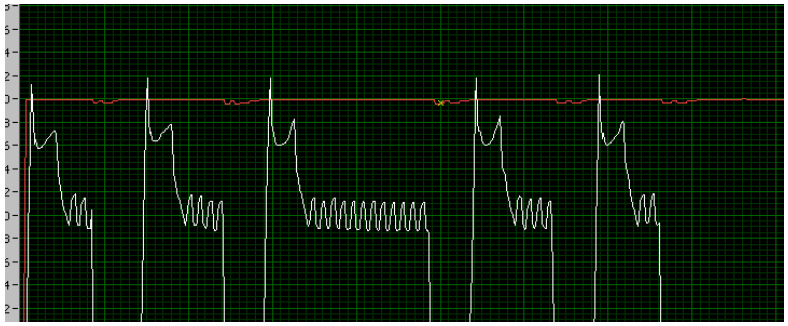
University Research

Diesel, gasoline, natural gas, and alternative fuel research systems in 19 universities around the world



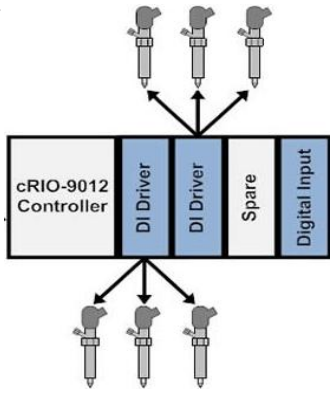


Injector Driver Kits

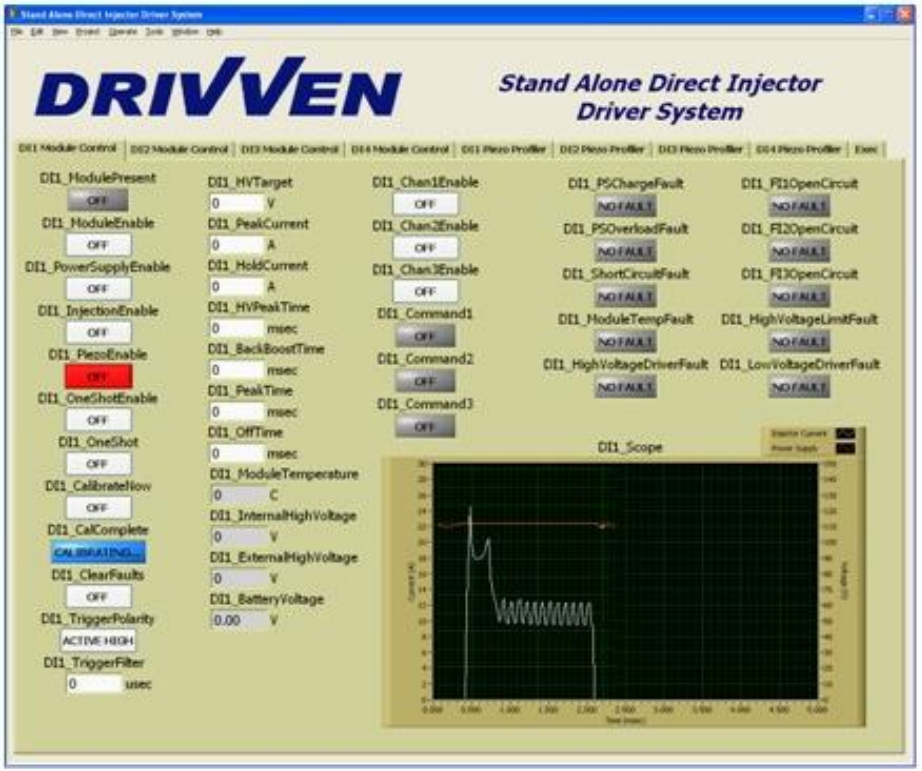


Direct Injector Drive Kit

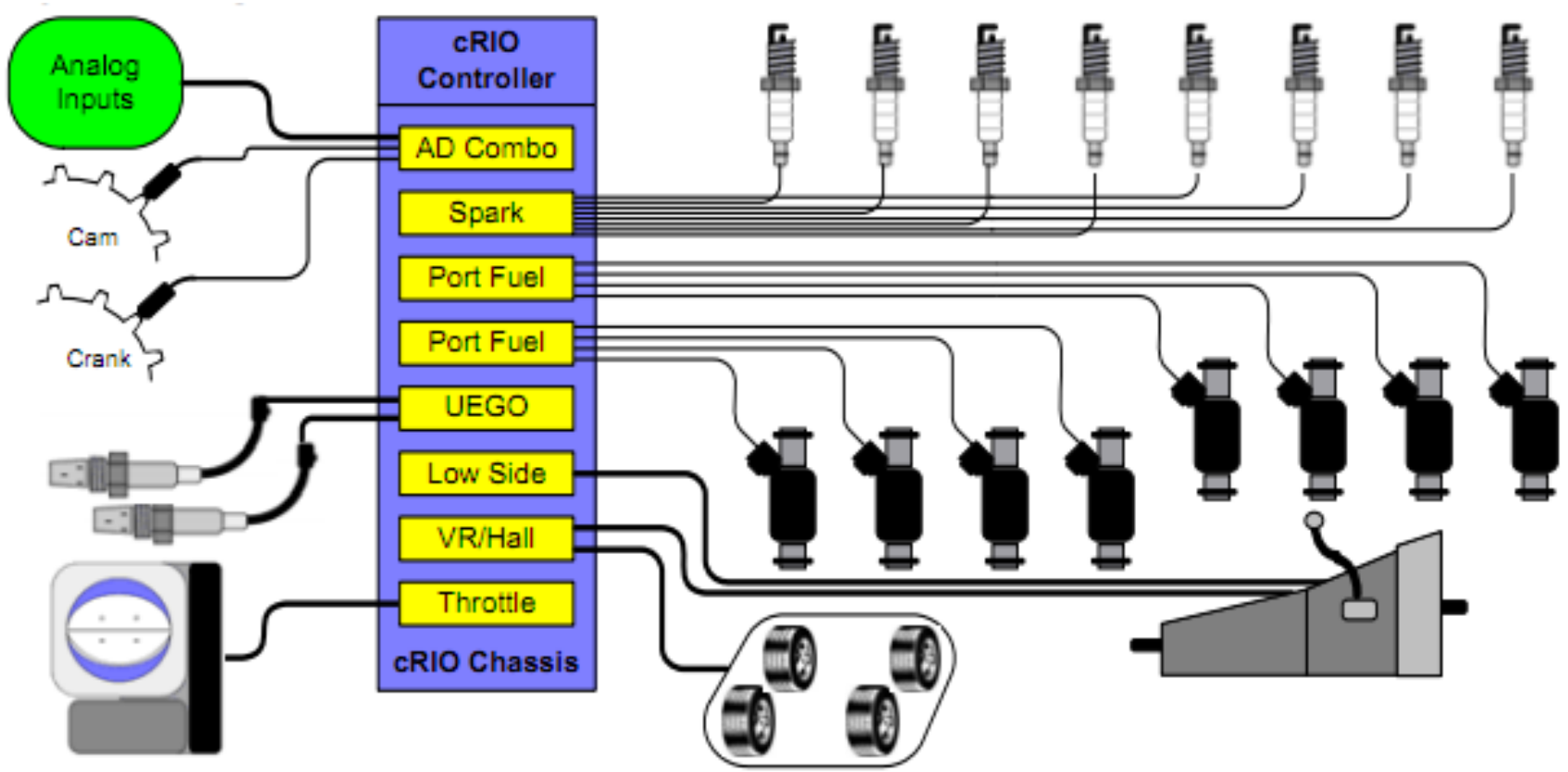
- Driver stage to interface with existing controller commands
- Ready to run out-of-box at power-up
- Calibration interface over Ethernet
- Add custom I/O for rail pressure control, etc



Stand-Alone Kits



Typical Engine Control Application



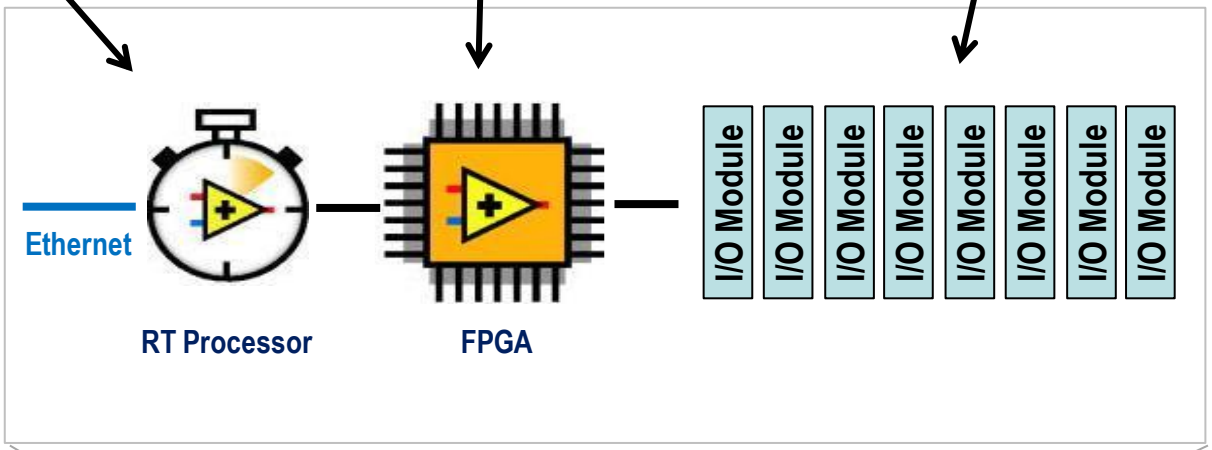
System Diagram

Engine control software and calibration points

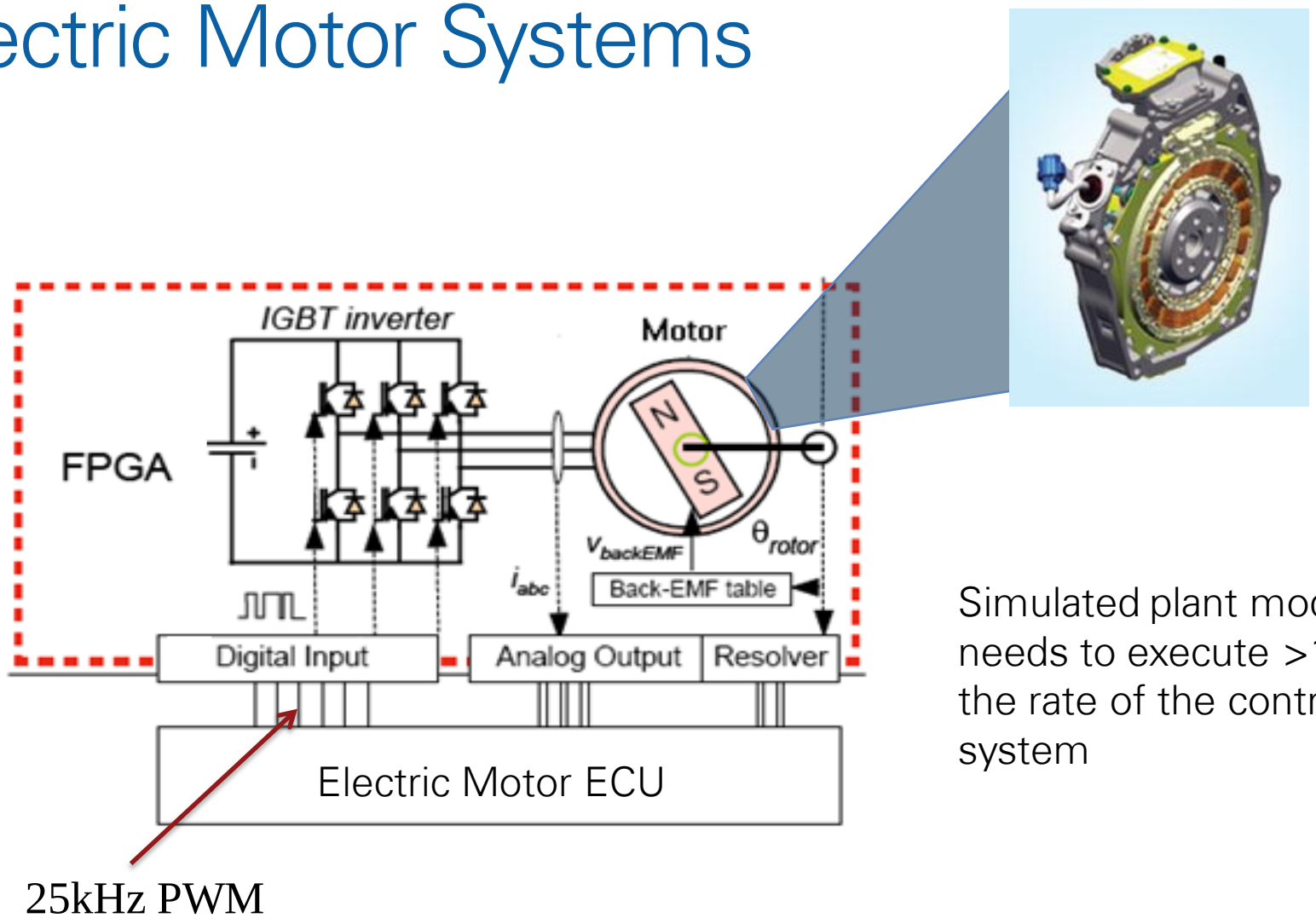
FPGA-based “driver” code for modules (ie EPT)

User-defined I/O configuration

User Interface Link:

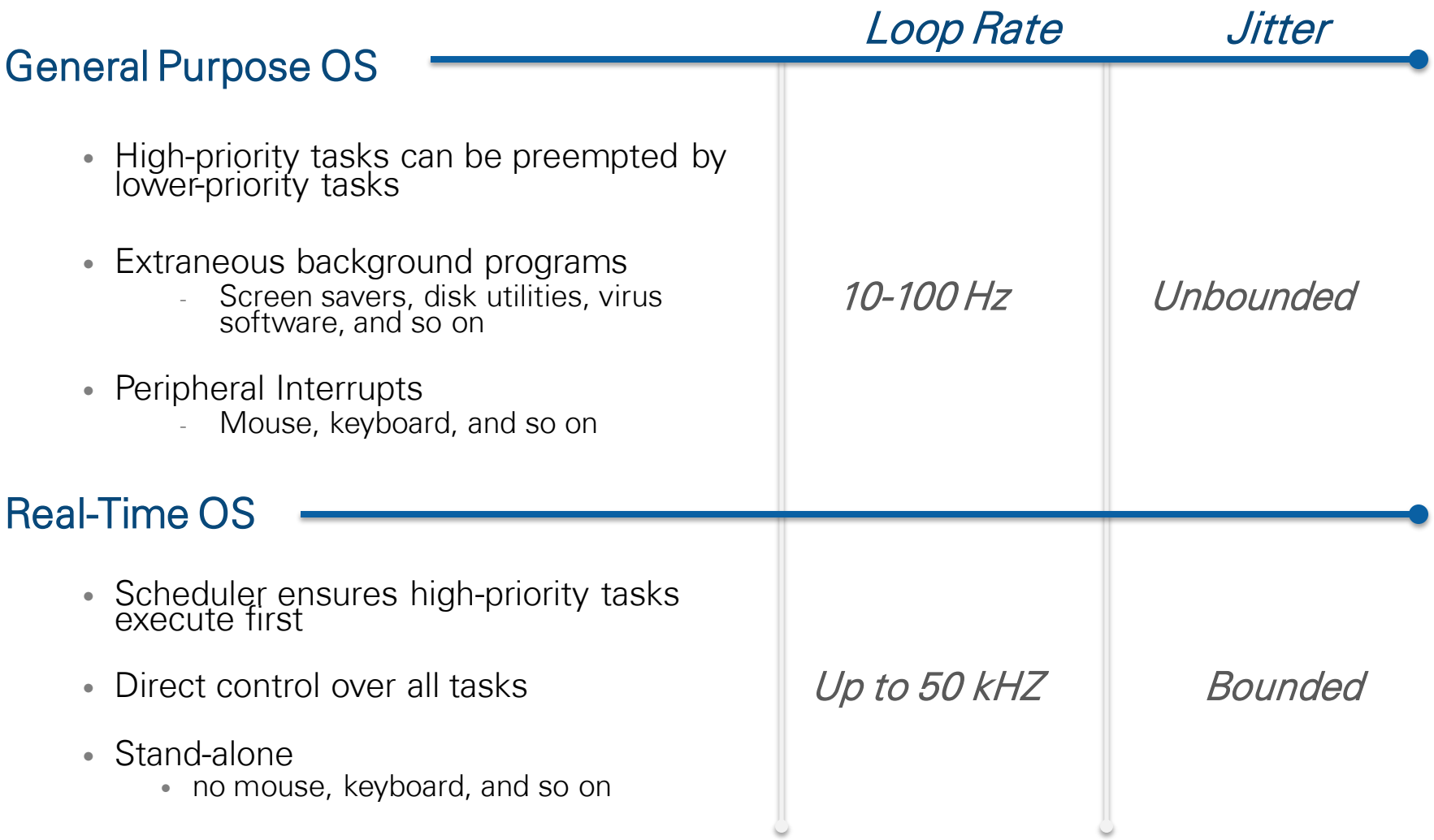


Electric Motor Systems



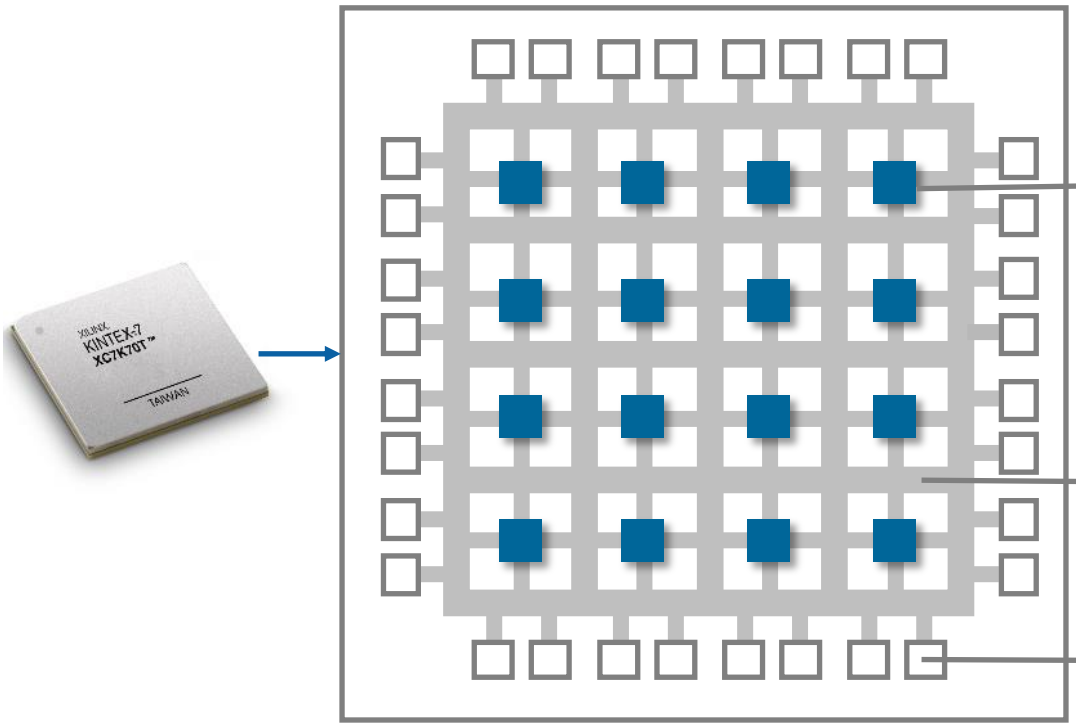
Simulated plant model needs to execute >10x the rate of the control system

Operating System Characteristics



Software Designed Hardware

Field-Programmable Gate Array (FPGA)



Memory Blocks

Store data sets or values in user defined RAM

Configurable Logic Blocks (CLBs)

Implement logic using flip-flops and LUTs

Multipliers and DSPs

Implement signal processing using multiplier and multiplier-accumulate circuitry

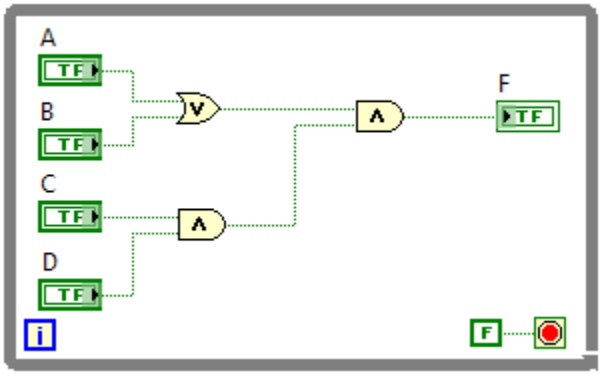
Programmable Interconnects

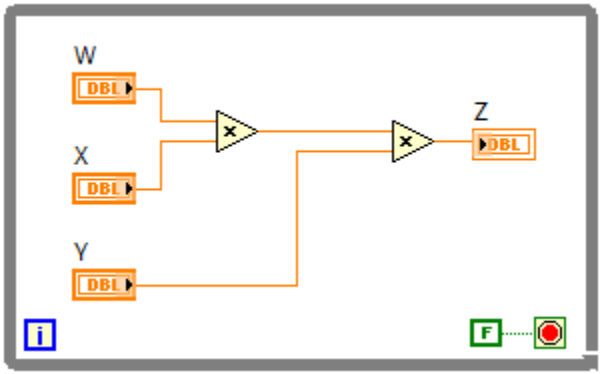
Route signals through the FPGA matrix

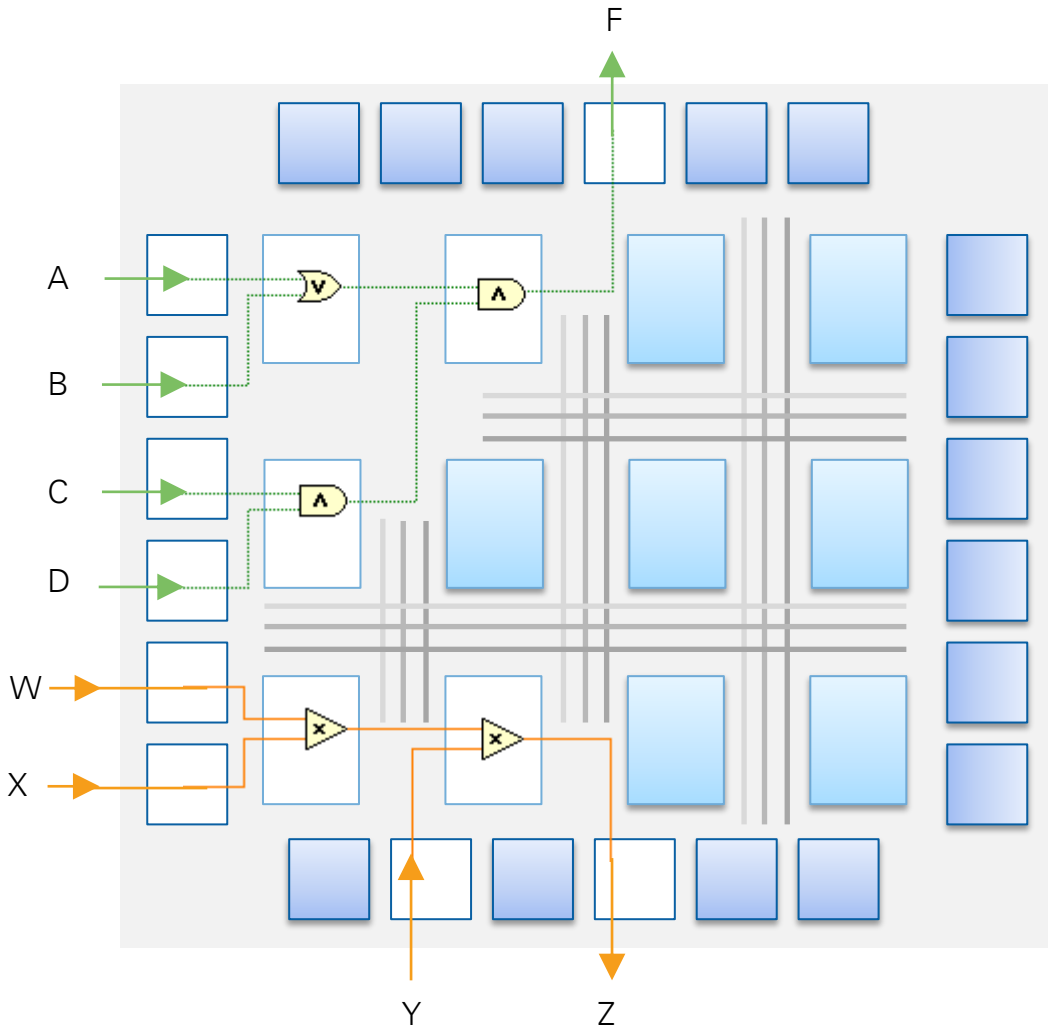
I/O Blocks

Directly access digital and analog I/O

FPGA: Parallel Processing

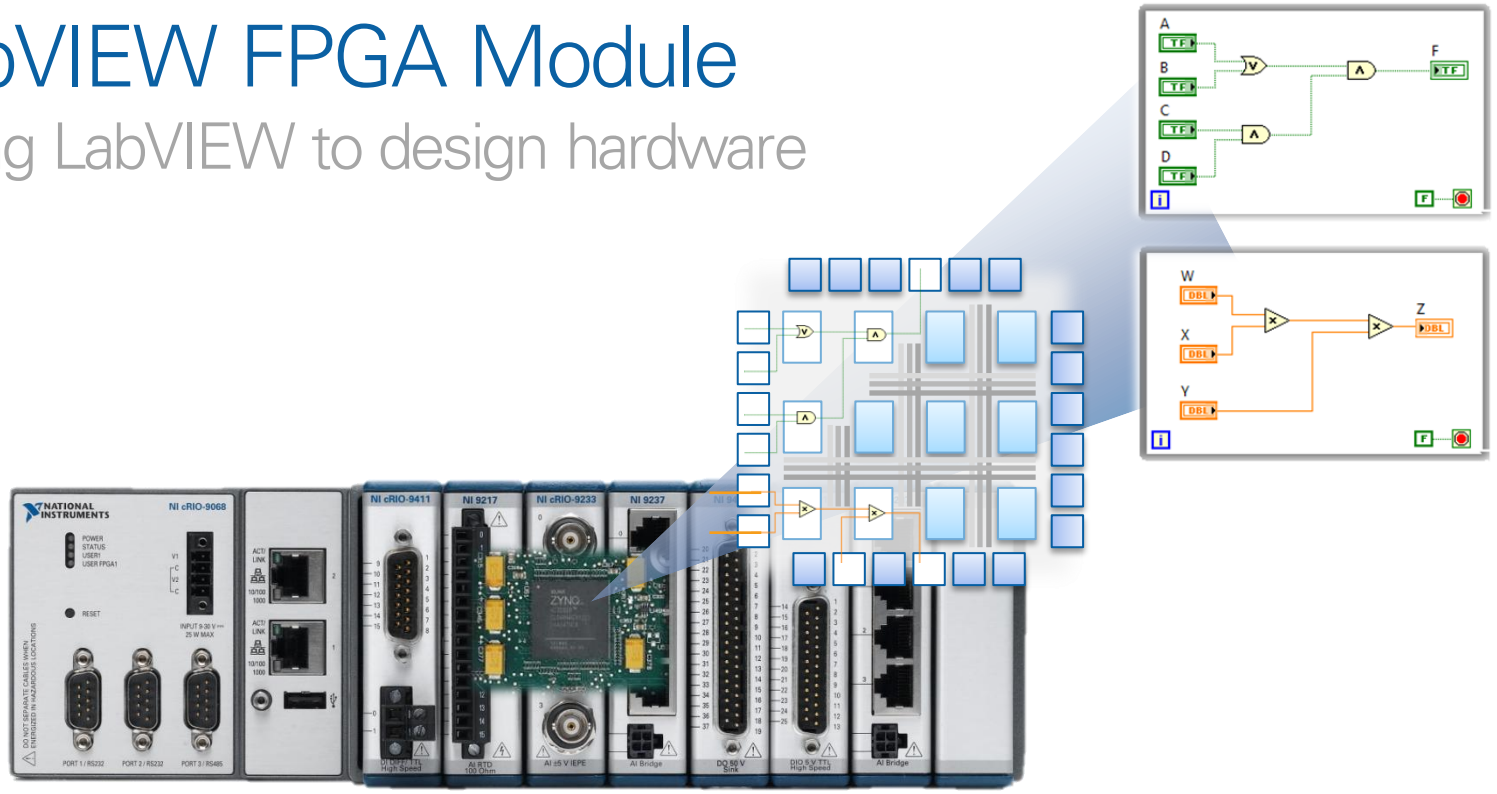






LabVIEW FPGA Module

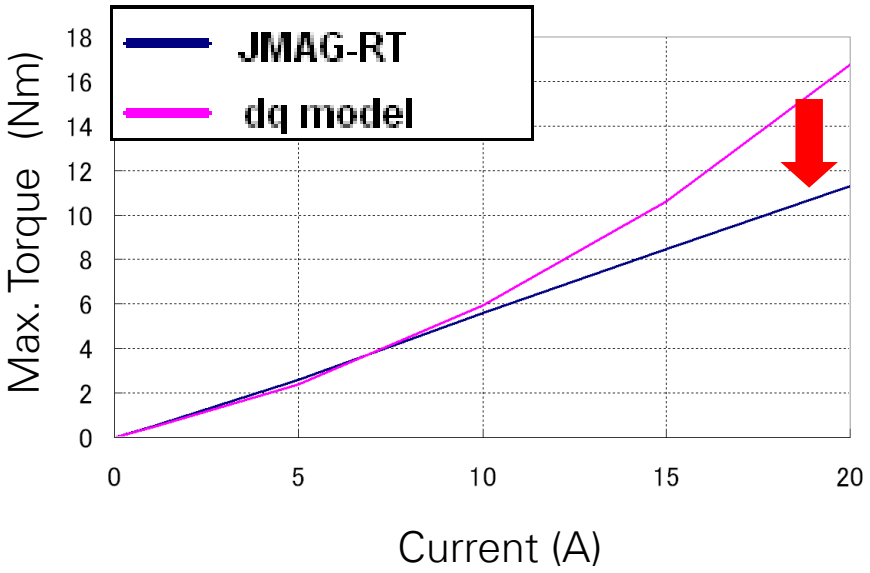
Using LabVIEW to design hardware

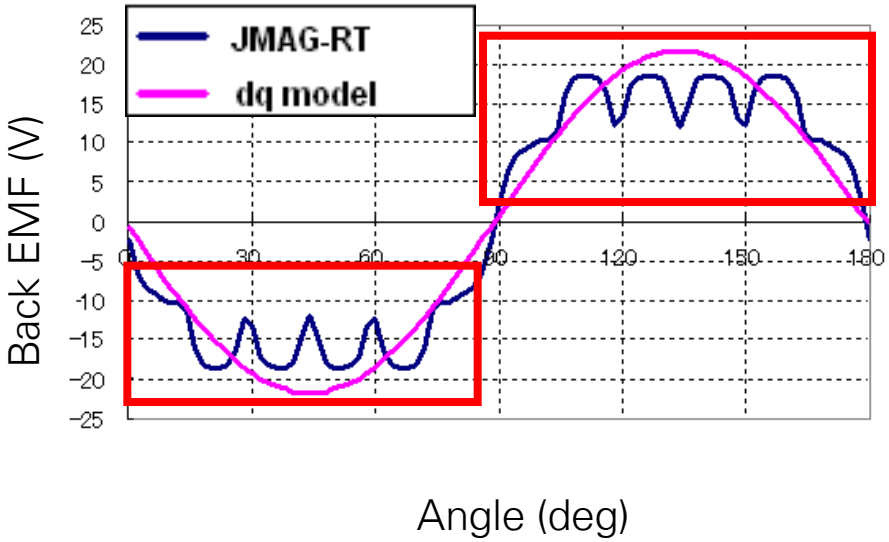


Replace custom circuitry with software-programmable FPGA logic

- High speed control: 1 MHz digital / counter-timer, 200 kHz motion control / analog PID
- Dedicated logic in silicon for highest reliability
- Custom timing, triggering, synchronization, counter/timers, PWM
- Pre-process data in parallel prior to execution on the CPU for high-throughput applications

Difference between DQ model and JMAG-RT model





- Saturation effects are critical for the current control.
- Geometry effects are critical for the back EMF tracking.
- JMAG-RT models are accurate enough for the control design.

Model	Execution Target	Simulation Fidelity	Real-Time Simulation Speed
FEA with JMAG	Windows	High	Non-RT: Minutes to hours
DQ Model with JMAG-RT	Windows Real-Time	Medium	20-30 us
	NI FPGA	Medium	2-3 us
JMAG –RT FEA Model	Windows Real-Time	Medium	20-30 us
	NI FPGA Hardware	High	~1-2 us

NI myRIO

Xilinx Zynq FPGA and dual-core ARM Cortex-A9

Onboard 3-axis accelerometer

User defined LEDs

Integrated WiFI

40 channels digital I/O (SPI, I2C, UART, PWM, Encoder input)

10 channels analog input
6 channels analog output

User defined button

Stereo audio I/O

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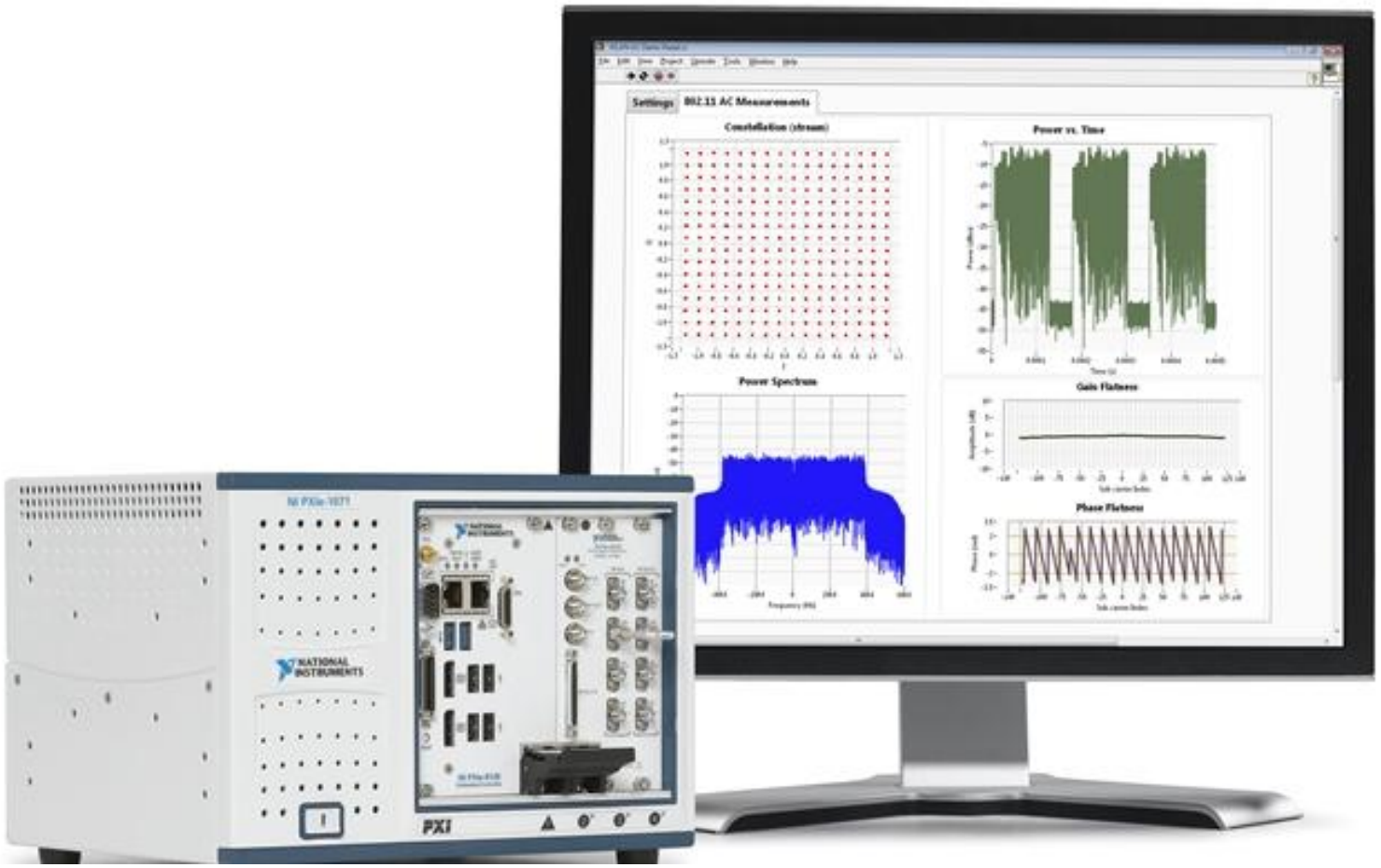
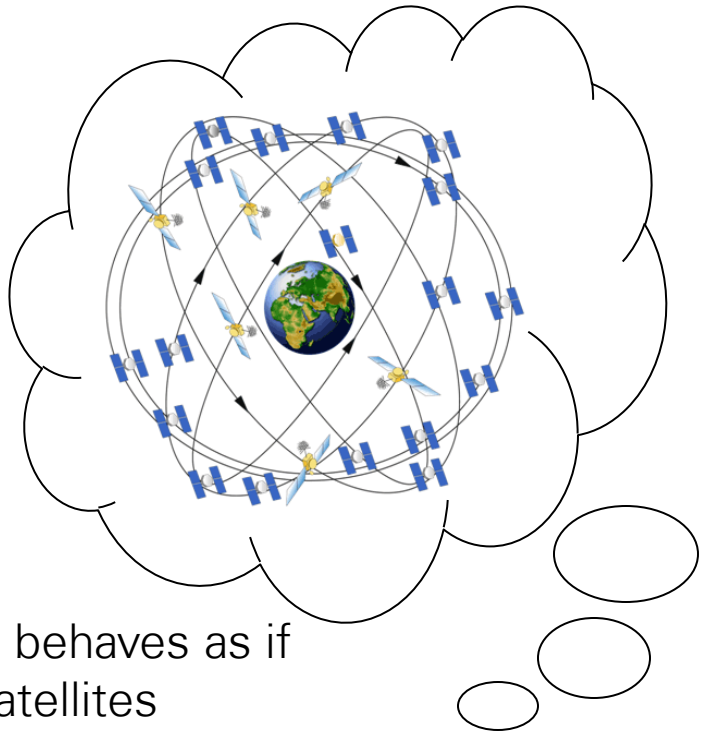
Additional Features

- Fully programmable FPGA through LabVIEW FPGA
- Dual-Core ARM Cortex-A9 processor
- Expandable ecosystem of sensors and actuators
- Ready to use projects and courseware
- Deploy code to real-time processor and FPGA via USB or WiFi
- Minutes to first measurement
- Processor programmable in C/C++

NI PXI-based System for RF Simulation & Test



GPS Simulation Works

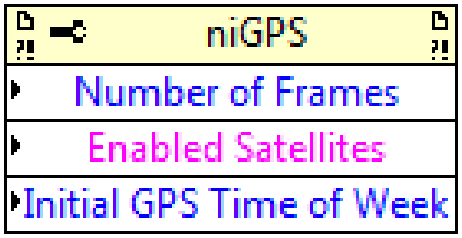


Things to Simulate

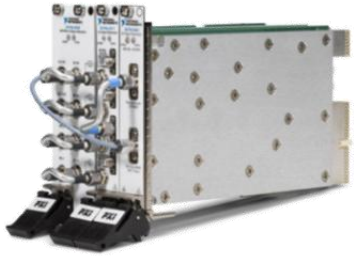
- Poor signal strength
- View of satellites obstructed
- Position constantly changing

GPS receiver behaves as if it sees real satellites

GPS toolkit Creates Signal in LabVIEW



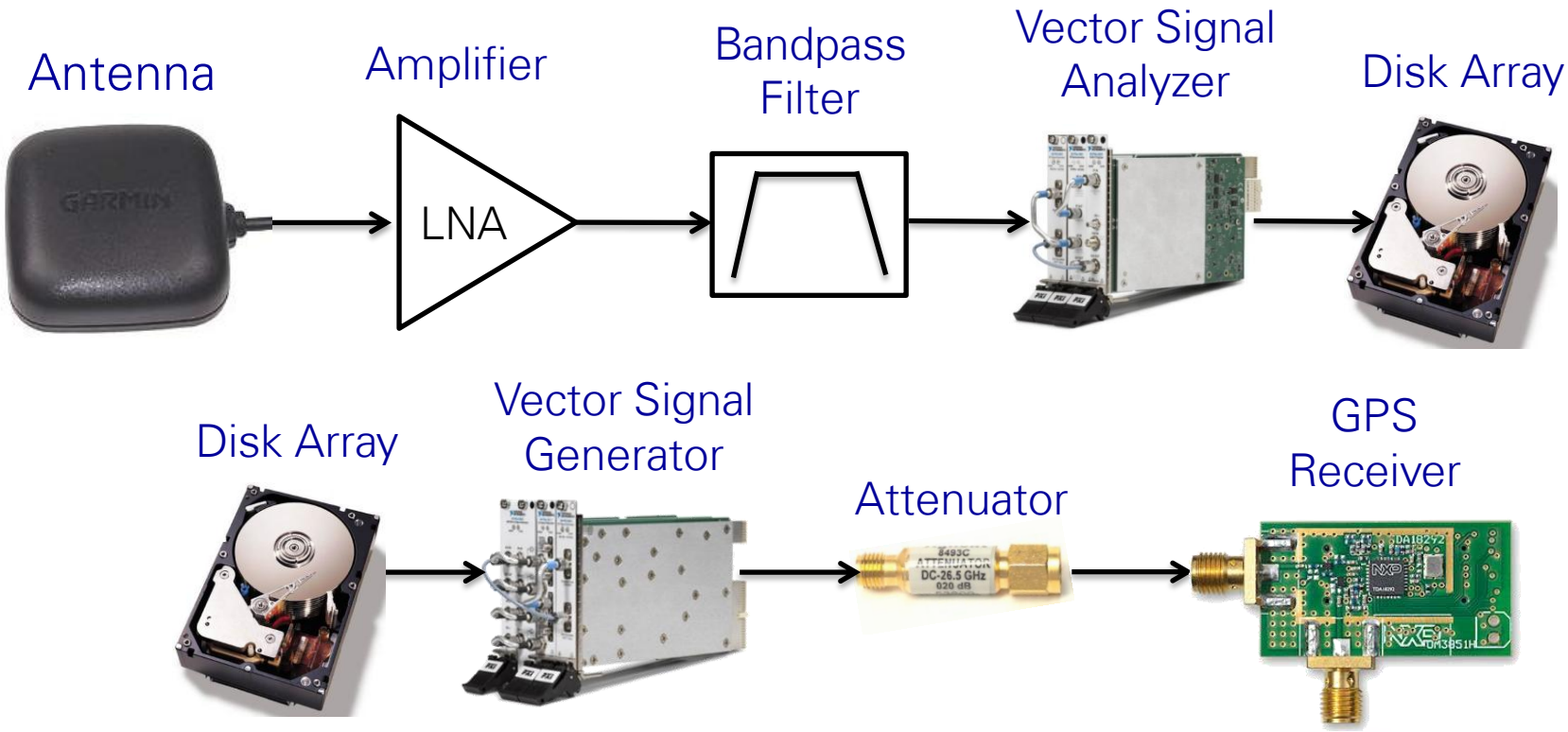
PXIe-5673 VSG Generates Signal



GPS Receiver

RF Record and Playback for GPS

- RF record and playback produces a repeatable field test
- Signal can be played back from disk with a vector signal generator
  - 2 TB raid drive can playback 25 hours of GPS signal

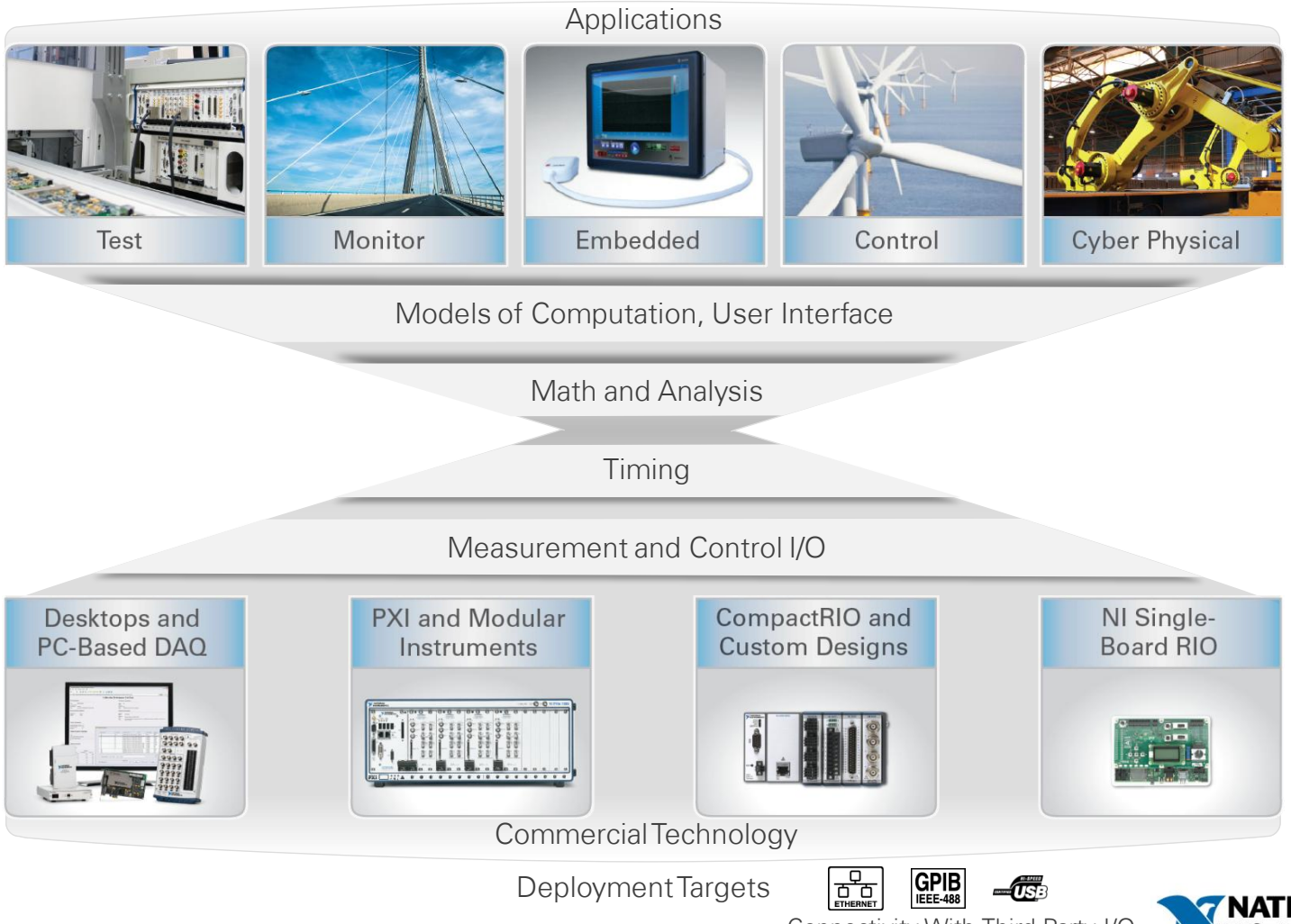


Think Platform.

Simplify	Customize	Reuse
Integrated software and hardware that simplifies system integration of processing, I/O, and data	Flexible, modular platform that scales to changing needs and integrates commercial technology	Supported by a community of users, partners, products, and examples

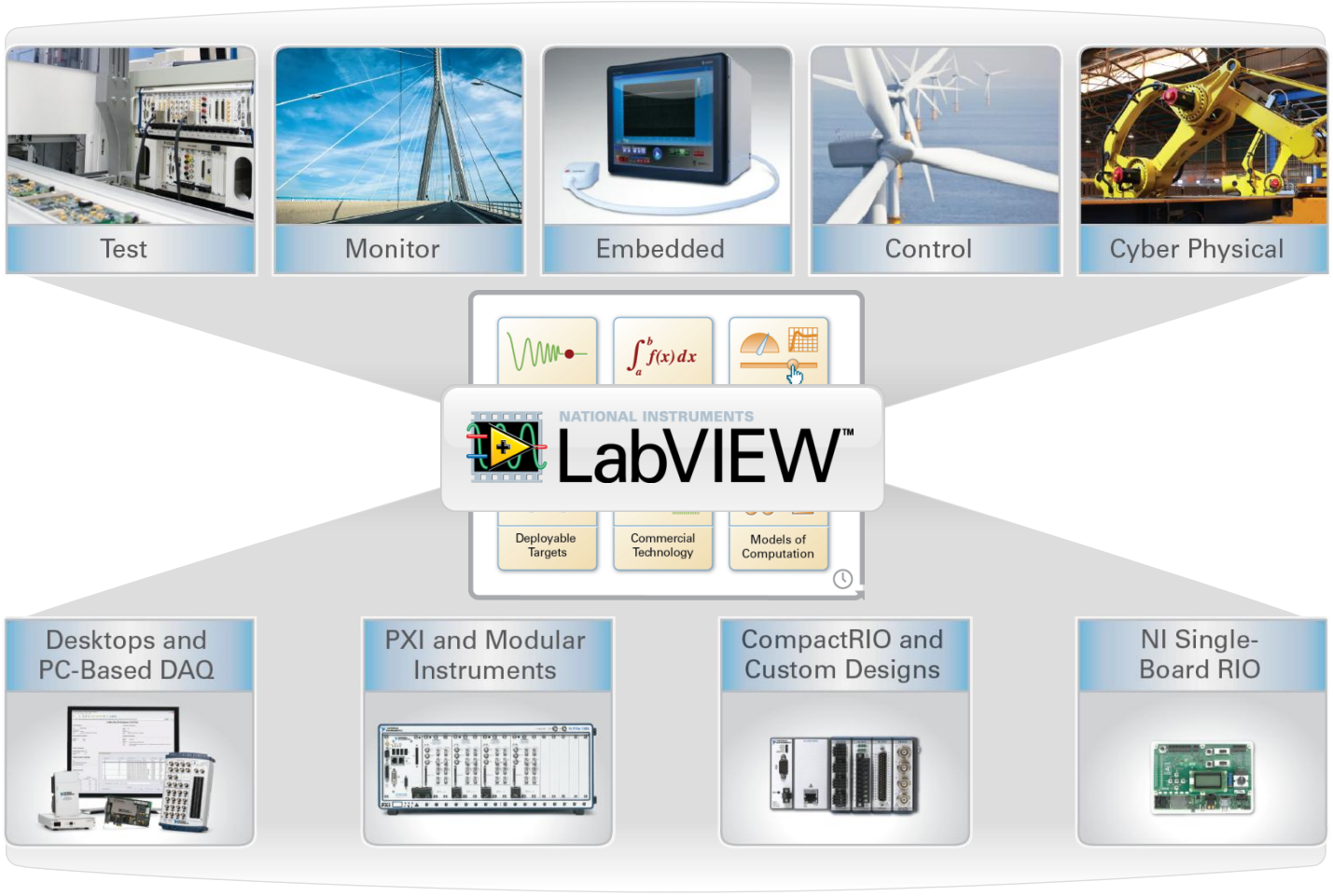
Graphical System Design

A platform-based approach for measurement and control



Graphical System Design

A platform-based approach for measurement and control



NI VeriStand™

Real-Time Testing and Simulation Software

- RT Stimulus Generation
- Data Logging
- Test Automation
- Single-Point I/O
- Alarming
- Calculated Channels
- Deterministic Model Execution
- User Account Management
- Multi-Chassis Synchronization
- Multi-Chassis Data Sharing
- Closed-Loop Control
- Scaling and Calibration

Multi-Chassis Systems

PXI

CompactRIO*

Single-Board RIO*

** 128MB DRAM or great required*

Multimedia Testing and Simulation

Navigation

Satellite Radio

Audio Testing

TV Standards

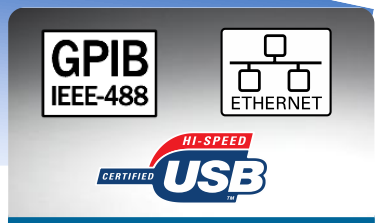
CD/DVD/HDMII

NI VeriStand™

Desktops and PC-Based DAQ

PXI and Modular Instruments

RIO and Custom Designs



Open Connectivity with 3rd Party I/O