

Introduction to Modular Instrumentation

Golfers' Top Money-Making Skill

Conventional Wisdom
Modern Wisdom
1996-2013



Putting



\$ 510,195.91

Versus



Driving



\$ 671,799.15

1 σ in Players Earnings

Source: Journal of Sports Economics, [March 25, 2014](#)

The Parameters of Golf Have Changed



Fairways getting longer

Grass in rough cut short

Cups shifted to harder locations

Technology improving

The Parameters of Automated Test Have Changed



Product complexity



Requirements



Cost of test



Number of tests



Data acquired / stored



Test and data throughput



Time to market



Product ASP



Conventional Wisdom has Changed



A New Approach: Modular Instruments

Traditional Rack and Stack



Modular Instruments

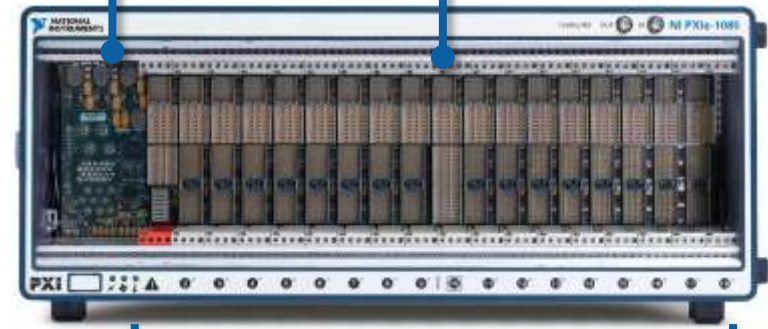


What Is a Modular Instrument?

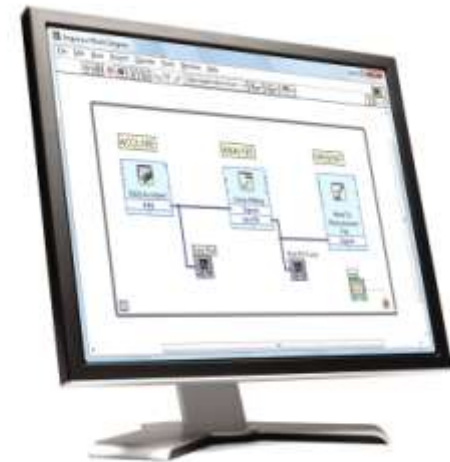


- Core Functionality
- Shared Components
- Software

Computer
Timing and Synchronization



Backplane



Modular Instrument Platforms



Benchtop Instrument Advantages



1. Portability
2. Quick setup
3. Fast DUT connection
4. Compliance testing
5. Built-in measurements

Modular Instrument Advantages



1. Speed
2. Flexibility
3. Integration
4. Size
5. Cost

Modular Instrument Advantages



1. **Speed**
2. Flexibility
3. Integration
4. Size
5. Cost

Modular Instruments Ride Moore's Law

PCI Express



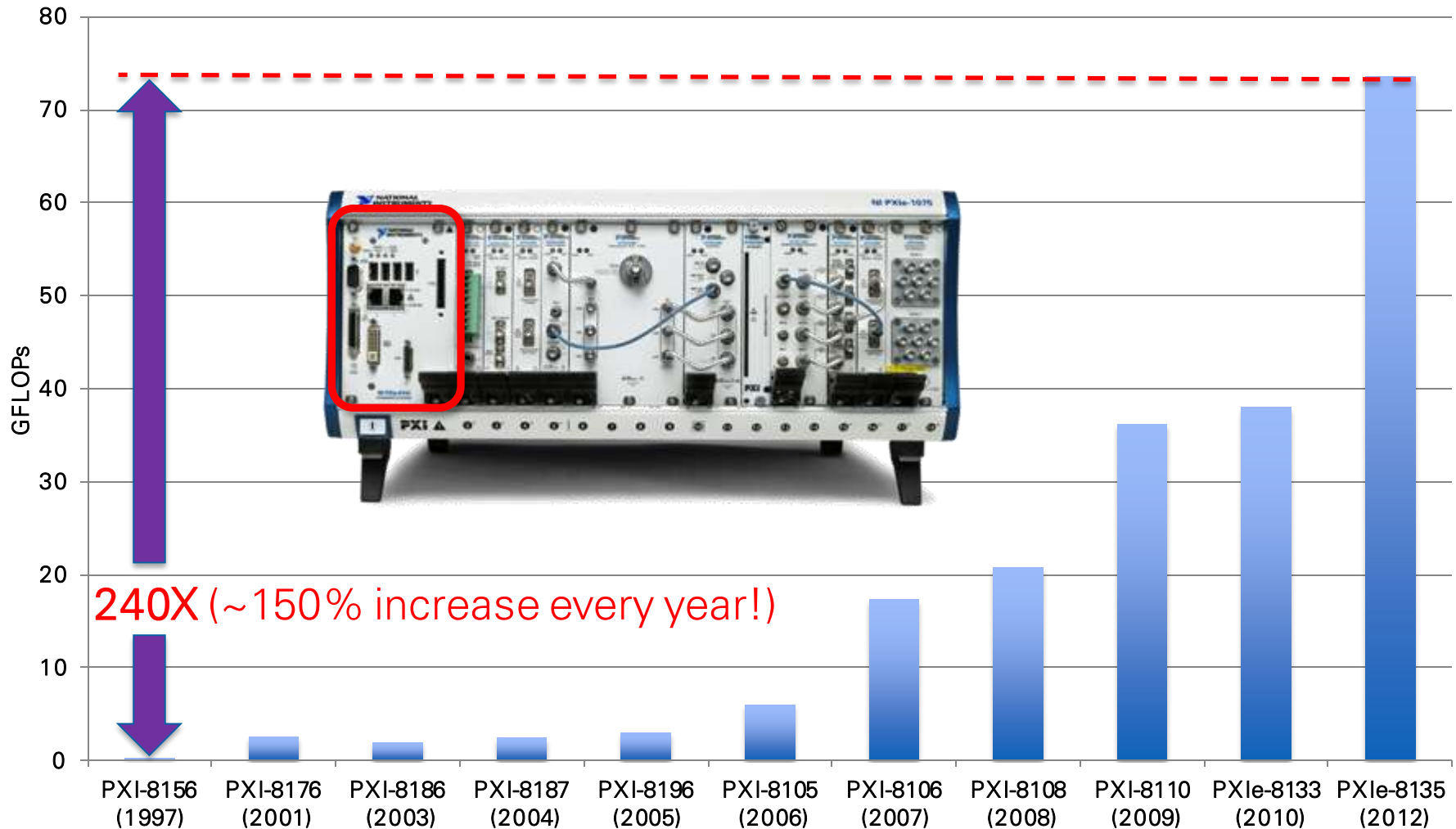
Multicore Processors



FPGAs



Harness Industry-Leading Performance With COTS Technology



Measurement Speed in PXI

- Measurement speed is a signal processing challenge
- Key technologies: FPGAs, multicore CPUs, PCI Express



LTE Measurements: PXIe-5665 versus Agilent MXA

Signal Type	NI PXIe-5665 Time**	Agilent MXA Time**	Speedup
5 MHz BW: EVM and Power	71 ms	541 ms	7.6X
10 MHz BW: EVM and Power	92 ms	703 ms	7.7X

*** All measurements were made on a single subframe with autodetection turned OFF.*

Modular Instrument Advantages



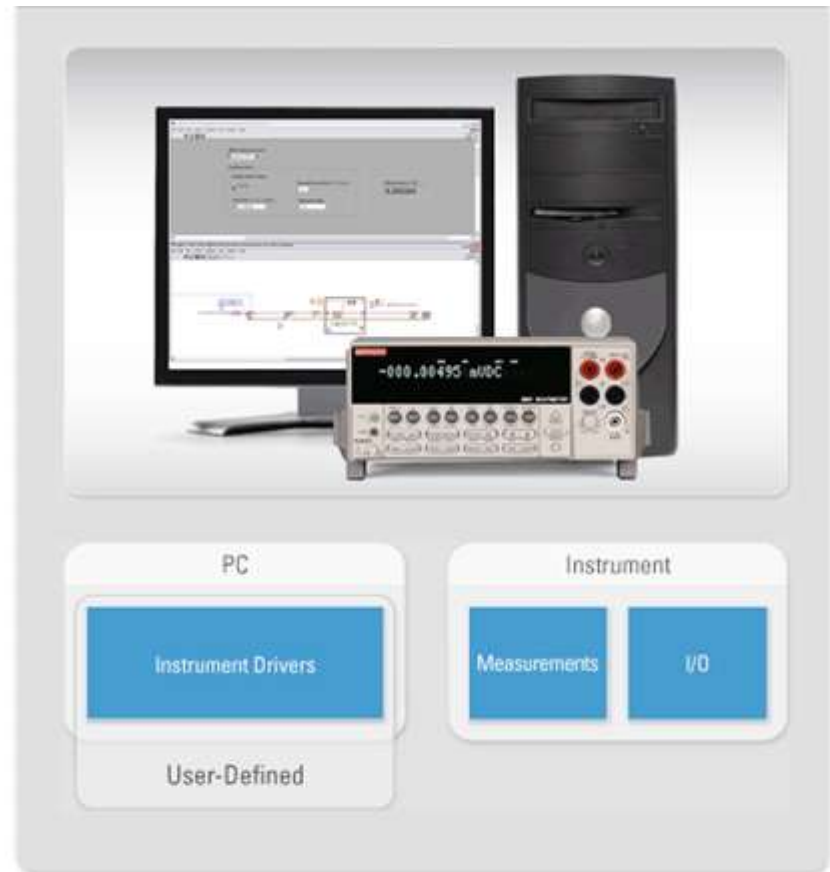
1. Speed
2. **Flexibility**
3. Integration
4. Size
5. Cost

Advantages of Modular Instruments: Flexibility

Modular Instruments



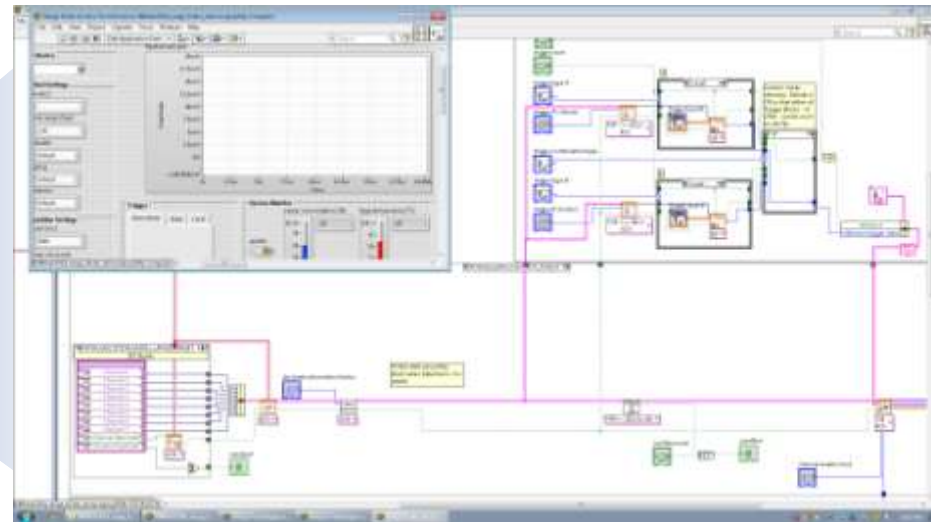
Traditional



Vendor-Defined Functionality

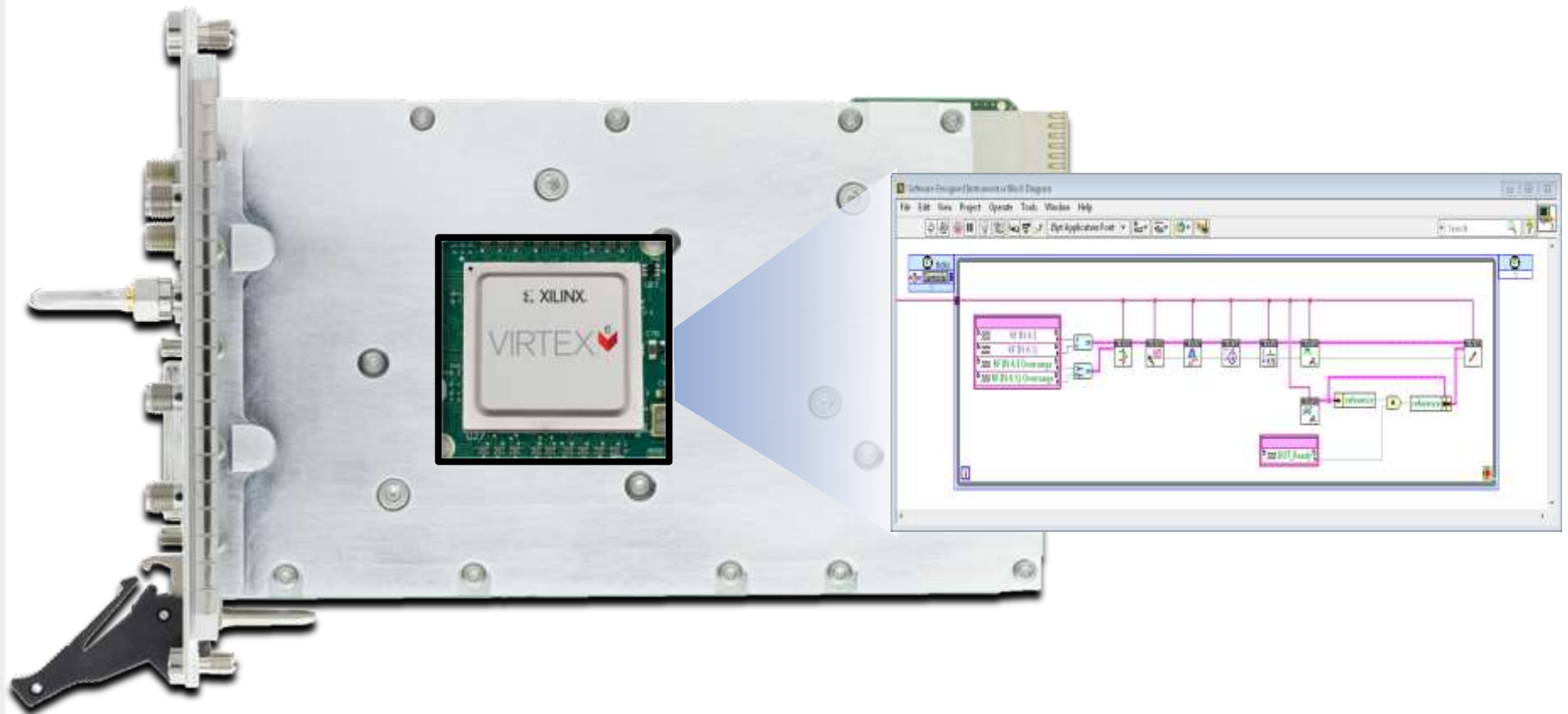


Software-Defined Functionality



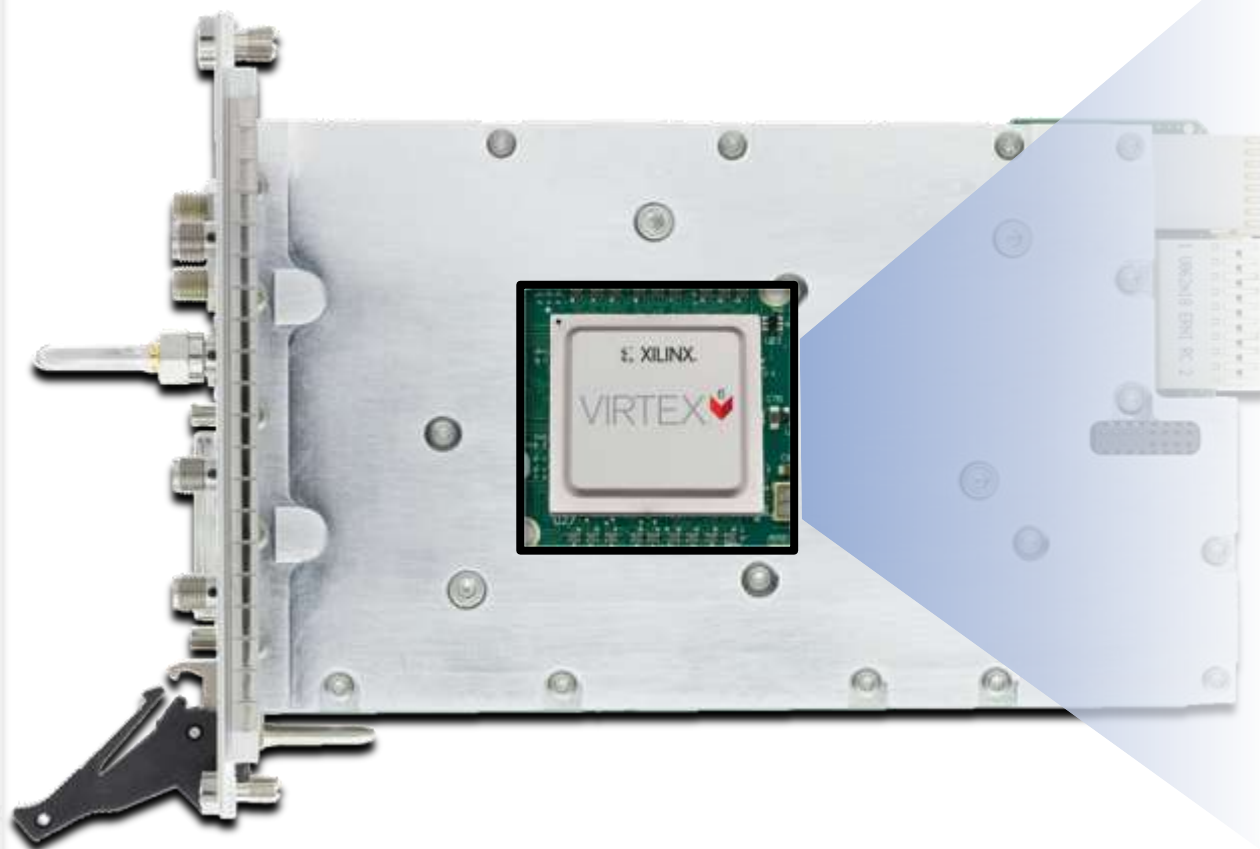
Software-Designed Instruments

Out-of-the-box functionality with FPGA enhancements



Software-Designed Instruments

Benefits



Higher Test Throughput

- Real-Time Signal Processing
- Onboard Decision Making

Hardware Reuse, Future-Proofing

- Future Expandability
- Real-Time Signal Processing

New, Innovative Tests

- Custom Defined Triggers
- Rapid Prototyping

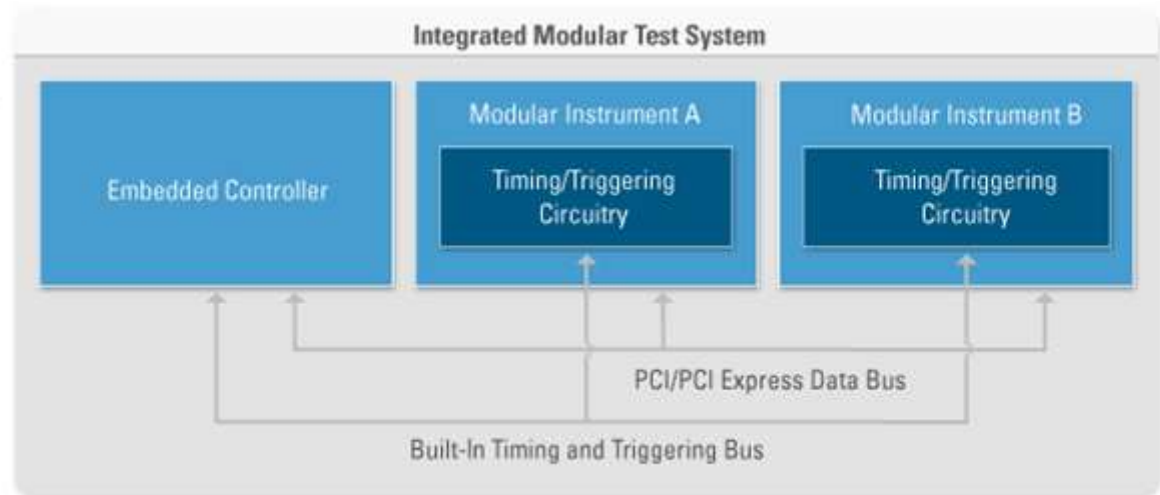
Modular Instrument Advantages



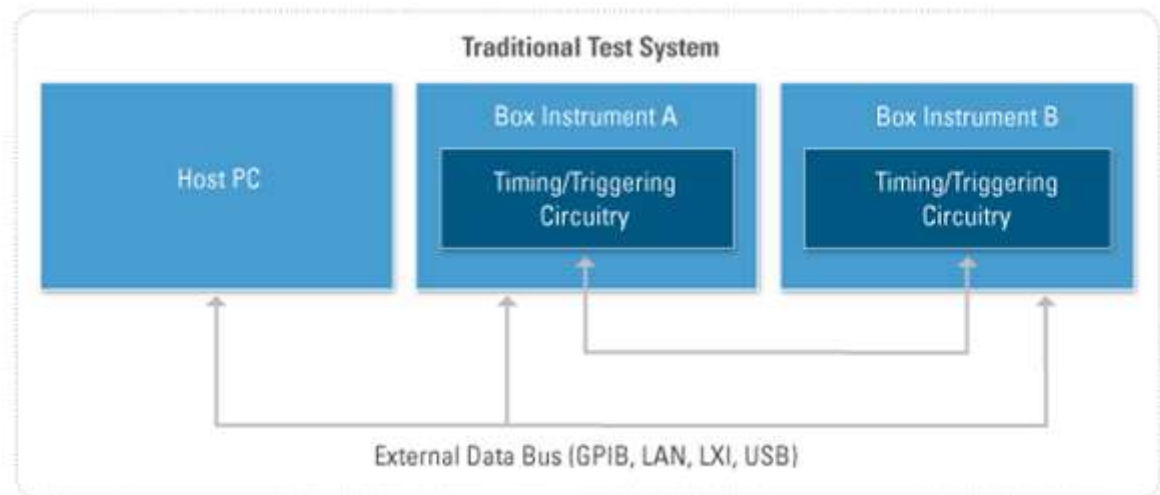
1. Speed
2. Functionality
3. **Integration**
4. Size
5. Cost

Advantages of Modular Instruments: Integration

Modular Instruments



Traditional Instruments



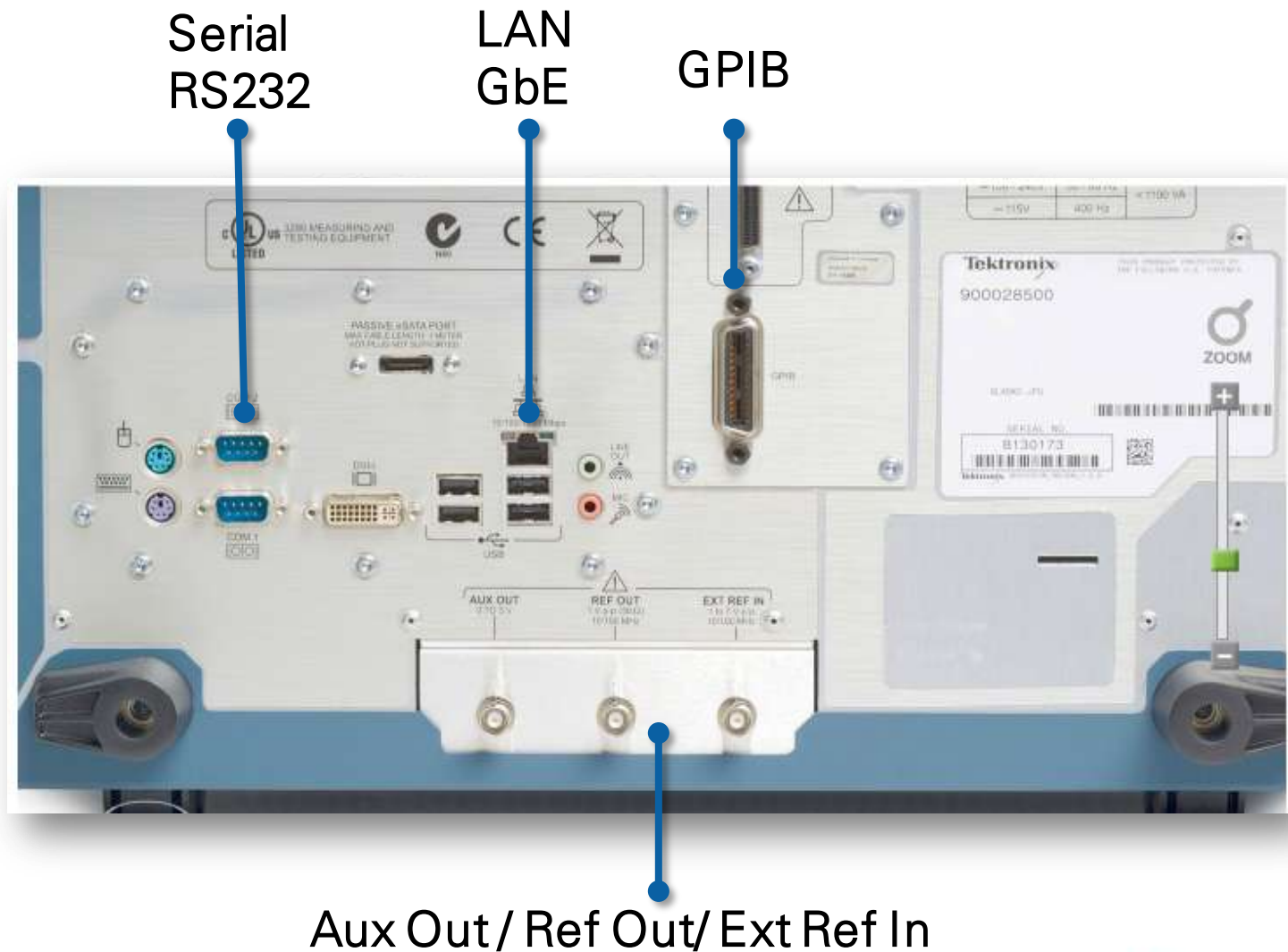
Modular Instruments Interoperable



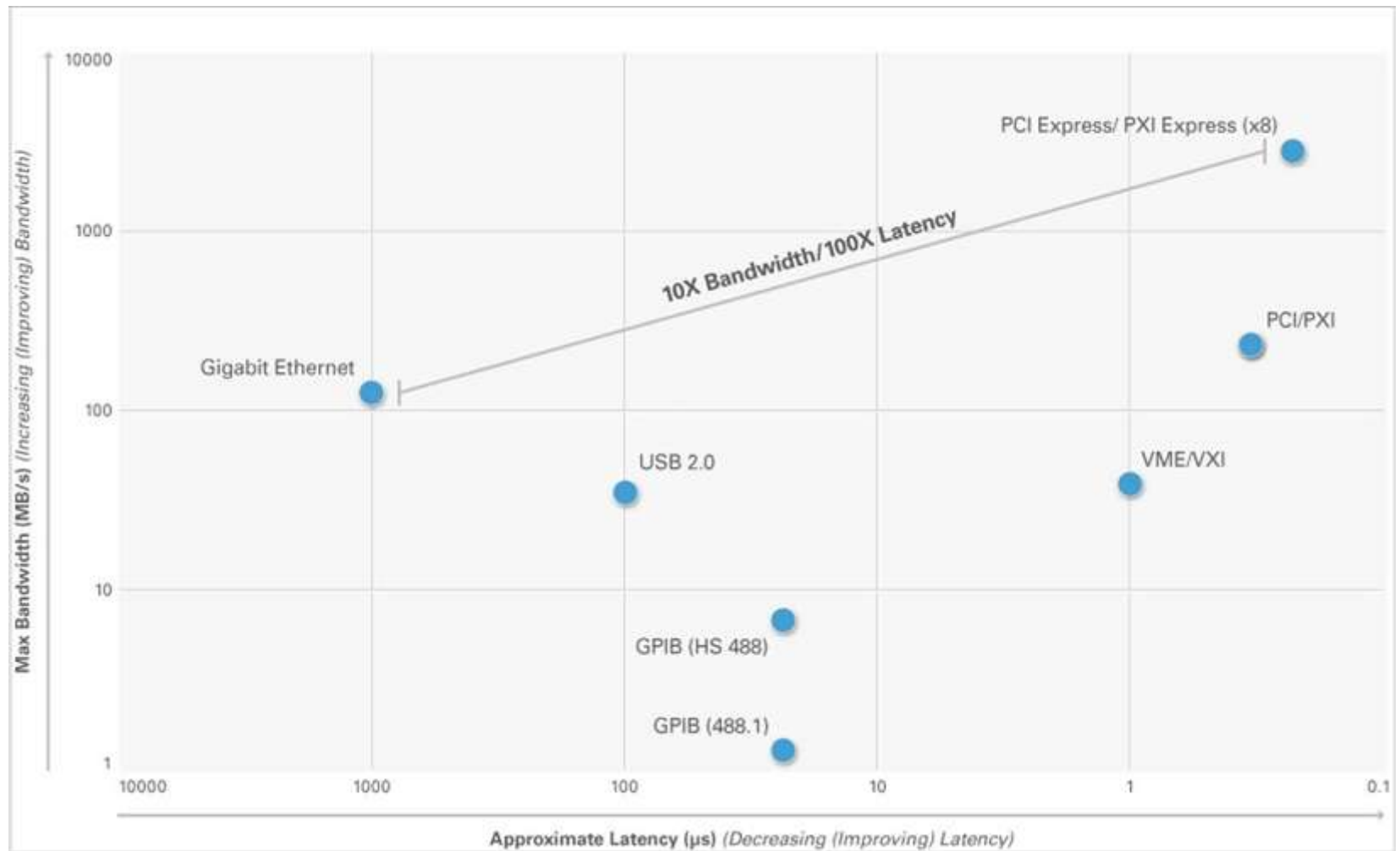
Completely Interoperable



I/O Ports on Box Instruments



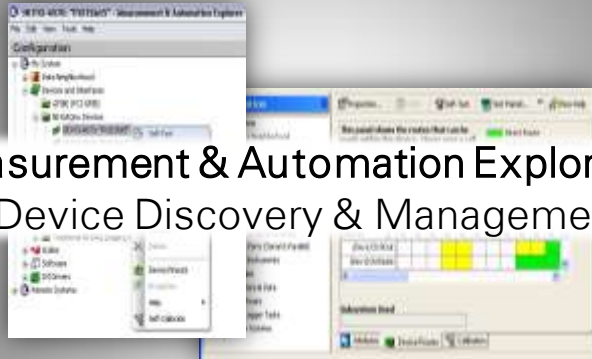
Bus Comparison



Tools for Accelerating System Development

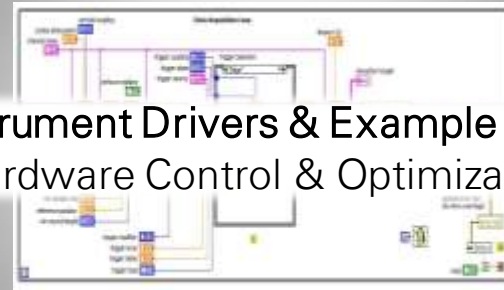
Time to First Measurement

NI Measurement & Automation Explorer (MAX)
Device Discovery & Management

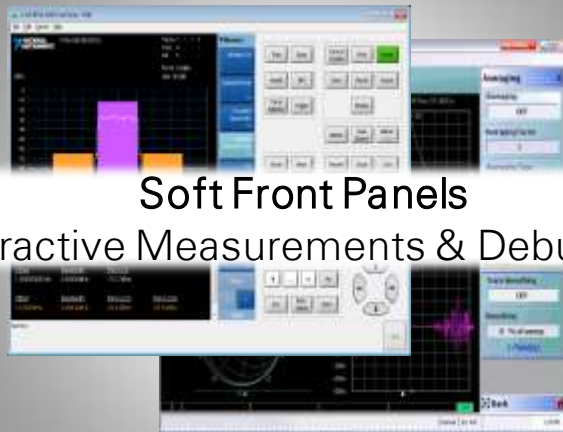


Path to Automation

Instrument Drivers & Example Code
Hardware Control & Optimization



Soft Front Panels
Interactive Measurements & Debugging



NI Switch Executive
Switch Management & Monitoring



Modular Instrument Advantages



1. Speed
2. Functionality
3. Integration
4. **Size**
5. Cost

Advantages of Modular Instruments: Size

Modular Instruments



0.67 ft³ (.019 m³)

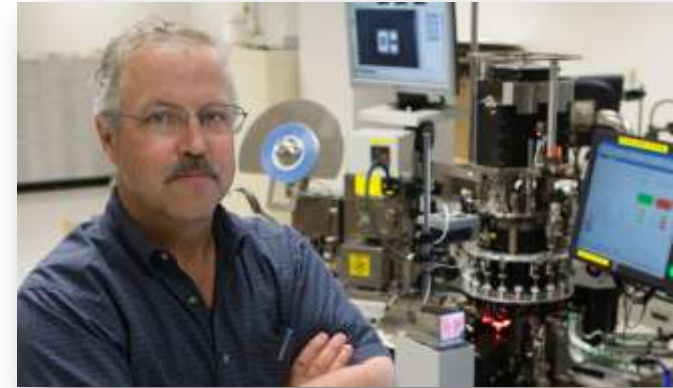
Traditional



6.12 ft³ (.1734 m³)

Semiconductor Characterization and Production

- Analog Devices Replaced Big-Iron ATE With PXI
 - 11X cost reduction, 16X power savings
 - Zero-footprint test system in production
- PXI Production Test of MEMS Microphone
 - 100% PXI instrumentation and LabVIEW
 - Cabled GPIB interface controls chip handler
 - Same system in characterization for correlation



	PXI Tester	Reduction	Previous ATE
Cost	\$40K USD	11X	\$450k+ USD
Footprint	18x24x7 in.	15X	98x66x74 in.
Weight	60 lb	66X	4000 lb
Facility	600 W	16X	10 kW

Modular Instrument Advantages



1. Speed
2. Functionality
3. Integration
4. Size
5. **Cost**

Total Cost of Ownership



Cost and Time Analysis



Cost			
	Previous Solution (USD)	PXI Solution (USD)	Improvement
RF Analyzer + SW	\$98,000	\$34,999	2.8X
RF Generator + SW	\$94,000	\$28,999	3.2X
Total Cost	\$192,000	\$64,000	3X

Test Time			
	Previous Solution	PXI Solution	Improvement
WCDMAACP	400 ms	30 ms	15X
LTE EVM	1.2 s	390 ms	3X
Total Time	3 days	8 hours	10X

Complete PXI Instrumentation Portfolio

DAQ and Control

Multifunction I/O

FPGA / Reconfigurable I/O

Digital I/O

Analog Input/Output

Vision and Motion

Counter/Timer/Clock

Instruments

Oscilloscopes

High-Speed Digital Instruments

Digital Multimeters

Signal Generators

Switching

RF Analyzers, Generators

Interfaces

GPIO, USB, LAN

RS232/RS485

CAN, LIN, DeviceNet

SCSI, Ethernet

VXI/VME

Boundary Scan/JTAG



Recognize the Changing Parameters

