

Create Without Limits: 4 Ways to Customize Your Software-Designed Instrument

<Presenter Name>

<Role>

National Instruments

Agenda

- What Is a Software-Designed Instrument?
- How Do I Customize a Software-Designed Instrument?
 - Instrument Driver API
 - FPGA Extensions
 - Sample Projects
 - IP from the Community

What Is a Software-Designed Instrument?

What Is a Software-Designed Instrument?

Typical Modular Instrument

Software-Designed Instrument

Hardware



Identical hardware architecture and measurement quality

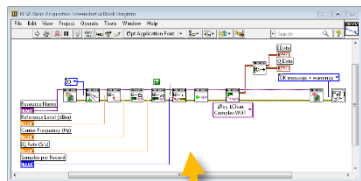
What Is a Software-Designed Instrument?

Typical Modular Instrument

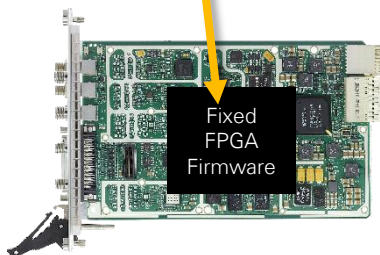
Software-Designed Instrument

Software

Processor

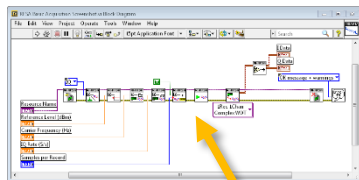


Hardware

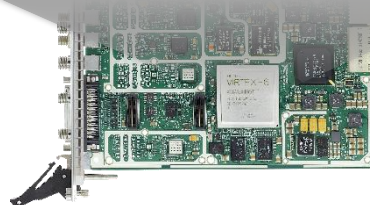
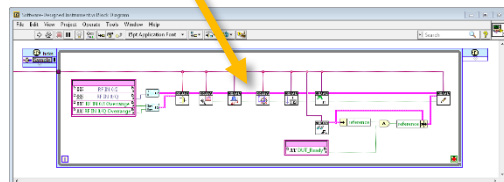


Fixed
FPGA
Firmware

Processor



FPGA



Identical hardware architecture and measurement quality

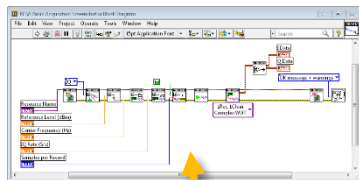
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Typical Modular Instrument

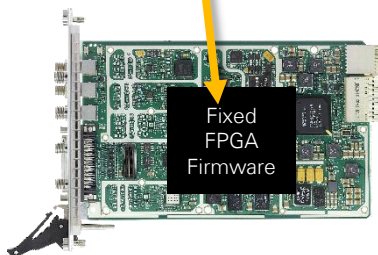
Software-Designed Instrument

Software

Processor

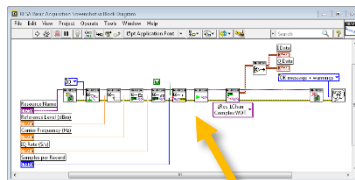


Hardware

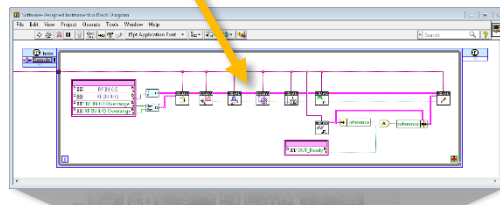


Fixed
FPGA
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Processor



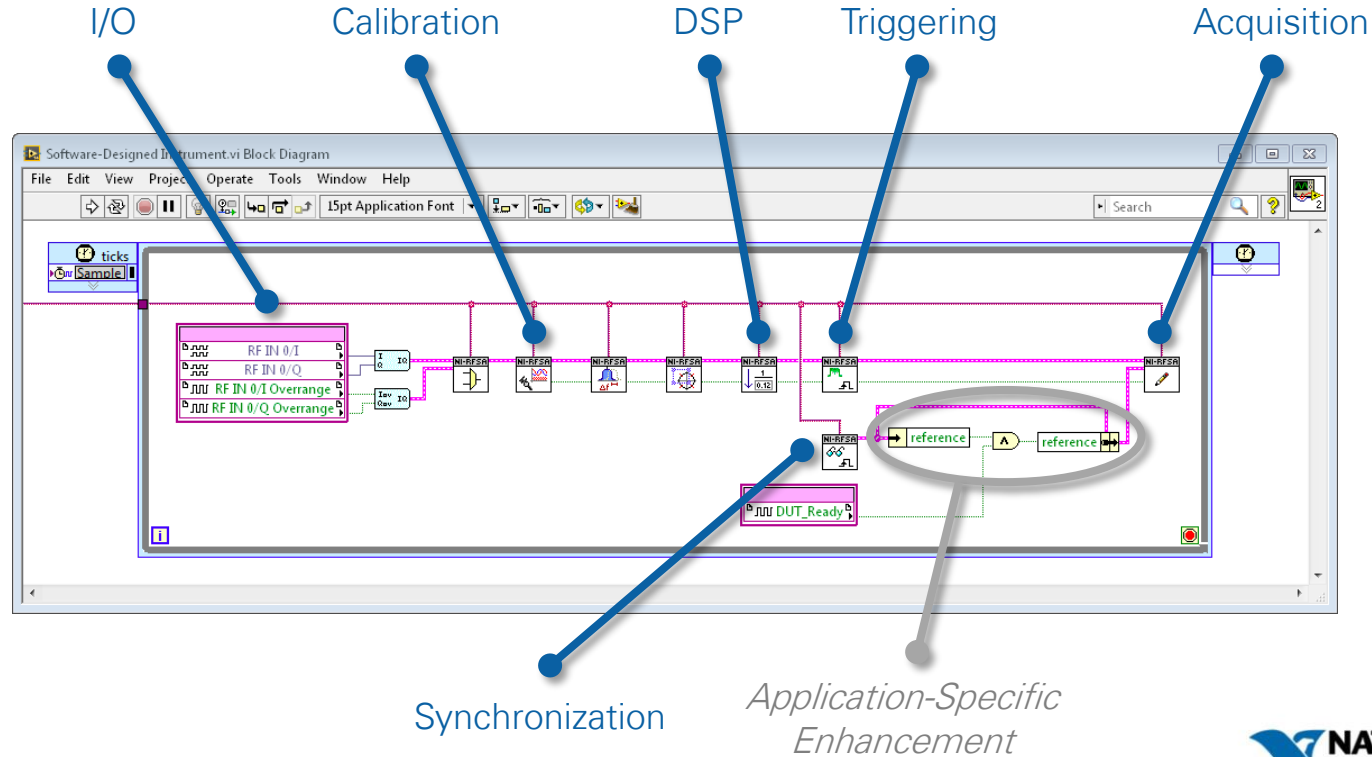
FPGA



Out-of-the-box functionality
with FPGA enhancements

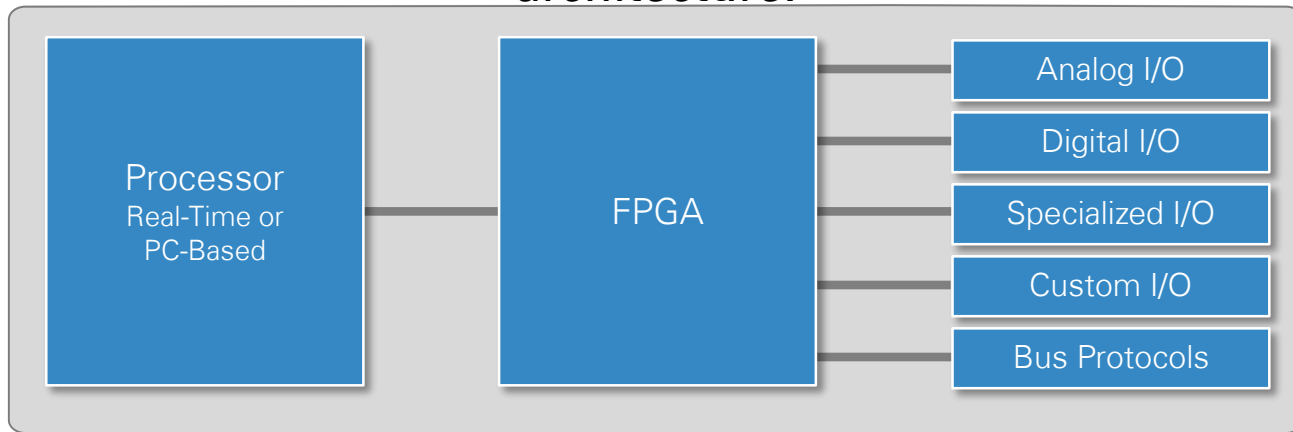
Identical hardware architecture and measurement quality

Out-of-the-Box Functionality + *FPGA Enhancements*



The NI Approach

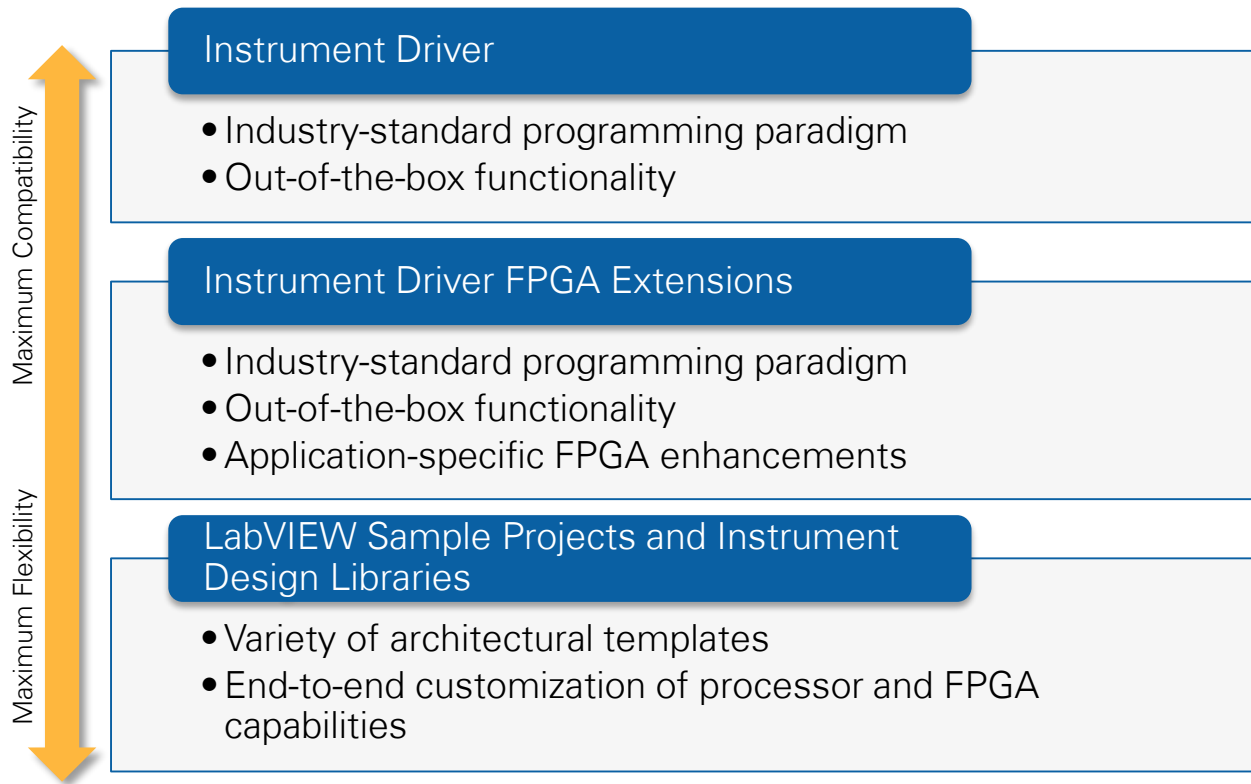
We call this the LabVIEW Reconfigurable I/O (RIO) architecture.



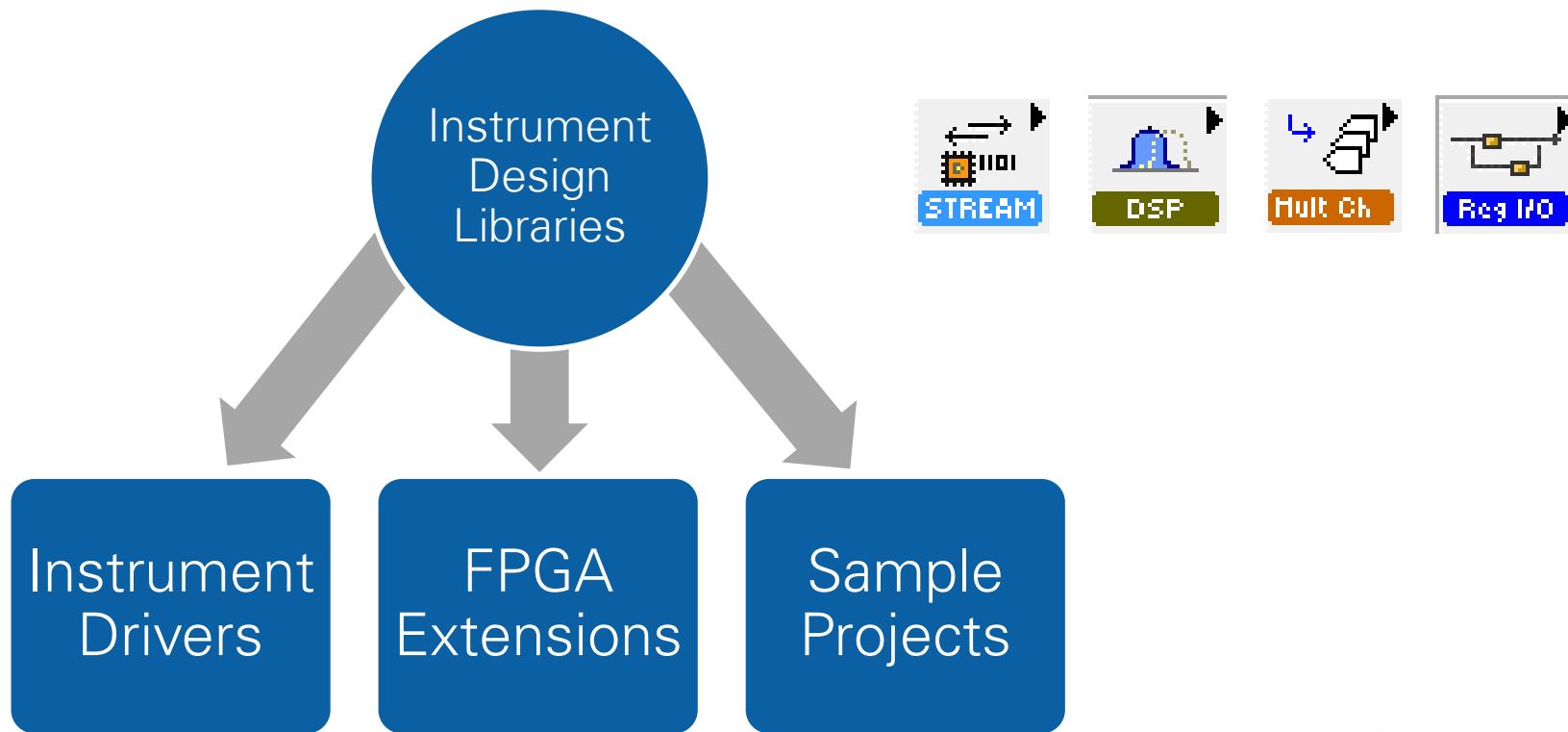
Highly Productive **LabVIEW** Graphical Programming Environment
for Programming Host, FPGA, I/O, and Bus Interfaces

How Do I Use a Software-Designed Instrument?

Software-Designed Instrument Programming Options

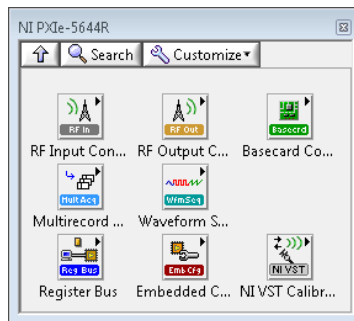


Instrument Design Libraries (IDLs)

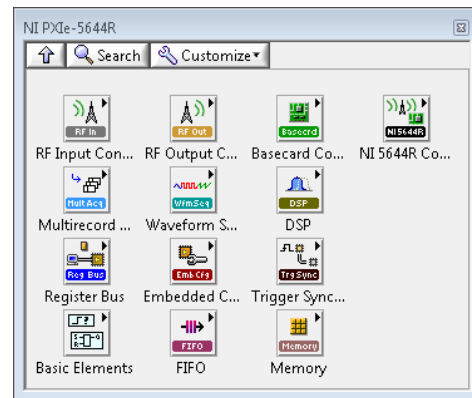


Instrument Design Libraries

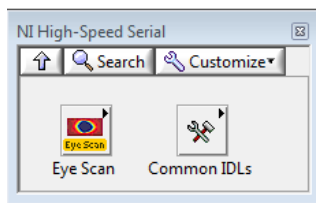
- Pre-written FPGA IP for common instrument functionality
- Consists of Host and FPGA Palettes
- Installed to Functions Palette
 - NI “owned,” but primarily open source
 - VIs are locked to avoid accidental editing



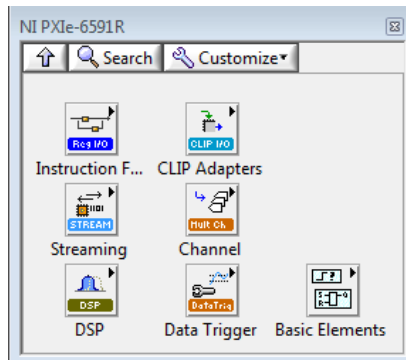
Host



FPGA



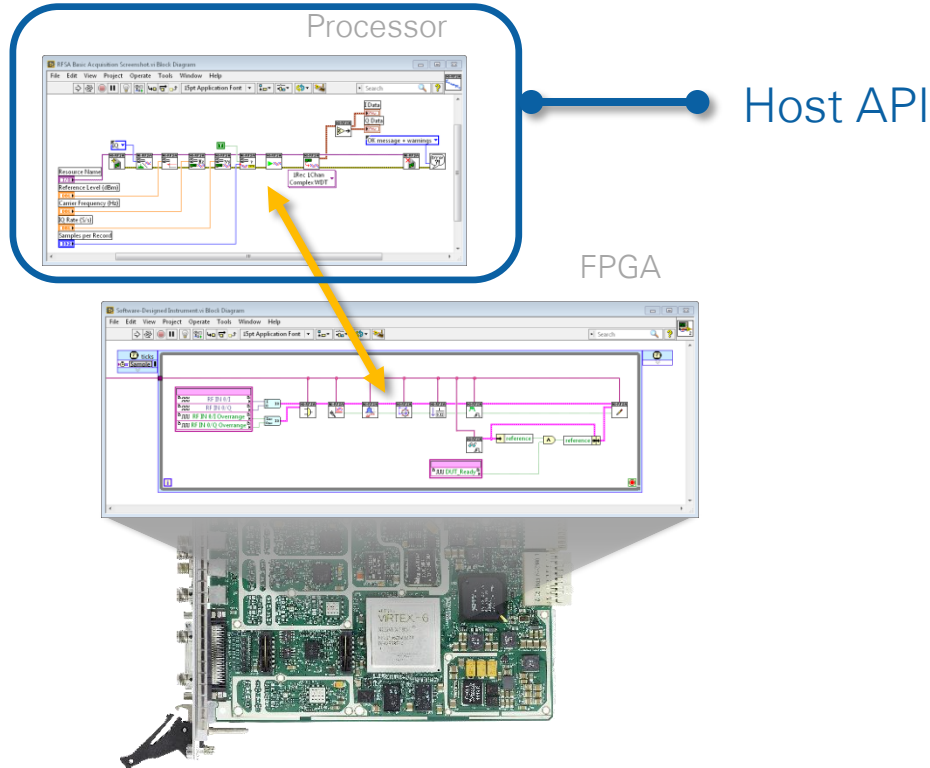
Host



FPGA

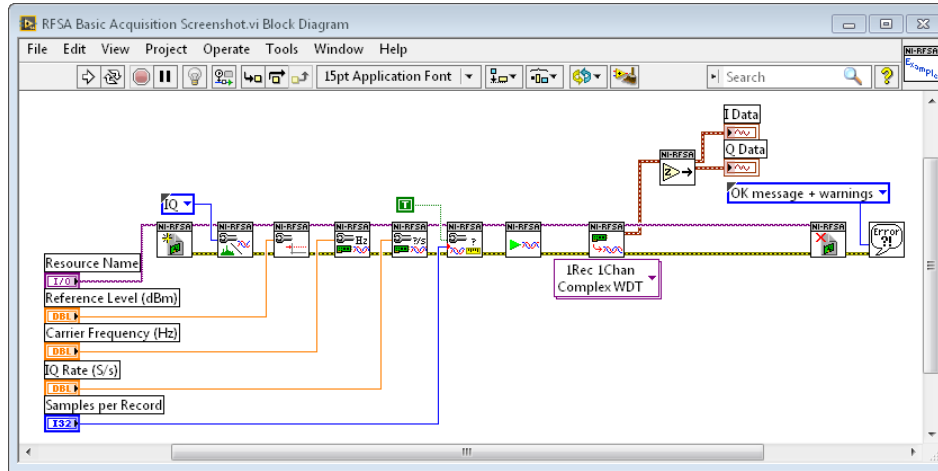
1. Instrument Drivers

- Highest level of abstraction from hardware



1. Instrument Drivers

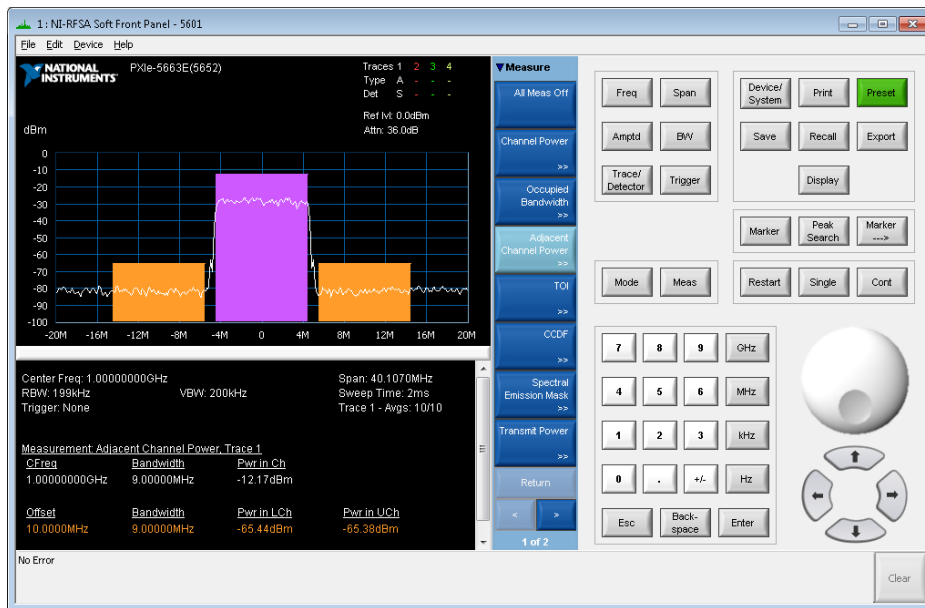
- Intuitive APIs with getting started examples
 - LabVIEW, C/C++, .NET
- Documented Help



NI-RFSA LabVIEW API

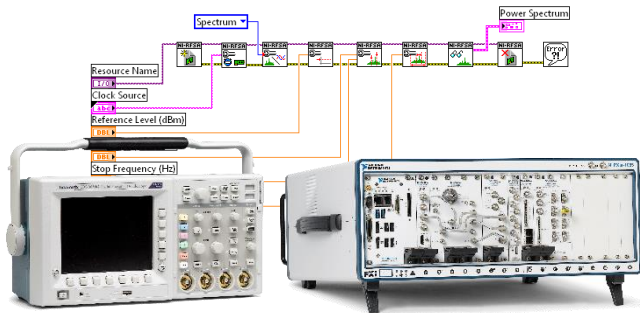
1. Instrument Drivers

- Soft Front Panels for interactive measurements

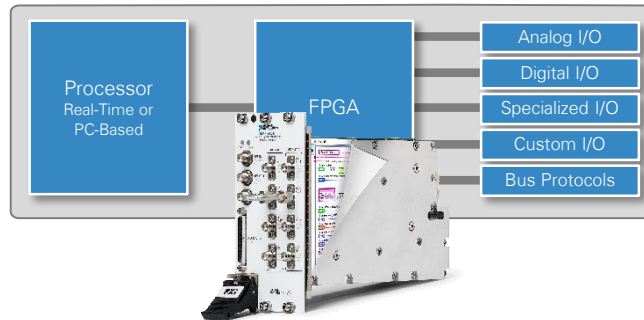


NI-RFSA Soft Front Panel

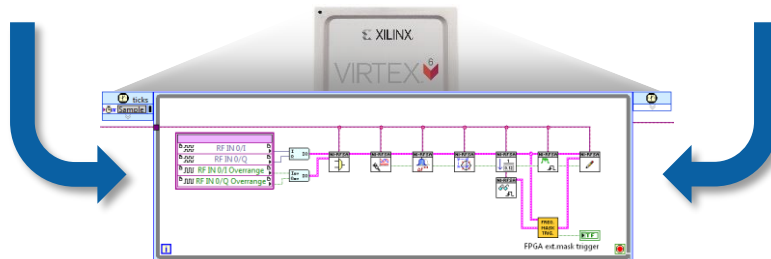
2. Instrument Driver *FPGA Extensions*



The *compatibility* of
industry-standard instrument drivers

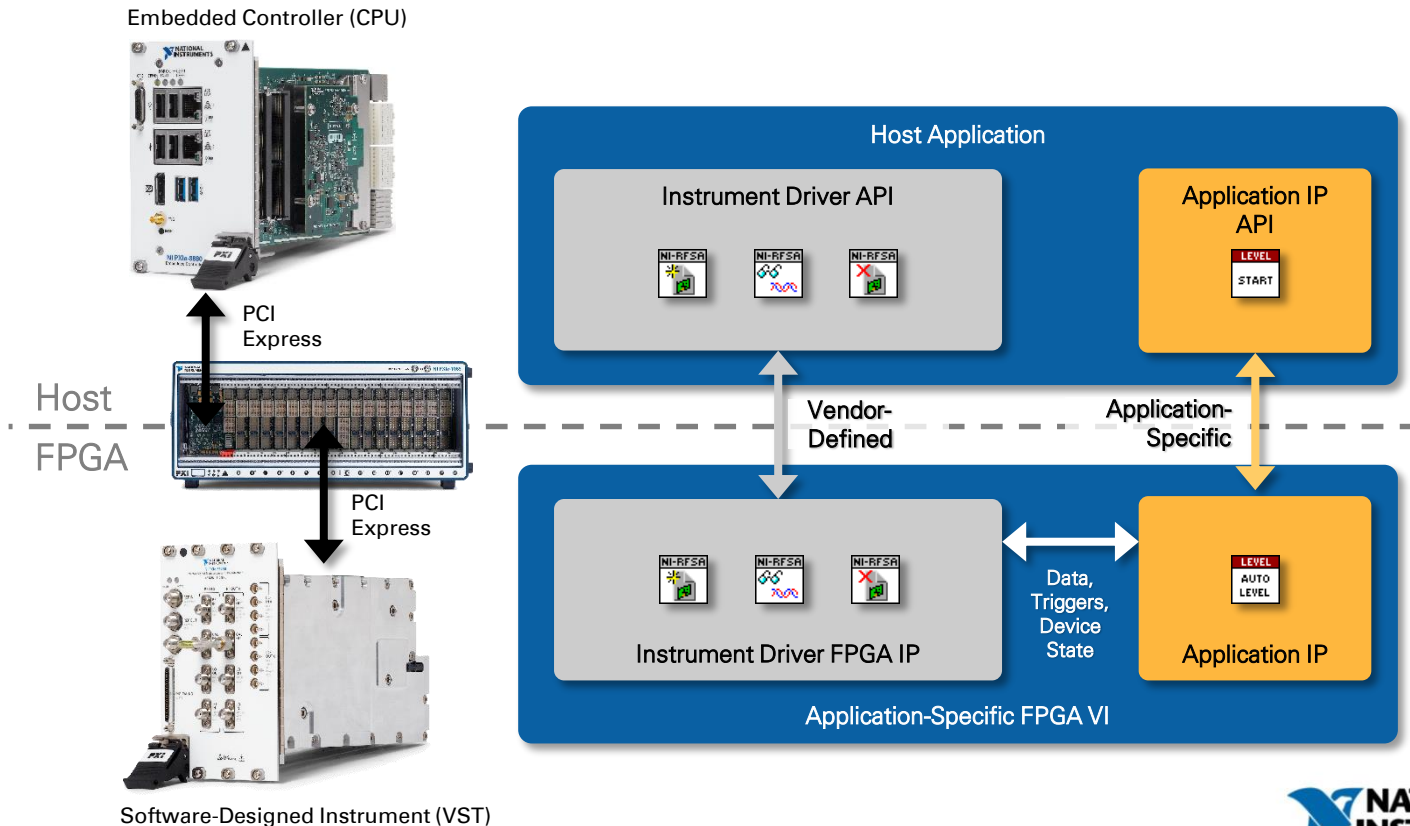


The *flexibility* of
the LabVIEW RIO architecture

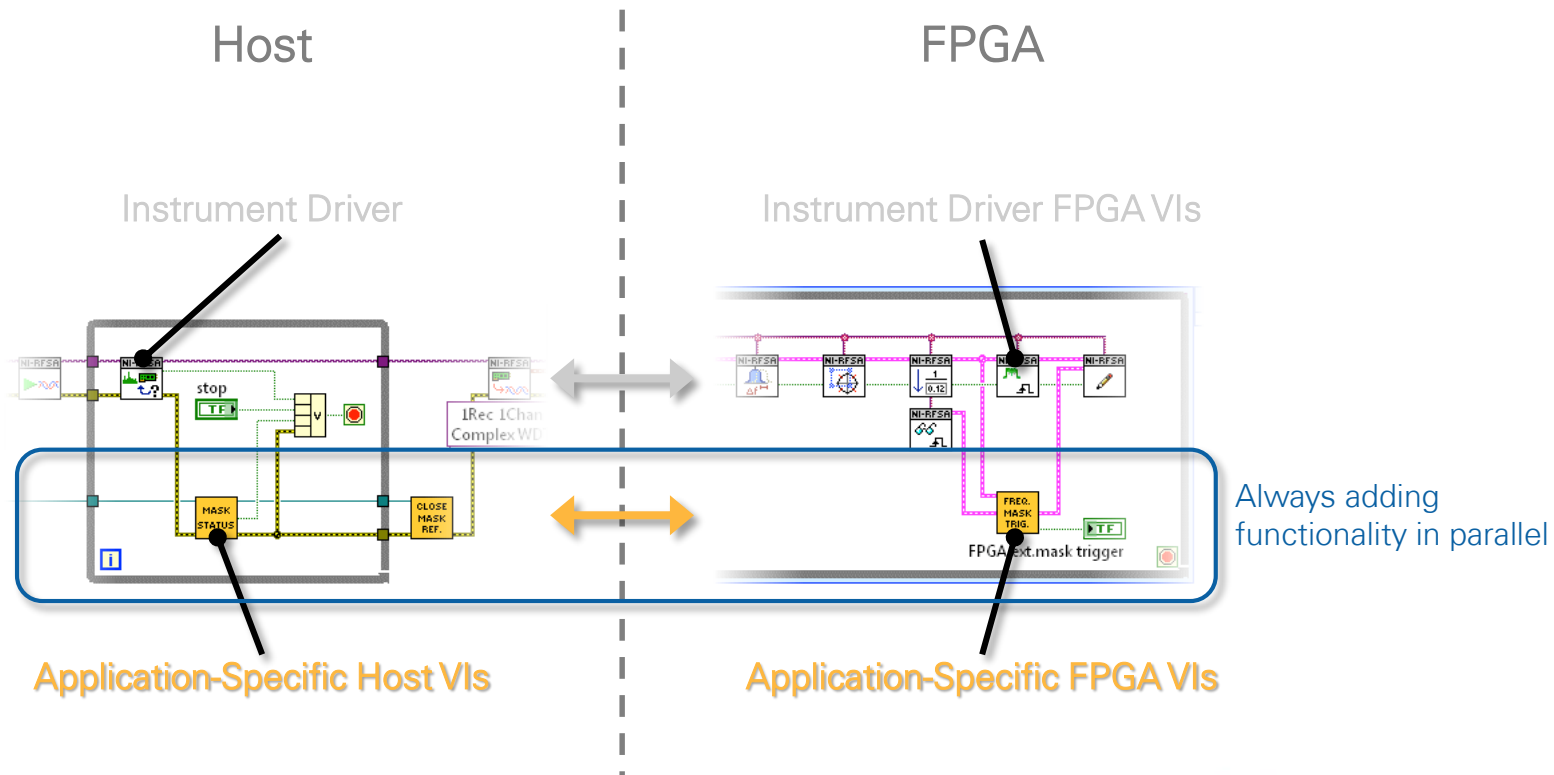


Instrument Driver *FPGA Extensions*

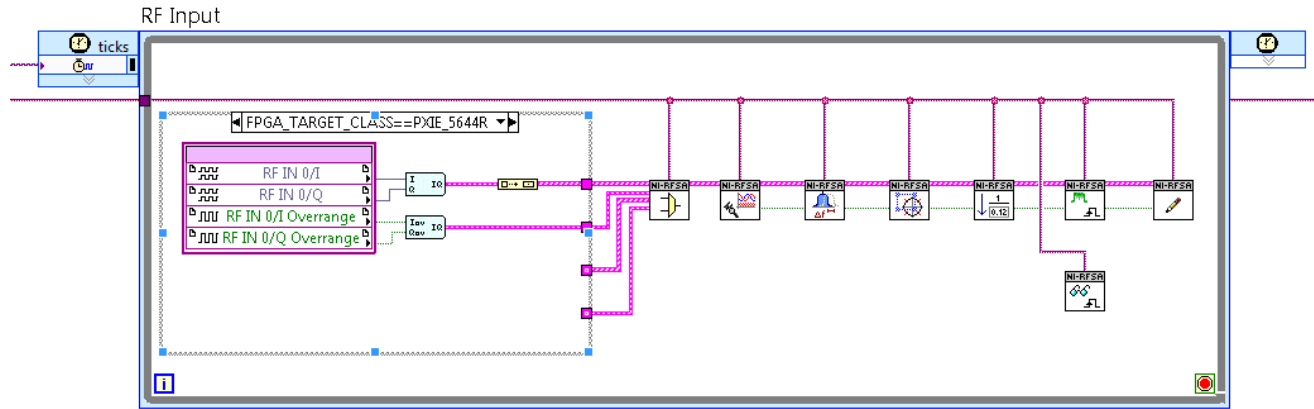
2. Instrument Driver *FPGA Extensions*



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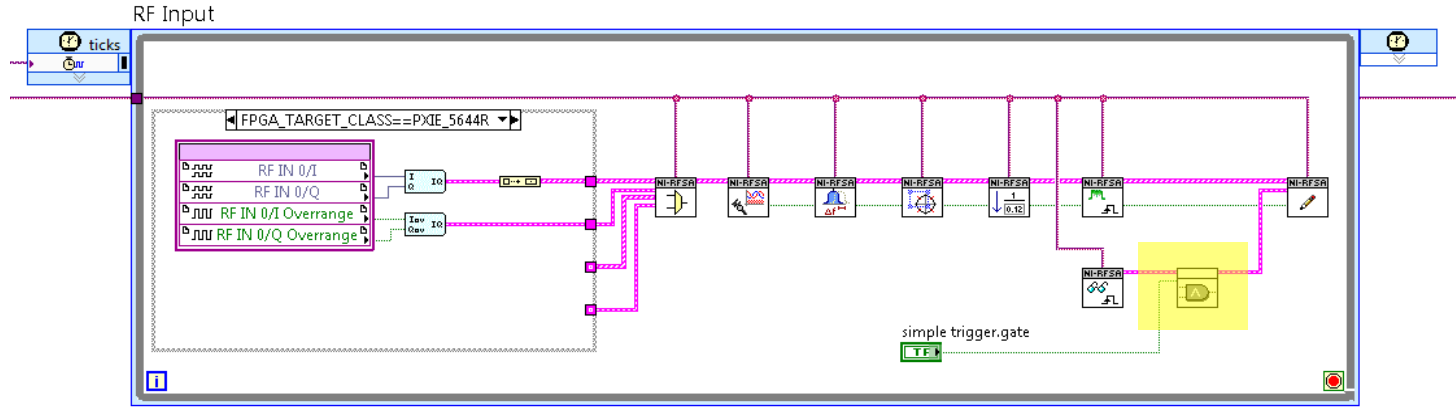


FPGA Extensions Development Example



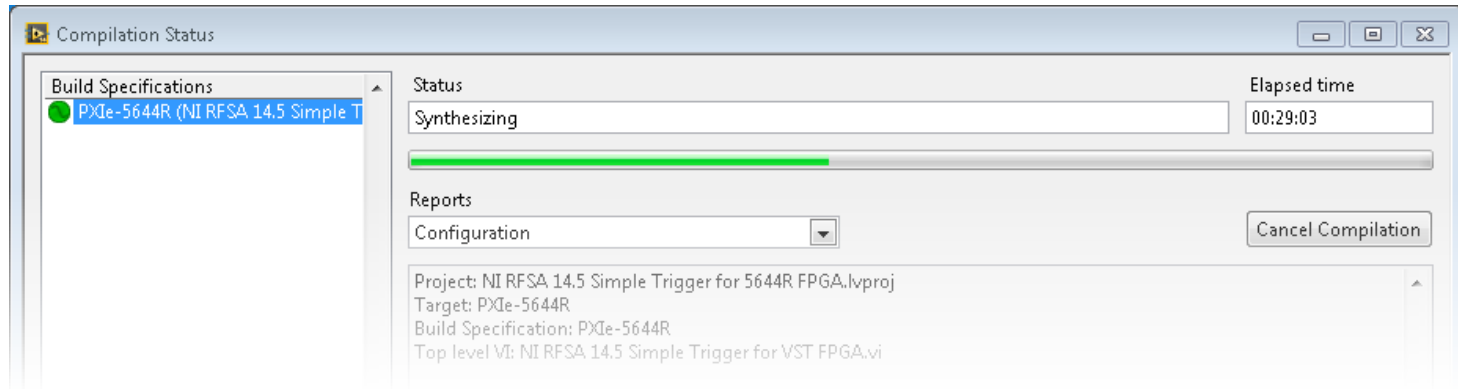
1) Obtain instrument driver default FPGA personality

FPGA Extensions Development Example



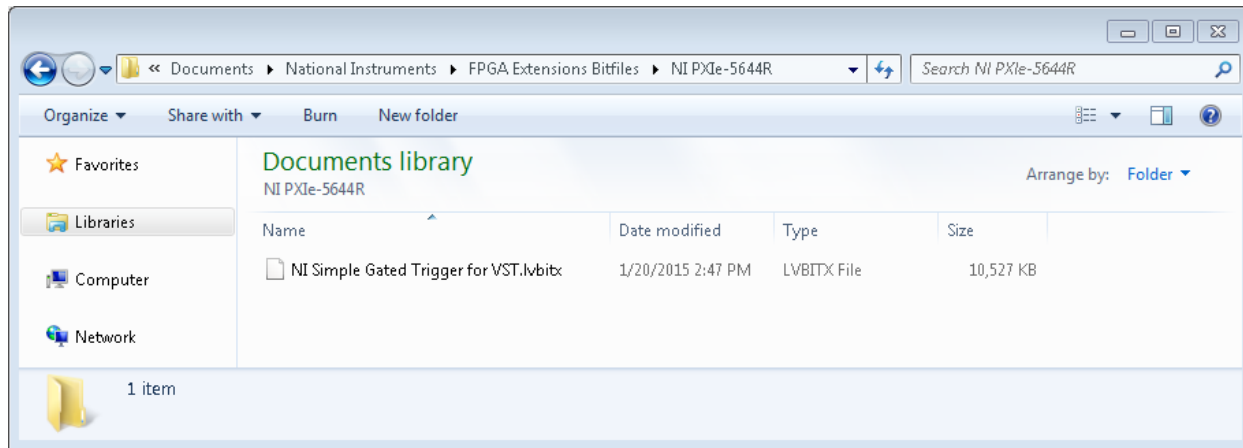
- 1) Obtain instrument driver default FPGA personality
- 2) Modify instrument driver FPGA

FPGA Extensions Development Example



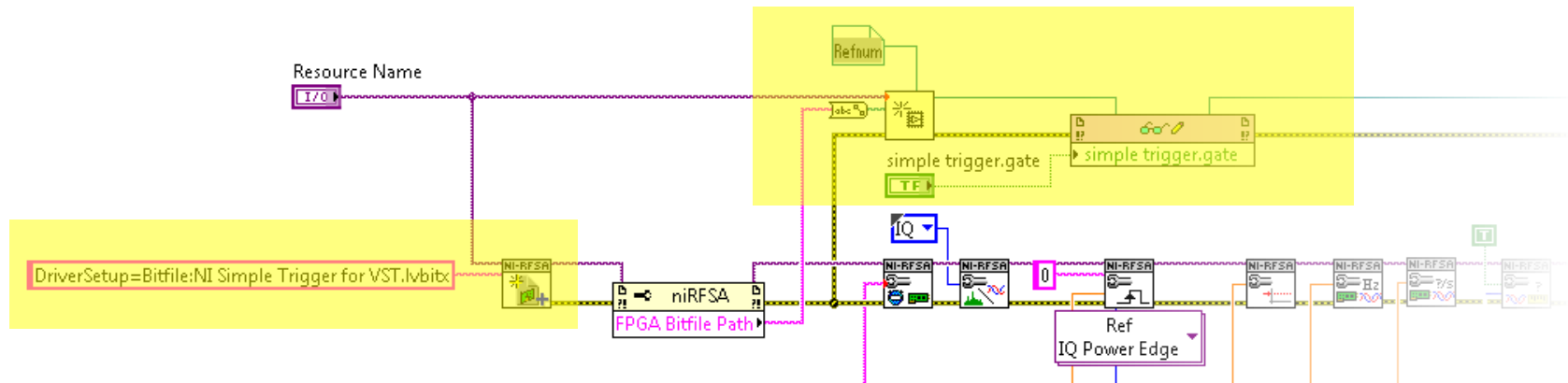
- 1) Obtain instrument driver default FPGA personality
- 2) Modify instrument driver FPGA
- 3) Compile instrument driver FPGA

FPGA Extensions Development Example



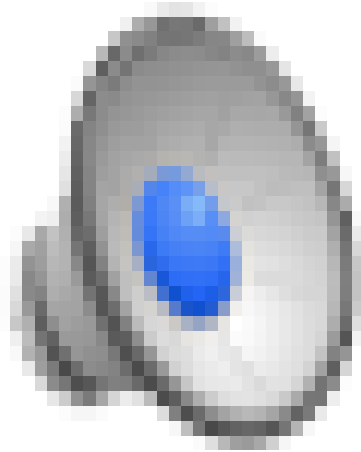
- 1) Obtain instrument driver default FPGA personality
- 2) Modify instrument driver FPGA
- 3) Compile instrument driver FPGA
- 4) Place bitfile in <Public Documents>\National Instruments\FPGA Extensions

FPGA Extensions Development Example



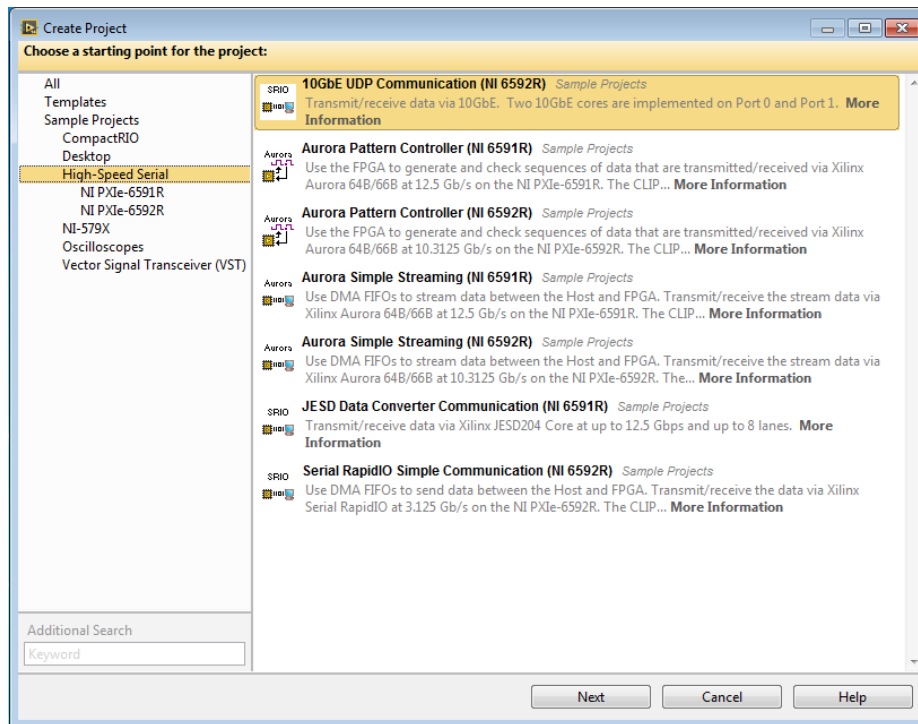
- 1) Obtain instrument driver default FPGA personality
- 2) Modify instrument driver FPGA
- 3) Compile instrument driver FPGA
- 4) Place bitfile in <Public Documents>\National Instruments\FPGA Extensions
- 5) Access custom functionality through FPGA host interface

FPGA Extensions Development Example

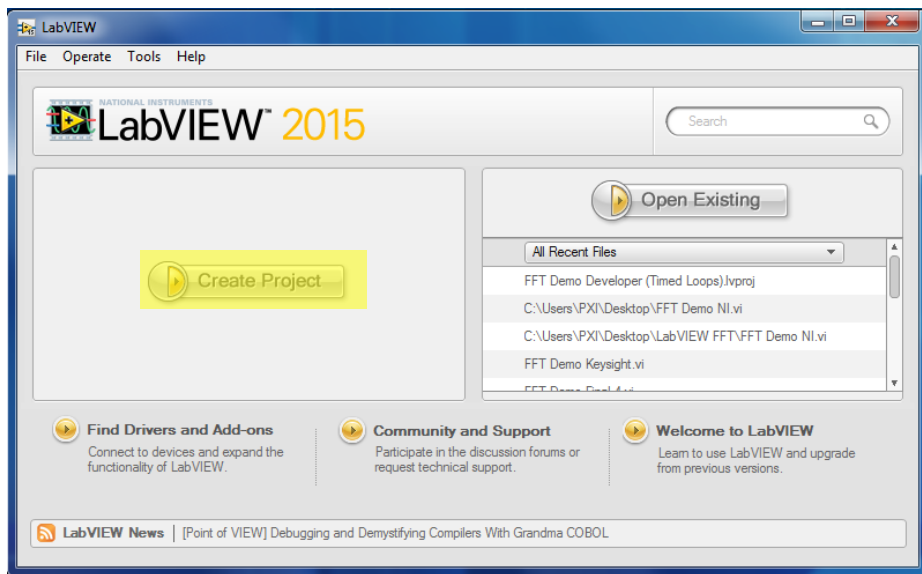


3. LabVIEW Sample Projects for SDIs

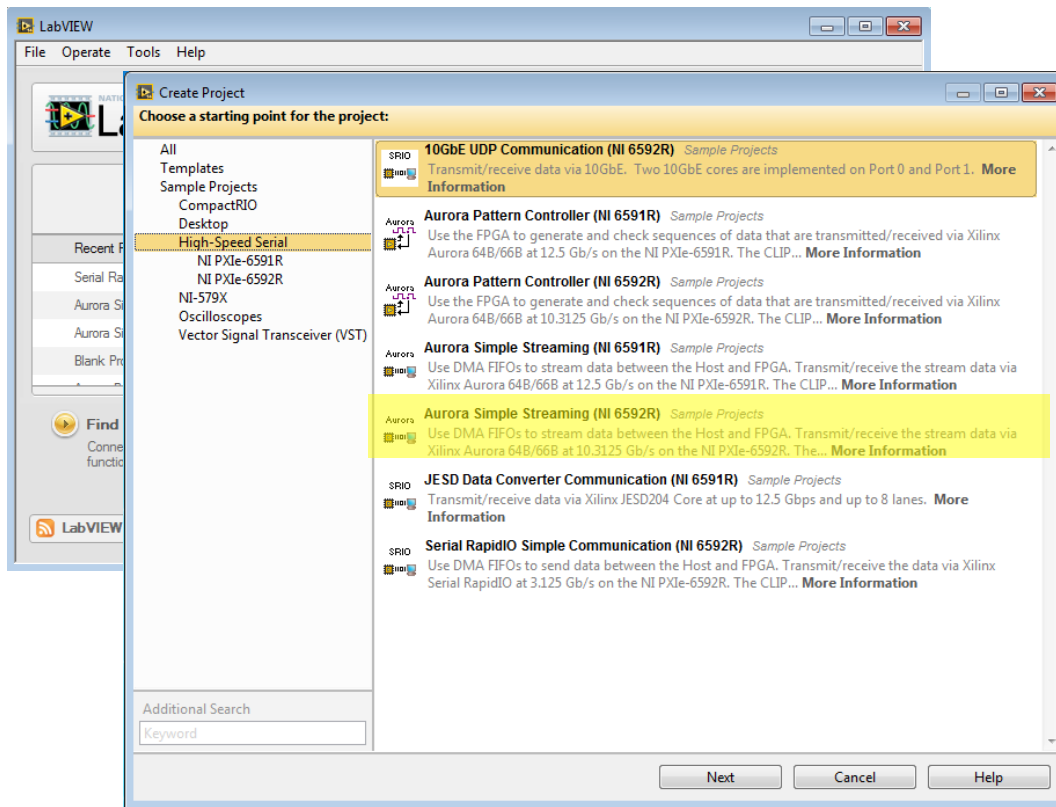
Completely flexible, built on instrument design libraries



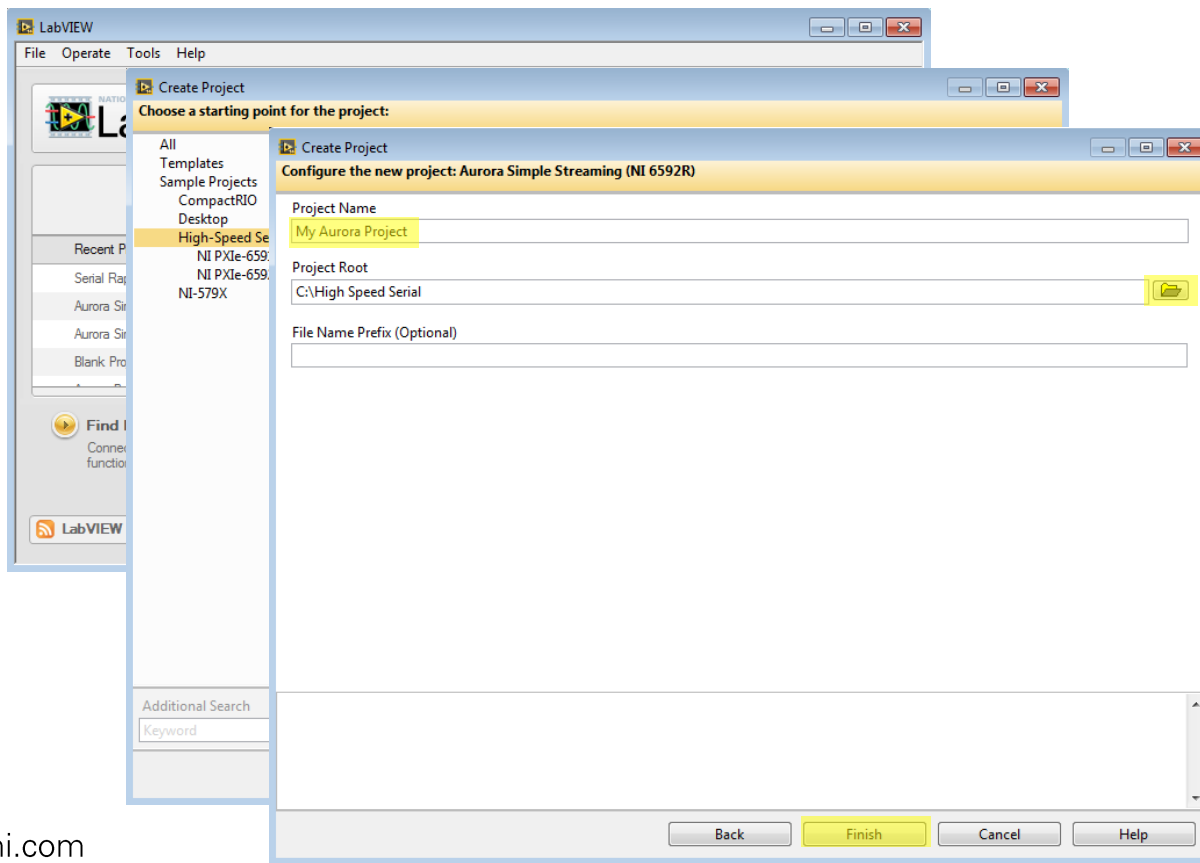
3. LabVIEW Sample Projects



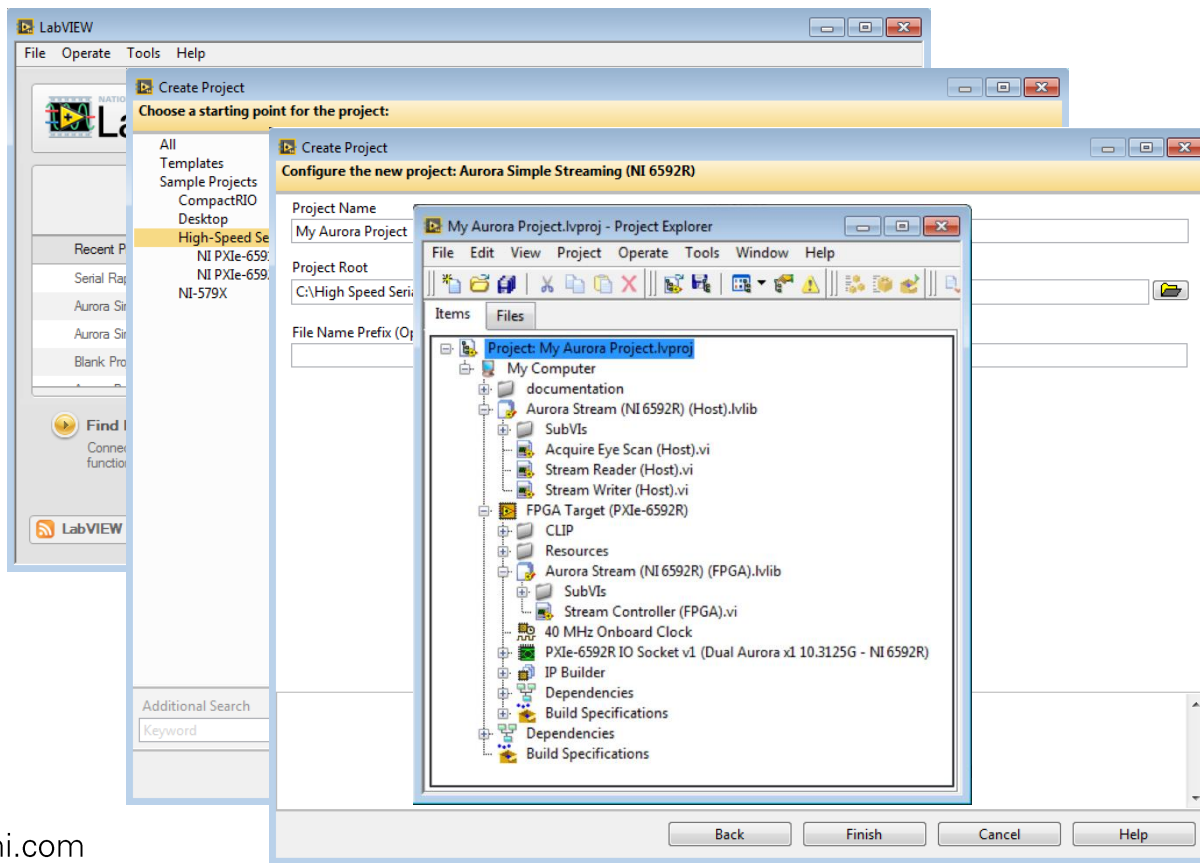
3. LabVIEW Sample Projects



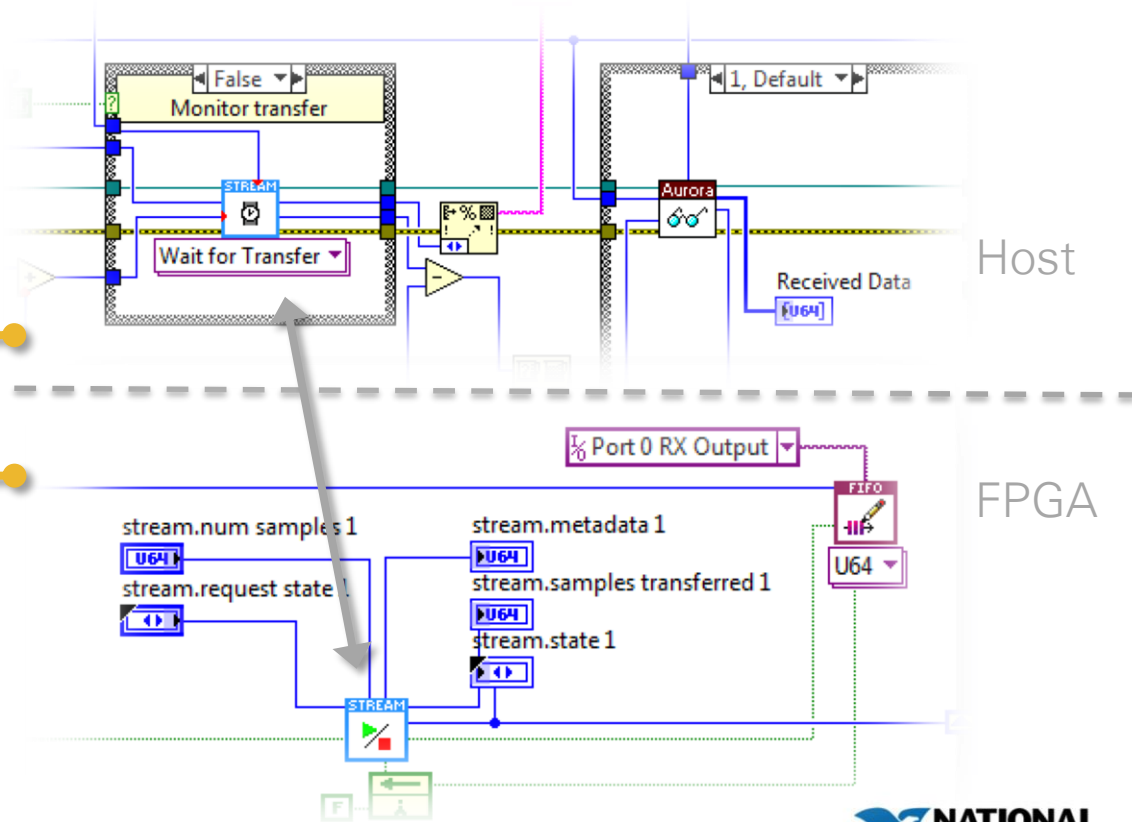
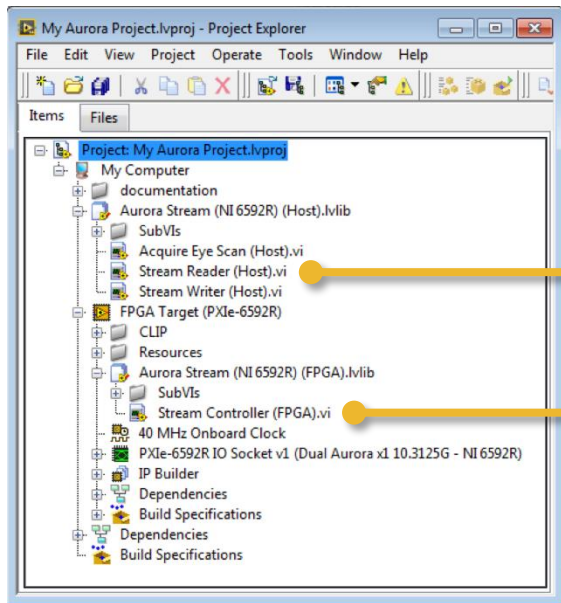
3. LabVIEW Sample Projects



3. LabVIEW Sample Projects



Automatically Generated Code



Demo: Starting from Sample Projects

High Speed Serial Cards

PXle-6591R & PXle-6592R Specifications

High-speed serial interface	Up to 12.5 Gbps Up to 8 TX and RX lanes
Connector	SFP+ or Mini-SAS HD
RAM	2 GB / 10.6 GB/s bandwidth
FPGA	Kintex-7 410T FPGA programmable w/ LabVIEW PXI Express x8 Gen 2 bus interface (> 3 GB/s)

Examples for:

- JESD204B
- Xilinx Aurora
- Serial RapidIO
- 10 Gigabit Ethernet
- CPRI

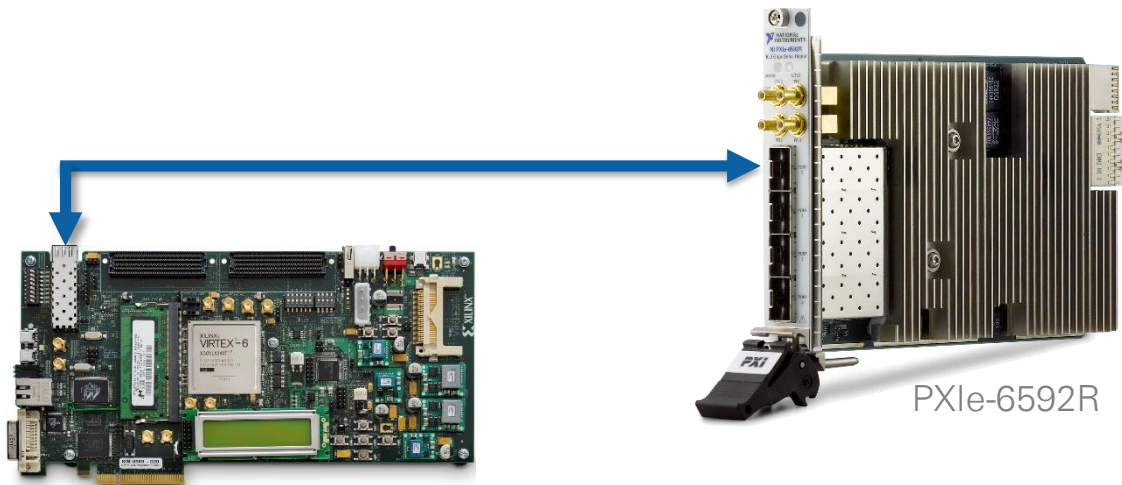
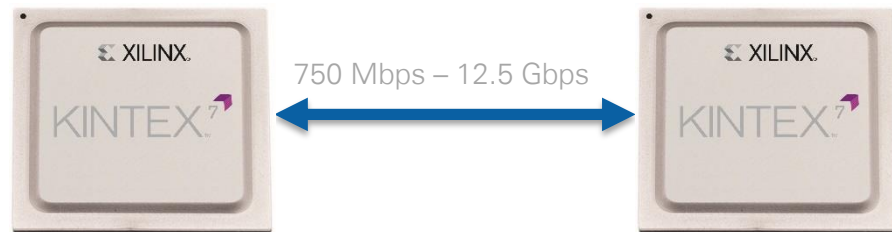
PXle-6591R

PXle-6592R

“FlexRIO-like” VHDL
control of Xilinx MGTs

Xilinx Aurora

- Ultra low latency (<500 ns)
- Ultra High Bandwidth (up to 8 lanes @ 12.5 Gbps each)
- Free IP from Xilinx



Demo: High-Speed Serial Sample Projects

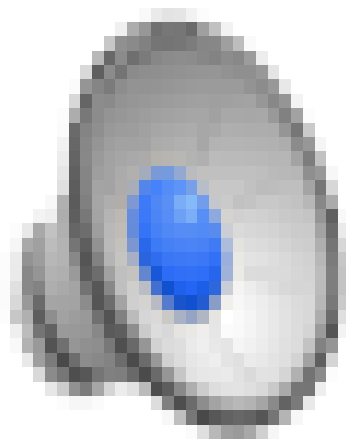
RF Channelizer
Receiver

Channel Info

Xilinx Aurora



Demo: High-Speed Serial Sample Projects



Instrument Model	Instrument Driver	Instrument Driver FPGA Extensions	LabVIEW Sample Projects and Instrument Design Libraries
Vector Signal Transceivers			
PXIe-5644R	✓	✓	✓
PXIe-5645R			
PXIe-5646R			
Oscilloscopes			
PXIe-5170R	✓	✓	✓
PXIe-5171R			
IF Digitizers			
PXIe-5624R	X	X	✓
Vector Signal Analyzer			
PXIe-5668R	✓	✓	✓
High-Speed Serial Instruments			
PXIe-6591R	X	X	✓
PXIe-6592R			

8 ch., 250 MHz Reconfigurable Oscilloscope

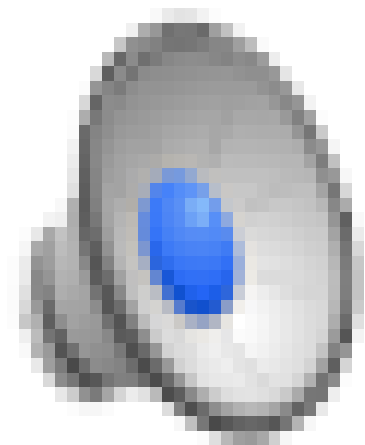


PXIe-5171R Specifications

Channels	8 (simultaneously sampled)
ADC	250 MS/s, 14-bit
Analog Bandwidth	250 MHz Selectable 100 MHz filter
Input ranges	0.2 V _{pp} to 5 V _{pp}
ENOB	11
DRAM	1.5 GB
FPGA	Kintex-7 410T FPGA Programmable with LabVIEW PXI Express x8 Gen 2 bus interface (> 3 GB/s)
No. of Slots	1

Finding IP from the Community

<http://www.ni.com/software-designed-instruments/getting-started/>



Next Steps

- ni.com/software-designed-instruments
 - Technical content
- ni.com/software-designed-instruments/getting-started
 - Examples and application IP
- High-Throughput LabVIEW FPGA Training
 - <http://sine.ni.com/tacs/app/overview/p/ap/of/lang/en/pg/1/sn/n24:16770/id/2158/>
- LabVIEW High-Performance FPGA Developer's Guide
 - <http://www.ni.com/tutorial/14600/en/>
- Alliance Partners
 - ni.com/alliance – LabVIEW FPGA specialty

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