



# Neue Technologien für die effiziente Datenerfassung von Analogen/Digitalen - Signalen

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# Agenda

- Introduction to National Instruments
- What is Virtual Instrumentation?
- Key Features of a DAQ Device for synchronized measurements

# National Instruments Profile

- *Leaders in Computer-Based Measurement and Automation*
- Long-Term Track Record of Growth and Profitability
- 4800 Employees +40 countries
- \$821 MM Revenue in 2008
- Investment in R&D: 16 % of revenue
- 9 R&D locations
- 2 Manufacturing sites
- 25'000 customers in 90 countries
- More than 600 alliance partner as system integrators



# What is Virtual Instrumentation?

**Traditional Vendor-Defined Instruments**



**Customer-Defined  
PC-Based Measurement  
and Automation Solutions**



Processor

Display

RAM

Power  
Supply

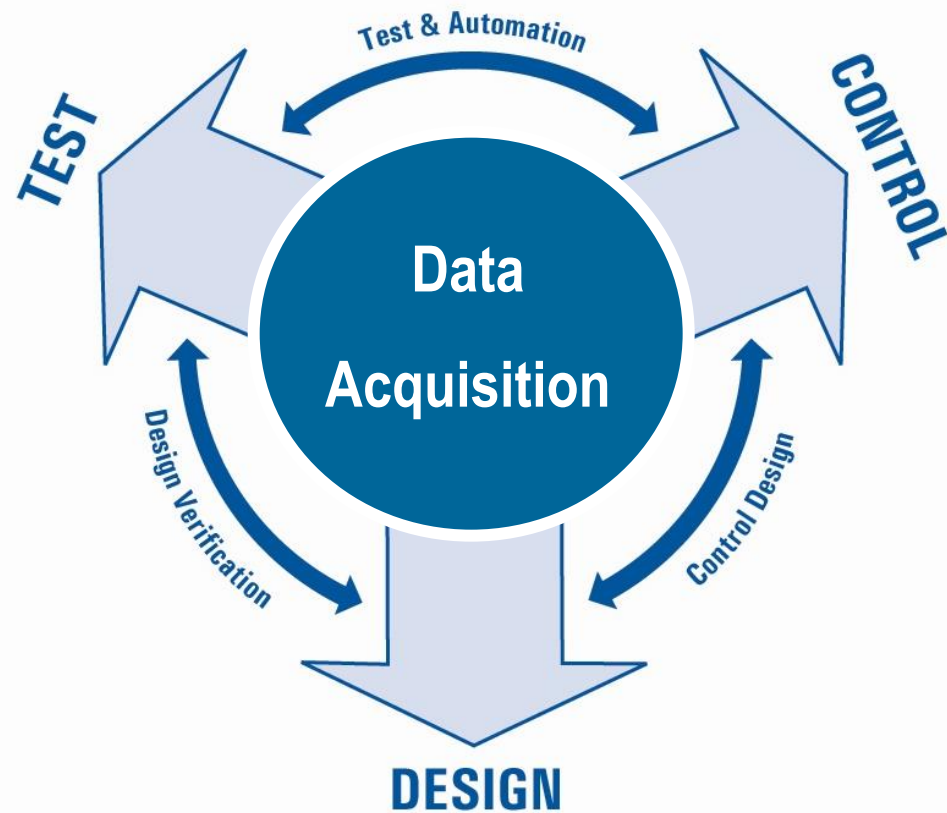
ROM

Hard Disk



# Virtual Instrumentation Applications

- Test
  - Physical/environmental measurements
  - Prototype validation
  - Manufacturing test
  - And more...
- Control
  - Industrial monitoring and control
  - Motion control
  - And more...
- Design
  - Simulation and prototyping
  - Design characterization
  - And more...



# The NI Approach – Integrated Hard- & Software-Framework

## Test and Data Management Software NI TestStand, DIAdem

### Interactive Tools

SignalExpress  
VI Logger  
Vision Builder AI

### Application Development Software

LabVIEW  
Graphical Development

LabWindows/  
CVI  
ANSI C Development

Measurement  
Studio  
Visual Studio Components

## Measurement and Control Services



GPIB/Serial  
and VXI



Data Acquisition and  
Signal Conditioning



Modular  
Instrumentation



PXI/CompactPCI



Motion



Vision



Distributed I/O



PLCs

# Evolution in Data Acquisition

	Legacy 198x	E Series 199x	S Series 200x	M Series 2004	X Series 2009
Sampling Rate	100 kS/s	1.25 MS/s	5/10 MS/s	250 kS/s-1.25 MS/s	250 kS/s-2 MS/s
Resolution	12 bit	12/16 bit	12,14,16 bit	16/18 bit	16/18 bit
# of AI channels	16	16/64	2,4,8 SS	16/32/80	32/16/16 SS
# of AO channels	2	2	2/0	4/2	4/2
# of DIO	8	8,32	8	24,48	24,48
# of CTR	2, 16 bit, 10 MHz	2, 24 bit, 20 MHz	2, 24 bit	2, 32 bit, 80 MHz	4, 32 bit, 100 MHz
Bus Interface	ISA	ISA/PCI/PXI/1394/USB	PCI/PXI	PCI/PCIe/PXI/USB	PCIe/PXIe
Data Transfer	Ca 1 MB/s sys	10 MB/s sys	80 MB/s sys	80 MB/s sys	250 MB/s/dev
DMA channel	3, 16 bit	3	3	6	8
Avg. Price	2000-4000	1500-4000	2000-7500	700-2000	700-10'000

# Data Acquisition Devices

- Most DAQ devices have:

- Analog Input
- Analog Output
- Digital I/O
- Counters

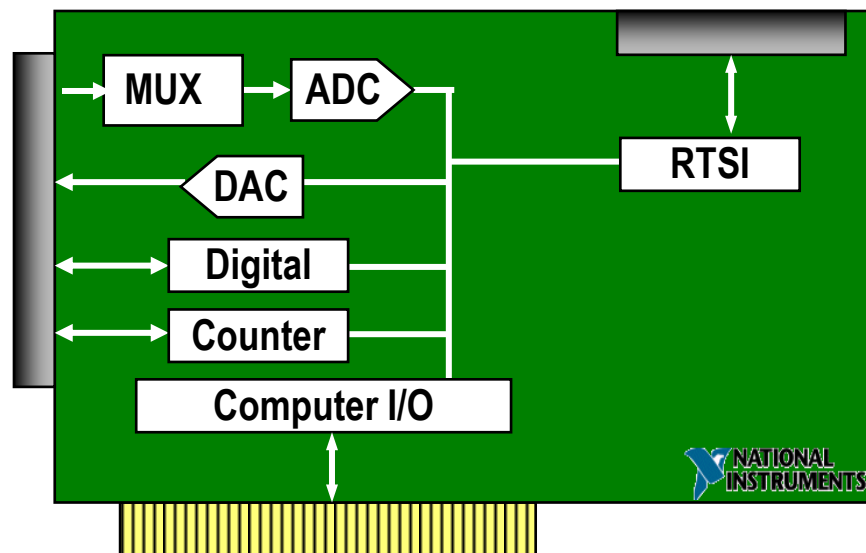
- Applications specific devices for:

- High speed digital I/O
- High speed waveform generation
- Dynamic Signal Acquisition (vibration, sonar)

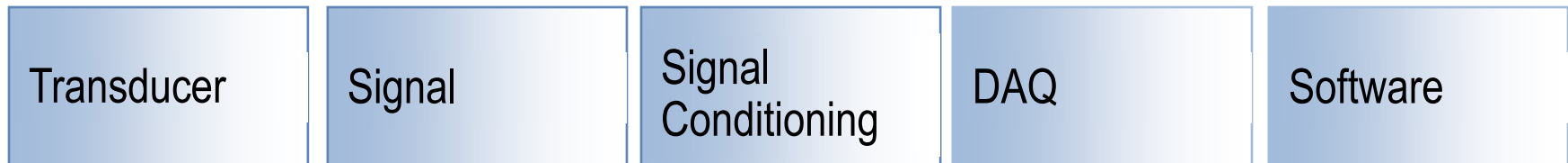
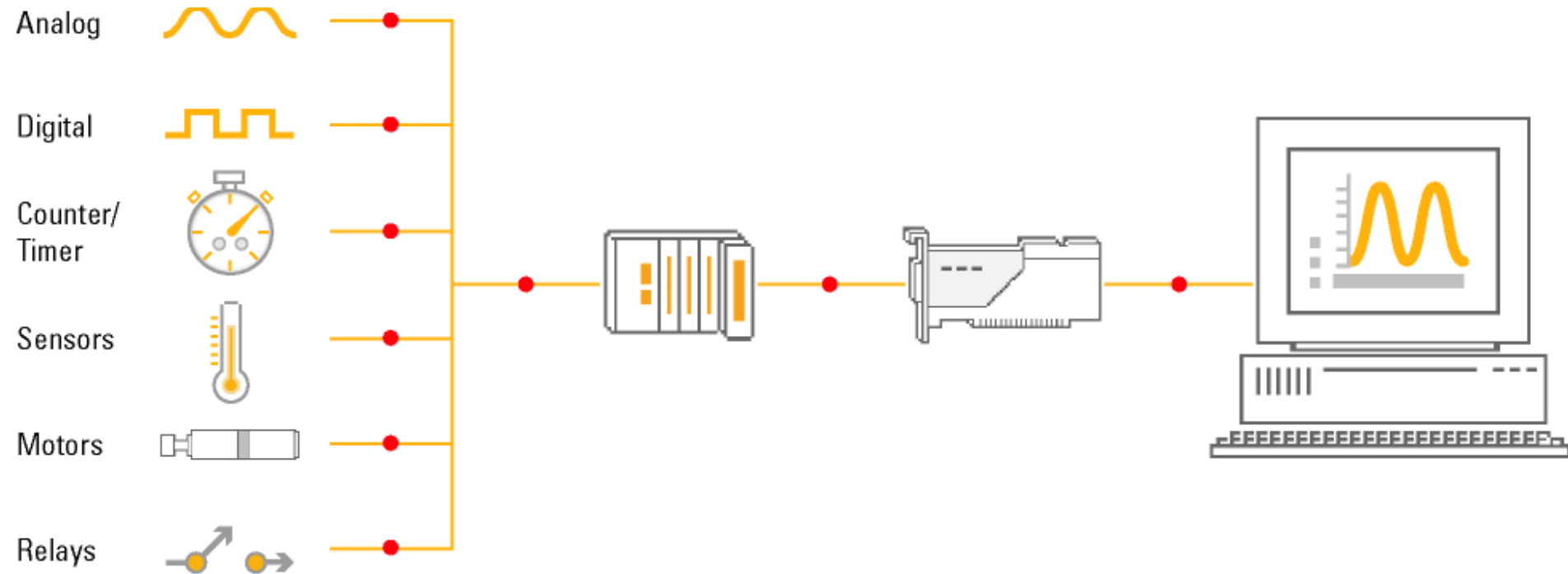
- Compatible with a variety of bus protocols:

- PCI, PXI/CompactPCI, PCI Express, PCMCIA, USB, 1394/Firewire®

## Multifunction DAQ Device



# PC-Based Data Acquisition (DAQ)



# Key Features of a DAQ Device

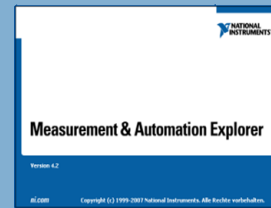
- I/O Specification
  - Analog Accuracy
  - Channel Count
- Software
- Timing/Event Counter/Synchronization
- Bus Interface
  - Data Throughput vs. Latency

# Key Features of a DAQ Device

- I/O Specification
  - Analog Accuracy
  - Channel Count
- **Software**
- Timing/Event Counter/Synchronization
- Bus Interface
  - Data Throuput vs. Latency

# Software Framework for DAQ

Application Software



Driver Software



Express-Technology

NI-DAQmx API

Measurement & Automation Explorer

DAQmx-Driver-Engine

Hardware



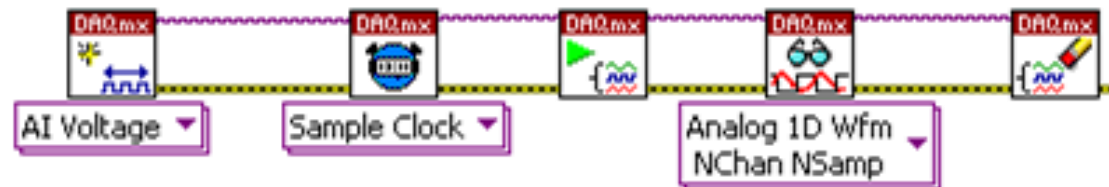
# Data Acquisition with LabVIEW

NI-DAQmx driver software provides connectivity between LabVIEW and your hardware

## Configuration Based



## Programmatic Interface

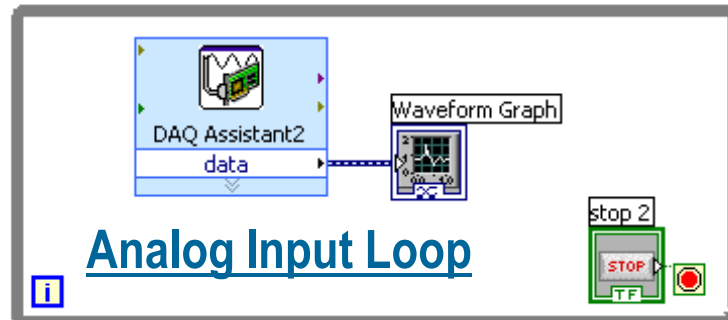
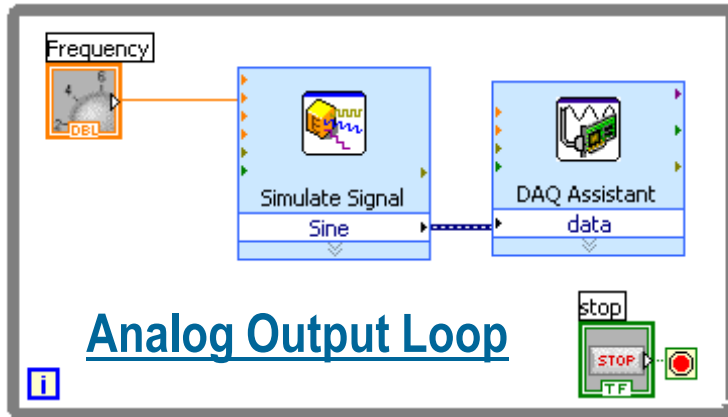


## NI-DAQmx driver configures

- Triggering
- Sample rates
- Clocking
- Buffering
- Signal routing
- etc...

# Parallel Operations in LabVIEW

Configuring and visualizing multiple tasks graphically is easier



Parallel loops automatically take advantage of multithreading and multi-core processors for higher performance

# Key Features of a DAQ Device

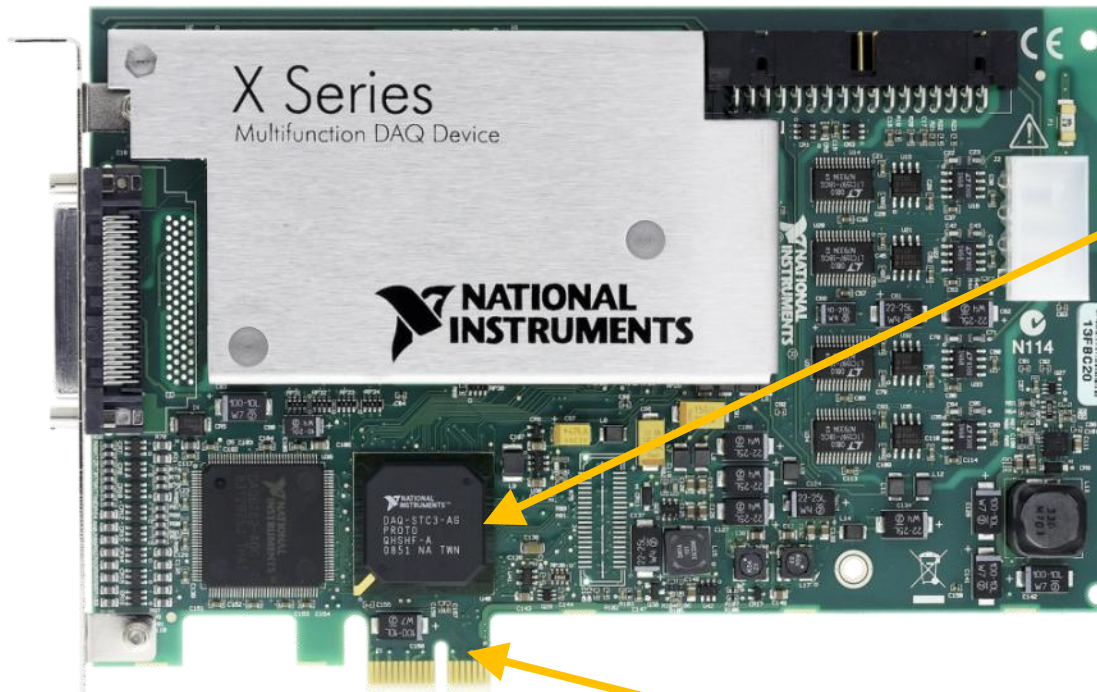
- I/O Specification
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- **Timing/Event Counter/Synchronization**
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# X Series Multifunction DAQ

- Up to 32 Analog Inputs, up to 2 MS/s (16-bit resolution)
- Up to 4 Analog Outputs, up to 3.33 MS/s (16-bit resolution)
- Up to 48 digital I/O lines, up to 10 MHz
- Four 32-bit counters on each device



# X Series Key Features



NI-STC3 timing and synchronization technology

NI-DAQmx software optimizations

High-throughput, native PCI Express interface

# NI-STC3 Timing and Synchronization Technology

- Counter improvements
- 100 MHz timebase
- New digital I/O timing engines
- Retriggering on every subsystem



# Counter Applications

## Input

- Counting Edges
- Quadrature encoder and position measurement
- Pulse and pulse-width measurement
- Frequency, period and semi-period measurement
- Two-signal edge-separation measurement

## Output

- Finite pulse train
- Continuous pulse train (PWM)
- Frequency generation
- Frequency division

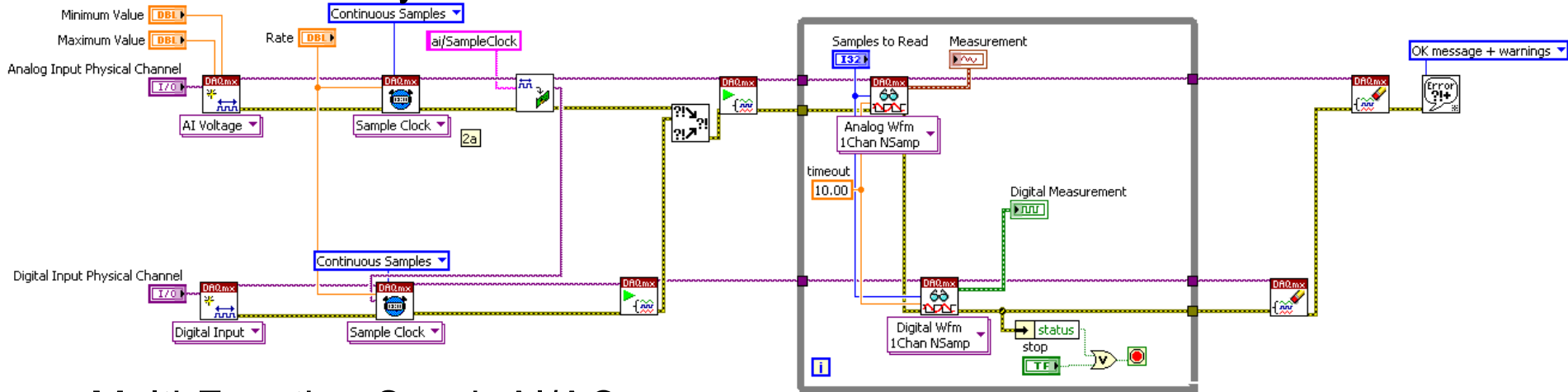
# 100 MHz Timebase produces more accurate sampling rates



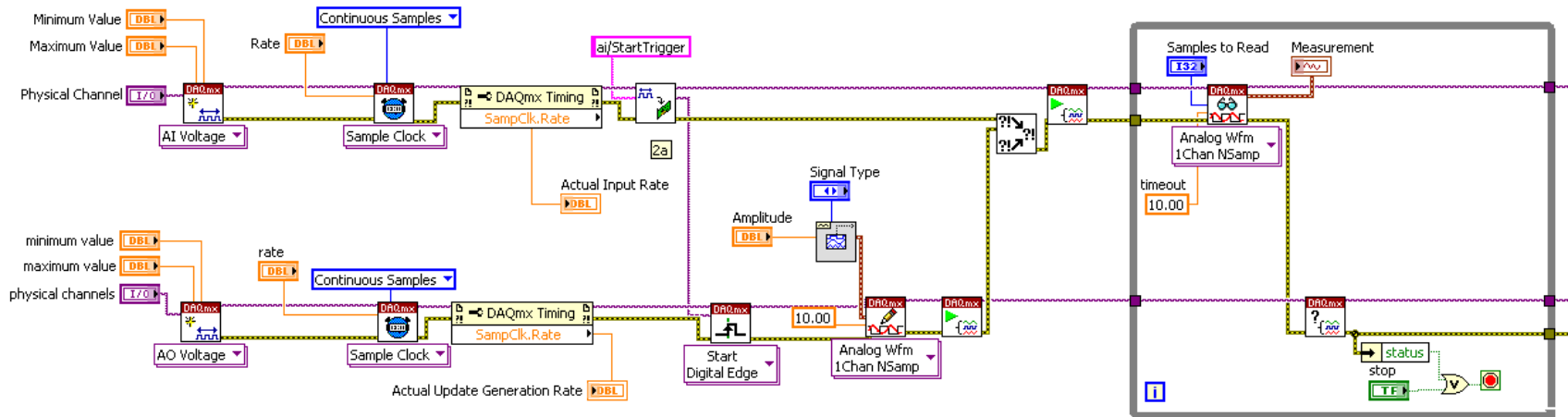
- How to create a 1.25 MS/s sample clock?
  - $20 \text{ MHz}/16 = 1.25 \text{ MS/s}$
  - $100 \text{ MHz}/80 = 1.25 \text{ MS/s}$
- How to create a 1.23 MS/s sample clock?
  - $20 \text{ MHz}/17 = 1.18 \text{ MS/s}$
  - $100 \text{ MHz}/81 = 1.235 \text{ MS/s}$

# Synchronizing Multiple Functions

## Multi-Function Synch AI/DI:

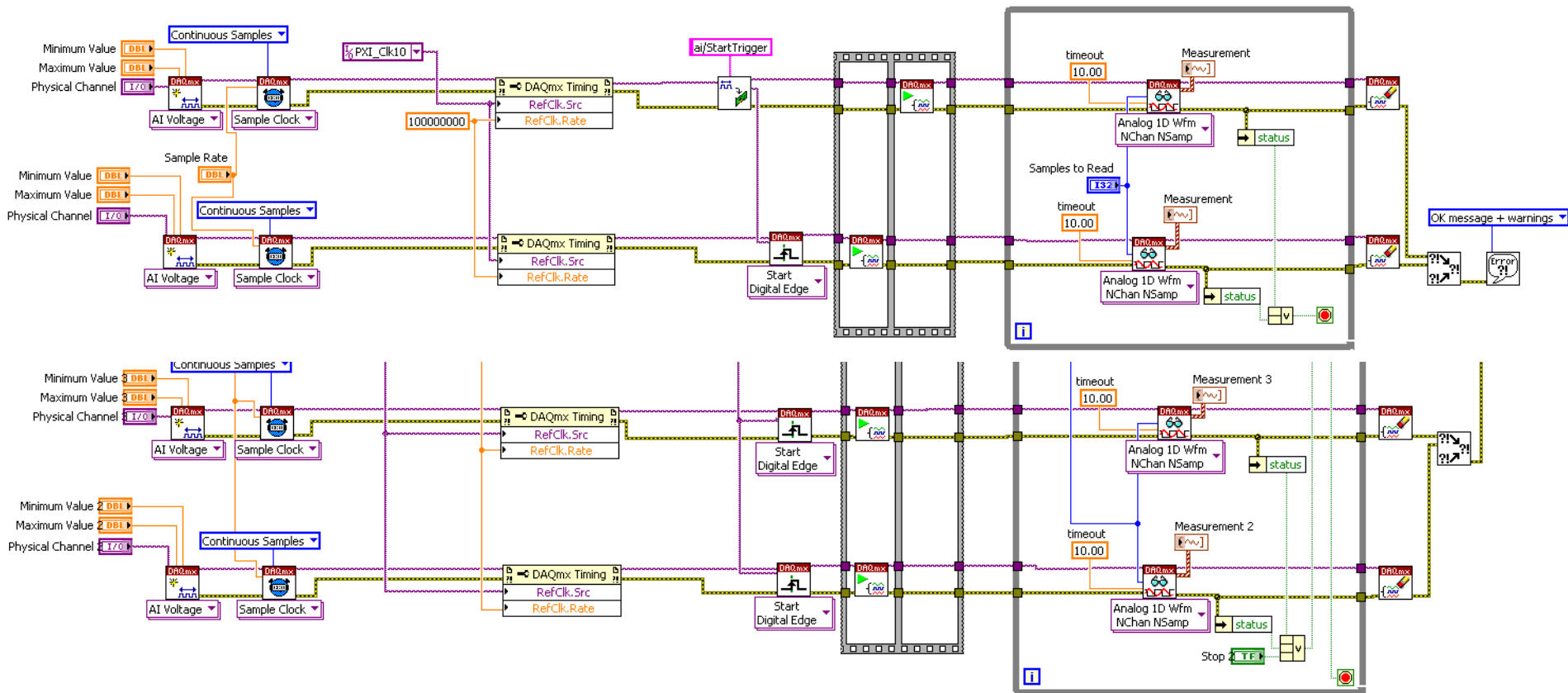


## Multi-Function Synch AI/AO:



# Synchronizing Multiple Devices

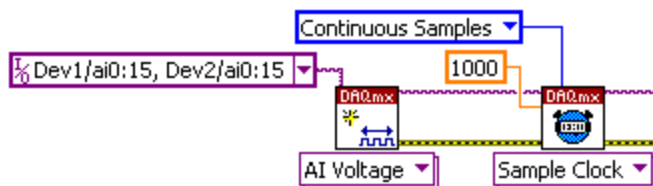
M Series:



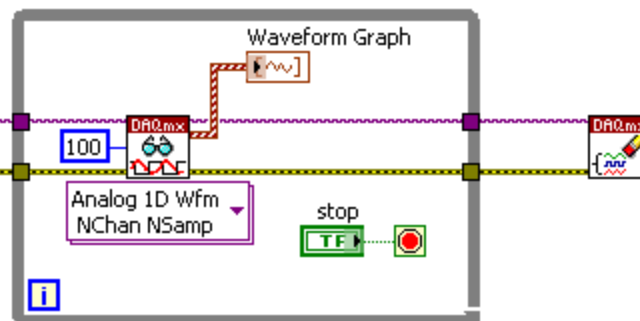
# Synchronizing Multiple Devices

X Series:

Create voltage channels for two or more DAQ devices with DAQmx Create Channel

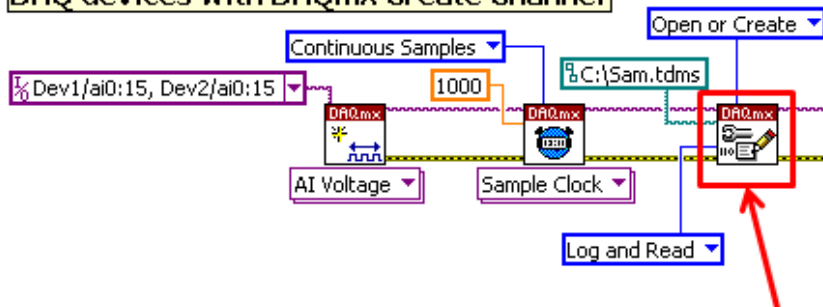


Acquire and plot values continuously

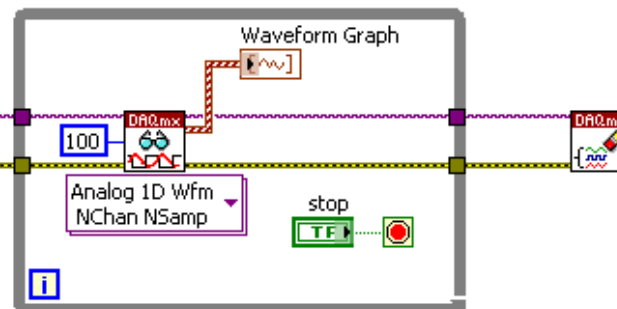


And what if we want to log this to disk?

Create voltage channels for two or more DAQ devices with DAQmx Create Channel



Acquire and plot values continuously



Configure Logging.vi Log at to disk at 1 GB/s with <5% CPU utilization

# Key Features of a DAQ Device

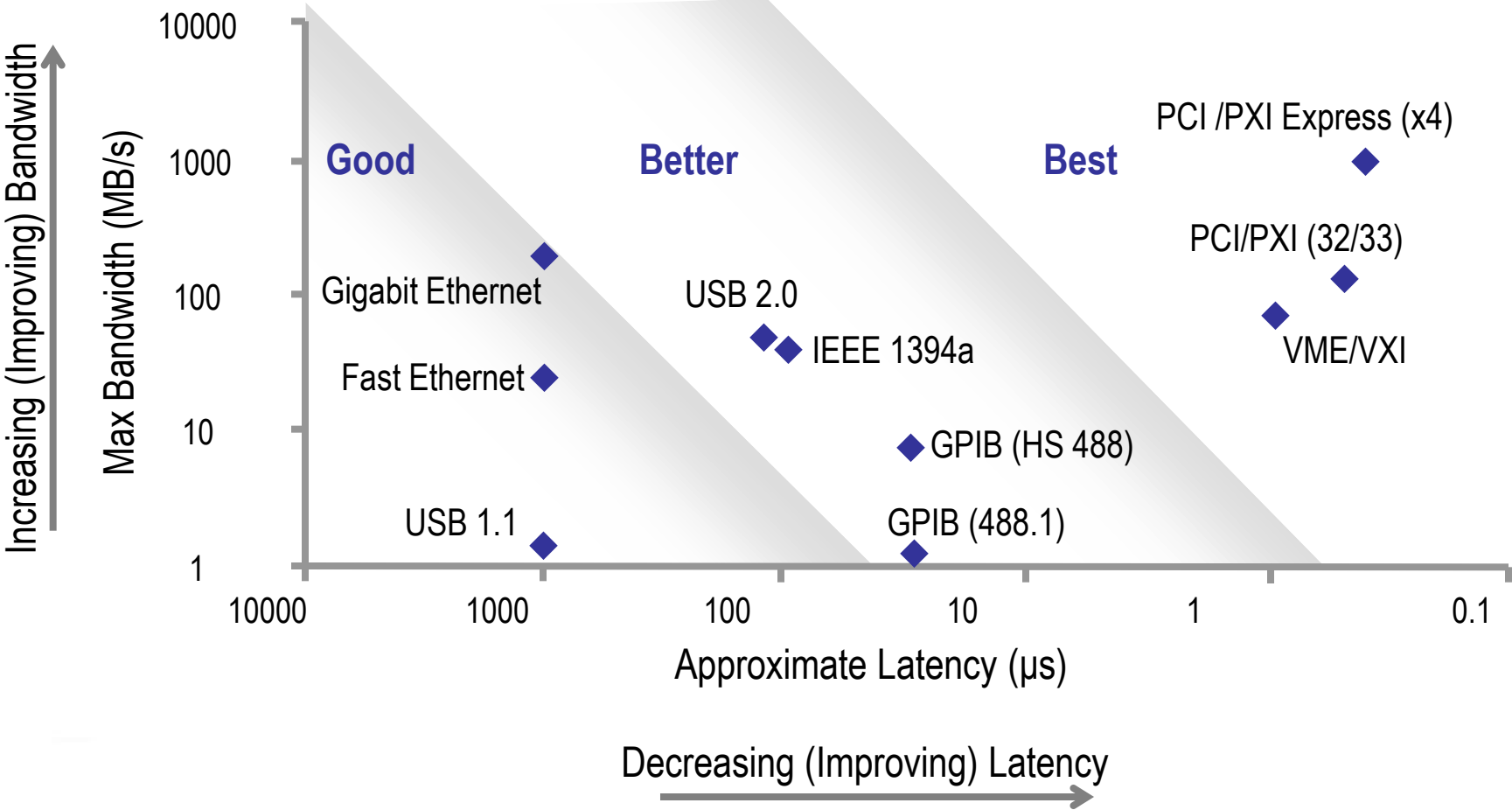
- I/O Specification
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- Software
- Timing/Event Counter/Synchronization
- **Bus Interface**
  - **Data Throuput vs. Latency**

# Native PCI Express x1 Interface

- Dedicated bandwidth of up to 250 MB/s in each direction
- 8 DMA channels
- Software optimizations for low latency and single-point control applications



# Bandwidth v. Latency



# Key Takeaways

- Devices are available from low-cost to 2 MS/s/ch with simultaneous sampling
- Easy multi-function synchronization
- Easy multi-device synchronization
- Easy data streaming and logging

