PXI Timing & Synchronization

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PXI Systems Alliance (PXISA)

- Founded in 1998
- PXISA Goals:
  - Maintain the PXI specification
  - Ensure interoperability
  - Promote the PXI standard
- Currently 65+ Members Comprise PXISA
- PXISA Website (www.pxisa.org)
  - Specifications
  - Tutorials, Application Notes, and White Papers
  - Locate member companies and products

PXI Systems Alliance

National Instruments

- Technology pioneer and leader in virtual instrumentation
- Software and hardware for test, control, and design
- PXI chassis, controllers, modular instruments, data acquisition, and bus interfaces
- Sponsor member of the PXISA

NATIONAL INSTRUMENTS™

Synchronization Requirements for Test Systems

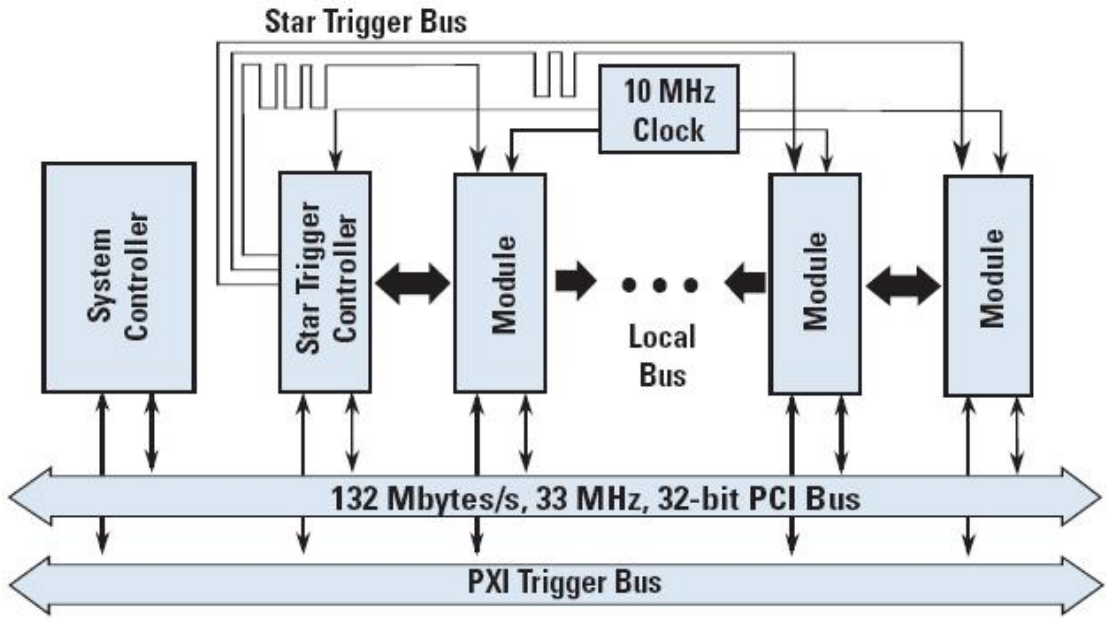
- Mixed-Signal Test
  - Arbitrary Waveform Generators
  - Digitizers
  - Digital Waveform Generators
  - Digital Waveform Analyzers
- Channel Expansion
  - Multiple Simultaneous Channels
  - Instruments with Switching

✓ **Improve Accuracy**

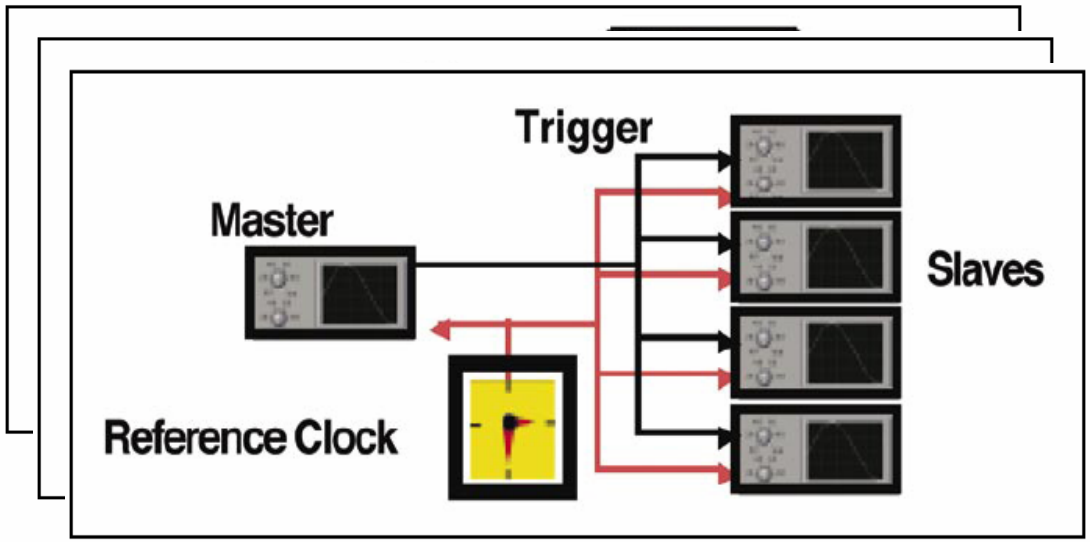
✓ **Reduce Test Time**

Timing and Synchronization Features of PXI

- PXI Trigger Bus
  - 8 TTL
  - Trigger, Clock, and Handshaking Signals
- System Reference Clock
  - 10 MHz TTL
  - Phase Lock Looping
  - Equal-Length Traces
  - < 1 ns Skew
- Star Trigger Bus
  - 1 Per Slot
  - Star Configuration
  - Matched in Prop. Delay to Within 1 ns



Mixed-Signal Synchronization Schemes



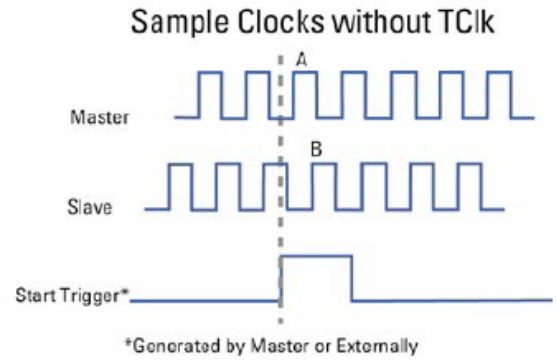
Start Trigger

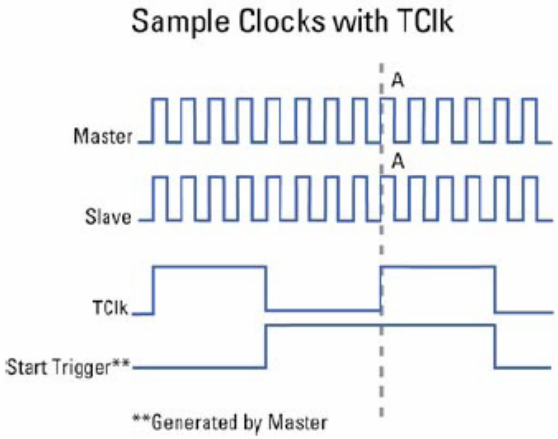
Start Trigger & Sample Clk

Start Trigger & Reference Clk

- Adequate for many applications
- High-speed tests require advanced techniques

Advanced Mixed-Signal Synchronization





Trigger Clock (TClk)

- NI Synch. and Memory Core (SMC)
- Typical skew between 200 and 500 ps
- Aligns sample clocks that may not be aligned initially despite being phase-locked
- Enables accurate triggering of synchronized devices
- Only three required functions/VIs

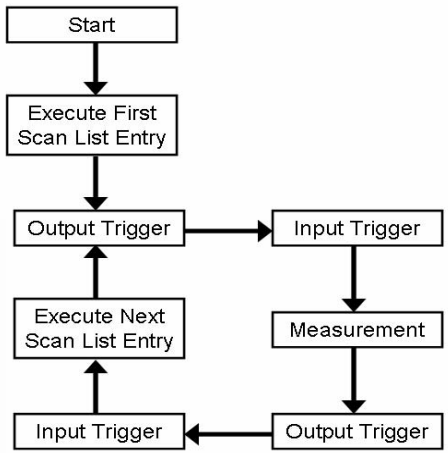
Example Trigger Clock Application

- Application:
  - Functional digital test
- Requirements:
  - Up to a thousand pins of digital I/O
  - Multiple digital pattern generators and analyzers
  - Minimal pin-to-pin skew and jitter between modules

Channel Expansion with Switching

- Software Scanning
  - Measurements and switching are done programmatically
  - Must add programmatic delay
- Synchronous Scanning
  - Instrument operates on trigger, switching is done programmatically
  - Must add programmatic delay
- Handshaking
  - Both the instrument and switch communicate states via triggers

Modular PXI Switch



Modular PXI DMM

Switching Benchmarks

Execution Time Comparison for 1000 Switched DMM Scans

	Standard Run (Rdgs/sec)	With Extra Processing (Rdgs/sec)	% Change
Software Scanning	331	260	27%
Hardware Handshaking	610	604	0.9%
% Throughput Increase Using Hardware Handshaking	**46%**	**57%**	

Advanced Synchronization with PXI

- Multi-chassis synchronization
- Custom timing and triggering with FPGAs
- Synchronization to external timebases - GPS

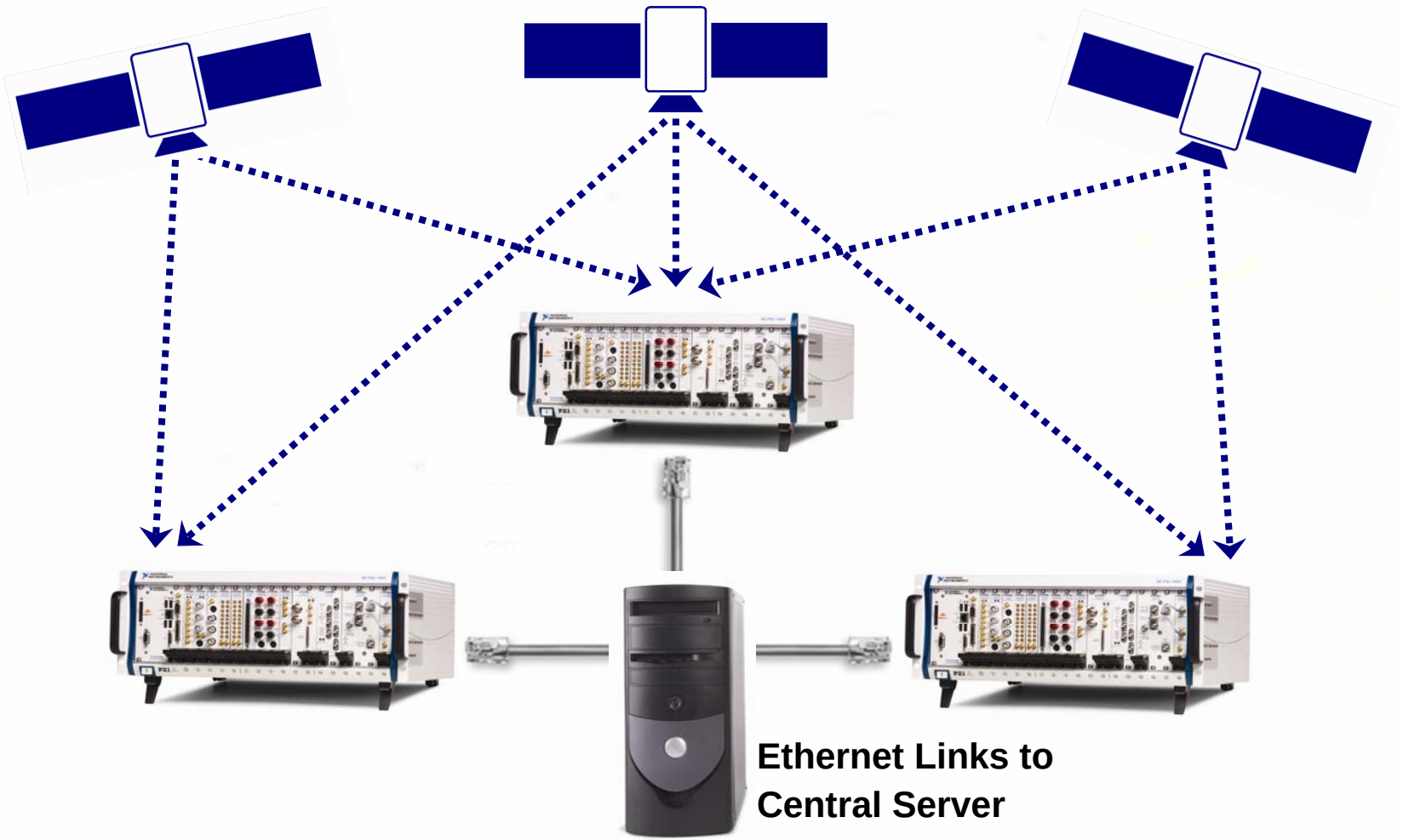
GPS Timing and Synchronization

Applications

- Timestamping events
- Timestamping events from multiple chassis to correlate measurements
- Generating hardware events at user-specified times
- Synchronizing chassis by generating triggers within multiple chassis

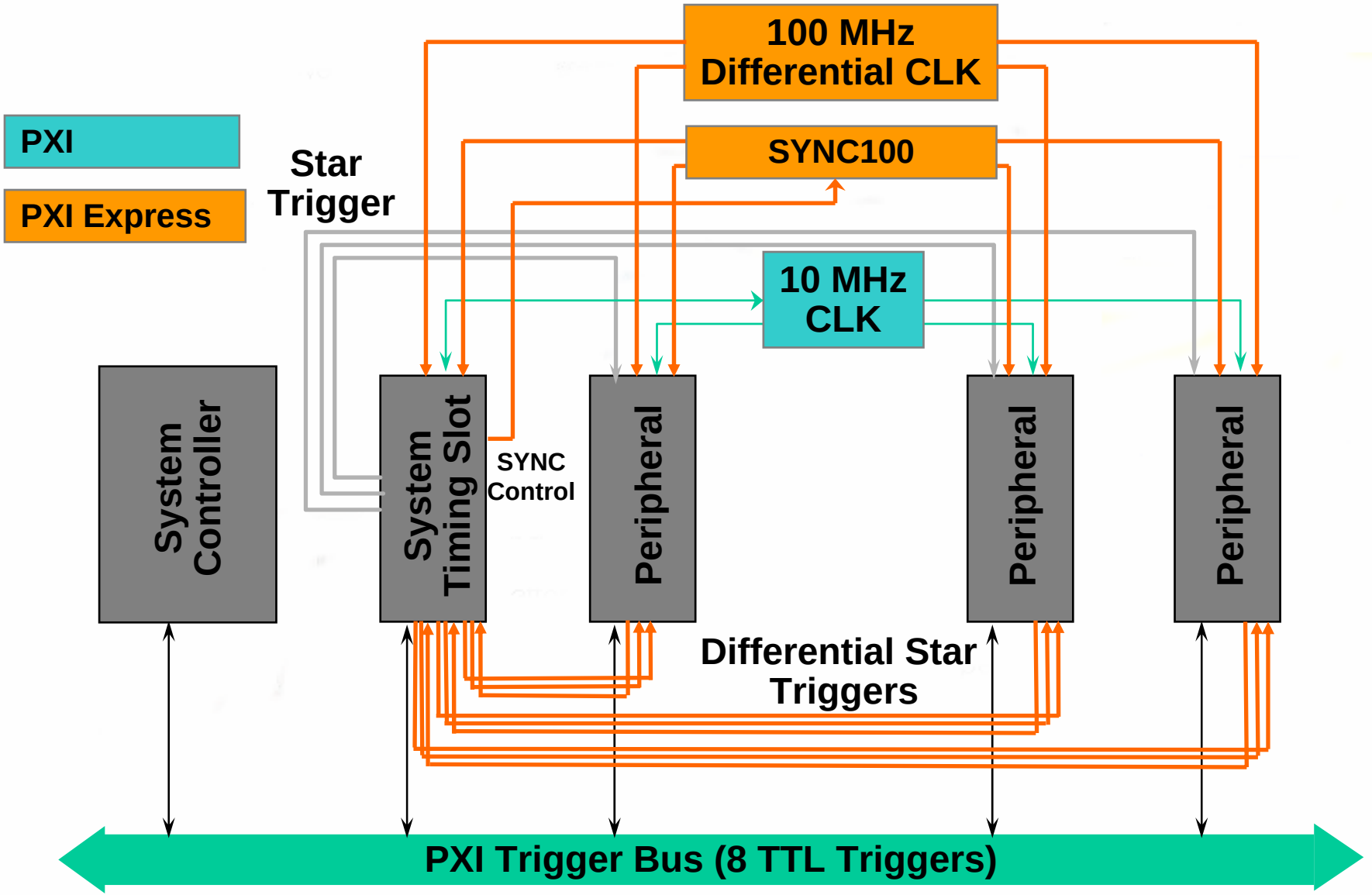
Solution: PXI modules are available with internal GPS receivers and/or the ability to read from external receivers

Example System Synchronized with GPS



PXI Express

Timing & Synchronization


100 MHz Differential CLK
SYNC100
PXI
PXI Express
Star Trigger
10 MHz CLK
System Controller
System Timing Slot
SYNC Control
Peripheral
Peripheral
Peripheral
Differential Star Triggers
PXI Trigger Bus (8 TTL Triggers)

PXI Timing & Synchronization

- **Applications**
  - Mixed-Signal Test
  - Channel Expansion
- **Benefits**
  - Improve Accuracy
  - Reduce Test Time
- **Synchronization Techniques**
  - Mixed-Signal Test (Trigger Clock)
  - Channel Expansion with Switching (Handshaking)
  - Advanced Synchronization with PXI (GPS)
- **PXI Express Introduces New Capabilities**