



PXI Timing & Synchronization

Spencer Stock

PXI Product Manager

National Instruments



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

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



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



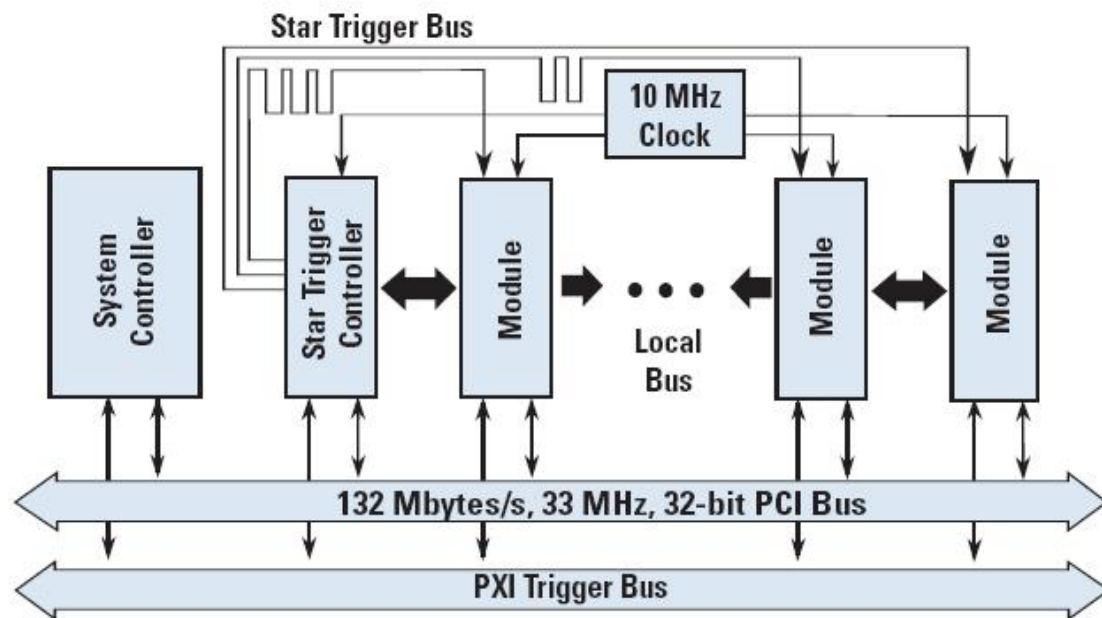
✓ **Improve Accuracy**

✓ **Reduce Test Time**

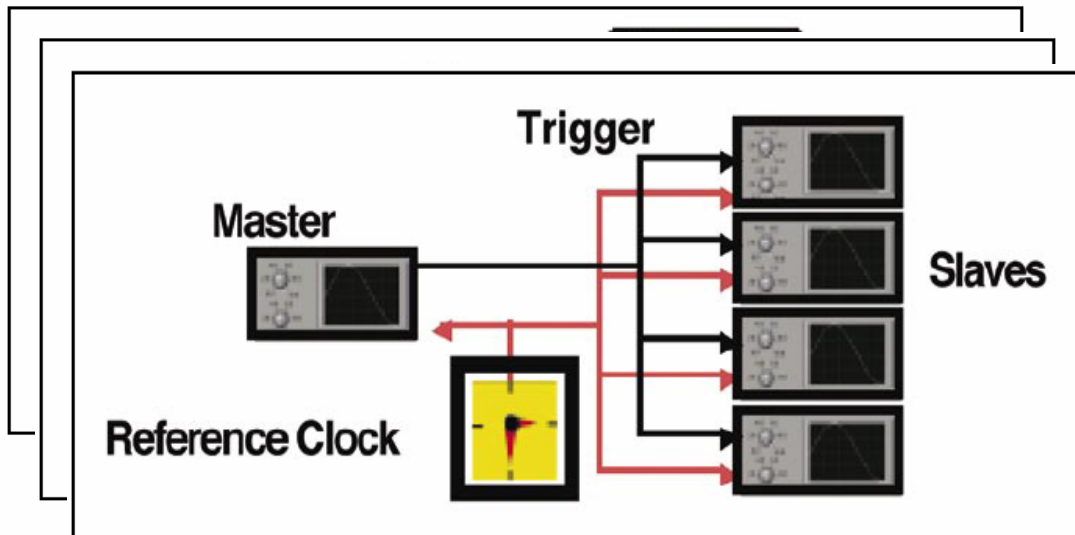


Timing and Synchronization Features of PXI

- 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

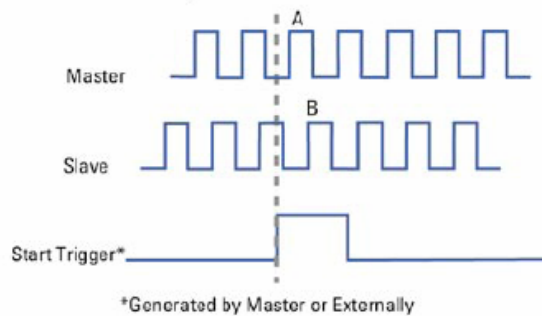


- Start Trigger**
- Start Trigger & Sample Clk**
- Start Trigger & Reference Clk**

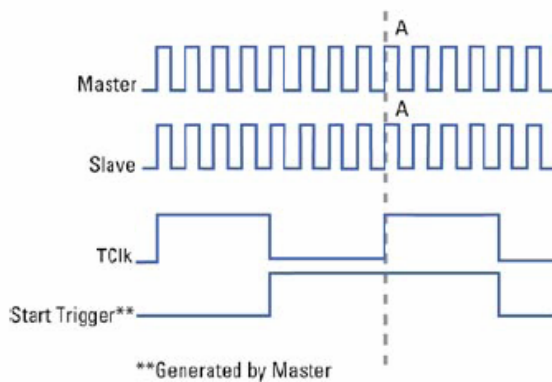
- Adequate for many applications
- High-speed tests require advanced techniques

Advanced Mixed-Signal Synchronization

Sample Clocks without TCik



Sample Clocks with TCik



Trigger Clock (TCik)

- 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



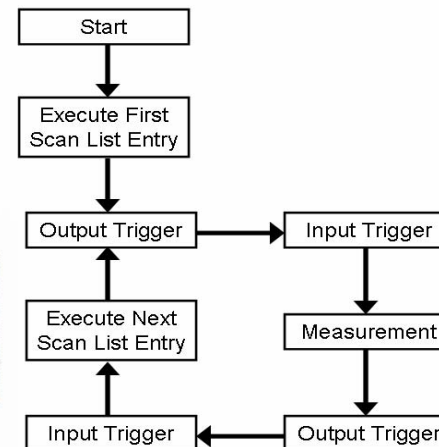
Channel Expansion with Switching

- **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

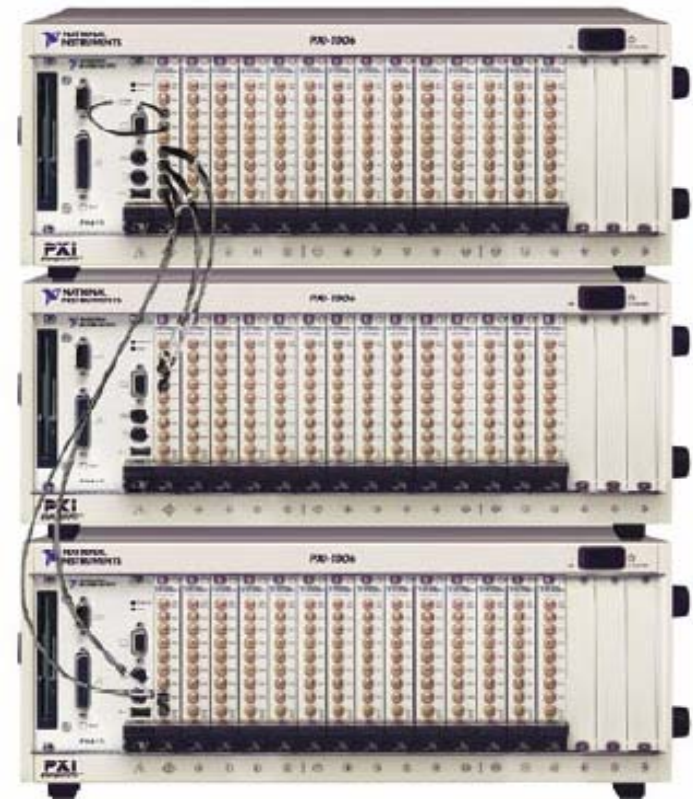
Execution Time Comparison for 1000 Switched DMM Scans

	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





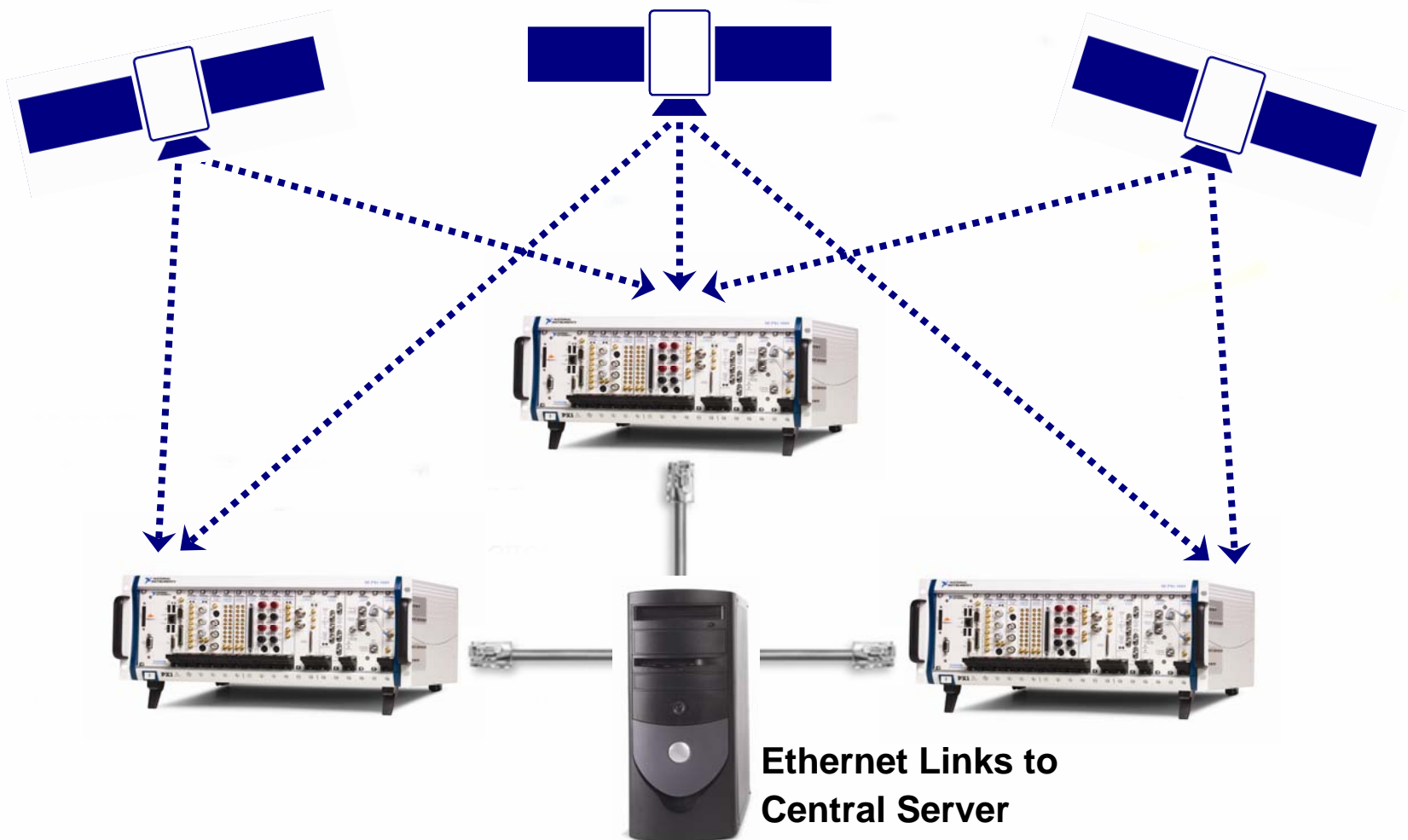
GPS Timing and Synchronization

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

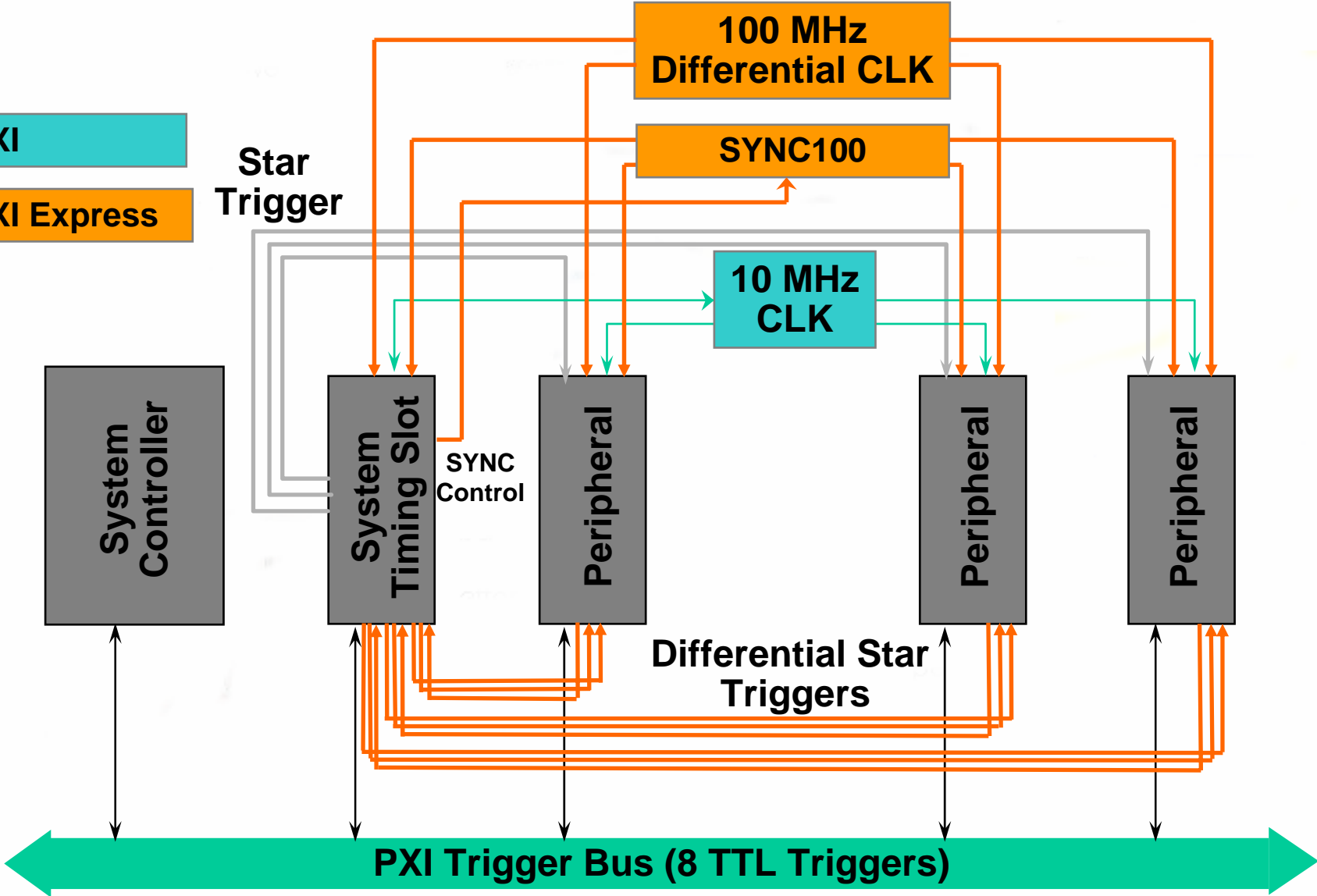
Example System Synchronized with GPS



PXI *Express*

Timing & Synchronization

PXI
PXI Express





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**