

COMMERCIAL-OFF-THE-SHELF TECHNOLOGIES FOR PICOSECOND TIMING AND SYNCHRONIZATION

T. Debele, M. Ravindran, National Instruments, Austin, TX 78759, U.S.A.

D. Monnier-Bourdin, Greenfield Technology, Massy, France

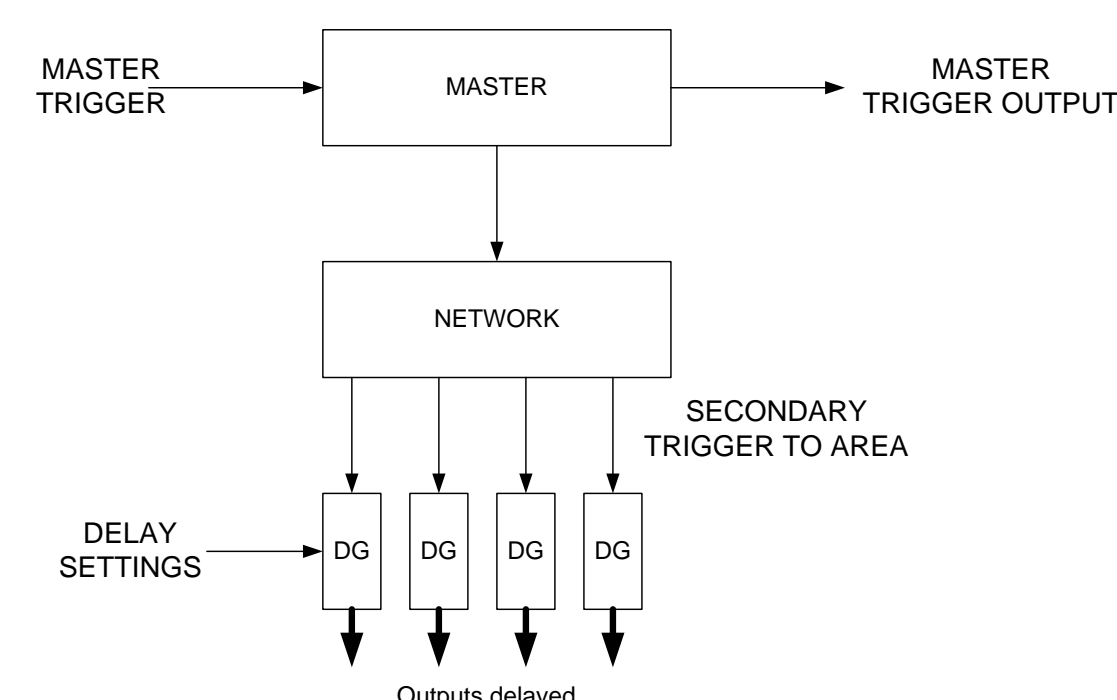
Abstract

Accurate timing is a key aspect of large physics experiments. More and more, Commercial-Off-The-Shelf (COTS) technologies are used to provide synchronization down to a few picoseconds. This approach allows a wide selection of equipment, offers a high level of flexibility, and guarantees a smooth evolution as new technologies become available. For example, Greenfield Technology proposes a picosecond timing system that provides several hundred triggers to equipments distributed over an area of thousands of square meters within a resolution of 1 ps and low jitter < 15 ps. This system is built around a central oscillator transmitter which delivers a serial data stream over an optical network to manage delay generator triggering and time base. By combining this distributed timing system with the clock and triggering synchronization features of the PXI backplane, high speed instruments, such as digitizers, can also be synchronized with picoseconds accuracy to guarantee the best measurement quality.

Distributed Timing Systems

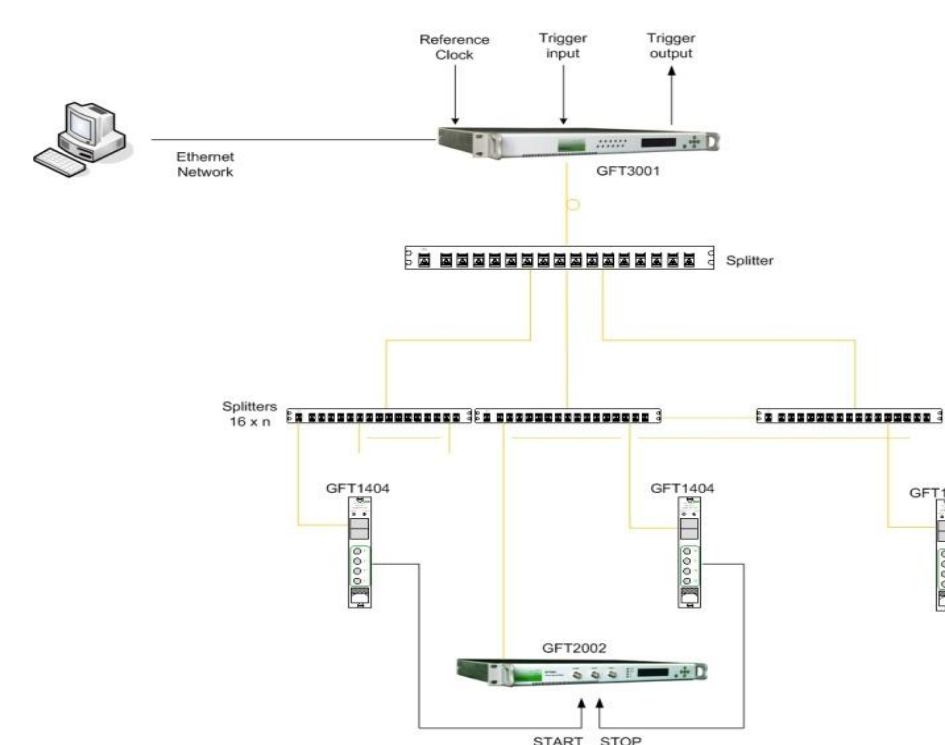
Typical architecture

- Master source
- Network
- Delay generators



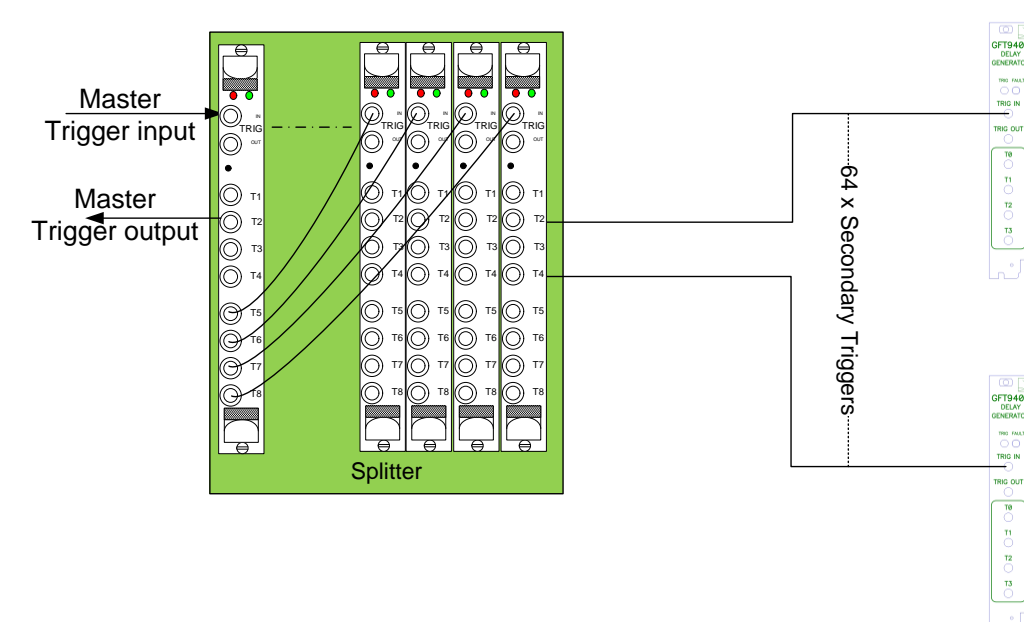
1. Optical network

- Synchrotron
 - Up to 255 delayed triggers
 - Single shot or repetitive
 - Multiple sequences possible
- Laser
 - Up to 3 repetition rates



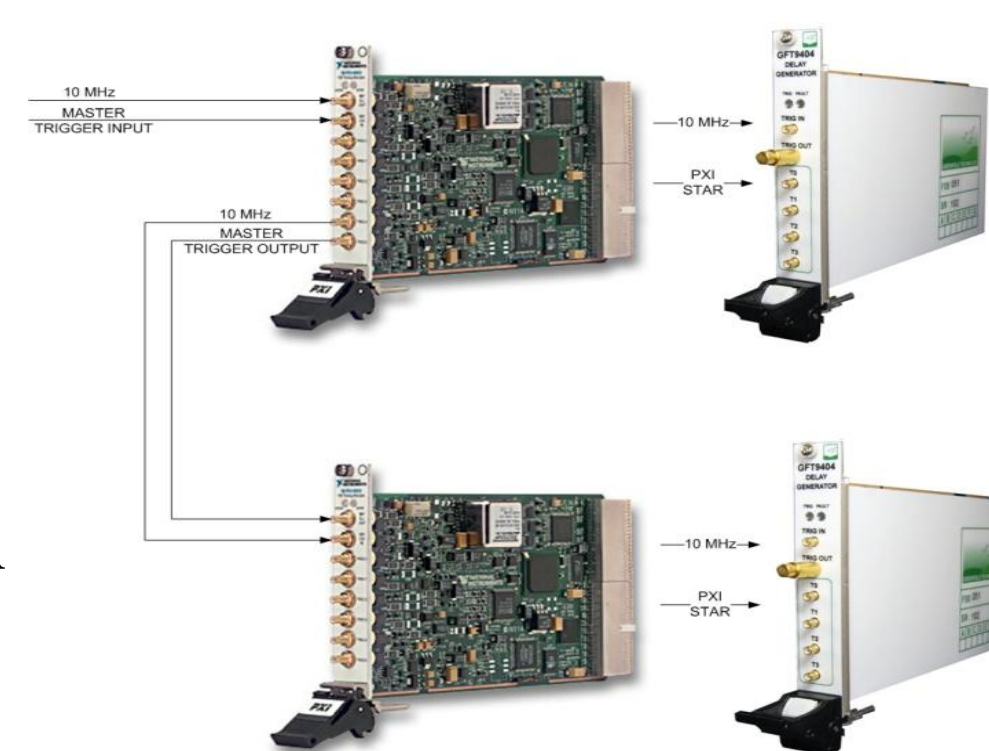
2. Electrical network

- Trigger distribution via splitters
- Up to 1024 triggers by daisy chaining



3. Electrical network with distributed clock

- Shared 10 MHz clock
- Complete PXI integration



Measured performance

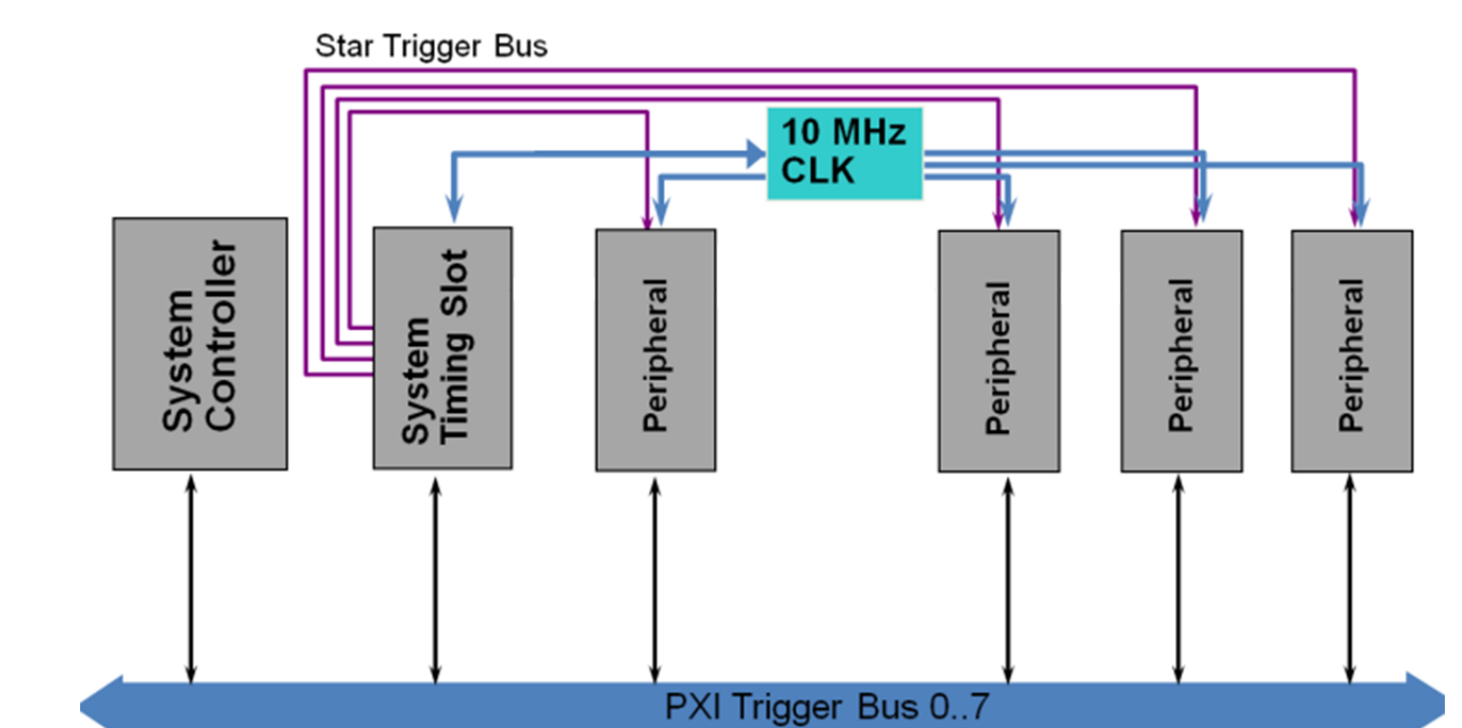
	Optical	Electrical	Electrical + Clock
Length (max)	1 000 m	10 m	50 m
Delay channels	256 x 4	64 x 4	64 x 8
Trigger source	External or internal	External	External or internal
Trigger mode	One shot, sequence, or repetitive frequency	One shot trigger	One shot trigger
Clock frequency	100 to 200 MHz	N/A	10 MHz
Jitter - Master trigger input to output delay	One clock period	< 50 ps rms ⁽¹⁾	< 100 ps rms ⁽¹⁾
Jitter - Master trigger output to output delay	< 30 ps rms ⁽¹⁾	< 50 ps rms ⁽¹⁾	< 50 ps rms ⁽¹⁾
EMI immunity	Better	Good	Good
Form factor	Rack, cPCI, PXI	Rack, cPCI, PXI	Rack, cPCI, PXI
Application	Synchrotron High power laser	Laboratory	Laboratory Ion beams

⁽¹⁾ for short delays

PXI Timing And Synchronization

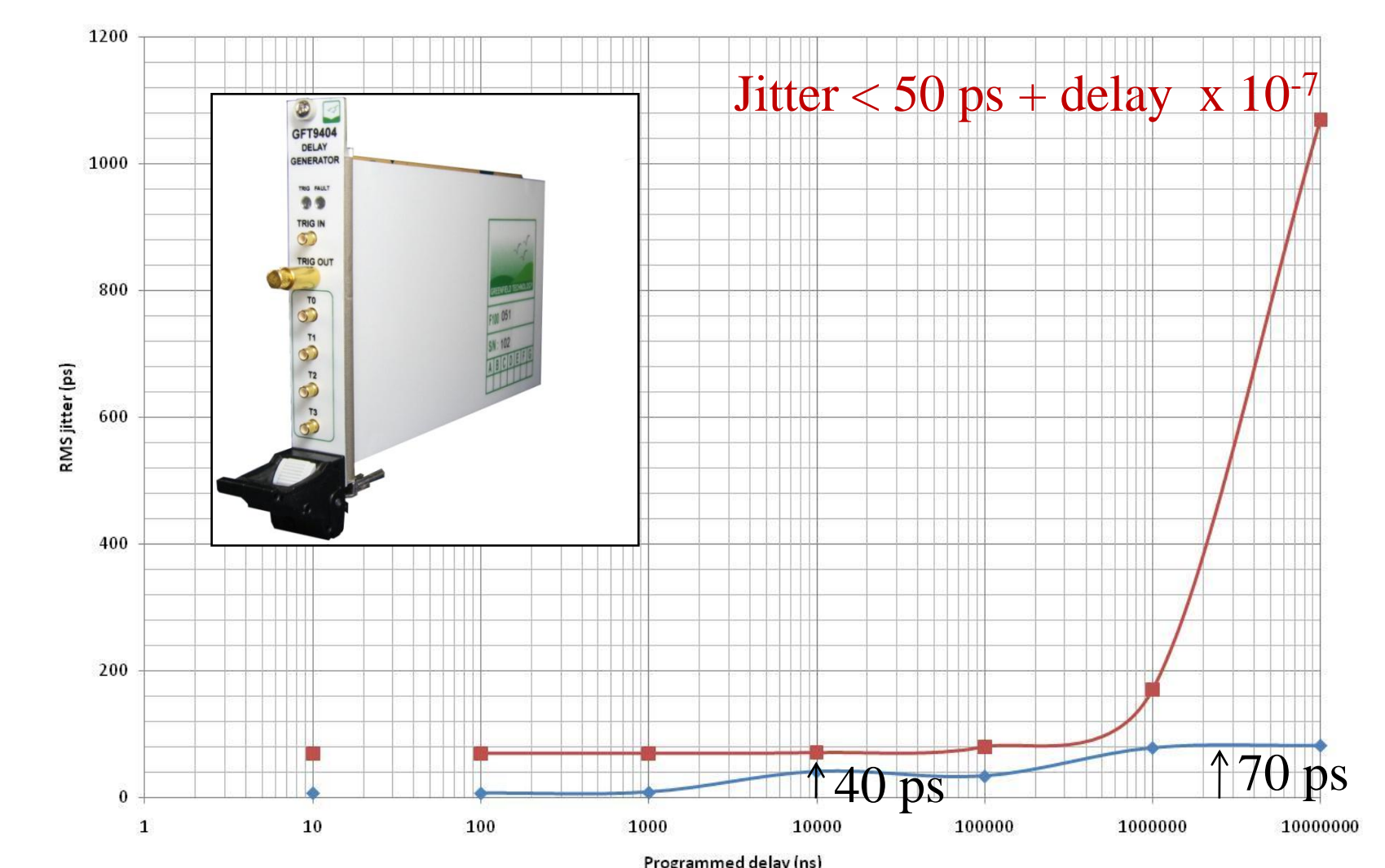
Key features

- CLK10 – 10 MHz clock to each slot
- STAR – point-to-point, matched skew (< 1 ns)
- TRIG – 8-line parallel trigger bus



NEW PXI delay generator

- 4 high precision delays
 - Resolution of 1 ps
 - Jitter < 50 ps rms
 - Variable pulse amplitude and width
- 4 auxiliary delays
 - Available on PXI TRIG or front panel
 - Resolution of 5 ns
 - Jitter < 100 ps rms



Trigger Clock (TClk) synchronization

- Reduces trigger skew and jitter between high speed devices (sample clock >= 100 MHz)
- TClk runs slow so that triggers have time to propagate between devices
- TClk generated from dividing the device's sample clock
- Easy to use, high level programming
- Out of the box: skew < 500 ps
- With manual calibration: skew < 30 ps

