

Understanding Configuration and Performance of LXI Devices

Steve Schink & Conrad Proft
LXI IT Working Group Co-Chairs

May 21, 2014

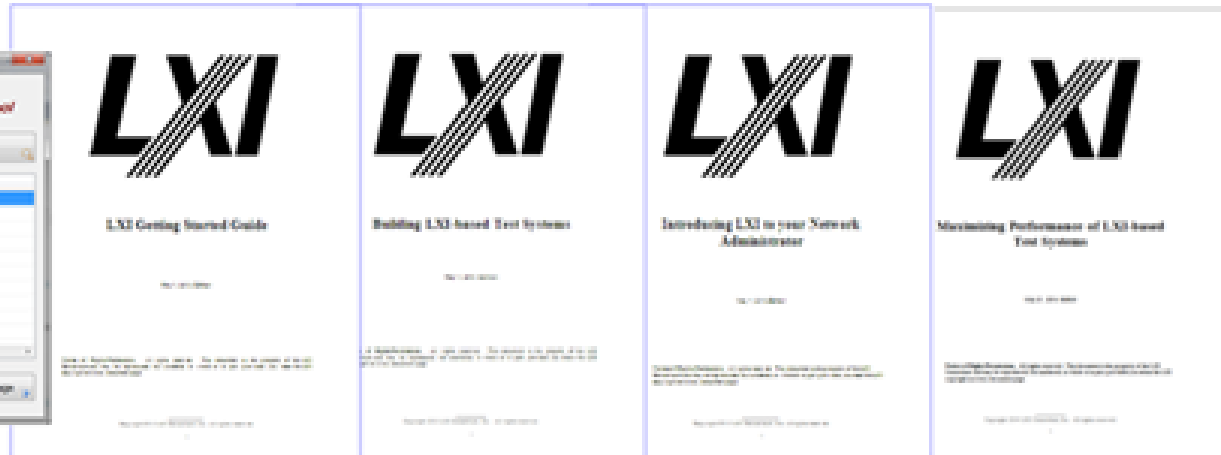
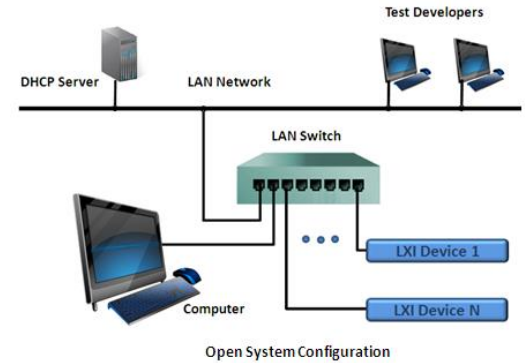


It's about YOUR time.

www.lxistandard.org

Overview

- Introduction
- LXI Tools and Documents
- Boosting performance with LXI Devices
- Wrap-up



Introduction

LXI - LAN eXtensions for Instrumentation



- LXI brings consistency to LAN equipped instruments
- LXI devices have predictable behavior on LAN
- LXI devices provide an IVI driver
- LXI devices are built upon the LAN infrastructure
- LXI can replace GPIB with VXI-11/HiSLIP, GPIB Emulation
- LXI devices provide Web Servers

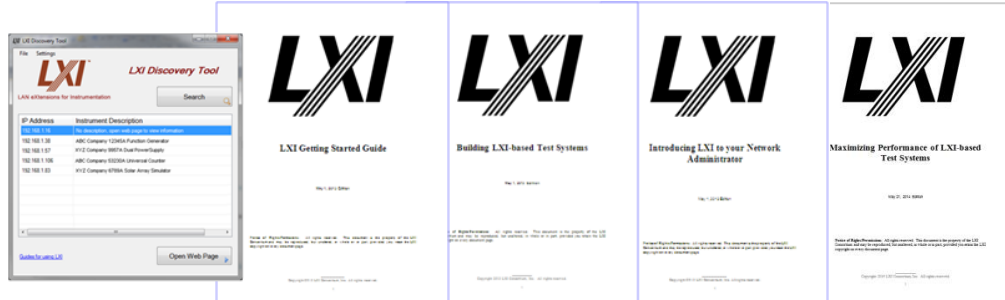
- Better system performance with overlap operation

Challenges to Users



- Users do not have a good understanding of LAN
- Users do not understand LAN behavior of LXI Devices
- Users need to determine the optimal LAN configuration for their LXI-based test system requirements
- Network administrators closely safeguard the security and performance of the company LAN
 - Users should work closer with IT department
 - Network administrators not familiar with LXI devices
- Users do not understand how to use overlap operations

LXI IT Working Group to the Rescue



- *LXI Discovery Tool*
- LXI Getting Started Guide
- Building LXI-based Test Systems
- Introducing LXI to your Network Administrator
- Maximizing Performance of LXI-based Test Systems

<http://lxistandard.org/Resources/GuidesForUsingLXI.aspx>

Guides for Using LXI...on the Web



The screenshot shows the LXI website header with the logo and navigation menu. The main content area features the title 'Guides for Using LXI' and a list of guides. The LXI logo is in the top left, and the navigation menu includes 'Home', 'About LXI', 'LXI Consortium', 'Products', 'Specifications', 'Resources', 'Events/Meetings', and 'News'. The 'Resources' menu item is highlighted. The main content area has a light beige background with a dark border. The title 'Guides for Using LXI' is in a large, bold, black font. Below the title is a paragraph of text and a bulleted list of guides. The list items are in a smaller, bold, black font with red underlines. The text is in a standard black font.

LXI
LAN eXtensions for Instrumentation

Login Site Map Contact Us

Home About LXI LXI Consortium Products Specifications Resources Events/Meetings News

Guides for Using LXI

These guides were written to aid the test system designer in building an LXI test system quickly and easily. They share best practices in key areas of interest connecting LXI Devices to LAN.

- **[LXI Getting Started Guide](#)**
(Released Aug. 3, 2013)
- **[Building LXI-Based Test Systems](#)**
(Released Aug. 3, 2013)
- **[Introducing LXI to Your Network Administrator](#)**
(Released Aug. 3, 2013)
- **[Maximizing Performance of LXI-Based Test System](#)**
(Released May 10, 2014)

Additional reference aids for the documents above:

- **[LXI Networking Basics](#)**
(Released Aug. 3, 2013)
- **[Glossary of Networking Terms](#)**
(Released Aug. 3, 2013)

<http://lxistandard.org/Resources/GuidesForUsingLXI.aspx>

LXI Discovery Tool



- Understands discovery methods for LXI devices
- Discovers LXI devices on computer subnet



| IP Address | Instrument Description |
|---------------|---|
| 192.168.1.16 | No description, open web page to view information |
| 192.168.1.38 | ABC Company 12345A Function Generator |
| 192.168.1.57 | XYZ Company 9957A Dual PowerSupply |
| 192.168.1.106 | ABC Company 53230A Universal Counter |
| 192.168.1.83 | XYZ Company 6789A Solar Array Simulator |

VXI-11 Protocol - LXI Standard 1.0 and above
XML Identification Document - LXI Standard 1.2 and above
mDNS (Multicast Domain Name System) – LXI Standard 1.3 and above

LXI Getting Started Guide

- For the first-time LXI device user
- Explains LXI device behavior
- Explains basic networking principles
- Comprehensive troubleshooting
- Establishes test system foundation

Get Ready

Connect

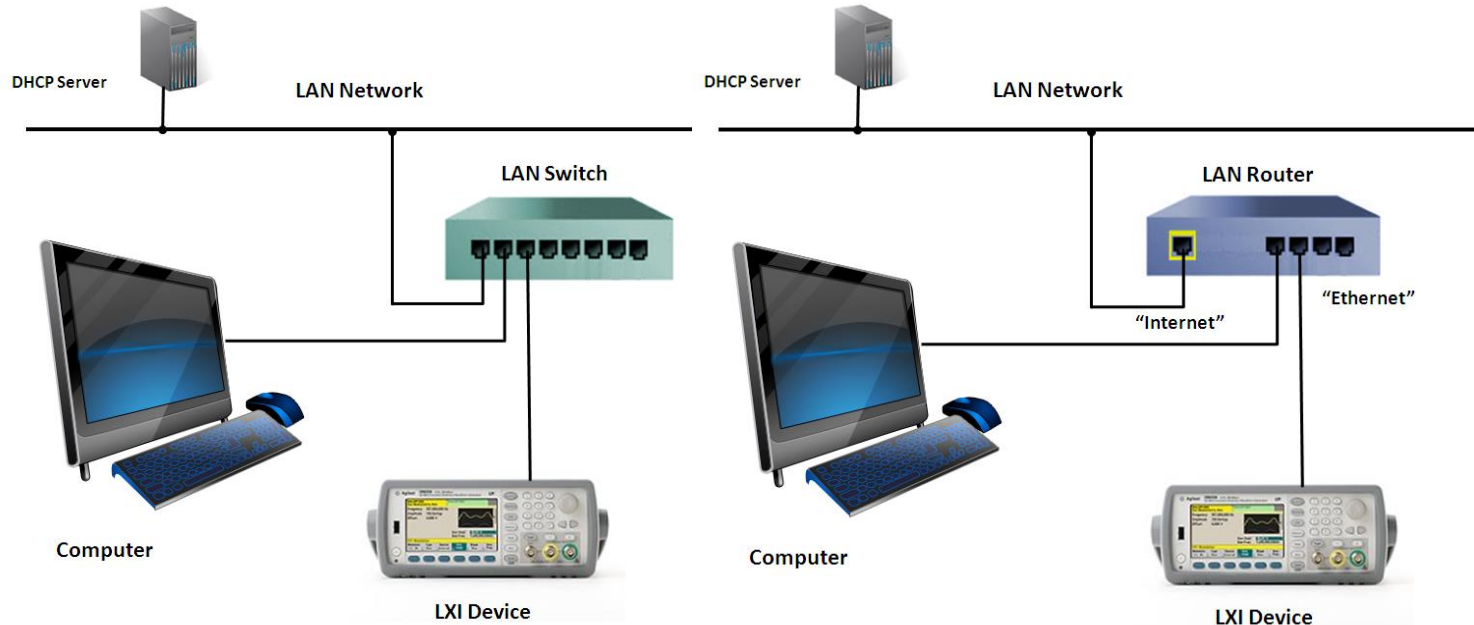
Discover

View & Identify

Connect to LAN

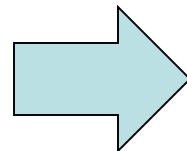
Next Steps

Finding LXI Devices, Connecting, Viewing

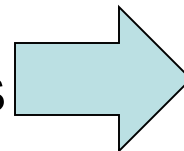


Open System Configuration

Isolated System Configuration Using Router



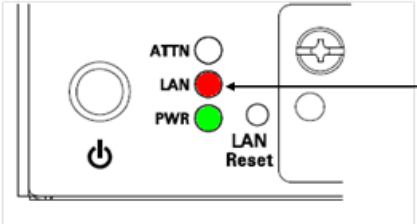
IP Address



Web Page

Troubleshooting tips...

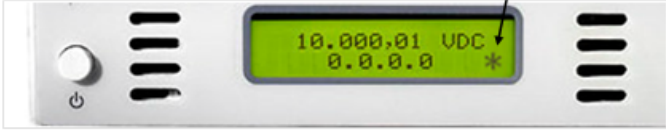
| | | |
|----------------------|--------------------------|--------------------------|
| IP Address: 0.0.0.0 | LAN Status: Fault | Front Panel with Display |
| Subnet Mask: 0.0.0.0 | Gateway: 0.0.0.0 | |



ATTN ○
LAN ● (red)
PWR ● (green)
LAN Reset ○

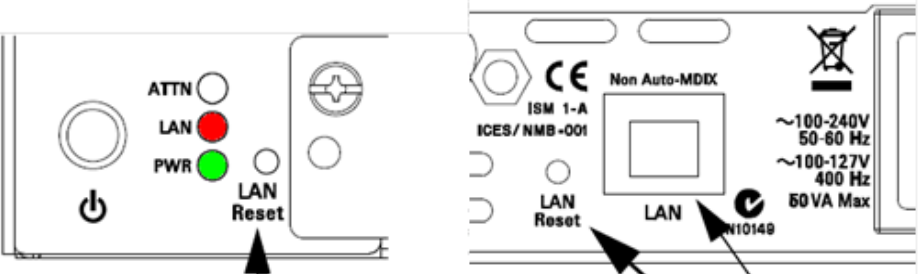
LAN Status Fault

Front Panel No Display



10.000.01 UDC
0.0.0.0 *

Front Panel Limited Display



ATTN ○
LAN ● (red)
PWR ● (green)
LAN Reset ○

LAN Reset

ISM 1-A
ICES/NMB-001

Non Auto-MDIX

LAN

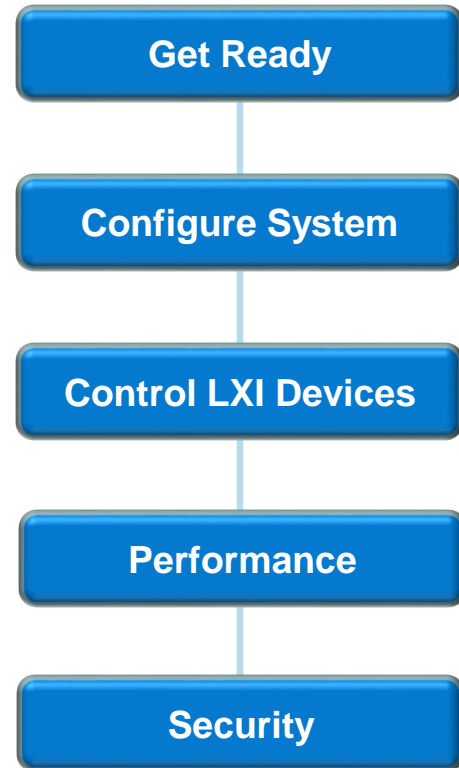
LAN Reset

LAN Port

~100-240V
50-60 Hz
~100-127V
400 Hz
50VA Max

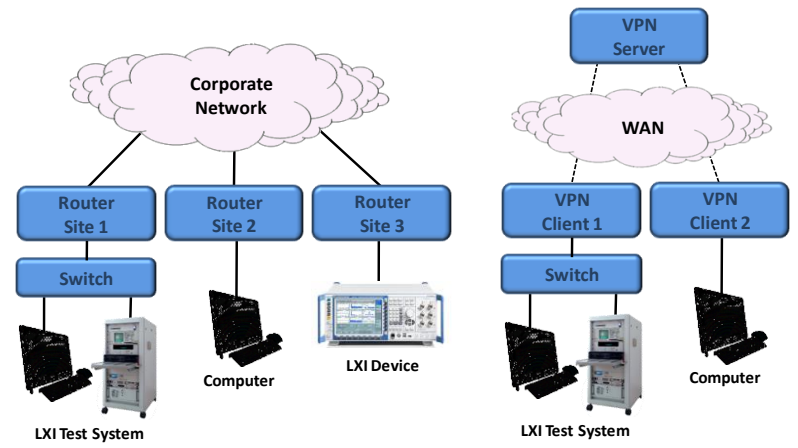
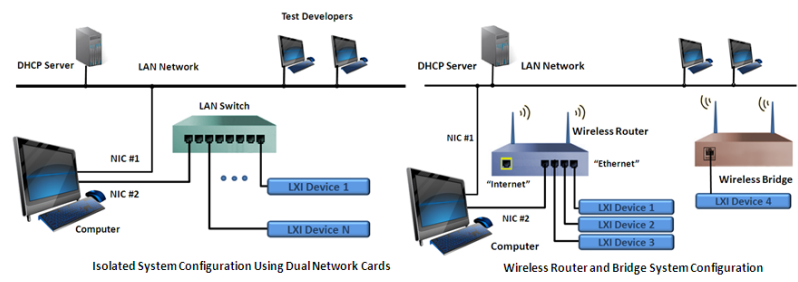
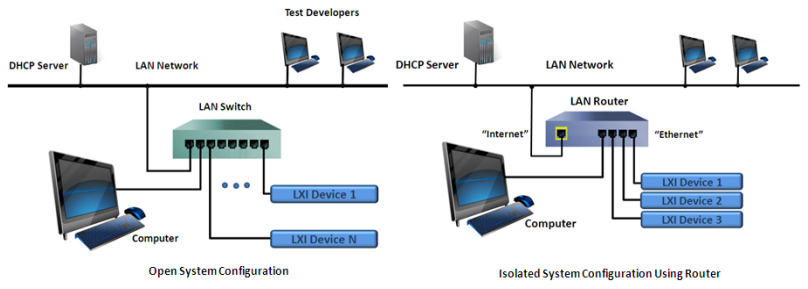
Building LXI-based Test Systems

- Next steps in learning
- LXI recommended configurations
- Benefits and cautions
- Insights into routers and dual NICs
- Troubleshooting



Test System Configurations

– Open vs. Isolated vs. Remote

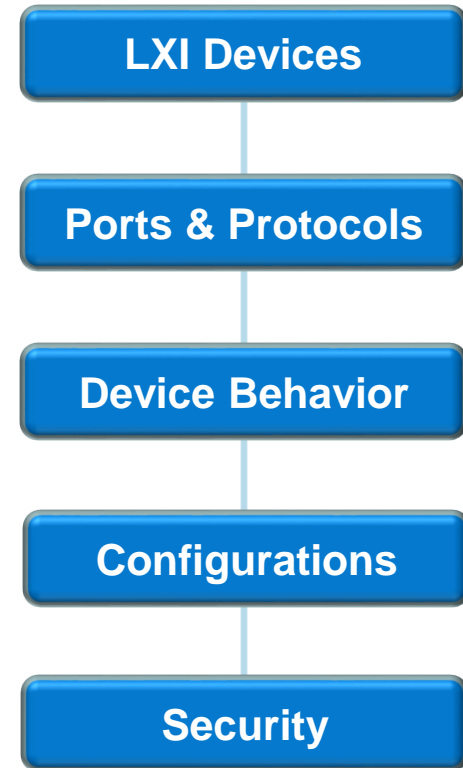


Methods for Remote Access of LXI Devices

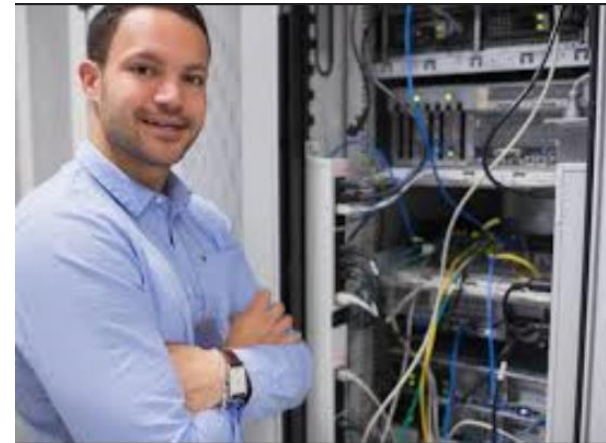
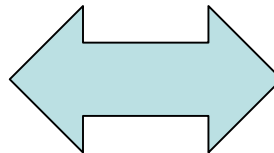
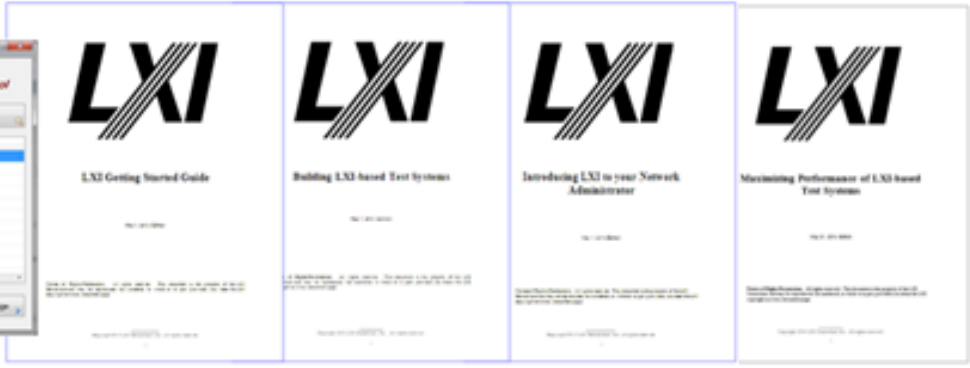
Introducing LXI to your Network Administrator

- Insights into Test Engineer needs
- Recommended Configurations
- Just the facts about LXI Devices...

| LXI Device-specific Ports, Protocols, and Services | | | |
|--|------|---------------|--|
| Protocol/Service | Port | Base Protocol | Notes |
| HiSLIP | 4880 | TCP | Optional instrument control protocol |
| VXI-11 | 111 | TCP | Builds upon Sun-RPC and port-mapper. |
| Scpi-raw | 5025 | TCP | Optional instrument control protocol |
| Scpi-telnet | 5024 | TCP | Optional instrument control protocol over Telnet |
| LXI-eventsvc | 5044 | UDP/ TCP | Optional LXI Event support for instrument triggering; multicast 224.0.23.159, FF02::138 |
| Ptp-event | 319 | UDP/ TCP | Optional LXI Profile IEEE 1588 Precision Time Protocol; multicast 224.0.1.129, FF02::181 |
| Ptp-general | 320 | UDP/ TCP | Optional LXI Profile IEEE 1588 Precision Time Protocol; multicast 224.0.1.129, FF02::181 |

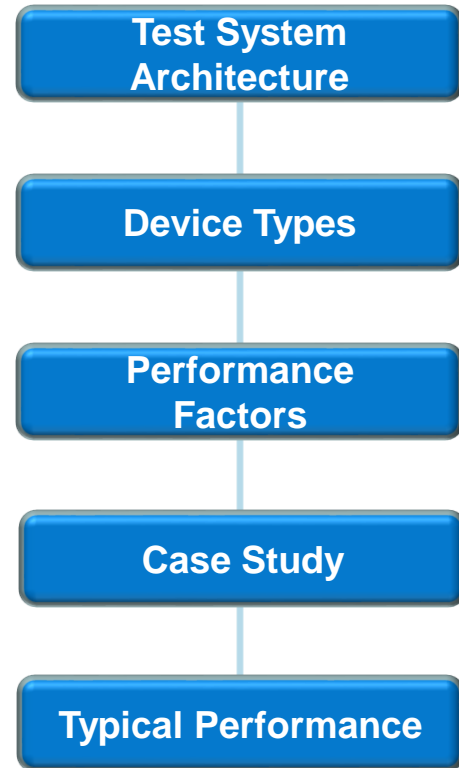


Learn, Cooperate, and Build



Maximizing Performance of LXI-Based Test Systems

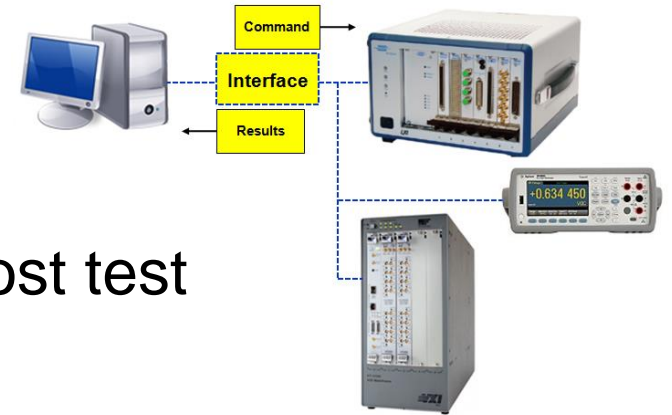
- Key Insights when using LXI
- Best Practices
- Measurement physics effects
- Understanding overlap operations



Performance of LXI

Key Assertions

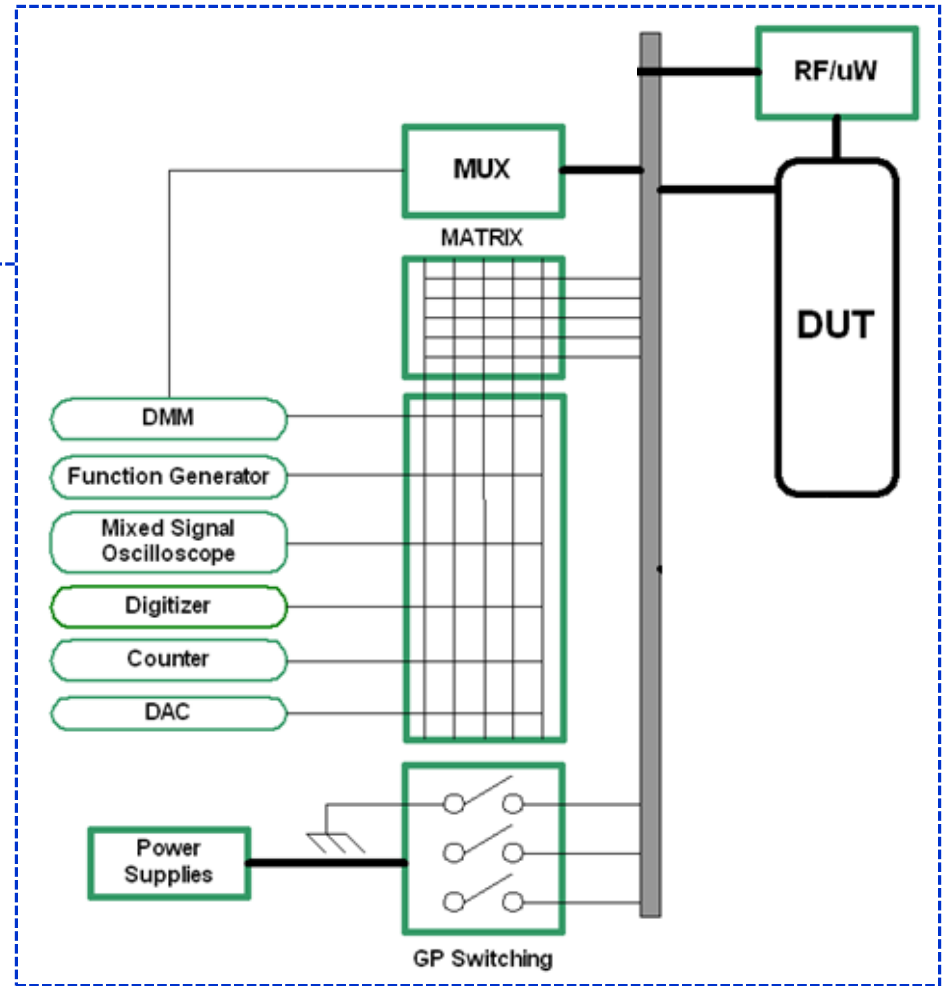
- I/O latency has little impact in most test systems
- Overlap operation can greatly improve performance
- Test system best practices greatly affect performance
- LXI provides additional performance benefits



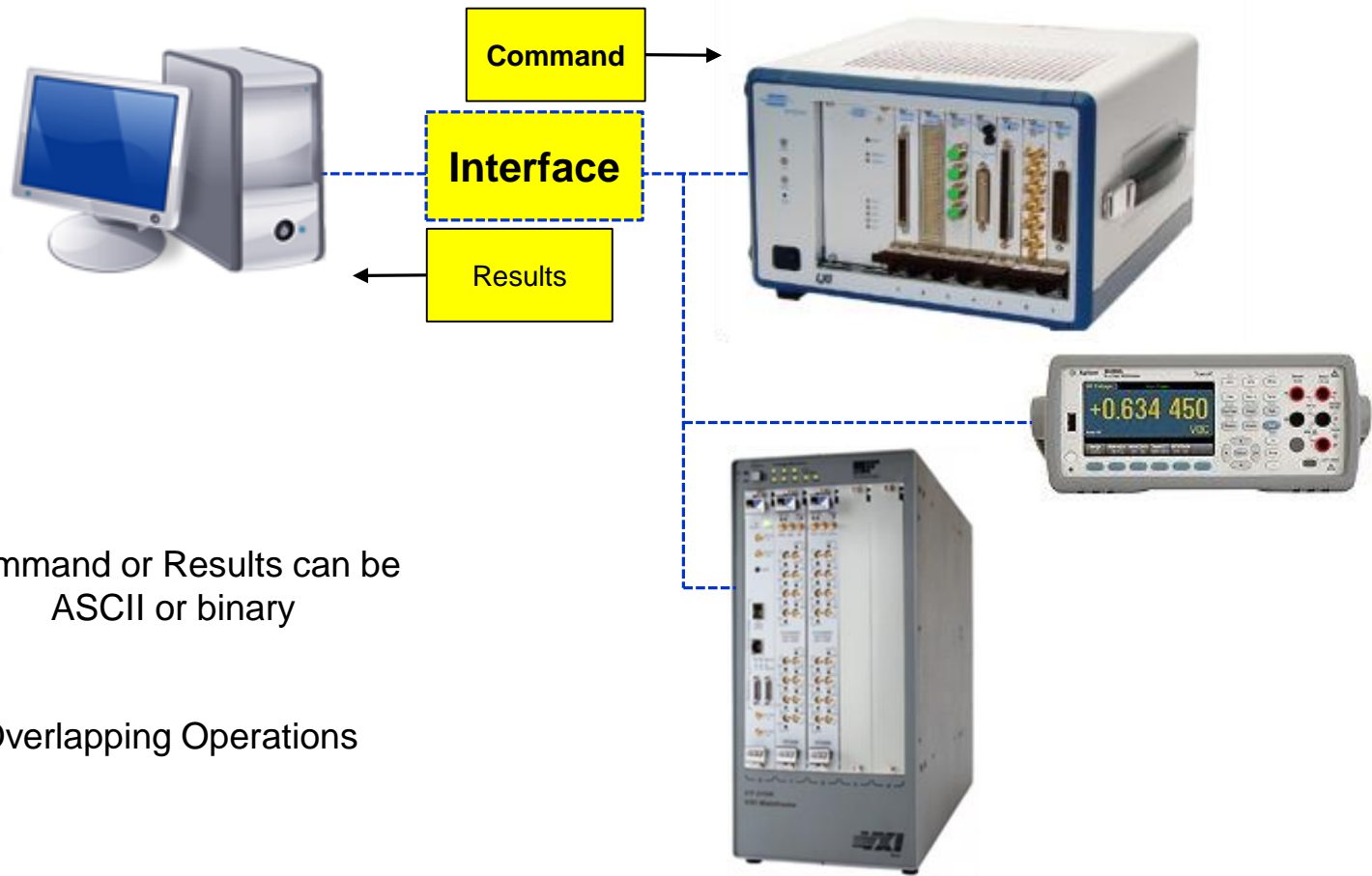
Test System Architecture



Interface



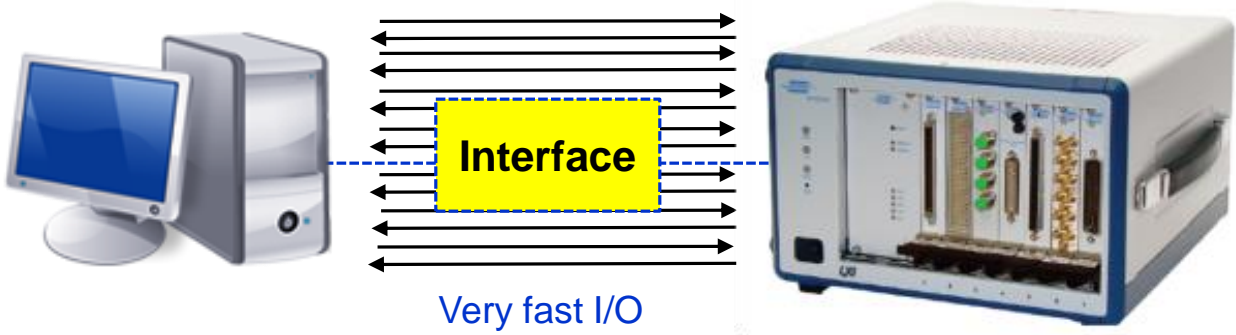
Smart and Simple Devices Distributed Intelligence



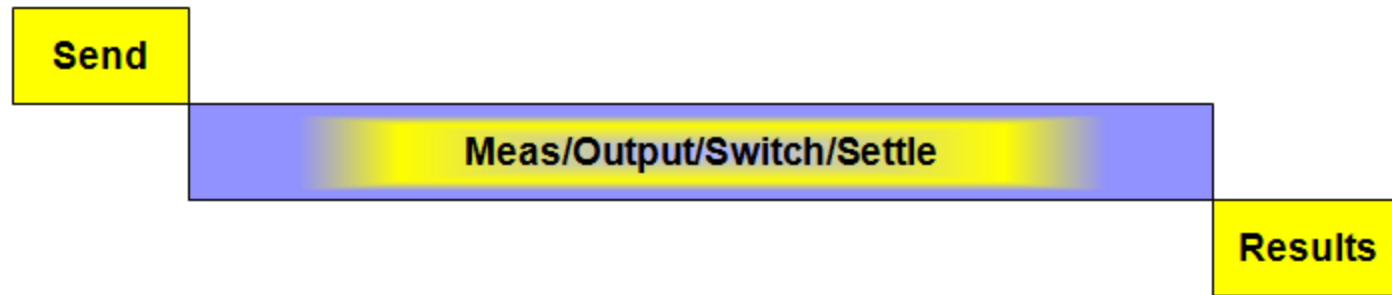
Command or Results can be
ASCII or binary

Overlapping Operations

Smart and Simple Devices Computer Controlled



Key Performance Factors Transaction Model



Send :

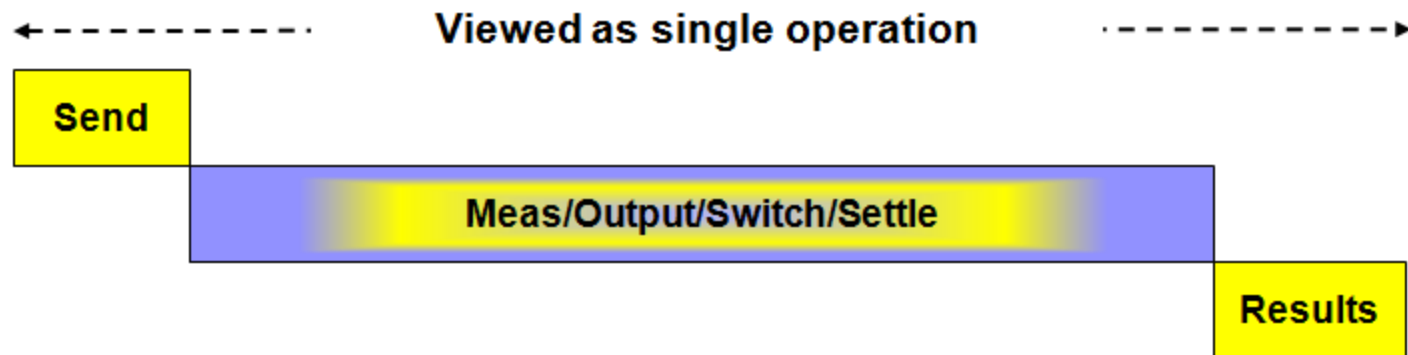
- Time to send command or driver call
- Time to Parse or Interpret what to do
- Time until hardware starts changing

Results:

- Time to initiate transfer from memory
- Time until all results in computer

Key Performance Factors

Serialized Operations



- Computer waits for operation complete result

Example 1: "ROUT:CLOSE (@1001);:ROUT:CLOSE? (@1001)"

Example 2: "VOLT:AC:RANGE 10";*OPC?"

Example 3: **IVI Driver call does not return until operation complete**

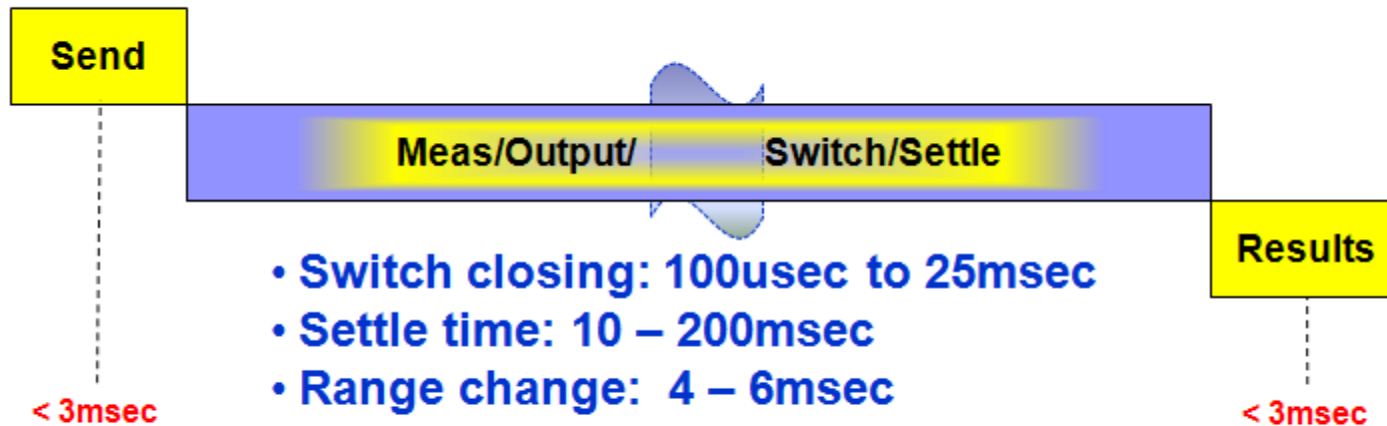
Key Performance Factors Measurement Physics



I/O Overhead

Physical Factors

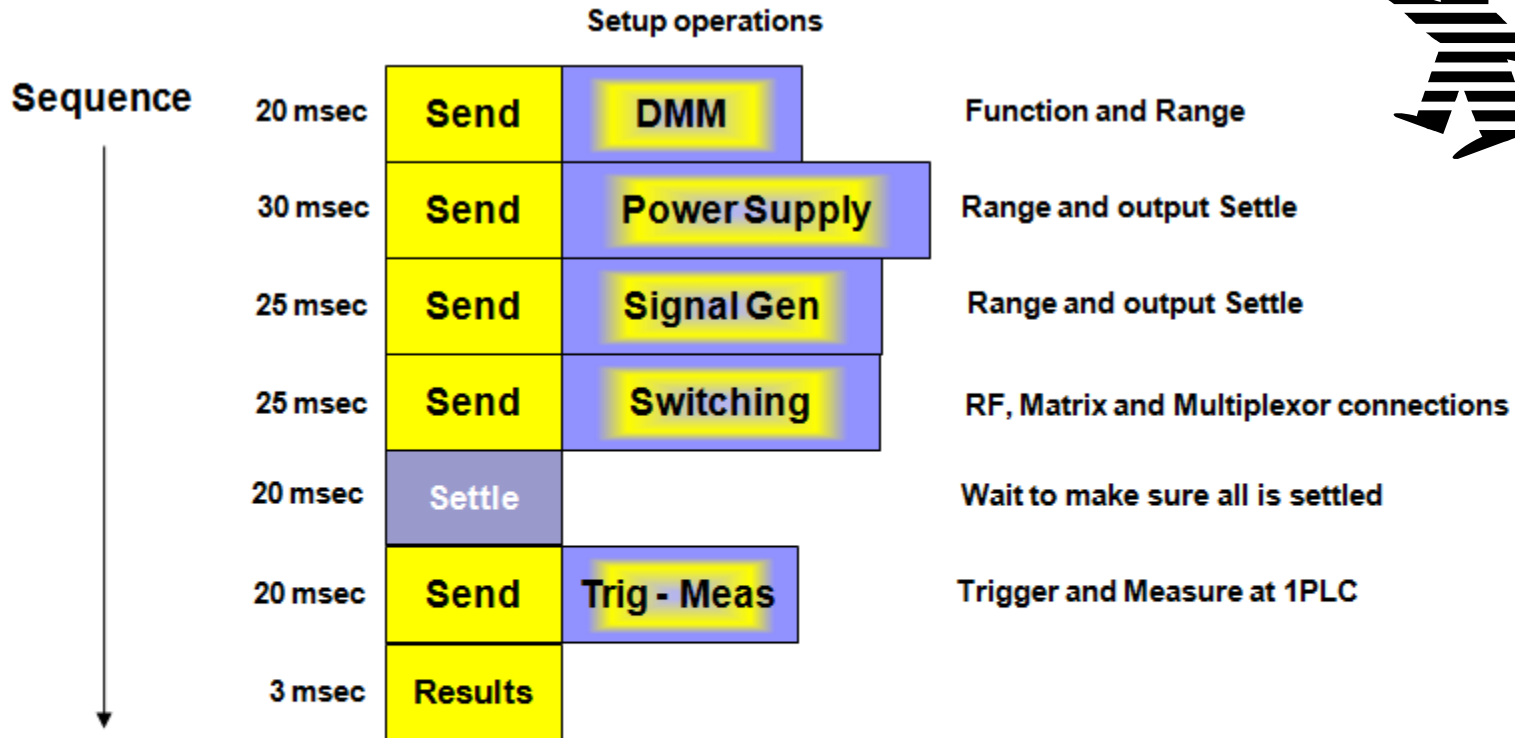
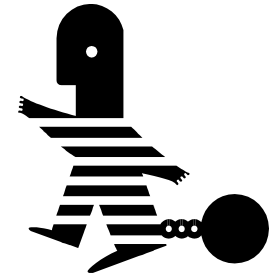
I/O Overhead



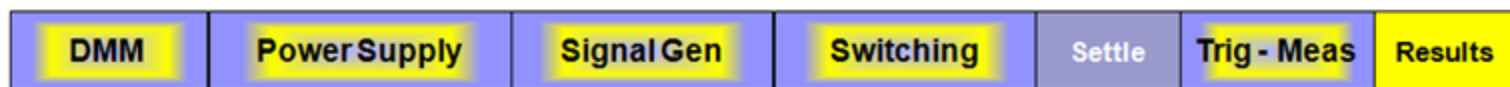
- Switch closing: 100usec to 25msec
- Settle time: 10 – 200msec
- Range change: 4 – 6msec
- Function change: 10 – 40msec
- Sweep time: 50msec to seconds
- DMM aperture: 16.667msec for 1PLC

Enhancing Performance Case Study

Baseline Performance



Serialized – talk, sync, talk, sync each operation



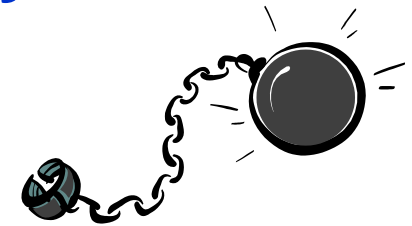
Total time: 143 msec

Enhancing Performance Case Study

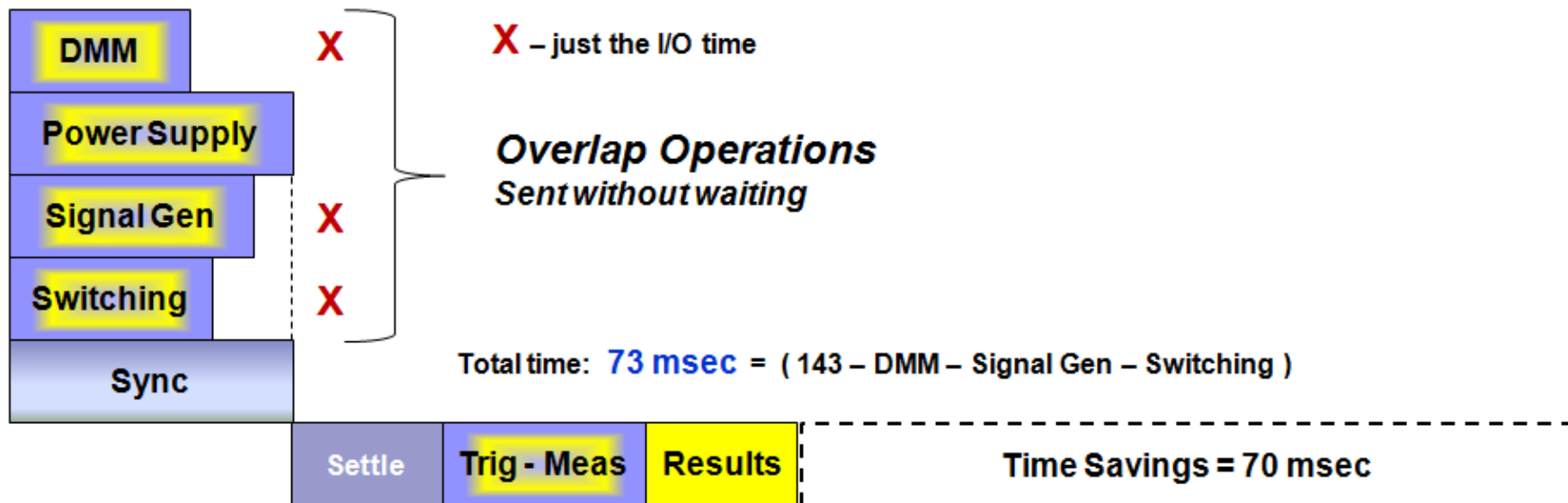
”Longest pole in the tent”



Enhancing Performance Case Study Using Distributed Intelligence



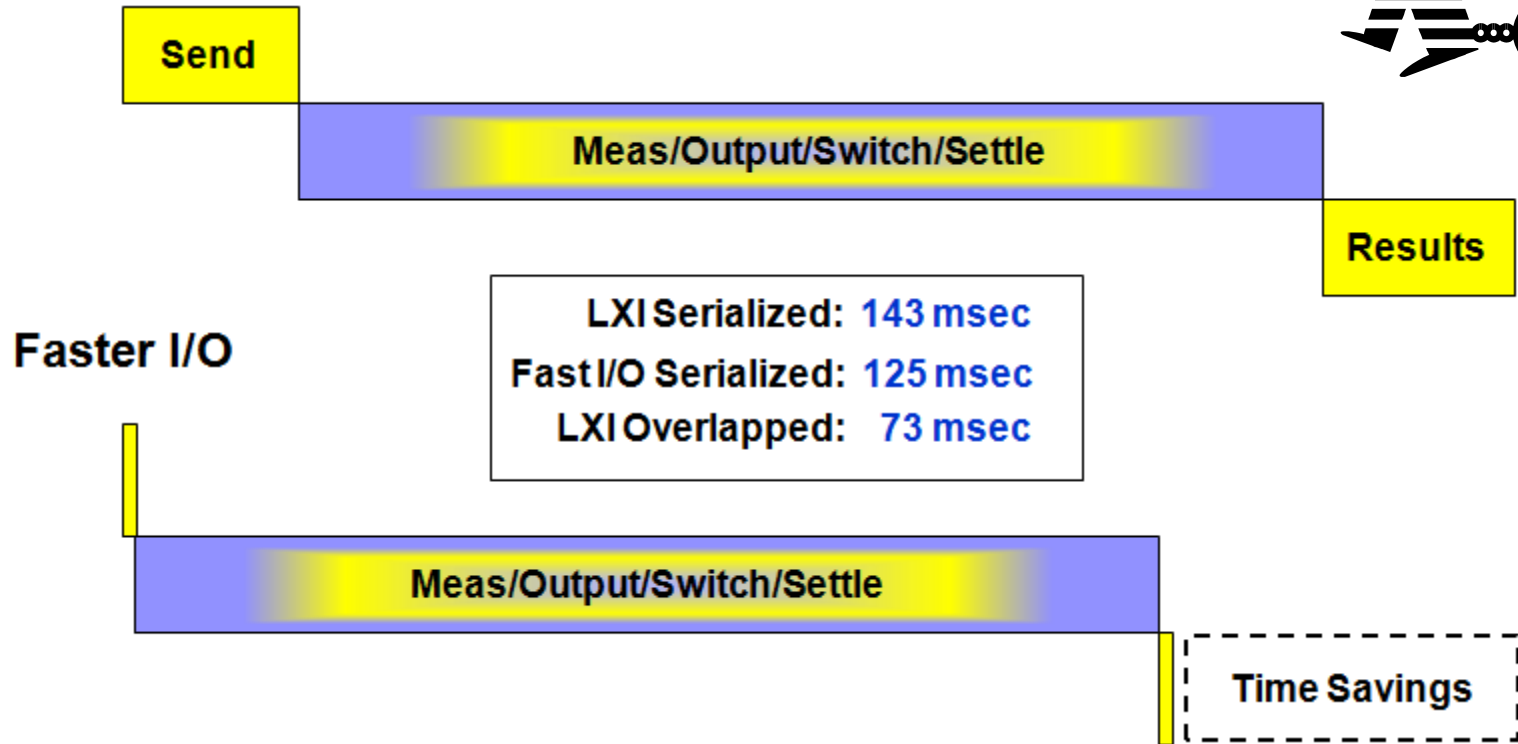
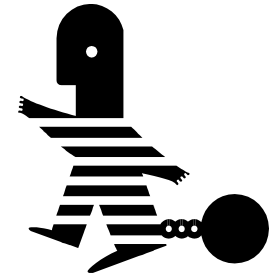
Overlapped – talk, talk, talk, then sync, sync, sync



LXI Serialized: 143 msec
LXI Overlapped: 73 msec

Enhancing Performance Case Study

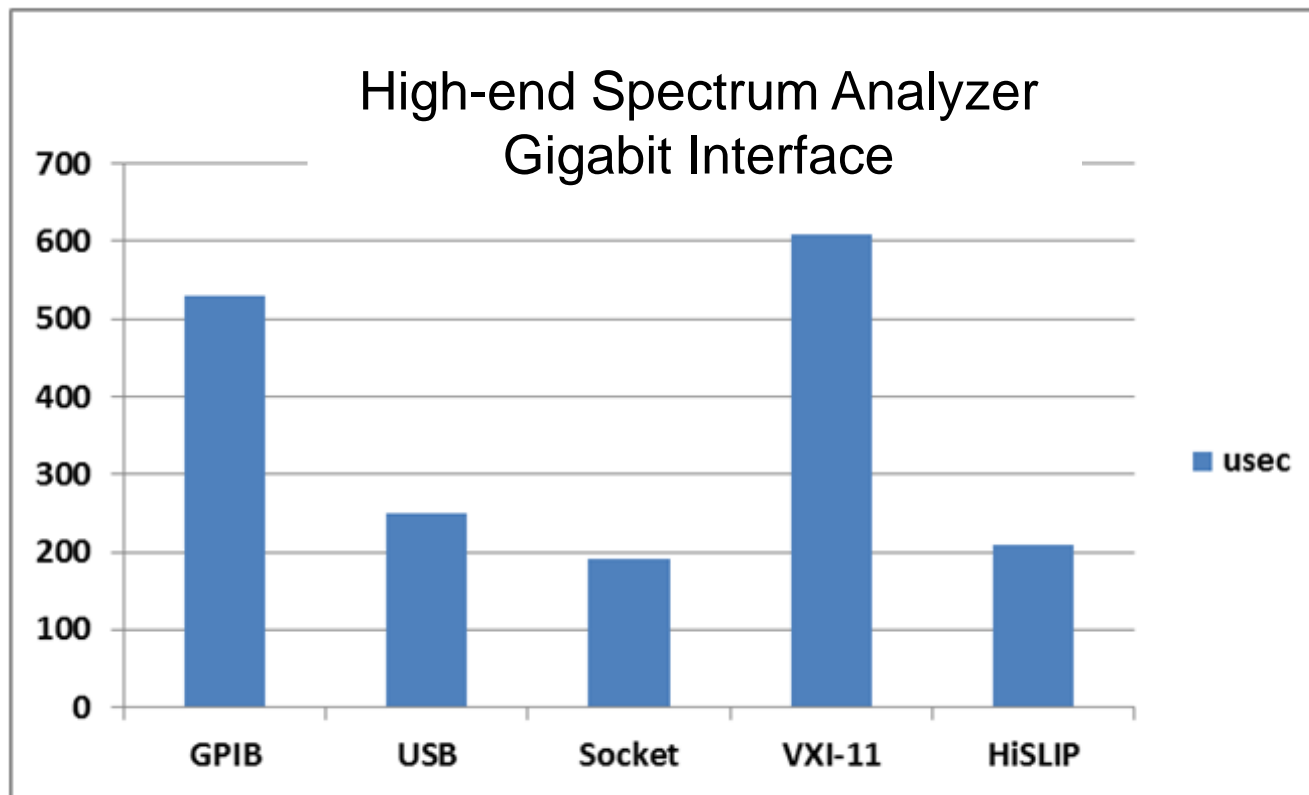
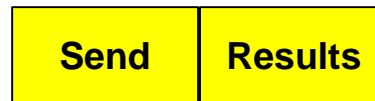
What about Faster I/O?



LXI Example Performance

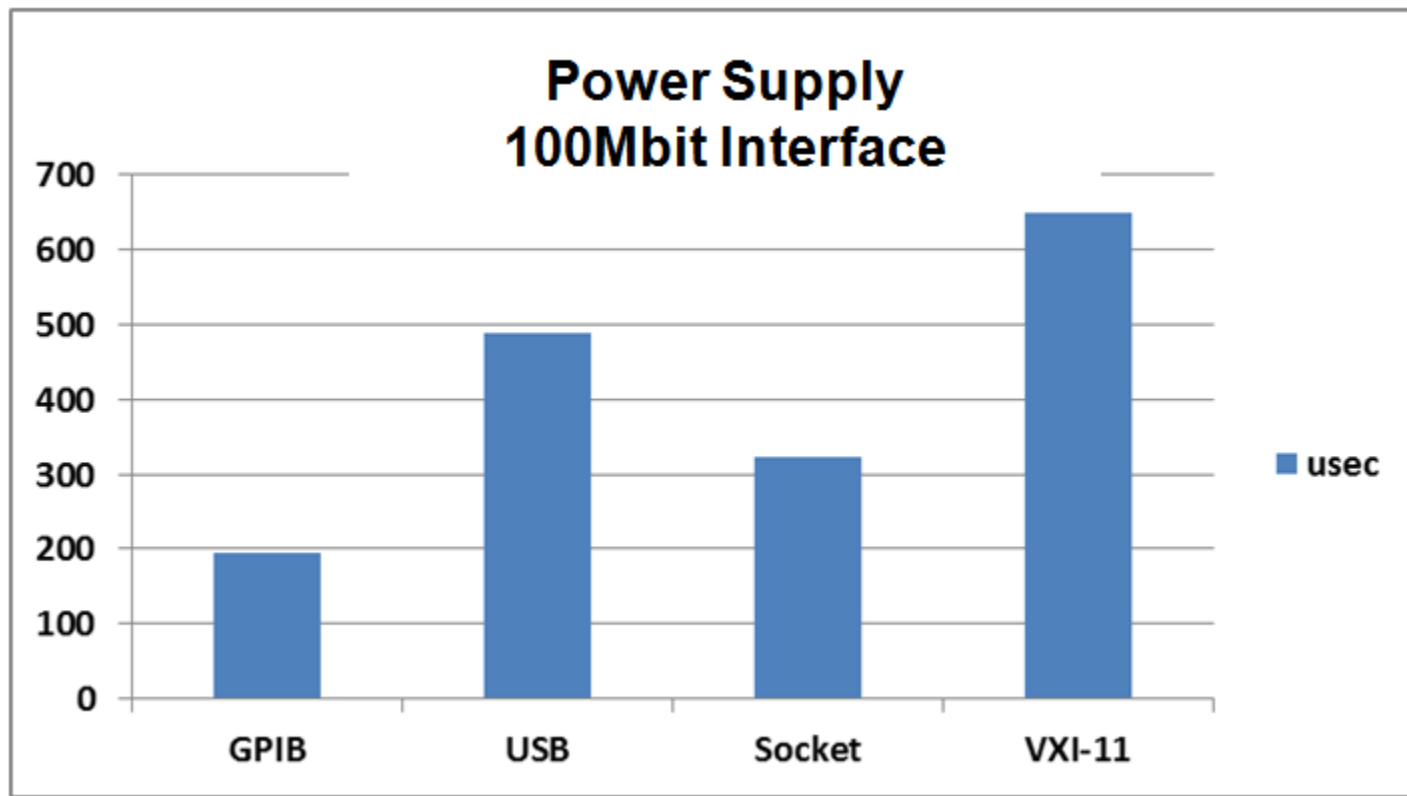
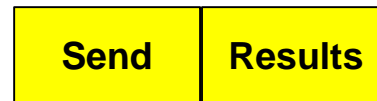
Transactional

*OPC?



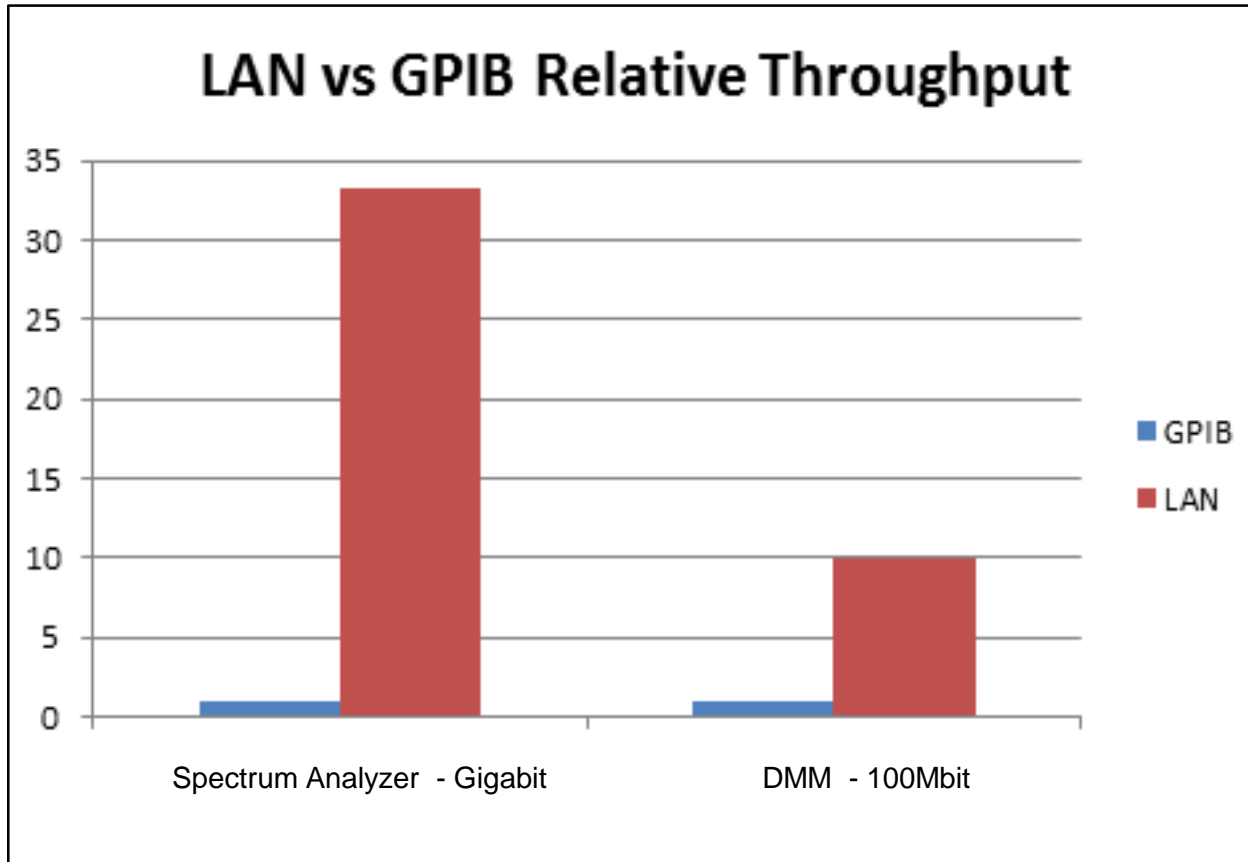
LXI Example Performance Transactional

*OPC?



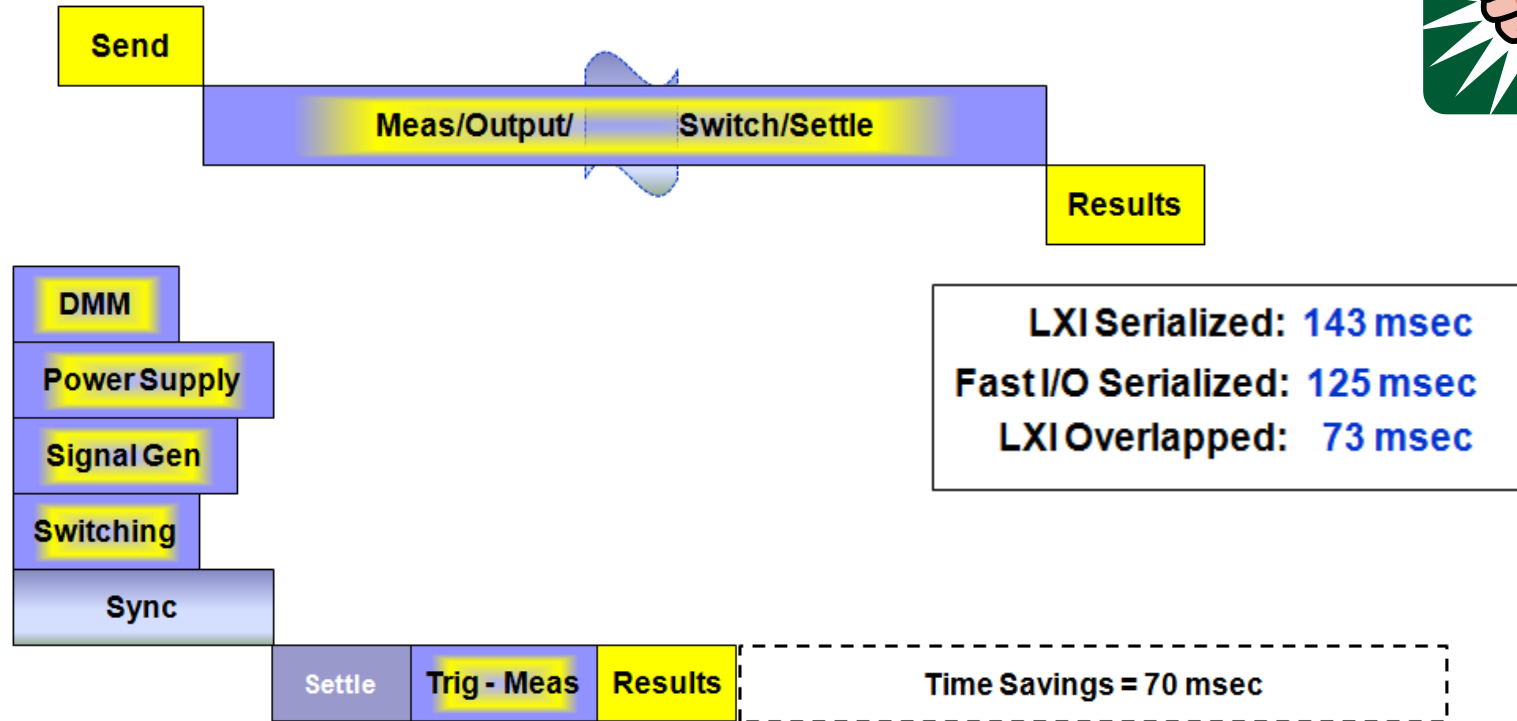
LXI Example Performance

Block Transfer



Wrap up

Key Performance Learning's



- Measurements and Physics make up a large part of the overall time
- Overlapping setup operations are more effective than faster I/O

Wrap up

LXI Tools and Documents



- *LXI Discovery Tool*
- LXI Getting Started Guide
- Building LXI-Based Test Systems
- Introducing LXI to your Network Administrator
- Maximizing Performance of LXI-Based Test Systems

<http://lxistandard.org/Resources/GuidesForUsingLXI.aspx>

Guides for Using LXI...on the Web



The screenshot shows the LXI website header with the logo and navigation menu. The main content area features the title 'Guides for Using LXI' and a list of guides. The navigation menu includes: Login, Site Map, Contact Us, Home, About LXI, LXI Consortium, Products, Specifications, Resources, Events/Meetings, and News. The LXI logo is in the top left, and the tagline 'LAN eXtensions for Instrumentation' is below it.

Guides for Using LXI

Guides for Using LXI
Resource Archive
LXI Newsletter Archive

These guides were written to aid the test system designer in building an LXI test system quickly and easily. They share best practices in key areas of interest connecting LXI Devices to LAN.

- [LXI Getting Started Guide](#)
(Released Aug. 3, 2013)
- [Building LXI-Based Test Systems](#)
(Released Aug. 3, 2013)
- [Introducing LXI to Your Network Administrator](#)
(Released Aug. 3, 2013)
- [Maximizing Performance of LXI-Based Test System](#)
(Released May 10, 2014)

Additional reference aids for the documents above:

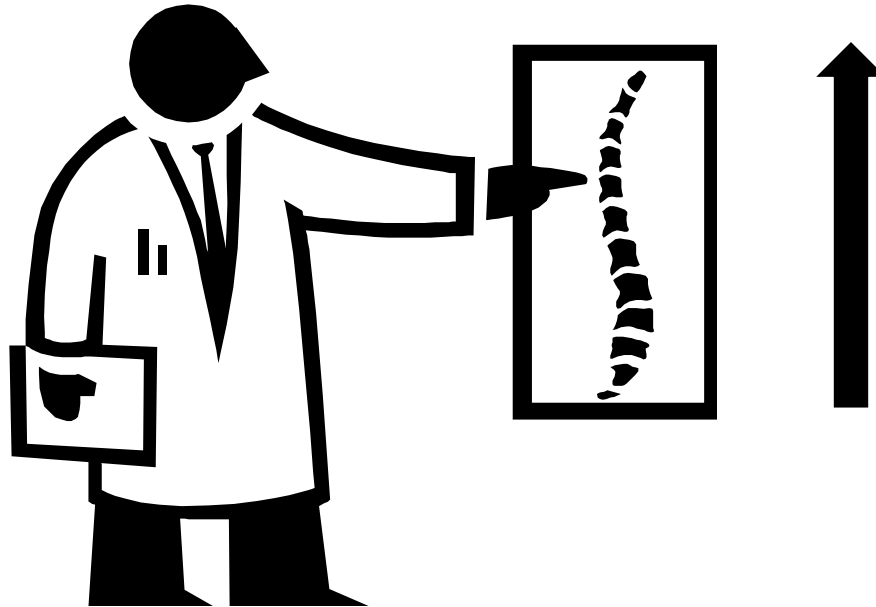
- [LXI Networking Basics](#)
(Released Aug. 3, 2013)
- [Glossary of Networking Terms](#)
(Released Aug. 3, 2013)

<http://lxistandard.org/Resources/GuidesForUsingLXI.aspx>

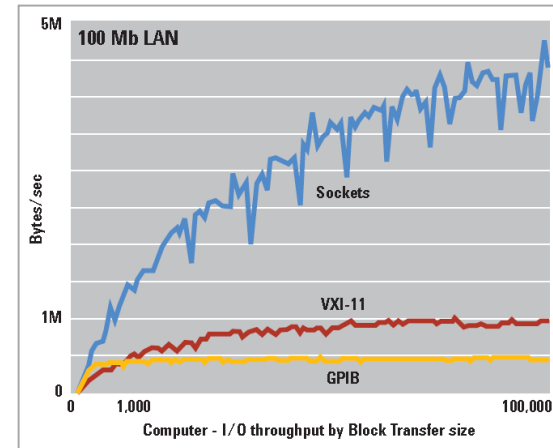
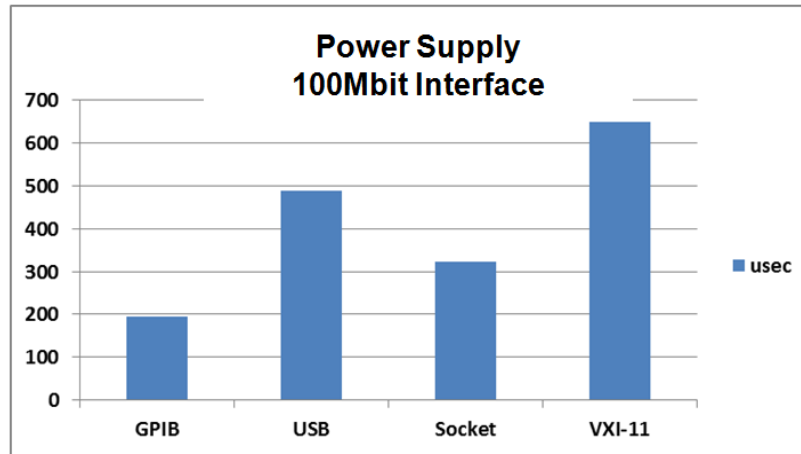
Links to Sources of Information

- LXI Consortium Resources
 - <http://www.lxistandard.org/Resources/Default.aspx>
- IVI Driver and SCPI-1999 Specifications
 - <http://www.ivifoundation.org/specifications/default.aspx>
- LXI Synchronization and Triggering
 - <http://wheelwrightenterprises.com/LxiSyncTrigger.pdf>
- LXI – An Integrator's View
 - <http://ieeexplore.ieee.org/Xplore/home.jsp>

Backup Slides



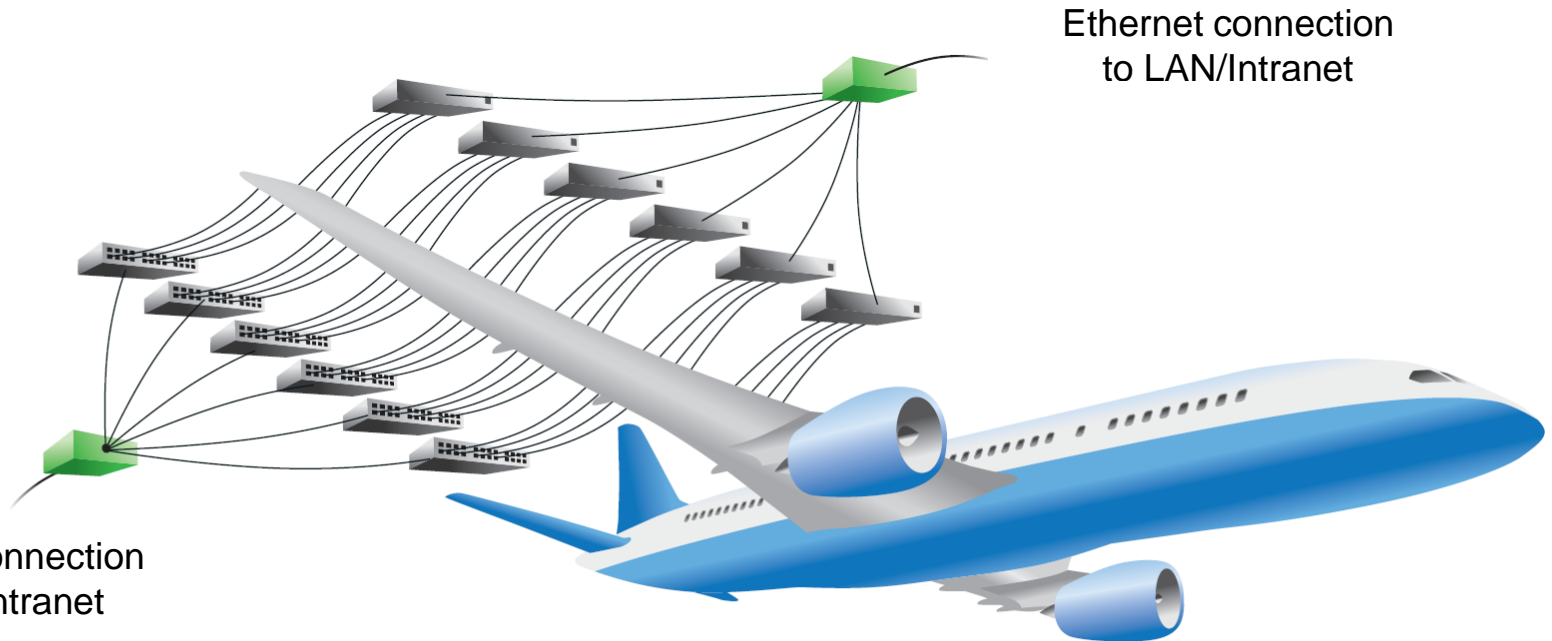
Performance Review



- VXI-11 and HiSLIP provide GPIB emulation for easy migration
- GPIB vs. LXI Latency comparable: often < 1msec
- LAN Block transfers: often 2 to 10 times GPIB

LXI Example Performance

Continuous Block Transfer



Ethernet connection
to LAN/Intranet

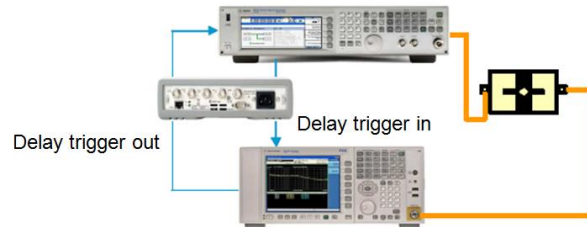
Ethernet connection
to LAN/Intranet

Multiple instruments strategically located
Around the aircraft are wired to individual strain gauge devices

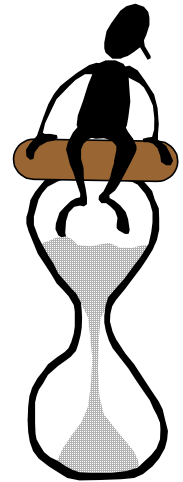
Best Practices

Key Performance Enhancements

- Device Synchronization – avoid Waiting
 - Polling of Status
 - Service Requests
 - Waiting for Operation Complete
- Incremental Device Setup – avoid Resets
- Device Triggering and Waiting for Trigger



- Use single I/O statement with compound statements
 - `"VOLT:AC:RANGE 10;:TRIG:COUNT 10;:INIT"`



Other Benefits of LXI

Built-in Web Server

The image displays three overlapping screenshots from an LXI instrument's web interface:

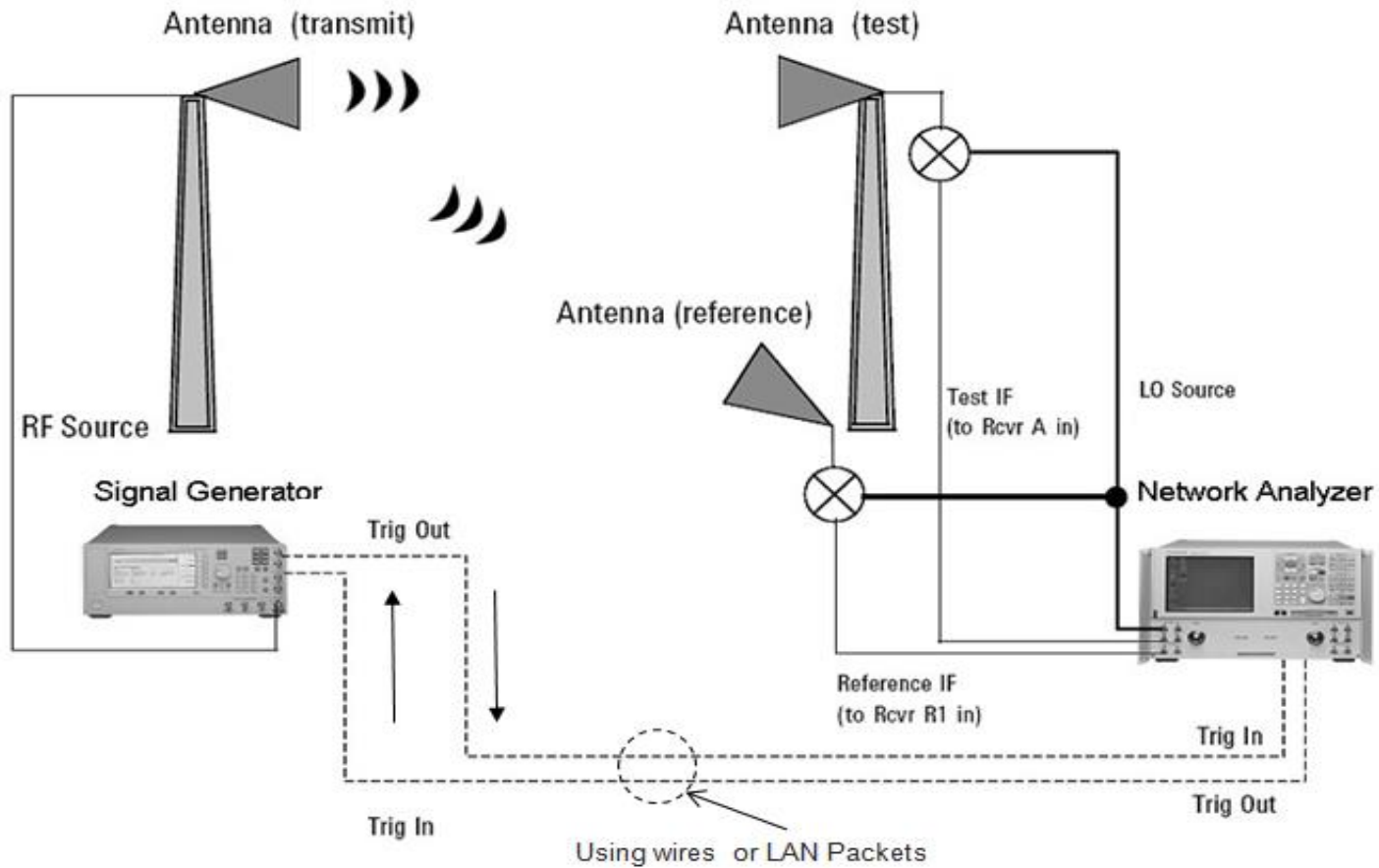
- Left Screenshot:** A waveform capture window showing a signal transition. The top status bar indicates "7 Jan 2014 11:55 PM" and "#Avs: 16". The main display shows a red waveform with a yellow cursor. Below the waveform, a table provides detailed timing and voltage data:

| Rise time (▲) | V min (▼) | V max (▲) | Overshoot (▲) |
|---------------|------------|-----------|---------------|
| Edge? | -1.83251 V | 3.23205 V | 66.8% |
| ----- | -1.81591 V | 3.24431 V | 61.9% |
| ----- | -1.83251 V | 3.23166 V | 0.0% |
| ----- | -1.78680 V | 3.30674 V | 68.2% |

- Middle Screenshot:** A schematic diagram titled "Slot 8: 70-Channel Reed Multiplexer". It shows a grid of switches connecting various input channels (e.g., Mez 12V 8015, Mez 3.3V 8016, Mez DITH 8017) to output channels (e.g., 8022, 8023, 8024, 8031, 8032, 8033, 8034, 8035, 8036, 8037, 8038). The diagram is organized into columns labeled "ABus 1" through "ABus 4".
- Right Screenshot:** A code editor window showing C# code for controlling the instrument. The code includes comments and commands for opening/closing supply channels and connecting the DMM or Scope analog bus.

Other Benefits of LXI

LXI LAN Events



Other Benefits of LXI

LXI Clock Synchronization

