The Next Generation of Test

LXI and Agilent Open
Major Test Challenges Today:

**Cost**
- Instruments, rack, cables, software, training, transitions

**Performance**
- Measurement accuracy/resolution/bandwidth, system throughput

**Compatibility**
- Application software, PC standard I/O, existing instruments

**Flexibility**
- Built-in measurements, personalities, test topologies, triggering

**Longevity**
- Measurement performance, PC standard I/O, support life

**Ease of use**
- Front panel operation, drivers, manuals, program monitoring

**Size**
- Sized for performance, reduce rack space, faceless modules (military)
## Today’s Test System Architectures

<table>
<thead>
<tr>
<th></th>
<th>GPIB</th>
<th>VXI</th>
<th>PXI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>GPIB card and expensive cables</td>
<td>Cardcage, Slot 0, MXI card/cable</td>
<td>Cardcage, Slot 0, MXI card/cable</td>
</tr>
<tr>
<td><strong>Measurement performance</strong></td>
<td>Best measurement performance</td>
<td>Limited by module size power / cooling</td>
<td>Limited by module size power / shielding</td>
</tr>
<tr>
<td><strong>I/O performance</strong></td>
<td>Slow interface (1 MB/sec)</td>
<td>Fast backplane and I/O</td>
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</tr>
<tr>
<td><strong>Compatibility</strong></td>
<td>&gt;90% of existing test systems, T&amp;M I/O</td>
<td>Cardcage, non-standard I/O (MXI)</td>
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</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Download personalities Limited to 14 instruments</td>
<td>13-slot Cardcage, Limited intelligence</td>
<td>17-slot cardcage, No intelligence</td>
</tr>
<tr>
<td><strong>Longevity</strong></td>
<td>All major vendors (&gt;30 years)</td>
<td>Based on VME, limited suppliers</td>
<td>Based on C-PCI, data acquisition</td>
</tr>
<tr>
<td><strong>Ease-of-use</strong></td>
<td>Front panel, SCPI, drivers, built-in intelligence</td>
<td>No front panel, Mostly register-based</td>
<td>No front panel, Register-based</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>Sized for performance with front panel</td>
<td>Large modules that require a cardcage</td>
<td>Small modules that require a cardcage</td>
</tr>
</tbody>
</table>
Why LXI?

PC backplanes change too rapidly
Test industry is moving to PC standard I/O (LAN, USB)
LAN has demonstrated longevity and backwards compatibility
Computer industry continues to improve LAN
LAN as the system backbone

Choose whatever software you prefer

LAN switch/router

LAN

LAN/GPIB converter

LAN Slot 0 or Embedded PC

VXI PKI

Cardcage Instruments

Classic Modular Synthetic

GPIB instruments

GPIB

Synthetic

Agilent Open

Agilent Technologies
LXI is widely endorsed

The LXI Consortium is a not-for-profit corporation made up of the leading companies in the Test and Measurement Industry.

LXI Consortium Members

| Agilent | Anritsu | Teradyne |
| VXI Technology | Bruel & Kjaer | Tektronix |
| Keithley | Adlink | The Math Works |
| Rohde & Schwarz | California Instruments | Universal Switching |
| Pickering | Complete Networks | Ztec Instruments |
| National Instruments | Beijing Aerospace | Acqiris |
| Aeroflex | Beijing Institute of Metrology & Meas | AMREL |
| BAE Systems | Goepel | JDS Uniphase Corp |
| Xantrex Technology | Lambda | Intepro Systems |
|                  | EADS N. Am. Defense | Pacific Power Source |
|                  | LXInstruments | Com DEV, Ltd. |
|                  |                | Symmetricom |
|                  |                | Altera Corp. |
|                  |                | Holding Informtest |
|                  |                | SofTec Microsystems |
|                  |                | C&H Technologies |
|                  |                | Circuit Assembly Corp |
|                  |                | Data Patterns |
|                  |                | Data Translation |
|                  |                | Dept of Defense |
|                  |                | Geotest/Marvin |
|                  |                | Kepco |
|                  |                | Pacific MindWorks |
|                  |                | Hitech Group Intl. |
|                  |                | Symtx |
|                  |                | Yokogawa Electric |
|                  |                | Digalog Systems |
|                  |                | Rigol Technologies |

Consortium President: Bob Rennard, Agilent
What is LXI?

LAN Extensions for Instruments
What is LXI?

Applying proven standards to test & measurement

Physical standards
(IEC sizes, Power, Cooling, Front panel Indicators, Reset button)

Instrument web pages
(Information, Set-up, control, and data access from a web browser)

Interface standards
(IVI driver, VXI-11 discovery, Device locking, Security)

Ethernet standards
(TCP/IP, DHCP, URL / IP addresses, Dynamic DNS, Auto-MDIX)

Trigger standards (optional)
(LAN triggers, IEEE 1588 time synchronization, Trigger bus)
# Major components of the LXI Standard

<table>
<thead>
<tr>
<th>Physical</th>
<th>Physical Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronization &amp; Triggering</td>
<td>New synchronization</td>
</tr>
<tr>
<td>Hardware Triggering</td>
<td>IVI drivers</td>
</tr>
<tr>
<td>Module to Module Communications</td>
<td>Ethernet</td>
</tr>
<tr>
<td><strong>LXI Programming (Drivers)</strong></td>
<td>Instrument pages</td>
</tr>
<tr>
<td>LAN Connection</td>
<td>LXI compliance</td>
</tr>
<tr>
<td>LAN Configuration</td>
<td></td>
</tr>
<tr>
<td>LAN Discovery</td>
<td></td>
</tr>
<tr>
<td><strong>Web Interface</strong></td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td></td>
</tr>
<tr>
<td>Trademark and licensing</td>
<td></td>
</tr>
<tr>
<td>Compliance</td>
<td></td>
</tr>
</tbody>
</table>
LXI allows flexible sizes

Classic Bench

Faceless modular

Remote devices

Remote operations
Physical standards for modules

- **Power**: (100-240Vac)
- **Ethernet**: 802.3 (RJ-45)
- **Trigger bus**: (Class A)
- **Indicator lights**: LAN status, Power status, IEEE 1588 status
- **Cooling**
- **Shielding**
- **Height**: (IEC rack units)
- **Width**: (IEC full or ½-rack)

**NOTE**: The LXI specification defines 1U, ½-rack modules and their rack mounting.
LXI devices serve a web page

Using any standard web browser

IP Address

Manufacturer
Model #
Serial #
Firmware rev.
IP Address
Domain name
etc.

Ability to change the IP address
LXI provides a programmatic interface – IVI driver required

Work in the software environment you prefer

Use industry standard drivers

Work with all types of instruments

Build a versatile system
Leverage your software

Classic Instruments

Same Software

Modular Equivalents

LXI

R&D

Design Validation

Depot Test/Manufacturing
Examples of standard, modular and compact instruments

- Power supplies
- RF Signal Generator
- Oscilloscope
- Power meter
- Time trigger
- Spectrum Analyzer
- Synthetic Instruments
- Switch/measure
- DMM
LXI increases I/O speed

- GPIB: 1.0 MB/s
- USB 1.0: 1.5 MB/s
- 100 Mb LAN: 12.5 MB/s
- USB 2.0: 60.0 MB/s
- VXI: 80.0 MB/s
- Gbit LAN: 125.0 MB/s

125x improvement

- ARPAnet: 3 Mb/s (1969)
- Ethernet: 10 Mb/s (1980)
- IEEE 802.3 Standard (1985)
- Ethernet 100 Mb/s (1990)
- Gbit Ethernet (2000)
- 10 Gbit Ethernet (2004)
LXI reduces overhead costs

System costs for up to 7 instruments (US$)

<table>
<thead>
<tr>
<th></th>
<th>VXI 13-slot</th>
<th>PXI 14-slot</th>
<th>GPIB</th>
<th>LAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface card</td>
<td>$50</td>
<td>$700</td>
<td>$500</td>
<td>$70*</td>
</tr>
<tr>
<td>(Firewire)</td>
<td></td>
<td>(MXI-4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cable</td>
<td>$</td>
<td>$125</td>
<td>$700</td>
<td>$25</td>
</tr>
<tr>
<td>Cardcage</td>
<td>$4400</td>
<td>$3500</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Slot 0</td>
<td>$2534</td>
<td>$800</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Total</td>
<td>$6984</td>
<td>$5125</td>
<td>$1200</td>
<td>$95</td>
</tr>
</tbody>
</table>

* No interface card required – use 16-port switch – Linksys SR216 ($70)
3 Classes of LXI

**Class C** (base class)
- Ethernet standards
- IVI driver
- Instrument web page
- Physical
  - Size / Shielding
  - Power / Cooling
  - Indicators / reset button

**Class B**
- Class C plus
- IEEE 1588 time sync
- LAN messaging

**Class A**
- Class B & C plus
- Hardware trigger bus
LXI Triggering

**LAN triggers (Class B)**

- **Switch/router**
- **LXI**

**IEEE-1588 triggers (Class B)**

- **Boundary Clock Switch**
- **Master Clock**
- **LXI**

**Trigger Bus (Class A)**

- **Trigger Bus**
- **LXI instruments**

**Message**

- Peer-to-peer
- Multi-cast
- < 1 ms

**Time**

- Time synchronization
- Time stamps
- < 100 ns

**Hardware**

- Instruments close together
- 5 ns/ meter

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MCO Technology Forum
13 November 2007
Marlo Manaloto
What does IEEE 1588 give you?

**Synchronization**
- Start actions in a sequence
- Synchronize timing even when running at multiple rates
- Troubleshoot test sequences
- Correlate data

**Time Stamps**

- **Measurement 1**: 000000
- **Measurement 2**: 000200
- **Measurement 3**: 000300
- **Measurement 4**: 008000
- **Measurement 5**: 010000
- **Measurement 6**: 012000
- **Measurement 7**: 030000

- **Trigger 3**: 000310
- **Trigger 5**: 010000

- **Instrument #1**: 0100 15.11178
  - 0200 15.23422
  - 0300 16.00101

- **Instrument #2**: 0100 385443
  - 0200 386332
  - 0300 387119

- **Instrument #3**: 0100 000333
  - 0200 000335
  - 0300 000440
## LXI is the Future of Test

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<td>LAN built into PC</td>
</tr>
<tr>
<td>Measurement</td>
<td>Best measurement performance</td>
<td>Limited functionality</td>
<td>Limited functionality</td>
<td>Best measurement performance</td>
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<tr>
<td><strong>performance</strong></td>
<td></td>
<td></td>
<td></td>
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<td>Slow interface (1MB/sec)</td>
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<td>Gbit LAN = 125x GPIB</td>
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<td>LAN as the backbone + converters for other architectures</td>
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<td><strong>Flexibility</strong></td>
<td>Personalties, 14 instruments, Limited distance</td>
<td>13-slot cardcage, Limited intelligence</td>
<td>17-slot cardcage, Small modules, No intelligence</td>
<td>Intelligence, Long distances, Unlimited instruments, New triggering</td>
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<td>Longevity</td>
<td>All major vendors (&gt;30 years)</td>
<td>VME, limited suppliers</td>
<td>C-PCI, data acquisition</td>
<td>All major vendors + computer standards</td>
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<tr>
<td>Ease-of-use</td>
<td>Front panel + drivers</td>
<td>No front panel, Register-based</td>
<td>No front panel, Register-based</td>
<td>Front panels + drivers + web interface</td>
</tr>
<tr>
<td>Size</td>
<td>Front panel</td>
<td>Large modules require cardcage</td>
<td>Small modules require cardcage</td>
<td>Flexible sizes, Front panel or faceless</td>
</tr>
</tbody>
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**Legend**
- **GPIB**: General Purpose Interface Bus
- **VXI**: Virtual Instrument Architecture
- **PXI**: Peripheral Component Interconnect
- **LXI**: Laboratorial eXtreme Interface
Agilent’s LXI Product Offering

LXI Class C

- MXA Spectrum Analyzer
- Digital Multimeters (34410A / 34411A)
- Oscilloscopes 8000, 80000 Series
- Oscilloscopes 6000A, 5000A Series
- Multi-Output Modular Power Supplies (N6700B)
- Single-Output Power Supplies Family (N5700A)

LXI Class B

- LXI class B trigger Box (E5818A)
- Power Meters (N8262A, N1911/12A)
- 20 GHz Analog Up Converter (N8211A)
- 20 GHz Vector Up Converter (N8212A)
- 26.5 GHz Down Converter (N8201A)
- 40 GHz Analog Up Converter (N8211A)
- 30 MS/s IF Digitizer (N8221A)
- 1.25 GHz AWG (N8241A)

LXI Class A

- EXA Spectrum Analyzer
- ENA, ENA-L Network Analyzers
- Digital Multimeter (L4411A)
- Oscilloscopes 6000L Series
- ENA, ENA-L Network Analyzers
- Oscilloscopes 8000, 80000 Series

>100 products
Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products.
Simpler computer control with Agilent Open

✓ Software included for free
  • Graphical Web Interface
  • New I/O Library Suite 15.0
  • IVI-COM, IVI-C, NI LabVIEW drivers

✓ Compatible with standard programming environments including:
  - Visual Basic
  - C/C++
  - Agilent VEE Pro
  - Visual Studio.NET with Agilent T&M Toolkit 2.0
  - LabVIEW

Remote access and control via standard Web Browser
Agilent LXI interfaces do more

- Monitor communications
- Control the instrument
- Download and Retrieve data
Tools for fast startup: Agilent Suite 15

System set-up in < 15 minutes

- Identify and set up LAN, USB, GPIB, and converter interfaces
- Identify and communicate with instruments
- Monitor IO activity
- Change addresses and set interface aliases
- Works with NI-488 software and NI VISA I/O library
Compatibility modes make conversion from GPIB instrument to LAN simple

#include "stdafx.h"
#include <atlstr.h>
#include <atlsafe.h>

int _tmain(int argc, _TCHAR* argv[]) {
    ::CoInitialize(NULL);
    try {
        try {
            IIviDriverPtr spDriver34410(__uuidof(Agilent34410));
            IIviDriverPtr spDriver34980(__uuidof(Agilent34980A));

            // Setup IVI-defined initialization options
            CString strStandardInitOptions =
                "Cache=true, InterchangeCheck=false, QueryInstrStatus=true,
                RangeCheck=true, RecordCoercions=false, Simulate=false";

            // Initialize Agilent 34410A/11A and 34980A IVI drivers
            spDriver34410->Initialize("TCPIP0::156.140.71.39::INSTR", VARIANT_FALSE,
                VARIANT_FALSE, LPCTSTR(strStandardInitOptions));
            spDriver34980->Initialize("TCPIP0::156.140.69.216::INSTR", VARIANT_FALSE,
                VARIANT_FALSE, LPCTSTR(strStandardInitOptions));

            IAgilent34410Ptr spAgilent34410 = spDriver34410;
            IAgilent34980A2Ptr spAgilent34980 = spDriver34980;
        }
    
    Replace the existing string "GPIB0::9::INSTR" with
Agilent Instruments have multiple interfaces

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E5061/62A</td>
<td>ENA-L RF Network Analyzers</td>
</tr>
<tr>
<td>E5071C</td>
<td>ENA Network Analyzer</td>
</tr>
<tr>
<td>34410/11A</td>
<td>Digital Multimeters / Digitizer</td>
</tr>
<tr>
<td>34980A</td>
<td>Switch / Measure Unit</td>
</tr>
<tr>
<td>33220A</td>
<td>Function Generator</td>
</tr>
<tr>
<td>N6705A</td>
<td>Power Analyzer</td>
</tr>
<tr>
<td>N6700B</td>
<td>Modular Power Supplies</td>
</tr>
<tr>
<td>N5700A</td>
<td>DC Power Supply Family</td>
</tr>
<tr>
<td>E836xx</td>
<td>PNA Microwave Network Analyzers</td>
</tr>
<tr>
<td>DSO6000</td>
<td>Digital Oscilloscopes</td>
</tr>
<tr>
<td>MSO6000</td>
<td>Mixed Signal Oscilloscopes</td>
</tr>
<tr>
<td>86100C</td>
<td>Digital Communications Analyzer</td>
</tr>
<tr>
<td>N1910A/11A</td>
<td>Power Meters</td>
</tr>
<tr>
<td>E8257/67D</td>
<td>PSG Signal Generators</td>
</tr>
<tr>
<td>E4438C</td>
<td>ESG Vector Signal Generator</td>
</tr>
<tr>
<td>E444xA</td>
<td>PSA Spectrum Analyzers</td>
</tr>
<tr>
<td>81140A Series</td>
<td>Pulse / Pattern Generators</td>
</tr>
<tr>
<td>83141A/42A</td>
<td>Pulse / Pattern Generators</td>
</tr>
<tr>
<td>N9020A</td>
<td>MXA Signal Analyzers</td>
</tr>
<tr>
<td>N5181/2A</td>
<td>MXG RF Signal Generators</td>
</tr>
<tr>
<td>N1996A</td>
<td>CSA Spectrum Analyzer</td>
</tr>
<tr>
<td>E4980A</td>
<td>Precision LCR Meter</td>
</tr>
</tbody>
</table>
Agilent provides converters

- USB/GPIB
- LAN/RS-232
- LAN/USB
- LAN/GPIB

Re-use existing instruments
Agilent provides built-in intelligence

**N6700B Modular DC power supply**
- 4 power “bricks” – synchronize outputs
- Ramp up/down
- Sense/Source voltage and current

**34411A Digital Multimeter**
- Selectable speed/resolution (1Ks/sec to 50Ks/sec)
- Data logging to memory (50K readings)
- Built-in temperature compensation algorithms
- Dual display / built-in peak measurements

**34980A Switch/Measure Unit**
- Scan lists (built-in DMM)
- Switch set-ups
- Relay switch counter
Smart instrument advantages:

Performance:

• Ability to **pre-load** repetitive setups speeds execution and limits communication “chatter”

• Decentralized computing allows **parallel operations**

• Common functions are handled automatically speeding execution and simplifying programming.

Programming/debugging:

• Built-in web pages assist debugging, make system monitoring easier

• Built-in help systems make programming easier.
Characterize your system performance
“System level MSO”
Agilent E5818A LXI Class B Trigger Box

- “Any Instrument” to Class B
- Two Channels
  - Time Stamp Inputs
  - Time Trigger Outputs
- Alarm
  - Start time
  - N pulses
  - Period
- P2P Messages
- External Trig to
  - P2P Message
  - Delayed Trigger

NEW!
It's About Time!

Agilent Technologies
LXI opens new possibilities

**Existing Test**

- Control
- Data
- Proprietary I/O

- Commands sent one at a time
- One module working at a time
- Wait states and queries
- All data sent to the PC
- Expert programming required

**Next Generation Test**

- Intelligent instruments leverage expertise
- LAN messaging makes it flexible
- Time-based triggering keeps control

- 10 Gbit LAN
- 1 Gbit
- 1 Gbit
- 54 Mbit
- 100 Mbit
- 100 Mbit
- 100 Mbit
- 10 Gbit

**Distributed**

**Computer-centric**

**LXI**

**Agilent Technologies**
LXI Possibilities

- Long distance operations
- Expert Troubleshooting
- Parallel operations
- Reduce programming
- Smart instruments
- Higher throughput
- No trigger wires
- Flexible triggering
- Eliminate latency
- Timestamp all data
- Asset Management
- Internal network
The Future of Test

Choose the software you prefer

SCPI

Suite 15

LAN switch/router

System Developer Center
www.agilent.com/find/open

LAN

LAN Slot 0 or Embedded PC

VXI PXI

GPIB instruments

GPIB converter

Cardcage Instruments

Classic Modular Synthetic

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MCO Technology Forum
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Marlo Manaloto