LXI Developers Track - Implementing the LAN & Web Specification

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LAN eXtensions for Instrumentation

www.lxistandard.org

Agenda

- Overview of the LAN & Web Working Group
- LXI specification overview with implementation highlights/details
  - LAN Specification – Section 7
  - LAN Configuration – Section 8
  - LAN Discovery – Section 10
  - Web – Section 9
- Compliance Testing
  - What to watch out for
- Roadmap Items
- Questions

LAN & Web Working Group (WG) Overview

- Specification sections covered by the working group:
  - LAN Specification (Section 7)
  - LAN Configuration (Section 8)
  - Web Interface (Section 9)
  - LAN Discovery (Section 10)

Guiding Principles for LAN WG

- If an existing standard meets our need, just use it.
- KISS (keep it simple …)
- There is immense investment in computer standard IO—we need to take advantage of this in Test & Measurement.
- Checked that popular embedded O/S's supported the feature before adding it to the spec.

LAN Specification – Section 7

- LAN Specification covers the physical I/O connection.
- Must be IEEE 802.3 for wired Ethernet.
  - 10baseT – ok.
  - 100baseT – most devices today.
  - Recommend devices be 1000baseT (Gigabit).

LAN Specification (cont)

- MAC Address for the device must be on a label or accessible from the front panel.
- Support Auto-negotiate
  - Higher speed devices work on lower speed networks
- Should support Auto-MDIX (Auto-Medium Dependent Interface) - Recommendation
  - The ability to use crossover or straight through cables. The PHY chip works out the correct polarity.
  - If you don't support Auto-MDIX then you must have a label saying Auto-MDIX NOT supported near the LAN connector.
  - Gigabit Ethernet supports Auto-MDIX

Adding LXI to a Device

- To add LXI to a device you need:
  - LAN connector – RJ45
  - Physical (PHY) layer
  - Media Access Control (MAC) layer
  - Network Stack
  - Web server
  - LAN Status indicator – can be an LED or incorporated into the existing User interface.
  - LCI – LAN reset.

Network Stack Features

- If you have an existing O/S or are going to add an O/S to your device then make sure that it has the following features:
  - LAN support
    - TCP, UDP, ICMP protocols
    - IPV4 - better if has both IPV4 and IPV6
    - Ping server
    - Supports multicast addressing
    - ONC-RPC for VXI-11 discovery
    - Connection Monitoring
  - Web server
    - Needs some mechanism to update the dynamic data on the Web page like IP address etc. Can't just have statically coded HTML pages. (cgi, IIS, ASP, JSP etc.)

LAN Configuration – Section 8

- LAN Configuration section is about which protocols and applications need to be in your device.
- TCP, UDP, ICMP, ARP protocols a must.
- For IP Configuration must have <u>all</u> of the following:
  - DHCP
  - Dynamic Link-Local Addressing (Auto-IP)
  - Fixed IP Address (Static IP)

LAN Configuration (cont)

- When the device gets an IP address it needs to do “Duplicate address detection”.
  - You do a ARP for the IP address you have but leave the MAC empty. If you get any responses that have a MAC entry different from yours, someone else is using that IP address, so you have a duplicate.
- LAN Reset (LAN Configuration Initialize)
  - Puts the LAN settings back to a default state.
  - If you mess up the LAN settings and can’t communicate with the device you can get it back to a known state.

LAN Configuration (cont)

- Every device needs a “LAN Status Indicator”
  - This is not the LAN activity light we see on the back of our PC’s
  - The indicator will signal
    - failure to acquire a valid IP address
    - detection of a duplicate IP address
    - failure to renew an already acquired DHCP lease
    - LAN cable disconnected
  - You should also have a way to make the LAN Status indicator flash from the Web page of the device. This provides a useful way to identify the instrument.
- IPV4 is a rule. IPV6 is recommended.
- Must support Ping.
- DNS is only a recommendation. You can choose to support this or not.

LAN Discovery – Section 10

- When using DHCP or Auto-IP it is not easy to keep track of the current IP address of the device.
- LAN Discovery is for identifying and retrieving the IP address of LXI Devices.
  - VXI-11 is the current discovery mechanism. This uses ONC-RPC and is different from Microsoft's RPC calls.

LAN Discovery (cont)

- VXI-11 specification is available at: http://www.vxibus.org/files/VXI_Specs/VXI-11.zip
- Example VXI-11 server code is on the LXI Web site for members only.
- To test your VXI-11 server implementation make sure you try all these client applications. They all behave slightly differently.
  - NI-MAX
  - Agilent Connection Expert
  - The LXI Compliance Suite
  - LXI Discovery utility – donated by Xantrex

VXI-11 tips

- To call port mapper (port 111) there are 2 RPC commands (Callit and GetPort)
  - Agilent instruments don’t respond to Callit.
- Spec calls out an Upper case “*idn?” but it would be wise to respond to both lower and upper case.

LXI Web Interface

- Why this section is included
  - Every Ethernet device today comes with Web pages.
  - Web pages makes it very convenient to check the instrument connectivity.
  - Web pages work through firewalls (port 80).
  - Some devices don't have displays and front panels. Web pages are a natural replacement.
- What we were trying to accomplish
  - Easy for user to configure the device.
  - Consistent way to accomplish configuration and control of the device.

Web Spec (Chapter 9)

- Must have a Web server on Port 80
  - HTTP version 1.1 compliant (changed to 1.0 in latest spec)
  - HTML version 4.01 or XHTML version 1.0 compliant
  - You are allowed to redirect to other ports or URL's as long as you can access the Web servers home page on port 80.
  - Welcome page doesn't have to be the home page as long as there is a clearly marked link to the LXI Welcome Page.

Web Spec (cont)

- Device Identification control – flashes the LAN status indicator light on the device.
- Password Protection of settings.
- LXI logo needs to be on the Web pages.

LXI Welcome Page

- All LXI Welcome pages need this information:
  - Manufacturer
  - Serial Number
  - Description
  - LXI Class <A, B, or C>
  - LXI version (initially 1.0, but it will grow)
  - Hostname
  - MAC Address <XX-XX-XX-XX-XX-XX>
  - TCP/IP Address <DDD.DDD.DDD.DDD>
  - Firmware and/or Software Revision
  - IEEE 1588 PTP Current time [Optional for LXI class C instruments]

IP Configuration Page

- Standard set of parameters that need to be configurable via the Web
  - Hostname
  - Description
  - TCP/IP Configuration Mode: DHCP, Auto-IP, Static IP
  - IP address
  - Subnet mask
  - Default Gateway
  - DNS Server(s)

IP Configuration Page (cont)

- When implementing "TCP/IP Configuration Mode" You can do one of the following 2 options:
  - Option 1 – Two selections: Auto or Manual
    - Automatic – this will do DHCP first and if it fails it will switch to Auto-IP. This is how Windows works.
    - Manual - Static IP
  - Option 2 – have check boxes for all 3 modes
    - DHCP
    - Auto-IP
    - Static IP

Sync Configuration Web Page

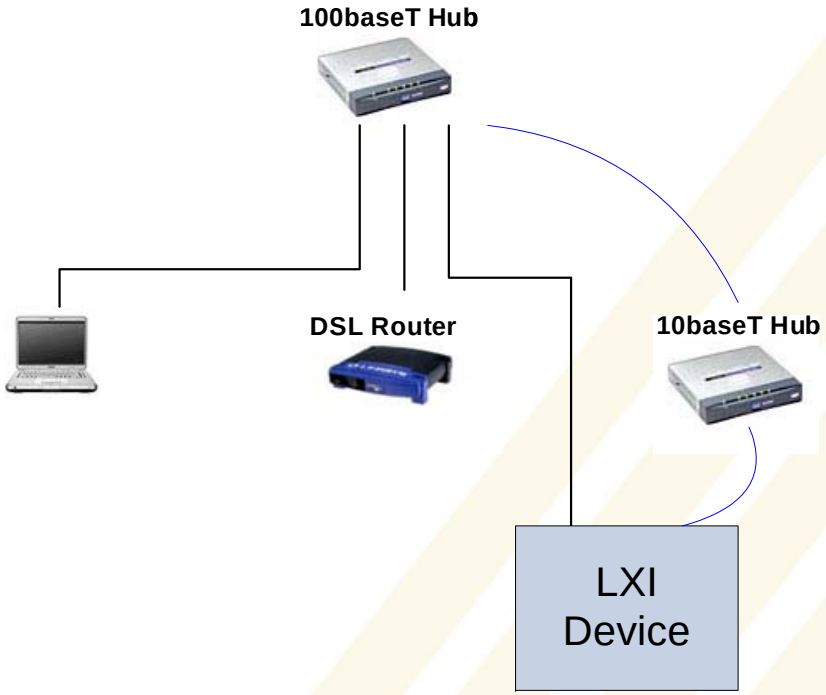
- All Class A & B devices need a page that has the IEEE-1588 and WTB information.
- See section 9.6 for details.

Compliance Testing

- To be LXI certified you need to do compliance testing.
- More on how and what this is in the later talk by Jochen Wolle from Rhode & Schwarz.

How We Test

- Test setup/process



Compliance Testing Tools

- Initially we just had an Excel spreadsheet that we went through and checked off the items.
- Now we have the “Compliance Testing Suite”
  - An application which leads you through the process.
  - It is very good!

Things to watch out for when doing LAN testing

- DHCP renewal failures
  - Disconnect DHCP server and see what happens when the DHCP lease times out.
- IP Address configuration
  - Make sure you can switch between all 3 modes.
- LAN Status indicator
  - Check all conditions per section 8.11
- LAN Configuration Initialize function (reset LAN)
  - Make sure it resets parameters as per section 8.14

Things to watch out for when doing LAN testing (cont)

- Duplicate address detection
  - Put the LXI device on the same IP address as the testing PC. Make sure device:
    - Puts its IP address to 0.0.0.0 (IPV4)
    - Lights the LAN status indicator showing an error
- Labeling (MAC address and no Auto-MDIX)
- Use packet monitoring (sniffer) software like Ethereal, now called WireShark, to monitor everything that is going on.

Things to watch out for when doing Web testing

- Use the W3C.org validator tool to check your Web pages for HTML/XHTML compliance.
- W3C validator tool
  - Best practice is to view the Web page source and then save it to a file for up loading to the W3C for checking. If you just save the Web page and then upload it extra “stuff” can be stored in the file which isn’t compliant. IE6 will do this on you while Firefox seems to be ok.

Things to watch out for when doing Web testing (cont)

- Hostname
  - On the Welcome and IP Configuration Pages there is a Hostname field. Make sure this is a valid Hostname if it is not then display the current IP address of the device.
    - Call getHostByName(Hostname) or getHostByAddress(ip address) and make sure what comes back is correct.

What's Ahead: Roadmap to rev 1.2

- LAN
  - A XML identification schema to replace "*idn?" This will be more descriptive and at a fixed URL in every LXI device.
  - New Discovery Mechanism
    - mDNS (Bonjour)
  - Event log
  - Miscellaneous open issues

What's Ahead: Roadmap to rev 2.0

- Resource Management (e.g. locking)
  - David Poole from Aeroflex heading this sub-group up
- Web
  - Better configuration, control and diagnostics for the WTB, IEEE-1588 and LAN events
- Timing and Sync
  - IEEE-1588 version 2

Acronyms / Terminology

- ARP – address resolution protocol
- PHY – physical layer of the OSI 7 layer model
- MAC – media access control
- uP – microprocessor
- O/S – operating system
- DNS – Domain Name System
- mDNS – multicast DNS
- RPC – Remote Procedure Call

Questions?