Open Architecture Design
Ideal for Airframe Structural Test

Introduction

The LAN eXtensions for Instrumentation (LXI) standard extends the capabilities of Ethernet by addressing key functional areas that are necessary to ensure instrument interoperability, performance and usability. This high-performance instrumentation platform is ideally suited for a wide range of applications, with the ability to scale up from small to very large testing requirements.

Open Architecture Environment

The advantages of adopting an open architecture test platform span both hardware and software, providing the engineer with a wide range of choices that are unavailable with proprietary designs. An open hardware approach guarantees that a well-defined set of signal and interface characteristics have been adopted, and that multiple vendors have joined together to provide support and product development. These features result in reduced costs, extended test system life cycles, and commercial off-the-shelf (COTS) product availability.

Open software support also plays an important role in reducing development costs and ensuring life cycle management. Software independence is built upon well-defined standards such as those seen in plug & play drivers and IVI. In the application development environment, this provides engineers with the freedom to select the environment best suited to meet their needs. Properly designed drivers can easily be used in a number of different application programming environments including C/C++, MatLAB, Visual Basic, VEE, and LabVIEW/LabWindows CVI.

Distributed Measurement Approach

Open hardware and software are fundamental requirements for any sustainable platform. However, system designs utilizing the LXI platform also provide an inherent benefit that is ideal for distributed data acquisition applications.

Many current data acquisition implementations involve placing the instrumentation in a control room that may be located hundreds of feet from the article that is being tested. This distance presents numerous challenges for the test engineer including increased cable costs, maintenance, calibration, noise, and debugging. Fortunately, the effects from most of these issues are greatly reduced by placing the instrumentation as close to the test article as possible.

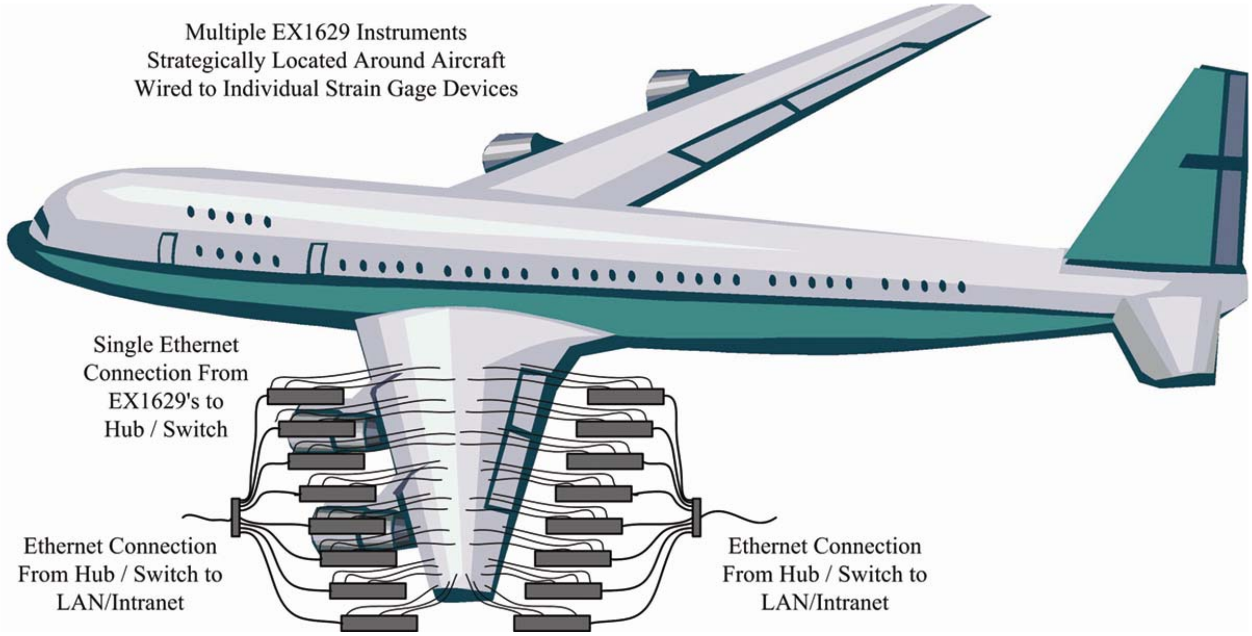


Figure 1. Example of airframe structural testing

Aircraft structural test applications illustrate this concept clearly. Not only is the test performed some distance from the control room, but the sheer size of the test article is an additional challenge. Structural testing on an aircraft wing may involve several thousand channels of strain gage transducers that must be located at strategic points on the structure. The complexity and magnitude of the installation and setup task for 3,000 channels is challenging, especially if 8-wire connections are required. The cost of cabling and installation as well as possible measurement errors from the cabling must be considered. Long-term maintenance and support could also be an issue.

Distributed LXI-based instrumentation, such as VTI Instruments' EX1629 (a 48-channel high-performance remote strain measurement unit), can greatly simplify the task. Each EX1629 can be placed near the test structure and connected to the test local area network using standard Ethernet cable and networking accessories (see Figure 1). A single Ethernet cable can then be routed to the control room for data collection and control.

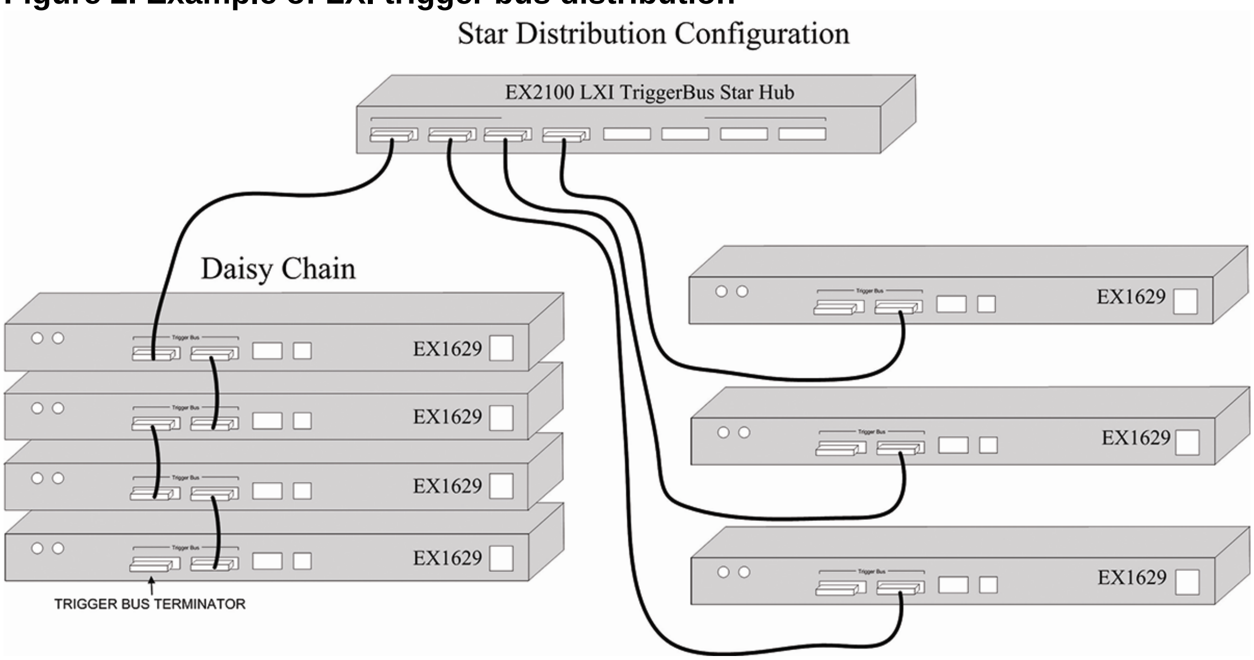
While this approach simplifies installation and addresses several key areas of concern, a distributed approach must also address synchronization and trigger control -- issues common to most data acquisition applications.

Hardware Trigger

The most accurate and deterministic synchronization mechanism between multiple devices involves the implementation of a hardware trigger interface. Because of this requirement, the LXI standard defines a high-performance trigger interface called the trigger bus. The trigger bus provides the link between all devices in the test system for both triggering and clock signal distribution.

Deterministic trigger generation and propagation between multiple devices is accomplished with an eight-channel, multipoint low voltage differential signal (LVDS) interface. This architecture permits individual lines to be configured as a source and/or receiver while supporting external time-based or software-generated triggering and clock distribution. Common topologies are supported including star, daisy-chain, and hybrid, which provide the flexibility to distribute the trigger lines as dictated by the application requirements. By adding a star hub, additional flexibility is available because the device permits very tight trigger tolerances to be maintained throughout a large distribution network (see Figure 2).

Figure 2. Example of LXI trigger bus distribution



The trigger bus can be automatically extended to other platforms, such as VXI with a LXI-VXI slot 0 control bridge, providing a mechanism to link a VXI chassis with other LXI hardware. The LXI-VXI slot 0 control bridge will provide a direct extension of the eight VXI trigger lines to any external device, enabling the ability to individually control specific instruments and switch devices within the VXI chassis. This type of flexibility allows the user to integrate other instruments into a homogeneous, open test environment that leverages the strengths of each subsystem.

Product Longevity

The longevity of LXI-based solutions is shown in Figure 3. LXI-based data acquisition and functional test system solutions, such as VTI Instruments' EX1048A precision thermocouple instrument, EX1629 high-performance remote strain measurement unit, and EX2500A LXI-VXI slot 0 control bridge, ensure the highest degree of forward-looking platform compatibility and interoperability. They also maximize investment capital by limiting vulnerability to PC platform changes and other market conditions that often restrict the effectiveness of other proprietary solutions.

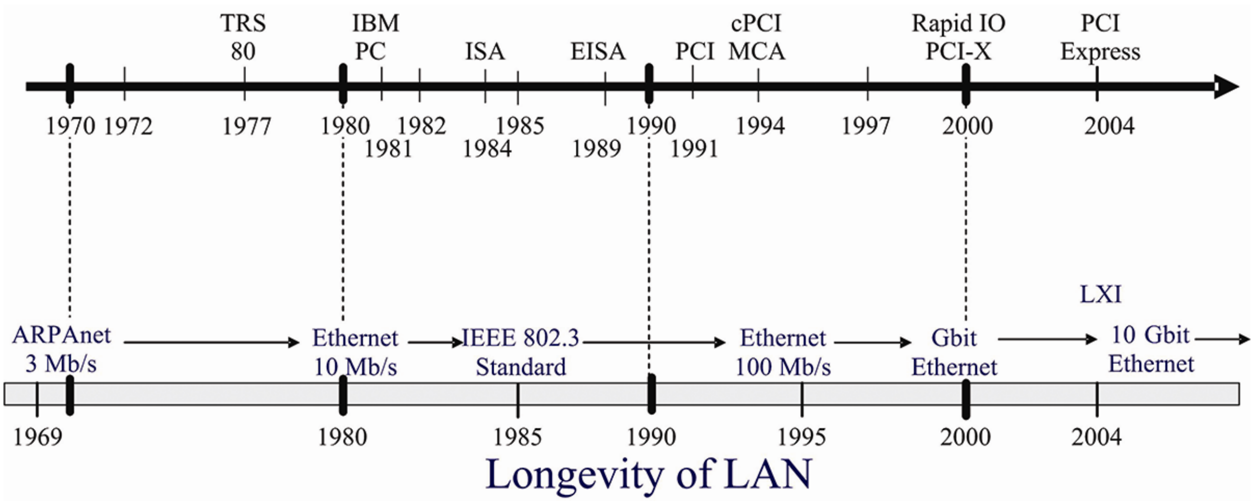


Figure 3. Computer bus architecture's disruptive cycle of change

Summary

LXI offers numerous benefits including an open hardware architecture that results in reduced costs, extended test system life cycles, and COTS availability. Open software support reduces development costs and ensures life cycle management. Distributed LXI-based instrumentation can greatly simplify the complexity and reduce the cost of cable installation and maintenance. The high-performance LXI trigger bus enables triggering and clock signal distribution throughout the test system. Product longevity ensures long-term compatibility and interoperability while maximizing capital investments.