Enhancing Structural Test Through Open Architecture Designs

High-Density Modular Instruments
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VXI Technology™

Introduction

- VXI Technology, Inc.
  - High-Density Modular Instrumentation and Switching Leader
    - Functional Test Switching Solutions
    - Functional Test Instrumentation Solutions
    - Integrated Data Acquisition and Signal Conditioning
    - Dynamic Data Acquisition
  - Software and Hardware Independent Design Philosophy
    - Open Architecture Approach Fundemental
    - Eliminates Pitfalls of Proprietary Solutions

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Hardware Architecture

- Open Hardware
  - Drives Hardware Independence
    - Well Defined Signal Characteristics
    - Multiple Vendor Acceptance
    - Reduces Development Cost and Time to Market
  - Industry Standard Interfaces and Platforms
    - GPIB
    - VME
    - VXI
    - Ethernet (LXI)
  - Enables COTS Support
    - Market Driven Performance Benefits User Community

Software Architecture

- Open Software
  - Drives Software Independence
    - Based on Well Defined Standards
    - Plug&play
    - IVI Com/C
  - Choice of Application Environment
    - MatLAB
    - Visual Basic
    - C/C++
    - VEE
    - LabVIEW / LabWindows CVI
  - Facilitates Development Environment Flexibility and Choice

LXI Emerges

- **L**AN e**X**tensions for **I**nstrumentation
  - High-speed Instrumentation Interface Standard
- LXI Consortium
  - VXI Technology Co-founded LXI Consortium September 2004
  - Chair LAN and Hardware Trigger Working Groups
  - Chair Marketing Committee / Secretary and Treasure
- Key Advantages of LXI
  - High-speed I/O
  - Instrument Grade Measurements
  - Tight Device Synchronization
  - Standard API
  - Modularity

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LXI: Immediate Industry Impact

- Distributed Data Acquisition: A Natural Fit
  - Long Inter-device Connectivity
    - 100 Meters Point-to-Point
    - 200 Meters w/Router/Switch
    - Kilometers Utilizing Fiber
    - Wireless
  - Simplifies Cabling
    - Standard CAT-5
    - Easy to Route and Install
  - Device Interconnect
    - Inexpensive Hubs, Routers, Switches

Key LXI Instrumentation Functionality

- Features Ideal for Distributed Measurements
  - Class A
    - Trigger Bus Hardware Triggering
    - Full Class B & Class C Compliance
  - Class B
    - Synchronization / IEEE1588
    - Full Class C Compliance
  - Class C
    - LAN Discovery
    - LAN Specifications
    - LAN Configuration
    - Web Interface
    - Physical

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LXI LAN Attributes Ideal for the Field

- Interface and Cable Requirements
  - Ensures Forward / Backward Compatibility
- Backward Compatibility
  - 10base-T → 100base-T → Gigabit
- Device Discovery Mechanism
  - Identifies All LXI Compliant Devices on the LAN
- Cross-over Cable Methodology
  - Auto-DMIX Eliminates Transmit / Receive Pin Conflicts
- Ping Operability
  - Simplifies Device Debug Operations

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LAN-based Synchronization Advantages

- IEEE-1588 Precision Time Protocol (PTP)
  - Key to LAN-based Instrument Synchronization
    - All Units Synchronized to Master Clock
  - Enables Time Based Acquisition
    - All Units Begin Process @ t_x
  - Synchronization Capability
    - Gigabit Implementations
      - -10nSec - 20 nSec Device Synchronization
    - Determines the Time of Transmission and Reception Messages
    - Basically a Form of Self-calibration
    - Eliminates Temporal Fluctuations in the Protocol Stack (jitter)

Hardware Trigger Implementation Essentials

- Trigger Bus Hardware Trigger Interface
  - Precise Hardware Trigger Mechanism
  - Defines Expansion Requirements
  - Supports Traditional Trigger Models
  - Permits Integration With Non-LXI Based Devices
  - Supports Daisy Chain and Star Configurations
  - Provides Deterministic Control of LAN-based Instruments
  - Compatible with VXI Trigger Model

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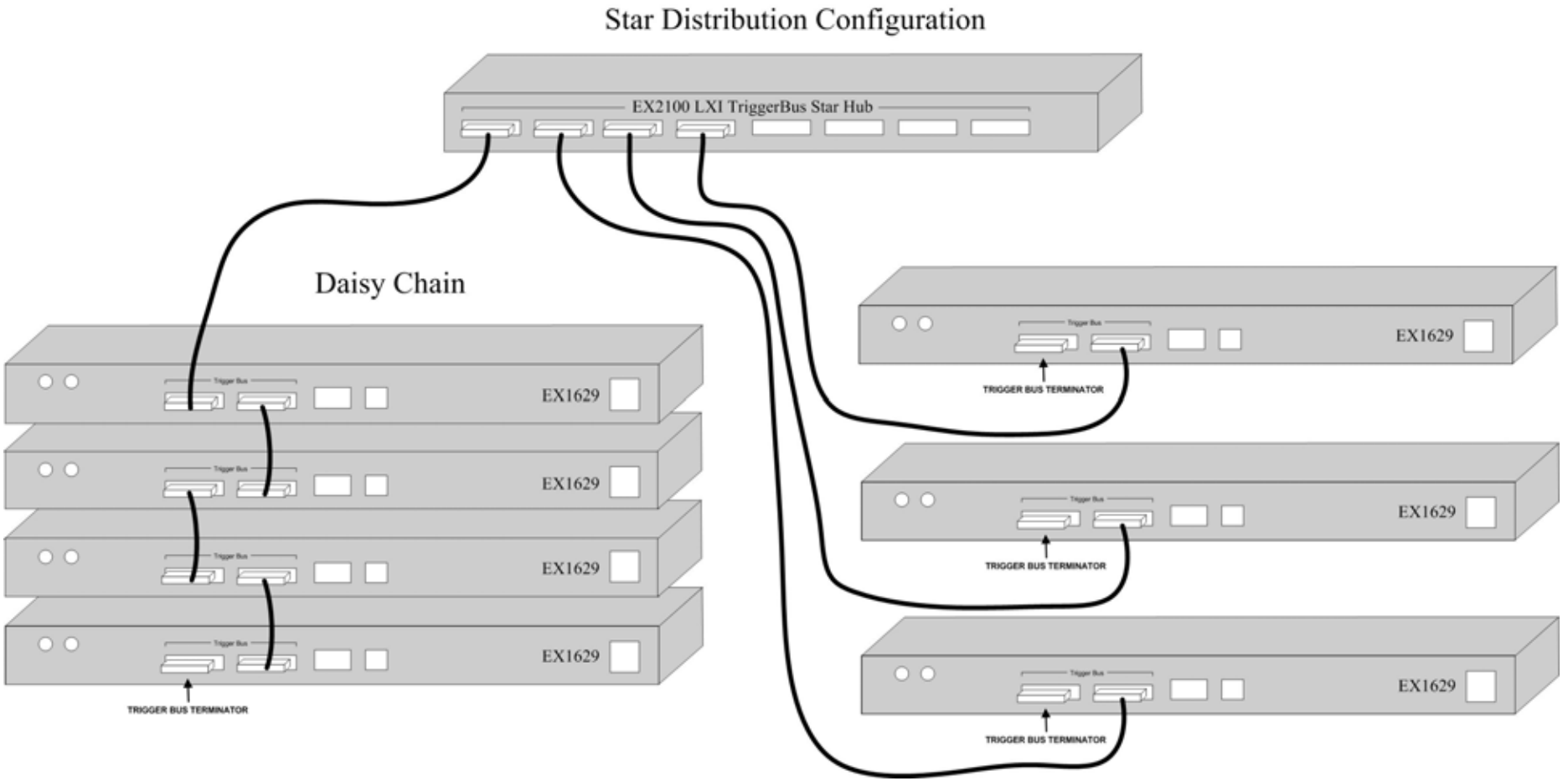
LXI Hardware Trigger Example



Structural Test Case Study Utilizing LXI

- Boeing 787 Dreamliner Commercial Aircraft
  - Aircraft Design Based Upon Composite Material
    - Required Extensive Characterization
    - Large Channel Count
  - Flight Safety Testing
    - Static Structural
      - -Hydraulics Load Structure and Response is Measured
    - Structural Fatigue
      - -Lower Load Cycle Over Entire Flight Profile
  - Key Concerns
    - Measurement Accuracy
    - Setup Time
    - Debug Time
    - Synchronicity of Measurements
    - Cost Associated With Transducer Cabling

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Boeing 787 Dreamliner
Structural Test Case Study

- Measurement Challenge
  - Approximately 6000 Channel Test Requirement
  - Strain Gage Devices Located Throughout Structure
  - Long Cable Lengths Contribute to Measurement Errors
    - Noise
    - Calibration Uncertainty
    - Incorrect Wiring
    - Broken Connections
    - Bridge Excitation Sources
- Problem Resolution
  - Distributed Measurement Approach

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Boeing 787 Dreamliner
Structural Test Case Study

- EX1629 Selected as Strain Gage Lab Standard
  - 48 Channel High-performance Strain Gage Measurement Unit
  - LXI Communications Interface
    - Inherently Supports Distributed Instrument Approach
    - Multiple Instruments Placed Strategically Around Test Structure
    - Low Cost Ethernet Connectivity
  - Reduced Cable Lengths Between Structure and Instrument
    - Instruments Placed Near Aircraft
    - Quicker Setup Due to Instrument Proximity
    - Calibration Simplified
    - Cabling Noise Reduced
    - Less Debug Time Required
    - Reduced Costs Associated With Transducer Cabling

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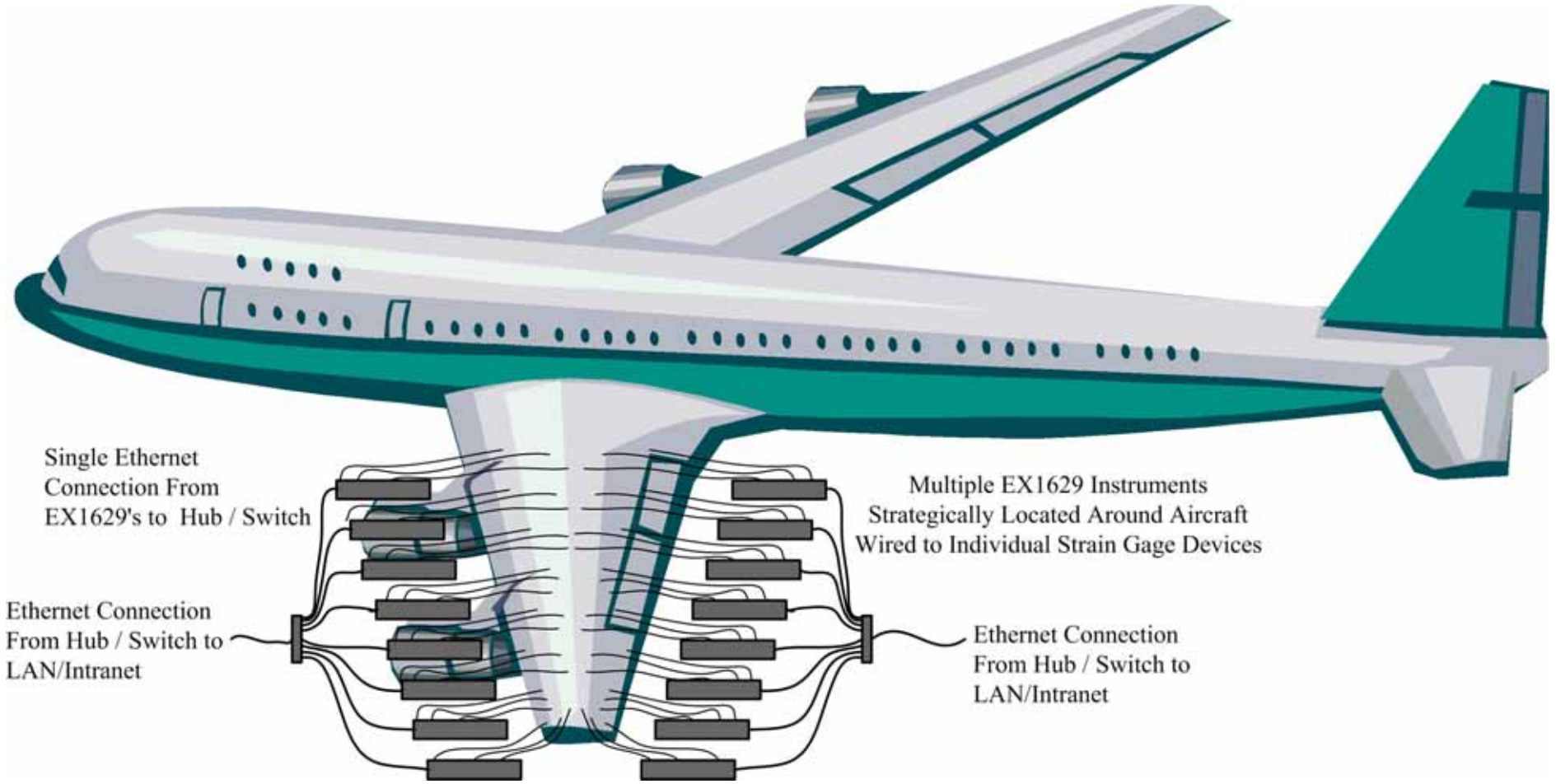
Boeing 787 Dreamliner
Structural Test Case Study



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Structural Test Case Study

- Measurement Synchronicity Critical
  - 6000 Channel Implementation
    - Over 120 Individual Instruments
  - Software Triggering
    - Not Acceptable
    - Channel-to-channel Skew to Great
  - Hardware Triggering
    - Essential Element for Synchronization
    - Propagation Delay Errors Not Acceptable
  - EX2100 LXI TriggerBus Star Hub
    - Fundamental System Component for Trigger Distribution

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Boeing 787 Dreamliner Structural Test Case Study

- EX2100 Resolves Trigger Distribution Hurdle
  - 16 Port LXI TriggerBus Star Hub
    - LXI TriggerBus for Expansion to Multiple LXI devices
    - Deterministic Trigger Pulse Distribution and Routing
    - Deterministic Clock Distribution and Routing
    - Eliminates Issues With Propagation Delays
      - -Equidistant Cables Utilized
  - Ethernet Control Interface
    - Single Point of Control
    - One Command to Initiate 6000 Channel Acquisition

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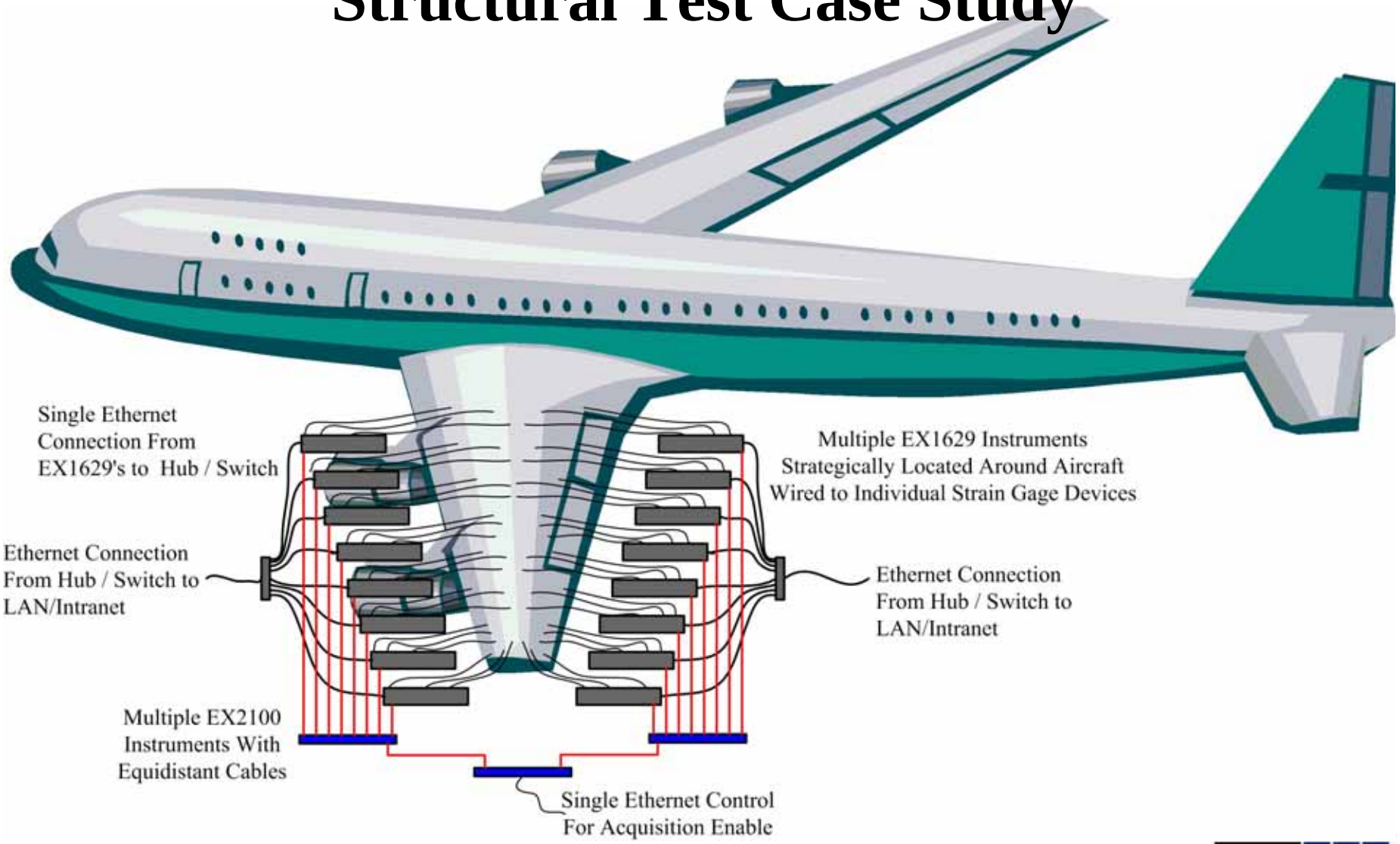
Structural Test Case Study



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LXI Product Introductions

- EX1048 Precision Thermocouple Instrument
  - 48 Channel Precision Thermocouple
  - 1000Samples/Second/Channel
  - Accepts All Standard and User Defined Thermocouples
  - End-to-end Self Calibration
- EX1629 Strain Conditioning & Measurement Instrument
  - 48 Channel High-performance Strain Gage Measurement Unit
  - 24-bit A/D per Channel
  - Built-in Bridge Completion and Excitation
  - End-to-end Self Calibration

LXI Product Introductions

- EX2500 LXI-VXI Interface
  - Gigabit Ethernet (CAT-5 & Fiber Standard)
  - 100 MByte/s Data Transfer Rates
  - Transparent Integration Into Existing Systems
  - 2eVME Support to VXI3.0 Standard
- EX2100 LXI Trigger Hub
  - Distribution of LXI TriggerBus to Multiple LXI Devices
  - 16 Port LXI TriggerBus Hub
  - (8) LVDS Channels per Port
  - Star Configuration with Buffered I/O

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