



Passive Wireless Sensor Technology Workshop

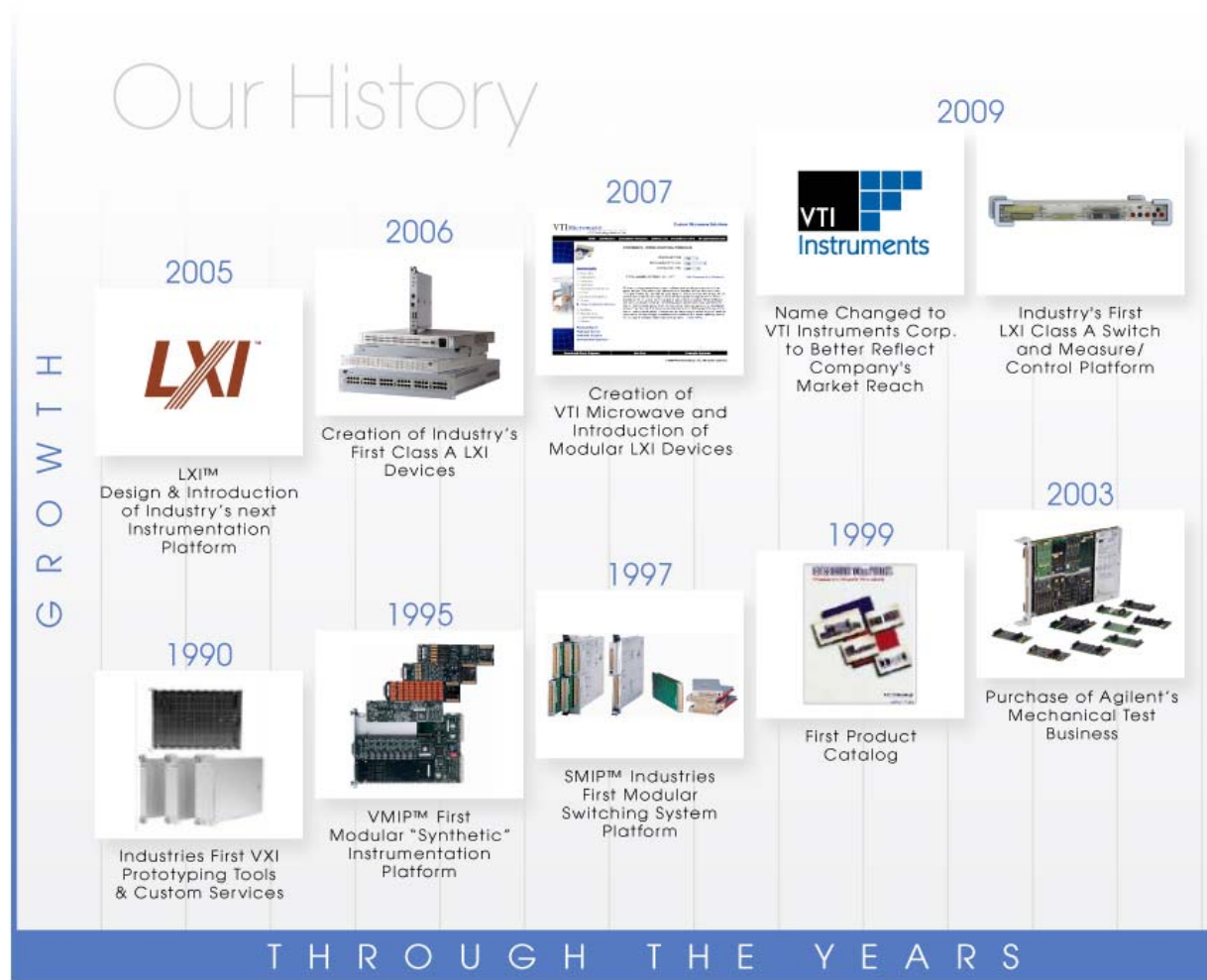
La Jolla, CA June 2012

INTEGRATING PASSIVE WIRELESS SENSORS WITH EXISTING DATA
ACQUISITION SYSTEMS



Introducing VTI Instruments

MERGING THE LEGACY OF AGILENT MECHANICAL TEST GROUP WITH THE STABILITY OF VXI TECHNOLOGY




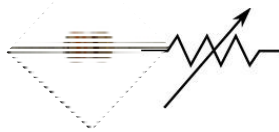
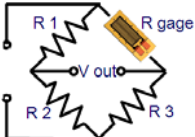
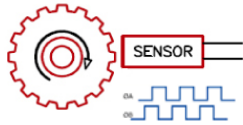





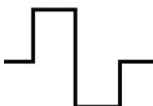
VTI - What We Do

- VTI designs and manufactures precision high-density instrumentation on open-architecture platforms.
- A growing portfolio of over 200 products that addresses electronic and mechanical test applications.
- The business units (product groups) address the following areas:
 - **Functional Test**
 - **Integrated Data Acquisition and Signal Conditioning**
 - **Dynamic Signal Analysis**
 - **Custom Microwave Subsystems**
- Primary customers are Aerospace/Defense/Military/Energy



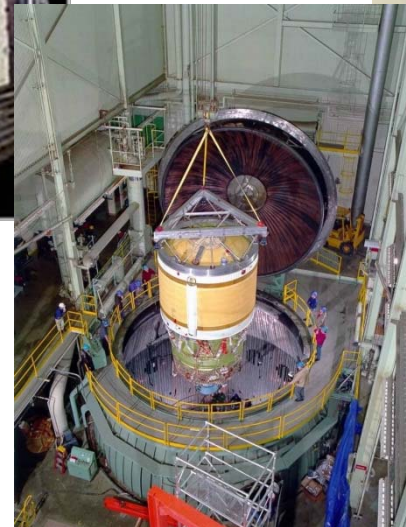
What is it we measure?

COMPLETE RANGE OF TRANSDUCER COVERAGE

Temperature (TC/RTD/Thermistor)		Resistance	
Strain/Stress		Frequency / RPM	
Pressure		Displacement	
Force & Load		Acceleration	
Acoustics		Discrete I/O	

Why do end users want wireless transducers?

CAN WE ADD WIRELESS MEASUREMENTS TO EXISTING TESTS?



NASA Dryden Flight Research Center Photo Collection
<http://www.dfrc.nasa.gov/gallery/photo/index.html>
NASA Photo: EC02-0203-55 Date: August 22, 2002 Photo by: Tom Tschida
A thin rod is all that is needed to transmit vibrations from a shaker device (at bottom) and the wingtip of the Active Aeroelastic Wing F/A-18 research aircraft during ground vibration testing

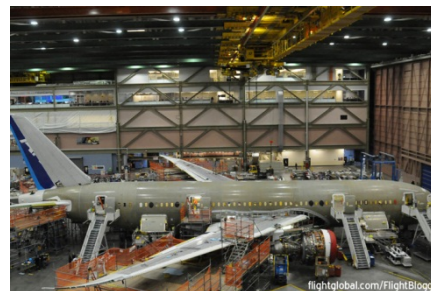
- Help me clean up the mess
- I don't like slip rings, give me a better way
- The cables effect my measurements
- How do pass cables through barriers



Primary DAQ Applications we address

STATIC AND DYNAMIC, RACKED AND DISTRIBUTED

- General purpose/high speed data acquisition
- Modal or GVT (Ground Vehicle Testing) testing
- Shock testing
- Vibration (shaker table) testing
- Order analysis or rotating machinery applications
- Acoustics
- Static Structural and Fatigue
- Temperature Testing



General Purpose DAQ Applications

BROAD COVERAGE OF SENSOR TYPES

- Multiple sensor types
 - Temperature
 - Acceleration
 - Speed/RPM
 - Pressure
 - Load/Force
 - Voltage
 - Strain/Bridge
- Low and high speed time-domain applications
- Typical Application Areas
 - Test cells
 - Jet engine
 - Rocket engine
 - White Good Manufacturers
 - General Automotive testing
 - Battery/Solar Cell Testing



General Purpose DAQ Applications

KEY EVALUATION CONSIDERATIONS

What is important to the end user?

- Cost/channel can be a key consideration
- Accuracy can be important depending on application
- **Ease of Use**
- **Quick test setup and teardown**
- Ability to distribute across large area is attractive
- Turnkey software, or minimal development effort
- Software tools that they can use to roll their own application
- Additional data processing done post test
- Continuous sampling important (no gaps)



Modal/GVT (Ground Vehicle Testing)

VIBRATION TEST OF MODAL PARAMETERS OF OBJECTS

Overview of Application

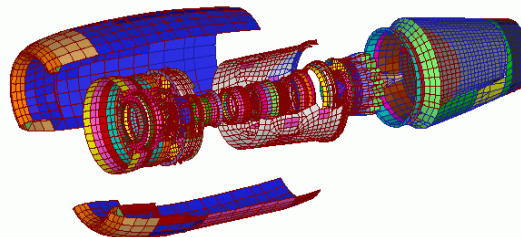
- Characterize the dynamic behavior
- The structure is modeled in Finite Element Analysis
- Excite the structure and verifies the actual behavior of the structure
- Frequency response functions data is used

Typical Type of Measurement

- Loads (voltage / bridges)
- Vibration (accelerometers ICP or charge)
- Strain

Typical Customers / Applications

- Aerospace
 - Space structures
 - Aircraft
 - Ground flutter
- Automotive



Modal/GVT (Ground Vehicle Testing)

KEY EVALUATION CONSIDERATIONS

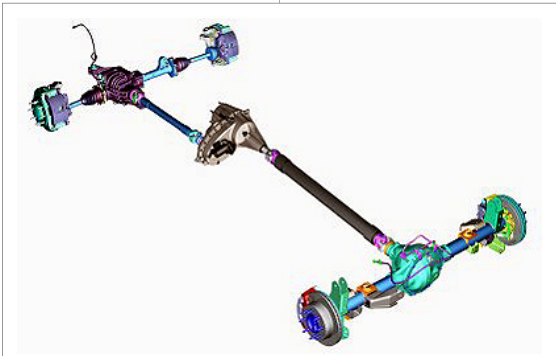
What is important to the end user?

- The ability to distribute the measurements close to the structure
- **Cables add mass and damping, I need to manage this**
- Simultaneous sampling to eliminate channel/channel phase skew
- The ability to move lots of data is very important
- Turnkey software is historically required
- Data is analyzed in the frequency domain
- Move raw data and have the PC do the analysis/processing



Rotational Machinery and Order Analysis

ROTATIONAL MACHINE HEALTH MONITORING



Overview of Application

- Characterize rotational vibration problems
- Utilities tachometer input with vibration readings
- Data acquired in the order domain
 - Predict bearing/race failures
 - Improve operational reliability



Typical Customers / Applications

- Turbine/Generator testing
- Drive train analysis
- Transmission analysis
- Windmill testing

Rotational Machinery and Order Analysis

KEY EVALUATION CONSIDERATIONS

What is important to the end user?

- Repeatability of measurements is a must
- High performance Tachometer inputs simply setup
- **I need to measure rotating mass**
- Data will be re-sampled for order domain analysis
- Phase angle/sampling and Tach accuracy important for balance operations
- Turn key software solutions are desired
- Distributed
- Software tools that they can use to roll their own application



Static Structural and Fatigue

STRUCTURAL VERIFICATION AND VALIDATION



Overview of Application

- Large infrastructures, buildings, bridges and anything carrying large loads
- Improve structural integrity, minimize failure due to environmental conditions
- Verify structural integrity, proactive health monitoring
- Distributed channel counts in small increments

Typical Customers / Applications

- Department of transportation
- Civil Engineering
- FAA
- Halliburton
- Bechtel
- Universities

Typical Measurement Types

- Temperature (mainly T/C)
- Pressure (voltage or bridge)
- Loads (voltage or bridge)
- Vibration
- Strain

Static Structural and Fatigue

KEY EVALUATION CONSIDERATIONS

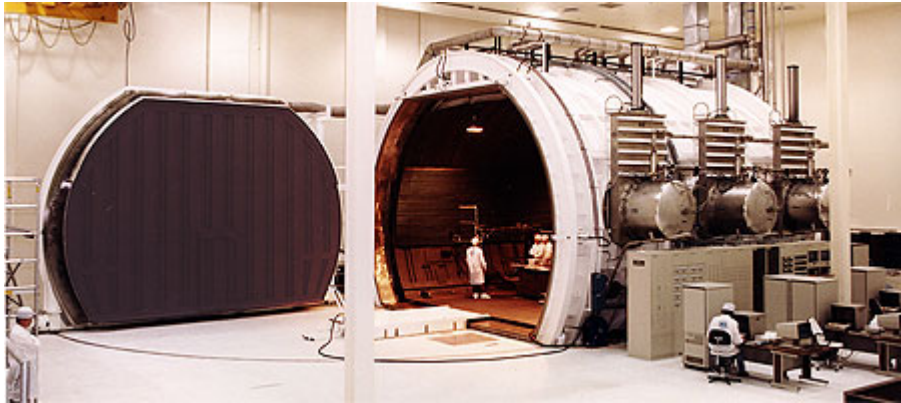
What is important to the end user?

- **The ability to place the instruments close to the structure to minimize cable lengths**
- Synchronization for improved data understanding in the event of a failure
- Front end configuration flexibility, support multiple transducer types (load, strain, pressure, displacement)
- **Scalability is critical as these can become very large tests**
- Turnkey software is preferred, ease of use
- **Help me manage channels for large test configurations**



Temperature Testing / Test Cell

TEMPERATURE MEASUREMENTS AND MONITORING



Overview of Application

- Thermal and Thermal Vacuum test chamber
 - Specimen performance or life testing
 - Measure temperature (TC, RTD, Thermistor)
 - Misc other channels as well (RH, Pressure, etc)
 - Measurements at slow sample rates except for Thermal Shock testing
- Engine Test Cell
 - Turbine test cells designed to test extreme limits of turbine engine performance
 - Developmental cells can measure >1000 channels
 - High mix of measurements in a system to capture all parameters (Temperature, pressure, load, acceleration, flow, etc)

Temperature Testing / Test Cell

KEY EVALUATION CONSIDERATIONS

What is important to the end user?

- Repeatability of measurements is a premium
- Temperature accuracy
- **Easy connectivity, mini-TC simplifies setup**
- OTD shows failed channels before critical testing
- Measurement stability, some tests last for a long time
- Distributed measurements ease setup and reduce noise
- Real time limit checking with alarm or shutdown capability
- Software tools that they can use to roll their own application

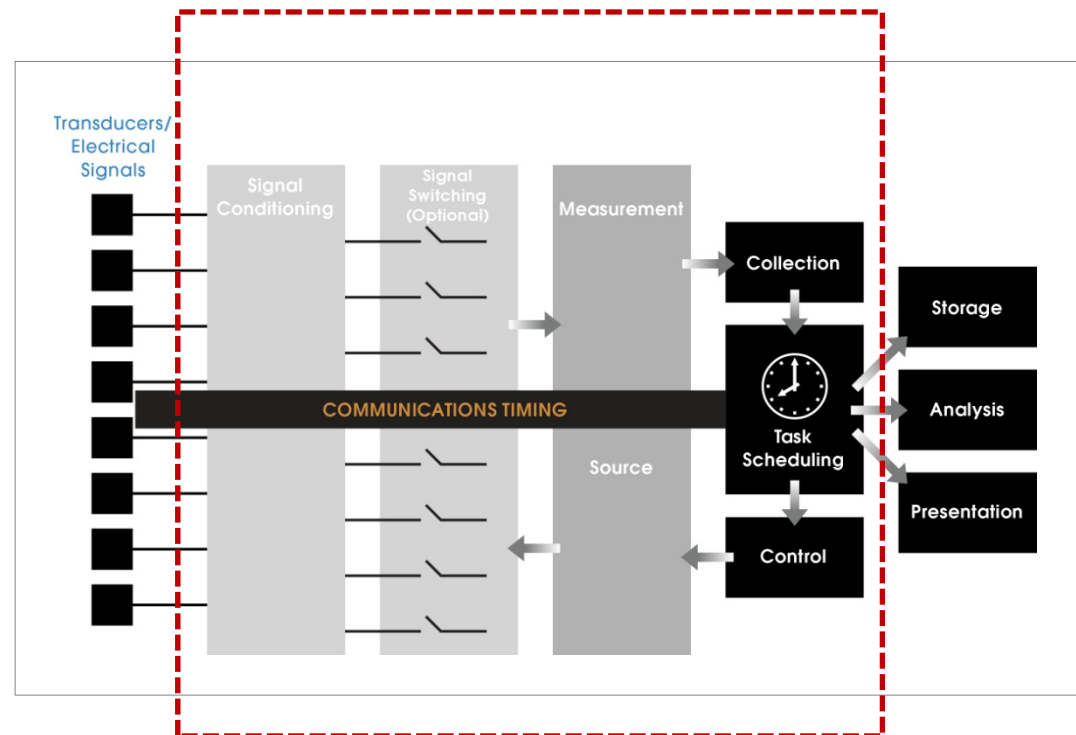


Why Are We The Gold Standard?

IT'S MORE THAN JUST A COLLECTION OF A/D CARDS

INTEGRATED DATA ACQUISITION DESIGN PHILOSOPHY

- System level design from the transducer inputs through to the digitizer
- Signal conditioning including filtering, gain, excitation, self-calibration
- Measurement uncertainty minimized with high integrity signal path
- Synchronization



LXI Overview

INDUSTRIAL ETHERNET FOR TEST AND MEASUREMENT

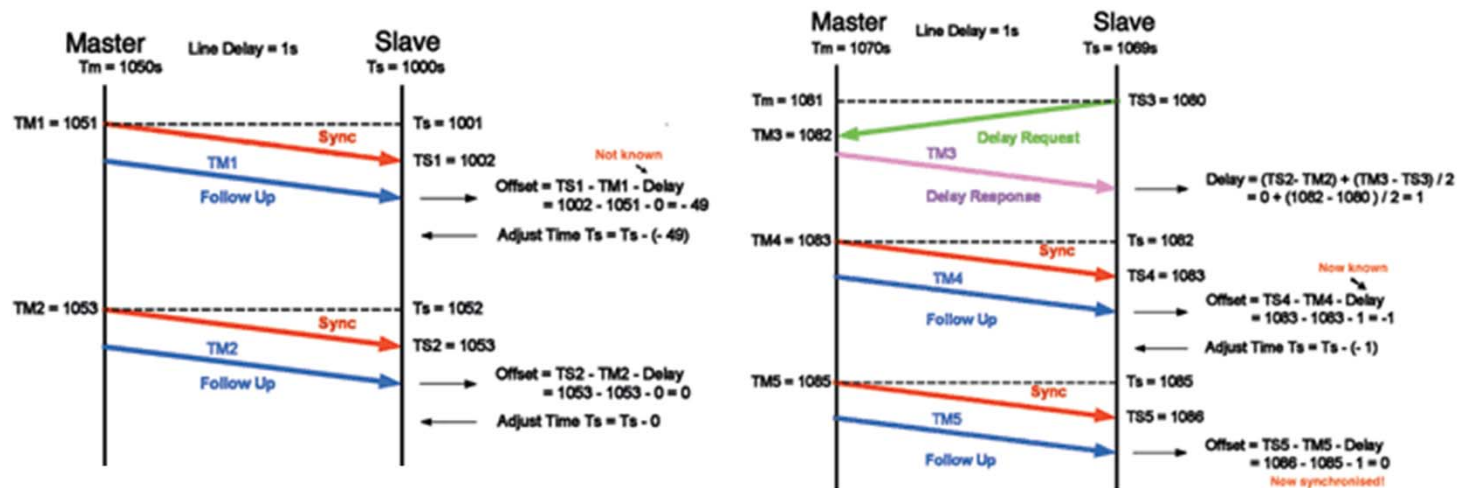
▪ Key Functional Areas of LXI Specification

- Physical
- Device Synchronization & Triggering
- Module-to-Module Communications
- Programmatic Interface (Drivers)
- Device Discovery
- WEB Interface



IEEE 1588 Precision Time Protocol

ETHERNET SYNCHRONIZATION



The synchronisation process is carried out in two parts. First the time difference between master and slave is corrected - this is the offset measurement. During this offset correction, the master cyclically transmits a synchronisation (SYNC) message containing an estimated value for the exact time the message was transmitted to the related slave at regular intervals. (Left diagram)

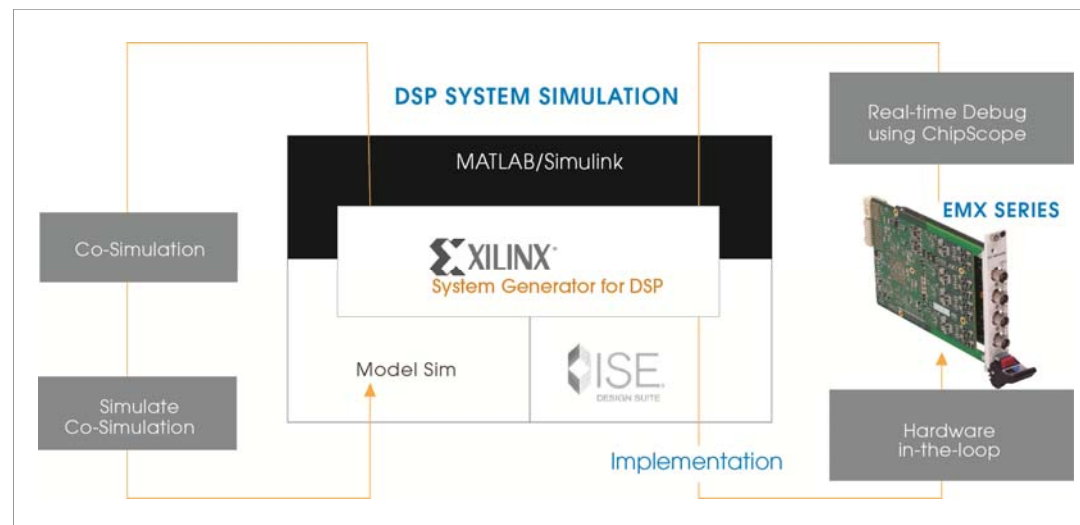
In the second part, the delay measurement determines the delay or latency between slave and master. For this purpose the slave sends a so called delay request packet to the master and uses this to calculate precisely how long it takes to transmit the message over a particular network section. (Right diagram)

Personalized Digital Signal Processing

SYSTEM-ON-A-CHIP (SoC) HARDWARE ENHANCEMENT

FLEXIBLE HARDWARE CONFIGURABILITY AND CUSTOMIZATION

- Customize hardware performance to meet challenging application requirements
- Real-time data manipulation and decision capability independent of host computer
- Access to hundreds of signal processing, analysis, and filter implementation methods
- Ideal for order analysis, event detection / response, and distributed closed loop control
- Industry standard open-platform MATLAB and Simulink design tools simplify implementation



Software Industry Standards

“OPEN” APPLICATION PROGRAMMING INTERFACE (API)

OVERVIEW

- Industry standard open source architecture drivers
- Supported on all operating systems (Windows, Mac OS, Linux)
- Support for many different programming languages (C/C++, C#, LabVIEW, Matlab/Simulink, Visual Studio, Visual Basic, Python etc.)

BENEFITS

- **High Performance** – powerful state-caching engine
- **Instrument Simulation** – built in instrument simulation capabilities
- **Instrument Interchangeability** – drivers are interchangeable across instruments
- **Cross Platform** – independent of operating system and programming language
- **Future Proof** – minimize obsolescence issues, provides software longevity





PRECISION MODULAR INSTRUMENTATION



VTI Instruments

YOUR WORLDWIDE PARTNER FOR PRECISION TEST AND MEASUREMENT

VTI INSTRUMENTS WORLDWIDE



● VTI Instruments Corporate Headquarters ● VTI Instruments Office ● VTI Instruments Sales and Support

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RELIABLE DATA FIRST TIME EVERY TIME