Virtual Instrument Software Architecture data management for VISA based LXI device

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***Abstract* ---LAN eXtension for Instrumentation (LXI) is an instrument based on local area network (LAN) and industry-standard Ethernet technology. This LXI technology makes system configuration simple using the widely-adopted Ethernet with VXI-11 instrument discovery, including VISA and IVI drivers to instruments. The LXI instrument is a switch matrix fitted between the engine sensors and the data acquisition and control system. It separately connect/disconnect the signals from either side and concurrently to connect them to an internal bus having a multimeter, an oscilloscope or a PWR supply. The LXI instrument allows us to simulate or measure the system without disconnecting and separating channels throughout the system wiring. National Instruments LabVIEW provides a Human-Machine Interface (HMI) to configure and run the integrated system allowing a complete system testing in a short time.**

***Keywords:*LXI technology, DAQ switching unit, oscilloscope, multimeter, programmable PWR Supply, LabVIEW.**

I. INTRODUCTION

The widespread adoption of LXI to replace GPIB is driving the development of high-performance, LXI-based tools [8] for a variety of applications. With LXI, engineers can add modularity, flexibility, and performance to new and existing systems, which provide new possibilities in their applications. LXI promotes ease-of-use with easily configurable LAN options, VXI-11 instrument discovery, and connectivity between test and measurement software, including VISA and IVI drivers to instruments. Because LXI offers numerous benefits as an emerging technology, and will continue to play a role in data acquisition applications where flexibility and seamless integration are critical application needs. Many companies have adopted LXI technology, which has been in existence since 2004.Common industries where LXI technology is used include Aerospace/defense, Power generation, Automotive, Industrial, Medical devices, Consumer electronics.

The Virtual Instrument Software Architecture (VISA) is a standard [7] for configuring, programming, and troubleshooting instrumentation systems comprising GPIB, VXI, PXI, Serial, Ethernet, and/or USB interfaces. VISA provides the programming interface between the hardware and development environments such as LabVIEW. NI-VISA is standard across the National Instruments product line. It provides a consistent and easy to use command set to communicate with a variety of instruments.

To develop real-time data acquisition and control system for aircraft engine testing, while maintaining the system configuration flexibility and efficiency is a big task. The channel selection for one-to-one switching, cross switching and measure/simulate withdevices to perform simulation, measurement plays a significant performance challenges.

Using National Instruments LabVIEW [1] Real-Time to program a system of four bussed lines LXI device with switching matrix to implement a data acquisition and control system. By distributing the system features to separate components, we reliably achieved very aggressive performance requirements. A feature-rich, database-driven host application [3] runs on a server-class PC to provide the system's user interface. The host application provides NI LabVIEW user interfaces to configure and run the system, with relevant settings according to the parameters for measurement, simulation or programmable or fixed PWR supply. Built-in networking features in LabVIEW allow remote access to calibration and run-time data displays.

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II. METHODOLOGY

The benefit of LXI device is that the device can be used for multiplexing signals of engine to the monitoring system. Signals coming from engine sensors are to be connected to the monitoring system through the Signal Switching Unit. The unit should be capable to route, measure & display the signal instantaneously through automated process. [6] Each parameter can be selected and configured without the user to know the device specifications. It includes several modules:

- First module is regarding switch matrix with one-to-one switching, cross selection switching and switching with devices for simulate/measure functions.
- Second module includes multimeter which can be used for simulate /measure parameters such as RTD, thermocouple, frequency, voltage etc.
- Third module is to generate waveform from the handheld oscilloscope which is can also be used for measurement of high voltage.
- The last module includes programmable PWR supply to generate voltage and current.

When a developer needs a Virtual Instrument (VI) [2] to perform certain function, he looks into the appropriate subdirectory for a suitable VI. By examining the VI'S front panel and block diagram, as well as reading the VI description, the developer can ascertain if the VI fits their requirement or can be readily modified to do so. If VI meets the needs, simply copy it to the computer for inclusion in the system they are developing. Thus, LabVlEW proved to be much more [4] than merely an instrumentation control language. This approach is not limited to aircraft engine testing. It can be applied in other industries to preserve existing application software.

III. SYSTEM DESCRIPTION

The custom developed solution meets the specific requirements of HAL-AERDC, as per tender reference and Technical requirements document reference. It is configured using offthe-shelf computer controlled instruments and interfaced through customized application software. This system is intended to interface with the signal and power cables, wired between aero engine under test and control room instrumentation. It is not intended to be a replacement system for data logging / control applications, although it's functionality can be programmed to perform such tasks.

A. Design considerations

The system has 4 major operations, which can be used in combination to assist operator, in various troubleshooting tasks. These operations can be categorized as Signal routing, Transducer Simulation, Signal measurement, and Power Supply.

1. Signal Routing

Signal routing capabilities of this system are at the heart of this system, and hence play's a critical role. Since, all signals will be routed through switch system; its specifications overrule the individual specifications of measurement as well as simulation instruments, connected to it.

2. Transducer Simulation

This system is able to simulate various types of transducers, by means of appropriate electrical quantities (Voltage, current, resistance, frequency etc).This capability of this system can be used for mimicking the engine sensors, their fault responses, etc. Combined with the switching system, and other power resources, various types of conditions including open loops, short circuit conditions, accidental short circuits to power lines, etc can be simulated.

3. Signal Measurement

This system is able to measure various electrical quantities, including the responses from various types of common transducers. The measurement resources include necessary signal conditioning to cater for various types of sensor linearization needs. The signal measurement resources can be broadly categorized as non-isolated low voltage level (< 20V) and ground isolated high voltage level types.

4. Power resources

This system is able to provide power to various external systems, for the purpose of enabling their functionality, or for excitation or for power bus fault simulation. This system uses two types of power resources for doing these functions. First one of the power resources is a 37V programmable voltage source, while the other is a fixed +24VDC supply.

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B. System architecture

The system which is used for engine testing mainly involves the engine sensors connected to the switching unit. This unit has 4 bussed lines with 0 to 192 channels for signal switching. The channels from 0 to 184 is used for one-to-one switching and cross switching without any device interfaced These switches are given to the user. The channels from 185-192 are specific in nature. Each channel is associated with different functions which can be individually configured. They are used for measuring, simulating and generating PWR supply.

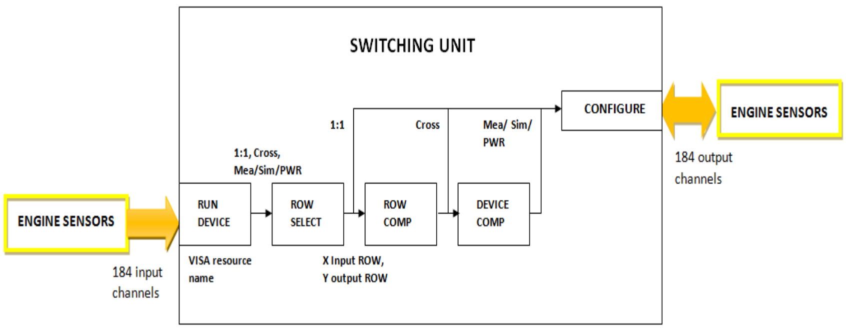

Fig.1 System Architecture

IV. PROPOSED WORK

For the implementation part of the LabVIEW framework, the application [5] requires minimum three modules with many VI's and sub VI's associated with it.

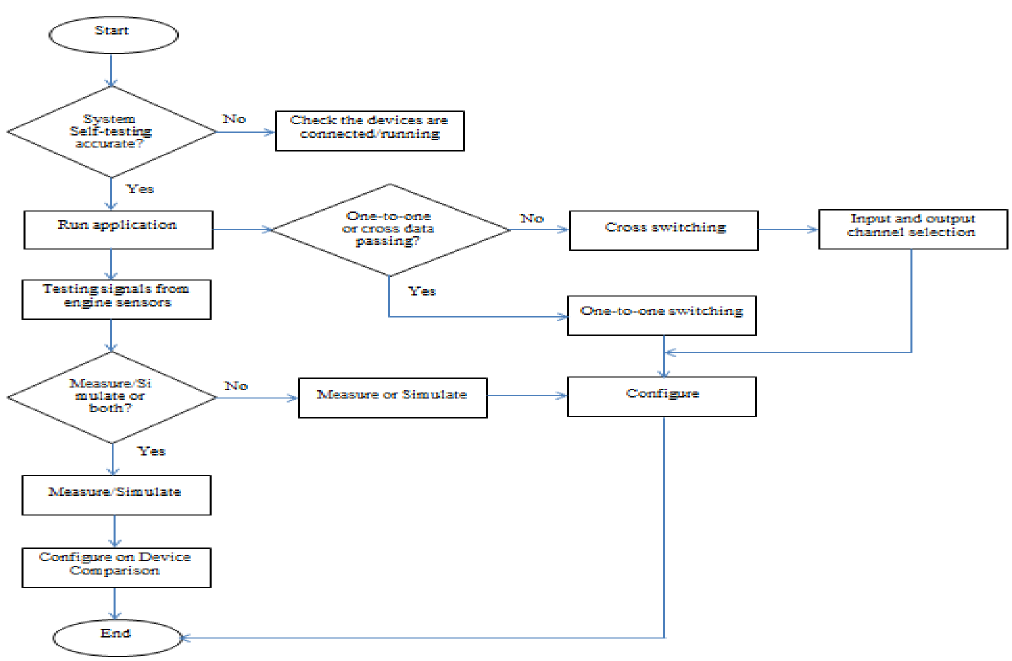

Fig.2 Control-flow diagram

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1. One-to-One data passing

One-to-One data passing through switching unit takes the signals from the engine sensors to the data acquisition and control system. The VI for one-to-one data passing include same channel for both input and output. The switching unit has a set relay matrix which is used to set the selected relay to OPEN or CLOSE and get relay is used to return the relay state. This relay matrix include controls and indicators having VISA resource name with instrument handlers, row and column selection. 184 switches are individually placed for single channel selection or select all/deselect all switches with a single click.

2. Cross data passing

The VI for Cross data passing involves both one-to-one or cross selection of input channels and output channels with 4 different combinations implemented on 4 bussed lines of the switching unit. The device first handles the instrument for the VISA resource name. It then checks for the input columns A, B, C, D row comparisons and similarly for output columns A, B, C, D comparisons to avoid repetitions of the column number used more than one time. Initialize is the first step to interact with the device.

3. Measure/Simulate

The actual data management for the application comes in this phase. The first step involves Initialize to interface with the device which involves VISA resource name, id query, reset device, errors handlers. This is further given to carry out the row comparisons and then device comparisons for device selection. On configuring, the user can Measure/Simulate the data, generating the data or generating the PWR supply for various parameters such as voltage, thermocouple, resistance, current, frequency, waveform and RTD.

4. System self-test

The data is managed between the devices internally through the switching matrix. This is done to test the system devices working accurately. The voltage from PWR supply is measured at the oscilloscope column B and the voltage from multimeter is measured at the oscilloscope column A.

V. CONCLUSION AND FUTURE WORK

The proposed methodology is an integrated real-time system with different device features programmed in one application software. Each parameter can be selected and configured without the user to know the device specifications. The engine sensors connected to the data acquisition and control system can be measured or simulated when the engine is in running state. Therefore, Signals generated by a signal source can be obtained and tested accurately in a short time. The host application provides Human Machine Interface (HMI) to configure and run the system. Relevant settings are provided according to the parameters for measurement, simulation or programmable/fixed PWR supply. LabVIEW offers several advantages over conventional programming languages in developing aircraft engine test software. LabVIEW establishes "generic" Vls (virtual instruments) for subsequent reuse for other aircraft engine types/variants. The instrument drivers take advantage of LabVIEW’s built-in VISA function to make the Virtual Instrument (VI) as generic and reusable as possible. This approach is not limited to aircraft engine testing. It can be applied in other industries to preserve existing application software.

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