Introduction and Application of LXI Bus Technology

Lei ZHU[1,a], Shuai CHENG[1,a], Haiming JIA[1,a]

[1]No. 63981 Unit of PLA, Wuhan, 430000, China

[a]email:zhulei1120@126.com

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Abstract. Based on Ethernet, LXI is a new generation modularization equipment platform standard. Comparing with GPIB, VXI and PXI buses, LXI bus provides many more advantages, such as networked, lower price, higher performance and smaller dimension. This article makes a full introduction of LXI bus and its key technology. As the ground system has the characteristics of numerous equipment types and wide geographical distribution, LXI bus is used to upgrade the original equipment monitoring system. Then a networked status monitoring and fault diagnosis system based on LXI bus is designed and realized.

Introduction

At September 2004，a new generation standard LXI（LAN extensions for Instrumentation）based on LAN modularization platform is pushed out by Agilent company and VXI technology company based on industrial standard ethemet technology. It expands the language, command and protocol needed by instrument, and several desktop instrument features are integrated on it, such as internal measurement technology, PC standard I/O connected capability, modularization based on framework system and dimension. Comparing with the solution raised by former testing system, the solution raised by LXI is more compact, more quickly and cheaper.

The main aspects of LXI standard are physics requirement, Ethernet protocol, LXI interface and LXI triggering [1].being different from traditional testing instruments, LXI modular has processor, LAN connection, power supply and input triggering. The input signal and output signal of LXI modular is on the front panel, and the LAN connector, AC power supply is on the back panel. The height of LXI modular can adopt one time or twice standard frame height, the width of LXI modular can adopt a half of the standard frame width [2].The modular structure is showed in Fig.1.

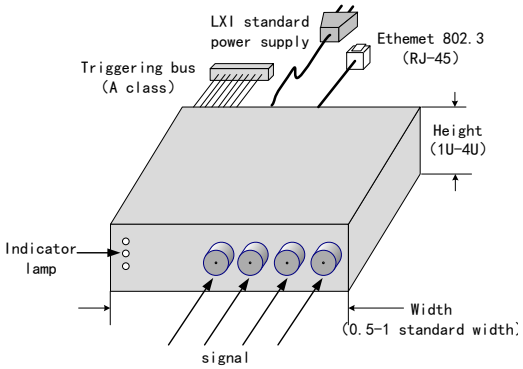

Fig.1 LXI modular structure feature

Key technology of LXI bus

As one kind of new instrument bus standards, LXI bus technology adopts various software and hardware technologies, such as timing and synchronization technology, oriented signal IVI-COM technology, and so on.

Timing and synchronization technology. LXI instrument is divided into three kinds: A class, B class and C class. C is the basic class. With ability of programming control according LAN, C class instrument must accord with physics requirement, Ethernet protocol and LXI interface standard. B

class posses all the abilities of C class, meanwhile B class has IEEE 1588 exact timing synchronization standard. A class posses all the abilities of B class, meanwhile A class has ability of hardware triggering .corresponding to three kinds of instrument, there kinds of synchronization triggering mechanism: network message triggering, IEEE-1588 exact timing synchronization triggering and triggering bus. The precision of the next one is higher than the former one.

Network Message Triggering .Network message triggering can realize one point to many points triggering application, and it usually adopts NTP（Network Terminal Protocol）.In this mode, several LXI instruments connect with each other according switch or concentrator. Network message is sent from one instrument to others by computer [4], as showed in Fig.2.

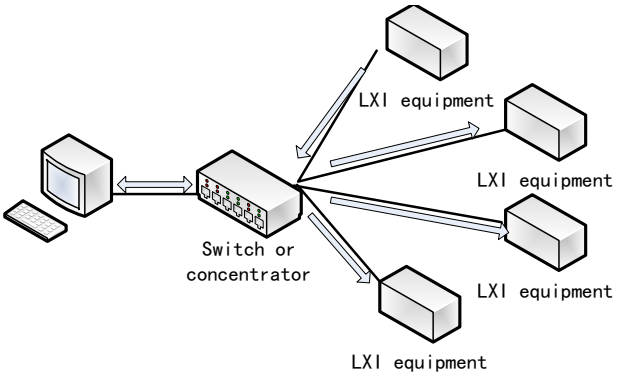

Fig.2 Network message sending condition

Timing message sent by GPS timing code is the reference standard of NTP. NPS does not need special triggering line, so it can adapt all kinds of international environment. in the normal environment, the clocking precision of NTP is to millisecond. So the precision of network message triggering method based on NTP is low, and this method is easy to obtain.

IEEE-1588 exact timing synchronization triggering. PTP（Precision Time Protocol）is usually called IEEE-1588， is one time checking mechanism for overcoming the real-time insufficiency of ethemet. According transmission of different clock signal, the network delay is calculated.

PTP adopts time stamp to synchronize local time. The TCP/IP protocol based on this technology can be used in high precision Net Control System without great changing. One 1588 PTP includes several nodes, and each represents one clock connecting with each other through network. Clock is divided into two parts: normal clock and boundary clock. Normal clock has one PTP port and boundary clock has several PTP ports. Using these two clocks, PTP system transmits synchronal signal. Sync principle includes message records of sending time and receipt time, and each message has time stamp. With time records, the receiver can calculate clock error and time delay in network. PTP can reach precision within 100ns, and it is suitable for triggering and synchronization of LXI modular [5].

Bus triggering. Hardware triggering bus style is used in A class instrument of LXI. It is hardware bus of eight linear M-LVDS. Every channel uses LVDS driver and receiver to transmit triggering. It can connect several instruments nearby by daisy chain style, and it also can connect instruments with distance by asteroid structure. Daisy chain and asteroid structure are showed in Fig.3. Hardware triggering bus style is of high synchronization precision. The reaction time of signal by this triggering bus style is very short, and the precision is about 3ns/m [6].

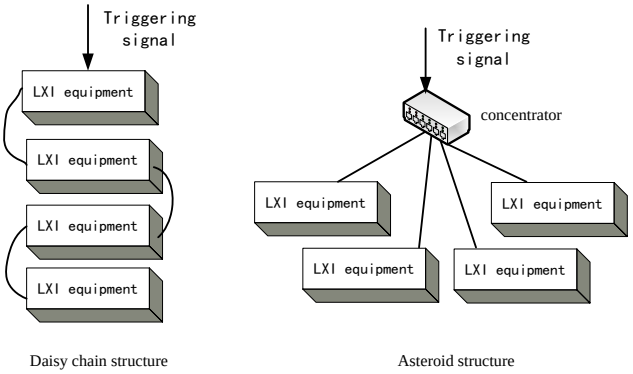

Fig.3 Triggering connection structure of LXI instrument bus technology

Oriented signal IVI-COM technology. IVI（Interchangeable Virtual Instruments） standard is used as driver for all the LXI instrument. IVI driver standard is a technology developed from VPP （VXI Plug & Play） standard. It defines the special function which can change the bottom hardware without changing the upper driver program. This function decreases the development period and cost of the testing software in the testing system. It provides effective methods for raising testing velocity [7].

Based on API (Application Programming Interface), IVI instrument driver program is divided into two parts: IVI-C and IVI-COM. They are combination production of ANSI-C, COM technology and virtual instrument. For IVI-COM driver program uses Microsoft COM technology which is supported by all main application program development environment as basement, the IVI-COM driver program is used in LXI standard.

Application of LXI bus technology in network monitoring system of testing ground management system

Testing ground management system is composed with standard equipment subsystems, such as fuel filling system, air condition, power supply and distribution and fire fighting, and non-standard equipment subsystems, such as crane, launcher and swing link. The technique condition of subsystem will affect the test task result.

PLC monitoring system is equipped in most subsystems of testing ground management system now, so the technician can know the running state of equipment in real time. For the function of each monitoring system single, the data cannot be shared in these systems, so it is not easy for the administrator to master all the data and the fault is not easy to be removed. Especially when the fault appears among several subsystems, historical data and real-time data is usually needed for debugging.

Using the network state monitoring system constructed by LXI bus technology, the technician or administrator can know running state of all the equipments by network server. So LXI bus technology is of great significance for information and management of testing ground management system [8].

General structure of network monitoring system. General structure of network monitoring system is showed in Fig.4.

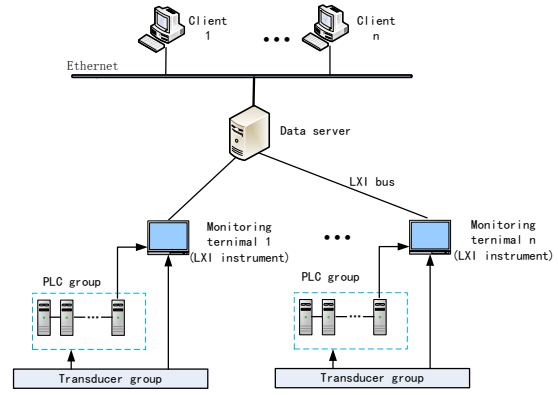

Fig.4 Structure of network monitoring system

In the structure of network monitoring system, the former “computer+PLC” mode is developed to “client+data server+acquisition terminal (LXI instrument) +PLC”mode.

From the base transducers, the analog signals changing slowly, such as temperature and humidity, air quantity and so on，are transformed to digital signal in PLC, and then these signals are transmitted to monitoring terminal; other analog signals changing fast, such as vibration, electricity and so on, are transformed to digital signal in monitoring terminal. Every monitoring internal which is equal to one LXI instrument is used to monitor subsystem running state of testing ground management system. It can upload the state data of subsystem equipment to data server through network interface. Using fault diagnosis and aid decision software, data server collects all the equipment state data of subsystem for data management and analysis. Meanwhile, long-range client can know running state of every subsystem through network data server.

Design of monitoring internal based on LXI bus technology. The monitoring system interface is LXI modular standard crate. The external interface is composed with aviation plug, power plug, net mouth, VGA, string and USB. LXI modular is composed with network controller, embedded microprocessor, memory location, function circuit, network interface and power supply. It is showed in Fig.5.

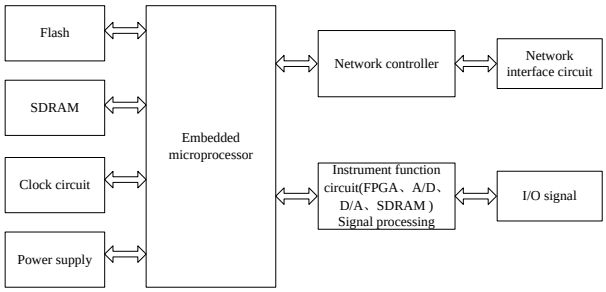

Fig.5 LXI modular composition

The core device of LXI bus interface is network controller. At present, the commonly used network controllers are RTL8019AS and CS8900A based on ISA bus interface and Intel21143 and RTL8029AS/RTL8039AS based on PCI bus interface. The RTL8019AS chip adopted in the design supports ethemet II and IEEE802.3, and it supports eight bit and 16 bit data bus. The network controller designed by RTL8019AS chip can connect ethemet through RJ-45 to transmit equipment data to distance data server. To ensure system performance, AT91SAM7X256 chip is chosen as the embedded microprocessor. The processing speed can reach 80MHz. the CAN bus register, USB interface register and 10/100base ethemet controller are integrated in the chip to satisfy requirement of environment.

Software design. The system software is designed under Windows CE operating system, using Embedded Visual C++ as development language. The software is used for network fault examination and aid decision of equipments in testing ground management system. The software composition is showed in Fig.6.

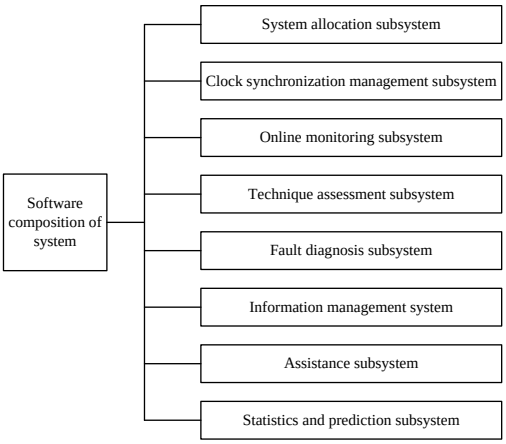

Fig.6 Software composition of system

In Fig.6, the system allocation subsystem allocates testing proposal and assessment proposal online based on user requirement and hardware resource. Clock synchronization management subsystem determines clock offset and clock delay for the purpose of clock synchronization based on PTP. Online monitoring subsystem has the function of data acquisition, memory and display, initial analysis and real-time classification alert for monitoring online and classification alert of equipment running state in testing ground management system. Technique assessment subsystem detects equipment technique state and evaluates the state changing trend through monitoring of historical data and real-time data. Fault diagnosis subsystem is composed of knowledge base, inference engine and explanation engine, and it is used for fault location and isolation. Information management system is used for data management and historical data analysis. Assistance subsystem provides assistance of software operation for user. Statistics and trend prediction subsystem is composed of statistics of working condition and prediction of fault period, location and detriment for user counseling. This subsystem is used for analyzing equipment running state to decrease fault probability.

Conclusion

This paper uses LXI bus technology to establish networking condition monitoring system. The application is of great significance for information construction and management level of range.

Ethemet is protagonist for future of testing system. LXI bus technology is generated based on ethemet technology, so it must be protagonist for future. In several years, LXI bus technology will exist with GPIB, VXI, PXI and LXI bus technology. The mixing testing system composed with them will be used. But LXI bus technology is the future tendency, and it will replace original bus technology for its performance, compatibility and easily use.

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