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Industrial LAN for Vibration Monitoring and Fault Diagnosis of Turbo-Generator*

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Abstract: The unique of using industrial LAN based on field bus to construct the system of vibration monitoring and fault diagnosis is introduced. The LAN topology, client/server architecture, database and designing of application software for vibration monitoring and fault diagnosis are involved. How to apply industrial LAN to the vibration monitoring and fault diagnosis of turbo-generator is discussed, and a scheme of how to construct the industrial LAN for vibration monitoring and fault diagnosis of turbo-generator is presented.

Key words: field bus, vibration monitoring, fault diagnosis

Industrial local area network (LAN) based on field bus is applied more and more widely. The industrial LAN discussed here is based on the Lonworks field bus. The traditional system of vibration monitoring and fault diagnosis of turbo-generator is made of a data acquisition system (DAS), many sensors, and many cables. While sensors are installed at the test point in the field, the DAS is installed in a central controlling room, which is usually far from the sensors. Each sensor is connected to the DAS by a cable. After the system is installed, it is difficult to add new sensors and new functional models, because of the limitation of the cables and the capacity of the DAS. Maintenance is also a problem, because repair technicians can't solve the problem just at the place near the fault; they have to shuttle between the central controlling room and the place where the fault occurs.

Recently, a new concept "field bus" is referred frequently. Field bus has been applied successfully to vehicle control, industrial process control and home automation etc. The system based on field bus is an LAN. This kind of system is cost effective, reliable and flexible. The network protocol has been integrated into an IC, so the network is transparent to device manufacturers, system integrators and end-users. With the services provided by the LAN, the system can grow smoothly and be transparent to the end-user except for the increase in capacity and functionality. Repair technicians can plug tools into any point in the network, so they can repair the system near the faults. There are two kinds of popular field buses: CAN and Lonworks. Bosch Corporation develops the CAN and Echelon Corporation and Motorola develop the Lonworks. The LAN based on these kinds of field bus allows different kinds of microcontroller, a PC running on Windows or Windows NT, and even a UNIX system with suitable interface to exist together. The CAN is relatively a simple system, but Echelon Corporation has developed many tools for the LAN integration, making it easy to be developed and used. The system of vibration monitoring and fault diagnosis of turbo-generators involves hard task of data management, so the Lonworks would be the best choice.

1 LAN Structure

ISO has defined a compute network model, named "open system interconnection basic reference model". With this 7-level model, different networks can interconnect to each other. But for LAN application, only the basic 3 lower layers are needed. They are physical layer, data link layer and part of net layer, and are described in detail in ISO 8802. Industrial LAN is a simplified, small scale LAN model of the standard one, its topological structure is a bus style, and all devices on the LAN are connected by one physical channel, so LAN structure obeys ISO8802.1, ISO8802.2 and ISO8802.3. It means that its medium access control (MAC) is carrier sense multiple access/collision detection (CSMA/CD). Fig.1 shows a complete structure of the Lonworks network. It may be tailored according to the demands of the end-user.

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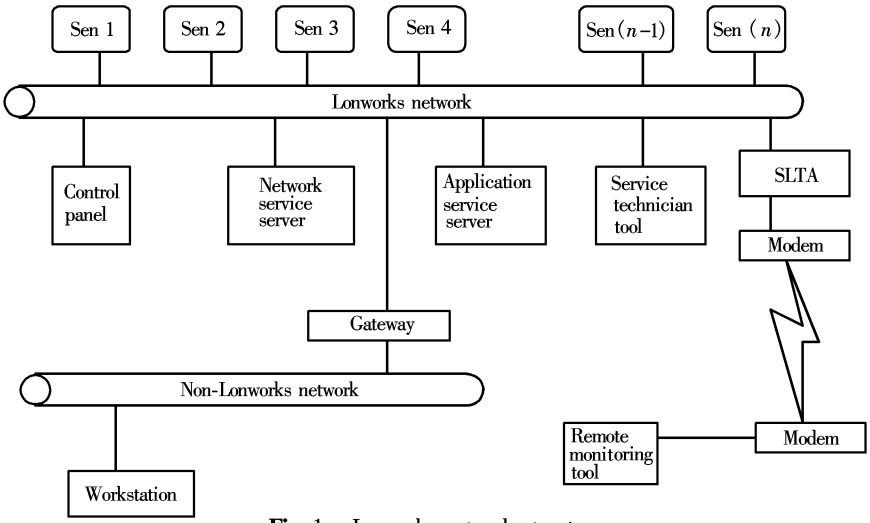

Fig. 1 Lonworks network structure

2 Client/Server Architecture

The service architecture of Lonworks network is a client-server one. The benefits of client-server architecture have made them the standard data network. Almost all-corporate data networks employ client-server architecture. The Internet — one of the hottest emerging markets, is probably the worlds largest client-server system. Lonworks network services (LNS) brings client-server architecture to industrial LAN. It provides the industrial LAN first multi-client, multi-server network operating system, overcoming many significant limitations faced by competing bus system. LNS allows multiple system integrators, managers, and maintenance personnel to simultaneously access network and application management services and data from any number of client tools. At the same time, using the services provided by the LNS architecture, tools from multi-vendors can work together to install, maintain, monitor, and control Lonworks network.

The LNS has two kinds of server, one is network service server (NSS), and the other is services application server. There can be many services application servers, but only one NSS. The NSS hosts and processes network services. It maintains the network database, enables the coordinates multiple points of access to its services and data. It also maintains a directory of all the network application service providers and event-generators. The application service servers are used to run network services application software. These applications are implemented by many vendors, including generic components from tool developer; device type specific software (DTSS) components from device manufacturers; and application-specific components from system manufacturers and system integrators.

The client can be any thing from laptop PCs to inexpensive hand-held tools with low cost microcontroller hosts, a PC running any operating system, intelligent sensors, electrical valves and simple LCD display etc.

Physically, each host is connected to network using a network service interface (NSI). The NSI provides the physical connection to the network, manages transaction with the NSS and application servers, and provides transparent remote access to the NSS service and application servers. The NSI and NSS work together to make remote access to the NSS services and data transparent to clients.

In industrial LAN of vibration monitoring and fault diagnosis of turbo-generator, one NSS and two service application servers are set up. The NSS manages the network and its database while the service application servers run application software for intelligent sensor configuration, monitoring peak and RMS values of the vibration, processing warning and dangerous conditions, normal analysis such as FFT, and fault diagnosis. More service application servers can be set up if it is necessary. All of the service application servers run on the platform of Windows 95.

Intelligent accelerometers and velocity sensors are set as part of clients. The number of sensors is tailored to the demands of the end-user. With the NSS, sensors can be added, deleted easily in the network. These sensors receive command and data from the NSS, and collect vibration data and its running state to the NSS. Unlike traditional in-line system, it is easy to sample

synchronically between different vibration signals, to fuse data from multi-sensors, to fulfill events recalling vary cheaply with the high memory capacity of server hosts. At the same time, many applications can share the data freely, so it truly integrates the monitoring system and the fault diagnosis system into one.

3 Software Designing

Echelon defines an open standard framework — Lonworks components architecture (LCA) for tools developers, device manufacturers, and system integrators to let their applications work together. LCA provides access to LNS services for hosts based on Windows NT and Windows 95. LCA uses Windows standard OLE interfaces to provide cooperation between Windows software components. LCA also defines a shared host database that is used to store host data shared between LCA components and not already stored in the LNS network database. Fig.2 shows LCA.

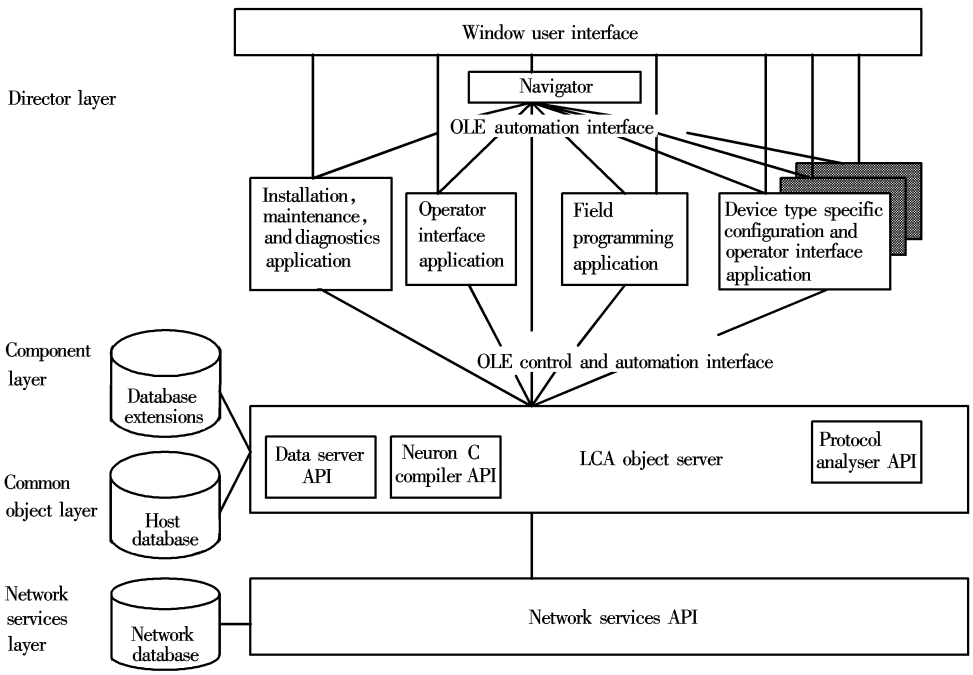

Fig. 2 Lonworks components architecture

Echelon provides network services layer and common object layer, so the system developers are not involved into network management. Network service layer provides the basic network services required by network service application running on any host. The LCA common object layer manages the network services object that are shared between multiple networks service software components on a Windows host. The common object layer defines OLE objects that are accessed by an OLE control and OLE automation interfaces.

In LCA, the software components of vibration monitoring and fault diagnosis of turbo-generator are implemented by using the services provided by the object server. These software components are interoperable with any other LCA-compliant software components. The programming environment should support 32-bit OLE controls, such as visual BASIC 5.0 or C ++5.0.

The following are a few ideas about the design of the software component of vibration monitoring and fault diagnosis of turbo-generator.

- Device manufacture should provide the DTSS of their own products, so configuration software components of intelligent sensor only direct these DTSS for end-user. The user interface is an important thing that the system software developers should do. To end-users, they can add, delete a DTSS and configure the sensors easily with the interface.
- Peak value, RMS value, warning level, dangerous level and time wave signal etc. are defined as standard network variable type (SNVT). A user interface is implemented by OLE controls for every SNVT. For example, warning level gauge control can be linked to any warning level representing a real analog value. Then an OCX library can be set up with standard controls for every SNVT.
- Software components of normal analysis and fault diagnosis are designed as network variable oriented. If the network variable assigned is changed, the software

components can adapt automatically. For example, in trending software, an end-user can trend peak value, RMS value, or the value of different sensors only by changing the network variable.

4 Database

The LNS can use two kinds of databases, one is an NSS database, and the other is a host database. The NSS database only contains information about network installation, diagnostics, maintenance, monitoring and control. A host database contains host specific data that must be shared between LCA applications. This data includes names, icons, bitmaps, and documentation for devices, Lonmark objects, configuration properties, and network variables, network variable formatting information, templates defining hardware and program properties for devices.

The host database can also include manufacture-specific extension data. This data is identified by unique manufacture IDs so that applications from different manufacturers can simultaneously add manufacture-specific extension data without causing naming or access conflicts. Application requiring extension data may implement an independent database that is referenced by indices stored in extension data in the LCA host database.

In the system of vibration monitoring and fault diagnosis of turbo-generator, there are three host databases — running time database, event database, and sensor database.

5 Conclusion

The authors discussed some aspects of lonworks LAN, and believe people working on vibration monitoring and fault diagnosis will understand its advantages. The LAN will make the system of vibration monitoring and fault diagnosis of turbo-generators more competitive.

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用于汽轮发电机组振动监测和故障诊断的工业局域网

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摘 要 介绍了基于现场总线的工业局域网构造振动监测和故障诊断系统的优越性.讨论了用于汽轮发电机组振动监测和故障诊断的工业局域网的拓扑结构、客户/服务器架构、数据库和应用软件设计,并给出了系统构造方法.

关键词 现场总线, 振动监测, 故障诊断

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