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인터넷을 이용한 분산제어 구현을 위한 네트워킹

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Internet-based Distributed Control Networks

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ABSTRACT

Requirements for device networks differ greatly from those of data (business) networks. Consequently, any control network technology which uses a filedbus protocol is, in general, different from IP network protocol TCP/IP. One needs to integrate fieldbus protocol and TCP/IP to realize distributed control over IP network or internet. This paper suggests a basic concept that can be applied to distributed control over IP network or internet. Specifically, LonWorks technology that uses LonTalk protocol is reviewed as device network. LonWorks technology provides networked intelligent I/O and controllers which make it a powerful, expandable solution. It is also addressed that many hardwired PLCs can be replaced by LonWorks devices. Connecting these remote LonWorks networks to the Internet can provide a powerful, integrated, distributed control system.

Key Words : Distributed Control, Device Network, Data Network, TCP/IP, Internet

1. Introduction

The ubiquity and cost structure of the Internet makes it an attractive option for implementing wide-area, distributed control systems. Using the internet can avoid long distance charges and provide a more uniform, reliable platform for delivering a wide range of remote monitoring and control functions [1].

Requirements for device control networks are different in many aspects from those of data networks. *Device network protocols such as fieldbus* exist on the ground of these differences. Fig. 1 depicts the typical examples of device network and data networks. There are also some common requirements between device and data networks. Examples are security, reliability, and flexible wide-area and remote access. The business networking solutions are addressing these requirements in a complete and expanding manner. Device networks can take advantage of these capabilities by properly interconnecting the device network with data network components.

Recent trends also require that access to the device network information be provided from several locations or anywhere in the enterprise. This causes the implementation of distributed control networks. Internet access is increasingly available and affordable, and along with the "internet" is the backbone of modern enterprise computing.

2. Fieldbus Networks as Device Networks

Fieldbus is a generic term that describes a digital, bi-directional, multi-drop, serial bus, communication network that supports field devices such as sensors and actuators. Using fieldbus as a means of industrial communication has several advantages.

- Reliability

- Easy implementation

Fieldbus systems for process control, automotive products and building automation are getting more and more attention. Intelligent, distributed network nodes communicate via various types of communication media and exchange data packets needed for either local or global decisions. Even if some data packets are lost, none of the cyclic transmitted messages may be lost in order to guarantee the correct behavior of the control systems. Most fieldbus systems propose mechanisms to detect modified or destroyed data packets caused by noise and interference on the transmission line. If a packet gets lost in an acknowledged service, the transmitting node is forced to retransmit this packet.

There are numerous fieldbus systems available today. These include BACnet, CAN, CEBUS, IEEE-488, ISP, Interbus, Profibus, DeviceNet, LonWorks, WordFIP, etc

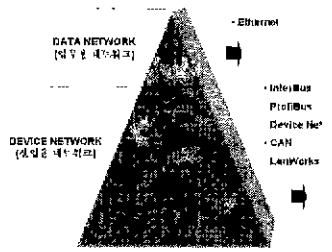

Fig. 1 Typical examples of device networks and data network.

3. Limitations of Existing Device Networks

Industrial automation spans a huge spectrum of complexity in terms of both the physical structures of devices and the tasks that they perform. This has led to an equally wide range of control devices and associated software building blocks. The lack of standardization between different control system components makes industrial control systems difficult to maintain, modify or integrate [2]. This has encouraged users to go to a single vendor for all their device control needs in order to minimize such problems. The dominance of closed, vendor specific solutions have generally resulted in stagnation rather than innovation and improvement in control systems.

Using current approaches, the application software is also difficult to design, maintain and modify because the designer cannot graphically visualize the effect on network operation and the potential problems which may result. In limited areas, simple graphics-based design tools are being created and useful standards are emerging: notably the IEC-1131 standard which defines a more open approach to the creation of PLC software based around the sequential function chart graphical language. The widespread utilization of better design approaches is, however, severely handicapped by a lack of sufficiently open, interoperable devices.

4. Interoperable (Open) Device Networks

There has been increasing interest by both end-users and device makers in interoperable (open) device control networks. Interoperable device networks and devices could lead to the following benefits:

(1) Reduction in development costs and time for highly automated manufacturing applications through a major change to the adoption of configurable, compatible block style network components. These components are selected on a price/performance basis rather than vendor dependency.

(2) Network design and configuration tools which are widely applicable and not tied to vendor specific target hardware. These are also selected on a price/performance basis rather than vendor dependency.

(3) Reduction in the cost of eliminating faults (fast identification and replacement of defective building block) and ease of service and maintenance of the building block network components. Service and maintenance personnel are trained to support standard network components.

(4) Flexibility and adaptability of the network to changes in business direction.

(5) Adaptations and alterations can be preformed by the end users on the basis of an interoperable modular network structure.

(6) Ease of integration with current manufacturing information systems MIS) or ERP systems.

5. LonWorks-based Distributed Control

The concept and design of the Distributed Control Networks (DCN) is based on sensors and actuators integrated into any on-line (real-time) control network. The requirements for the infrastructure and capabilities of DCN need to be carefully evaluated. Among many available fieldbus protocol, LonWorks was chosen as the device control network for several reasons. The most significant ones are as follows [3]:

(1) Interoperability. Users can design products according to interoperability guidelines. This means that every device will work with each other. The router connects the two channels in LonWorks which have different communication media or transmission rates. The sensor node converts measured variable to digital signal other than normal analog signal and sends it to network through a network transceiver. Depending on the communication media, data rates can rage from 300bps up to 1.25Mbps.

(2) Intelligent/distributed network: Because each point in the network has intelligence, the system has no central pointer of failure. This is particularly true in distributed control networks where fault-tolerant is naturally resident. The distributed network based on LonWorks technology is compared with the traditional master/slave type network in Fig. 2

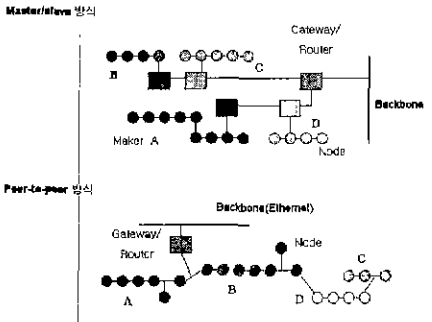

Fig. 2 Comparison of distributed network with the traditional master/slave type network.

(3) Multiple media options: LonWorks supports multiple topologies such as Star, Bus, or Ring topology. Also supported are media such as twisted pair, fiber optic, RF and power line. Users can mix and match topologies or media in the same network.

LonWorks technology is the accepted standard in the semiconductor industry for implementing a distributed control system (DCS) as well as in the building automation industry.

6. Distributed Control over IP Network/Internet

It is clear that IP (family of Internet Protocols including TCP/IP), is the integrating network for the enterprise. This makes it the obvious choice for integrating (remote) device network with business networks via the Internet. By integrating deice network with IP network, the Internet can be directly used for remote parts of a system with local enterprise subsystems via the enterprise LAN.

By connecting device network via IP, multiple sites can be simply integrated into a seamless "Virtual Device Network" (VDN) [1]. The VDN includes one or more remote sites connected with one or more monitoring/control applications located on the Internet.

The general architecture of a VDN is shown in Fig. 3. The key concept to this architecture is the peer to peer network.

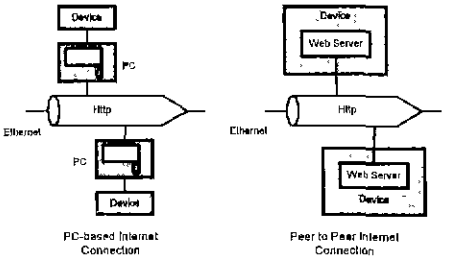

Fig 3 Comparison of peer to peer device network with PC-based network

Current existing solutions implement the web-based control by using Java, CGI and External Helper program to control remote LonWorks devices over TCP/IP as shown in Fig. 4. Connecting LonWorks network with JAVA is a possible solution for easy-to-create visualization application [4]. With

the help of visualizing JAVA applets, one can graphically monitor industrial control data in the comfortable and impressive web pages.

Fig. 4 also shows the typical implementation of LonTalk protocol (for LonWorks network) over IP network architecture. LonTalk over IP network utilizes a computer with one Ethernet card and one LonTalk adapter as a LonWorks over IP Router. The Ethernet card can support user to access IP network, and the LonTalk adapter can support user to access LonWorks network form any workstation with a TCP/IP connection.

In this client/server model, a server will control and monitor LonWorks network locally and clients can control and monitor LonWorks network remotely [5]. The server obtains the LonTalk network variable from LonWorks network using LonTalk Adapter. The server then sends it to IP network using Ethernet Adapter. In the client sites, the client will read it out and send back the related control command.

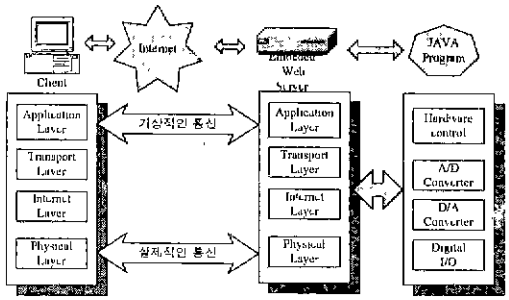

Fig. 4 LonTalk over IP network considered in this study.

7. Conclusions

A basic concept that can be applied to distributed control over IP network or internet. Specifically, LonWorks technology was considered as fieldbus network. Connecting these remote LonWorks networks to the IP network or Internet can provide a powerful, integrated, distributed monitoring system. Future work includes real-time implementation of distributed control devices and web-based control.

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