# Java-based LonTalk/IP Network for Predictive Maintenance (PM)

Gi-Heung Choi
Department of Mehcanical Systems Engineering, Hansung University

## 1. Introduction

Recent trends require that access to the device/equipment information be provided from several locations or anywhere in the enterprise. One example is virtual machine/manufacturing system (VMS) where predictive maintenance is performed both on factory floor and in remote site through internet [1]. Internet access is increasingly available and affordable, and along with the "internet" is the backbone of modern enterprise data networks. Typical functions of such a system includes monitoring and control for diagnosis and remedy action in realizing preventive maintenance.

Such a VMS inevitably involves the implementation of Distributed Monitoring and Control Networks (DMCN). DMCN are generally equipped with smart sensors, controllers, and other CPUs which provide very useful information if utilized properly [2]. Many sensors and actuators supporting various types of manufacturing processes are, however, seldom integrated into any real-time interoperable network. The concept of the inter-operable DMCN can be justified in this sense.

Requirements for monitoring and control networks are also different in many aspects from those of data networks [3,4,5]. 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. DMCN can take advantage of these capabilities by properly interconnecting the device network with data network components. Interoperability between devices and equipments is, however, essential to enhance the quality and the performance of predictive maintenance (PM). The objective of this study is to suggest a basic framework for DMCN to better perform predictive and preventive maintenance in a VMS environment and a method to guarantee interoperability between devices.

## 2. LonWorks-based Distributed Control

The concept and design of DMCN is based on sensors and actuators integrated into any on-line (real-time) control network. The requirements for the infrastructure and capabilities of DMCN therefore need to be carefully evaluated. Among many available fieldbus protocol mentioned above, LonWorks was chosen as the device control network for several reasons. The most significant ones are as follows [6]:

(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. 1

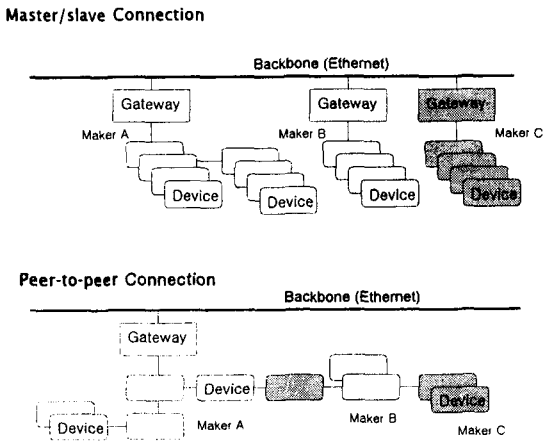


Fig.1 Comparison of distributed network with the traditional master/slave type network.

(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 DMCS as well as in the building automation industry.

## 3. LonTalk over IP Network

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 device network (LonWorks network with LonTalk protocol) with IP network, the Internet can be directly used for remote parts of a system with local enterprise subsystems via the enterprise LAN. In other words, by connecting device network via IP, multiple sites can be simply integrated into a seamless VMN. The VMN includes remote sites connected with monitoring/control applications located on the IP networks.

## 4. Examples

Equipment utilization measures the fraction of total operating time in an observation period, hence the overall effectiveness of equipment [2]. Factors that affect the equipment utilization include time lost due to breakdown and setup adjustment losses. A key factor in calculating a reliable equipment utilization time is to perform a proper process parameter logging.

The monitoring node in this case is a digital input node. It typically has optically isolated input channels and the On/Off state of sensor is interfaced with this I/O device. If this device has no realtime clock in it, any change of state sensed by the sensor has to be propagated in the LonWorks network to the web server or further to the client over IP network for data logging. In order to minimize the network traffic, a "send-on-delta" technique can be used. In this technique, the sensed value must change by at least this amount before a new value is sent. The value of "send-on-delta" can be configured in the network by windows compatible plug-in function of LonWorks devices.

Current existing solutions implement the web-based control by using Java, CGI and External Helper program to control remote LonWorks devices over TCP/IP. In order to maintain the continuous connection between server and client, Java-based distributed server model can be considered. In addition, connecting LonWorks network with JAVA is a possible solution for easy-to-create visualization application [7]. In this model, server uses CGI (Common Gateway Interface) functions to interface with database and expert system if necessary. Platform independent Java applet allows the system to continuously monitor the processes and machines. With the help of visualizing JAVA applets, one can graphically monitor industrial control data in the comfortable and impressive web pages. Fig.2 shows the typical web browser screen written in JAVA to monitor and control the LonWorks device for digital I/O. This web page was supplied by the web server/gateway developed in this study.

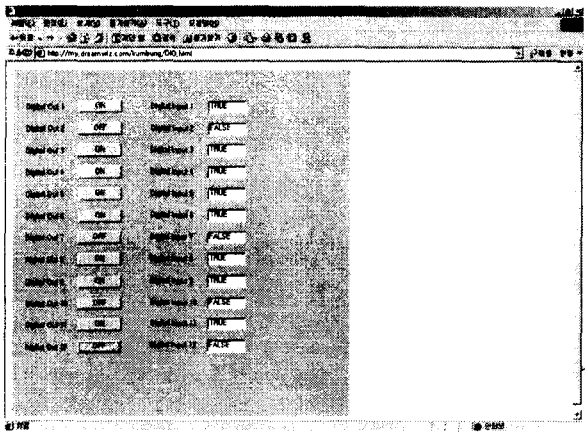

Fig.2 Web browser screen to monitor digital I/O data. This page was written in Java.

## 9. Conclusion

A basic concept that can be applied to distributed monitoring and control over IP network was suggested. Specifically, LonWorks technology was considered as fieldbus network. Connecting these remote LonWorks networks to the IP network can provide a powerful, integrated, distributed monitoring and control performance. A problem of security arising from the fact that a number of users access the DMCN over the internet and a safety issue arising from the human-machine interface need to be resolved for practical implementation of DMCN. Future work therefore includes implementation of a security and safety mechanism on distributed monitoring and control devices for real-time data collection and web-based tele-monitoring.

## References

[1] J.W. Seo and M. Kang, "A Study on the Fault Diagnosis in Web-based Virtual Machine", *Proc. KSPE Spring Conf.*, pp.430-434, 2001

[2] J. Seltzer and J. Hertle, "Utilizing A Distributed Data Collection System to Perform Predictive Maintenance and Equipment Reliability Studies,", *Proc. IEEE*, pp.175-179, 1999.

[3] D. Gaw, "LonWorks over the Internet: Technical Issues and Applications," *Technical Note*, Coactive Aesthetics, Inc., 1999.

[5] O. Vahamaki, A. Allen and J. Gaff, "High Speed Peer-to-Peer Communication System for Integrated Protection and Control in Distribution Network", *Development in Power System Protection, IEE,* pp.243-246, 1997.

[6] H. Shahnasser and Q. Wang, "Controlling Industrial. Devices over TCP/IP by Using LonWorks," *Proc. IEEE*, pp. 1309-1312, 1998.

[7] H Reiter, C. Kral, "Interaction Between JAVA and LonWorks," *Proc. IEEE*, pp. 335-339, 1997.