NEW ADVANCEMENT IN FIELD NETWORK TECHNOLOGY AND IN YOKOGAWA'S SOLUTION

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Until recently, We treated Process IO, Remote IO and Subsystem communication as individual approach. Today they are integrated into one concept called Field Network. The Field Network is becoming a part of the system integrating the field devices into control equipment. In addition to the basic process values, the bi-directional digital communication technology enables the Field Network to configuration, diagnostics and maintenance related information. Yokogawa did recognize the importance of this new technology and did participate in its development from the early stage through international standardization activities. This article reports the enhancement in the Field Network technology and in Yokogawa's fieldbus solution since the last report in 1998.

INTRODUCTION

The Field Network technology has made significant progress since the last report three years ago. Yokogawa has made a large contribution to this progress by implementing the new technology into products.

It has been Yokogawa's development policy to quickly introduce advantages of the Field Network into our DCS, a highly functional and reliable control system. By making our field instruments compatible with Fieldbus, the Field Network now enables the communication of much more instrument and plant information, when compared to the past when analog transmission (4-20mA) was used.

At the same time, Yokogawa recognizes the importance of connectivity or interoperability with other manufacturers' products and has been working with Fieldbus Foundation in order to realize this. Please see Figure 1 for the Yokogawa Fieldbus Lineup.

This paper discusses the progress made in the Field Network technology and Yokogawa's challenges in the last three years.

CENTUMCS1000/3000

EJA YEWFLO ADMAG YTA EXAxt PH & SC YVP

Figure1 Yokogawa Fieldbus Lineup

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Table 1 IEC61158 Protocol

IEC
ControlNet
PROFIBUS (PA & DP)
P-Net
FOUNDATION™ Fieldbus HSE
SwiftNet
WorldFIP
Interbus S
FOUNDATION™ Fieldbus H1
ProfiNet

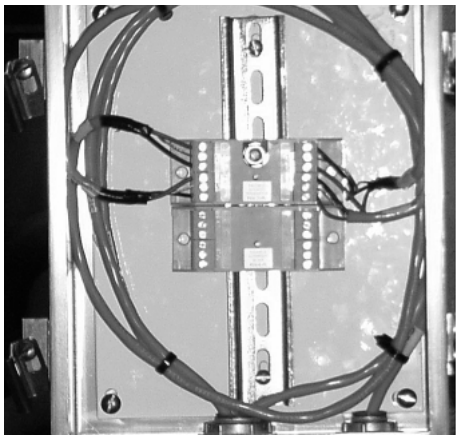

Figure 2 Example of Terminal Block (Relcom)

INTERNATIONAL STANDARDS

After long time discussions, International Standards for IEC Fieldbus were agreed upon in February 2000. Eight types of protocols are included. TC65SC65WG6 is still cleaning it up as MT9. With additional 2 protocols, now 10 types of protocols are included. See Table 1.

As you will see from this table, there are many kinds of instruments used at user's manufacturing sites and necessary network functions vary according to what instrument or application is applied at the site. Reality is that the current technology is unable to determine a single network that suits all applications. The FOUNDATION™ Fieldbus consists of two layers called HSE (High Speed Ethernet) and H1. H1 meets the requirements of process sites and HSE integrates Fieldbus with the enterprise level network by adoption of IT. Thus Yokogawa basically adopts the FOUNDATION™ Fieldbus for the process industry and other networks when necessary. Please refer to the following section for detailed information on the FOUNDATION™ Fieldbus.

EVOLUTION OF THE FIELD NETWORK TECHNOLOGY

1. Evolution at H1 level

As practical implementations progressed, more practical parts became available. For example, cables with better shields resulted in easier terminal treatment, connecting devices for safer connection /disconnection for multi-drop topology, terminal blocks with a built-in terminator, etc. In Figure 2, an example of a terminal block is shown. Various measures are taken such as smooth cable connection/disconnection, built-in terminator, cable shield treatment, power status display, easy expansion, etc.

As for the intrinsic safety system, the number of field instruments to be connected to one cable was limited because of energy restriction in a hazardous area. Based upon the FISCO (Fieldbus Intrinsic Safety Concept) model, which a group led by PTB in Germany has been researching; the number of instruments in a multi-drop segment has been increased. When a barrier with integrated repeater function appeared, the number of instruments to be connected per logical segment has become the same as a for non-intrinsic safety segment. The control blocks in field devices is a feature of the FOUNDATION™ Fieldbus, and the valve positioner with built-in control blocks including PID became available. By assigning field instruments to conduct a part of the control function, it has become possible to continue necessary control functions when control devices such as DCS stop. For that purpose, the bus schedule function (Link Active Scheduler : LAS) is also built in the field device. Figure 3 shows a configuration where a PID inside the field instrument continues the control function when the host system fails where the PID block inside the host system conducts control under normal conditions. PID in the host system can be configured as part of sophisticated control strategy combined with other control functions in the host system. When the host system fails, the PID inside instruments continues the control function with a fixed set-point. This configuration is effective to continue critical loops when a control system fails and production stops. Typical examples are a tank shape retention loop, and an explosive gas purge loop.

2. Evolution of Technology and Mechanism that Supports Interoperability

From the perspective that interoperability of Fieldbus is a significant technical issue, Fieldbus Foundation set up a project on interoperability improvement in April 1999 and has completed related specifications, has enhanced interoperability tests, has established a method of host support tests, and so on. Yokogawa took the initiatives in all those activities and has offered its system and devices for evaluation.

By adding the tests for the capabilities file and the device description files to the new interoperability test (4th edition), those files are now submitted by all companies.

Yokogawa was the first manufacturer to pass this new interoperability test with its differential pressure transmitter / pressure transmitter and temperature transmitter. All of Yokogawa's commercially available field instruments passed the test.

For the Host Interoperability Support Test (HIST), Fieldbus Foundation classified the host functions according to technical aspects as shown in Table 2. Actual test items are determined by

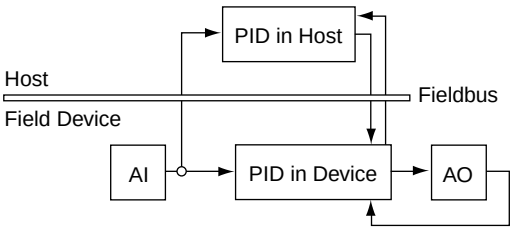

Figure 3 an Example of a PID Block in a Device Used as Backup

the combination of the each host system's function and the subject field instruments. The test procedure is defined for each host by the manufacturer. The test is carried out in presence of a Fieldbus Foundation's engineer and is passed if the test procedure is in accordance with the Foundation's specifications. Then the connectivity with instruments of other manufacturers is tested by each host manufacturer. Yokogawa is also the first to pass this test with CENTUM CS/CS1000/CS3000 and started operation in April 2001. Connectivity with several manufacturers' instruments has been tested continuously and testing will continue its new devices are introduced.

3. Introduction of HSE

The basic specifications for HSE, which Fieldbus Foundation started developing in 1999 have been issued. The specifications under development such as redundancy are expected to be completed and put into practical use by the end of 2001. In this development project, not only communication specifications but also the function block specification such as the definitions of the flexible function block which connects to factory automation and multi-I/O blocks were added. Further, the preparation work of the HSE interoperability test has started. The scope of the HSE system is shown in Figure 4. In H1, the host and the device were the only components, in HSE the linking device which connects HSE with H1, and the gateway device which connects HSE with other Fieldbuses were added. Furthermore, a flexible function block (FFB) was added to the specifications as a function block to have a built-in sequence control. As a whole, the scope of applying Fieldbus systems has widened.

YOKOGAWA'S SOLUTION

Yokogawa has contributed to the enhancement of the Field Network technology and has since been developing products using the technology to offer them as an part of its solutions.

Petroleum, petrochemical, chemical, and paper industries have started to apply them for example. A Field Network consists of a FOUNDATION™ Fieldbus to connect process I/O, and various other communication methods including hybrid communication such as HART communication and 4 to 20mA equipped in a Remote IO and communications with PLC's or other special control equipment. Figure 5 is an example of CS3000 showing above options. Using the combination of the existing control station (RIO) and the R3 control station (FIO), it can be applied to various applications. There are new developments in each area of the Field Network. However, in this paper, the latest development of Fieldbus is introduced. Please refer to other articles in this special edition.

1. Control System

In the control system, CENTUM CS3000 R3, ease of use and performance were improved in many aspects. For example, space efficiency was improved by applying 4 ports for the Fieldbus interface card, operation availability was improved by applying dual redundant cards, engineering was simplified by integration of Fieldbus engineering with the control drawing. Automatic device recognition (plug and play) in addition to offline

Table 2 Host Functions List

(✓ : Supported functions by CENTUM)
✓ Device Tag Assign
✓ Device Address Assign
✓ Link Mask Device Setting
✓ Block Tag Setting
Block Substantiation
✓ Standard Block Configuration
✓ Extension Block Configuration
✓ Custom Block Configuration
✓ Block Connection Configuration
✓ Alert Configuration
✓ Alert Process
✓ DD Service
✓ DD Method Execution
✓ DD Menu
✓ DD Edit Display
✓ Capability File Use
✓ Offline Configuration

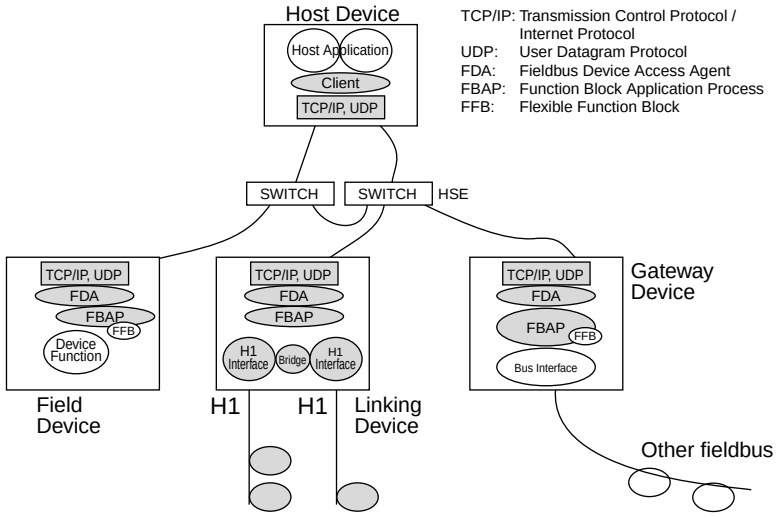

Figure 4 HSE System Configuration

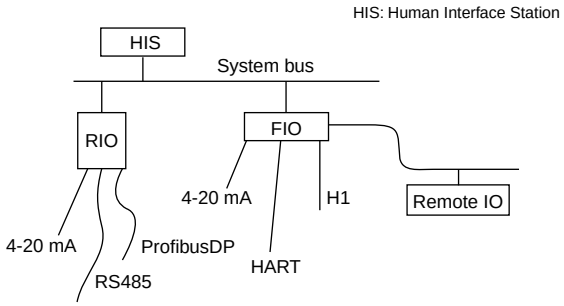

Figure 5 Field Network of CS3000

Table 4 Yokogawa Product Lineup Registered with Fieldbus Foundation

Differential Pressure/Pressure Transmitter EJA
Temperature Transmitter YTA-320
Valve Positioner YVP
Vortex Flowmeter
Magnetic Flowemeter
Paperless recorder
DAQstation, Mobilecorder
Liquid Analyzer EXAxtpH

engineering function are further enhancements included in R3. Furthermore, guidelines for Fieldbus segment design are provided. (Table 3)

2. Plant Management Tool

The Field network concept as shown in Figure 5 enables access to a wealth of information residing in the field using a unified method. This concept is not only beneficial for plant operation, but also promises a new approach to field device support and maintenance issues. Unlike conventional routines where each field device had to be accessed individually, the Plant Resource Manager (PRM) takes advantage of the field device integration and offers a unified centralized access to all devices within the Field Network.

3. Enhancements of Field Instruments

Yokogawa started to offer the field instrument models with PID block and LAS function since last year. There are also some other models where we are considering to add computing blocks or signal selector blocks according to their basic functions.

For use in hazardous areas, we are working to develop FISCO intrinsic safe models, explosion-proof models, and Non-Incendive models so that they can be selected according to the areas they are used in.

The paperless recorder, DAQstation has become Fieldbus compatible as an extended product. We expect that they will be applied as a multi-point signal I/O device and as a simple monitoring system. It has the multipoint signal I/O block which was developed for HSE, built in. In Table 4, Yokogawa's products registered by Fieldbus Foundation are shown.

Table 3 Checkpoints for Segment Design

No.of devices to be connected
Cable length and spur length
Current consumption & Device terminal voltage
Control cycle and Fieldbus Schedule

CONCLUSION

In summary the development in the Field Network technology and Yokogawa's involvement has been discussed. Regarding the Field Network technology, not only Fieldbus Foundation, but also some other organizations are examining industry communication using Ethernet technologies. There is also an activity going on to add functions to Field Network necessary for safety systems. Yokogawa committed to develop new Field Network technologies and to implement it into practical products. The use of Fieldbus will increase by promoting the interaction between the sophisticated function/ multifunction of field devices and applications including diagnostics and system design, in other words the collaboration between manufacturers and users.

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REFERENCE

Yokogawa Technical Report, English Edition No.27, 1999, Fieldbus Special Edition