Field Digital Device Diagnostics for Effective Use of Device Information

- Visualizing Device Status and Reducing Device Alarms in a Chemical Plant -

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Digitized field devices provide a large amount of information, requiring users to identify important information among the many alarms and events and to suppress unnecessary device alarms. Yokogawa's Field Digital Device Diagnostics service, one of the services of Plant Asset Effectiveness Optimization Services InsightSuiteAE, solves these issues. This service includes the Field Asset Key Performance Indicator (KPI) Report which visualizes the state of health of field devices by using data in Plant Resource Manager (PRM), and Baseline Tuning which optimizes the parameters of field devices and PRM for effective operation. This report outlines the Field Digital Device Diagnostics service and introduces its application examples.

INTRODUCTION

More than ten years have passed since the first digitized field devices were introduced. These support either a hybrid communication protocol such as HART Note 1) or a full digital communication protocol such as FOUNDATION Fieldbus Note 2). Standardization of fieldbus communication protocols and advancement of information and communication technology (ICT) have accelerated the growth in intelligence of field devices, enabling much information to be used to monitor device conditions online.

However, such information and functions are not always utilized effectively at the site, and users of these digitized field devices are confused by handling the overwhelming amount of information.

Yokogawa's Field Digital Device Diagnostics service, one of the services of Plant Asset Effectiveness Optimization Services InsightSuiteAE, helps to solve these issues. This paper outlines the Field Digital Device Diagnostics service and introduces its application examples where important device alarms have been extracted and visualized and nuisance device alarms have been drastically reduced.

ISSUES IN OPERATION OF DIGITIZED INTEGRATED SYSTEM

When using digitized field devices, the upper system can obtain much information including the current status and various setting parameters of the devices as well as measured process values. Devices can send alarms to the upper system in the case of abnormality. Figure 1 illustrates the difference in the amount of information between analog and digital instrumentations; this is an outstanding benefit brought by digitization of field devices. However, the increase in information has made it difficult for users to understand the information correctly and take appropriate actions.

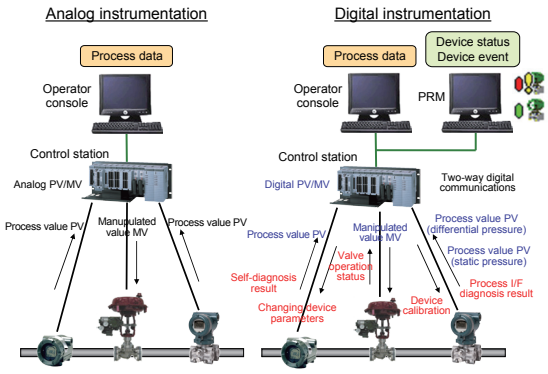

Figure 1 Difference in the amount of information between analog and digital instrumentations

Ironically, as a result, the advantages of digitization of field devices have sometimes proved to be disadvantages; for example, an alarm that needs to be recognized is overlooked,

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Note 1) Abbreviation of Highway Addressable Remote Transducer. An induatorial sensor communication protocol proposed by HART Foundation
Note 2) A fieldbus communication protocol proposed by the Fieldbus FOUNDATION

buried in an overwhelming number of alarms due to alarm flooding. Device alarms and device diagnostic information do not seem to have been sufficiently utilized by many users.

FIELD DIGITAL DEVICE DIAGNOSTICS SERVICE

This service removes the causes of inaccurate measurement and control of field devices by diagnosing the operating conditions. By monitoring the status of field devices and by assessing the risk of abnormalities, one can prioritize the maintenance order. In addition, the standardization of maintenance procedures based on status data changes the procedure from that based on each maintenance engineer's experience to a more scientific basis, and so even inexperienced engineers can carry out the same or better quality of maintenance works.

The following section outlines the Field Asset Key Performance Indicator (KPI) Report and the Baseline Tuning, which are two major activities included in this service.

Field Asset KPI Report

The Field Asset KPI Report creates tables of the current status of field devices by utilizing the information accumulated in the PRM, the integrated plant resource manager[(1)], from each device or equipment used in the plant. It then summarizes the alarms and events that occurred during a specified period. The device status summary provides good suggestions on necessary actions to be taken according to the priority of each alarm. Also, the past event summary identifies problems with devices. By utilizing the Field Asset KPI Report constantly, the self-diagnostic function of devices can be fully utilized and abnormalities in devices can be detected at an early stage.

Baseline Tuning

After the current status of field devices is correctly monitored using the KPI report, the Baseline Tuning service is used to optimally adjust the field device parameters, and customize the upper system (PRM, etc.) according to the maintenance workflow. By implementing this service, even a small defect in field devices can be detected earlier and more certainly. The implementation procedure is as follows.

■ Grasping device status correctly

Classify the alarms sent from field devices into the following categories using a KPI report.

1) Wrong basic device parameter settings
2) Device parameter settings not matching the operating conditions of the plant
3) Defect of devices

For cases classified into 1) and 2), investigate the causes of alarms and study measures to be taken.

■ Optimizing device parameters

Verify whether the current parameter settings of devices meet the user's environment. The parameter settings of all the alarming devices including some normally working devices are verified and modified in alliance with users, if required.

■ Optimizing and customizing the upper system (PRM, etc.)

The upper system (PRM, etc.) that manages the information of devices is optimized and customized by modifying the system as follows according to the user's maintenance scheme.

1) Suppressing unnecessary alarms (filtering)
2) Customizing device icons
3) Configuring a maintenance support tool dedicated for devices
4) Enabling a device status monitoring (patrolling) function
5) Reconfiguring the database according to the maintenance scheme

EXAMPLE OF APPLYING THE FIELD ASSET KPI REPORT TO KASHIMA PLANT OF MITSUBISHI CHEMICAL CORPORATION

Background of the Service Introduction

In recent years, the Kashima plant of Mitsubishi Chemical Corporation has actively been replacing field devices by digital devices having the HART communication function.

Such devices are connected to Yokogawa's CENTUM CS3000 R3 control system, ProSafe-RS safety instrumented system, and PRM plant resource manager, constituting a comprehensive system where more than 1,100 field devices can be monitored online.

By the digitization of field devices, a huge amount of information on devices, which used to be invisible, is being gathered into the PRM. For instance, the current device status as well as alarms and events during operation are always monitored by the PRM.

The next challenge after the digitization of field devices was how to handle the huge amount of information quickly and correctly and utilize it for maintenance works.

Introducing the Field Asset KPI Report

Much available information as a result of the digitization, on the other hand, triggers many more alarms and events than before. Many of these alarms tend to lie neglected because of oversight or delayed response. Device alarms are often left untouched provided they do not cause major problems.

Device statuses, alarms, and events, which are the results of self-diagnosis of field devices, are continuously stored in the PRM database. The Field Asset KPI Report summarizes them and displays the results as a form of alarm summary report. Accordingly, proper actions will be taken for the alarming device without omission.

Thus, the Kashima plant of Mitsubishi Chemical Corporation decided to fully utilize the self-diagnostic function of field devices by introducing the Field Asset KPI Report, while reviewing the procedures of maintenance works.

Effect of the KPI Report

After introducing the Field Asset KPI Report, the daily checking of the report was added to the maintenance work procedure to monitor the health of devices. Described below is an example which shows how a hidden defect in a field device

was successfully detected in advance.

Thermometers connected to the ProSafe-RS safety instrumentation system are usually redundant to increase the security level. The primary sensor for normal operation was not found to be abnormal. However, a defect in the backup temperature sensor was detected in the KPI report just after the Field Asset KPI Report was introduced. Thus, necessary repair works were immediately taken for the defective sensor. If any trouble of the primary sensor had resulted in switchover to the backup sensor, it could have caused a shutdown of the plant.

The defect in the backup sensor seems to have existed before the introduction of the Field Asset KPI Report but had not been detected. This had likely happened because checking the PRM alarm display had not been included in the daily maintenance procedure and/or the device was not included in the list of devices for immediate maintenance.

A shutdown of the plant causes a loss of approximately 50 million yen a day, and requires up to five days for restoration works. Moreover, it might trigger the shutdown of subsequent plants. In view of this, the financial effect of introducing the Field Asset KPI Report is immense.

The PRM has the capability to monitor a vast number of field devices online, but in practice it is difficult to monitor all the devices one by one every day. The report monitors the whole plant status and is a powerful tool for maintenance by diagnosing the causes of problems. For fully utilizing digital information of field devices, the Field Asset KPI Report has changed the maintenance strategy from that based on conventional time and experience, to a scientific approach based on opportunities and risks, thus contributing to the reduction of maintenance costs.

APPLICATION EXAMPLE OF BASELINE TUNING

Background of the Service Introduction

A chemical plant in Southeast Asia has entirely adopted the FOUNDATION Fieldbus full digital communication protocol to introduce the latest technology since its initial startup. A total of 1,346 field devices are connected to the CENTUM CS3000 control system and the PRM integrated device management software package.

By introducing the latest intelligent devices at the plant, the company enjoys such benefits as improved maintenance procedures for valves using such tools as Yokogawa's ValveNavi [(2)] valve adjusting and setting software. On the other hand, a large number of alarms always sent from the field devices made it difficult for operators to cope with awkward situations. They had intended to improve maintenance work by early detection of defects, but the situation was far beyond their initial expectation, and their enthusiasm for the benefits of digitization was fading.

Consulted about these issues, Yokogawa proposed the Baseline Tuning to solve them. The Baseline Tuning prevents alarm flooding, which is common in digitized field devices, and offers a basis for appropriate alarm thresholds.

Current Status

In this plant, no less than 162 (12.1%) among 1,346 field devices showed an abnormal status. In addition, on average approximately 30,000 messages were sent to the upper system each month. Operators or maintenance engineers cannot handle as many as 1,000 messages a day. Despite so many alarms in PRM, no operational problem emerged. Thus, the user could not judge whether the information about device defects was correct or not.

Figure 2 shows the PRM display before service introduction. Many of the device status icons, which should usually be green, were red. In such a situation, it is difficult to detect a new defect.

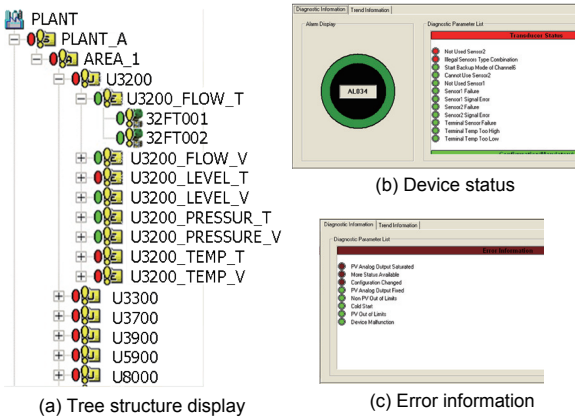


Figure 2 Device status before the tuning

Through the service introduction, it was found that the users were still thinking in analog ways: they were only concerned about proper process values (PV) and manipulated values (MV). For fully utilizing digital instrumentation, it is necessary to analyze various digitized information and to determine a maintenance strategy for individual devices.

According to the KPI report before the tuning shown in Figure 3, some devices were in the alarm status for 100% of the time. Such a status is impermissible and requires immediate action.

Type	Model	Vendor	Total No.	Red (%)	Yellow (%)	Grey + White (%)
FF-H1	EJA	Yokogawa	802	0	0	0
FF-H1	FVP	Dresser	372	8 (2.15)	0	0
FF-H1	YTA320	Yokogawa	84	84 (100.00)	0	0
FF-H1	FP302	SMAR	36	36 (100.00)	0	0
FF-H1	3051	Rosemount Inc	2	0	0	0
HART	HDLT	MASONEILAN	33	32 (96.97)	0	0
HART	EJA	Yokogawa	10	0	0	0
HART	LEVELFLEX M	Endress+Houser	4	0	0	0
HART	SVI2	MASONEILAN	2	2 (100.0)	0	0
HART	3095MV	Rosemount Inc	1	0	0	0
		TOTAL	1346	162 (12.04)	0 (0.00)	0 (0.00)

Figure 3 KPI report before the tuning

Details and Results of Improvement

The Baseline Tuning implemented by Yokogawa optimized the device parameters, reducing the number of device alarms from 162 (12.1%) to 28 (2.1%). These 28 field devices were confirmed to have an actual defect and require maintenance. Figure 4 shows the KPI report after the tuning.

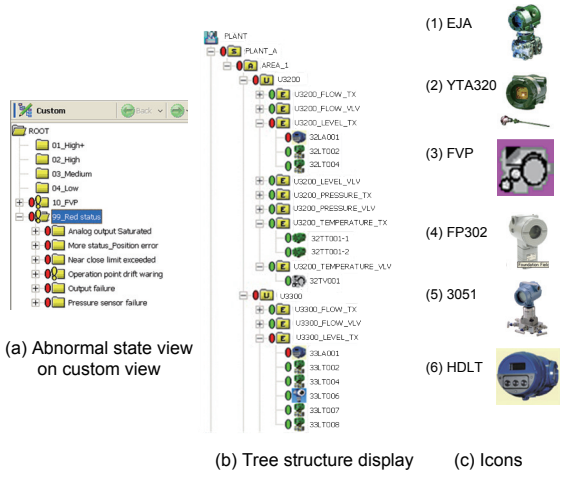
Figure 5 shows an example of customization of the PRM featuring the following items.

1) Classifying abnormal devices according to the order of maintenance priority
2) Changing device icons to easy-to-understand ones
3) Filtering of process-related alarms

It has become possible to recognize all abnormal devices by a single custom view. The customized device icons are expected to reduce misreading and misidentification of devices.

Type	Model	Vendor	Total No.	Red (%)	Yellow (%)	Grey + White (%)
FF-H1	EJA	Yokogawa	802	0	0	0
FF-H1	FVP	Dresser	372	11 (2.96)	0	0
FF-H1	YTA320	Yokogawa	84	0	0	0
FF-H1	FP302	SMAR	36	4 (11.11)	0	0
FF-H1	3051	Rosemount Inc	2	1 (50.00)	0	0
HART	HDLT	MASONEILAN	33	10 (30.30)	0	0
HART	EJA	Yokogawa	10	0	0	0
HART	LEVELFLEX M	Endress+Houser	4	0	0	0
HART	SVI2	MASONEILAN	2	1 (50.00)	0	0
HART	3095MV	Rosemount Inc	1	1 (100.00)	0	0
		TOTAL	1346	28 (20.80)	0 (0.00)	0 (0.00)

Figure 4 KPI report after the tuning



(a) Abnormal state view on custom view

(b) Tree structure display

(1) EJA
(2) YTA320
(3) FVP
(4) FP302
(5) 3051
(6) HDLT

(c) Icons

Figure 5 Example of customization of the PRM

Expected Effects

The following effects are expected from the improvement by the Baseline Tuning.

1) Prioritizing the order of maintenance based on the monitored device status information
2) Earlier and easier detection of abnormal devices
3) Reducing excessive maintenance
4) Reducing operational errors
5) Improving plant availability by minimized unscheduled shutdown

The user started to review their maintenance workflow affected by the results of the Baseline Tuning, and clearly noticed the need for changing their mindset to utilize the digitization of field devices. As a result, the user is now looking forward to a lower working load on maintenance and also much lower maintenance costs.

CONCLUSION

Field instrumentation of recent plants is shifting from digitization to the maximum utilization of field assets. Taking this opportunity, Yokogawa has launched new asset services, the Field Asset KPI Report and the Baseline Tuning. As reported in this paper, new maintenance workflows are inevitable to utilize field digitalization.

Without exaggeration, the benefits of digitization of field devices can not be attained without introducing the Field Digital Device Diagnostics service. All the information from devices is processed according to the best practice proposed by the service and is utilized to predict the appropriate maintenance timing, so-called predictive maintenance. Life prediction helps to drastically reduce maintenance costs as well as to improve asset availability and plant operation stability.

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