FIELDBUS DIAGNOSTICS: LATEST ADVANCEMENTS OPTIMIZE PLANT ASSET MANAGEMENT

Stephen Mitschke, Manager-Fieldbus Products
Fieldbus Foundation

Acceptance of the Fieldbus Foundation's open, non-proprietary technology, FOUNDATION fieldbus, is growing throughout the control and instrumentation market. FOUNDATION technology is becoming the dominant digital control solution for process automation worldwide, and is gaining a strong foothold across the Europe, Middle East & Africa (EMEA) region (See Fig. 1).

Since May 2006, the Fieldbus Foundation (http://www.fieldbus.org) has been collaborating with NAMUR (http://www.namur.de), an international process industry end-user association based in Germany, on fieldbus performance enhancements such as device diagnostics, which both parties identified as requiring further clarification and guidance for the user community.

Figure 1. Acceptance of the Fieldbus Foundation's open, non-proprietary technology, FOUNDATION fieldbus, is growing throughout the control and instrumentation market.

A key objective of this collaborative effort is to unify the integration of fieldbus self-monitoring data to ensure the availability of valuable device diagnostic information to process plant personnel. Advancements in field diagnostics support a structured approach to asset management, which simplifies operators' tasks and increases their confidence in utilizing equipment diagnostics and asset software.

New field diagnostics profiles will benefit a wide range of automation stakeholders, including process engineers, maintenance technicians and operators. This technology will optimize plant asset management programs and enable improved process performance, greater reliability, increased uptime and lower operating costs.

BACKGROUND

In order to maximize the output of an industrial facility, all assets need to be maintained at certain intervals—i.e. monitored, serviced, refurbished or replaced. Plant asset management assists in determining these intervals through continual asset condition monitoring, which predicts time-to-service; detailed diagnostics with guidance of required service actions; and system-supported planning and execution of service tasks.

The goal of an asset management solution is proactive rather than reactive maintenance wherever possible. Condition-Based Monitoring (CBM) focuses on optimizing the timing of maintenance. It seeks to avoid unexpected equipment failures on the one hand (too late maintenance) and unnecessary maintenance on the other (too early maintenance). To achieve this goal, individual assets either require embedded intelligence or specific condition monitoring techniques at a higher level.

Due to demands for increased availability and uptime, various techniques for monitoring plant assets have been developed. These include using control equipment for monitoring field devices (e.g., electro-pneumatic positioners monitoring control valves, electrical drives monitoring conveyors, etc.); installing specialized sensors, measuring and diagnostic equipment; and process modeling at a higher system level.

Many process industry end-users configure their asset management software for predictive maintenance. By using the diagnostic features built into intelligent instrumentation, they track indications of impending failure. Some applications can produce a notice resulting in a work order when repair is required. This is significantly more economical than crisis repair, which is waiting for the failure and repairing the device on an emergency basis.

INDUSTRY OBJECTIVES

Today, the field device revolution is centered on reducing process variable uncertainty and enhancing device functionality and diagnostics while providing more integrated solutions around the desired process measurement.

Over the years, plant constructors and operators have consistently pursued two main goals: to lower installation costs and to optimize production conditions. This has led to the widespread use of digital bus technologies in the process and manufacturing industries, as well as development of intelligent automation devices. But, in many cases, the savings potential from fieldbus wiring reductions and digital device communications have already been exhausted.

Intelligent maintenance concepts, on the other hand, still offer tremendous potential for added value. This potential must now be tapped. In addition to increasing plant availability, diagnostics-driven maintenance strategies reduce fixed and variable maintenance costs and extend useful asset life by reducing the interval between maintenance events, reducing the cost of failures, and making it easier to plan maintenance and service work.

With the advance of intelligent automation components, an extensive amount of data is being generated on all levels of the automation hierarchy and, increasingly, in the field devices themselves (See Fig. 2). Many of these components provide parameterization options, and some include diagnostic and analytic functions—but usually only in proprietary formats. Vendor-specific software is therefore often needed to access these functions and the information they generate.

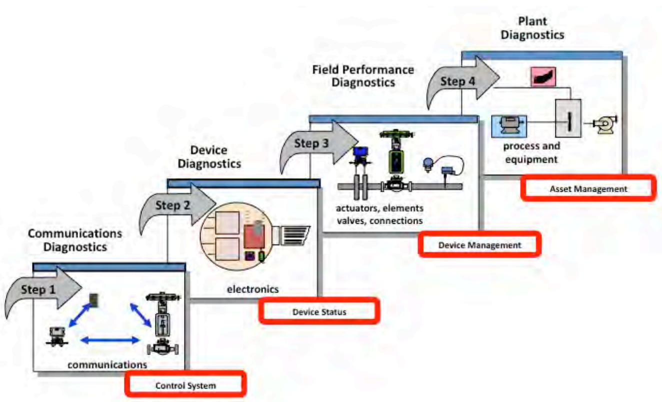

Figure 2. With the advance of intelligent controls, an extensive amount of data is being generated on all levels of the plant automation hierarchy.

If modern methods of preventive or condition-based maintenance are to gain more widespread acceptance, the available information must be centrally collated, evaluated and given to maintenance providers in an understandable form. Asset or lifecycle management systems can only be used consistently and effectively if there is easy access to parameterization, status and diagnostic data from the field.

END-USER REQUIREMENTS

As the ability to self-diagnose device health and integrity improves, available information is too valuable to ignore. For example, standard temperature measurement options offering hot backup redundancy are being expanded into detecting sensor drift and predicting when a temperature sensor will fail. Pressure transmitters now detect plugged impulse lines and inform the operator when an apparently good measurement is, in fact, not valid.

Control valve diagnostics and the ability to generate valve signatures for online diagnostics allow many valve problems to be easily isolated and remedied without the cost associated with pulling a valve out of service and unnecessarily rebuilding it (See Fig. 3).

Figure 3. Field device diagnostics help processing facilities practice more preventive and less reactive maintenance.

All of these developments in device diagnostics help processing facilities practice more preventive and less reactive maintenance. With approximately 50% of the work accomplished in most organizations being reasonably preventable maintenance, potential cost savings from utilizing device diagnostics data are tremendous.

As part of its work on behalf of process industry end-users, NAMUR has published recommendations describing the functions and features that should be provided by modern plant asset management systems (NE 91, "Requirements for Online Plant Asset Management Systems") and the types of diagnostic functions and status reports they should offer (NE 107, "Self-Monitoring and Diagnosis of Field Devices").

Development of the NE107 recommendation was driven by automation end-users seeking greater consistency in their installed field device networks. Many plants utilize a variety of technologies for different applications, including FOUNDATION fieldbus, PROFIBUS and HART. However, diagnostic information is often represented amongst these networks in different ways. This can include different data structures, different parameter names, etc. Even within the same protocol, there are areas where vendors can add additional diagnostic information that is presented in many different formats.

As part of the NE107 guidelines, NAMUR members expressed the need for a common set of asset management tools ensuring important information regarding device status and operating condition gets to the appropriate person within the plant. In turn, the organization proposed a common structure for representing all instrument diagnostics. This would allow device developers, as well as industry organizations such as the Fieldbus Foundation, Profibus Nutzerorganization and HART Communications Foundation, to write specifications mapping their particular technology into a standardized group of diagnostic categories.

According to the NE107 document, fieldbus diagnostic results should be reliable and viewed in the context of a given application. Plant operators should only see status signals, with detailed information viewable by device specialists. The NAMUR guidelines further recommend categorizing internal diagnostics into four standard status signals, and stipulate configuration should be free, as reactions to a fault in the device may be very different depending upon the user's requirements.

NE107 proposes diagnostic signals/categories be identified as follows:

Maintenance Required: Although the device is still able to provide a valid output signal, it is about to lose functionality or capability due to some external operational condition. Maintenance can be needed short-term or mid-term.

Failure: The instrument provides a non-valid output signal due to a malfunction at the device level.

Check Function: The device is temporarily non-valid due to some type of maintenance activity.

Off Specification: The device operates out of the specified measurement range. Diagnostics indicate a drift in the measurement, internal problems in the device, or the consequence of some process influence (i.e., cavitations, empty pipe, etc.).

NE107 further recommends the classification and association of a diagnostic event to one of these four levels of diagnosis be configurable by the user. The configuration would depend on the process constraints (e.g., loop criticality) and the role of the addressee, such as an operator, maintenance technician, etc. (See Fig. 4).

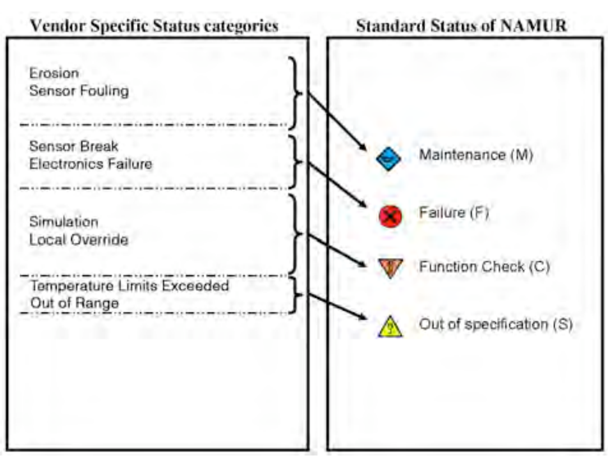

Figure 4. The NAMUR guidelines recommend categorizing internal diagnostics into four standard status signals.

NEW PROFILE SPECIFICATION

During a press briefing on April 25, 2006, at the INTERKAMA Trade Fair in Hannover, Germany, the Fieldbus Foundation announced the establishment of a liaison relationship with Working Group 2.6 Fieldbus of NAMUR. This cooperation has focused on two key issues: grounding and shielding, and device diagnostics profiles.

Key to the foundation's liaison with NAMUR was the establishment of a dedicated working group to investigate standard end user work processes for employing field device diagnostics. This initiative was critical to ensuring FOUNDATION instruments are consistent with the NE107 guideline requiring field devices deliver extensive diagnostics, which help ensure optimum plant efficiencies are achieved.

The Fieldbus Foundation/NAMUR working group analyzed specific requirements for device diagnostics in developing a field diagnostics profile specifiction. These included:

- Common view of instrument-specific diagnostics
- Common configuration environment
- Extensibility
- Leverage of existing "push" technologies (e.g. alerts and alarms)
- Flexible configuration to meet user applications
- Simulation for FAT/SAT activities
- Ease of understanding and implementation
- Adoption by system and instrument vendors

Using the power of FOUNDATION fieldbus, and considering the NAMUR NE107 recommendations, the Fieldbus Foundation developed a profiles specification enhancing the organization and integration of device diagnostics within FOUNDATION fieldbus systems. The new diagnostic profile includes a standard and open interface for reporting all device alarm conditions, and provides a means of categorizing alert conditions by severity. The technology facilitates routing of alerts to appropriate consoles based on user-selectable severity categories. In addition, it provides recommended corrective actions and detailed help, as well as an indication of the overall health of the device.

The FOUNDATION fieldbus Diagnostics Profile Specification (FF-912) was defined to allow any Electronic Device Description (EDD)-based system to access and configure the diagnostics in fieldbus devices. The field diagnostics profile makes no changes to the existing FOUNDATION fieldbus stack specifications. However, the profile does introduce a new field diagnostic alert type. System updates will provide more extensive integration capabilities (such as Wizards for configuration) that will enhance diagnostics performance.

Rather than introduce significant changes to the current FOUNDATION protocol, the new diagnostic profile specification builds upon the existing, powerful diagnostic capabilities of FOUNDATION fieldbus equipment, and at the same time, adds a greater degree of organization so field instruments can represent their diagnostics in a more consistent way.

FOUNDATION fieldbus has always utilized "push" diagnostics, which allows the user to receive alerts much faster, instead of the traditional "polling" method of requesting diagnostic information from devices. Every fieldbus function block has a standard block alarm parameter providing 16 standardized diagnostic conditions. Current control systems scan field devices and may receive diagnostic event information once per day. This process requires a considerable amount of time to scan a large population of installed instruments. With the FOUNDATION fieldbus push method, diagnostic information is obtained within seconds instead of days.

The FOUNDATION fieldbus Diagnostics Profile Specification provides common, network-visible parameter names that go into fieldbus device resource blocks. The parameter names will all have the same data types and the same behaviors. In this way, device vendors can map their current equipment diagnostics to a common structure for presenting diagnostic information via the host system and plant asset management tools.

The diagnostic profile specification also allows for common tools and engineering procedures, which will reduce costs and deliver actionable intelligence from the field level to the end-user.

As part of the field diagnostics solution, individual device vendors will define which diagnostics are available in their instrument, with the end-user modifying these diagnostics based upon their specific process requirements. Each device will come with a default mapping of the field diagnostics developed by the supplier, and active diagnostic conditions will have a recommended course of action.

ROLE-BASED DIAGNOSTICS

Field diagnostics technology per the NE107 recommendation offers a robust solution for implementing role-based diagnostics, meaning the right information is sent to the appropriate person—when they need it—without flooding others in alarms (See Fig. 5).

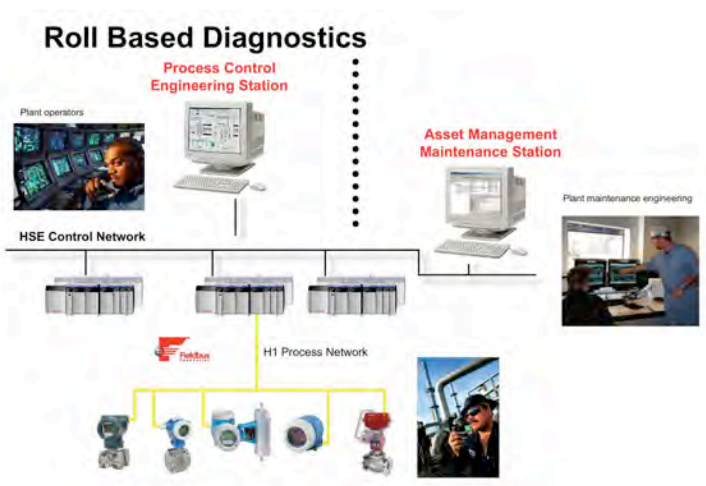

Figure 5. Role-based diagnostics means the right information is sent to the appropriate person—when they need it.

Fieldbus devices offer greater value than older analog 4-20 mA devices through their ability to indicate data quality—i.e., whether signals communicating setpoints, PVs, etc. have good, bad or uncertain quality. This improves diagnosis of equipment problems and helps validate measurement or control actions by field instrumentation.

It is helpful to think of a field diagnostics alert as a "check engine" light on an automobile. The diagnostic features of FOUNDATION fieldbus provide an indication that something is wrong with a particular device, as well as a standardized way to interpret and apply this information for maintenance and repair purposes.

Once an alert is acknowledged, the first step is determine the nature of the abnormal condition. Next, field diagnostics provides a clear recommended action. The third step is the detailed EDD screen, which helps to back up the operator action. Diagnostic information offered via enhanced EDDL features such as charts and graphs is available to assist troubleshooting.

Field diagnostics enhances user control and distribution of messages between field devices and host/asset management systems. This allows for faster response times as each message is presorted according to criticality, whether it is a process alarm or a maintenance alarm. Users can map alerts (whichever of the four categories) based on their particular device situation and its importance to the overall process line. This, in turn, builds a standardized diagnostic system across all sorts of devices and creates a common way to structure, filter and deliver diagnostics to controllers.

Using this technology, industrial facilities have the ability to specify the diagnostics most important for a given operation or process area. They can also determine the priority of the diagnostic information and identify all appropriate recipients for particular data.

For example, device diagnostics like those for thermocouple degradation, temperature tracking, and statistical process monitoring can be prioritized and categorized according to the NAMUR NE107 recommendation.

In the past, operators were frequently overwhelmed by nuisance alarms and alerts that distracted their attention from running the process. This situation can result in unnecessary shutdowns, or cause operators to disregard online asset management tools, which, in turn, leads to valid alarms being ignored. Now, thanks to field diagnostics, plants can avoid wasting money and resources on irrelevant diagnostics, and can take appropriate control or maintenance actions when they are truly needed. Plant personnel are able to make better decisions, in less time, and potentially save or extend the life of valuable assets (See Fig. 6).

Figure 6. Field diagnostics enables plant personnel to potentially save or extend the life of valuable assets.

ASSISTING DEVICE DEVELOPERS

The Fieldbus Foundation is recognized as one of the few automation industry organizations that has implemented a rigorous procedure for control equipment registration. The foundation is now paving the way for adoption of field diagnostics technology per NE107 by developing a comprehensive tool kit which assists in the registration of devices implementing new diagnostic profiles.

The FOUNDATION H1 Interoperability Test Kit (ITK) 5.1 has been updated from previous versions with field diagnostics profiles enhancing the organization and integration of device diagnostics within FOUNDATION fieldbus systems. The test kit verifies the functionality of an H1 (31.25 kbit/s) device and its conformity with the FOUNDATION fieldbus Function Block and Transducer Block specifications. An excellent tool for troubleshooting and debugging devices, the test kit includes all hardware and software required to ensure a manufacturer's complete device interoperability as specified by the foundation's official registration testing procedure.

By using the H1 ITK 5.1, device developers can run tests identical to those used by the Fieldbus Foundation before submitting their device for official registration.

The H1 ITK now includes support for the FF-912 Field Diagnostics Profile Specification. The kit also provides a Resource Block parameter set to implement the field diagnostics profile, as well as various other software enhancements.

Additionally, the Fieldbus Foundation will test for field diagnostics support as part of the standardized host features verified during its host registration procedure. This feature will become mandatory for all registered hosts starting in late 2010.

CONCLUSION

Cooperation between the Fieldbus Foundation and NAMUR has enabled the global process automation industry to develop a greater understanding of end-user requirements for adopting fieldbus technology. It has also helped pave the way for process plants to implement better and more useful asset management strategies.

Asset management based on end-user requirements, with a consistent and structured approach to information, gives plant personnel a meaningful tool to achieve operational excellence. To be effective, it is essential that the right information gets to the right people in the right form—and at the right time.

Ultimately, plant owners will benefit from field diagnostics advancements thanks to easier diagnostic configuration, greater application flexibility, and fewer spurious alarms.

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