



REDUCING LIFECYCLE COSTS WITH THE POWER OF FIELDBUS

HOW YOKOGAWA TURNS ADVANCED FIELDBUS FUNCTIONS INTO ECONOMIC RETURN

FOUNDATION fieldbus offers some advanced functionality and features that suppliers can take advantage of to make things easier for end users across the plant lifecycle. In this paper, we look at some of the advanced functions of fieldbus from the design phase through the operational phase and show you how suppliers can use the FOUNDATION fieldbus specifications to create a truly powerful process automation solution for the end user. Yokogawa is one supplier that has truly taken advantage of the advanced functionality of FOUNDATION fieldbus to provide a good return on investment to the end user.



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EXECUTIVE SUMMARY

From engineering to installation, commissioning, operations, and maintenance, FOUNDATION fieldbus offer significant cost reductions of 30 percent or more versus conventional analog systems. Many of these cost reductions come from the advanced functions that fieldbus offers versus analog technology.

This paper looks at the lifecycle cost advantages that are made possible by the advanced functionality of FOUNDATION fieldbus, and how key process automation suppliers are embracing these functions while at the same time making the technology easier and more accessible to the end user. The prize is real, and can include 30 percent or more reductions in engineering, installation, and maintenance costs, all while helping your people work smarter and avoiding unplanned shutdowns.

The beauty of FOUNDATION fieldbus is that it is a standard technology and a standard set of specifications, but process automation suppliers can take this standard and build their own knowledge and expertise onto it to create a truly powerful automation solution that is still standards-based. Yokogawa is a good example of a process automation supplier that has truly embraced all the functionality of FOUNDATION fieldbus, enabling users to take advantage of many of the more advanced functions of the technology—while at the same time

REGISTERED PRODUCTS & HOSTS

Interoperability is possible with FOUNDATION fieldbus because devices and software must all conform to the same standard and they are tested and registered to that standard. Products bearing the FOUNDATION Product Registration symbol have undergone a series of common tests administered by the Fieldbus Foundation.

Yokogawa offers two integrated DCS hosts that have been tested and registered under the Fieldbus Foundation's host profile testing. Yokogawa also has 20 different registered FOUNDATION field devices, from pressure transmitters to valve positioners.



Fieldbus Foundation Registered
Product Checkmark

Please share your
comments with us at
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removing complexity from the automation solution—allowing for faster time to startup, reduced installed costs, and reduced operational costs.

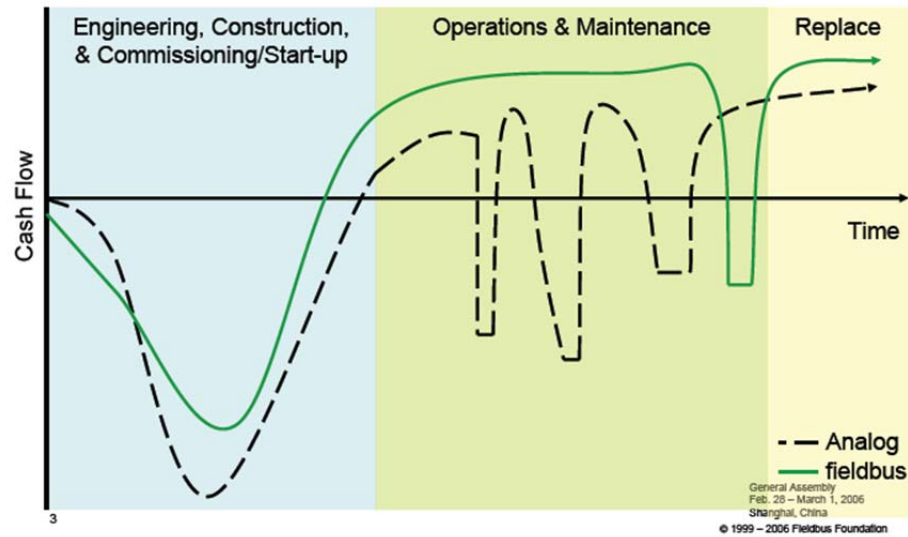
THE LIFECYCLE VALUE OF FOUNDATION FIELDBUS

Automation end users must make their purchasing decisions based on the economic value proposition of technology. As such, there must be concrete and documented installed and operational cost benefits.

Engineering and Design

Engineering of fieldbus systems is slightly different from that of conventional 4-20 mA analog-based systems. You can achieve more advanced functions with FOUNDATION fieldbus designs compared to traditional technologies. These advanced functions offer considerable opportunities for operating cost-savings and improved commissioning and start-up. You just need to keep a few key points in mind.

FOUNDATION fieldbus accommodates late changes in projects very easily because many of the functions provided by hardware in a conventional control system are no longer required by a Foundation fieldbus system, or are handled through software instead. Foundation technology was developed to provide a solution for VirtualMarshalling™ — software-based distributed



Lifecycle Cost Reduction Opportunities for FOUNDATION fieldbus Include Faster Time to Startup, Reduced Unplanned Shutdowns

I/O connectivity — in which devices provide multiple signals over the same two terminals. Instead of relying on custom hardware configurations to accomplish the functions of traditional marshalling, Foundation fieldbus accomplishes these tasks through a software-based structure. All signal linking (block to block) is done in software without hardwiring. This approach allows late addition of feedback and auxiliary measurement and control signals without the need for additional wiring. More devices can be added without laying more cable. Modifications to fieldbus instrumentation can continue until quite late in a project, thus reducing project schedule delays and their accompanying project cost overruns. All I/O is "soft," while traditional "hard" I/O can be eliminated.

With FOUNDATION fieldbus, field devices and segments become an integral part of the DCS. This requires an integrated configuration, data management, and system architecture approach to field network design. You can no longer treat devices and process automation systems as separate islands of automation. Many end users find that with fieldbus, it is easier to make their segment

diagrams on DCS graphics, and use the DCS database to self-document all the ways a given variable is interconnected. Many DCS suppliers are providing tight integration of configuration capabilities.

The block structure of FOUNDATION fieldbus also makes it possible to do control in the field. Having control functions residing in your valve positioner or field device means there will be an impact on loop diagrams, and may in fact mean the end of loop drawings in process plants.

Done correctly, a FOUNDATION fieldbus installation can save you 30 percent or more on your engineering costs. There are many end user installations to document this cost saving. Pick a good engineering partner or Main Automation Contractor (MAC) who knows what they are doing, has successful project references, and is well trained in FOUNDATION fieldbus and can help you realize the advanced engineering functions.

Installation and Commissioning

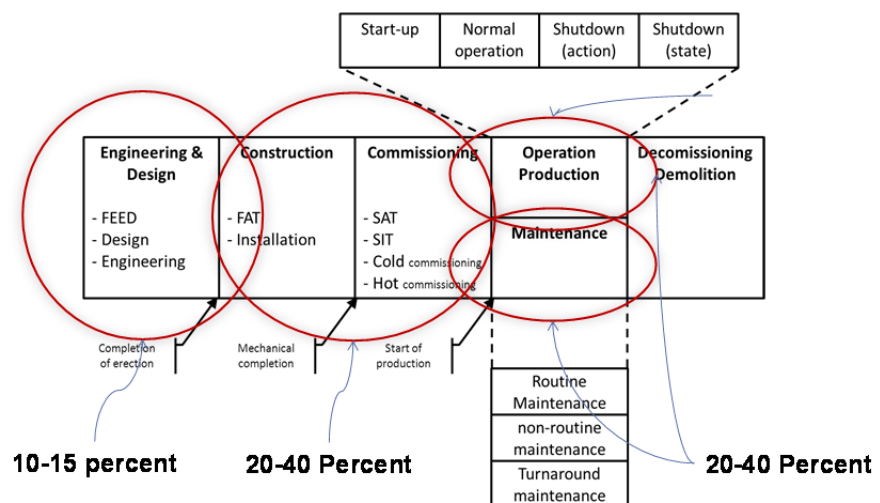
We talk a lot about faster time to startup, but FOUNDATION fieldbus also allows you to deal with project changes more effectively, and manage delays in preceding phases of the project better. A botched startup can cost you millions in lost potential revenue and profit. The advanced diagnostic capabilities of FOUNDATION fieldbus technology can also help you distinguish between process problems and problems with a device or sensor, and these diagnostics are provided in real time. For some end users, this means they were able to avoid plant shutdowns during crucial startup activities such as plant performance runs. In many cases, faster time to startup alone can provide a return on the investment in a FOUNDATION fieldbus system.

Installation and commissioning of fieldbus is different, but it is not difficult. With FOUNDATION fieldbus technology, you can reduce your commissioning times by up to 50 percent. What used to take 2 hours per device for two technicians can be done in 25 minutes with one technician.

The vast majority of fieldbus problems—more than 90% by most accounts—owe to deficiencies in the physical layer, that is, the wiring, terminations, and power supplies. Experienced fieldbus users are adamant that a little effort in training the installers pays immense dividends at commissioning time. At Reliance’s

Jamnagar Refinery in India, for example, hundreds of local electricians were trained in the rudiments of the installation. When it came time for commissioning, only three out of more than 3,000 segments exhibited any network issues.

Bus technologies connect multiple devices on the same pair of wires instead of using individual wires for each device. This reduces project



Significant Lifecycle Cost Benefits can be Achieved with FOUNDATION fieldbus

cost and time associated with cable and cable tray, field labor to install tray and lay the cable, as well as cutting, stripping, crimping, labeling, and connecting at every intermediate point. The cable savings are largest for complex devices with multiple signals each, such as electric actuators (MOV), gas analyzers, and discrete devices such as on/off valve actuators.

Operations and Maintenance

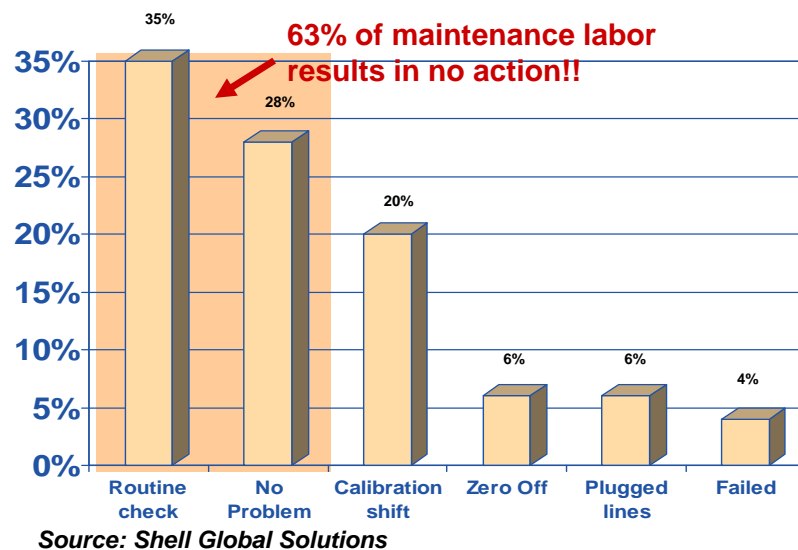
The real payoff of FOUNDATION fieldbus is in the operational and maintenance phases. Today's process automation end users face production challenges including variability in quality/yield, inability to reach or maintain capacity, and unplanned downtime. Fieldbus technology enables increase of production output in terms of higher quality, increased throughput, and greater availability (reduced downtime). Process variability affects both quality/yield and throughput and is therefore a great concern to the plant's operations manager.

Some "digital control systems" still rely on analog 4-20 mA input and output, using digital device communication only for maintenance. Transmitters are digital, controllers are digital, and valve positioners are digital so it makes sense to also have pure digital signals between them. This is what fieldbus is all about. Standards-based interoperability enables control to be embedded in devices from different suppliers.

A digital bus runs much faster than earlier hybrids of analog and digital, enabling a closed loop, which is digital end-to-end, from sensor to valve. FOUNDATION fieldbus is uniquely suited for control loops because the bus is time synchronized, scheduled, and real-time communication is separated from non-real-time communication, achieving the precisely periodic sampling ideal for PID control. FOUNDATION fieldbus control loops execute faster than 4-20 mA loops (which have asynchronous sampling delays) resulting in tighter control and lower process variability, which translates into greater consistency and quality.

Reduced process variability also permits the setpoint to be moved closer to the ideal point of operation, with less "comfort margin." This, in turn, results in better process reaction efficiency, greater throughput, etc. Improvement for each transmitter and valve, loop, and process unit aggregates for better overall plant performance.

FOUNDATION fieldbus has the capability to transform maintenance, and eliminate wasted activity in the maintenance cycle. Traditional preventive maintenance practices can mean that over 60 percent of your process automation



Maintenance Costs can be Significantly Reduced with FOUNDATION fieldbus

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maintenance activities may ultimately result in no action, because you are doing a routine check on a device or valve that does not require maintenance. Fieldbus allows your maintenance team to work smarter and avoid problems before they happen.

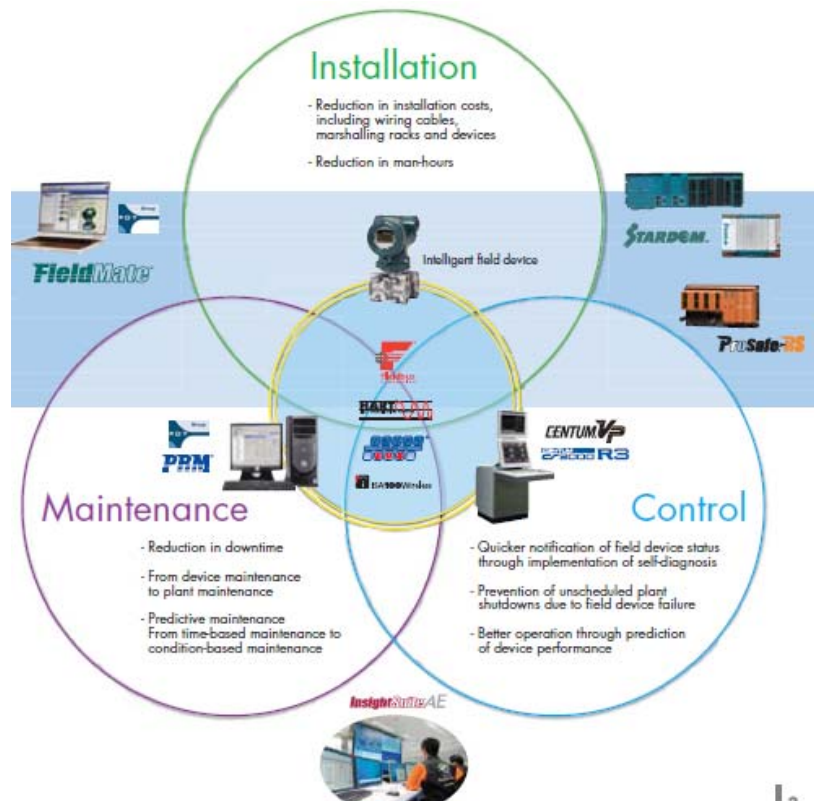
FOUNDATION fieldbus technology has also been found to reduce unplanned plant shutdowns. According to industry experts such as the ARC Advisory Group, unplanned downtime costs the process industries over \$20 billion a year. Control in the field helps to reduce incidents of unplanned downtime by keeping things running even if you lose visibility into the process. Control in the field also provides single loop integrity, which means that even if one control loop is affected in the plant, the impact is limited to that one loop and does not affect other loops running in the plant.

In addition, the advanced diagnostics of FOUNDATION fieldbus allows you to identify problems with devices immediately, as they happen. Fast communication also means that device diagnostics alarms arrive quickly, in seconds instead of hours. Prioritized and filtered device failure alerts delivered to operators at their operator stations is an early warning enabling them to react properly to the process disturbance caused by the device failure and notify appropriate personnel promptly. Service can be carried out sooner, and thanks to detail diagnostics, production returned to normal operation quicker. This reduces maintenance outage and percentage lost production. Diagnostics becomes a natural part of operations, keeping the plant running for continued production, thus improving availability.

YOKOGAWA'S LONG HISTORY WITH FOUNDATION FIELDBUS

Yokogawa has always been one of the core supporters of FOUNDATION fieldbus, and was one of the original members of the Fieldbus Foundation. The company was also one of the leading developers of the initial FOUNDATION fieldbus physical layer, including MAU and H1 communication chip provision, application layer specifications, and especially the concept creation and realization of "Interoperability." This includes development of the Fieldbus Foundation's Conformance Test Kit (CTK) and Interoperability Test Kit (ITK).

Today, Yokogawa has 20 registered FOUNDATION fieldbus devices and two registered host systems, including the [CENTUM VP](#) system and the [STARDOM](#) system. It also offers plant asset management applications such as [Plant Resource Manager](#) (PRM) and [FieldMate](#), which are designed to make it easier for end users to manage diagnostic and maintenance



Yokogawa Offers Fieldbus Products and Services Across the Plant Lifecycle

information that comes from digital devices.

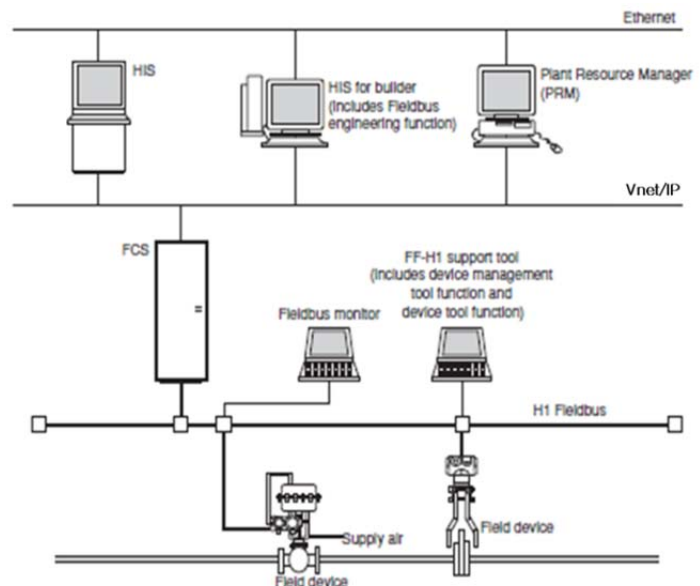
Yokogawa delivers a full range of engineering, installation and commissioning services and can serve as a MAC for fieldbus projects. The company has functioned in this capacity for several large FOUNDATION fieldbus installations around the world, including the very large CSPC Nanhai Petrochemical Complex in China, PTT Exploration in Thailand, Petroleum Development Oman, Shell Exploration and Production in the UK, the NAM gas fields in the Netherlands, and many more. Yokogawa's VigilantPlant Services business offers project management and MAC-related services as well as maintenance and operational services to help end users get the maximum benefit out of FOUNDATION fieldbus predictive diagnostics and reduced maintenance costs under the name of [InsightSuiteAE](#).

While many suppliers offer a full range of fieldbus-compatible host systems and devices, Yokogawa does some interesting things to allow users to take advantage of the more advanced functionality of fieldbus—making it easier to achieve the lifecycle cost benefits. For example, Yokogawa initiated the work at the Fieldbus Foundation on Common File Format (CFF), which is quite useful in concurrent and offline engineering activities. It also offers the concept of parallel downloads, where multiple segments can be downloaded simultaneously on a fieldbus system. Furthermore, Yokogawa offers devices templates, which can be used to configure large numbers of devices in a consistent manner. Let's take a look at some of these advanced functions in more detail.

Advanced Tools for the Engineering Phase

There are some fundamental aspects of engineering a fieldbus project that are different from a conventional 4-20mA analog project. Fieldbus allows for truly concurrent engineering, which means that different aspects of a fieldbus project can be engineered at different locations by different people simultaneously. During a fieldbus project, device suppliers will be determining things like device parameters, whereas system designers are configuring control schemes, selecting devices, and determining which control functions will be executed in devices or positioners versus the process controller. The end user will also perform engineering and related activities at installation and startup. This high degree of concurrent engineering involves a lot of offline engineering, meaning that the system designer is going to be doing a lot of engineering related to device configuration and control loop design without actually having the devices.

The Fieldbus Foundation specifies a CFF and Electronic Device Description Language (EDDL), which allow for easier sharing of engineering data across concurrent engineering sites. However, vendor implementation of the fieldbus engineering environment must itself provide good support of integrated online and offline engineering capabilities. An interoperable host system that supports off-



line configuration uses the CFF, along with the Device Description (DD), to build an offline configuration of the field devices.

Yokogawa is one process automation supplier that has fully embraced the concept of FOUNDATION fieldbus engineering and has fully embedded its expertise into its CENTUM VP process automation system to provide a good offline engineering environment. CENTUM VP Engineering Station features automatic CFF file generation and also allows off-line engineering of devices compatible with block instantiation without a connection to an actual device. If an actual device is installed, it executes block instantiation as necessary to enable engineering data to be set in the actual device.

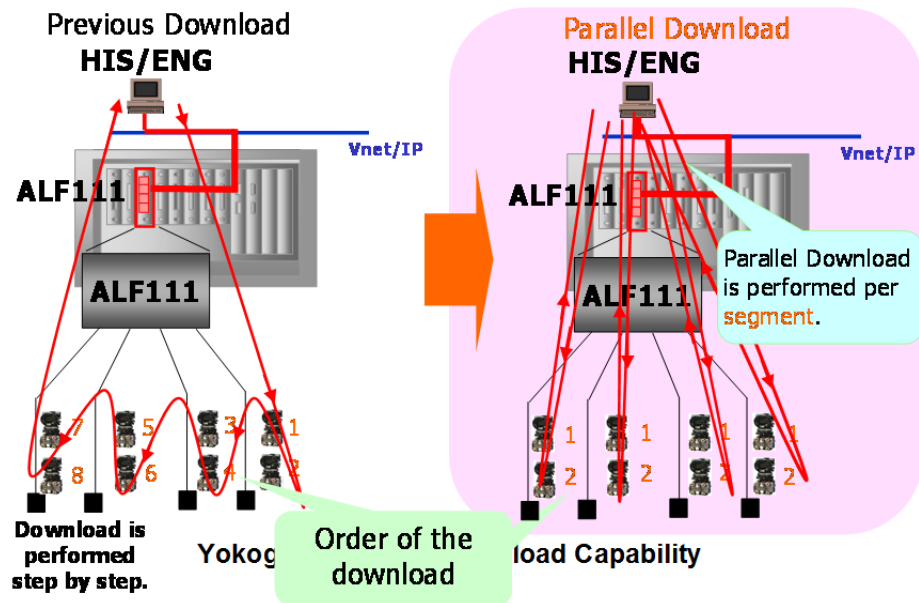
Segment Design

Physical layer implementation of FOUNDATION fieldbus revolves around good segment design. Fieldbus segments take up a lot less cable and fieldbus systems have a much smaller footprint than conventional systems, but requirements for good segment design should be followed. Many suppliers offer segment design tools that make this task quite easy. Yokogawa provides a free segment check tool to determine if segments are designed correctly, and automatically checks for things like terminators, cable length, voltage drop, number of devices per segment, and more.

Parallel Downloading Can Drastically Reduce Commissioning Times

Today, the installation and commissioning of field equipment, and the configuration and download of the control system, are done independently using a field digital technology. Yokogawa's goal is to provide innovation to the commissioning process to make it a truly automated procedure. The company calls this "Parallel Downloading." How does Parallel Downloading work? Yokogawa's

ALF111 fieldbus card features four ports, all of which can be downloaded in parallel. In a complete fieldbus control system, the user can perform parallel download on as many as five ALF111 cards at a time, or the equivalent of 20 segments at a time. All revisions of the ALF111 can handle parallel download functionality. All of the instruments in a domain can be selected at one time and are downloaded automatically.



The value proposition of parallel download becomes greater when you look at it from a domain perspective. Every Yokogawa fieldbus control system consists of domains, and a domain can consist of multiple Engineering Stations. In a domain that has the maximum of 64 Engineering Stations, you can download up to 640 segments simultaneously. That means for a large fieldbus system you have

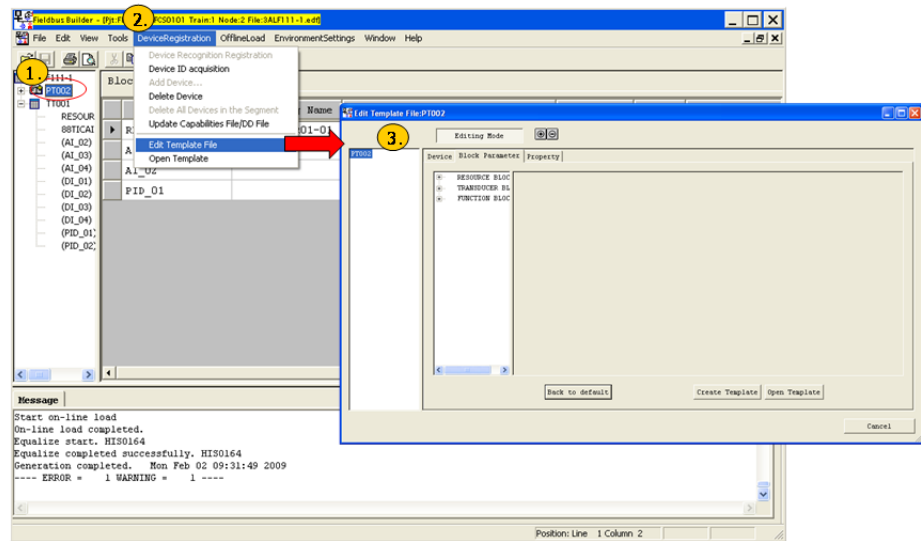
the capacity to simultaneously download thousands of devices at a time. A very powerful timesaver when it comes to installation and commissioning.

Fieldbus Device Templates Provide Repeatability

A template is a file that holds the user-specified block parameter values and the information about the equalized parameters of all the blocks. In plain English, it is a template file that contains all the parameters for a generic type of device, such as a differential pressure transmitter. You can use a template to set the parameters on large numbers of devices simultaneously. Aside from being a timesaver, templates also provide a level of consistency to device configurations. Since the user-specified parameters

can be reutilized, registration of the devices and initial downloading to the devices can be performed more quickly and efficiently. Multiple devices can use the contents kept in a template file. Since the user-specified parameters can be reutilized, registration of the devices and initial downloading to the devices can be performed more efficiently. This allows for parallel download on multiple devices.

1. Choose a device on tree view for saving information in a template.
2. On the fieldbus builder, choose [Edit Template File] from [DeviceRegistration] menu.
3. A window for editing template will be displayed.



Three Easy Steps to Creating a Device Template in Fieldbus Builder

Fieldbus Builder provides all the key functions required by a registered DCS integrated host system, which is tested and registered by the Fieldbus Foundation under our Class 61 Host Profile Registration process. Fieldbus Builder can read the template file for the device with the same vendor ID, device type and revision number. When manually registering a device, a template file list will be displayed for selecting the required template to use. When recognizing and registering a device, the template file list will not be displayed and the default template file for the recognized device will be used. When the Fieldbus Builder reads the template file, the user-specified parameters would be applied to the block parameters in the project database.

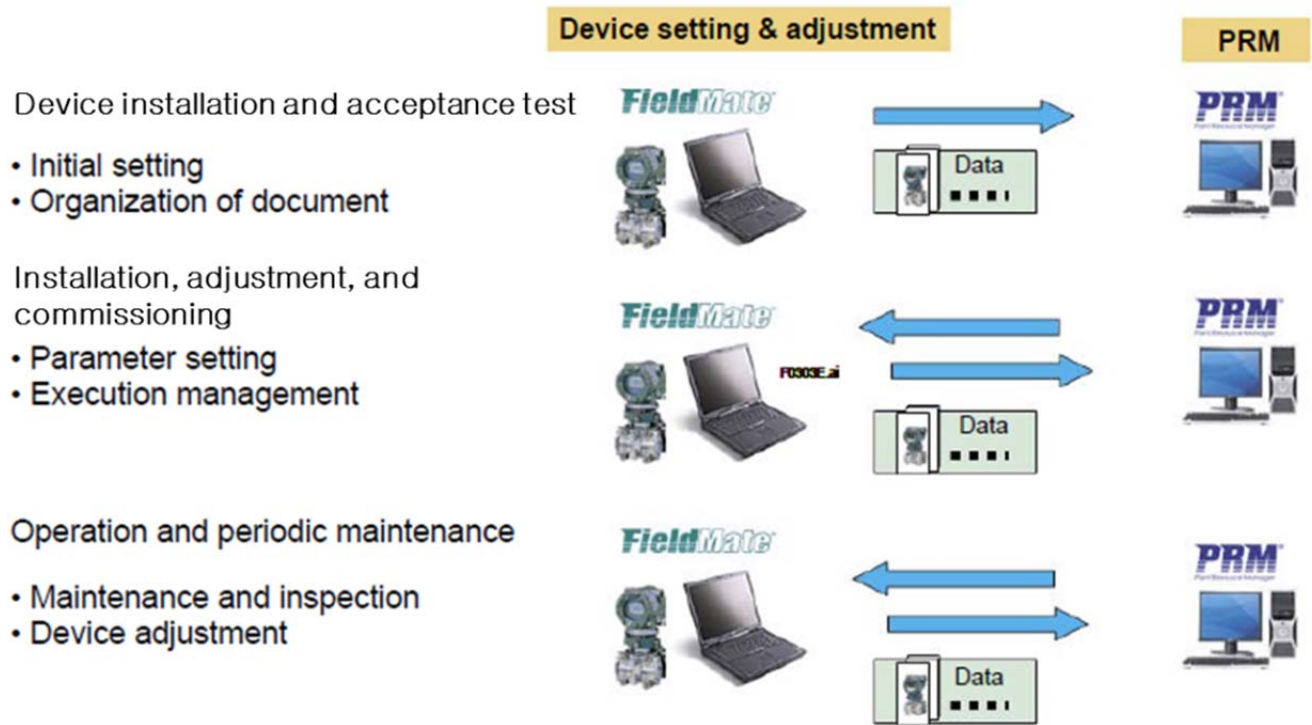
The Importance of Integrated Plant Asset Management and Intelligent Diagnostics

According to ARC Advisory Group, "Plant Asset Management (PAM) systems provide predictive asset health information derived from data embedded in smart field devices, control systems, and

sensors in conjunction with an intelligent analytical engine to predict problems before they can escalate.” Yokogawa offers a fully functional PAM application called Plant Resource Manager (PRM), which has direct integration with its CENTUM VP and STARDOM process automation systems, as well as the ProSafe-RS process safety system. With PRM and intelligent field devices, operators and maintenance personnel can monitor the condition of plant assets remotely. PRM’s diagnostic functions detect early signs of performance deterioration such as valve sticking and impulse line blocking.

FieldMate is a field tool that facilitates the configuration of a single device. FieldMate also performs device operations such as parameter setting, maintenance, and diagnostic functions. These activities and results can be easily transferred to PRM. Additionally, Yokogawa PRM has the functionality to synchronize databases with the configuration data in FieldMate. Several key functions are available for synchronization with FieldMate, from device installation and acceptance test procedures to operations and periodic maintenance.

Yokogawa has alliances with four global valve vendors under the VigilantPlant Integration Partnership (VIP) program. By integrating these valves using the FDT/DTM functions, PRM is able to perform high-quality device management and diagnosis along with the valve positioner configuration.



PRM Synchronizes with FieldMate for Key Fieldbus Work Processes

Yokogawa offers a solution for machinery diagnosis via an OPC interface in association with GE Energy, the world’s leading manufacturer of rotating and reciprocating machinery diagnosis. GE Energy’s System 1 is a machine/asset status supervision and diagnostic software platform that provides users with access to equipment status, and rotating and reciprocating machinery diagnostics. With System 1 integration, PRM can display the status of motors and pumps in addition to the control and instrumentation equipment. When the machinery fails or predictive alarms are generated, System 1 sends messages to DCS via PRM to notify operators.

CONCLUSIONS

FOUNDATION fieldbus offers a powerful return on investment for any process automation end user. The benefits are available across all phases of the plant lifecycle, including engineering, design, installation, commissioning, startup, operations, and maintenance. As a user, your supplier selection will drive many of the potential benefits that can be obtained. It's important to work with a supplier offering fieldbus products tested and registered by the Fieldbus Foundation. In that way, you're assured of the robust interoperability and integration capabilities only FOUNDATION technology delivers. Does the supplier offer registered products and host systems? If you're hiring the supplier in the capacity of a MAC, make certain they have the project expertise to ensure your installation will be a success.

Aside from expertise and internal competency, you need to evaluate supplier tools. How well does the supplier's plant asset management system support FOUNDATION fieldbus? How well can they support engineering and commissioning functions? And do they offer continued support with regards to system updates and software enhancements? FOUNDATION fieldbus is a standard technology, and we test and register devices and host system to meet our specifications, but we also leave room for suppliers to add their own competitive advantage through things like advanced tools and functions that can be found in supporting applications, such as the plant asset management system, or embedded within the DCS itself.

As a general rule, you should look for host systems that support the latest version of our Host Profile Testing and registration. For integrated DCS hosts, that would be what we call our Host Profile 61b. You can view a complete list of registered hosts at www.fieldbus.org under End User Resources/Registered Products.