Building on the Foundation

Steady improvements and enhancements over the last decade together with an increasing knowledge base in the process industries have made it far easier to realize the promised benefits of Foundation fieldbus plant network technology. *Jonas Berge* explains more.

When Foundation fieldbus (FF) was first introduced, manufacturers, engineering companies, and plant personnel needed to climb the learning curve of technology, products, and practices. Thousands of systems later, users can make their fieldbus project a fast and economical success, as well as support fieldbus more easily, allowing most any plant to achieve the project and operational results.

It is thanks to continuous improvement over the past ten years that using Foundation fieldbus has become easier at every phase of the system lifecycle. The fieldbus technology has matured and the knowledge base and user community has grown to where this highly efficient automation approach is no longer just for experts.

The growth of Foundation fieldbus is not surprising when you consider that this communications approach for industrial plants produces proven project savings of as much as 30 percent and operational improvement of at least two percent. A digital plant architecture that uses the power of field intelligence to improve plant performance can be implemented and supported in nearly any plant.

Foundation fieldbus is now used by leading companies in the chemical, oil & gas, refining, petrochemical, power, and pulp & paper industries in an increasing number of their process plants around the world. For many of them, fieldbus is now the norm for new plants.

Most manufacturers of process automation products now supply Foundation fieldbus devices. For example, Emerson's PlantWeb digital plant architecture uses the technology to network digitally intelligent instruments and equipment throughout facilities. Leading engineering companies have gained experience and now execute fieldbus projects. And process licensors now accept fieldbus and have established requirements to guarantee best process performance.

To expedite the implementation of fieldbus in control systems and incorporation into work practices, use of latest technology and product enhancements, as detailed below, will help ensure best results.

Setup & diagnostics

Foundation fieldbus has already made it possible to network all types of devices around the plant from different manufacturers to the same single tool – portable or in a central location. These include simple temperature transmitters as well as sophisticated analyzers, advanced valve positioners, radar level and machinery health transmitters, and more.

Technicians can now access all functions of the most advanced fieldbus devices, and advanced setup and sophisticated diagnostics are now are presented graphically for easy interpretation. Looking back, It was not always so easy.

The original DD (device description) technology from 1992 had no graphics and therefore did not support sophisticated fieldbus devices or advanced setup and diagnostics. Intermediate solutions included graphics that worked on one control system but not another so advanced diagnostics and setup was possible on one system but not the other. Another solution required installation of third-party software

EDDL – the most significant advancement to fieldbus technology.

drivers, which is not permitted when control systems are running and sometimes not at all.

The most significant advancement to the fieldbus technology since it was first introduced is that the Electronic Device Description Language (EDDL), formerly known as just "DD", has been enhanced with powerful graphics as a solution to the early shortcomings (see *Control Engineering Asia* September 2007, page 24-29).

This important step forward resulted from a partnership with the Hart Communication Foundation, Profibus International, and the OPC Foundation known as the EDDL Cooperation Team (ECT). Using EDDL, device information is presented as waveform graphs, trend charts, gauges, images, bar graphs, histograms, and tables etc. Device vendor experts transfer their know-how to technicians through images, text, and context sensitive help. Moreover, tabbed card, tree, frame, and pop-up window for menus make diagnostics easier to navigate.

EDDL now makes it easier to monitor, configure/setup, and diagnose simple as well as sophisticated fieldbus devices from any manufacturer using the same software or handheld field communicator. Moreover, EDDL allows fieldbus device diagnostics to be integrated to the operator workstations because device manufacturers supply compressed text files, not software. What used to be a mystery is now a method. EDDL makes it easier to setup and calibrate fieldbus devices correctly, even by non-experts.

For example, "methods" written by device manufacturers appear in device management software and handheld field communicators as "wizards" that guide the technician making complex procedures such as radar level transmitter false echo elimination easy and minimizing mistakes. Similarly, the calibration trim process is also guided step-by-step, taking the mystery of out fieldbus.

And compared to the days when, for example, pressure transmitter calibration required two persons in touch by walkie-talkie, one in the field to work the manifold, the second at the software in the control room, now, lightweight handheld field communicators for Foundation fieldbus enable a single operator to perform a full day of work in the field without requiring a second person in the control room. Based on EDDL, one communicator supports all fieldbus devices.

Interoperability testing

Counting different manufacturers and models of fieldbus devices in the main plant and on package units, the number of fieldbus device types can be very high. These fieldbus devices must interoperate with each other and with the control system software. But in the early days of fieldbus, interoperability testing was not done, which meant that some fieldbus devices and systems could not work together or required undue integration effort.

A rigorous interoperability program was thus created and an automatic Interoperability Test Kit (ITK) designed. Fieldbus devices and their EDDL file must now be tested before they can bare the checkmark insignia. Fieldbus Foundation members collaborate in a steering committee of experts in order to resolve technical issues, and specifications and tests are updated accordingly. Even hardware such as power supplies and couplers are tested.

The latest addition is a more stringent test of control systems through something called the Host Registration Process (HRP), which tests to ensure system features are supported to enable full benefit from fieldbus devices, for example EDDL graphics capability.

These processes of rigorous testing and continuous improvement have reduced the risk of fieldbus device and software incompatibilities making integration easier. Similarly, risk of issues with the networking hardware is reduced. No other bus technology has a comparable level of interoperability testing for devices, systems, or networking hardware.

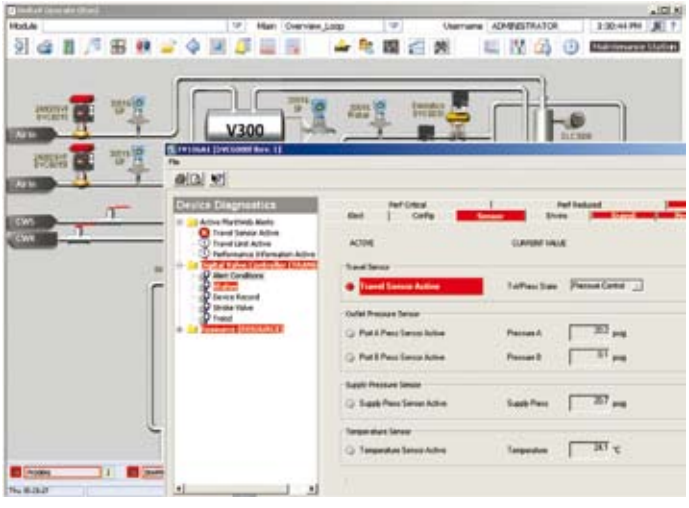
Intrinsic safety

Facilities in the oil & gas, refining, petrochemical, and chemical industries and some others that process flammable fluids are considered hazardous areas. A popular automation approach for these hazardous areas is intrinsic safety. But back in the early days, this was based on the original "entity" concept. Apart from the number of devices and wiring distance being severely restricted, the engineering burden to document entity parameters of all components and verify capacitance and inductance was high.

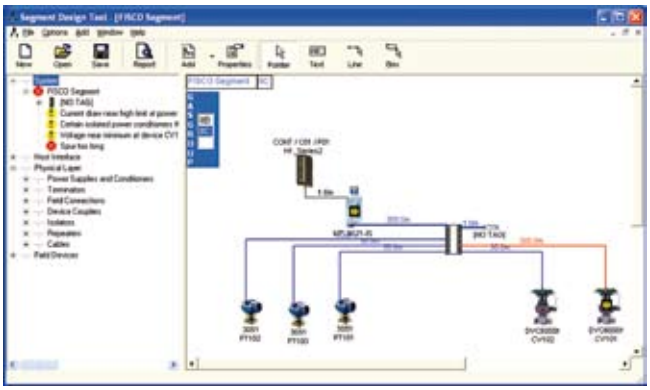
Leading suppliers of safety barriers and networking hardware have developed more than a dozen new options to wire Foundation fieldbus in hazardous areas. An important advancement is Fisco (Fieldbus Intrinsically Safe Concept), which not only allows more power, more devices, and longer wires, but at the same time drastically simplifies the design work. Tabulating entity parameters is no longer required. Fisco simplifies device selection as well as the documentation burden.

Segment design

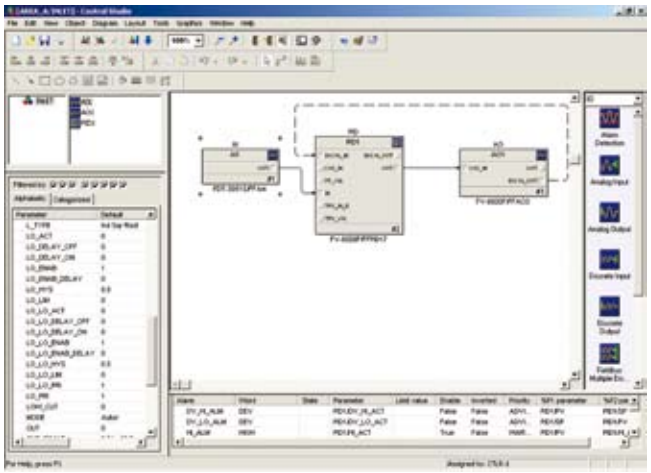
Demonstrating that sufficient supply voltage will be available for devices at the end of long fieldbus wires, particularly for intrinsic safety where voltage is low, is a challenge for



Operators can now access all functions of the most advanced fieldbus devices, and advanced setup and sophisticated diagnostics are presented graphically for easy interpretation.



Segment design software tools automate the bus design validation process.



Central and field control can now be configured from the same software in exactly the same way.

system design engineers. In the past, such calculations were done using simple spreadsheets, which is tedious and error prone.

Fortunately, new segment design tools automate bus design validation. First the hazardous area classification is chosen, and next come power supplies, safety barriers, limiters, and fieldbus devices. Product data is built into the database eliminating lengthy research. The software verifies the design according to rules for spur and total length, limitations for current and voltage, etc, producing a report that makes up part of the system documentation.

Using such a software tool, design verification becomes easy and self-documenting. Manual labor is reduced, cutting cost and speeding up project completion. (An example of a free fieldbus design tool can be found at www.emersonprocess.com/systems/support/segment)

Strategy configuration

The Foundation fieldbus function block diagram language conforms to the international standard IEC 61804-2. Function blocks in fieldbus devices and automation system controllers link seamlessly, including windup protection and bumpless transfer between controller and positioner as well as non-safety-related process interlocks from transmitters through to valve. Central and field control are configured from the same software in exactly the same way, eliminating the need to grapple with two tools to make the configuration.

Configuration tools automatically build the schedule responsible for precisely periodic control execution and communication so critical to PID loops. New control systems allow fast and slow loops to be mixed on the same bus, for example, 250 and 1000 ms. Visualization of the schedule now makes it easy to validate it, ensuring correct sequence for optimum performance and bus loading leaves sufficient bandwidth for non-real-time communication. The result of all these enhancements is that system configuration and validation become much faster.

Hot upgrading

Plants may have hundreds or thousands of fieldbus devices installed. These devices are reliable and last for decades. As new and improved versions become available it may make sense to upgrade fieldbus devices in operation to get even better results by improving solutions using new capabilities. In the past, device firmware could not be upgraded, or the device had to be taken to the workshop for the procedure.

Because execution and transmission scheduling in Foundation fieldbus ensures separation between real-time and non-real-time communication, large firmware files can be downloaded without disrupting real-time control. Advanced valve positioners can receive new firmware from the software utility while in operation and switchover without bumping the process.

The consequence is that plants can stave off obsolescence to reap the results from fieldbus device improvements. Only Foundation fieldbus has firmware download capability because it is the only intrinsically safe bus that has scheduled separation of real-time from non-real-time communication. No other bus can claim the same results.

Execution time

In some industries the process licensor requires fast loops such as flow and liquid pressure to be executed on a 250 ms cycle. Previously, control was often done centrally requiring more values to be communicated across the bus. Fast response times were only possible with few devices per bus, resulting in less cost effective installations.

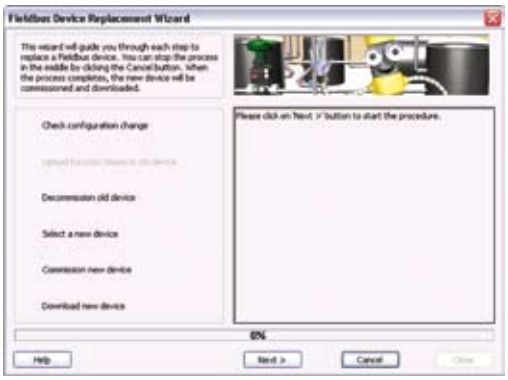
New fieldbus devices are more powerful, executing blocks as fast as 20-30 ms. Control systems support control in the field (CIF) to reduce communication. Control cycles of 250 ms can now be achieved without undue engineering effort.

Foundation fieldbus is the only bus scheduled to support control in the field and as many as 80 percent of control loops can be implemented this way, i.e. with PID and other loop functions executed in positioners and other instruments. Some loops are still executed in a central controller because they require interlocks with other buses or conventional signals. Thus there is a mix of central and field control, although pure centralized control is still used by some.

Simulation testing

During factory acceptance test (FAT) of a new control system, field device signals must be simulated to test graphics, control strategy, and alarms. It used to be that the only way to fully loop test was to connect all the actual fieldbus devices to the system. This had to be done late in the project after devices were manufactured, and, often, only typical loops were tested.

Some control systems now have simulation capability for fieldbus devices and function blocks, making it possible to mimic process



A software wizard helps to ensure the correct sequence of steps are followed when replacing a device on the fieldbus network.

conditions and alarms to verify system behavior. Full loop test at the FAT to reduce the risk of surprises at site is hence very much improved.

Auto tuning

A plant may have hundreds or thousands of PID control loops. These loops must be "tuned" for the process to perform optimally. This also applies to PID executed in fieldbus devices. Although control systems have had auto tuning software for many years, in the past, such software only worked for the control system's centralized controllers. PID in the field had to be tuned manually.

The auto tuning software in some control systems now tune PID controllers in fieldbus devices as well, without upsetting control during test. As a result, tuning control-in-the-field controllers to achieve better performing loops is now easier than ever before.

Rapid replacement

Depending on size, a plant may have anywhere between hundreds to thousands of devices. With an average MTBF of two hundred years there will be a device failure each month somewhere in the plant. A failed device must be replaced quickly for production to continue.

In the past, control systems required the technician to manually perform several complex operations in the correct order to replace a device, requiring expert knowledge. Now some control systems have software "wizards" to effectively manage the process of decommissioning the failed device, commission the replacement device and reconcile the configuration.

Special bus diagnostic tools also exist. One type may be permanently installed to measure supply voltage, signal, and noise in the control room end of the trunk, while the other type is portable to measure anywhere, including at the device spur. Maintenance of the bus and devices is very much easier than before.

Practices & procedures

Aside from technology, to fully benefit from fieldbus, projects must be executed differently and the plant must be operated differently. If not, there may be higher cost and no advantage.

One of the greatest barriers to fieldbus adoption in the past was that plants had to develop all the engineering practices, operational procedures, and maintenance work processes themselves. Those that did not change their behavior merely got a better DCS (distributed control system), not a quantum leap in convenience and output. But now, successfully executing projects and deploying fieldbus systems is easier than ever, through a number of initiatives and industry advances:

• The Fieldbus Foundation has developed documentation including design guidelines and installation guides to help in the project phase

• Control system suppliers now have internal consultants experienced working with the EPC to develop project specific and provide additional documentation including checkout forms and functional design specifications, etc.

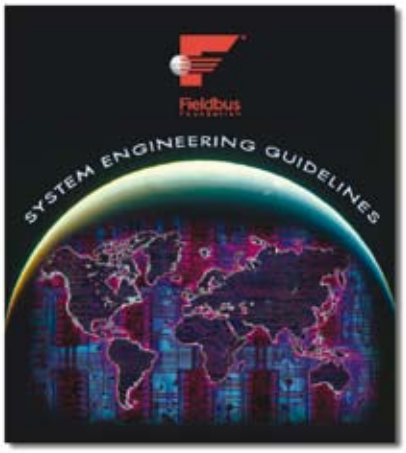
• Support teams are trained on fieldbus

• Asset management solution suppliers have developed programs to facilitate implementation and incorporation of fieldbus device management into the daily work processes

A new legacy

In many older "brownfield" plants, control systems must be upgraded because it becomes difficult to find spare parts. The cables may also be deteriorating to the point where they must be replaced. When upgrading the control system at a brownfield installation, a major concern is the existing instrumentation.

Plants that purchased a DCS years ago, and that used proprietary protocols, are now faced with continuing to buy transmitters only from the DCS vendor to maintain



Users can now call on a lot more resources to ease the fieldbus implementation process.

interoperability. Without alternate sources, maintenance departments pay higher prices for spares and replacements. Some DCS vendors still happily sell proprietary communication interfaces and devices and non-standardized device integration solutions, so buyer beware.

Foundation fieldbus with EDDL finally delivers what has long been promised by others. When upgrading an old control system, transitioning from proprietary technology and moving to the standards-based approach with fieldbus protocol is a major objective. Some plants start on a small scale to enable personnel to familiarize with the fieldbus technology. In these instances, a gateway can be used to integrate process variables to legacy systems using Modbus while providing modern device management on a separate workstation.

Foundation fieldbus makes it possible to source replacement instruments from multiple suppliers at best price, performance, support, or delivery time. There are plants that have made the switch to fieldbus using "hot cut over", that is migrating loop-by-loop while the plant was running.

It has become easier than ever to upgrade the plant's control system to a digital architecture delivering accurate, actionable information to the right person in time to make a difference. The plant can continue to build on this architecture for the digital future, ready to accept new kinds of digital devices to solve problems that could not be solved before. **CEA**

Jonas Berge (Jonas.Berge@emerson.com) is Senior Manager, PlantWeb Consulting, at Emerson Process Management Asia Pacific, and the author of the books 'Fieldbuses for Process Control' and 'Software for Automation'.