

ARC WHITE PAPER

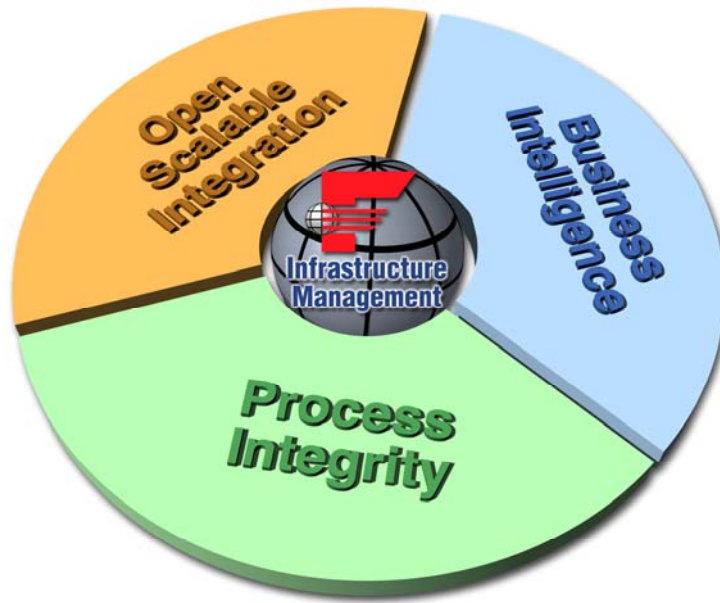
By ARC Advisory Group

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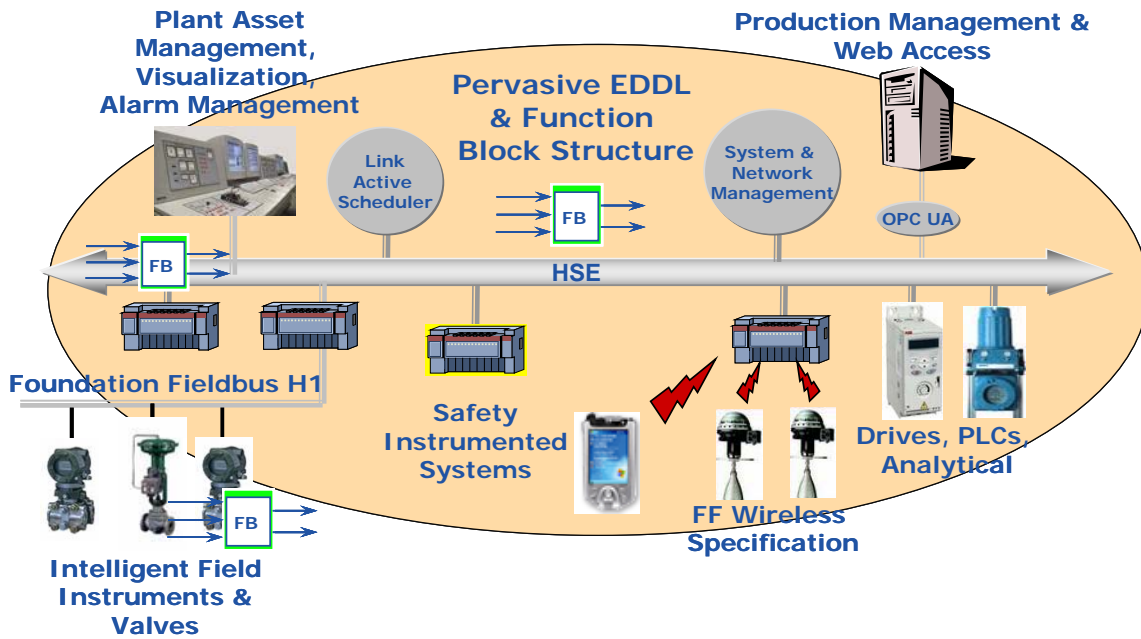
FOUNDATION Fieldbus Provides Automation Infrastructure for Operational Excellence

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The Primary Value Proposition of FOUNDATION™ Fieldbus as a Standards-Based Automation Infrastructure



The Network is Only Part of the Equation in the Overall FOUNDATION Technology Offering

Executive Overview

For too long, the discussion of fieldbus has centered around the network aspects. FOUNDATION™ Fieldbus technology was built from the ground up to be more than just a digital replacement for 4-20mA technology. FOUNDATION technology is a unified infrastructure that manages data, communication, plant assets, and plant events while providing highly distributed control functionality and interoperability between devices and subsystems. This infrastructure is supplier neutral, standards-based, and provides end users with a common framework to implement and manage strategies for operational excellence and continuous improvement in process manufacturing.

The scope of FOUNDATION technology really makes it a process automation system, and it is arguably one of the most advanced and scalable systems available.

End users are increasingly specifying automation products and services not based upon the level of technology they provide, but on the business value proposition. FOUNDATION Fieldbus technology should be looked at from the same point of view. The three primary value propositions of FOUNDATION technology include process integrity, business intelligence, and open and scalable integration of information across process manufacturing plants.

FOUNDATION technology provides a path to greater process integrity through its capabilities for field level control, enhanced diagnostics for process safety systems, providing a common architecture for both process and safety systems, and providing more accurate measurements. Enhanced business intelligence is provided by the unification of FOUNDATION technology with the OPC UA standard and through the open data access that fieldbus can provide to any plant application. Open scalable integration is possible with FOUNDATION technology through its ability to interface with OPC UA and provide a unified data model with the incorporation of Enhanced Electronic Device Description technology.

Many other aspects of FOUNDATION technology enable this threefold value proposition. Aside from the highly publicized aspects of EDDL and field level control, FOUNDATION technology incorporates key aspects of what ARC calls the Collaborative Process Automation System vision, including common data, common time, common presentation, high availability, and network management.

The Business Value Proposition of FOUNDATION Technology

End users are finding it increasingly difficult to justify automation purchases based solely on technology. Automation must provide solid business value benefits based on a combination of metrics, such as enhanced asset availability, return on assets, reduced lifecycle cost, and many other strategic and financial objectives. FOUNDATION Fieldbus was built

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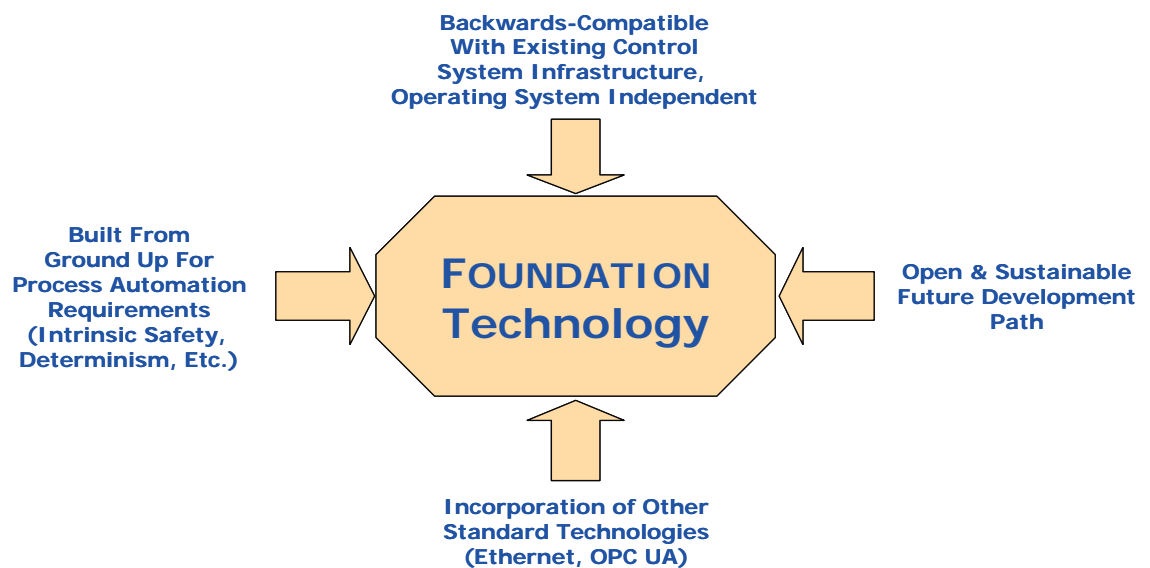
from the ground up to address these business issues, and the development of the technology was directly in response to end user demand for access to better data from the field so they could improve the performance of their plants and businesses.

The replacement of 4-20 mA technology with a digital network was a big factor in the development of FOUNDATION technology, but that is only part of the equation. The real differentiator between FOUNDATION Fieldbus and its counterparts in process automation, such as Profibus PA and HART, is the incorporation of a function block structure and supporting functions that really make FOUNDATION technology a complete infrastructure for process automation.

FOUNDATION technology includes not only control function blocks, but also has mechanisms for time management, global data access, an open and standards-based control network backbone in the form of HSE, and many other aspects that make it a true automation infrastructure. At the same time, FOUNDATION technology is open and based on international standards, allowing any automation supplier to incorporate the technology into their framework for automation while still allowing room for competitive advantage. FOUNDATION technology is essentially a standards-based template for high availability process automation that can serve as a common infrastructure for any process automation system from basic regulatory control to safety applications.

Designing FOUNDATION Technology – Fit For Purpose, Backwards Compatible, Sustainable

One of the advantages of this openness and standards-based structure is that FOUNDATION technology is free to evolve in step with the overall world of technology, providing a sustainable framework that is being continuously updated. The initial development phase of FOUNDATION technology was to develop a standards-based baseline technology that is operating system independent and “fit for purpose” for the stringent requirements of process automation, including intrinsic safety, determinism, and redundancy.



FOUNDATION Technology was Designed from its Inception to be “Fit For Purpose” for Process Automation, Flexible, Adaptable, and Sustainable

FOUNDATION technology was also designed to operate within the limits of the installed wiring infrastructure that already exists in process plants. The wiring specifications call for the same type of twisted pair shielded cable typically used for analog instrumentation wiring. It also demands that devices be powered from the same twisted pair and for the instruments to be capable of supporting intrinsic safety with barriers in the line before being admitted to the generally safe control room environment.

FOUNDATION Technology also avails itself of other standard technologies already available and well accepted in the marketplace. This is evident in the adoption of standard high-speed Ethernet in the FOUNDATION Fieldbus HSE high-speed network. FOUNDATION Fieldbus HSE is the control level bus for a FOUNDATION Fieldbus system. It enables the construction of con-

trol cascades between instruments on different H1 segments, as well as the more conventional view of being the communications pathway to all of the field instruments. Without HSE, bridging from one fieldbus segment to another is a software function of the controller. HSE removes all of this

CPAS Functional Requirements
Common Network
Ethernet-Based Control Network
Common Time
Network Management Facility
Enables Advanced Data Visualization
Incorporates Standards
Common Presentation
Global Data Availability
High Availability
Data Certainty & Quality
Online Upgrades
Publish/Subscribe
Traceability

FOUNDATION Technology Corresponds to These Key Aspects of the CPAS Functional Requirements

complexity and avoids the delays always encountered with software bridging.

The current development phase of FOUNDATION technology is focused on adapting this baseline technology for various applications in process automation, including wireless, safety systems, batch control, and adoption of the FF standard into the communications standard for the New Sampling Sensor Initiative (NeSSI) Generation II Draft Specification. These new developments and adaptations for FOUNDATION technology would not be possible without the high-level design foresight of openness and adaptability in the original specification.

Fieldbus Foundation has also started a remote I/O working group for HSE so they have a consistent device model. The working group will develop use cases and requirements for HSE remote I/O, including discrete I/O and gateways to other networks, such as HART, Profibus, and Modbus, which are in-

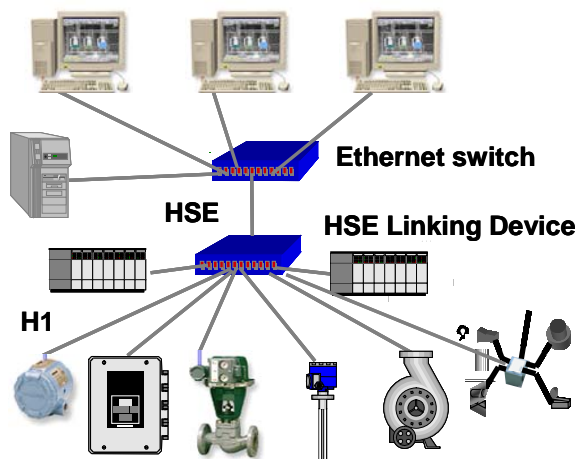
teroperable using function blocks and EDDL. After the specifications are completed, validation of specifications using lab prototypes will occur, followed by demonstration of interoperability at end user sites. The real benefits are for the end user so that with a consistent device model, it will be possible to develop common configuration tools instead of requiring a special tool for each remote I/O. These tools will be driven by the device's Electronic Device Description (EDD), and EDDL technology will be an enabler for these tools.

FOUNDATION Fieldbus Provides Key Functions Outlined in ARC CPAS Vision

ARC's vision for a Collaborative Process Automation System (CPAS) consolidates our ideas about what a process automation should look like given the technologies and standards that are available today. The ultimate goal of CPAS is to provide an enabler for Operational Excellence (OpX) in to-

day's process plants. Many aspects of the CPAS model revolve around what the automation supplier offers as a common hardware platform, a single user interface, and standards-based programming tools. FOUNDATION Fieldbus technology, however, fulfills many of the infrastructural requirements. Automation suppliers have the ability to avail themselves of this common infrastructure and build their own solutions for process automation in parallel with it.

Beyond the core requirement for a common network infrastructure, which is clearly addressed with the combination of H1 and HSE networks, FOUNDATION technology provides key services outlined in CPAS such as common data, common time, a network management facility, global data



The Foundation Fieldbus-based CPAS Architecture

availability, ability to perform online upgrades, and a publish/subscribe model. H1 addresses the requirement for providing a unified environment for sensors and actuators that also supports a distributed environment for field control. HSE fulfills the requirement for a fault tolerant and common control level backbone, and provides integration of discrete devices and networks. FOUNDATION technology is also based on standards that are pervasive throughout the FOUNDATION architecture, not just at the network level. The technology provides synchronization in a time sense through its own publish/subscribe transport mechanism.

Common time is shared across all devices, and time stamping takes place closer to the process at the device level, providing more accurate sequence of events time stamping on alarms and alerts.

Another key requirement for a collaborative process automation system is the ability to conduct online upgrades. For the typical DCS, this means upgrading firmware while the controllers are still running, without the need to shut down the process. FOUNDATION technology also supports online upgrades with no interruption in the process. These include blockware mode, and firmware changes. FOUNDATION technology is also an object-based system, with the function blocks serving as objects.

Core Business Value Propositions of FOUNDATION Technology

Features and underlying technology are important, but these are not enough to justify their application, especially in today's capital-averse environment. End users today are highly focused on business issues and any technology under consideration must meet business value criteria. At ARC, we see the same business issues being mentioned repeatedly in the process industries – increasing process availability, the need for actionable business intelligence, and the need for a common environment that can be scaled down to very small process applications or scaled up to large, critical applications that require integration of multiple control domains. FOUNDATION

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Technology addresses all three of these issues, and should be approached as a system in order to achieve the benefits.

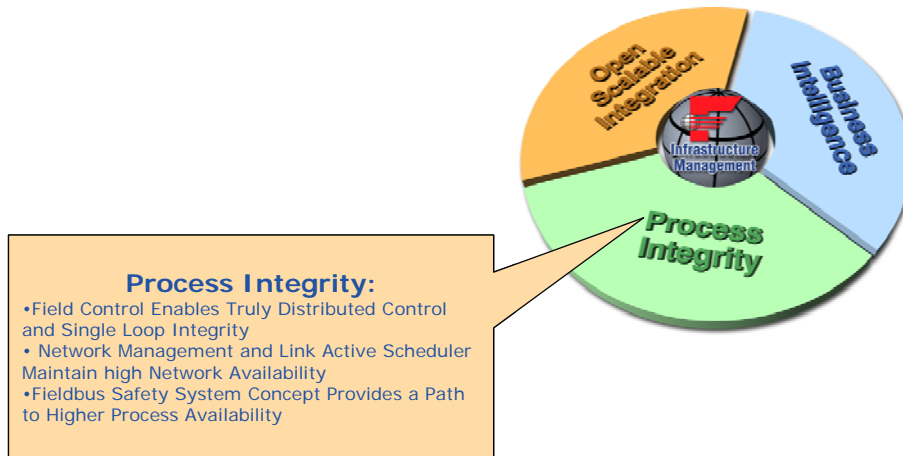
Process Integrity addresses the requirement to keep the plant up and running at all costs. If an abnormal situation arises and the plant does need to shut down, it does so in a logical and controlled manner that avoids the creation of waste and, more importantly, avoids damage to people and the environment. The need for

business intelligence addresses the requirement for global data access and availability, allowing users in various roles in the plant to access the data they need, when they need, from any point in the system. At the same time, this data should be presented in a manner that is easy to understand and act upon. Open, scalable integration addresses the need to drive out custom integration costs and the requirement for best of breed applications to work seamlessly together in an open environment. As an open automation infrastructure, FOUNDATION Technology addresses all of these requirements in several different ways.

FOUNDATION Technology Enables Enhanced Process Integrity

Of all the business requirements for process automation, process integrity is the most important. Aside from requirements for manufacturers to provide a safe working environment and minimize impact on the environment,

high availability control has a direct impact on eliminating waste and lost revenues due to unplanned plant shutdowns. Unplanned downtime and the inability to respond effectively to critical situations are the bane of the process industries. According to NIST (U.S. National Institute of Standards & Technology), for example, the inability of control systems and operating personnel to control critical conditions costs the U.S. economy at least \$20 billion a year.



Primary Areas of Enhanced Process Integrity Provided by FOUNDATION Fieldbus

FOUNDATION Technology addresses the need for enhanced process integrity and availability in several ways. The function block structure of FOUNDATION Technology enables control in the field, which is an enabler for single loop integrity and higher process availability. The network management and Link Active Scheduler aspects of FOUNDATION technology ensure that the network will remain up

and running. Redundancy is available down to the I/O layer. Finally, the FOUNDATION safety system concept will revolutionize the way that end users approach safety and critical control systems through the FOUNDATION SIS concept.

Truly Distributed Control Provides Path to Single Loop Integrity

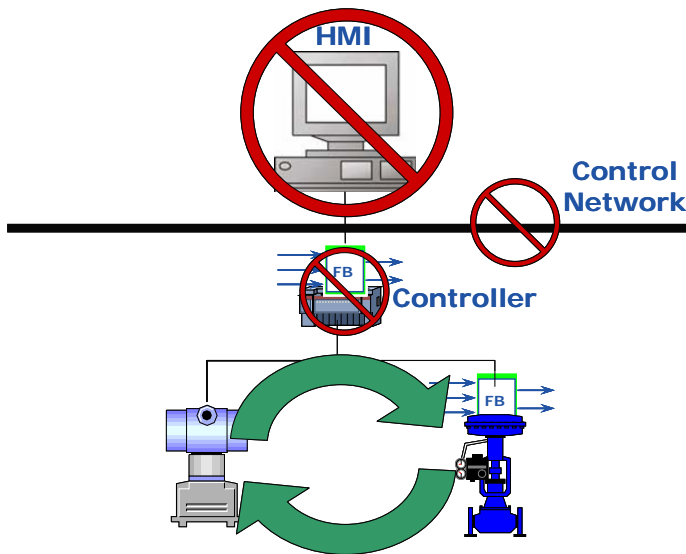
Embedded control functionality in field devices, otherwise known as field control, is one of the key enablers for achieving high availability control and a stepping-stone toward single loop integrity. The premise is simple. With control at the device level, control is truly distributed and there is truly no single point of failure in the system above the H1 level. That means if there is a malfunction in the HMI, controllers, or any other component in the system, the control loop consisting of the intelligent field device, network, and positioner will remain unaffected. When control is placed in the DCS controller, field level control can add another level of re-

dundancy. Many end users have already managed to avoid unplanned downtime when field level control took over after interface card failures.

Field level control means not only increased availability and reliability, but also increased flexibility. Controllers are free to handle higher-level control functions. FOUNDATION Fieldbus allows for "dynamically instantiable function blocks", and there is a large library of different block types that can be used (PID, selectors, switches, alarms, arithmetic etc.)

Network Management & Link Active Scheduler Roles in Process Integrity

Network management is assuming greater importance in the world of process automation systems, and FOUNDATION Technology already has mechanisms in place to address this issue. The FOUNDATION Link Active Scheduler is an arbitrator that decides which devices will have access to the fieldbus network and when. In fieldbus, LASs preside over only their particular local bus segment.



Field Control Keeps the Process Running Despite Loss of Visualization, Control Network, and Controller Functions

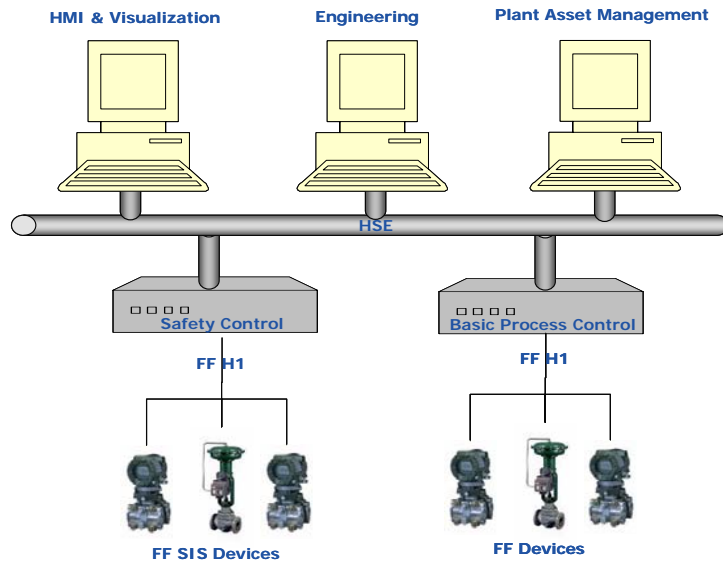
The implementation of a backup link active scheduler (BLAS) is a crucial step in providing high availability fieldbus control. Most suppliers currently support Link Active Scheduling (LAS) technology, but not all provide full BLAS support for all devices on the bus that have this function. The advantage of having a BLAS is that it will take over in the event of failure of the primary LAS. Any device can function as an LAS, and in some supplier control schemes any device or all devices on the bus can also function as a BLAS, ensuring that network traffic will resume uninterrupted in the event of a failure.

FOUNDATION Fieldbus Safety Systems Increase Process Availability & Security

In early 2006, Fieldbus Foundation announced that TÜV had granted Protocol Type Approval for the Fieldbus Foundation Safety Instrumented Systems specifications. The specifications outlined by the Fieldbus Founda-

tion comply with the IEC 61508 standard for functional safety of electrical/electronic/programmable electronic safety-related systems requirements up to, and including, Safety Integrity Level 3 (SIL 3).

TÜV Protocol Type Approval extends FOUNDATION technology to provide a comprehensive solution for Safety Instrumented Systems in a wide range of industrial plant applications. The specifications enable suppliers to build FOUNDATION devices in compliance with IEC 61508. TÜV will certify that



The Common Architecture Enabled by the FOUNDATION SIS Concept Reduces Installation & Operational Costs & Increases Availability

these devices are suitable for use in safety instrumented systems. End users will be able to choose devices meeting the requirements of IEC 61511 (functional safety: safety instrumented systems for the process industry sector) from multiple suppliers, instead of being restricted to devices designed specifically for a proprietary safety system platform.

But what are the benefits of Fieldbus at the safety system layer? Over 90 percent of the causes for failure are due to the failure of field devices. Today, a safety system should address overall safety needs by checking the health of the I/O, field devices, and valves. The

system should also incorporate components such as sensor validation, environmental condition monitoring for conditions that can cause sensor degradation, and impulse line blockage monitoring.

Common cause failures of electronic components are frequently due to environmental conditions. Many electronic device failures are due to elevated humidity and temperature, which need to be monitored closely. Sensor calibration is also becoming an integral part of safety systems. FOUNDATION Fieldbus allows for remote monitoring, diagnostics, and validation.

The FOUNDATION SIS concept provides a common platform for SIS and process automation that ARC espouses in its “same but separate” model for safety systems, where the process automation system and the safety system share the same control network and are able to use common visualization, engineering, and asset management tools, while the logic is executed sepa-

rately for each system. Sharing a common platform reduces installation costs, eliminates the cost of custom integration, and provides a unified view of control and asset management that encompasses the SIS and the basic process control system.

According to an ARC end user survey for safety systems, there is a pent-up demand for FOUNDATION Fieldbus for process safety applications, which was reflected in the survey results. Over a third of the respondents indicated they were willing to use the present FOUNDATION Technology for safety applications.

Improving Alarm and Alert Capabilities

Incorporating best practices for alarm management is also key to avoiding abnormal situations and should be part of an overall safety and critical condition management strategy. To realize this goal more efficiently, the Fieldbus FOUNDATION started a working group in 2006 to improve the alarming and device diagnostics that already exist in FOUNDATION standard

Incorporating best practices for alarm management is also key to avoiding abnormal situations and should be part of an overall safety and critical condition management strategy. To realize this goal more efficiently, the Fieldbus FOUNDATION started a working group in 2006 to improve the alarming and device diagnostics that already exist in FOUNDATION standard block alarms.

block alarms. The group is working on a set of new parameters and standard, flexible, and configurable user defined alerts.

This is done by allowing the user to set up individual alerts that can be directed to the appropriate plant personnel. For example, a failure in the process variable due to a sensor fault may be directed to operations so that they can use this information to better control the process. However, a maintenance needed

soon alert would only be sent to the maintenance personnel so they can schedule a trip to work on the device. In the end, the user gets the flexibility to configure these alerts at the device levels, their severity, and where they should be sent.

Keep in mind that the diagnostic actions will have a different meaning depending on the process applications. In some situations, some faults may require a scheduled maintenance, while in other applications the same diagnostics may require the operations to make changes to the process. The good news is the user has this choice. This new working group will provide this flexibility to the user. Of course, this also directly supports the

business intelligence requirement of getting the right data to the right people at the right time.

Another important differentiator for FOUNDATION Technology is the integrated status delivered with every process value. Data is assigned a quality of GOOD, BAD or UNCERTAIN that is "pushed" to the network with each process value (PV). This continually validates the data. This information is then used to take actions in the process. For example, if the status is changed to BAD, this can trigger an action in the control system to bring the plant to a safe operating state.

FOUNDATION Technology Provides Advanced Business Intelligence

Providing actionable information rather than raw data to the people that need it, when they need it, is the foundation of business intelligence. At ARC, we refer to this need in several ways. In the CPAS mode, it means providing information in context. In our model for Real Time Performance

Management, we call it performance intelligence. Regardless of the terminology used, the drivers are the same. Currently, many organizations "do not know what it is that they know" nor do they have adequate provisions to manage what they know. What is worse is that they are losing knowledge through employee retirements and attrition.



Business Intelligence:

- Publish/Subscribe Technology Support Global Data Access & Availability
- Alliance with OPC UA Enables Business Process Integration
- Enhanced Capabilities for Tracking & Tracing, Validation

FOUNDATION Technology Facilitates a Strategy for Business Intelligence

Companies need to develop strategies that elevate the responsibility level of employees by driving decision-making down onto the production floor where it can have the greatest effect on performance. For knowledge workers to perform at the highest level, companies must provide them with high quality "On Demand" knowledge that is easily accessible, in the correct

context, accurate, and easy to understand. Ensuring that the knowledge is up-to-date is imperative to encourage employees to use it appropriately.

FOUNDATION Technology provides a high degree of business intelligence at the infrastructural level through publish/subscribe technology. Support of business processes, production management, and enterprise level applications is provided through the alliance with the OPC FOUNDATION and incorporation of OPC UA into the FOUNDATION Technology scheme. FOUNDATION Technology also provides enhanced capabilities for tracking, tracing, validation, and regulatory compliance both for continuous and batch/hybrid process industries.

Publish/Subscribe Technology Supports Global Data Access

Publish/Subscribe is one of the core requirements for CPAS. FOUNDATION technology facilitates the sharing of business intelligence by moving data where it is needed when it is needed. ARC refers to this as “information synchronization” in the CPAS model, which really means getting the right information to the right people when they need it, regardless of where it may exist in the system. A key aspect of information provided in context is how the information is transported across the network. The real requirement driving the way in which information is transported is to have the

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The functionality of publish/subscribe is relatively straightforward. With the understanding who the users of the data are and how frequently they need it, subscriptions are designated and

publishing schedules are established in the onset. FOUNDATION Technology supports publish/subscribe with two different communication models. The first model is primarily for process variable data. The main use case is for pushing data from function block to function block in the distributed architecture. For those with controllers, the data is pushed up to the controller.

FOUNDATION Technology supports isochronous (precisely periodic and scheduled) communication to enable fully distributed control. FOUNDATION

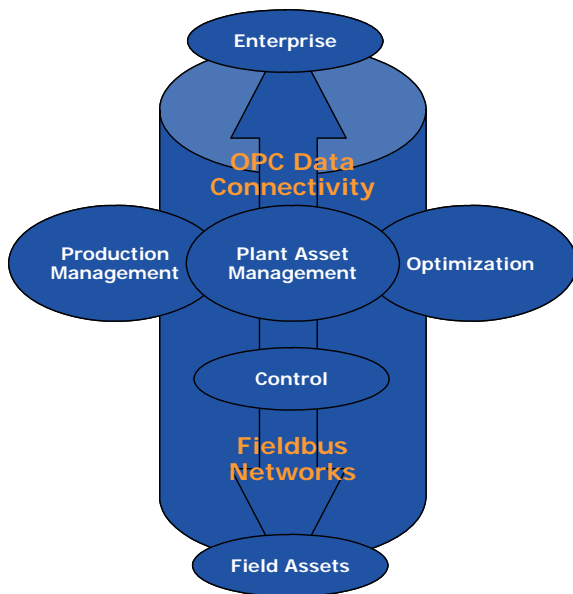
Technology also employs the "Source/Sink" model -- also commonly referred to as Report Distribution. "Source/Sink" is event driven and is used to push alerts to the appropriate personnel. Process alarms, for example, go to operations, while Device Alarms can be directed to maintenance.

Of course, FOUNDATION Technology also supports the client/server model. Once you have the data pushed to the appropriate personnel, they to communicate with the device to understand the diagnostics and know how to make better decisions. The client/server model permits this communication. The incorporation of all three models is an important and unique aspect of FOUNDATION Technology.

FOUNDATION Fieldbus Alliance with OPC UA Provides Business Process Integration

In February of 2005, the OPC Foundation announced that it was joining the collaborative effort of the Electronic Device Description Language (EDDL) Cooperation Team (ECT) to enhance EDDL and bring it into the OPC Uni-

fied Architecture. EDDL is a text-based language for describing the digital communication characteristics of intelligent field devices. EDDL files are similar to XML schemas, and are used to describe equipment parameters, such as device status, diagnostic data, and configuration details. EDDL is operating system independent and host system independent. For example, a FOUNDATION Fieldbus-compatible device built on EDDL technology can be added to a FOUNDATION Fieldbus-compatible host system from any supplier, and the system can automatically recognize the characteristics and parameters of that device, regardless of the operating system software the host system is using.



OPC's Inclusion in a Fieldbus Control Architecture Provides for Seamless Integration from Enterprise to Device Level

The inclusion of EDDL in the OPC framework will significantly enhance interoperability at the system and enterprise level in a truly open fashion that is independent of any operating system architecture. The ECT is working on extensions that include mapping EDDL into OPC UA servers. This enables OPC UA client applications protocol independent access to Fieldbus FOUNDATION, HART and Profibus devices that end users have been demanding.

The OPC Foundation's Unified Architecture is a technology that is being driven by the trend on the plant floor towards decentralization and interoperability. OPC recognizes the need for providing a technology that the automation suppliers are able to adopt and deploy in the pursuit of universal, standardized and interoperable solutions to comprehensively describe automation components. OPC-UA provides a uniform, standards-based protocol for transparency, integration and a central view of all data and functions from the plant floor to the enterprise, and is used by manufacturers for device configuration, device replacement, diagnostics, and audit trails. All of these are building blocks in modern field device management systems.

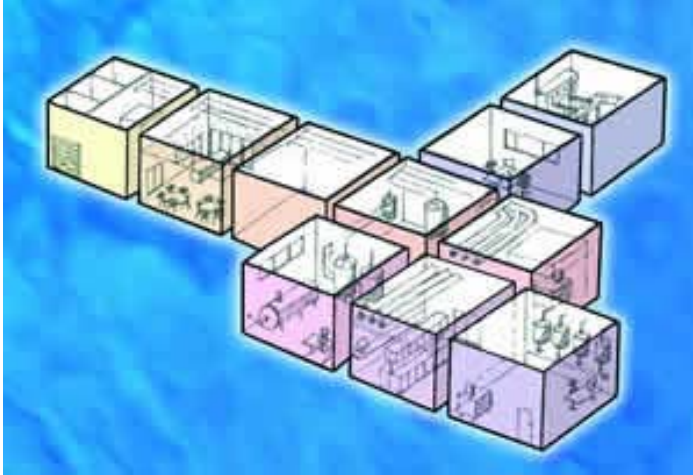
EDDL enables legacy devices to be plugged into OPC-UA components and provide information and full services for reading, writing, and exception-based notification as well as basic functionality of diagnostics, data acquisition, and alarm and event based notification. Phase 2 of the development agreement between OPC and EDDL will continue to enhance the delivery of critical data from the device, and provide a standard and consistent structure for data transport within the OPC Unified Architecture. The result will be a vastly simplified approach for users to access and distribute performance measurements and process data such as alarms. Users can also take advantage of increased system interoperability and cost-effective control system integration. The inclusion of OPC in a framework such as FOUNDATION Fieldbus creates unified and common data access across the enterprise.

Enhanced Regulatory Compliance & Validation

One of the more overlooked benefits of FOUNDATION Technology is that it provides a path to easier validation and regulatory compliance that are so important in pharmaceuticals, food & beverage, chemical, and other industries. This includes continuously validating and correcting the real-life measurements while monitoring the health of the field system. Regulatory compliance is eased through the capability of fieldbus-compatible devices to store data and also through reduction in startup and commissioning times.

Even more interesting, however, is the use of FOUNDATION technology to reduce the startup times for new pharmaceutical and biotech plants. Users in pharmaceutical and biotech industries need to react quickly due to patent expirations, customer demand, market shifts, and other factors. New

drugs must come to market as quickly as possible, and the regulatory compliance process can be extremely time-consuming. Many pharmaceutical engineering firms and OEMs have adopted the practice of creating standard modules that come with all the associated documentation. The



FOUNDATION Technology Greatly Reduces Time Needed to Integrate Modular Skids in Pharma and Biotech Plants
(Source: Emerson Process Management)

modules are produced by the skid vendors in parallel and all the skids are put together at the site.

This modular concept is still relatively new and there are still hurdles that need to be overcome, but the benefits are great. The real savings come when FOUNDATION technology is employed in the modular skids, which greatly reduces the installation and commissioning times, as well as qualification times. Using FOUNDATION segments on each skid greatly simplifies interconnections, and allows skids to be quickly duplicated if capacity needs to be increased.

Qualification tests can be done in a parallel fashion for multiple sites. FOUNDATION Technology used in conjunction with Plant Asset Management (PAM) tools with audit trail functionality allows configuration to be strictly controlled, even if the skids are being implemented in different geographic locations. This results in greater system integrity and easier compliance to FDA requirements.

FOUNDATION Technology Provides Open Scalable Integration

Driving out the cost of custom integration is a primary imperative for process automation end users. Two of the primary ways that end users can drive out the cost of custom integration is through the adoption of international standards and by employing a control infrastructure that is scalable to varying size requirements and flexible enough to adapt to the user's own requirements as they change over time. Users should also strive to incorporate a common data framework that allows for enhanced capabilities in

data visualization, data storage, and so on. FOUNDATION Technology effectively addresses these requirements.

Standards Conformance Goes Beyond the Network

A formal standard is prepared and approved by a recognized national or international standards organization, such as ISO, IEC, and ANSI. These standards may include product design requirements, test methods, classifications, recommended practices, and other considerations. The incorporation of standards within the scope of FOUNDATION Technology is pervasive from the network through the infrastructure itself. At the network

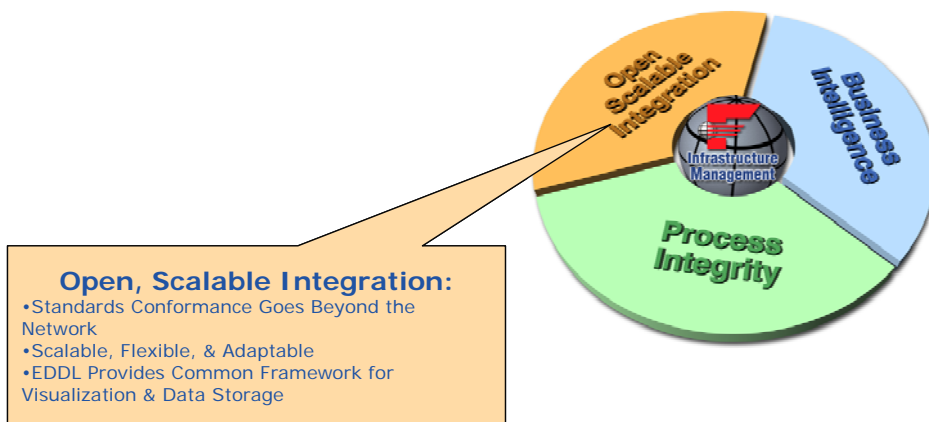
layer, FOUNDATION technology conforms to the IEC 61158 standard for fieldbus networks. Significantly, IEC 61158 embraced IEC 61131-3 as its programming standard and therefore supported function blocks.

EDDL technology was adopted as an international standard under the IEC 61804 standard. In October of 2006, ISA's new standards committee

working to adopt EDDL as specified by IEC 61804 for device integration announced they are releasing their first committee draft for ballot. The goal of the committee is to work toward adoption of the IEC 61804 Standard as an ANSI/ISA standard.

For the safety system concept, the Fieldbus Foundation Safety Instrumented System (FFSIS) project team is preparing a FOUNDATION fieldbus safety requirements specification and safety manual according to the IEC 61508 guidelines. End users taking part in the initiative will develop an end user safety manual incorporating IEC 61511 requirements.

The openness of FOUNDATION Technology and its non-reliance on a particular operating system or supplier platform will make it easy to adopt new standards as they come along. The alliance with OPC is a good example. While OPC is not part of an official international standard sponsored by the



Open, Scalable Integration:

- Standards Conformance Goes Beyond the Network
- Scalable, Flexible, & Adaptable
- EDDL Provides Common Framework for Visualization & Data Storage

Open, Scalable Integration is Provided Through Adherence to Standards and a Common Data Framework

IEC, it is a widely used de facto standard in the automation business and will continue to be so for the foreseeable future.

Scalable, Flexible, & Adaptable

FOUNDATION Technology offers essentially unlimited scalability, and can be implemented in the smallest to the largest process automation systems, from a single transmitter and valve with some software to a plantwide scheme. This is mirrored in the adoption trend of FOUNDATION Fieldbus, which started in very small, noncritical applications and pilot plants, and is

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now being deployed in very large grassroots refineries and other projects.

HSE is really the key to the scalability of the technology because it provides a mechanism to connect multiple H1 segments, and there

are no gateways required between H1 and HSE. All of the functions that are available on H1 are also available on HSE. Having this same functionality at every layer further contributes to scalability and openness. FOUNDATION systems can also be expanded without the need to shut down the process. Devices can be added or swapped “hot”, and the technology supports online firmware downloads and upgrades, which is another key CPAS requirement.

Function Block Model is Key to Flexibility & Adaptability

The function block model adopted by Fieldbus FOUNDATION is another key contributor to its flexibility and adaptability. FOUNDATION Fieldbus defines four types of function blocks. Standard Function Blocks handle inputs, outputs, and contained parameters defined by FOUNDATION Fieldbus. Enhanced Function Blocks include features added by the manufacturer. Manufacturer-Specific Function Blocks are completely defined by the manufacturers. Lastly, there are Flexible Function Blocks.

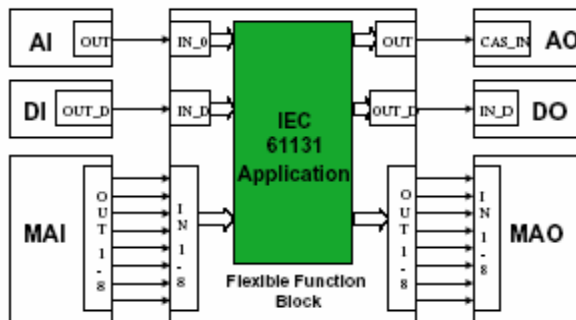
There are several benefits related to the function block structure. In the engineering process, for example, standard block profiles enable templates for designing process applications. This reusability reduces startup times and overall installed cost. Different types of users also have different requirements. Some prefer centralized control, while others prefer highly distributed control, and FOUNDATION Technology provides solutions for

both of these customers. The distributed block architecture also allows for increased scalability since controllers are technically not required.

Benefits of Flexible Function Blocks

The Fieldbus Foundation released the specifications for Flexible Function Blocks (FFBs) in 2001. Flexible Function Blocks (FFBs) are essentially wrappers for application-specific algorithms. FFBs can handle user-specified algorithms, multiple analog and digital I/O, and application-specific functions such as coordinated drives control, supervisory control and data acquisition (SCADA), batch sequencing, burner management, and I/O interfacing. FFBs can be either programmable or non-programmable. Fieldbus FOUNDATION released specifications for pre-configured or non-programmable FFBs in March of 2000. Specifications for fully configurable, programmable FFBs were released in September of 2001, after field tests were completed. Today, many registered FOUNDATION Fieldbus products contain FFB functionality.

Pre-configured FFBs include predefined numbers and types of I/O parameters and predefined device descriptions that are similar to standard FF function blocks. Initial pre-configured FFBs were developed as Multiple Input/Output (MIO) blocks that included eight analog or discrete parameters per block. MIO Blocks are important in a fieldbus architecture because



FOUNDATION Fieldbus Flexible Function Block

they can serve as gateways or protocol translators, so users can transparently access data in devices that are on outside networks.

Even more powerful are FFBs that incorporate a Variable Object Dictionary (VOD), which the user can program to perform the necessary function. The VOD-enabled FFB serves the same function as a nano PLC that can fully communicate with all other devices on the network. FFBs combined with HSE provide users with a fully functional

and seamless solution for batch and hybrid control. Many applications such as burner management and drives control for industries such as power generation and pulp and paper could also benefit from the use of FFBs in a FOUNDATION-based architecture.

EDDL Provides Common Framework for Visualization & Data Storage

EDDL is a core component of the openness and scalability of FOUNDATION Technology. EDDL is a text-based language for describing the digital communication characteristics of intelligent field devices. EDDL files are similar to XML files, and are used to describe equipment parameters, such as device status, diagnostic data, and configuration details. EDDL is operating system independent and host system independent. For example, a FOUNDATION Fieldbus-compatible device built on EDDL technology can be added to a FOUNDATION Fieldbus-compatible host system from any supplier, and the system can automatically recognize the characteristics and parameters of that device, regardless of the operating system software the host system is using.

There are already millions of devices installed based on EDDL technology, which was originally introduced in 1992. In 2003, a serious effort was made to enhance the capabilities of EDDL when the Fieldbus Foundation, HART Communication Foundation, and Profibus International formed a cooperative joint working group to extend the capabilities of EDDL called the EDDL Cooperation Team (ECT).

The ECT joint working group has developed extensions for EDDL enabling improved organization and graphical visualization of device data, and providing support for persistent data storage, while maintaining operating system and platform independence. The first wave of EDDL enhancements

Key EDDL Phase I Extensions:

- Graphical Data Visualization — EDDL provides capabilities for common graphic display for a common look and feel across different devices
- Improved Data Organization — EDDL provides information to host system about how to organize parameters
- Persistent Data Storage — EDDL provides information to the system for organization of archived data

is finding its way into commercially available products now. Enhancements recently added extend the capabilities of EDDL to provide an industry standard solution for advanced visualization of intelligent device information. Enhancements were also made to data archiving capabilities. The first wave of enhancements should result in more consistency in instrumentation and equipment engineering processes and should facilitate the contextual presentation of data.

The Road Ahead: Evolution & Challenges

FOUNDATION Technology has a clearly sustainable development path for the future and ARC sees no issue with the technology evolving in lock step with the overall world of automation. This is already evident in initiatives with the Foundation such as the wireless working group. The real challenge for FOUNDATION technology at this point in its evolution is to get the end users of automation to think about the technology as a true system infrastructure, not a network.

Clearly, the business value is there when the end user applies fieldbus as a full-scale system. In ARC's view, there are a few key challenges that need to be addressed in order for FOUNDATION Technology to be more broadly accepted among the end user community as a system and not merely as a network. First and foremost is acceptance among the community of engineering firms and systems integrators that wield a considerable amount of influence when it comes to technology selection. Fieldbus Foundation has already made a lot of progress in this regard and several major engineering firms are now on board with FOUNDATION Technology, including Fluor Daniel and Bechtel.

Another key element for future adoption of FOUNDATION Technology as a system includes the end user community itself. More end user advocates are needed to articulate the business value proposition of elements such as

In many ways, the value of FOUNDATION Technology as a system can be overshadowed when it is placed in the context of a supplier-specific automation system architecture.

the function block structure, FF safety instrumented systems, and reduced operational and lifecycle costs. Fieldbus Foundation must also continue to reach out to the supplier community.

In many ways, the value of FOUNDATION Technology as a system can be overshadowed when it is placed in the context of a supplier-specific automation system architecture. FOUNDATION Technology essentially eliminates the requirements for many of the traditional elements of an automation system, such as controllers and I/O. Obviously, the suppliers need to maintain their competitive advantage, and FOUNDATION Technology provides many ways for suppliers to do this with flexible function blocks, EDDL, and so on. ARC fully expects that Fieldbus Foundation will successfully rise to these challenges and continue to create value for end users through the 21st century.

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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Community/terms/terms.htm

API Application Program Interface	ERP Enterprise Resource Planning
APS Advanced Planning & Scheduling	HMI Human Machine Interface
B2B Business-to-Business	IT Information Technology
BPM Business Process Management	MIS Management Information System
CAGR Compound Annual Growth Rate	MRP Materials Resource Planning
CAS Collaborative Automation System	OpX Operational Excellence
CMM Collaborative Manufacturing Management	OEE Operational Equipment Effectiveness
CNC Computer Numeric Control	OLE Object Linking & Embedding
CPG Consumer Packaged Goods	OPC OLE for Process Control
CPAS Collaborative Process Automation System	PAS Process Automation System
CPM Collaborative Production Management	PLC Programmable Logic Controller
CRM Customer Relationship Management	PLM Product Lifecycle Management
DCS Distributed Control System	RFID Radio Frequency Identification
EAI Enterprise Application Integration	ROA Return on Assets
EAM Enterprise Asset Management	RPM Real-time Performance Management
	SCM Supply Chain Management
	WMS Warehouse Management System

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