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FOUNDATION™ Fieldbus:
Tested. Proven. Available Today.

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Introduction

The challenges facing modern industry are different from those of the past. Shareholders expect increased profitability and sustainable growth. Expanding global markets lead to increased competition. These demands require that companies find new ways to reduce operating costs, streamline and/or re-orient workforces, accelerate delivery times, and develop innovative products.

Put another way, corporations are no longer seeking to *maximize* their operations, but rather *optimize* their enterprise. Management's directives are clear: make it cheaper...make it better...make it quicker...make it safer.

Meeting the challenges of the 21st century requires a new way of thinking. Industry can no longer afford to rely on outdated strategies. Rather, it must break out of the paradigms of the past and adopt new, enabling tools for continuous improvement.

Fieldbus: A New Era of Control

In today's marketplace, technology innovations must conform to changing business requirements in order to maximize the return on capital investments. Working arm-in-arm, technology providers and industrial manufacturers benefit from a convergence of enthusiasm, talent and expertise that offers new solutions for difficult challenges. Such is the case with fieldbus, a step change in process control that transcends the limited capabilities and high costs of older analog technology, and in doing so, enables unprecedented improvements in plant – and business – performance.

Revolutionizing industrial automation. By all accounts, fieldbus technology is revolutionizing the way companies automate their plants and factories. This all-digital, two-way communications system allows end users to achieve true distributed control, thereby freeing valuable plant resources for real-time production control. Fieldbus not only takes advantage of today's smart instrumentation to provide reliable, deterministic control, but also reduces wiring requirements and decreases installation and equipment costs.

Unlike traditional control technology, fieldbus delivers system self-diagnostics supporting predictive/preventive plant maintenance. Through fieldbus device and subsystem interoperability, users can remove the constraints of proprietary network architectures. The technology's "plug and play" ease-of-use also simplifies network expansion and device selection, and allows users to take advantage of "best-in-class" measurement and control solutions.

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Fieldbus Foundation provides leadership. A driving force behind the development of fieldbus technology is the not-for-profit Fieldbus Foundation. Representing nearly all major instrumentation and control suppliers worldwide as well as many prominent end users, the Fieldbus Foundation fulfilled the promise of fieldbus by providing the *"Freedom to Choose"* and the *"Power to Integrate."*

The Fieldbus Foundation's open, non-proprietary technology, FOUNDATION™ fieldbus, delivers the power to integrate the plant enterprise — and the freedom to choose how to integrate. This complete fieldbus solution includes H1 (31.25 kbit/s) fieldbus for continuous control, and COTS (Commercially Available Off The Shelf)-based, 100 Mbit/s High Speed Ethernet (HSE) for advanced process and discrete automation. Users are free to implement tightly-integrated digital control based on a unified system architecture and a high-speed backbone for plant operations. This, in turn, removes the constraints on device and subsystem interoperability.

By giving business access to more information, easily integrated into their enterprise software management tools, plant personnel are able to make better decisions and respond faster to changing market demands.

Path of Development

First developed in the 1980s, fieldbus superseded earlier network protocols due to its ability to easily distribute control across the process, move large amounts of data throughout the plant, and integrate that data within and between control subsystems.

In late 1994, the path of fieldbus technology took a promising, new direction. Two parallel supplier consortiums, the InterOperable Systems Project (ISP) and WorldFIP North America, merged to form the Fieldbus Foundation. The new consortium organized development programs, conducted field trials, and established the industry's most rigorous program for testing and registering fieldbus devices.

Important milestones. Among the Fieldbus Foundation's many important technology milestones were the completion of draft preliminary specifications for the FOUNDATION fieldbus H1 protocol in May 1995; registration of the first tested, interoperable fieldbus devices in September 1998; and the registration of the first HSE linking devices in May 2001.

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The Fieldbus Foundation's growing worldwide support has been evidenced by the establishment of fieldbus End User Councils in the U.S., Australia, New Zealand, Singapore, Japan, China, Europe and Canada. Most recently, the foundation responded to demand for its technology in Asia/Pacific by entering into an agreement to translate the FOUNDATION fieldbus specifications into Mandarin Chinese.

Adoption rate increasing. As of January 2003, the Fieldbus Foundation has tested and registered more than 140 fully-interoperable fieldbus devices from the industry's leading automation equipment suppliers. The installed base of these products has doubled within the last three years, with over 205,000 fieldbus devices and 4,000 host systems shipped or installed worldwide. The growth in registered devices includes controllers, transmitters, mag meters, vortex meters, analyzers, valve positioners and many others types of instruments. Additionally, eleven FOUNDATION-compliant host systems have successfully completed the Fieldbus Foundation's Host Interoperability Support Test (HIST).

Industry adoption of FOUNDATION fieldbus is widespread, with major installations found in petrochemical, refining, chemical, oil & gas, metals/mining, water & waste, pulp & paper, utilities, food & beverage, and others.

Gaining Global Acceptance

Key to industry's acceptance of FOUNDATION fieldbus was approval of the technology by global standards organizations. Today, end users can install FOUNDATION-compliant control systems with the confidence that their investment is based on recognized international fieldbus standards.

In December 1999, the International Electrotechnical Commission (IEC) voted to approve the Final Draft International Standard (FDIS) documents for the Data Link Layer (DLL) and Application Layer (AL) of the IEC 61158 international fieldbus standard. The FOUNDATION fieldbus H1 and HSE specifications are a compliant subset of IEC 61158.

The CENELEC Technical-Bureau (BT) voted in March 2000 to add the FOUNDATION fieldbus H1 specifications to EN 50170, the fieldbus Euronorm. Ratification of the CENELEC ballot demonstrated that end users throughout Europe recognized the technical merits of FOUNDATION technology, and were anxious to implement the technology.

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An Enabling Technology

For companies in the process and discrete manufacturing industries, FOUNDATION fieldbus is an enabler for greater manufacturing flexibility and productivity, improved asset utilization, higher quality products, and improved regulatory compliance.

The technology replaces incompatible networks and systems with an open, fully-integrated architecture for control system and information integration across the enterprise. The complete, complementary H1+HSE fieldbus solution supports both device and subsystem interoperability, while integrating critical data from the plant floor to higher level MIS and ERP applications.

Performance improvements. Intended for mission-critical applications where the proper transfer and handling of data, and control loop integrity, are essential, FOUNDATION fieldbus is suited for closed-loop continuous control, batch sequencing, high-speed process automation, information integration, recipe management and data gathering.

By installing FOUNDATION fieldbus, end users realize performance improvements such as communication of multiple variables from a single field instrument, device interoperability, enhanced field-level control, simpler integration, reduced wiring, and easier maintenance.

Business benefits. The results from major installations around the world show that FOUNDATION fieldbus offers numerous business benefits. End users of the technology are realizing higher returns for shareholders, improved environmental safety for local communities, and increased efficiency for customers served.

By optimizing performance across the enterprise, FOUNDATION fieldbus enables industrial manufacturers to significantly improve their bottom line. Companies deploying fieldbus-based control strategies are able to lower capital costs, reduce installation costs, decrease operating expenses, reduce maintenance requirements, and decrease time-to-market.

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Testing Proves Advantages

In 1999, a group of ex-Hoechst companies known as IPR (Industrial Practices Interest Group) commissioned Infracerv Höchst, an independent industrial service provider and site operator that originated from the former Hoechst AG's engineering division, to conduct an evaluation confirming the suitability of FOUNDATION fieldbus for use by the German chemical and pharmaceutical industries.

Infracerv Höchst operates in the Höchst Industrial Park, located near Frankfurt, Germany, and is recognized as a valuable resource for German industry. The organization has a long-standing technical partnership with chemical and pharmaceutical end users comprising the NAMUR association, and assists in the development of production strategies for products such as pharmaceuticals, basic and specialty chemicals, dyes and pigments, plastics, food additives and crop protection agents.

A milestone in Germany. The Infracerv Höchst evaluation – one of the most comprehensive and rigorous tests of FOUNDATION fieldbus to date, would prove to be an important milestone for the technology in Germany. The evaluation was conducted by Infracerv's experienced engineers in a formal, vendor-neutral test laboratory environment, and was intended to assess how closely FOUNDATION technology meets the strict engineering and safety requirements of German end users.

To initiate the technical evaluation, Infracerv Höchst established a multi-vendor FOUNDATION fieldbus test system at its Frankfurt test laboratory. Phase One of the testing involved three hosts, with two additional hosts later included in Phase Two. A total of 42 field devices from 11 instrumentation suppliers were also utilized. The test setup included six H1 bus segments with different network hardware and connection methods (See Appendix).

Infracerv's test lab manager, Manfred Dietz, and his staff worked diligently for more than three months to create "real world" scenarios for the testing. This included mixing and matching various hosts and devices to verify true interoperability and interchangeability within a FOUNDATION fieldbus system. Among the key test requirements: All devices must be formally registered with the Fieldbus Foundation and link to hosts via official Device Description (DD) and Capability File (CF) files. Proprietary hardware descriptions cannot be used.

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Infraserv's test team reviewed the technical layout and procedures for the evaluation during December 2001, and shipments of pre-assembled test systems from participating suppliers began arriving at the Frankfurt facility in late January 2002. Testing officially commenced on Feb. 1, 2002.

Test protocol. The Infraserv Höchst study focused on the functional performance of FOUNDATION fieldbus in chemical and pharmaceutical plant applications. Aside from interoperability and interchangeability requirements, the technology's conformance to German industry norms, Intrinsic Safety (IS) requirements and the Fieldbus Intrinsically Safe Concept (FISCO) standard were important investigation factors. Additionally, the evaluation looked at the availability of registered FOUNDATION fieldbus devices and local support for these products in Germany.

Specific test criteria included:

Market availability

- Is the technology supported in the German market and available to IPR end users?
- Are there enough suppliers?
- Are all the device types covered?
- Do the devices comply with German industry IS standards?
- Are all the devices of commercial grade?
- Are the devices supported locally in Germany and in neighboring countries?
- Are the devices registered in compliance with the FOUNDATION fieldbus ITK 4.0 guidelines?
- Are the devices supported by CF files available and downloadable from the foundation web site (www.fieldbus.org)?

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Interoperability

- How easy is it to activate devices on the system (i.e., connecting and powering up, establishing communication with the host, configuration from the host engineering tool, recognition in the system structure, host access to measured values, etc.)?

Interchangeability

- How easy is it to interchange field devices of the same type from different suppliers?
- How easy is it to remove, insert, and commission devices on-line?

Control in the field

- How does the technology support PID control based on devices in an H1 segment?

Other criteria

- How does the technology support backup Link Active Scheduler (LAS)?

Results confirm benefits. Manfred Dietz presented results from the FOUNDATION fieldbus evaluation on November 8, 2002, at the NAMUR General Assembly in Lahnstein, Germany. The conclusions: FOUNDATION fieldbus meets the safety requirements of German chemical and pharmaceutical producers, and delivers on its functional performance promises. Furthermore, the technology is mature and well supported within Germany by local suppliers of industrial-grade equipment (including FISCO-compliant Ex-field instruments).

The testing found:

1. Fieldbus systems are interoperable

To test the interoperability of a fieldbus system (i.e., "plug and play" devices), suppliers' hosts were first connected to an assigned H1 segment. Segments were then swapped between hosts and the connectivity tests re-run.

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Each of the host systems worked with their assigned H1 segments. The test demonstrated that all six segments could be swapped between different hosts, with 100% of the DD files working correctly.

Although a majority of field devices could be activated from the host, in some cases, devices could not be activated due to incompatible CF files. Also, field device CF files often could not be located on the Fieldbus Foundation web site. These issues were subsequently addressed through collaboration between Infracore and the Fieldbus Foundation (see below).

2. Fieldbus devices and segments are interchangeable

To test fieldbus' subsystem closed-loop control capabilities, the PID loop on each H1 segment was first configured with the allocated devices. Devices were then interchanged, and the PID loop reconfigured.

Function blocks located in the various field devices could be interconnected, with the PID loops working properly. The exchange of active field devices (connected in H1 PID loops) with devices from other suppliers also worked on all six segments.

3. Fieldbus provides stable, reliable control

To test fieldbus' backup Link-Master capability, backup LAS was first configured on each H1 segment, followed by an interruption in host communication. Backup LAS was then located in a new device and the procedure repeated.

Infracore engineers found that backup LAS worked on all of the different segments. This test also demonstrated the need for a clearly defined, well-documented procedure covering the activation of a backup Link Master.

Since concluding the initial evaluation, the Fieldbus Foundation and Infracore Höchst have collaborated to address technical issues arising from the tests. This work will ensure FOUNDATION fieldbus meets the needs and expectations of IPR members, as well as other end users around the world.

Specific recommendations include:

- Adding test cases to the foundation's device registration process to ensure the compatibility of CF files with any host,

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- Enhancing CF test cases to eliminate possible syntax errors,
- Requiring host systems participating in the HIST program to support the required CF files without changes,
- Improving documentation for backup LAS,
- Providing field devices for binary signals,
- Providing local displays for Ex-zone.

Centre of Excellence. Infracore Höchst and the Fieldbus Foundation have reached an agreement in principle for the creation of a Centre of Excellence for FOUNDATION fieldbus. This agreement, which is part of a continuing, joint effort to support the needs of the German and other European end user communities, includes the establishment of a site at the Höchst Industrial Park to educate and train technical personnel on the benefits of FOUNDATION technology. Infracore will be certified by the Fieldbus Foundation to deliver services ranging from fieldbus integration and device pre-registration testing, to fieldbus technical consulting, technology demonstrations, product evaluation and stress testing, and end user training.

In a further test phase to identify FOUNDATION fieldbus commercial benefits, Infracore Höchst and the Fieldbus Foundation will work together to quantify the operating expenditure (OpEx) reductions enabled by the technology throughout the total life of a plant. This involves studying cost-saving parameters such as device multi-variable capabilities, self-calibration, and continuous online monitoring.

Infracore Höchst will be enabled to conduct project feasibility studies and cost analysis for its clients to determine total lifetime savings made possible by FOUNDATION fieldbus' powerful diagnostics and asset management functions.

Expected benefits include:

- Increased asset utilization
- Reduced maintenance costs
- Reduced downtime
- Higher yields
- Better quality
- Improved regulatory compliance

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Capital costs lower. A technical analysis initiated by InfraServ GmbH & Co Höchst KG and Aventis Pharma Deutschland GmbH has already shown that fieldbus provides capital expenditure (CapEx) savings over traditional and remote I/O communication. Although differences exist between respective bus architectures, these savings apply to established technologies such as FOUNDATION fieldbus and Profibus PA employing a common physical layer.

Known as FuRIOS (Fieldbus and Remote I/O System comparison¹), the analysis verified that fieldbus provides reductions in engineering, wiring and component costs, and enables faster commissioning through standard coding, reduced errors, and improved error diagnosis. The technology also enhances quality by eliminating many systematic sources of error (allowing prevention of errors before they can occur). Errors can be recognized, and rectified, faster than in conventional systems. Furthermore, the analysis showed that fieldbus reduces training requirements by eliminating manufacturer-specific “code decryption,” and thus minimizes device-specific training requirements.

Additionally, the FuRIOS study concluded that the project lifecycle can be shortened through accelerated loop check-out, commissioning and start-up times. For the specific automation project used in the study, start-up and commissioning time was reduced by two weeks as compared with a traditional analog-based system. Although not quantified as to the financial impact of reduced time-to-market, these additional revenues will no doubt be significant.

Conclusion

As evidenced by Infracerv Höchst's rigorous technical evaluation, FOUNDATION fieldbus is helping industry meet the challenges of a new century. This enabling technology holds the key for end users who must optimize their plant enterprise to achieve improved financial performance. Indeed, today's competitive business environment demands nothing less.

Initial testing by Infracerv Höchst demonstrated that FOUNDATION fieldbus works and is well-supported in the German market. Tests have also proven that fieldbus provides significant project cost savings for plant automation. Further evaluation is expected to show that the technology enables lower lifecycle costs by reducing maintenance, decreasing downtime, increasing yields and improving quality.

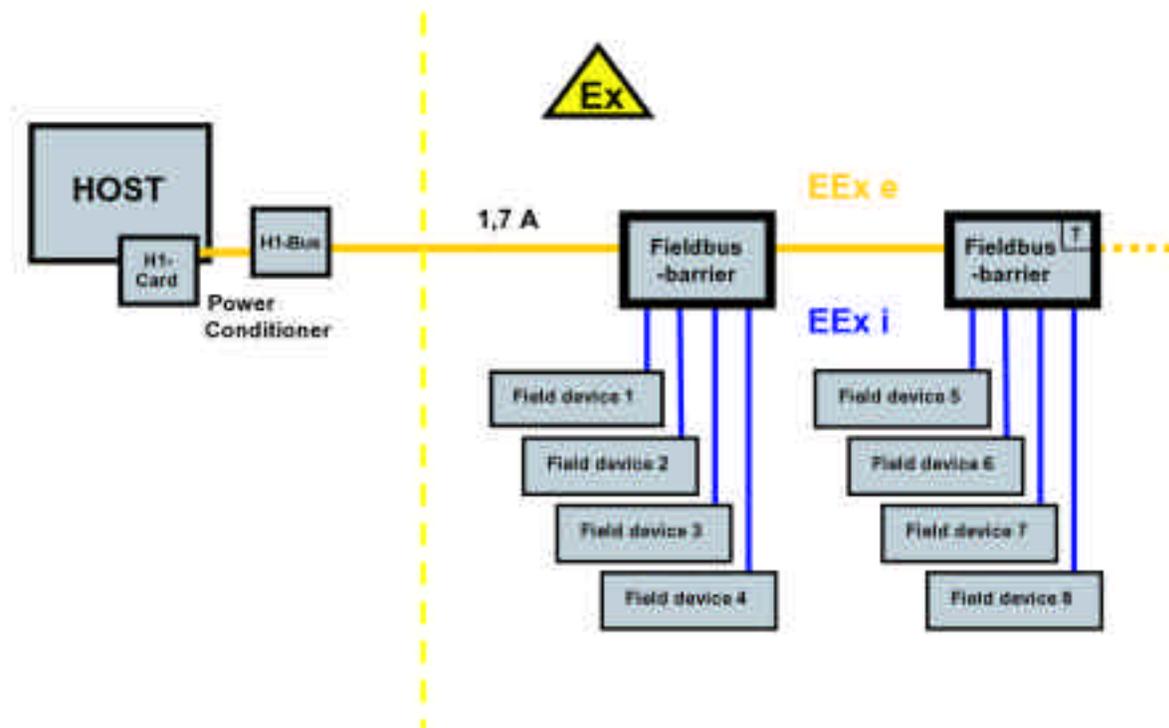
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¹ FuRIOS: Feldbus und Remote I/O-ein Systemvergleich
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Appendix



Fieldbus segment topology, Infraseriv Höchst evaluation