# Field-Bus Technology in Modern Control

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***Abstract*—In this paper about the important concept of fieldbus and its application has been discussed. The fieldbus technology promises to improve quality, reduce costs and boost efficiency. These promises made by the fieldbus technology are derived partly from the fact that information which a field device is required to transmit or receive can be transmitted digitally. This is a great deal more accurate than transmitting using analogue methods which were used previously. Each field device is also a 'smart' device and can carry out its own control, maintenance and diagnostic functions. As a result it can report if there is a failure of the device or manual calibration is required, this increases the efficiency of the system and reduces the amount of maintenance required.**

***Keywords*–** Fieldbus, Feathers, Application and Architecture

## I. INTRODUCTION

The path to fieldbus technology began in the 1970s with the first attempts to distribute control functionality to the field level. With the introduction of the Distributed Control System (DCS), processing plants were able to distribute intelligent control throughout process facilities. Fieldbus is a generic-term which describes a new digital communications network which will be used in industry to replace the existing 4 – 20mA analogue signal. The network is a digital, bi-directional, multidrop, serial-bus, communications network used to link isolated field devices, such as controllers, transducers, actuators and sensors. Fieldbus systems are characterized by the use of a Network which interconnects several devices at the machine level.

Although fieldbus systems were established some time ago in the field of electrical drive Technology, the hydraulic drives have been slow to follow this trend. In particular,

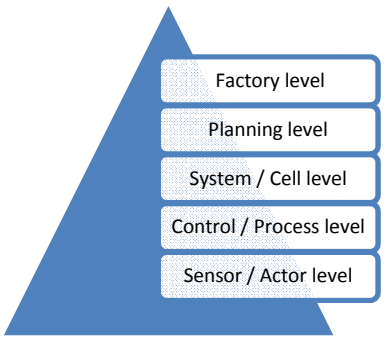


Fig. 1: The fieldbus in the layer model

industrial proportional valves with fieldbus interfaces have not been available in the Pas. Each field device has low cost computing power installed in it, making each device a 'smart' device. Each device will be able to execute simple functions on its own such as diagnostic, control, and maintenance functions as well as providing bi-directional communication capabilities. With these devices not only will the engineer be able to access the field devices, but they are also able to communicate with other field devices. In essence fieldbus will replace centralized control networks with distributed-control networks. Therefore fieldbus is much more than a replacement for the 4 - 20mA analogue standard [2]. Each field device will be more flexible as they will have computing power. One fieldbus device could be used to replace a number of devices using the 4 - 20mA analogue standard. Other major cost savings from using fieldbus are due to wiring and installation the existing. 4 - 20mA analogue signal standard requires each device to have its own set of wires and its own connection point. Fieldbus eliminates this need so only a single twisted pair wiring scheme is required. Fieldbus technology involves a variety of solutions and techniques which, although frequently seen as closely related, are different from each other. Fieldbus technology is a kind of technical, political, and human adventure, which for more than 20years has led to a lot of papers in journals, a lot of announcements, a lot of so-called scoops, a lot of conferences and Workshops and a lot of products and standards. Fieldbus is no longer simply a communications standard but is a complete open, integrated measurement and control system which is looking to change the face of process control forever.

## II. FIELDBUSDEVELOPMENT

There have emerged literally hundreds of fieldbuses developed by different companies and organizations all over the world. The term fieldbus covers many different industrial network protocols. Most fieldbus protocols have been developed and supported by specific PLC manufacturers [1]. The accompanying table summarizes some of the main ones. At the lowest level are the sensor networks, which were originally designed primarily for digital (on/off) interface. These are fast and effective, but with only limited applications beyond relatively simple machine-control. ASI (actuator/sensor interface) is popular in Europe, while Seriplex is a US development. ASI - perhaps the simplest and least expensive fieldbus. ASI was developed by a consortium of European automation companies, which saw need for networking the simplest devices at the lowest level. ASI is

easy to configure and low in cost. It is most often used for proximity sensors, photo eyes, limit switches, valves and indicators in applications like packaging machines and material handling systems. ASI is designed for small systems employing discrete I/O. It allows for up to 31 slaves, which can provide for up to four inputs and four outputs each for a total of 248 I/O. Fieldbus was developed by GESPACas a comprehensive remote I/O system, based on distributed intelligence and peer-to-peer communication. Firmware functions are built into each Fieldbus I/O module and allow basic capabilities such as pulse count, delay before action and sending/receiving messages to/from other modules on the network. Bitbus was originally introduced by Intel as a way to add remote I/O capability to Multibus systems. This original fieldbus is one of the most mature and most broadly used networks today. Bitbus allows programs to be downloaded and executed in a remote node for truly distributed system configurations.

WorldFIP provides a deterministic and reliable scheme for communicating process variables (generated by sensors and executed by actuators) and messages (events, configuration commands) at up to 1Mbit per second on inexpensive twisted pairs cables. FIP uses an original mechanism where the bus arbitrator broadcasts a variable identifier to all nodes on the network, triggering the mode producing that variable to place its value on the network. Once on the network, all modules which need that information "consume" it simultaneously. This concept results in a decentralized database of variables in the nodes and remarkable real-time characteristics. This feature eliminates the notion of node address and makes it possible to design truly distributed process control systems. Wide array of development tools for systems and devices Kits contain all required components for given system or device Create a small Fieldbus control system or host system Develop your own foundation Fieldbus devices. National Instruments starter kits for foundation Fieldbus offer all the components necessary for a control system, host system, or device. Starter kits include hardware and software, power supply, and cabling. We have tools for a wide array of Fieldbus development projects.

Micro cyber provides the Foundation fieldbus H1 communication board customized as customer's requirements. This solution can upgrade the traditional instrument to Foundation fieldbus instrument rapidly. The board supports bus communication, control and integration in fieldbus controller, stack, function block and interface circuit, micro cyber can assist customer in passing certification test of Foundation fieldbus and integration test with all kind of DCS system. The standardization process began at this time in these different countries and at an international level, with IECTC 65/SC65C/WG6 [4], simultaneously with the Instrumentation Society of America (ISA) in the United States (in The ISA SP50 (ISA-Standard Practice).

The Fieldbus Foundation is moving forward on the development of a specification standardizing the interface of remote I/O into the open, integrated foundation automation infrastructure. The new High Speed Ethernet Remote I/O (HSE-RIO) specification will define the structure for interfacing remote I/O over the Fieldbus Foundation's tightly

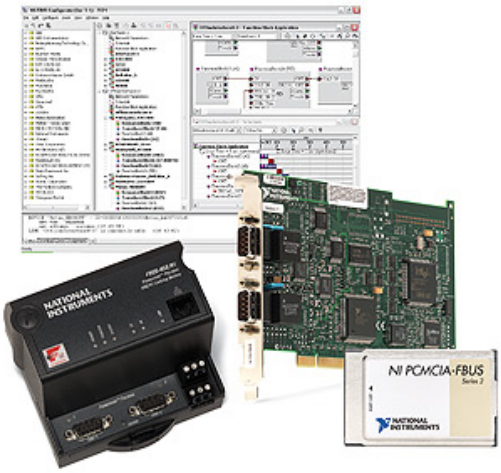


Fig. 2: Fieldbus Starter Kit

integrated HSE control backbone. The addition of remote I/O further tightens the integration of process instrumentation within the foundation fieldbus architecture. The Fieldbus Foundation's End User Advisory Council (EUAC) recently [3] completed its review of use cases for the HSE-RIO citation and submitted its comments to the foundation's Technical Steering Committee (TSC). EUAC review, which involves leading process automation end users from around the world, is a vital step in the process of developing new areas of FOUNDATION technology. The Fieldbus Foundation achieved many important milestones along the way to the maturity and success of Foundation technology. These included:

- Completion of H1 draft preliminary specifications, May 1995
- Demonstration of H1 technology at Monsanto Chocolate Bayou, October 1996
- Registration of the first H1 fieldbus products, September 1998
- Completion of High Speed Ethernet (HSE) draft preliminary specifications, September 1999
- Registration of the first HSE linking devices, May 2001
- Demonstration of HSE and Flexible Function Blocks (FFBs) at ISP Lima, May 2005
- Completion of SIF protocol specifications, 2005

## III. FIELDBUS REQUIREMENTS-APPLICATION

Foundation fieldbus makes instrument data an integral part of the control and operating level. This technology is the optimum interface for your plant planning and maintenance. The basic feature of a foundation fieldbus is the distribution of intelligence to sensors and actuators of the respective plant. Field instruments are used as link masters and can thus function with each other and assume regulating tasks without the involvement of the controller. This means an unrivaled increase in safety and profitable productivity for the plant operator. The fieldbus Requirements-application [6]:

- Definition of traffic
- Definition of other services
- Types of data
- Polled and unsolicited messages
- Full logical connectivity
- Application architectures
- Time coherences
- Space consistency

## IV. INTRODUCTION TO FIELDBUS

Foundation Fieldbus is a control strategy primarily used by the Process Industry because it allows for high reliability and distributed control foundation Fieldbus consolidates communication and power onto a single twisted pair of wires. The digital bus enables devices to pass more than just the traditional Process Variable; Additional data in the form of device mode, status, health and alarming are also available to the user. In telecommunication, token passing is a channel access method where a signal called a token is passed between nodes that authorize the node to communicate. The most well-known examples are token ring and ARCNET. Token passing schemes provide round-robin scheduling, and if the packets are equally sized, the scheduling is max-min fair. The advantage over contention based channel access is that collisions are eliminated, and that the channel bandwidth can be fully utilized without idle time when demand is heavy.

## V. FIELDBUS CABLE

Fieldbus, an emerging instrument standard [5], promises data communication among low-power field instruments. The standard specifies a low-speed data rate under 100 Kbits/second using single- and multiple-twisted-pair cables at distances up to 1900 meter. The intent is to allow Fieldbus instruments to be retrofitted to installed cable now used with low-frequency analog-signaling instruments. Therefore, Fieldbus represents a new application for this cable.

The cable parameters of importance to data communication are attenuation and phase constants, characteristic impedance, and crosstalk; which are generally not available for the existing installed cable. Knowledge of these parameters is helpful in determining acceptable lengths and topologies of proposed networks, and is essential in simulation of signaling on proposed networks. These parameters have been measured in the range of 1 kHz to 100 kHz for a group of 15 representative cables and the results are presented here. A compromise terminator that approximates the cable characteristic impedance in the measured frequency range is proposed, and expected crosstalk is determined.

## VI. FIELDBUS OVERVIEW

Fieldbus networks for Process are more complex, use devices containing processors. Fieldbus provides much more data to the end-user not only process variable data, but diagnostics, network health information, Trending data, data for Predictive maintenance as opposed to Preventative

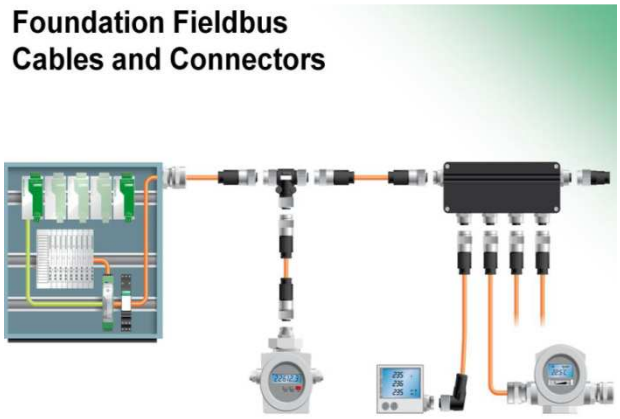


Fig. 2: Fieldbus cables and connectors

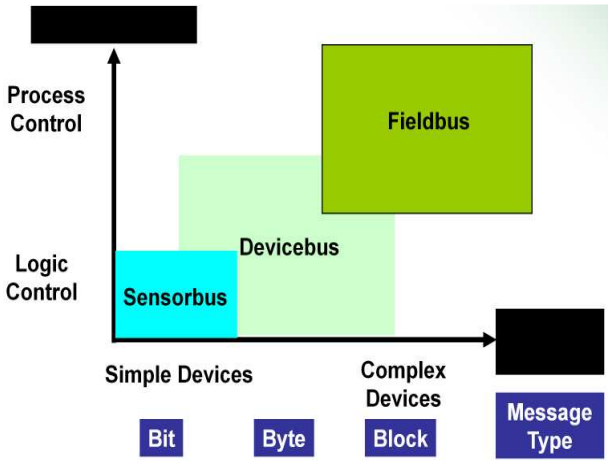


Fig. 3: ARC Definition of fieldbus

maintenance. According to the ARC Advisory Group, results from testing and real-world applications demonstrate that "Control in the Field" with Foundation technology has the potential to deliver a 30 percent improvement in control performance with very fast, fast and medium-speed process dynamics [6].

### *A. Fieldbus Benefits*

- Open automation infrastructure
- Greatly improved asset management
- Reduced wiring costs
- Reduced process variability
- Increased capacity utilization
- Reduced maintenance costs
- Reduced commissioning – auto detection

- Reduced spare parts inventory
- Improved safety & regulatory compliance

Again according to the ARC Advisory Group 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 from the ground up to address these business issues, and the development of the technology was directly in response to end

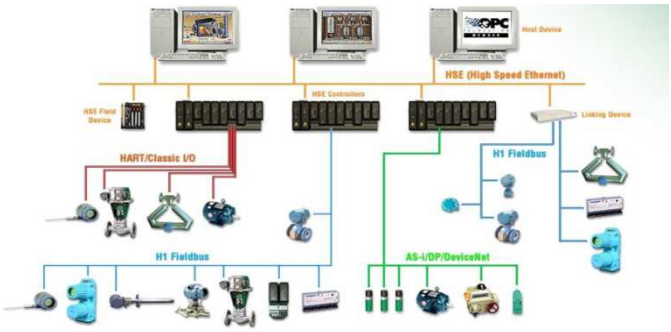


Fig. 4: Process Automation

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.

## VII. FIELDBUS SOLUTION

Three generations of field device are now in use in the process industries. Firstly, there are the classic, conventional sensors and actuators with analogue 4-20 mA signals and, secondly, the hart transmitters and positioners. The Foundation Fieldbus H1 and Profibus PA, the third generation of field device, were recently introduced. The predominant types of protection for explosion protected sensors and actuators continue to be intrinsically safe and flameproof encapsulated.

The FISCO Specification in accordance with IEC 60079-27 has gained general acceptance for intrinsically safe fieldbus devices. The FISCO model was accordance with IEC 61158-2, the explosion protected. Version of which was initially viewed as an intrinsically safe bus. However, the numbers of connectable devices are small.

Far more current can be provided for more field devices if we do without intrinsic safety. However, we do not need to do without the intrinsic safety of the field device connection. Appropriate solutions must be provided for this. Besides the conventional IS isolators this does of course relate to Remote I/O Systems for hazardous areas and field device couplers for connection of H1 or PA field devices. Conventional and HART field devices can be interfaced efficiently with higher-level systems using Remote I/O. For example, this is possible with Profibus DP.

R. STAHL now provides suitable couplers and fieldbus power supplyfor fieldbus devices (H1 and PA). With this concept, the fieldbus is not operated intrinsically safe [7]. This is the only way of implementing an efficient and economical installation powering adequately large number ofField devices. R. STAHL has made it its business to provide simple, efficient and economical solutions and integrate these.

## VIII. CONCLUSION

In this paper about the fieldbus technology that covers a very large spectrum of techniques and its applications has discussed. The fieldbus is present everywhere. Each field device is also a 'smart' device and can carry out its own control, maintenance and diagnostic functions. Each device will be able to execute simple functions on its own such as diagnostic, control, and maintenance functions as well as providing bi-directional communication capabilities. In the end Modern control systems without fieldbus technology is not possible.

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