ARC WHITE PAPER

By ARC Advisory Group

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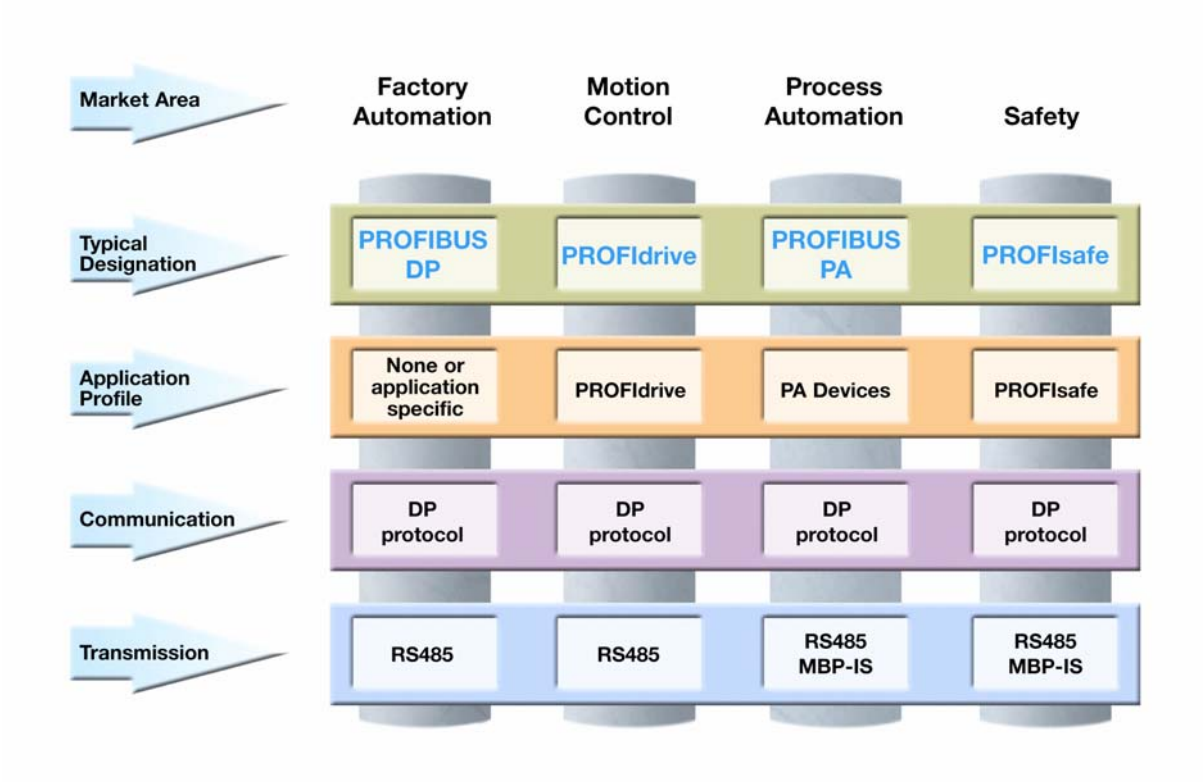
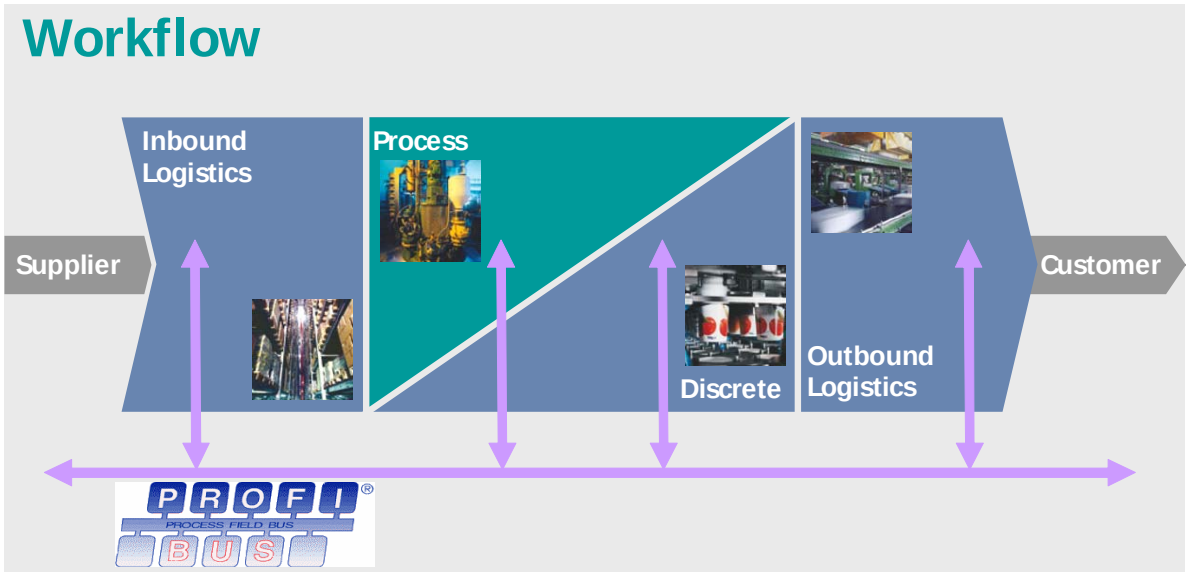
The Value Proposition of PROFIBUS in the Hybrid Industries



PROFIBUS' Application Profiles Address Specific User Needs While Sharing a Common Communication Layer



Source: Siemens AG

PROFIBUS Provides a Seamless Networking Infrastructure for Hybrid Plants

Executive Overview

The adoption of fieldbuses and device networks in manufacturing continues to grow rapidly. Especially in hybrid industries that use process and discrete applications, manufacturers are realizing the benefits of homogeneous fieldbus architectures that enable industrial networking across domain boundaries from simple sensors to complex field instrumentation. PROFIBUS, with its common communications layer, many application profiles, and breadth of media alternatives, offers manufacturers a solid long-term value proposition to protect their automation investments.

The value proposition of fieldbus and device networks has changed from the initial perceptions of the marketplace. Benefits such as reduced wiring and installation costs are apparent, but often mask the long-term benefits of fieldbus and device networks. According to ARC's research, the greatest benefits of fieldbus and device networks are realized in the areas of maintenance and operations, long after a plant has been commissioned. In other words, fieldbus itself is often not the cost-saver, but merely an enabler to a new level of asset management effectiveness that can significantly reduce operating costs and help manufacturers achieve operational excellence. Many of the benefits of fieldbus and device networks are still being discovered as users gain more experience with these technologies in real world plant settings.

While the use of a fieldbus can reduce installation and engineering costs, the greatest are realized in the areas of maintenance and operations, long after a plant has been commissioned.

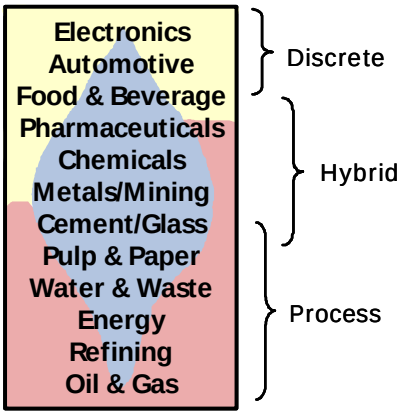
In typical hybrid industries such as pharmaceutical, food & beverage, and fine chemical, fieldbuses can contribute significantly to the achievement of operational excellence. Hybrid production processes are made up of both process and discrete applications with unique, individual requirements. The process side uses equipment such as transmitters, valve positioners, and analyzers to collect data or control processes such as distillation and exothermic reactions, often in a hazardous or explosive environment. Intrinsically safe, bus-powered devices are crucial in this area, while network speed is rarely an issue.

On the discrete side, applications such as bottle filling or pelletizing are found in the heart of production while materials handling and packaging are typical applications for the inbound and outbound areas. Here, speed and determinism are critical factors.

PROFIBUS, based on the international standard IEC 61158, is the most widely used device network in the discrete industries to connect programmable controllers with peripheral devices such as remote I/O, intelligent sensors and actuators, AC drives, and motion controllers. To meet the special needs of the process industries for intrinsic safety and bus power with two-wire technology, PROFIBUS offers MBP-IS (Manchester Coded, Bus Powered, Intrinsic Safety) transmission technology as well, while still using the same communication protocol.

Hybrid Manufacturers Demand Integrated Fieldbus Solutions

Hybrid users must deal with daily operational issues on both the process and discrete sides of their plants. The more similar the automation architectures between these two sides, the lower the operational and maintenance costs. For this reason, hybrid users demand a seamless industrial network solution that is at home in both manufacturing domains. Here, PROFIBUS' unique value proposition lies in its common communication layer that enables a single approach to network configuration and diagnostics in all areas of the plant.



Hybrid industries such as pharmaceutical, food & beverage, and fine chemical, employ both process and discrete applications.

In addition to the choice of network media, PROFIBUS' application profiles cover the range of requirements demanded by hybrid users. PROFIdrive, which is popular in packaging applications, allows the synchronization of multiple frequency inverters or servo drives. PROFIsafe adds an additional safety protocol layer to help users satisfy the stringent failsafe requirements of international safety standards such as IEC 61508. Both of these profiles use PROFIBUS DP as a basis, but provide additional application-specific functionality.

PROFIBUS Addresses the Needs of Hybrid Users

For hazardous areas, the PROFIBUS PA Devices application profile employs an intrinsically safe physical layer that provides bus power to devices on two-wire technology. This solution is referred to as PROFIBUS PA. Be-

cause the same communication layer is used in discrete environments, PROFIBUS PA segments can be coupled as extensions to a PROFIBUS DP backbone network in non-hazardous or discrete areas via segment couplers that are transparent to the bus protocol.

The HART protocol has become a de facto standard in the process industries, and ARC estimates that the majority of intelligent, microprocessor-based field instruments installed today are HART-compatible. In view of the large number of installed HART devices, the PROFIBUS HART specification was developed to enable the mapping of the HART client-master-server model on PROFIBUS. Installed in DCS controllers and field devices, a communications channel allows the transparent transmission of HART messages between devices utilizing PROFIBUS.

FuRIOS Study Highlights Fieldbus Cost Savings in a Hybrid Application

The debate over reduced capital costs with fieldbus implementation has been raging for years. End-users continue to pay a price premium for fieldbus-compatible devices while trying to understand the long-term benefits of fully networked instrumentation. Remote I/O (process instrumentation with 4-20 mA signals wired to networked I/O blocks) has been an attractive alternative to fieldbus for users and systems integrators because it promises a similar degree of cost savings for wiring and physical infrastructure. To better understand these costs, Infraserv Höchst, IGR and Aventis Pharmaceuticals conducted a study, dubbed "FuRIOS" (Fieldbus and Remote I/O System comparison), to contrast fieldbus with remote I/O in a major pharmaceutical installation. FuRIOS proves that substantial capital cost reductions are possible with fieldbus over remote I/O. This poses a strong argument for fieldbus implementation, particularly for systems integrators, whose primary concerns are reduced installation costs rather than of lifecycle costs.

The FuRIOS study, conducted by Infraserv Höchst, IGR and Aventis, proves that substantial capital cost reductions are possible with fieldbus over remote I/O.

System and Application

Control systems and instrumentation were the same for both the remote I/O reference system and the fieldbus-based system. ABB Industrial IT

control systems were used along with a wide range of instrumentation, control valves and software. The comparison took place in a newly constructed Aventis pharmaceutical plant. Both systems had the same plant requirements, including availability and partial redundancy. The fieldbus-based system used in the study incorporated two redundant PROFIBUS DP lines for field devices, one PROFIBUS DP line for drives and converters, two segment couplers, 17 PROFIBUS PA segments and 64 fieldbus barriers. Plant construction began in 2001 and commissioning occurred in 2002. Project costs totaled €13.8 million while instrumentation and control costs were € 3.5 million.

Device Cost Comparison

Fieldbus eliminated the need for several devices required in the remote I/O system. For example, limit switches were used in conjunction with control valves in the remote I/O system, but the digital positioners used with the fieldbus-compatible system had the ability to notify the system over the fieldbus network when limits were reached. Also, a solenoid valve in the remote I/O installation was positioned upstream from the control valves to shut down the flow of product completely, but digital positioners enable system deactivation that can be monitored by integrated valve position signaling. For some devices, such as signal lamps and condition monitoring equipment, fieldbus-compatible devices were not available at the time of plant construction. These devices had to be wired to the automation system through conventional I/O.

Instrumentation & Control Points	369
Total I/O Points	821
Analog Inputs	155
Analog Outputs	58
Digital Inputs	405
Digital Outputs	203
Drives	62 (Profibus DP)
Converters	2 (Profibus DP)

FuRIOS Remote I/O Comparison System Statistics

I/O Cost Comparison

The fieldbus installation achieves significant I/O cost reduction since much of the I/O and related hardware is eliminated. Instead of the remote I/O system, the fieldbus system features the PLC I/O cards needed to connect signals from devices that were not fieldbus compatible, fieldbus barriers, valve interface boxes, segment couplers, and power link modules. In total, the investment in I/O and related products with the fieldbus system resulted in a net savings of over 18 percent compared to the conventional remote I/O based system.

	Remote I/O System Cost	Cost Differential	Fieldbus System Cost	Percent Difference
Electrical	140,000€	0€	140,000€	0.0%
Analyzers	140,000€	0€	140,000€	0.0%
Project Management	280,000€	0€	280,000€	0.0%
Field Devices	770,000€	4,489€	774,489€	0.6%
I/O System	420,000€	-76,212€	343,788€	-18.1%
DCS incl. Engineering	525,000€	-24,795€	500,205€	-4.7%
Installation	700,000€	-10,732€	689,268€	-1.5%
Calibration/Quality	140,000€	-5,976€	134,024€	-4.3%
Commissioning (IBS)	105,000€	-2,400€	102,600€	-2.3%
Engineering	280,000€	-9,076€	270,924€	-3.2%
Total All Process I&C	3,500,000€	-124,702€	3,375,298€	-3.6%

Installed Cost Savings of Fieldbus vs. Remote I/O in FuRIOS Study

Fieldbus also had a significant impact on DCS engineering costs. Direct digital connection with the DCS facilitates engineering, commissioning, and checkout. Much of the device-specific configuration costs are also eliminated since, with technologies such as EDD, devices connected to the network are instantly recognized by the system, and the system can identify device functions and characteristics. Overall DCS engineering cost savings of 4.7 percent were achieved.

Installation, Calibration, and Commissioning Cost Comparison

While there are considerable cost savings with remote I/O versus conventional systems because of reduced cabling, costs can be further reduced with fieldbus through shorter cable lengths to spurs. The study measured overall installation savings of 1.5 percent with fieldbus compared to remote I/O, while calibration and qualification cost savings amounting to 4.3 percent were achieved due to the reduced need for signal calibration and reduced qualification and documentation costs. An additional 2.3 percent was saved in reduced commissioning time due to the elimination of loop checks.

All in all, the Aventis study showed the highest savings in hardware and engineering costs, following by calibration and commissioning, resulting in an overall net savings of 3.6 percent in favor of the fieldbus installation.

PROFIBUS in the Hybrid Industries: Three Case Studies

With more than 10 million installed nodes, PROFIBUS is the most widely deployed fieldbus in the world. This success is due in part to the backing of PROFIBUS International with its broad technical resources, the marketing strength of its 1200+ members, and the wide range of application profiles for PROFIBUS that address manufacturer-specific needs from the discrete to the process industries. The following section looks at fieldbus applications of three users who have taken advantage of PROFIBUS' flexibility in typical hybrid industry processes and applications.

PROFIBUS' value proposition lies in its ability to address the needs of each of SABMiller's manufacturing domains, from bus power for field instruments to high-speed deterministic control, all running on a common communication layer.

PROFIBUS Unifies Control Architectures at SABMiller

Through its merger with Miller Brewing Company in 2002, SABMiller became the world's second largest brewer by volume with presence in over 40 countries. Headquartered in South Africa, the company brewed over 115 million hectoliters of beer in more than 120 breweries worldwide in 2003, with sales of over US$9 billion. In addition to beer, SABMiller's other business interests include non-alcoholic beverages and bottling operations.

Brewing is one of the classic hybrid industries, combining process applications such as fermentation and filtering with typical discrete tasks like high-speed filling, labeling, packaging, and palletizing. The process and discrete sides often have little to do with each other and may even employ different control and fieldbus technologies. SABMiller uses PLCs for both process and discrete applications and, where appropriate, uses PROFIBUS to unify control architectures in plants that use legacy or current Siemens controllers. Here, PROFIBUS' value proposition lies in its ability to address the needs of each of SABMiller's manufacturing domains, from bus power for field instruments to high-speed deterministic control, all running on a common communication layer.

Using PROFIBUS allows SABMiller to tap into the network's "tool box" of application-specific profiles common to the network's single bus protocol. For applications requiring a deterministic response, SABMiller uses PROFIBUS DP to connect PLCs and PC-based controllers to remote I/O, AC drives, and bottle inspection equipment. On the brew house side, PLCs control the processes through field instruments such as pressure, temperature, and level transmitters on PROFIBUS PA. On/off valves and drives to power the tank agitators are networked directly through the PROFIBUS backbone.

PROFIBUS helps unify control architectures at SABMiller by satisfying both process and discrete application needs.

SABMiller recognized long ago the value of employing a single network solution for both process and discrete applications. With PROFIBUS, the company can simplify installation and maintenance by using a single bus protocol in the wet and dry ends of its operations. For data collection, new machines must have a PROFIBUS connection, even if it means using a serial-to-PROFIBUS converter. Data collected from PROFIBUS devices is stored in data historians or shared with Laboratory Information Management Systems (LIMS) and production tracking applications. In the future, the company also intends to use industrial networks increasingly for software backup and change control.

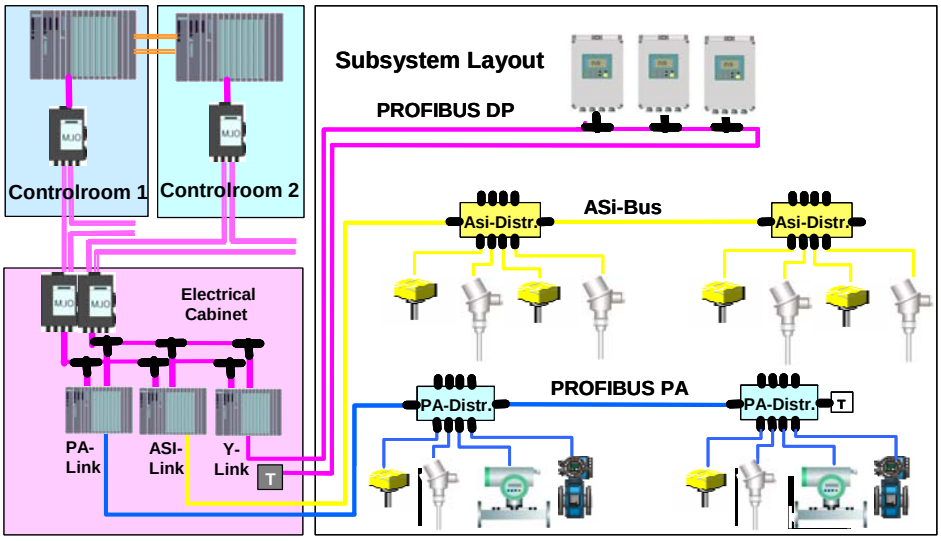
Besides lower wiring and installation costs, SABMiller also points to other PROFIBUS benefits. Machine-mounted remote I/O blocks replace PLC I/O cards, simplifying cabling while allowing the use of smaller electrical cabinets, or sometimes no cabinets at all. From an operational point of view, maintenance staff takes advantage of built-in diagnostics when troubleshooting problems. Faults can be localized and fixed more quickly, which reduces maintenance costs and shortens downtime.

Much of SABMiller's growth in the past decade has come from acquisitions in Europe, North America, and Africa. With acquisitions comes the burden of supporting installed automation systems from different suppliers. The result is often a patchwork of plants that use different control systems networked by different industrial field and device busses. In South Africa alone, SABMiller's seven breweries use PLCs from at least three different suppliers, including Siemens S7 and legacy S5 controllers. For new projects

and upgrades, SABMiller's strategy is to use Siemens PLCs together with PROFIBUS where appropriate to integrate automation hardware and software with production and enterprise level applications.

Merck Designs New Pigment Plant around PROFIBUS

From cosmetics to metallic paint, pearl-lustre pigments create an attractive glitter effect that finds a wide range of uses in everyday products. To meet the increasing demand for mica-based pigments, Merck KGaA of Darmstadt, Germany, recently commissioned a €60 million pigment production facility at its Gernsheim plant. While the production processes are one of the company's core competencies, Merck's engineers had not previously used fieldbus to network the nearly 2,500 devices planned for the new plant.

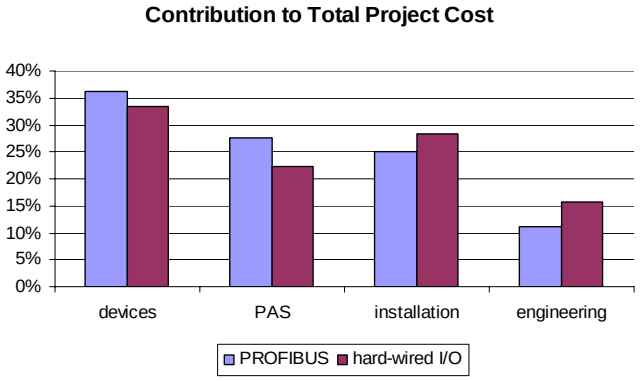


Merck's modular networked architecture uses multiple subsystems consisting of a standardized electrical mini-cabinet containing PROFIBUS DP, PA and AS-i links, local I/O blocks, and power supplies.

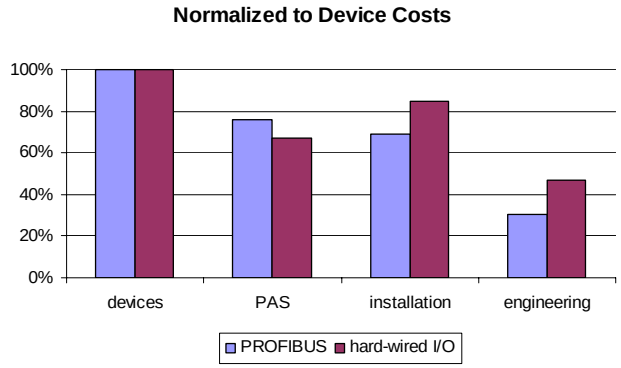
Designing a new plant from the ground up is a rare luxury today in a market where only about 25 percent of automation investments are for new plants. Starting from scratch allowed Merck to use the latest technologies available, including fieldbus. Merck looked at the available fieldbus solutions during the planning phase, but quickly zeroed in on PROFIBUS due to the large number of devices available as well as its high rate of acceptance. The challenge was to find a solution that would handle both process and discrete applications without having to use multiple fieldbuses. The

company claims that no other fieldbus came close to matching PROFIBUS' adaptability to both environments.

To corroborate their decision, Merck's engineers performed a cost analysis, comparing the use of PROFIBUS to hard-wired I/O in terms of device, installation, and engineering costs. While the overall purchase costs of devices and Plant Automation System (PAS) hardware were slightly higher due to the price adder for each network interface, the engineers determined that substantial cost savings could be realized by using a fieldbus. According to project-specific calculations, they estimated a 19 percent savings on installation costs and as much as 36 percent on engineering costs. The lower installation costs were due to the reduced wiring necessary for networked field devices.



Using PROFIBUS, installation costs per device were 19 percent lower and engineering costs 36 percent lower than with hard-wired I/O.



PROFIBUS' lower installation and engineering costs more than made up the difference for higher purchase costs.

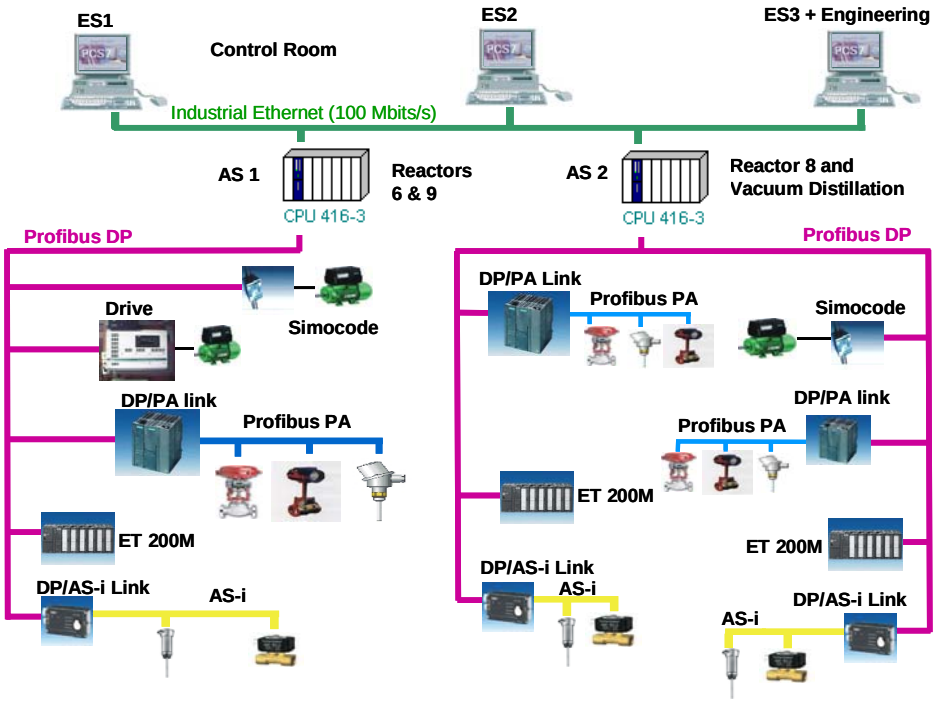
In place of thick bundles of wires, PROFIBUS enabled Merck's engineers to use 2-wire technology throughout most of the plant, augmented by several kilometers of fiber optic cable that provided both noise immunity and ring redundancy. Prefabricated cables and T-connectors helped reduce wiring errors while speeding up installation. The substantial savings in engineering costs and shorter planning time resulted from greatly simplified CAD drawings due to reduced wiring requirements.

A major source of cost savings stemmed from Merck's decision to employ a decentralized architecture designed around PROFIBUS. This architecture allowed Merck's engineers to use subsystems, each consisting of a standardized electrical mini-cabinet containing PROFIBUS DP and PA links, local I/O blocks, and power supplies. Field devices such as drives, field instruments, and other I/O devices are connected to redundant Siemens PCS 7 controllers via the network links in each of the 60 mini-cabinets. By designing these sub-systems around a standardized PROFIBUS-based architecture, engineers were able to "copy and paste" much of the plant design, simplifying the engineering and greatly reducing costs.

From an operational point of view, Merck's fieldbus-based architecture has also paid off in terms of maintenance costs. Using centrally located diagnostic and configuration tools, plant engineers can configure a replacement field device or quickly locate wiring faults from one of two redundant control rooms. The standardized sub-systems mean identical wiring in all parts of the process, meaning shorter downtime for repairs. Finally, when field devices need to be repaired or replaced, most can be "hot-swapped" without having to shut down the process.

PETROM Makes PROFIBUS Part of Migration Strategy

PETROM (Petroquímica Mogi das Cruzes S.A.), a Brazil-based division of the CIPATEX Group, is Latin America's largest producer of phthalic anhydride, an agent used mainly in the production of plasticizers, unsaturated polyester resin, and alkyd resins. Faced with increasing demand for phthalic anhydride, Petrom recently implemented two phases of a migration project to a Siemens PCS 7 control system optimized with modern PROFIBUS fieldbus technology. The goals of the project were to increase production capacity while improving both reactor performance and plant safety.



Petrom's migration strategy takes advantage of both PROFIBUS DP and PA, as well as AS-interface for simple bit-level devices.

The migration project was laid out for three phthalic anhydride reactors and a vacuum distillation tower with a total of 1,200 existing and new I/O points. Since Petrom planned to continue using installed instrumentation and hard-wired I/O while adding new components for the expansion, the company had to decide whether it made business sense to use a fieldbus. Not all fieldbus installations are necessarily cheaper than hard-wired alternatives, but Petrom found that using a fieldbus allowed them to place network gateways closer to the process, resulting in cheaper field wiring costs.

PROFIBUS was chosen for both process and discrete fieldbus applications because of its solid reputation as an open fieldbus, the variety of field instruments available, and the large number of installed applications around the world. Equally important was the fact that Petrom could use one fieldbus system to connect discrete I/O devices (PROFIBUS DP) as well as to network field instruments – primarily flowmeters from Smar and Endress + Hauser - while supplying bus power (PROFIBUS PA). Petrom's engineers connected existing 4-20 mA instrumentation and discrete I/O signals for motor control to the new control system via standard Siemens ET200M I/O blocks on PROFIBUS DP. Simple actuators and sensors for valve control and monitoring were wired via gateways to low-cost AS-Interface bus segments. Although the unit costs were higher for new instrumentation with PROFIBUS PA adapters when compared with conventional 4-20 mA devices, Petrom found that commissioning time for instrumentation was shorter and that diagnostics and configuration turned out to be faster and easier for maintenance personnel. The final decision to go with PROFIBUS was driven by a projected long-term decrease in total maintenance costs.

Petrom engineers monitor and operate three reactors from operator stations networked via PROFIBUS to both field instrumentation and discrete I/O, greatly simplifying remote configuration and diagnostics.

The long-term benefits of fieldbus-enabled diagnostics are often underestimated. A pivotal case for Petrom surfaced when a flowmeter connected via PROFIBUS started to deliver erroneous information to the company's Plant Asset Management (PAM) system. The usual fix was to connect to and download remote calibration information to the device to correct the problem. However, this became increasingly difficult as the condition of the instrument worsened. The gradual deterioration led plant engineers to di-

agnose a problem remotely with passive electronic components in the device's communications adapter. The problem was quickly located and solved – much faster than if the flowmeter had been directly wired to the control system.

Petrom is satisfied with its decision to make PROFIBUS an integral part of its migration strategy. Project personnel found the fieldbus installation to be easier than they had expected, resulting in lower project costs. Process control engineers appreciate the ability to configure and diagnose field devices online, saving them costly downtime while allowing maintenance workers to predict some problems before they occur. Petrom claims that PROFIBUS allowed them to reach their goals of increasing production by optimizing system performance while lowering Total Cost of Ownership through smart diagnostics.

Recommendations

- Fieldbus solutions can add long-term value to manufacturing systems by reducing downtime through better diagnostics, simplifying routine maintenance and supporting predictive maintenance. To maximize these benefits, users should evaluate a fieldbus' value as it applies to whole processes – not just islands of automation – especially in terms of asset management.

- Hybrid industry users in the chemical, pharmaceutical or food & beverage industries can benefit from PROFIBUS' unique value proposition in its ability to seamlessly integrate process instrumentation, like pressure transmitters and flow meters, with devices for the discrete side of the application, like drives and sensors. PROFIBUS' common communications protocol creates a familiar environment, which can help to lower engineering, training and maintenance costs.

- New control systems can take advantage of the existing installed base of HART field devices while also incorporating PROFIBUS functionality. Users should consider these systems as a cost-effective method for fieldbus migration.

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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

AI	Artificial Intelligence	**ERP**	Enterprise Resource Planning
API	Application Program Interface	**HMI**	Human Machine Interface
APS	Advanced Planning & Scheduling	**IT**	Information Technology
BPM	Business Process Management	**MIS**	Management Information System
CAGR	Compound Annual Growth Rate	**OpX**	Operational Excellence
CAS	Collaborative Automation System	**OLE**	Object Linking & Embedding
CMM	Collaborative Manufacturing Management	**OPC**	OLE for Process Control
		PAS	Process Automation System
CPAS	Collaborative Process Automation System	**PLC**	Programmable Logic Controller
		PLM	Product Lifecycle Management
CPM	Collaborative Production Mgmt	**ROA**	Return on Assets
CRM	Customer Relationship Mgmt	**ROI**	Return on Investment
DCS	Distributed Control System	**RPM**	Real-time Performance Mgmt
EAI	Enterprise Application Integration	**SCE**	Supply Chain Execution
EAM	Enterprise Asset Management	**WMS**	Warehouse Management System

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