ARC WHITE PAPER

By ARC Advisory Group

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How Profinet and Industrie 4.0 Enable Information-Driven Industries

VISION, EXPERIENCE, ANSWERS FOR INDUSTRY

The manufacturing ecosystem requires a solid foundation of both commercial and industrial-grade infrastructure.

Industrial automation architectures are a key part of a manufacturing ecosystem in support of the vision of Industrie 4.0.

Executive Overview

It goes by a variety of names, but the much talked about convergence of technologies that is taking place in manufacturing is not a trend at all. Much more, it is a significant step in a gradual but inevitable evolution driven by persistent inefficiencies and technology gaps in the conservative industrial world. If the first Industrial Revolution was spawned by the steam engine and the second and third by electrification and the advent of the computer, then it is fair to declare the internet- and information-driven economies of today as the dawn of the fourth Industrial Revolution, or "Industrie 4.0".

> Industrial companies stand to reap huge benefits by realizing Industrie 4.0, but to achieve this, they need to ensure that the right manufacturing ecosystem is in place to support it.

The concept of Industrie 4.0, sometimes also called Industrial Internet of Things (IIoT), began as an initiative by the German government to ensure the competitiveness of German industrial companies at home and abroad (hence the German spelling of *Industrie*). Other concepts like IIoT are not as formal, but have also risen out of the necessity for manufacturing industries to catch up to the rest of the world in terms of the strategic use of information technologies.

Industrial companies stand to reap huge benefits by defining and implementing the tenets of Industrie 4.0, but to achieve this, they need to ensure that the right infrastructure is in place to support it. This is where a future-proof automation architecture plays an important role. In the past decade, commercial information technologies have pervaded, replaced and enhanced traditional "hardened" industrial technologies in an unprecedented way. Leading the pack has been the success of industrial Ethernet at both the control and the device level. Industrial users benefit from industrial Ethernet's seamless compatibility with enterprise level networks and standard internet protocols, but also from technical enhancements that address the specific performance needs of demanding industrial applications. These include service orientation and interoperability at the application level, permitting devices to interact in all life cycles of a plant.

Business Drivers for Industrie 4.0

Global manufacturers today demand simpler and more modular automation solutions that use open networks and interfaces. New business drivers require the seamless integration of production data with business systems to make better use of information originating from the plant floor. Meeting these new requirements means investing in modern automation architectures based on open standards and Ethernet-based networks so that key production data can be easily and cost effectively gathered on the plant floor and shared with production and enterprise applications.
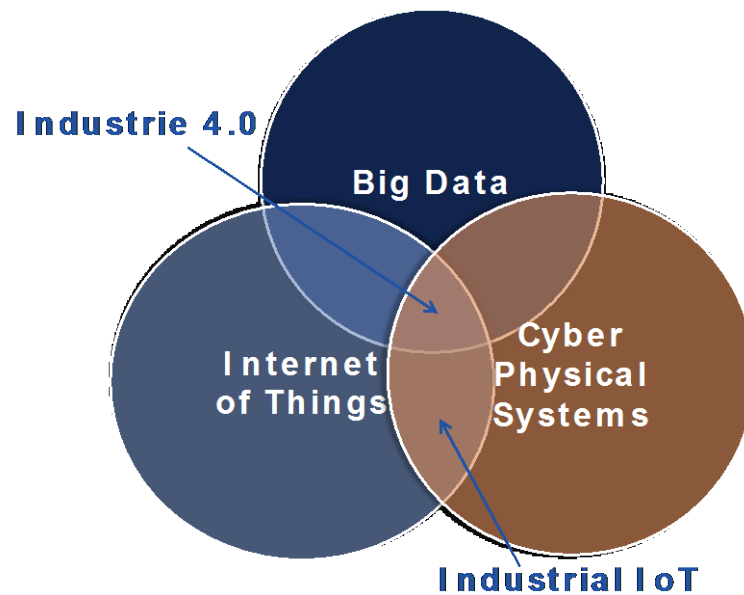
All this information availability means that process manufacturers today are driven more and more by key performance indicators (KPI) – business targets based on measured and forecasted process information. To meet these targets and improve business performance, users focus on continuously improving the performance of plant assets. Typical business metrics include return on assets (ROA) and overall equipment efficiency (OEE), both of which are critical contributors to the overall goal of achieving operational excellence (OpX).

The nemesis of all process and manufacturing plants is unscheduled downtime – stopping a manufacturing process due to equipment failure, operator error or security breaches. Achieving business goals means ensuring constant, uninterrupted plant operation while having a contingency plan in place for rapid recovery should a disruption occur. A sound security policy, even if not 100 percent foolproof, contributes substantially to the achievement of these business goals by reducing the risk of unexpected interruptions.

Finally, as commercial IT and traditional manufacturing technologies converge, asset lifecycles will become shorter and manufacturers will have to get accustomed to investing more frequently in new assets, or in updates of existing assets, both hardware and software. While this seems to contradict the old adage of "never touch a running system", a new generation of cyber-savvy engineers and stakeholders will help usher in the culture necessary to effect this change.

Industrie 4.0 and Manufacturing

Since its initiation by the German government several years ago, the concept of Industrie 4.0 has taken on a dynamic of its own, driven by an industry hungry for a new direction in an increasingly IT-dominated world. To put it in perspective with related concepts, ARC sees Industrie 4.0 as the convergence of the Internet of Things (all devices connected via the internet), cyber physical systems (intelligent, connected industrial devices), and Big Data (data extracted from industrial processes and analyzed).

Industrie 4.0 is Located at the Convergence of IoT, Cyber Physical Systems and Big Data.

Cyber physical system (CPS) refers to intelligent devices employed in a manufacturing environment that collaborate with other devices by sharing information. These devices can be anything from a sensor to an intelligent drive to a smart pump. Typically, they are connected to a control system via an industrial network or a wireless network.

Internet of Things

CPSes are the industrial "things" or devices that are part of the greater ecosystem of all connected devices, commonly called the Internet of Things.

Big Data and Analytics

Big Data refers to the plethora of data and information associated with modern manufacturing processes. These data can e.g. describe a product

being manufactured, document production equipment, or provide status and performance information from a running manufacturing operation. Finally, the concept of Internet of Things suggests that all devices are connected and intelligent enough to communicate at least basic information to make themselves useful in a collaborative manufacturing environment.

Industrial data sets are growing in size. Many activities in manufacturing processes drive this increase in data, including capturing audio, photographic and video information, remote sensing, information-sensing mobile devices, radio-frequency identification readers, wireless sensor networks, and even social content and sentiment analysis. These data may be captured from manufacturing processes via industrial networks or they may arrive from external sources.

Large data sets are difficult to work with using existing tools such as relational databases, spreadsheets, desktop statistics packages, or visualization software. But the current generation of in-memory, parallel processor servers running columnar databases now make it practical to deal with data sets on the order of exabytes in size, or even larger.

Putting Information to Use: Information-Driven Manufacturing

Information-driven manufacturing is a manufacturing strategy that builds on the concepts of collaborative and networked manufacturing and embraces new technologies to achieve and sustain a competitive edge. Information-driven manufacturers take a holistic view of manufacturing and the production plant's position within an extended value network. With this perspective, they apply information technology broadly to improve or replace business processes. Information technology has matured to the point where a host of new possibilities can be considered, and the latest set of disruptive technologies only amplifies this trend.
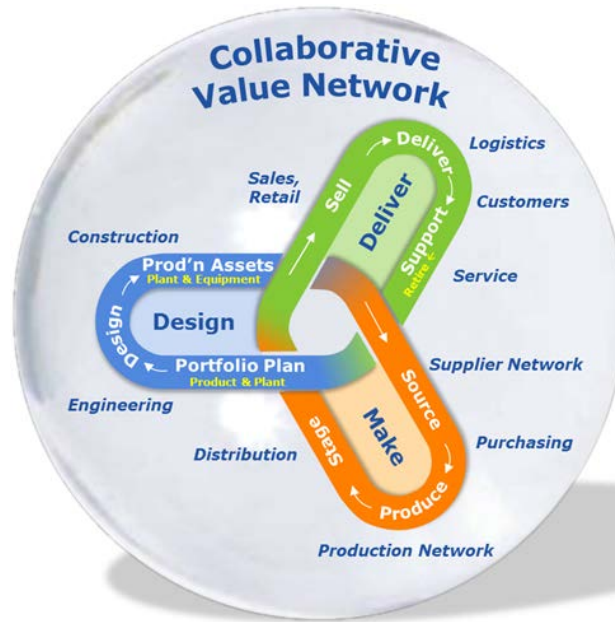
Consider some of the implications of the term "information-driven". Information-driven companies:

- **Make decisions based on process and business process data** and typically employ software to collect, contextualize, visualize, and analyze the data. With the advent of extremely fast in-memory computing platforms and Big Data analytical tools, information-driven companies are

beginning to use ever more massive datasets in a host of new applications.

- **Embrace IT technologies** throughout the enterprise. Almost every plant or facility runs the latest version of the appropriate software so that it can operate in a connected, information-driven mode consistent with the rest of the organization.

- **Have resources to manage IT systems** and explore new ways to access computing resources, so cloud computing is an important part of any IT discussion.

- **Are demand-driven**. They use information systems and supply chain data to generate real-time signals to their supply, production and distribution networks.

- **Put information at their employees' fingertips** by giving them access to new analytical, social, visualization, and other new technologies at their devices so they can be highly productive and make better, more informed decisions.

- **Collaborate internally and externally**. Their systems and business processes are well integrated within the enterprise, and they connect and share information with partners in a real-time ecosystem.

- **Are increasingly focused on services**. They use real-time data and execution and transactional information systems to invent, promote, and manage new services and business models to their customers.

Today's information and analysis technologies can be transformative. With the information-driven approach, companies employ information-driven value networks, business processes, and decision-making to support corporate initiatives such as energy management and sustainability programs; global growth initiatives; and innovation in product, process, systems and business models.

Information-driven manufacturers collaborate with partners throughout the value network.

Information-driven manufacturers recognize that IT technologies will increasingly drive a manufacturer's competitive advantage, and sooner than many realize. They embrace a technology adoption strategy wherein advanced technology is considered as soon as practicable, and where it's seen as a virtue to be part of the "early majority," or even the "early adopter" community, instead of a technology laggard. Of course, ROI and business justifications will remain important, but the cost of falling behind the technology curve should also be factored in.

Information-Driven Manufacturing Ecosystem

An important reason for manufacturers to adopt an information-driven strategy is the fact that manufacturing exists in an increasingly dynamic and complex ecosystem. A manufacturer should be information-driven not only because it may be the only viable way to deal with issues brought about by dynamic complexity, but because information technology will increasingly be deployed throughout the rest of the ecosystem, right down to the plant floor.

The Information-Driven Manufacturing Ecosystem

Application platforms supporting ERP, CRM, PLM, SCM at the enterprise level, and MOM/MES at the plant level continue to be an important part of an information-driven strategy, because this is where the bulk of the transactional and operational processes are executed. But the tendency to settle on a working system, and upgrade it as infrequently as possible can no longer be tolerated.

To remain competitive, information-driven manufacturers will have to deploy these solutions aggressively throughout the enterprise and plant, and update them regularly to gain and maintain the latest technological edge. Achieving this will require new mindsets and new ways of thinking for traditional industrial companies that traditionally measure lifecycles of production assets in decades rather than in years.

Automation Architectures: The Link to Industrie 4.0

No manufacturing ecosystem could exist without a solid, reliable plant infrastructure to support it. Today's industrial companies have IT departments that implement and maintain a company's infrastructure just as professionally as in any other modern, competitive company. The difference is that manufacturers have the additional burden of integrating and

supporting a manufacturing ecosystem, or "manufacturing IT", the conservative cousin of enterprise IT.

Manufacturing IT refers to the infrastructure hardware and supporting software that enables manufacturing applications for control, visualization, production management, maintenance and logistics to communicate freely with one another and also with enterprise applications, first and foremost ERP. While the emergence of internet-enabled applications at the plant software level is a major step toward the realization of Industrie 4.0, none of this would work without the existence of a solid manufacturing IT infrastructure.

Automation architectures that support manufacturing IT use industrial Ethernet at least as a backbone network. This means that Level 3 and Level 4 devices (according to ISA95/IEC 62264) such as PLCs, DCSs and plant floor PCs and operator stations all share the same network domain. The advantage is seamless connectivity with enterprise networks and simple device integration and maintenance.

> Profinet uses Ethernet throughout the automation architecture as a single network with "commercial" qualities and acceptance, coupled with technical enhancements to make it the ideal industrial network.

Even better is the penetration of industrial Ethernet down to Level 1 and Level 2 devices, such as IO modules and servo drives. Industrial Ethernet solutions like Profinet offer performance enhancements at this level that provide additional qualities like determinism that are not available from standard Ethernet. Such a hybrid approach allows the industrial use of Ethernet throughout the automation architecture as a single, standard network with "commercial" qualities and acceptance, coupled with just the right technical enhancements to make it the ideal industrial network.

Profinet as a Stable Basis with Future Extensions for Industrie 4.0

Manufacturers often speak of a wall between the plant and the enterprise. This wall is currently reflected in the differences in technologies and standards used on both sides. There are two reasons for this:

1. Over the last thirty years, technologies were developed independently.

2. The plant floor has higher requirements than the enterprise environment in terms of reliability, environmental conditions, real-time behavior and robustness.

While the first reason is purely organizational, caused by separate development in different application areas, the second reason is just applications in different environments.

In terms of modeling there is no reason for different solutions in the plant and enterprise. Work on Industrie 4.0 has already proven that a common model will address most of the needs of both. However, extensions will have to be made to fulfill the plant requirements mentioned in the second reason. Thus the aim is a consistent model for both environments with some extensions for the plant.

Demands	Challenges
Increased Wide Area Network qualities of services	Extensions of capabilities of Wide Area Networks with respect to reliability and real-time behavior
Higher degree of interoperability (at least partial interchangeability)	Standardized generic services Service-orientation with self-x functionality (self-configuration, self-optimization, self-healing)
Significantly improved cyber security	Single, comprehensive security solution for both enterprise and plant
Formal description of functions (i.e. measurement and control, drilling, welding...)	Intelligent parts to be produced Standardized solutions
Well adapted product quality that guarantees reliable product combinations; self-configuring production lines	Improved reliability of things
International legal framework	Inclusion of legislation described and derived from standards and regulations
Cooperation and collaboration of products	Standardized methodologies

Demands and challenges of Industrie 4.0

For this purpose, a common semantic model will play an important role in Industrie 4.0. The aim is to create a model that minimizes the wall between the plant and the enterprise. While "shopfloor" and "topfloor" will continue to exist separately for organizational reasons, Industrie 4.0 will create a

common architecture that goes not only beyond a "pure" IT environment. Instead, it will be an IoT-based *extended* environment that serves as a single architecture for the enterprise office *and* its associated plant.

Demands and Challenges for Current Automation Architectures

Meeting the challenges of Industrie 4.0 will require substantial changes to existing system architectures, taking into account a variety of drivers such as:

- More digitalization of devices and processes

- More data generated by smart field devices

- More decentralization and therefore the need for more network bandwidth

- More standardization of software and hardware based on existing or extended standards

In summary, the demands can be split into six areas described on the next few pages.

Extended Reliable Communication

Reliable, real-time communication using Profinet and/or Profibus protocols has been state-of-the-art for some time. Profinet is based on standard Ethernet, which is being continuously improved and expanded. For example, a task group within IEEE is currently developing enhancements for improved real-time behavior for Time Sensitive Networks (TSN). As the technology becomes available, PI will look at how TSN could benefit industrial networking and possibly be incorporated into Profinet.

Service-Oriented Information Exchange

Industrie 4.0 will adopt OPC UA as its service-oriented architecture (SOA). This existing technology likely will become the basis for the development of Industrie 4.0. PI and the OPC Foundation have already cooperated for years and together will continue to play an important role in the communication architecture of the future. This cooperation will be intensified to allow the integration of OPC UA into the Profinet system architecture. Work has already begun and plans are to incorporate the currently developed Industrie 4.0 specific generic services based on OPC UA.

Cyber Security for Enterprise and Manufacturing IT

Cyber security refers to the protection of unauthorized access to a company's digital assets. Unfortunately, the openness and ubiquity of the internet make it inviting for malicious use as well. As more and more critical parts of public infrastructure and private industrial enterprise are put online, the risks to public safety, commerce and trade have grown enormously. But while every enterprise has a stake in ensuring that its digital assets are secure, the particular interests of the various stakeholders differ.

Industrial companies have long since digitalized their business processes, creating a world of paperless transactions with untold advantages and efficiencies. This side of the business is heavily dependent on the confidentiality and integrity of information stored and transacted digitally. For this reason, ensuring confidentiality and integrity is the highest priority for cyber security.

> Cyber security takes on a different meaning in manufacturing. For the enterprise sides, the highest security priority is the confidentiality and integrity of data. For the plant side, it is availability.

The plant side, on the other hand, relies on physical assets such as heavy machinery and equipment that produce products. While the plant also shares information digitally, the highest priority for plant cyber security is to ensure the uninterrupted availability of these physical assets. Unscheduled downtime of equipment and interruptions to manufacturing processes are the worst scenarios for plant engineers – and these have little to do with data integrity.

For these reasons, it is critical to consider these differing and often conflicting priorities when designing a comprehensive enterprise-wise cyber security strategy. PI has created security guidelines for Profinet networks and continues to monitor and assess the need for additional steps.

Common Semantics for Interoperability

With its communication protocol and interface, Profinet is well prepared for Industrie 4.0. This includes the use of data types and data semantics that cover mainly the operational phase of a plant. One of the aims of Industrie 4.0 is to create an infrastructure for random collaboration of "things" (industrial devices) in an installation throughout the whole life cycle. This necessitates requirements for interoperability not only during the operational phase, but also in all other phases. Industrie 4.0 currently specifies a common vocabulary (semantics) for these purposes based primarily on eCl@ss, a product classification standard, in conjunction with

AutomationML, an open mark-up language for the transfer of data objects between engineering tools.

For the operational phase of a plant, Profinet and Profibus offer more than 20 profiles with relevant, standardized semantics and formats. Based on the positive experience of users, PI will likely add more profiles for other phases of a plant such as engineering, commissioning, maintenance and decommissioning. For suppliers of field devices, PI publishes the Identification and Maintenance Guidelines that define standard parameters (semantics) and rules for devices. In the future, new content may be added to ensure uniform behavior during all phases of a device's lifecycle, such as configuration, commissioning, parameterization, diagnosis, repair, firmware update, asset management and audit trailing.

Intelligent Algorithms at the Application Level

Cooperation and collaboration need common standardized methodologies to ensure that products can interact with each other, but with enough room left for manufacturers to still differentiate their products. PI is currently working on solutions at this level, for example, for condition monitoring. Based on the reference model for condition monitoring from the German Engineering Federation (VDMA), PI is defining a communications profile to access condition monitoring data via Profinet.

Legal Framework

It is likely that legal and regulatory requirements will impact future Profinet solutions. Specifics are not known at this time, but PI plans to conform to these requirements at the appropriate time.
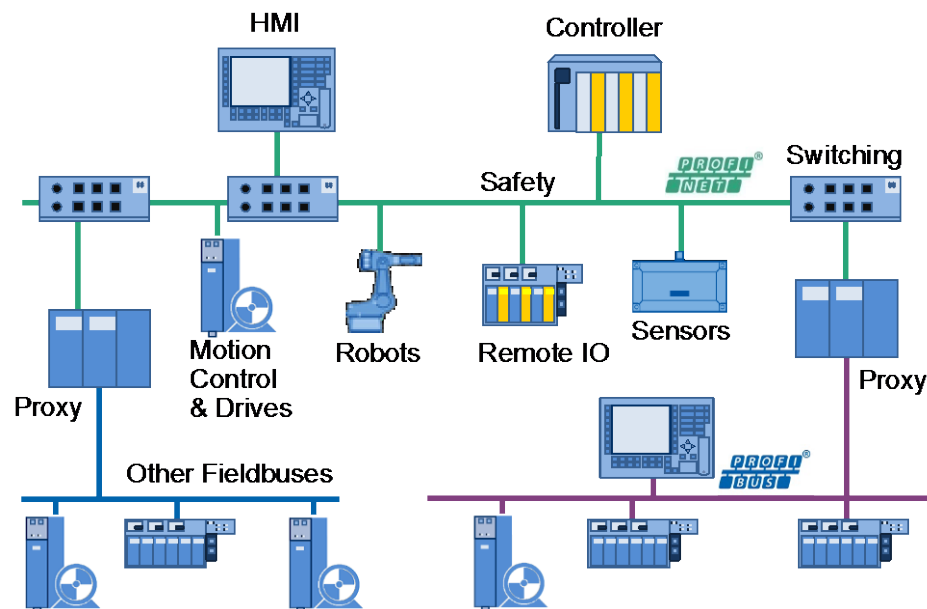
Industrie 4.0 Components and Profinet

Devices with a Profinet interface come with product descriptions for configuration and device integration such as the General Station Description (GSD) or the Electronic Device Description (EDD). This fits well with the idea of Industrie 4.0 components that have their own administration shells. Both solutions contain information that will have to be integrated into the administration shell for engineering, commissioning, etc. Thanks to the cooperation agreement with the FieldComm Group, the information of the extended concept of the FDI device package may also become part of the administration shell to be adopted in Profinet.

Profibus and Profinet in Manufacturing and Process Industries: An Overview

In the face of increasing complexity, manufacturers today demand simpler and more modular automation solutions that use open, non-proprietary networks and interfaces. In the spirit of Industrie 4.0, they want to seamlessly integrate device and production data to business systems to make more use of data generated on the plant floor, and to harness the power of modern analytics. In the past decade, Ethernet-based industrial networks have established themselves in the plant as the winning solution.

A large part of the success of Ethernet in the plant can be attributed to its commercial nature and legacy. With ubiquitous Ethernet, users can take advantage of familiar IT tools and enjoy seamless connectivity between plant and enterprise-level applications. The technology is essentially future-proof for industrial users because industrial Ethernet can easily adapt to future enhancements. The net effect is a lower total cost of ownership for plant assets thanks to an all-encompassing approach to industrial networking.

Profinet integrates legacy networks to serve as a plant backbone and expose plant data that are otherwise difficult to access.

After the success of Profibus in the 1990s, Profibus International (PI), with a global community of more than 1400 member companies, began develop-

ing Profinet, an Ethernet-based industrial network about 15 years ago. To understand the needs of industry users, working groups investigated and defined the range of services and functions required for Profinet to address all aspects of process and discrete manufacturing. Each group set out to identify a particular industrial application need, ranging from safety to motion control to wireless communication.

Reducing complexity:
Technology innovations bring improvements, but they can also have the negative effect of increasing complexity, especially if implemented on top of rather than replacing legacy technologies. Truly great innovations allow you to do both: augment a legacy solution with a view to replacing it completely over time. In industrial networking, Profibus and Profinet allow you to do just that.

For industrial users, simply using Ethernet and TCP/IP does not mean that industrial devices can automatically communicate with each other. Application protocols such as HTTP and SMTP (for email) are not suitable for transferring control data between automation devices in time critical industrial applications. PI recognized this shortcoming early in the game and developed an industrial protocol that supports specific performance re-requirements for industrial applications.
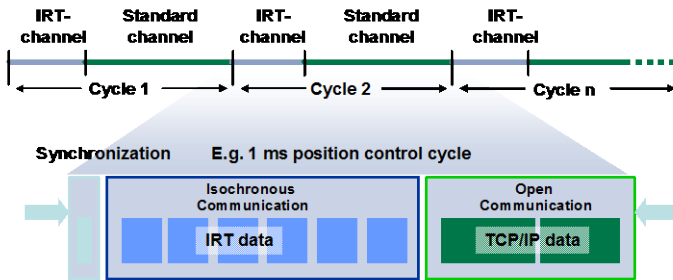
Profinet uses the TCP/IP protocol suite without limitations or modifications. Automation-specific tasks such as device parameterization, configuration, network diagnostics (SNMP) and other IT applications are handled via the TCP/IP channel. However, for applications such as remote IO and motion control that place high demands on speed and determinism, TCP/IP, with its large overhead and long stack throughput times, is insufficient. To address these issues, PI's experts added an additional channel for real-time (RT) transfer of time-critical data. This method uses standard Ethernet hardware and network components (switches), but performs a prioritization of the datagrams in the switches via IEEE-based priority tagging. This enables deterministic response times in the range of 0.25 to 10 milliseconds and opens up Ethernet to a whole new world of industrial applications.

Real-time communication with remote IO and other field devices of Profinet uses the RT channel. Since Ethernet and wireless LAN are both based on the IEEE 802.xx standards set, Profinet can be easily extended to wireless communication via access points.

Profinet for 'Hard' Motion Control

For high performance motion control applications such as the precise coordination of hundreds of axes with microsecond precision, Profinet includes an isochronous real-time channel (IRT). Profinet with IRT adds hardware

support by means of a standard Profinet ASIC to achieve a high level of synchronization. A reserved time window is used to transfer datagrams in a reliable, cyclic sequence, while the remaining cycle time is used for stand-ard TCP/IP communication.

Critical data for motion applications are transmitted on Profinet via the IRT channel to ensure a precise and deterministic response.

Profinet with IRT has opened up new technolog-ical frontiers by allowing hundreds of machine axes to be synchronized electronically rather than mechanically. Using a motion controller, these mechanical linkages have been replaced by electronic gearing, enabling rapid reconfigura-tion of axis movements. This greatly increases a machine's flexibility, making product changeo-vers possible within minutes rather than hours or days, and allowing manufacturers to run a larger variety of products on a single machine.
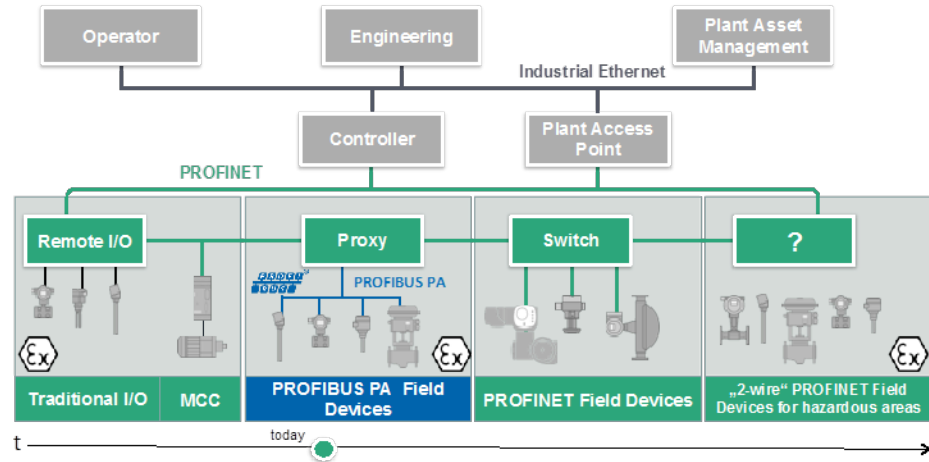
Profinet in the Process Industries

Profinet has been enhanced to address the specific needs of users in the process industries. As a backbone network, Profinet is ideally suited to the task of aggregating process data stored in control systems and field devices. Process instrumentation users have made substantial investments over the years in process field devices wired with two-wire current loop (4-20mA), HART, Profibus PA or FF H1. In addition, many process plants also have installed bases of other intelligent devices - from simple remote IO to motor control centers - that are networked with legacy device networks such as Profibus DP, Modbus or DeviceNet. To protect these investments, PI is continuing development of its networks solutions for process automation.

Profibus PA is PI's fieldbus for process users with a physical layer (cable) that conforms to IEC 61158-2 (powers field instruments but limits current for use in explosive or hazardous environments). While these features are crucial for process applications, the performance of this physical layer has limitations. With transmission speeds measured in kilobits per second, such solutions cannot transmit data in the quantities and speeds demanded by the information-driven enterprises of the future. To address this issue, PI is taking steps to integrate process field devices directly with Profinet.

The diagram bellows shows a timeline with four stages of PA device inte-gration with Profinet. The first stage, long since complete, connects field devices either directly to Profinet or via remote IO modules, including de-

vices used in explosive or hazardous environments. The second stage, also complete, allows field devices on Profibus PA to be connected to Profinet via a proxy. Stage three involves an update of the PA Devices profile to allow the connection and mapping of process field devices directly to Profinet for use in non-hazardous environments.

For process automation, PI is developing its process fieldbus offering to allow direct integration of process field devices with Profinet.

The fourth stage is quite interesting. Connecting process field devices used in explosive or hazardous environments to a network fast enough to transmit data for today's connectivity requirements means bringing a high-speed network like Ethernet right down to the process device level. But Ethernet does not fulfill the strict electrical requirements for this type of use. What is needed is a new high-speed physical layer that still meets these requirements.

To address this challenge, two new concepts are currently being evaluated by the Advanced Physical Layer Group (APL), a consortium of process automation suppliers. Both concepts include a new two-wire physical layer for both power and data transmission, similar to existing process fieldbuses. But the physical layer will be IP-capable and will offer transmission speeds in the range of modern Ethernet networks, providing the level of high performance and seamless connectivity that today's users expect. APL hopes to select a concept by the end of 2015 to give member companies a clear direction in which to focus their development efforts. However, since it depends on other developments in the industry, PI's implementation may take a few years to realize. Currently, the roadmap for the final step is still open.

Profinet and OPC

Extracting information from devices below the controller is handled by Profibus or Profinet, which provide the physical layer and application profiles with the required performance for specific functions. But what about communication with devices such as operator stations at the controller level or above, especially in a mixed-vendor environment? Rather than programming an own routine to allow these devices to communicate with each other, users can take advantage of OPC.

OPC is an interoperability standard for industrial automation that provides a wide variety of communications protocols. OPC abstracts controller-specific protocols into a standardized interface to converts generic-OPC read/write requests into device-specific requests and vice-versa. In short, OPC provides the final "glue" that allows non-deterministic communication between dissimilar devices. Thanks to its ease of use and support for a wide variety of products and protocols, OPC enjoys tremendous popularity in the automation community.

Profinet and Safety

PI introduced Profisafe, a TÜV-certified safety application profile for Profibus, in 1999, and obtained additional certification for use with Profinet in 2005. The introduction of Profisafe heralded a new era of industrial networking in which a single bus can handle both standard and safety-related messages, eliminating the need for a separate safety bus.
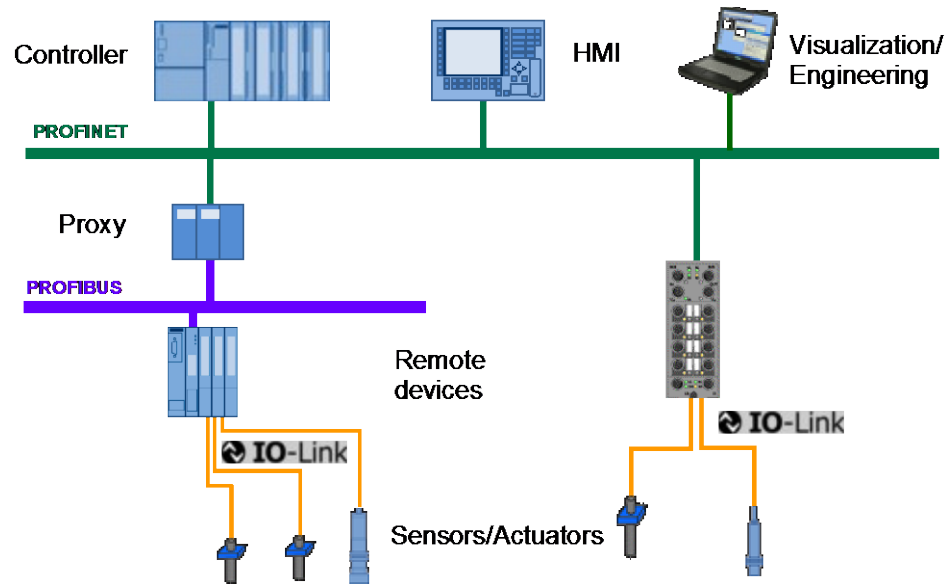
Profisafe is designed to work seamlessly with all possible Profibus and Profinet architectures. This means a complete SIL 3-certified system in single architecture with the option of using Profisafe in a redundant architecture for higher availability. Since both Ethernet and wireless communication are based on the same set of IEEE 802.xx standards, Profisafe can also be extended seamlessly to wireless devices.

IO-Link

IO-Link is an open technology for communication with sensors and actuators and is standardized in IEC 61131-9. IO-Link's point-to-point communication is based on the long established 3-wire sensor and actuator connection with no additional cable requirements. An IO-Link master can service several channels, but each is a point-to-point connection with IO-Link enabled sensors, so IO-Link is not a fieldbus in the classic sense. IO-

Link data can be transmitted to higher levels via fieldbus or through IO devices connected directly to Profinet.
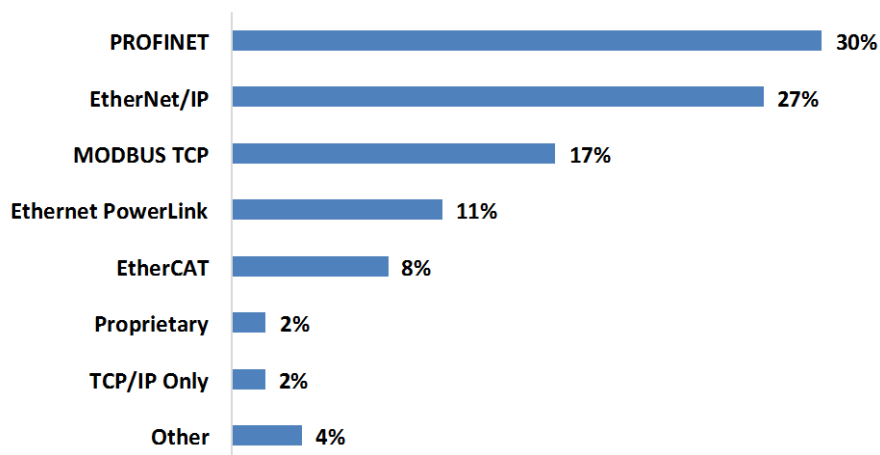
In the context of Industrie 4.0, IO-Link devices are associated with their device description (IODD), a virtual description of configuration parameters. This makes IO-Link well prepared for the administration shell of an Industrie 4.0 component.

IO Link integrates sensors and actuators into fieldbuses and provides additional two-way communication over existing wiring.

Profinet's Market Position

More than a decade after their introduction, the dust has settled around the market positions of the top five industrial Ethernet protocols. According to ARC research, in 2013 Profinet took over the top position for the volume of industrial Ethernet devices by protocol. While this achievement was certainly driven by the top market position of Siemens, the largest provider of Profinet-enabled devices, it is also supported by other automation suppliers that actively support Profinet, including ABB, Endress+Hauser, GE, Murr Elektronik, Pepperl+Fuchs, Phoenix Contact SEW, Sick and WAGO.

PROFINET   30%
EtherNet/IP   27%
MODBUS TCP   17%
Ethernet PowerLink   11%
EtherCAT   8%
Proprietary   2%
TCP/IP Only   2%
Other   4%

Market shares by device sales volume and by industrial Ethernet protocol, base year 2013. Source: ARC Advisory Group

One important issue not reflected in the above snapshot is large growth that ARC forecasts for the industrial Ethernet market. Acceptance of industrial Ethernet has increased rapidly in recent years and ARC anticipates just under 20 percent annual growth in device volume sales from 2013 through 2018, even as average selling prices decline slightly. This translates to a doubling of the market size in five years. As market leader, Profinet stands to profit from this high growth period.

Last Word

While the concept of Industrie 4.0 is still being finalized and standardized, the inspiration unleashed by this and related concepts have created an unprecedented awareness in the discrete and process industries for a common, IT-driven vision of the future of manufacturing.

To take advantage of Industrie 4.0, manufacturers must rethink their IT strategies by taking into account the new requirements of a truly information-driven enterprise. This includes both enterprise-level applications for business planning and execution and plant floor-level applications that are at the source of manufacturing information. A sound, future-proof automation architecture is crucial to provide the infrastructure necessary to fulfill these requirements.

Thanks to industrial Ethernet, manufacturers have access to data previously hidden by technical barriers that can be used effectively by both production

and enterprise applications to measure and better understand what is happening in manufacturing processes, helping to cut costs and increase productivity. While Ethernet can greatly enhance data gathering from the plant floor, this is especially useful if the data are effectively evaluated using applications such as asset management.

Under the Profinet name, PI offers an all-encompassing suite of solutions for Ethernet in the process plant or factory. PI's technology portfolio makes it well prepared for future challenges. Currently, the organization is identifying the gaps and extensions of its concepts needed to meet the challenges of Industrie 4.0. However, PI alone cannot accomplish everything. Cooperation with other open standards organizations provides easier vertical information movement using OPC UA and common asset management approaches using FDI – all very much in the spirit of Industrie 4.0.

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Acronym Reference: For a complete list of industry acronyms, please refer to www.arcweb.com/research/pages/industry-terms-and-abbreviations.aspx

API	Application Program Interface	**HMI**	Human Machine Interface
B2B	Business-to-Business	**IOp**	Interoperability
BPM	Business Process Management	**IT**	Information Technology
CAGR	Compound Annual Growth Rate	**MES**	Manufacturing Execution System
CAS	Collaborative Automation System	**MOM**	Manufacturing Operations Management
CMM	Collaborative Management Model		
CPG	Consumer Packaged Goods	**OPC**	OLE for Process Control
CPM	Collaborative Production Management	**PAS**	Process Automation System
		PLC	Programmable Logic Controller
CRM	Customer Relationship Management	**PLM**	Product Lifecycle Management
		RFID	Radio Frequency Identification
DCS	Distributed Control System	**ROA**	Return on Assets
EAM	Enterprise Asset Management	**RPM**	Real-time Performance Management
ERP	Enterprise Resource Planning		
		UA	Unified Architecture

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