ARC BRIEF

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Taking the Mystery Out of Connecting Factory Automation Systems to the Enterprise

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Summary

There are many options available for bridging the gap between enterprise systems and automated plant floor systems. However, years of experience, improved technology, and the benefits of a connected enterprise still haven't solved all the challenges of seamless integration between the enterprise and the plant floor. Ironically, more options and a myriad of technologies can actually expand the gap and further complicate the enterprise-wide connection of multiple plants, suppliers, and customers.

The connected enterprise integrates plant operations with other business units within or associated with the enterprise. Benefits include better response to customer needs, increased productivity, shortened time-to-market, and reduced operating costs, which result in additional business growth and sustainability. Because plant floor data helps executives make more informed business decisions, risks are reduced, providing the manufacturer with an added competitive edge.

This ARC brief is designed to provide an enterprise systems and factory automation overview, especially for those who may not be familiar with or experienced in each other's domain of expertise. This paper addresses different plant floor control systems, types of processes, and methods of communication between servers to familiarize both IT and automation professionals with the most effective ways to connect factory automation systems on the plant floor to the enterprise.

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ARC Advisory Group

Enterprise Server & Plant Floor Data Connectivity Issues

Enterprise IT professionals and manufacturing engineers often have different areas of expertise. For example, IT professionals work closely with Enterprise Resource Planning (ERP) systems, which deliver business intelligence to support essential corporate strategies and functions; increase the speed and accuracy of customer orders; and provide customer, raw material, product, inventory, and supplier information. These systems also work closely with production management tools such as Manufacturing Execution Systems (MES), which provide a comprehensive view of factory-floor operations, and improve manufacturing processes by integrating real-time data, event management, and analytical tools. MES maximize equipment performance and processes, as well as reduce set-up and changeover times; monitor productivity; oversee preventive/predictive maintenance; and manage quality control, scrap, and warranties.

IT professionals also work with commercial applications such as SAP, using the latest IBM, Oracle and Microsoft operating systems and server hardware. These systems integrate PC-based enterprise data, such as accounting, order entry, engineering, and sales and marketing. Communicating with different varieties of MES, these ERP systems also download manufacturing recipes, machine/process configurations, production and inventory management data, and quality control information to the plant floor. All of these activities require experienced IT personnel to implement.

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Activities at the enterprise level are executed as needed by downloading information from databases to other IT systems, servers, and the factory. Plant floor systems, however, are explicitly designed and implemented for real-time monitoring and control. To integrate the enterprise and the plant floor often requires the combined efforts and collective resources of manufacturing system experts, system programming and networking personnel, as well as a team of project management and integration consultants; all of which are costly and labor intensive.

Communicating through networks, servers, and systems designed for radically different functions can be daunting to manufacturing organizations trying to integrate the plant floor with the enterprise. Understanding fac-

tory automation infrastructures, communication layers, and methods of communication to servers are first steps toward taking the mystery out of connecting factory automation systems to the enterprise.

Factory Automation Overview

Factory automation means different things to different manufacturers. Discrete manufacturing is a process on the plant floor that builds actual products and parts based on bills of material and routing, such as automotive and aerospace components, furniture, and building products. Batch manufacturing is a method in which components and goods are produced in groups of flexible and limited production runs, often driven by recipes, such as food and beverage processing. Process control, on the other hand, manages formulas and provides continuous control of such variables as temperature, pressure, levels and flow rates in applications such as oil and gas distribution, paper processing and chemical production.

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Infrastructure – Different Controllers for Specific Applications

Manufacturing companies typically rely on a combination of control and information systems best suited for different production disciplines to automate the plant floor. The range of manufacturing disciplines and the infrastructure to support it translates into complicated integration issues.

Programmable Logic Controllers (PLC) are designed to support sequential operations for discrete manufacturing. They provide fast machine performance with multiple inputs, often simultaneously, with functionality that includes I/O control, counting, timing, logic, and report generation. PLCs are widely used in applications such as parts production, conveyor control, and material handling, along with OEM machinery.

Programmable Automation Controllers (PAC) combine the ruggedness of a PLC with the processing power of a PC, delivering high function speeds and advanced control. With a single hardware and software platform, PACs provide multiple production discipline automation, including discrete, batch, process, and motion control, all with common programming and tagging, and a single database. Some refer to PACs as **Hybrid Control Systems (HCS),** which combine aspects of these programmable controller processes to help improve integration and information sharing on the plant floor that promotes efficiency, productivity, and flexibility.

Distributed Control Systems (DCS) collect data from multiple systems and determine how that data is used, providing system and process control of distributed equipment, as well as addressing plant-wide information needs. They are used to control continuous and batch-oriented manufacturing processes, such as steel production, oil refining, and petrochemicals.

Communications

Communication between and among industrial automation devices and standard computer platforms on the plant-floor requires an array of hardware and software products and protocols. Real-time communication is critical in factory automation applications and an understanding of device, control, and system layers facilitates reliable and accurate data exchanges.

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IT professionals should work closely with plant engineers to understand plant automation layers when connecting the enterprise to the plant. These automation layers, commonly used in industry, define the interfaces between instruments used on the plant floor all the way up to the ERP system.

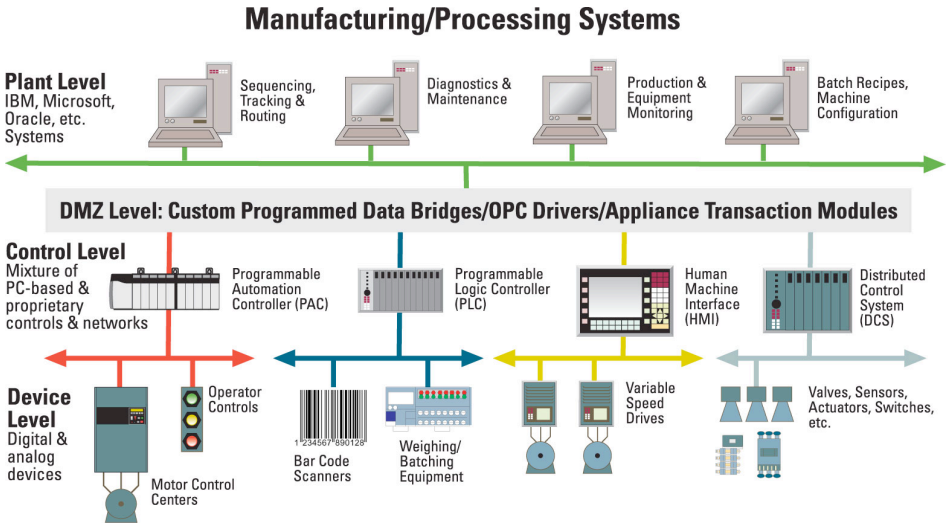
Device Level – Plant floor devices on manufacturing machinery, consisting of products including instruments, motors and drives, pumps and actuators, are connected and share networking infrastructure at this level.

Control Level – Process and supervisory controls, along with maintenance, configuration, and engineering workstations, are part of this layer. DCSs, PLCs, PACs and human machine interface (HMI) devices are connected and share a networking infrastructure at this level.

Plant Level – At this level, manufacturing operations are controlled. Where the plant floor is connected to the enterprise, business functions through ERP are included. MES functions, such as production scheduling, system maintenance, inventories, performance analysis and reporting, are performed at this level. The business planning and strategy functions of the MES and ERP systems are connected and share networking infrastructure at this level.

Standard serial interfaces such as RS-232, RS-422, and RS-485, connect computers and related devices used in the levels described above. Software

protocols such as ASCII are used by many device manufacturers to command industrial devices. For example, PLCs often use communication protocols developed by the PLC vendor that require specialized hardware and software drivers to interface with the automation system. Industrial networks such as Foundation Fieldbus help devices from multiple suppliers communicate with one another and exchange data, including diagnostic and performance information, and leverage the increased intelligence of automation devices.



Automation Layers

Methods of Communication with Servers

Integrating plant floor control layers with IT servers at the business management level presents another, and maybe the most complicated aspect of enterprise-wide connectivity. Challenges abound between manufacturing automation engineers and IT professionals when systems are implemented for information sharing.

Four popular methods of communicating with servers include:

- Automation Vendor Software and Hardware
- Commercial Software and PCs
- OPC/OPC UA-Specific Drivers Operating on a PC
- Appliance Transaction Modules (ATMs)

The key to implementation success is for plant engineers and IT professionals to share best practices and leverage each other's respective systems toward common business goals. For example, communicating with IT servers to bridge the gap between the enterprise and the plant floor should:

- Minimize the number of data interfaces and system layers
- Standardize interfaces
- Provide organized analysis and reporting of manufacturing data to the enterprise and enterprise data to the plant floor
- Be easy to configure and install in a user-friendly fashion

An overview of the four aforementioned communication methods follows. Each has pros and cons, but ATMs are gaining wide acceptance because they eliminate custom programming and reduce the associated costs of enterprise-wide connectivity solutions.

Automation Vendor Software and Hardware – Leading providers of industrial control and motion products such as GE Intelligent Platforms, Mitsubishi Electric, Rockwell Automation, Schneider Electric, and Siemens provide computer systems and tools designed to link plant control and enterprise systems. These systems include configuration checklists, import/export tools to configure transactions off-line in programs such as Microsoft Excel, and user interfaces for online configuration transactions. They are often compatible with Microsoft, Oracle, and IBM databases and messaging systems. While coding is required, familiar languages are employed and coding is often modularized and reusable.

Appliance Transaction Modules are gaining wide acceptance because they eliminate custom programming and reduce the associated costs of enterprise-wide connectivity solutions.

Commercial Software and PCs – Visual Basic from Microsoft is used as a stand-alone product or licensed to software vendors that include it with their manufacturing process control and automation applications. In many cases, Visual Basic allows users to automate and extend the functionality of plant-floor software. It also enables them to integrate information from the plant floor to the executive suite. While programming is required, commercial software solutions are minimizing code-intensive solutions.

OPC/OPC UA-Specific Drivers Operating on a PC – When OPC was first introduced in 1995, it enabled interoperability between process control hardware and software and Windows-based applications. OPC delivers a standard interface that enables applications from different vendors to exchange information. The introduction of OPC-UA (Unified Architecture) a couple of years ago was built around Service Oriented Architecture (SOA) technology, which involves creating programs for specific functions such as factory automation. Because of the necessary reliability and performance demands of automation systems, OPC-UA is extremely effective in terms of performance and security. In addition to working with PLCs and other shop floor devices, OPC-UA brings a unified architecture to link the factory floor and the enterprise.

Appliance Transaction Modules (ATMs) – These units are ideally suited for exchanging controller data and plant computer systems with business and enterprise systems via widely used PLCs and PACs. Without custom programming or the use of middleware software or a computer system, they enable the exchange of plant floor data with Java Messaging Service (JMS), as well as database or messaging queues such as MS SQL and Oracle. Available messaging systems enable near real-time, two-way data flow to ERP, manufacturing, operations, distribution and suppliers.

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ATMs Overcome Programming and PC Issues

These ATMs are simple to install and use, economical, and leverage proven technology. Users can choose from an array of messaging, database and PAC/PLC adaptors. ATM modules automatically find all controller tags and corresponding tags in the enterprise or plant databases. Configuration software selects specific tags, groups the tags to projects, sets triggers for data transfers, and selects the destinations for data.

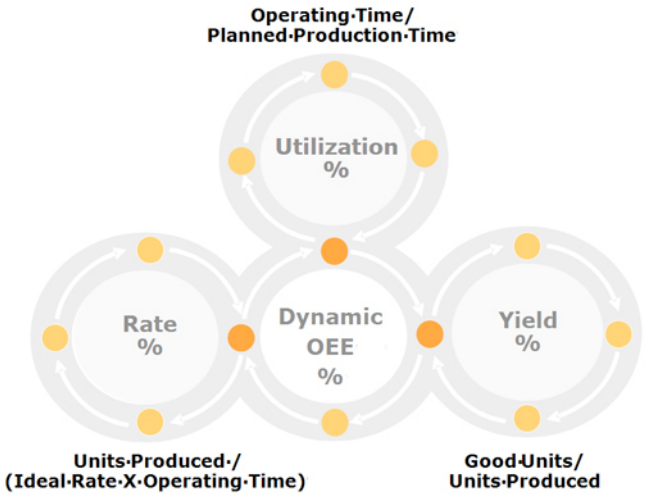
ATM modules can either be installed to a host PLC or PAC via the backplane, or they are available as standalone modules installed in panels and connected to computer systems via Ethernet. Data exchange can be performed completely in parallel with existing PLC or PAC operations and no additional programming, training, equipment or enterprise drivers are required, which reduces installation costs. The modules are virtually maintenance free, requiring no software updates.

ATMs typically provide password protected access and all configurations are stored in the module's memory. As an industrial product, they have better security and are not as exposed to viruses or hackers as PC-based options. ATMs also feature store-and-forward and failover features to protect the integrity of data during system outages. For commissioning and troubleshooting, there are extensive status and logging available.

The Business Value of Enterprise-wide Connectivity

Most importantly, bridging the gap between enterprise systems and automated plant floor systems provides key business value to manufacturers, including reducing unplanned downtime and increasing dynamic overall equipment effectiveness, otherwise known as Dynamic OEE.

No downtime is positive for manufacturers, but unscheduled downtime is the most expensive and impacts the business' ability to meet its production schedule and customer commitments. Unplanned downtime, which also includes unexpected stoppages resulting from equipment failure, operator error, or nuisance trips, is the nemesis of all manufacturers. Unscheduled downtime is also costly in terms of equipment damage, environmental harm, and worker safety. The cost of downtime is reflected in a primary key performance indicator (KPI) used by many manufacturers. Dynamic OEE helps determine the real-time impact of the performance of any individual process or piece of equipment on the overall efficiency of the plant. Unscheduled downtime is a primary factor that significantly lowers Dynamic OEE, which translates to the manufacturer decreasing both its efficiency and profitability.



Dynamic OEE

Dynamic OEE is one of the driving forces in creating a collaborative manufacturing event-driven environment where each manufacturing process is connected across the entire manufacturing enterprise, which translates to the manufacturer increasing both efficiency and profitability. This collaborative environment provides manufacturers with the ability to access, aggregate, and move the real-time production process information that is

needed to drive factory visibility and intelligence. This collaborative environment allows manufacturers to utilize flexible, multi-functional, interoperable platforms that can easily interface peer-to-peer with other platforms, provide downward connectivity to factory floor devices such as PLCs, PACs and motor controls, and upward connectivity to ERP, production management, and manufacturing intelligence tiers. This approach requires deploying collaborative production systems designed and configured to deliver complete enterprise to plant floor connectivity.

Conclusions

Discrete and process manufacturers need to evaluate the options available for bridging the gap between enterprise systems and automated plant floor systems to break down the remaining barriers to information visibility, collaboration, and unified plantwide control to achieve the next level of business performance. However, challenges of seamless integration between the enterprise and the plant floor still exist. To address these challenges, many manufacturers should consider Appliance Transaction Modules (ATMs) to provide interoperability between enterprise systems and automated plant floor systems. These ATMs play a key role in creating a collaborative environment that integrates plant operations with other business units within or associated with the enterprise. ATMs help solve the problem of seamless integration of the enterprise and reduce the gap between the plant floor and the executive suite.

This paper was written by ARC Advisory Group on behalf of Online Development, Inc. The opinions and observations stated are those of ARC Advisory Group. For further information or to provide feedback on this paper, please contact the author at cresnick@arcweb.com.