Emerson Process Management Manufacturing Execution Systems Capabilities

By integrating today's sophisticated enterprise resource planning systems with real-time production data, process plant managers can now more easily schedule production, manage raw materials, and optimize equipment use.

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Introduction

Manufacturing Environment

A fundamental shift is occurring in how manufacturers approach production automation. Historically, the process unit definition and associated equipment defined the overall system architecture. The user definition for the process unit instrumentation determined the plant automation strategy. The focus was on individual unit operations. The expected benefits related primarily to improved unit repeatability and reductions in head count: goals narrowly focused on localized operational improvement.

In recent years, manufacturing needs have changed. Minimizing the total time from conceptual development through implementation and startup are paramount to ensuring maximum return on research and development investment. Competitive pricing pressures continue to limit the ability to increase price. In conjunction with price constraints, increasing regulatory compliance, reporting requirements and growing raw material costs are squeezing profitability.

In response, automation users and suppliers have developed an expanded approach, called Manufacturing Execution Systems (MES), for production automation systems. The premise of MES is simple:

- Provide open information exchange across manufacturing production and business planning systems

- Provide integrated real-time manufacturing applications

MES has great potential. By integrating today's sophisticated enterprise resource planning systems with real-time production data, process plant managers can now more easily schedule production, manage raw materials, and optimize equipment use. Closing the "information gap" is key for achieving an agile manufacturing environment.

In practice, however, MES systems have been anything but simple. To date, MES solutions have required a significant investment in additional hardware, software and application engineering. Essentially users have been required to implement an additional system layer on top of existing systems in order to support the information routing and numerous interfaces required across functional areas. As may be expected, initial user adoption of MES has been slow due to the added cost, complexity and inflexibility of this approach.

Further complicating this picture is the diverse nature of MES offerings by the industry. The Plant Systems environment is currently composed of a vast number of independent system providers. No one vendor or product dominates the plant systems environment.

Emerson Process Management Approach to MES

Emerson Process Management's approach to MES is to simplify the solution by eliminating unnecessary software layers and adopting open systems standards across the business. There are three main elements of our overall MES strategy:

- Investment in core technologies that are principle building blocks for enabling effective integration of MES applications
- Tight integration of "best in breed" applications
- The Emerson Process Management Service and Application Provider Network to provide turnkey MES application projects worldwide.

The diagram below represents the Emerson Process Management framework for MES.

Business Systems / Plant Systems / Intelligent field	Presentation
Business Systems **Order Mgmt., Inventory Mgmt., Quality, Plant Maintenance Mgmt, Warehouse Mgmt** **Plant Systems** **Process / Batch Automation, Asset Optimization, Process Optimization, Scheduling, Material Genealogy, LIMS** **Intelligent field** **HART, FOUNDATION Fieldbus devices, DeviceNet**	**Presentation** Internet Intranet ActiveX Explorer Browser Search engine

The Emerson Process Management MES framework consists of the traditional MES functions found in business and plant systems. In addition we have extended the classic definition to consider intelligent field devices as well as the presentation and retrieval of information.

The Emerson Process Management MES framework is built upon a foundation of information from intelligent field devices. The addition of the intelligent field is a deliberate extension of traditional MES definitions. A careful examination of the Business System reveals numerous applications that need information about both the process and process equipment (or assets). If you only consider process information, you fail to benefit from information about the availability or readiness of the process equipment to perform in an optimal manner.

The MES framework is based upon Microsoft Technologies COM (Component Object Model) and OPC (OLE for Process Control) for real-time information and XML (eXtensible Markup Language) for transactional information. OPC and XML are communication standards that permit the free flow of information across functional areas without an additional software application or multiple custom programmed interfaces.
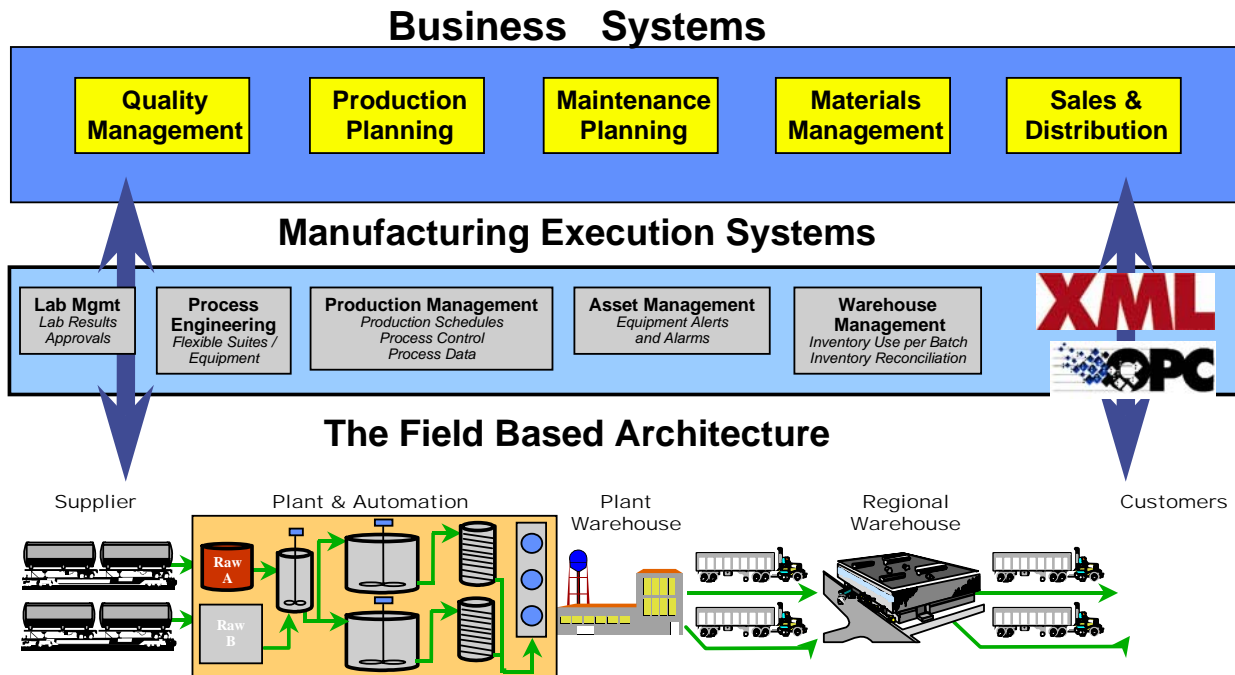
Emerson Process Management is a leader in the deployment of OPC and is the master editor for the definition of a COM/OLE-based specification for the industrial automation market. OPC is an extension of the OLE (Object Linking and Embedding) interface standard, which defines a set of standard object access interfaces for developers to use in building industrial automation software applications. Industrial automation hardware manufacturers are able supply an OPC interface for their hardware. This enables customers to pick the "best-in-breed" components and integrate them seamlessly. OPC provides standardized software protocols that enable true plug-and-play capability.

OPC is a seamless extension of Microsoft's enterprise computing model for data connectivity upward. Microsoft's enterprise model, based on Distributed Component Object Model (DCOM) technology and OLE for controlling and messaging between objects, is being implemented as follows:

- A feature-rich multi-threaded operating system (Microsoft Windows NT)
- A standard object access method (Object linking and embedding with the COM / DCOM model)
- An SQL database engine (MS SQL Server)
- An electronic information exchange standard (Microsoft Electronic Exchange based on MAPI)

A growing standard for transactional information is XML. XML is being recognized as the transactional language of choice in the web enabled enterprise environment. Emerson Process Management is currently making a substantial investment in delivering XML capabilities to allow easy enterprise communication of transactional information that is not available with OPC.

The illustration on the next page demonstrates the effective use of XML / OPC to unify the plant system environment. The adoption of the OPC standard has been rapid and broad based. The first release of the standard has been out for almost two years, with a wide variety of clients and server applications already deployed in the market. Phase 2 of the standard defines the communication structures for alarms and events. Work to extend the standard into the areas of Batch and Process Information Management Systems (PIMS) is ongoing. XML use is just starting, but the promise for simplifying transaction integration is significant. The net effect is that XML / OPC offers the best path for integrating the diverse collection of applications comprising the plant systems environment.

Business Systems

| Quality Management | Production Planning | Maintenance Planning | Materials Management | Sales & Distribution |

Manufacturing Execution Systems

| Lab Mgmt *Lab Results Approvals* | Process Engineering *Flexible Suites / Equipment* | Production Management *Production Schedules Process Control Process Data* | Asset Management *Equipment Alerts and Alarms* | Warehouse Management *Inventory Use per Batch Inventory Reconciliation* |

The Field Based Architecture

Supplier | Plant & Automation | Plant Warehouse | Regional Warehouse | Customers

XML / OPC compliments the Fieldbus Foundation's effort to provide a communication standard between field devices. The Fieldbus Foundation is focusing on communication standards between devices. OPC is focusing on how to serve process device information out to and between applications. XML is focusing on how to serve transactional information out to and between applications. End users can receive tremendous benefits by selecting the best device for a particular need and can be confident that it will easily fit into their overall information system architecture.

Emerson Process Management has considerable experience in MES. We were an early adopter of the POM's Incode technology and have implemented several layered MES solutions. Also, Emerson Process Management was early to the market with Enterprise Server, a Solution for integrating Emerson Process Management DCS systems with a SAP R3 ERP system. To date, Emerson Process Management has several systems online feeding live process data to SAP's Production Planning (PP), Materials Management (MM), and Quality Management (QM) application modules. What we have discovered is that complex software applications with multiple point to point interfaces are difficult and expensive to maintain. Implementing the solution the first time is only part of the problem: the real challenges arise in modifying the system and in revision management. XML / OPC is available today and holds the potential for greatly simplifying plant systems integration.

Emerson Process Management MES Solutions for Pharmaceuticals

Emerson Process Management has developed a strong reputation for being the pharmaceutical process industry's automation leader. This section will discuss our approach to MES Solutions. We have made significant investments in both Emerson Process Management products and the integration of third-party applications through our customer service network. Emerson Process Management is focused on dock-to-dock solutions for real-time applications in the following plant systems areas:

- Process Automation and Control
- Advanced Control
- Asset and Maintenance Management
- Process / Batch Information Management
- Quality - Lab Information Management
- Document Management
- Statistical Process Control
- Scheduling and Resource Allocation
- Material Handling and Equipment Tracking
- Optimization / Modeling
- Enterprise Integration
- Solution Services

The following sections describe the Emerson Process Management capabilities for each functional area.

Process Automation and Control

The Emerson reputation as the premier provider of batch automation is continued and enhanced by the addition of the DeltaV "built for batch" software. DeltaV Batch fills the pharmaceutical industry's need for a scaleable, flexible batch application. Based on the S88.01 physical and procedural models, DeltaV Batch is a tightly integrated system that provides seamless information flow from the plant floor to the operator's desktop and even further to the plant's business system through the use of OLE for Process Control (OPC). The built-for-batch architecture eliminates low value engineering tasks and increases productivity. The tightly integrated engineering environment eliminates duplicate data entry and reduces training requirements.

In DeltaV Batch, process control, recipe management and historical data collection components are tightly integrated, eliminating multiple databases and no-value data mapping exercises commonly associated with many of the "flanged" batch solutions on the market today. It provides many pre-engineered, out-of-the-box solutions to common batch strategies, which are easily modified to custom-fit pharmaceutical industry's needs. The Batch Operator Interface provides the flexibility required to handle abnormal processing conditions, i.e., users can dynamically modify step order during recipe execution, manually control phases, intervene in the equipment arbitration queue, and access batch event journal information. Recipe Studio provides applications supporting implementation of master and control recipe layers. The application supports translation/movement between recipe levels and supports flexible recipes. This flexibility includes branching, if-then-else, and parallel processing. Complete recipe edit, archive, and restore with audit trail are supported. The user interface for developing and editing these recipes is graphical. The application supports the complete S88.01 resource model.

In addition to the application of these Emerson Process Management products, the customer service network has experience with application of:

- Intellution's iBatch / Visual Batch
- Wonderware's InBatch
- Sequencia's Open Batch
- Incode's POMS
- Base 10 / Consilium's Flowstream
- Hilco's Monitrol
- ProcesSoft's Prophecy

Advanced Control

Processes can exhibit different control challenges, such as difficult dynamics, inadequate process measurements, multivariable interaction, process non-linearities, external influences, poor process design and process/equipment constraints. Emerson Process Management has embedded powerful advanced control capabilities usually found in higher-level unit optimization applications in the DeltaV system to address these challenges. DeltaV software handles auto-tuning, fuzzy logic, model predictive control, continuous adaptive tuning, neural network soft sensors and multi-variable fuzzy logic control.

DeltaV advanced control features are available by simply activating the desired functionality license. The ability is embedded in the controllers, providing a superior approach to traditional applications. The advanced control may be applied to as many or as few loops as necessary. Thus, a project may apply advanced control for a low cost. Additional benefits of embedded control include increased reliability because the software resides in the controller instead of a host computer. Also, the control is written for installation and maintained by the end user, further reducing the installed cost of advanced control.

Asset Management

Plant maintenance costs an average of 15-20% of the cost of goods sold. In addition, for every $1,000,000 spent annually on new plants, $5,000,000 is spent on maintaining existing plants. This means there is tremendous opportunity to reduce the cost of ownership of equipment by using a preventive-maintenance approach. Benefits of this type of approach include:

- Reducing maintenance costs
- Reducing equipment breakdowns
- Reducing spare parts inventory
- Reducing overtime premiums
- Increasing equipment life

The DeltaV / Asset Management Solution (AMS) provides the capability to configure, calibrate, monitor, and troubleshoot intelligent field devices. The system provides the following capability:

- Complete device configuration capability for (FOUNDATION fieldbus) and HART devices
- Complete capturing of all current device data
- Comparison/reconciliation
- Device alert monitoring
- Device template creation
- Device signal tag and device tag search capability
- Conventional I/O, HART-based, and fieldbus-based support
- On-line help
- Diagnostic add-on capability

The field device management solution is capable of completely configuring the parameters associated with both Ff and HART devices. To insure interoperability, the device configuration functionality employs standard Device Description Language (DDL) technology as provided by the Fieldbus and HART Foundations. The field device management solution is capable of completely configuring any Ff or HART device for which a device description has been registered with the FIELDBUS or HART Communication Foundations. The device configuration capability includes:

- Capability to display all device parameters directly from the field device
- Capability to modify and immediately download any changeable parameter in the field device
- Organization of device parameters in a logical manner on the device display
- A separate display of all process values
- A separate display of device status
- The capability to modify multiple device parameters and apply the changes in a single operation
- Capability to configure future (i.e., placeholder) devices
- Capability to configure devices using drag-and-drop technique
- A place holder device used in combination with off-line configuration to describe a virtual device. During the commissioning step, the physical device will be automatically commissioned utilizing the placeholder configuration. The moment a device is commissioned, a representative icon of the physical device is shown in the explorer instead of the place holder container.

The specific device configuration is stored in the system database with the configuration actually stored in the device provided. A comparison screen comparing the value of the device attributes actually stored in the database with the attributes stored in the device is presented to the user upon each of the following conditions:

- When a device is being commissioned
- When a drag-and-drop operation between the field device and the database takes place
- When a Compare Configuration operation is selected by the user

Maintenance Management

Emerson Process Management is in the initial stages of developing Alliance relationships with key Computerized Maintenance Management System (CMMS) suppliers.

Until formal relationships are confirmed, Emerson Process Management is currently providing point solutions on individual projects using applications such as PSDI's Maximo and SAP's PM Module.

Process / Batch Information Management

Emerson Process Management DeltaV digital process automation systems provide integrated continuous and batch history data collection (as described above). The system has full database capabilities using current standards for data storage, retrieval and management of batch records. Emerson Process Management has a strong ongoing investment program to extend the process data historian.

In addition to the application of Emerson Process Management products, our customer service network has experience with:

- Aspen's CIM/21 and related modules
- Aspen's Info+21 and related modules (Batch21, Event21, etc.)
- Oil Systems' PI and related modules
- SimSci's AIM and related modules

Quality - Laboratory Information Systems

Emerson Process Management products and application projects typically do not directly connect to a laboratory information management system (LIMS) application or provide a sign-off and approval process for quality management. The raw process data is typically collected in a Process Information Management System (PIMS). An event monitor notifies the LIMS system that data is available to be processed. Emerson Process Management does support information servers such as OPC (or alternatively @aGlance, and netDDE) to facilitate populating LIMS applications with real-time data if they support appropriate clients.

Emerson Process Management has implemented the association of sampling information to recipe lots via applications such as Recipe Studio, Flowstream, POMS, and InTrac. At the appropriate point in the recipe, the operator is directed to take a sample and process it. The application then provides a user interface to enter the data, sets up appropriate tables to store the data (with time stamps) and links the sample information to the recipe currently executing. Emerson Process Management has not fully implemented a managerial sign-off application.

Since there are many options for potential LIMS / Quality solutions, Emerson Process Management has a formalized process for evaluating a customer's needs and matching those needs against both Emerson and third-party products and integration requirements.

Document Management

Most companies have an enterprise document management system (EDMS) for tracking important documents including standard operating procedures, material handling data sheets and emergency safety shutdown procedures. These documents are typically under tight control requiring various levels of approval and traceability.

Typical workflow/document management systems in the industry include Documentum's EDMS and Novasoft's Novation.

All the major suppliers of EDMS provide a browser for viewing the documents in the document vault. Emerson Process Management provides a mechanism to call up key documents from the vault by a context-sensitive launch so operators can call up key documents by the touch of a button.

Emerson Process Management anticipates that as these third party suppliers move towards ActiveX that one will be able to optionally embed the document viewer in the DeltaV Operator Interface.

In some projects, Emerson Process Management has been requested to generate documents for submission to the document vault. For example, we have created Microsoft Word documents with batch report data and submitted these to the document vault for archiving.

The strategy in this area is clear: we will provide the necessary hooks in to EDMS to enable our customers to enjoy the best-of-class benefits provided by professional world-class suppliers while also providing tight links to the DeltaV process control system.

Statistical Process Control

Statistical process control clients will be forthcoming in the next release of the DeltaV Batch Historian. The Emerson Process Management approach will provide the tools to compare and analyze batches dynamically. In addition, the customer service network has implemented several applications of statistical process control. Products utilized in these applications include:

- Aspen's Q and related modules
- SimSci's AIM SQC and related modules
- Gensym's G2 for very customized applications

Production Planning and Scheduling / MRP II Integration

Emerson Process Management has implemented several solutions integrating order schedules from MRP II systems to the recipe management system used for process automation. The implementation utilized business systems integrators, often selected by our customers for the ERP integration. Products utilized and integrated in these applications consisted of:

- SAP's PPPI
- Oracle's Oracle Manufacturing
- Marcam's PRISM
- Marcam's Protean
- SSA's BPCS

These solutions range from ASCII flat file transfer (parsed and translated into the specific recipes required to execute a given order) to integrated Enterprise Server application for real-time bi-directional exchange. Since there are custom versus standard product options for potential MRP II integration, Emerson Process Management has a formalized process for evaluating a customer's needs and matching those needs against both its products and third-party products and integration requirements.

Material Handling and Equipment Tracking

Emerson Process Management has involvement providing dry material handling and mobile production equipment tracking through an application called Campaign Studio. The purpose of this application is to manage dispensing and charging manually added materials during the batch production process and to track the equipment used to hold and transport these materials. The solution is made up of the following elements:

- A configuration application that defines material charge templates
- A dispensing application that manages the dispensing of materials into containers for later charging
- A charging application that receives requests form the control system for manual addition of materials and manages the charging process to ensure that the correct container is charged and the information about the charging operation is captured
- An equipment tracking application that uniquely identifies mobile equipment and tracks its location and status during the execution of a batch

Emerson Process Management has also formalized process for evaluating a customer's material and equipment tracking needs and matching those needs against both F-R and 3rd party products and integration requirements.

Process Optimization

Emerson Process Management implements process optimization requirements through two mechanisms. For less complex applications, it uses a growing suite of advanced control applications within our own process automation systems. Emerson Process Management has the capability to use neural networks, fuzzy logic, and dynamic matrix control algorithms within the control system to provide process optimization around very specific units or processes.

For more complex applications, Emerson Process Management uses product and services from two Alliance partners, Gensym and Aspen / Setpoint. Typical examples of optimization and modeling done with these products and services include:

- Minimizing batch execution time
- Optimizing electrical power generation costs (price to sell to grid for excess power versus producing steam for process)
- Optimizing manufacturing process throughput (and WIP) versus finished goods packaging throughput
- Optimizing throughput via maximizing key production limiters and minimizing key equipment variables (e.g. mechanical equipment aging)

Enterprise Integration

Emerson Process Management is your dock-to-dock solutions supplier. Utilizing the flexibility of the DeltaV scaleable system and its capabilities, you can truly achieve enterprise-wide integration.

The DeltaV system communicates with upper-level business systems in real time using pre-configured "user case" templates. The user cases define many familiar activities such as "Get Production Schedule" or "Run Batch X," which predetermines the steps in the above transactions. Users do not have to program transactions from scratch but rather configure the functions provided. The system can be set up to connect to multiple MIS modules, which means additional programming in the MIS system is not needed. This directly translates to reduced configuration costs.

One example of Emerson Process Management's experience involved integration of SAP's R3 system. The project included the following:

- Integration of SAP's PP-PI with AspenTech Data Historian and control system
- Integration of five plant sites with one corporate business system
- Production planning via process orders
- Automatic "Start" and "Complete" of a batch
- ABC accounting on a unit basis
- Integration of a lab system and QC system

This customer's ability to have activity-based costing resulted in better knowledge of the facility's cost position and allowed them to use this to improve processes, reduce costs, make more informed production decisions, and serve customers better.

Solution Services

Approximately three years ago, a new division was created, called the Emerson Performance Solutions division (hereinafter referred to as EPS). The charter for this division is:

> *To serve that segment of the worldwide market where we bring more value as a group than as independent divisions*.

EPS's overall business strategy is to leverage the strength of the Emerson Process Management product lines with EPS's application engineering expertise and project management excellence to provide our customers top-notch automation solutions. Our three key areas of excellence are:

- Understanding and delivering the project's economic benefits justification (not just cost savings)

- Providing comprehensive process automation solutions (broadest practical scope)

- Minimizing the process automation implementation risk

With today's dynamic process control industry, end users and engineering contractors can stretch their project resources thin by trying to keep current with all of the new technology out on the market today. By teaming up with the EPS, end users and engineering contractors can concentrate on value-add activities while counting on EPS to bring new application and technology knowledge to the team. The customers benefit by working with one automation vendor, reducing the interface time and headaches by dealing with a single point contact for the full integration of products, systems, and services for all of their automation needs. The contractors benefit because they are able to leverage the Emerson Process Management knowledge base to provide the best solution for the customer.

The goal of the EPS is to provide consulting, planning, engineering, and project execution services across Emerson products, for our customers who require a single-point responsibility for product, applications knowledge, and project execution services. By providing an entire automation solutions package, EPS can solve not only process and automation problems, but also its business issues as well. Performance Solutions is a faster, better, and cheaper way to complete project execution of an automation package.

Project Organization

Emerson Process Management's project execution organization is based on a distributed project structure. As shown in the following figure, Emerson Process Management will coordinate resources from throughout our worldwide network to ensure that customer needs are met. We also ensure that local support personnel are included for ongoing support.
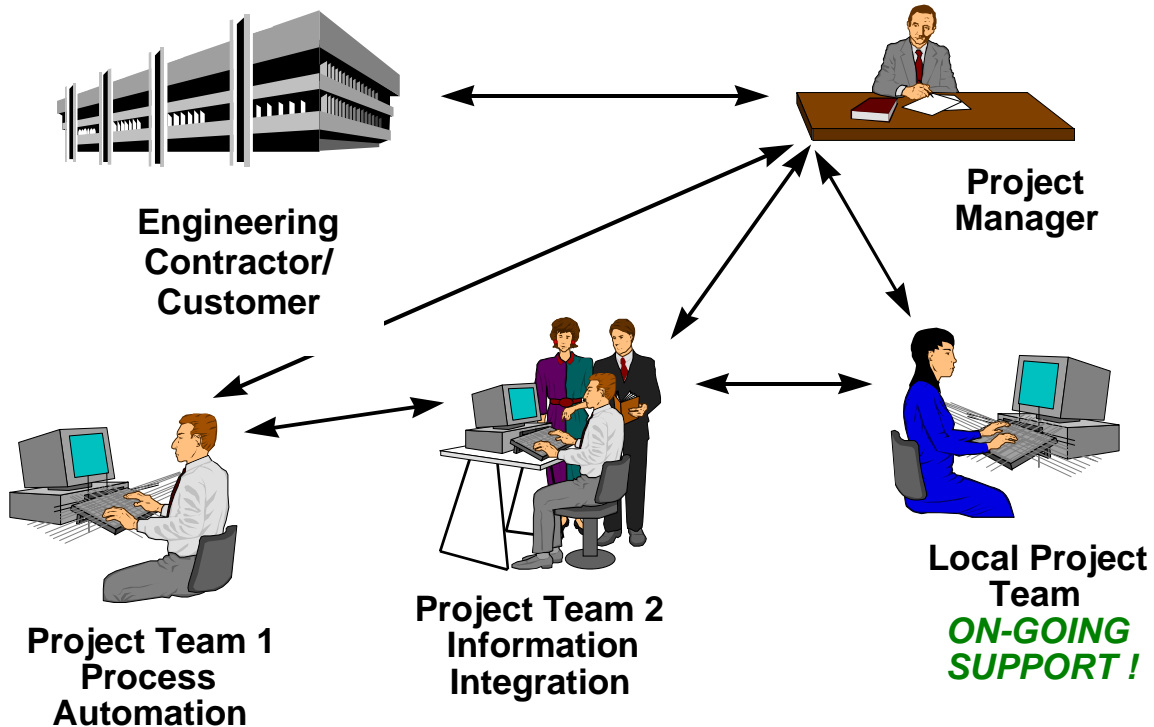
Available Resources

Emerson Process Management has many different types of resources available to provide batch automation and information integration solutions. The North American resources available to provide pharmaceutical batch automation and information integration internal to EPS are as follows:

- Project managers   12
- Project engineers / leads   35
- Integration engineers / technicians   120

Other skill sets, including CAD, electrical safety and power, DCS application (separate from PLC / integration listed above) are also available.

Over the past two years, EPS introduced the expansion of engineering service capabilities through the acquisition of PC&E, Inc. of St. Louis and Kenonics Controls of Calgary. PC&E brings together over 200 process, instrument, and electrical engineers who specialize in providing the full automation and electrical solution to the industries they serve, including chemical, food and beverage, environmental, and power. PC&E will remain a separate business entity under the Emerson organization, but has meshed with the existing EPS service capabilities to further enhance the direct EPS engineering strengths. The PC&E organization compliments the automation skills available to you from EPS and also adds depth for comparable resource skills. PC&E provides process control consultation expertise, drafting/CAD resources, electrical and instrument engineering expertise, integration resources, and environmental engineering.

Kenonics brings together over 300 process, instrument, and electrical engineers that specialize in providing the full automation and electrical solution to the industries they serve, including oil and gas, refining, and custody transfer. Kenonics will remain a separate business entity under the Emerson organization, but has meshed with the existing EPS service capabilities to further enhance the direct EPS engineering strengths. The Kenonics organization compliments the automation skills available to you from the EPS and also adds depth for comparable resource skills. Kenonics provides process control consultation expertise, drafting/CAD resources, electrical and instrument engineering expertise, and information management and integration resources.

Vision

With many years of experience in MES, Emerson Process Management embarked in 1995 to reorder the real-time data management world.
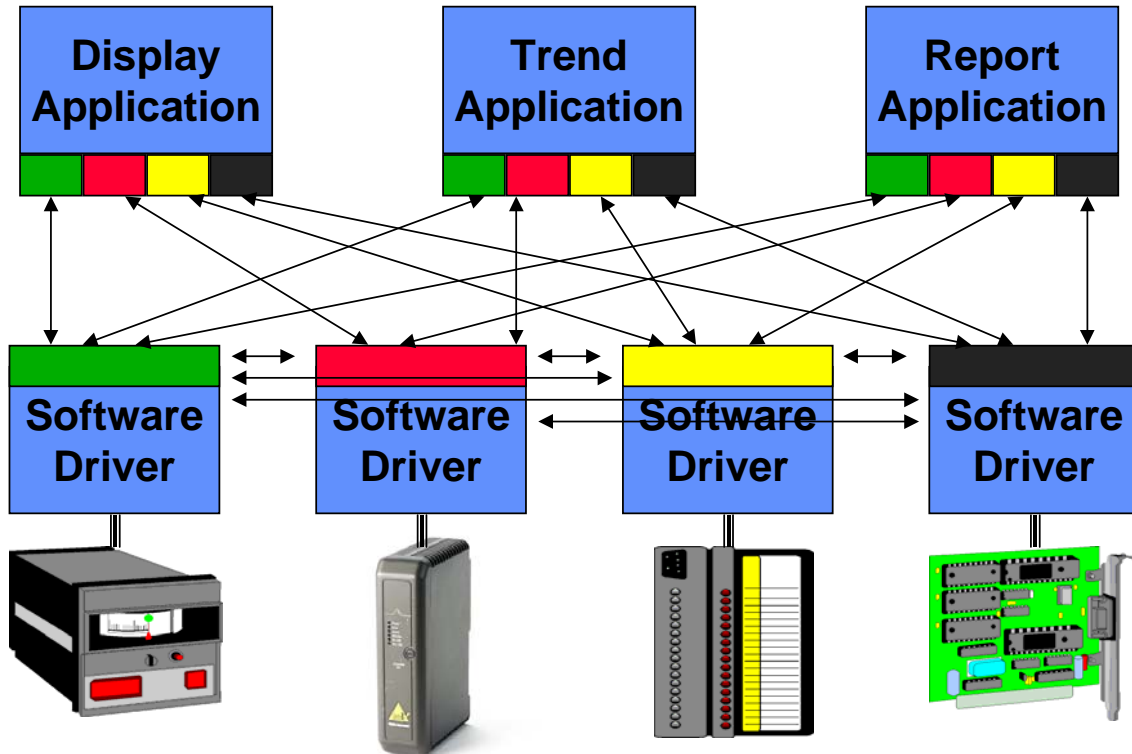
From the illustration, one can see that in yesterday's paradigm, connecting four applications to four servers required six proprietary and different interfaces.

Clearly the overhead associated with this type of integration was (and is) significant. In 1995, Emerson Process Management, together with Microsoft and three others, rewrote the integration book bringing OPC to the market.
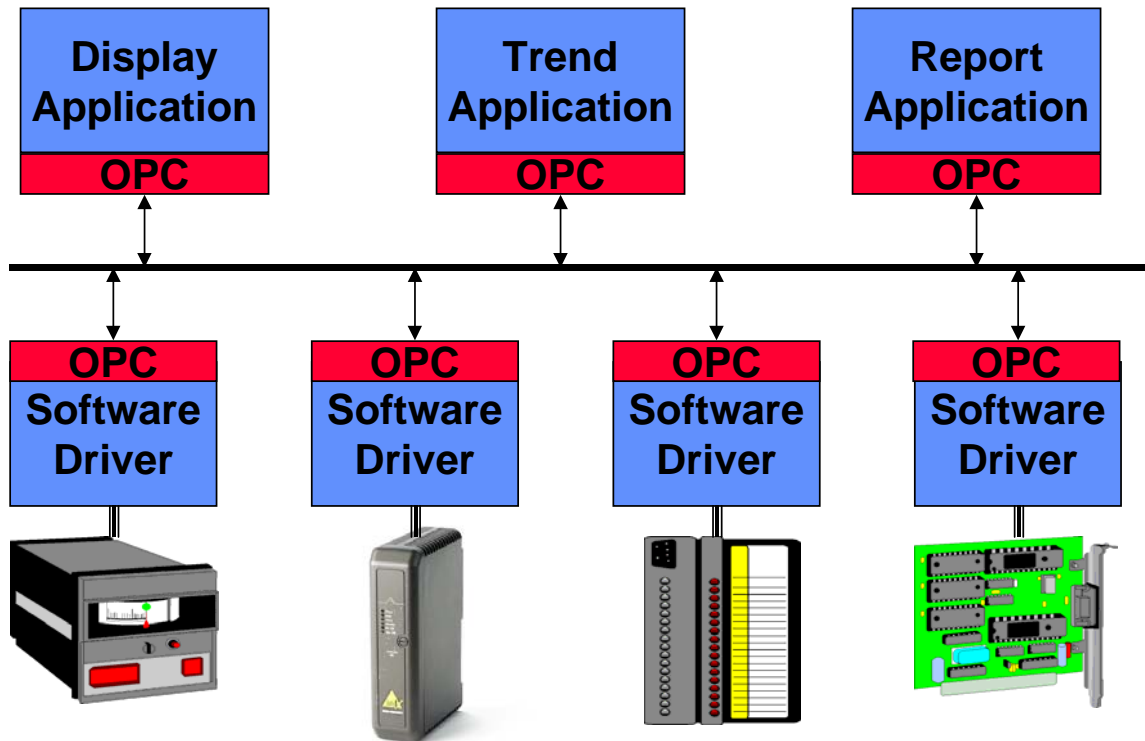
Now, the number of interfaces is reduced to one per application. But the key issue is that the addition of each additional application requires only one interface (for that application). The benefits are obvious. OPC has indeed changed the integration landscape forever. Delivery of the real-time OPC solution has been a key first step in the march to a true plug-and-play integration landscape.

Emerson Process Management has continued the leadership role in the OPC Foundation. Two key specifications are in their final forms. OPC Alarms and Events is a new specification that enables applications to push event notification from one application to another. OPC History allows applications to get data readily from different history servers.

With the OPC Alarm & Event extension, any process system can trigger an event that passes through a standard plug-and-play interface to any receptive client application. A great example is a smart-field-device-failure event triggering a maintenance management system to trigger work orders to repair the device.

The last part of the OPC development critical for pharmaceutical applications is the batch Extension to the OPC specification. This work is focussed on providing a standard mechanism whereby recipes may be passed from ERP systems to manufacturing systems and production data passed from the shop floor back to the ERP system. This work is in its draft development with a release anticipated soon.

In addition to the world of real-time data, transactional data is important in the area of enterprise integration. The following is an example of XML-based mapping of transaction information.
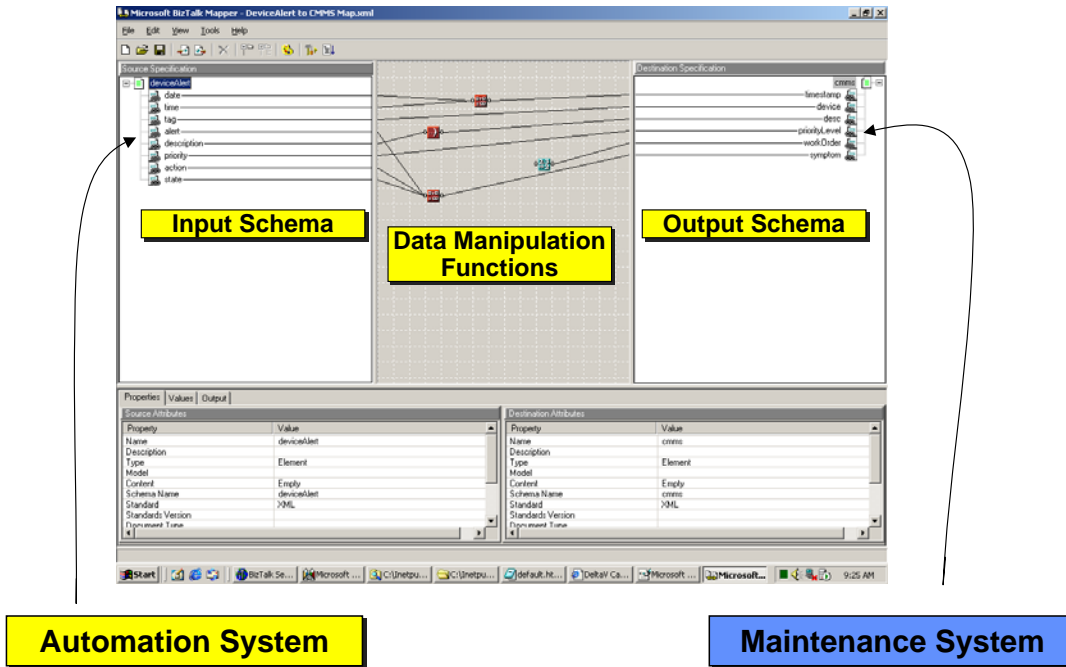
Emerson Process Management's objective in our current XML infrastructure program is to allow transaction information to move between manufacturing logistics applications such as the DeltaV system and the maintenance system with no custom programming.

This combined real-time and transactional data management infrastructure will allow any required manufacturing logistics applications to seamlessly fit within a common architecture to truly deliver on the promise of MES as shown below.
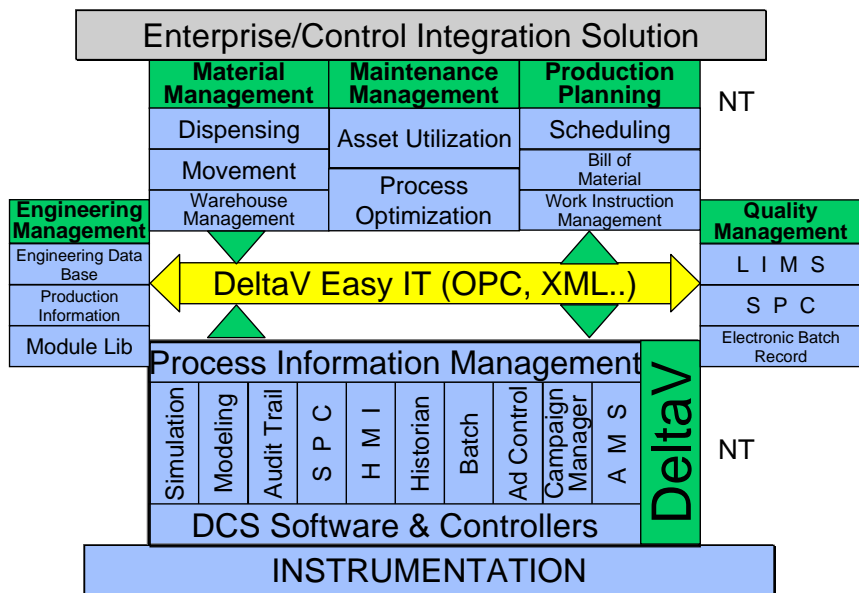
MES Application Brief

The following describes the Manufacturing Execution System (MES) as it is realized at Janssen Pharmaceutica Plant 4 in Geel, Belgium.

Emerson Process Management delivered the total project scope, including functional analysis, design, implementation, FDA validation and installation. Project size: 1 million US$, 8000 work-hours engineering over two years.

Overview

The Janssen Pharmaceutica, Plant 4 facility is a multi-purpose, flexible batch plant for the production of bulk pharmaceutical chemicals and is controlled by a RS3 system (ABC Batch).

The objective of the MES is first of all to ensure the documentation of the production process. In addition, the system is responsible for the organisation of the data flows between business management and the production floor. In this way the MES helps to achieve an improved process management and contributes to a more efficient production.

The MES stores the process information from DCS and provides a layer for recipe/batch management, material management, reporting and process analysis.

The system is integrated with the materials/warehouse management and production planning modules of the ERP computer (SAP). The MES manages and transfers batch planning and bill of materials to the DCS system.

The electronic batch record (EBR) contains important process parameters together with acceptable ranges, used materials, operator initials, process deviations, trends and operator information entered from the DCS.

System Architecture

An overview of the system architecture is given in the illustration on the next page. Some of the key components and solutions are listed below:

- Client/server architecture with 4 Windows-NT servers.
- Compaq Proliant 4500R server hardware
- Oracle relational database (batch, plant recipe, reports)
- Graphical User Interface : MS-Access Clients
- 2 x PI System (OSI Software, Inc) : 3000 pts
- 5 x RNI (RS3 Network Interface) : interface between MES and RS3 system
- ASCOM Hasler paging system: RS3 alarms are directed to the operator responsible for handling the alarm.
- Redundancy : interfaces with DCS, storage of process data on backup server (PI and Batch data)
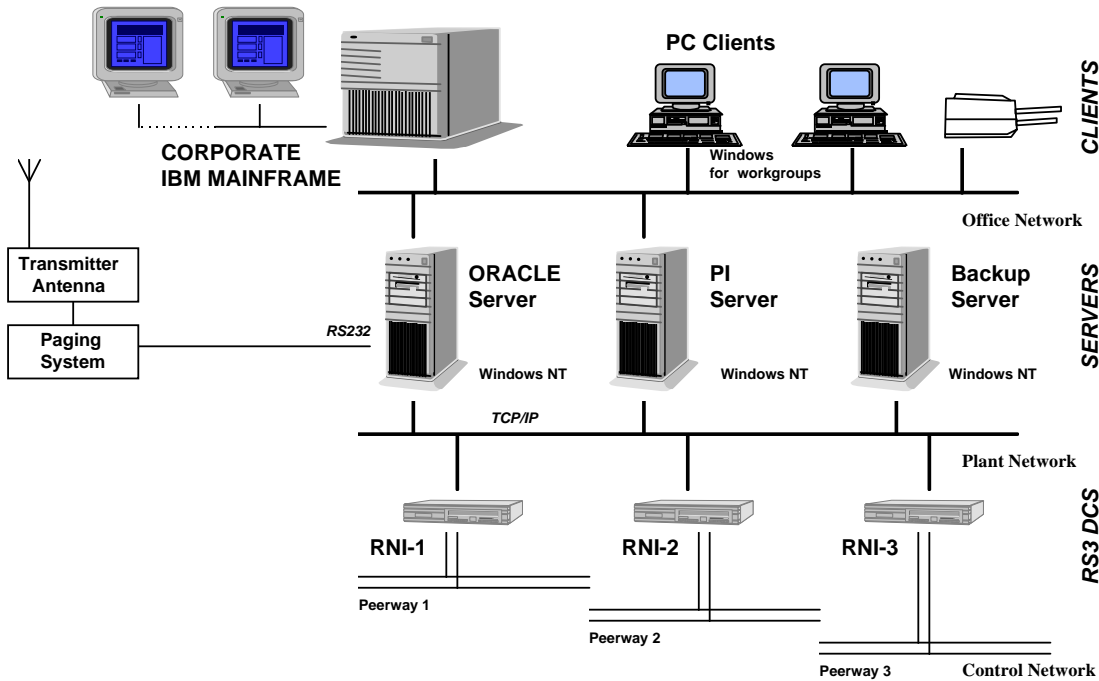
Functional Description

Although they are strongly related through the different data flows, the functionality can be devised into the following branches:

1. Storage of process data

   - The MES is responsible for storing the data on how the production process fared.

   - An important module here is an RS3 Historical Batch Database in which batch data from the working recipes on the RS3 system are collected and stored in the Oracle relational database.

   - The continuous data collection is done with the PI system (OSI Software, Inc.).

2. Plant Recipe database

   - The plant recipe defines the production process on a higher level than the RS3 ABC Batch recipe. Further, the plant recipes contain information that is not directly process control related (proven ranges, safety and environmental information, criticality information, product information). The plant recipes are structured in sub processes, instructions and parameters.

- Plant recipes are used as a basis for printing operator instructions and for passing information to the business system (batch planning and materials).

- The definition of the corresponding reporting for the electronic batch record is entered, together with the plant recipe.

3. Process Data Calculation

- While process data (batch and analog) are logged, the necessary calculations and queries are performed automatically. The results of these calculations are again stored in the database, from where they are available for queries and reports.

- Calculations are done as defined in the report definition in the plant recipe database. In this way, the reporting depends on the recipes run.

4. Batch Production Report

* The completed electronic batch record is printed out at the end of the batch. It has the same layout as the printed operator instructions, but with the actual values filled-in. Important trends are integrated graphically with the electronic record. The latter is accomplished using PI-ProcessBook and OLE Automation.

5. Management of batches

- The batches are initiated on the central business computer according to the production planning. It is the task of the MES to ensure that the batches to start (batch planning) are available on the production floor (through screens of the RS3 control system) and that the corresponding RS3 recipes are started up.

- This module has a link with the production planning module of SAP.

6. Deviation reporting

- Deviations of actual batch report values against the defined ranges of the parameters in the plant recipe are automatically detected and reported.

7. Standard reporting and analysis

- In addition to the electronic batch record, the MES is responsible for the standard reporting : campaign reports, deviation reports, overview reports, equipment occupation, etc.

8. Paging system

- The MES processes the alarms and steers the paging system so that alarms reach the operator who is responsible for the unit from which the alarm originates (according to the units--operator assignment).

DeltaV Enterprise Integration Technologies

The DeltaV system is the industry's most capable system to implement and maintain enterprise integration between the process automation environment and other manufacturing systems such as production scheduling, material tracking, document management, warehousing, and laboratory information systems. The information included in this section provides information on the specific DeltaV capabilities that make enterprise integration very flexible, cost effective, and easy.

OPC Server

OPC is one of the foundation technologies for the DeltaV system. When the DeltaV OPC server is installed, all of the system is available to the enterprise via OPC without doing ANY engineering. **Absolutely no engineering needs to be done to get DeltaV system data into the OPC server. This is an embedded capability of the system.** Simply install OPC server and it is done. In addition, Emerson Process Management makes the engineering work of interfacing DeltaV OPC parameters to other enterprise OPC servers simple with the OPC Mirror tool provided. OPC Mirror allows drag-and-drop mapping of data between two different OPC servers for easy interfacing with no programming
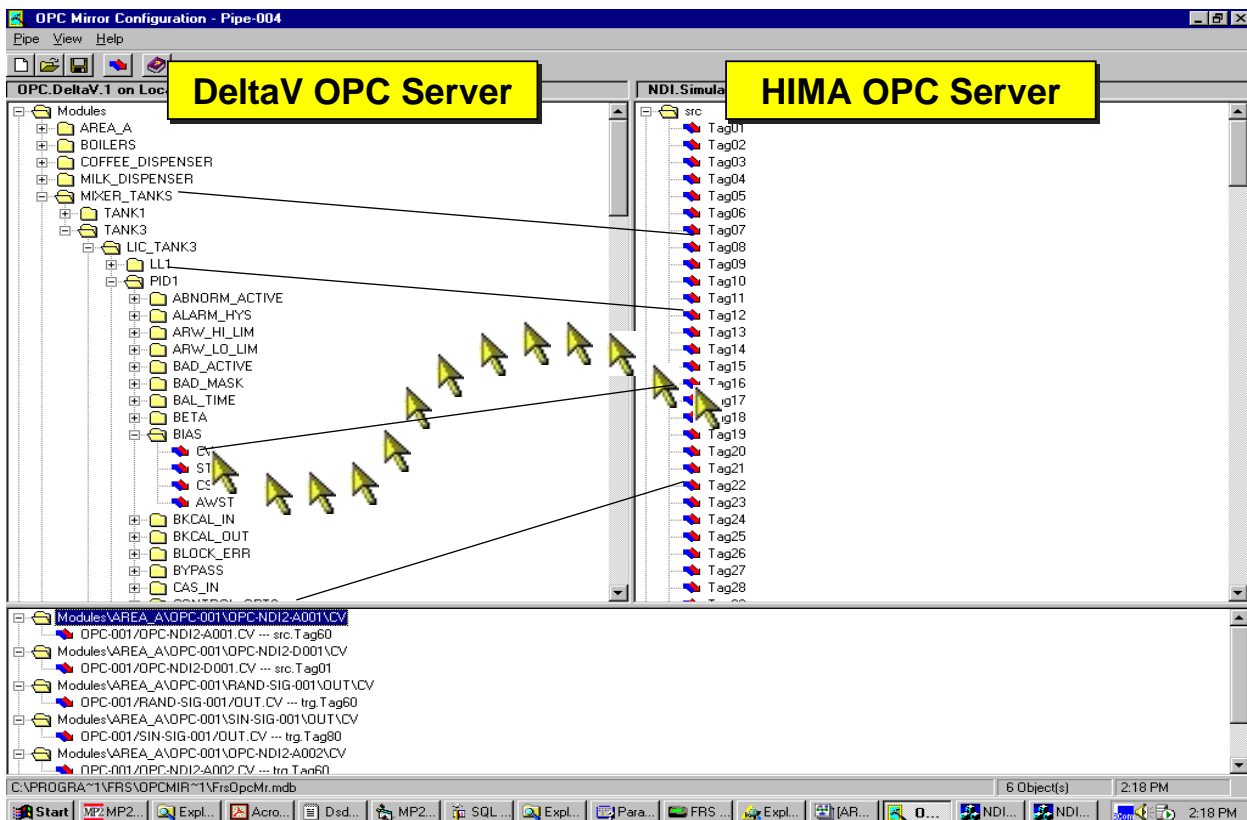
OSI PI

OSI PI is a very popular software product in the Pharmaceutical and Biotech industries and PI is very often used as the interface point between process automation systems an other enterprise applications.

When the DeltaV system is used as the automation platform, using PI as the interface to other enterprise applications becomes very easy. PI is an embedded component. **Absolutely no engineering needs to be done to get DeltaV system data into the OPC server. This is an embedded capability of the system.** This is handled as part of the DeltaV system configuration by simply enabling history collection. Once you enable DeltaV history collection, process data is stored in a DeltaV local PI database and is available to collect into a plantwide PI database using PI to PI links as well as to any enterprise application where a PI interface is available.

SQL Server

All batch and process events can be captured within a DeltaV-embedded SQL Server database. SQL Server is a very versatile data platform to distribute process and batch events out to other enterprise applications. **Absolutely no engineering needs to be done to get DeltaV system data into the OPC server. This is an embedded capability of the system.**

Campaign Management

Integrate campaign management and execution into the enterprise by linking production schedules with material handling, equipment management, recipe execution, and manufacturing procedures for manual activities. Create and manage campaign information for both automated and manual activity.
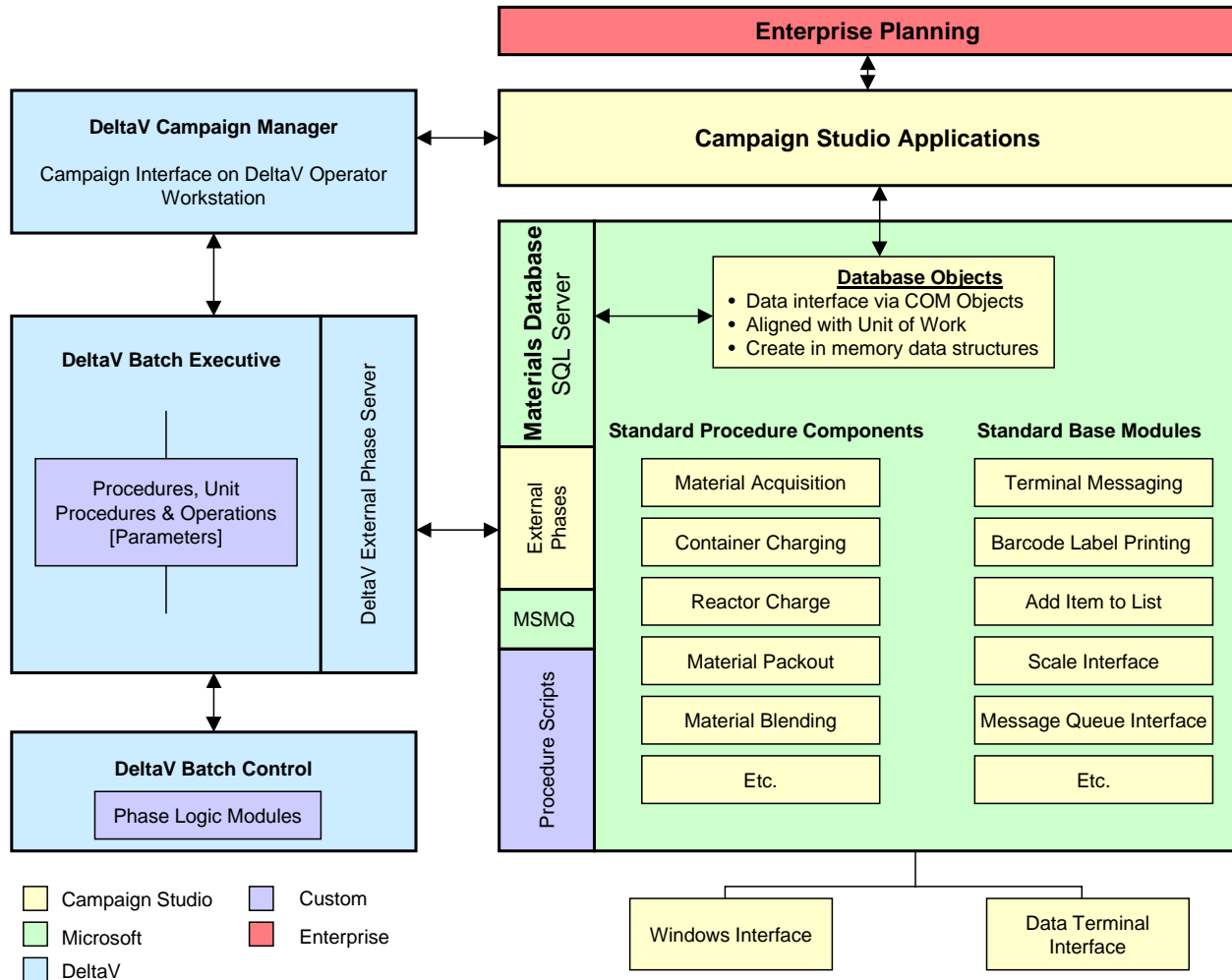
- Defines manufacturing campaigns, including materials, equipment, recipes, and manufacturing procedures
- Allows for the definition and assignment of campaign resources--containers, rooms, etc.
- Provides for assignment and tracking of materials, and material lot numbers on a batch basis
- Configures and runs manufacturing procedures initiated by DeltaV recipe execution
- Captures a compete materials usage and production record
- Uses the DeltaV Campaign Manager API to integrate enterprise campaign scheduling with the DeltaV system
- Provides buffering for enterprise recipe information

Enterprise Integration

The Enterprise/Control Integration architecture embraces the two-domain concept of the ISA-SP95 standard, which identifies required interactions between core business functions in the Enterprise Domain and manufacturing execution and process control functions in the Control Domain.

There are two event monitors: one monitors the enterprise domain and the other monitors the Control Domain. When an event occurs in either domain, a "transaction" is processed. This transaction might move information from the enterprise domain to the control domain or in the other direction. The delivery of the right information in near-real-time empowers organizations as never before in making critical business decisions.

Emerson Process Management delivers this integration via our alliances with "best of breed" software and hardware suppliers as part of our total solutions. Two key alliances in our enterprise/control integration solution are with OSI, Inc., and Agilent Technologies (formerly a business of Hewlett-Packard).

OSI Inc.'s PSRLink software is a critical part of OSI's Plant Suite initiative and provides a certified interface to SAP. The product leverages the extensive data collection and management capabilities of their OSI PI product to provide a consolidated source for control domain information from 200+ plant floor systems.

Agilent Technologies Enterprise Link product provides integration between the enterprise and control domains through a number of communication objects. The communication objects include certified interfaces to SAP modules, as well as communication objects to OPC, relational databases, flat files, message queues, and other plant floor systems.

Conclusion

The Emerson Process Management solution set for delivering enterprise integration is unmatched. The DeltaV system provides a process automation platform that makes process data accessible with no engineering costs! DeltaV software offers flexibility in data availability through OPC, OSI PI, SQL Server and XML.

Our service capabilities are experienced in the pharmaceutical and biotech industries to deliver the specific solutions you need, including electronic batch records, production scheduling, document scheduling, material tracking, and other enterprise integration.