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Line Integration Concept for Food & Beverage Lines

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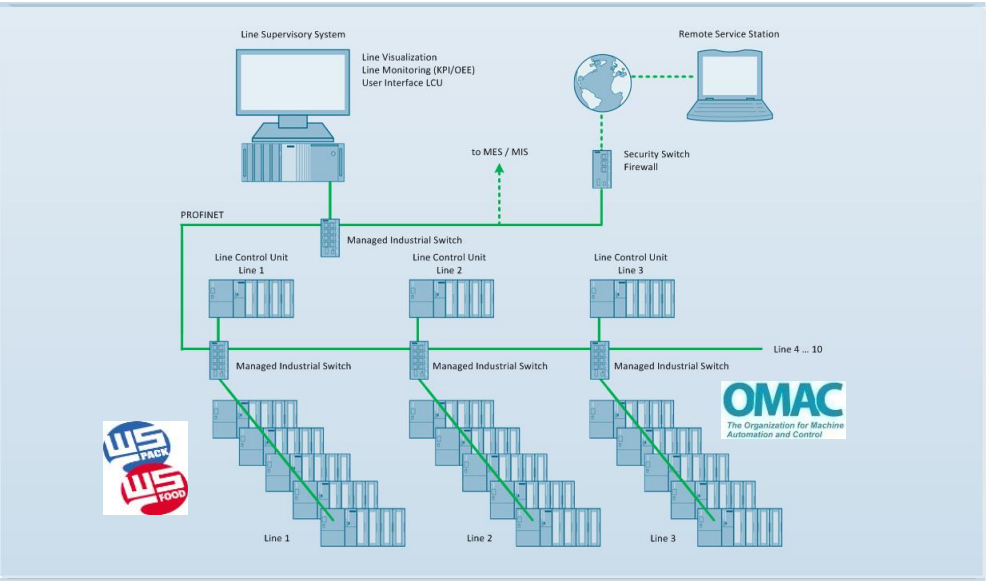


Line Integration Concept overview (example)

Executive Overview

In today's challenging environment, integration of production and packaging lines is the key to increase productivity. Many existing production and packaging lines consist of stand-alone machines, which are coupled pure mechanically by conveyor belts and sensors. This lack of integration creates unnecessary downtimes, complicates efficient diagnostics and reduces the efficiency of the line. This explains why there is a great demand for integration concepts that do not interfere with the internal automation of the individual machines but still allow comprehensive line integration on the basis of standardized data interfaces and network connections.

The Line Integration Concept developed by Siemens supports a standardized approach to make all relevant processes within the lines visible on a central Line Monitoring System. It includes extended diagnostic tools that enable the precise identification of downtimes and allow the calculation of KPIs for the entire production or packaging line. Finally, it orchestrates effective line control to guarantee a harmonious flow of products and minimize the critical ramp-up and ramp-down sequences. The advantages of these functions are obvious:

- Less downtime and less wear and tear
- More output and less scrap
- Less energy consumption per product
- The ability to continually increase production efficiency
- Less noise

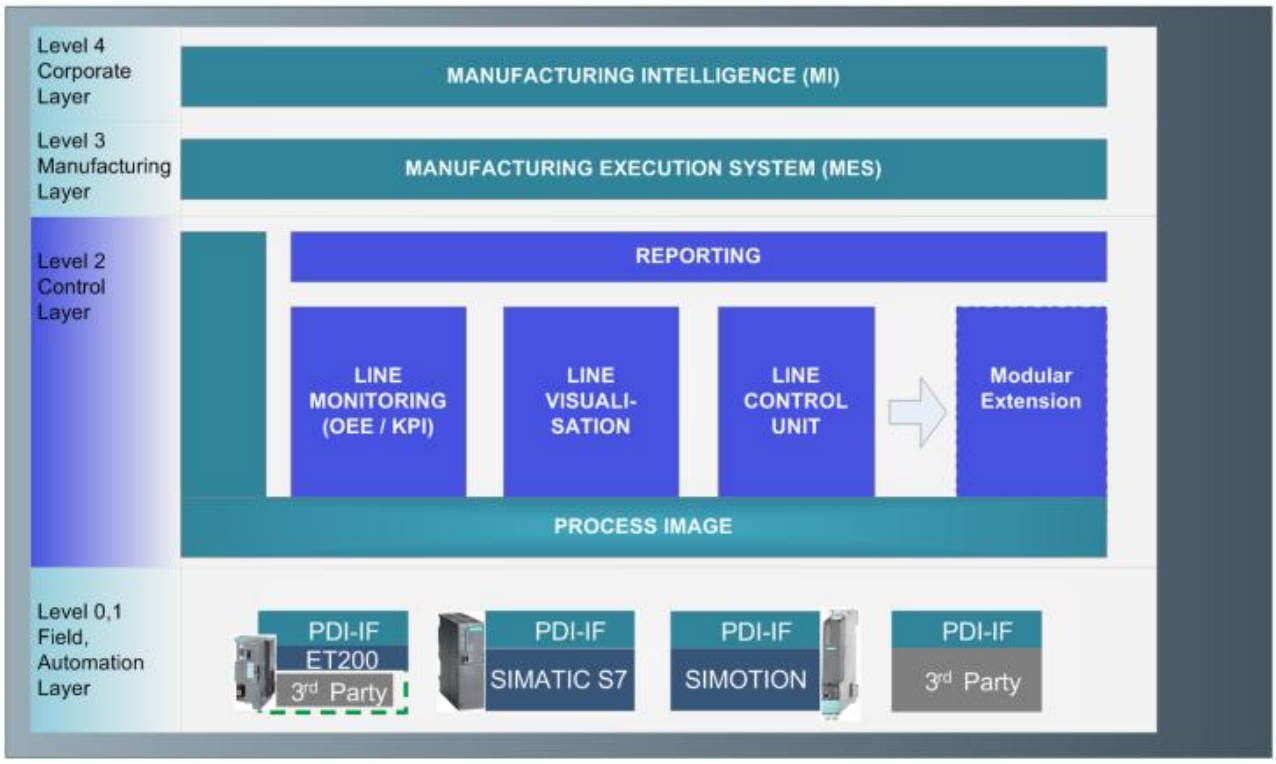
The definition of clear standards for a machine level data interface and network architecture, ensures that new and existing machines or lines can be added with minimal effort and that a production or packaging line can easily be integrated into the network of the entire plant. The ability to integrate with a Manufacturing Execution System (MES) enables the combination of data from line level with other information – for example, product ID, order ID and batch ID – to enable more meaningful, complete, and detailed data analysis and visualization.

Bidirectional communication on the basis of the Line Integration Concept makes the relevant data available on all levels, from the machine to management. The necessary software and datablocks for Siemens PLCs, HMIs and Motion Control Systems are developed as well as tested by Siemens and are available for download from Industry Online Support. Implementation security concerns raised by such bi-directional communication can be handled from the beginning with a properly laid-out defense-in-depth network architecture, combined with an enhanced remote solution with static configuration and high security standards. All this provides the benefit of simplified line integration, combined with secure remote access for authorized individuals.

Line Integration Concept

The picture below shows the system structure from Automation Level up to Plant Management Level. Field Automation Layer is based on the standard SIMATIC and SIMOTION product spectrum of Siemens offer plus the PDI-IF which will be explained more in this white paper. The Interface is available for download from the Siemens Industrial Online Support. The Control Layer is based on the SIMATIC IT Line Monitoring System (LMS), a standard product of the Siemens Automation software offer.

Additionally the layer includes visualization screens based on SIMATIC WinCC and the Line Control Unit which is also available on Siemens Industrial Online Support. Modular expansion of the Line Control Layer is possible with a complete MES and Manufacturin Intelligence (MI), which is an offer of the Siemens Automation Software group as well.



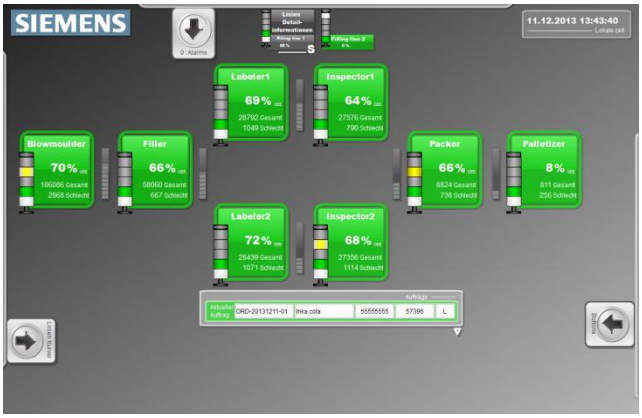
System architecture

Functionality of the Line Integration Concept

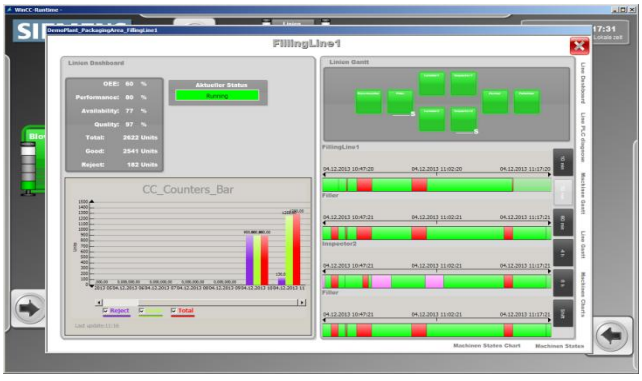
Line Visualization

Line Visualization provides an overview of the current line state and offers comprehensive diagnostic information. On the basis of this easily accessible and centralized information, the line can be operated and maintained in a highly efficient way.

Line Visualization is easily implemented with preconfigured screens and prepared templates in SIMATIC WinCC. The screenshots below illustrate how the line layout and the information from the data interface – such as machine states, produced products, and current alarms – are displayed.

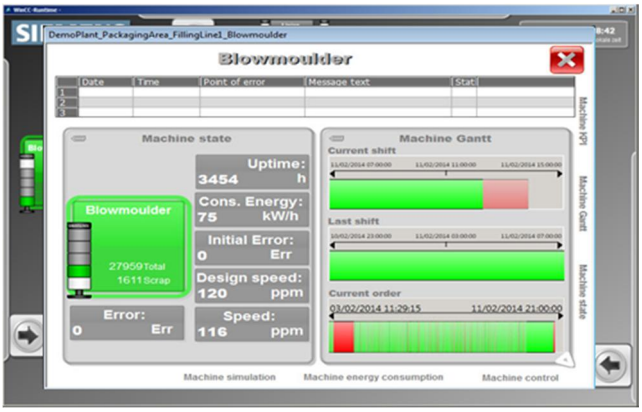


Line overview (states, stack light, buffer)



Line information details (dashboard, Gantt-Chart)

The line overview screen provides all important information needed for the complete line with its machines (including buffers and KPI's) to make further analysis in case of machine faults or downtimes. Additional screens with charts, trends and dashboards provide more details about downtime reasons and durations.

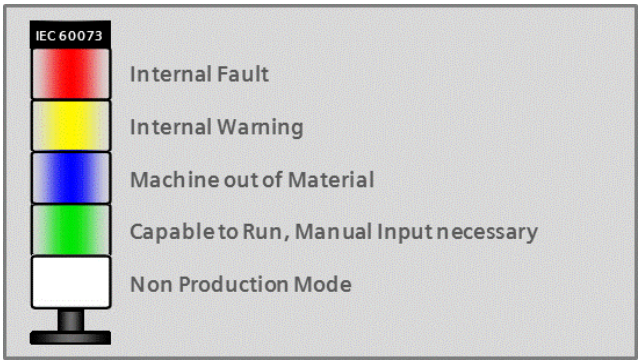


Line machine information details (machine charts, status)

The Line Visualization uses fast, easy and native channel to implement communication. Siemens provides an integrated communication channel for SIMATIC and SIMOTION connectivity. These can be added easily to any existing machine application. For corntrollers from other automation vendors either channel communication or communication based on the international OPC standard can be used.

Stack Light Indication

Stack lights show you directly the main machine information and conditions at first glance. The stack light information of each machine will be displayed on the Line Visualization screens. The colors and states are based on the international industry standard IEC60073. If other colors are requested, the colors can be customized as well. The following screen shows a typical visualization of a machine stacklight. The color fields are either off, solid-on (continuous) or flashing.



Colour classification

Line Monitoring System

KPI System Introduction

It is the key for companies in the Food & Beverage industry to eliminate efficiency-minimizing factors and increase asset utilization in their production. One important topic in this context is the identification of machine or line down-times. However, even in an optimized line machine, down-times due to jams, machine or external failures can occur. In order to be able to react in a timely manner, relevant information must be available to the staff in real time, e.g. as Gantt-Chart, KPI trend or downtime hit list. Archiving and processing of this information supports the continuous improvement processes in the plant, helping to accurately identify bottlenecks.

The Line Monitoring System (LMS) allows automatic and real-time collection of relevant data by standard channel communication. The continuously captured machine data is aggregated into significant KPIs such as Overall Equipment Effectiveness (OEE).

Overall Equipment Effectiveness is a widely accepted standard for measuring, monitoring and optimizing asset performance and operational efficiency in different areas (e.g. production, packaging, filling) of a manufacturing plant. OEE is a formulation of the following three dynamic variables used to determine a metric that represents the overall performance of an asset:

OEE = Availability x Performance x Quality

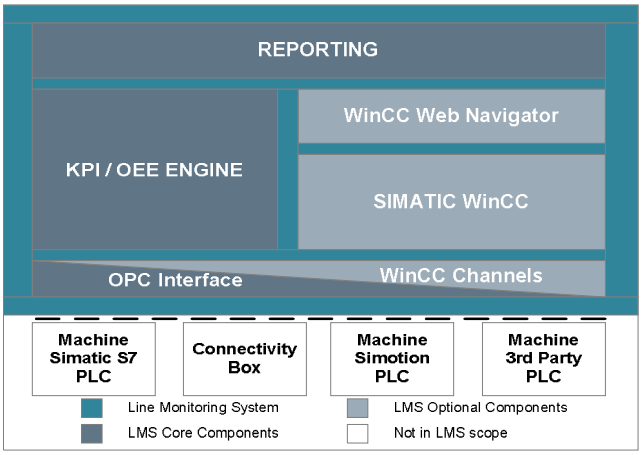
Availability: A measure of the time the line / machine was actually available for production compared to the to the planned production time. Any losses in this area occur for example due to major breakdowns or extended set up time.

Performance: The rate of actual produced units compared to the designed output. Losses in this area could be due to slow running speed, minor stoppages or adjustments, and material shortages.

Quality: A measure of good quality, sellable products, minus any waste. Losses for this element would be rejects or products needing rework.

Line Monitoring System Overview

The Siemens Line Monitoring System (LMS) adresses exactly these issues. Seamlessly integrated into the Total Integrated Automation (TIA) concept and using Siemens standard automation hardware, LMS is an efficient way to improve plant performance and save costs. The LMS allows automatic and real-time collection of production relevant data directly from the factory floor. The link to production machines is possible through standardized OMAC and Weihenstephan compliant machine data interfaces.



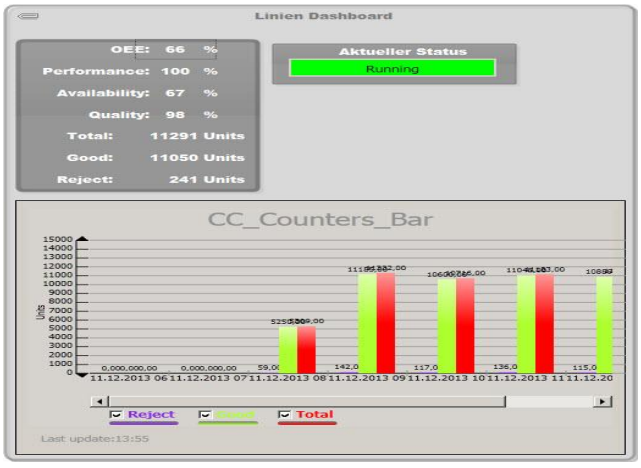
Line Monitoring System: Overview components / interface

- Downtime management can be used for detecting downtime by constantly monitoring the plant lines/machines. This can be accomplished in real time, by the analysis of equipment messages and state variables.
- KPI management provides a list of predefined KPIs, like Downtime Loss, Effective Output, Maintenance that enables a plug and play approach for monitoring the real efficiency without any additional engineering effort. In addition, it provides the capability of defining customizable KPIs, for customer specific needs to fulfill corporate or plant requirements.
- Production efficiency monitoring with dedicated graphical components is useful for displaying collected data and executing algorithm calculations. A number of pre-defined graphical screens provide out-of-the-box analysis of OEE-related KPIs and equipment downtimes.
- Gantt Charts allow enable the visualization of complete downtime records related to one or more machines or lines in a graphical way.
- Contextualized analysis enables more meaningful, complete, and detailed analysis and visualization, through contextualization of data against manufacturing events with information related for instance to orders, batches or shifts.
- User can obtain relevant information from standard predefined reports. In addition reports can be customized for more complex analysis or contextualization with data from other systems.
- A predefined set of webpages provide the user with all the out-of-the box OEE information in a flexible, scalable and “easy-to-use” environment. Should the predefined pages be extended or adapted for customer needs, customization of the pages is easy through the provided Web Portal.

Line Monitoring System Functionality

LMS offers a powerful monitoring and control environment for line relevant information. It can be displayed in two ways. Fully integrated in the Siemens scada system WinCC or alternatively in a web portal with ready to use web pages. On request they can be configured to your specific needs and settings. Using this approach, the relevant data can be provided to the complete hierarchy in the company: from shop floor with WinCC to the top floor with Internet Explorer. Information is even available when connecting from a remote location.

Line Dashboard (KPI's, Counters)



Machine Status List (Machine Downtimes)

Some of the most important functions of the Line Monitoring System include:

- Calculation of all standard and custom KPIs
- Downtime management and analysis support
- Line operator production monitoring and manual data input
- Alarm and message management for machines and lines
- Preventive and corrective actions (with MES integration)

Further options

- Reporting
- Manufacturing Intelligence
- Vertical Integration

Line Control

The Line Control Unit (LCU) coordinates the various machine states and speedsb in a line. By avoiding unnecessary start/ stop sequences, the LCU helps to optimize product flow. Based on a dedicated PLC, the LCU is also able to integrate transport systems and conveyor belts that are not dedicated to specific machines.

In particular, the LCU includes the following functions:

- Start/stop line
- Line speed set point
- Machine speed set point
- Machine speed calculation based on buffer filling
- Delayed machine start/stop

The functions “start/stop line” and “line speed set point” allow basic control of the overall line operation and speed. Line speed can be configured via the line HMI according to specific machine speeds, where the maximum speed of the line is defined by the bottleneck machine. As an alternative to this, each machine can also be controlled separately with the help of the “machine speed set point” feature. Thereby for example the wear and tear by setting the speed set point for the machines to the appropriate operating range can be reduced.

If buffers with a filling level measurement are provided, then the LCU can minimize the critical starts and stops of the machines and can effectively optimize line productivity by calculating the machine speed according to the buffer filling. Operators can configure three different ranges of buffer filling with corresponding speed factors to ensure highly flexible buffer management.

To support harmonious line operation, machine stops and starts can also be delayed depending on the status of other machines in the line. Delay times can be configured separately for each machine according to the state of the upstream and downstream machine. This “delayed machine start/stop” feature also supports energy-efficient operation.

The user interface for all set point configurations (line/ machine speed, machine delay time, parameter machine buffer entry/exit, etc.) is integrated in the Line Supervisory System. By centrally controlling conveyors, the LCU also allows project-specific synchronization of machine and conveyer speeds.

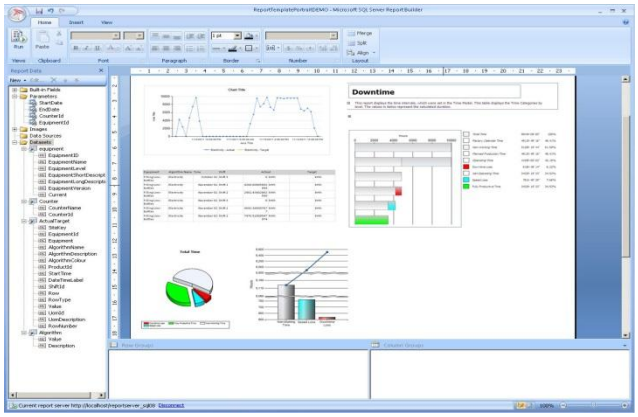
Optional Systems Extensions

Reporting (Option)

Reporting is a key instrument to provide concentrated information sets for operators, line supervisors, maintenance managers and plant managers, which facilitate them to make the right decisions and take the right actions at the right time.

SIMATIC IT Reporting Framework offers the required operational reports with contextualized and constantly updated data at plant level based on data acquired by LMS. With these reports the performance and efficiency of production lines, machines and complete plant can be documented and monitored. By comparing different shifts, lines or even machines using their KPIs potential losses in equipment efficiency can be analyzed and measuresd in order to optimize the manufacturing process. As an example two different shifts on the same line with major deviation on the KPI “Performance” or the main differences for two lines with different maintenance team on the KPI “Maintenance” can be compared.

Reporting Framework is based on standard Microsoft SQL Server Platform, with its data management, reporting and analysis technologies.



Sample report with key items (downtimes, total time, total items)

The reporting component provides reporting parts, already organized and structured in specific entities (downtime info, algorithm, shifts, etc.), which can be used to create quickly parameterized custom reports, through drag-and-drop. The provided report parts are used inside the following standard Microsoft tools: Reporting Services, Report Builder or Excel.

Plant KPIs are defined as quantifiable and strategic measurements that reflect the critical success factors of each organization. Most relevant KPIs are provided out-of-the-box and are organized into catalogs according to the S95 pillars: Production, Asset (Energy, Maintenance, OEE), Quality, Inventory.

SIMATIC IT Reporting Framework can easily be extended with the advanced data analysis functionalities provided by SIMATIC IT Intelligence Suite.

Manufacturing Intelligence (Option)

Manufacturing Intelligence (MI) transforms plant floor data into Key Performance Indicators and metrics that managers use to monitor and to improve the manufacturing operations performance. This option is typically used above line level, for complete plants or on company level.

The Line Monitoring System can be enhanced with a Manufacturing Intelligence solution. Manufacturing Intelligence serves as a basis for extended and detailed data analysis possibilities, using interactive and dynamic scorecards and dashboards. They can be personalized and adapted to the specific needs of the plant management.

SIMATIC IT Intelligence Suite or in other words Manufacturing Intelligence offers additionaly to SIMATIC IT Reporting Framework business reports for production managers, analysts and executives. It provides the most important information and alerts to the decision makers in case of critical changes of production KPIs . The main features of a MI system are:

- Dashboards, providing an at-a-glance overview of key business data
- Scorecards, comparing results against targets simply and effectively

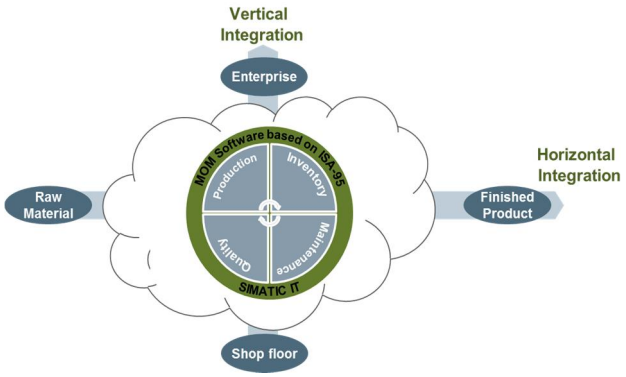
Reporting Framework and Intelligence Suite are complementary to the Production and R&D Suites. Through extraction, transformation and contextualization of MES data, the Reporting Framework and Intelligence Suite provide meaningful information, as well as enable simple visualization and analysis through dashboards, report and analytic tools.

Manufacturing Intelligence with LMS data (dashboard)

The Line Monitoring System is prepared to be used by line operators and supervisors and helps to optimize the line efficiency. It can be extended with further MES modules and functions for the plant management.

Vertical Integration (Option)

For manufacturing companies, vertical integration of systems, from automation to MES and ERP layers, is crucia in order to meet their challenges, such as price pressure, production efficiency targets and product innovation and quality.



Vertical and horizontal integration with SIMATIC IT

MES addresses business drivers in many ways

- To take advantage of favourable conditions in the marketplaces, MES provides the abilitiy to respond rapidly and execute differently than previously planned.
- To increase profits, MES enables plants to produce more cost-effectively and use plant resources wisely not only by keeping utilization high, but also by ensuring activities are in line with business needs and customer satisfaction goals.
- As new technologies increase the sensitivity of production processes, MES can provide structure to execute them properly

Siemens MES concept is a strong and flexible platform to build your plant specific solution and extend your LMS solution with Reporting, Manufacturing Intelligence and MES functions at later stages.

The comprehensive software portfolio of Siemens supports the complete product lifecycle from product definition up to service and from raw material input up to finished goods.

Siemens Software Portfolio:

QSYS® Professional is a cross-industry Quality Management System and supports all phases of the Product Life Cycle, including Product Development, Manufacturing, and Testing.

SIMATIC IT R&D Suite is a laboratory and specification management system to optimize manufacturing processes by integrating R&D labs with the plant.

SIMATIC IT Intelligence Suite is an extended analysis and reporting system for the corporate layer with various tools to represent KPIs via dashborads and scorecards.

Preactor APS / GMPS is an advanced planning and detailed scheduling system to optimize manufacturing efficiency through managing individual resources and individual orders in real time.

SIMATIC IT Production Suite offers a wide range of MES functionalities, i.e. Material / Order Management or Production Modeler in a modular and scalable structure.

The Siemens SIMATIC IT MES Portfolio completely covers all 4 pillars of ISA-95 (Production, Maintenance, Quality, and Inventory). Both the functionality and the architecture of SIMATIC IT allow modular, scalable approaches and enables faster roll-outs. The open SIMATIC IT portfolio enables collaboration across plants and integration to the enterprise layer (ERP, PLM and SCM).

Machine Integration Concept

To ensure efficient bidirectional communication between the individual machines, the line control units and the LMS, the Line Integration Concept is based on two overarching principles:

- Standardized data interface on the machine level
- Network architecture based on industrial switches and Ethernet down to the field level

Machine Prerequisites: Standard Data Interface

The very basis of line integration is a standardized data interface. Because the concept does not address the internal automation of the individual machines, it is vital to use uniform information between the various machines and the control level to ensure visualization, diagnostics, and effectiveness calculations for the entire line. The Line Integration concept uses the internationally accepted OMAC PackML as well as the Weihenstephan standard and the IEC60073 light stack standard. Within the concept, the following information has to be exchanged according to the PackML standard:

- OMAC PackML PackTags for line monitoring and line visualization
- Operational state of the machine (execute, stopped, aborted, held, suspended etc.)
- Machine mode (production, maintenance, manual, etc.)
- Alarm messages (with reason code)
- Counters for KPI calculations
- Line control commands.

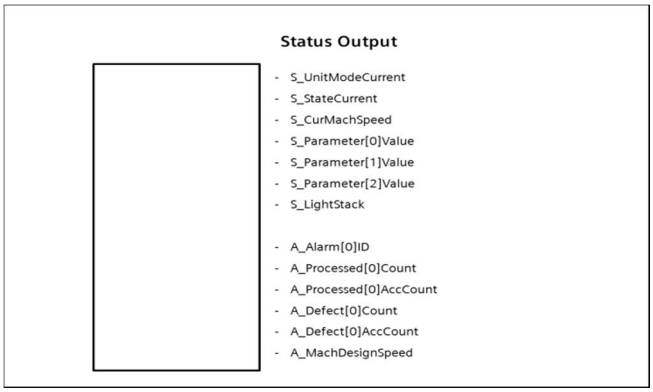
For further information regarding OMAC or Weihenstephan standards see following links:

OMAC Standards:
http://www.omac.org/content/packaging-workgroup

Weihenstephan Standards:
http://www.weihenstephaner-standards.de/index.php?id=2&L=1

The standardized PackTags also enable data exchange with enterprise level IT such as Manufacturing Execution Systems and Enterprise Information Systems.

If an OEM already has a program which does not provide an existing interface based on the named standards, the mapping of the state tags can easily be added.



OMAC Machine data interface

For further information regarding the PDI interface see following link:
http://support.automation.siemens.com/WW/view/en/86302104

The PDI Interface can optionally be expanded for line control commands and the visualization of energy data.

Network Prerequisites

Efficient network architecture has to start on the machine level. The optimized architecture of the Line Integration concept connects the LMS and its options with the individual machines via Ethernet interface and a managed industrial switch.

The integration of managed industrial switches on the machine level has several advantages. In brief terms, the use of managed industrial switches enables the following functions:

- Connection to Line Monitoring System
- Extended diagnostic functions
- Reliable security concept
- Separation of machine communication from line communication to avoid effects in the machine automation subnet
- Integration of additional devices or HMIs on the machine level
- Service access (also for OEMs and service providers via remote access)
- Switches can also be used for drives functionality with Industrial Real Time (IRT)

Support / Service- Concept (Life Cycle)

Overview of Implementation Support

Siemens offers a complete range of services.

Project manual

It defines the standardization scope. This means: specification, components list, machine architectures, software libraries, standard operating interfaces, documentation and program management

Global network of application centers

Conversion service for OEMs, local support, training, back-office support center, compatibility tests and project coordination

Coordinator between Siemens, OEMs and operating company

Plant and system planning, gap analysis, project coordination, online knowledge platform, commissioning support for the operating company, operator training

Training

With SITRAIN we offer a comprehensive training for automation products and solutions

Application Centers

With our industry sector and technological know-how, we support you with your machine application and any issues associated with motion control.

Together with the machine builder we can draw-up and implement optimum applications for the machine.

We will start to help with support in the conceptual design through engineering and implementation up to commissioning and optimization on-site.

Consulting Conceptual Design

- Carry-out a detailed actual status analysis and requirement profile
- Coordinate and harmonize technical questions
- Develop the automation concept
- Feasibility analysis
- Create a solution concept
- Provide a recommendation for implementation

Engineering Implementation

- Select the optimum products and systems
- Draw-up project architectures and implementation profiles
- Implement the software solution
- Test the software on machines or mechatronic test setups
- Provide proof of technological requirements and performance

Commissioning Optimization

- Parameterize and setting
- Carry out integration tests at the machine
- Optimize the machine and parts of the machine
- Carry out trial operation
- Provide instruction and training
- Provide diagnostics, hotline and remote online support

Online Support (free deliverables)

Templates, application examples and ready-to-use built-in components like machine interfaces, communication concepts, line HMI and line monitoring can be found on the online support web pages.

For further information see following link:

http://support.automation.siemens.com/WW/view/en/56937910/136000

Project Generator “easyProject”

The PDI can be expanded by using the Project Generator easyProject for SIMOTION or SIMATIC. This uses the standrardized interface and generates machine projects for technology functions as well as for horizontal and vertical communications.

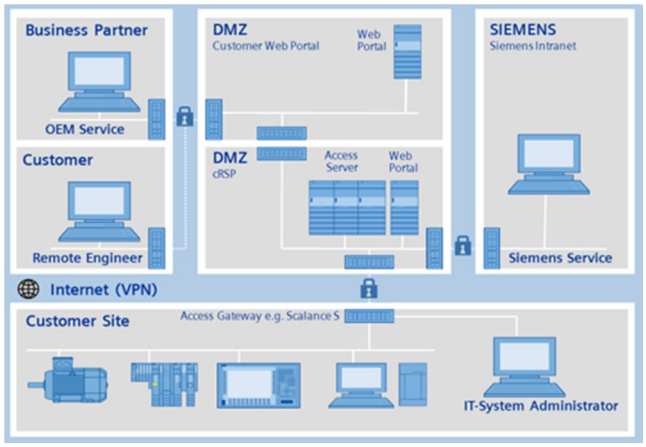
In addition to communication, you can also use standard machine applications such as handling through to templates for the user interfaces

Remote Service Access and Security

The interface of the integrated production / packaging line with super-ordinate systems also paves the way for remote access to all line functions as well as to the individual machines. If this access is based on high network security principles, elaborate remote service can be implemented in full compliance with security guidelines. This allows service providers to service machines from a remote system, which reduces downtime due to system failure, saves time and money, and enables the integration of preventive maintenance services.

To comply with security standards, an enhanced remote solution with a static configuration involving a Demilitarized Zone (DMZ) should be implemented because dynamic solutions with P2P communication tools do not provide a sufficient level of security. In addition to network security, topics like data protection, safety, and legal issues should also be addressed. It is therefore advisable to first integrate a reliable remote service concept before access to the systems is actually needed. Target equipment, users, and roles should be clearly defined and all these details should be laid out in an agreement.

The Line Integration Concept includes a reliable security concept with a Customer Web Portal (CWP) and the common Remote Service Platform (cRSP) in the DMZ. The general network layout of the Line Integration Concept with the managed industrial switches also helps to implement security measures from the beginning. It considers redundant topology, wherever required, as well as the integration of firewalls to control and protect the production area.



Secure remote service access involving a DMZ

Core features of the security concept are:

- Isolation of networks
- Graded security and access concept
- CERT and ISO 27001 certification
- Compatibility with plant IT security concepts

Abbreviation

cRSP	common Remote Service Platform
CWP	Customer Web Portal
DMZ	Demilitarized Zone (perimeter network)
ERP	Enterprise Resource Planning
HMI	Human Machine Interface
IE/PB	Industrial Ethernet / PROFIBUS
IRT	Industrial Real Time
KPI	Key Performance Indicator
LCU	Line Control Unit
LMS	Line Monitoring System
MES	Manufacturing Execution System
MI	Manufacturing Intelligence
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturer
OMAC	The Organization for Machine Automation and Control
OPC	OLE for Process Control
P2P	peer-to-peer
PDI-IF	Production Data Interface
PLC	Programmable Logic Controller
PLM	Product Lifecycle Management
SCM	Supply Chain Management
TCP/IP	Transmission Control Protocol / Internet Protocol
WS	Weihenstephaner Standards

Appendix

SIMATIC IT MES
More information and details in the following link:
http://www.automation.siemens.com/mcms/automation/en/manufacturing-execution-system-mes/Pages/Default.aspx

SIMATIC IT Line Monitoring System (LMS)
More information and details in the following link:
http://www.automation.siemens.com/mcms/mes/en/mescomponents/lms/pages/default.aspx

SCADA System SIMATIC WinCC
More information and details in the following link:
http://www.automation.siemens.com/mcms/human-machine-interface/en/visualization-software/scada/Pages/Default.aspx

SIMATIC HMI Panels (Key, Basic, Comfort, Mobile, Thin)
More information and details in the following link:
http://www.automation.siemens.com/mcms/human-machine-interface/de/hmi-panel/Seiten/Default.aspx

SCALANCE X Industrial Ethernet Switches
More information and details in the following link:
http://www.automation.siemens.com/mcms/industrial-communication/en/ie/IE_switches_media-converters/Pages/IE_switches_media-converters.aspx

Motion Control System SIMOTION
More information and details in the following link:
http://www.automation.siemens.com/mcms/mc-systems/en/automation-systems/mc-system-simotion/Pages/motion-control-system-simotion.aspx

SIMATIC Rack PC's
More information and details in the following link:
http://www.automation.siemens.com/mcms/pc-based-automation/en/industrial-pc/rack-pc/Pages/Default.aspx

SIMATIC Panel PC's
More information and details in the following link:
http://www.automation.siemens.com/mcms/pc-based-automation/en/industrial-pc/Panel_PC/Pages/Default.aspx

SIMATIC Box PC's
More information and details in the following link:
http://www.automation.siemens.com/mcms/pc-based-automation/en/industrial-pc/box-pc/Pages/Default.aspx

Modular Controllers SIMATIC S7 (PLC's)
More information and details in the following link:
http://www.automation.siemens.com/mcms/programmable-logic-controller/en/simatic-s7-controller/Pages/Default.aspx

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