3 / 2014

production manager

Journal for logistics & production

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PSI solution architecture for production processes of the future

On the way to the smart factory

Requirements for software systems can be derived from the basic ideas of the smart factory. These are based on technology stacks widely used in the industry, ensuring the future viability of the solutions. With the Java-based solution architecture, PSI AG offers a powerful platform that, with a modern user interface and numerous productivity enhancements, provides the customer with the optimum technological basis for future production processes.

The implementation recommendations for the future-oriented project Industry 4.0 made by the research alliance make it clear that this is, importantly, an integration project for the industry as a whole. The core element is the "smart factory", which consists of cyber-physical systems (CPS). The smart factory is thus a cyber-physical production system (CPPS). The smart factory is integrated into the entire flexible infrastructure and has interfaces to smart mobility, smart logistics, smart grids and smart services. The production systems will be adaptable and use adaptive logistics concepts. The production of the future is economical, urban, "human" and conserves resources.

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PSI

News ticker

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IMPRINT

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Repro- & Druck-Werkstatt

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Editorial

Dear readers,

Smart production is the future. According to industry experts and market analysts, we are entering the fourth industrial revolution. Numerous industrial associations, research institutes, machine and vehicle and leading software manufacturers, supported by the German federal government, are striving to implement Industry 4.0 in the industrialised nation of Germany, and therefore for the comprehensive propagation of these novel forms of production by 2025.

As one of the most experienced software companies originating from Germany, PSI has forty five years of expertise and the software products that have arisen from this to support the entire production and logistics process including planning, optimisation and control. With the PEC (Planning/Execution/Control) concept we began, several years ago, to prepare our products for the requirements of the future project Industry 4.0 in numerous research projects. In close collaboration with leading partners from the fields of science, research and industry, we are involved in implementing this vision in production and logistics in multiple research projects. The results are tested practically in pilot projects and are incorporated in the further development of our software products. Production processes, production systems and production planning and control must all be revolutionised simultaneously. And this has to happen not only for a few completely new production systems, but for the entire breadth of existing production. In the process it is extremely important that we offer our customers not only the long-term perspective until 2025, but also interim steps that can be used in practice.

You can learn more about this in the current edition of the production manager.

Enjoy reading!

Dr. Harald Schrimpf
Chairman of the Executive Board, PSI AG

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Human-centric applications and interaction concepts

The new requirements in the context of Industry 4.0 need innovative assistance systems and multimodal user interfaces with the production process, the machines and systems, as well as the participating software systems. The smart factory therefore requires human-centric applications and interaction concepts. The need for information is based on the role of the person in the process, this person's tasks, the tools used, the available sources of information and the overall organisation of the factory of the future. The information needs of employees depend on a wide range of influencing factors. For this purpose, role-based application concepts in conjunction with tailored and flexible interaction interfaces are required. In addition, work is becoming increasingly mobile. Mobile application scenarios together with location-based services help users to fulfil their tasks in the smart factory.

Safety and security

The high-level networking between machines and systems and the software systems that control them requires safe and stable communication channels (safety and security) based on standards. The use of the Internet of Things and Services requires secure connections and the reliable authentication of operators, machines and software systems when interacting with each other.

Horizontal and vertical integration

The vertical integration of the systems involved, from engineering to automation technology, requires standardised interfaces and technology for networking. The flexible design of the interfaces requires simple and stable tools to ensure the efficient networking of all components. Only in this way can the high-resolution production control systems be coupled—right down to the machine control system. The horizontal integration within value creation networks requires open and stable interfaces be-

Industry solutions
The standard software is enhanced with industry-specific or customer-specific functions and algorithms. These include interfaces to existing enterprise software or project-specific links to the machinery via SCADA systems.

Application
The application layer provides ready-to-use and useful functions for solving operational tasks. Functional areas offered include optimisation calculations, production control and logistics.

Framework
Basic interfaces and tools that enable the infrastructure to be used efficiently and enable the fast and cost-effective development of applications entirely based on Java. This provides the framework for scalable, reliable and secure software solutions.

Infrastructure
Core elements that provide all components and services required for the operation of application software. Key elements include the operating system (client and server), databases and networks.

The technology behind the PSI software: the Java-based PSI platform.

tween the partners of the higher level production system.
The underlying technological basis for such software systems has the required properties for the implementation of the Industry 4.0 concepts, such as real-time capability, sophisticated communication and software safety and security, flexible design options for interaction with the process and the software, support for context-adaptive methods or automated workflows and notification mechanisms.

On the way to the smart factory

The PSI platform is built 100 % on Java™. In the first instance, this ensures support for different platforms (Windows, Linux, HP/UX, AIX, etc.) and an integrated means of handling internationalisation. In the context of the requirements of Industry 4.0, however, other aspects come into focus. The special modular capabilities of Java and an OSGi-based core system allow the dynamic compilation of generic modules at runtime. This enables the composition of requirement-oriented systems that implement self-organizing logistics in an adaptive manner. The co-modelling of real and virtual production, which is the aim of Industry 4.0, thus includes the software modules as integral system components.

Multiple layers

The PSI platform supports multilayer client/server architectures. The main motivation behind this is to separate the business processes and production structures from aspects of the presentation logic. The multimodal interaction required for the interaction with a cyber-physical production system is hardly conceivable without the separation of these layers. But separation alone is not sufficient. The different modes of interaction must be specifically addressed. Here, in addition to the conventional user interfaces, technologies such as "multi-touch" and "motion detection" are used on the PSI platform and are represented by stand-alone modules.

GUI—graphical user interface

The user interface of the PSI platform (GUI) allows the interaction interface to be adapted on an individual basis. In addition to role-based versions, the user can edit personalised views of the data worlds and save them in profiles. This includes not only the relational data and comprehensive functions such as presentation in tables (sorting, filtering, grouping), but also many graphic design possibilities (schematic 2D diagrams as well as realistic 3D visualisation) that make it easy to use the task context of the employee to provide proactive support functions. As an example, location-based views can represent the immediate physical environment and thus integrate augmented reality technologies into the user interface.

Role-based authorisation

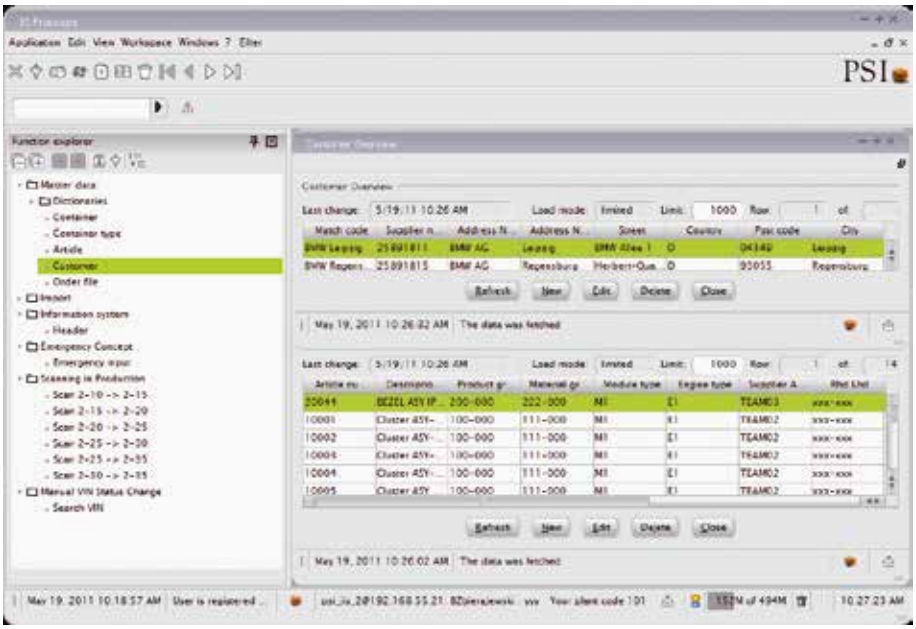
From a system perspective, support for context-adaptive working methods requires the application of role-based authorisation, which the PSI platform provides consistently. Not only the elements of the user interface but also the underlying service structures on other system levels are fully controlled by the "AUTH" module.
The protection of critical infrastructure is also ensured. In addition, with the CPCT (Code Protection) module, the PSI platform supports various mechanisms for ensuring that digital process expertise is protected and protecting against manipulation and sabotage.

Standardisation

Model-based methods are particularly important in the PSI platform. The structure of the applied models is not specified by the platform and can be adapted to the needs of the application. Various modelling aspects in the context of Industry 4.0 are not yet universally standardised. With the progressive standardisation of the reference architecture, the PSI platform structures based on metamodelling can be adapted to a specific architecture at any time.
The PSI platform already supports automation technology modelling such as factory models in the context of preconceived product-specific domain models. With the workflow module, controlled by process models, the programmed sequence logic can be made more controllable via structures that can be adapted at runtime.
A further aspect is the ability of software systems to monitor and control value creation networks. This includes not least the integration of actuator and sensor signals. The PSI*integration* module helps to transmit these signals in real time. System interfaces across all levels and company boundaries can also be implemented via stable asynchronous data exchange. The digital vertical and horizontal consistency of the data and information flows allows transparent control over the entire production network.

Just-in-sequence: Deliveries straight to the production line

PSI*jis* supports a highly automated, sequence-optimised and synchronous production and delivery—from supplier to car manufacturer. In other words, different variants of the same part or a pre-configured mod-



Sequence optimisation for a balanced production flow.

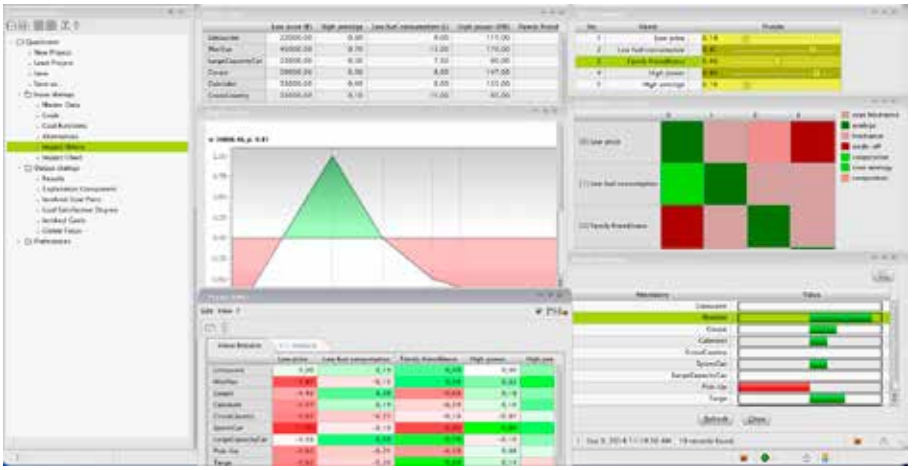
ule are delivered to the car manufacturer's assembly line according to the pull principle, at the right time and in the right sequence and position. Generally, the process has three calls (n days, n hours and n minutes), known as JIS-CALLS, which are generated by the OEM for the supplier before the start of assembly in order to react to configuration requests by the customer at short notice.

PSI*jis* is an independent software component that can be integrated into an existing software infrastructure at any time and has interfaces to ERP systems.

Qualicision®: Multi-criteria optimisation of production processes

Qualicision® is used in many different sectors as an optimisation and decision support technology in the optimisation of production processes, in the energy sector, in logistical applications and in the transport area. F/L/S has developed a release of the Qualicision® Functional Decision Design Engine (QFDD) based on the PSI GUI technology.

The data modelling of multi-criteria decision support solutions is performed with QFDD.



QFDD—data modelling of multi-criteria decision support solutions.

All elements of the QFDD engine, such as target criteria, target functions, effect matrices, relationship matrices and the corresponding editors can be configured with PSI GUI in a user-friendly way.

Sector specifics using the example of the metal industry

The multi-layer client/server architecture of the PSI technology platform separates the business processes from the presentation logic.

Sector-specific processes such as dimensioning production in primary metals can thus be mapped in software products such as PSI*metals*. At the same time the operator guidance can be configured in a role-based way alongside the user's individual work processes.

PSI*metals*: Dimensioning production in primary metals.

In this way PSI*metals* uses the standard applications of the PSI platform and supplements them with sector-specific modules while using its own Factory Model for the metal industry.

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