Contact at Fraunhofer IESE

Dr. Thomas Kuhn
thomas.kuhn@iese.fraunhofer.de
Phone +49 631 6800-2177
www.iese.fraunhofer.de

Fraunhofer Institute for Experimental Software Engineering IESE

Fraunhofer-Platz 1
67663 Kaiserslautern
Germany

Fraunhofer IESE

The Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern has been one of the world's leading research institutes in the area of software and systems engineering for more than 20 years. Its researchers have contributed their expertise in the areas of Processes, Architecture, Security, Safety, Requirements Engineering, and User Experience in more than 1,200 projects. The institute is working on innovative topics related to digital ecosystems, such as Industrie 4.0, Big Data, and Cyber-Security. It is a technology and innovation partner for the digital transformation in the areas of Autonomous & Cyber-Physical Systems and Digital Services, and its research focuses on the interaction between embedded systems and information systems in digital ecosystems.

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THE MIDDLEWARE FOR INDUSTRIE 4.0

BaSys 4.0

INDUSTRIE 4.0

Industrie 4.0 needs a software revolution

In the automation industry, embedded systems control and automate the production processes. In the context of Industrie 4.0, the manufacturing industry is facing numerous disruptions. In order to enable also small and medium-sized enterprises to manage this revolution, the German Federal Ministry of Education and Research (BMBF) has initiated the national reference research project BaSys 4.0 under the leadership of Fraunhofer IESE.

Lot size 1 is the classical goal of Industrie 4.0. Dr. Kuhn, what other goals does this also encompass?

Thomas Kuhn: The term Industrie 4.0 does not represent a single concept, but rather a collection of concepts and goals. The aim is to adapt production to ever higher quality requirements, more rapidly changing markets, and a greater variety of products. Changeable production in lot size 1 is certainly one of the main goals. But Industrie 4.0 is also about open, highly networked automation systems that enable data to be accessed across several levels of the automation pyramid and even across companies. In addition, we need to integrate modern information technology concepts such as Big Data to a greater extent. There will be a change of paradigm from embedded systems to cyber-physical systems. However, the typical infastructure found in production plants today makes it nearly impossible to achieve these goals. This is why we need new concepts for Industrie 4.0 and new architectures for production processes – in other words: a software revolution.

This sounds like a great challenge especially for SMEs. How can they, too, manage to master the software revolution with the help of BaSys 4.0?

Frank Schnicke: Our national reference research project BaSys 4.0 focuses particularly on small and medium-sized enterprises. The implementation project Eclipse BaSyx realizes an open-source reference implementation of the BaSys 4.0 middleware, which implements central Industrie 4.0 concepts and enables companies already today to develop their own solutions for Industrie 4.0. The middleware is intended to make it easy for companies to move towards Industrie 4.0 step by step, without having to invest utopian amounts of money into new manufacturing plants.

How should I imagine this? How does BaSys 4.0 work?

Thomas Kuhn: The special feature of BaSys 4.0 is the concept of service-based manufacturing, which separates the implementation of a service from the manufacturing process that calls this service. This addresses a central problem in the transition of today's manufacturing processes: Today, programmable logic controllers (PLCs) define the production process, which is distributed across implementations in numerous PLCs. A change made to a process has side effects that require adaptations in many PLCs, for example because the meaning of output terminals or bus telegrams changes. Service-based manufacturing defines interfaces for services that are called independent of a process. The manufacturing process is realized in an orchestrator that calls the services. Thus, it is possible to change the manufacturing process without changing the services and therefore without producing side effects. In all this, the asset administration shell is one of the central pillars of the Industrie 4.0 production architecture.

In the project BaSys 4.0, Dr. Thomas Kuhn and Frank Schnicke from Fraunhofer IESE make sure that individual manufacturing will not remain merely a vision for SMEs.

And what is the task of the asset administration shell within the production process?

Frank Schnicke: The asset administration shell serves as a general communication interface. The basic idea is that each asset in production, e.g., a machine, a production line, a product, or a worker, has such an asset administration shell, which contains all the information about this asset in digital form or refers to it. Among other things, it contains information abour fundamental properties of the device, such as size, weight, energy consumption, as well as formulas, respectively simulation models, describing the phyical process implemented by the device. The asset administration shell also serves as an abstraction layer with which access to the information about an asset is standardized. Through this standardization of the access to assets we not only increase the reusability of software, but also enhance changeability. This enables BaSys 4.0 to exchange devices with the same production capabilities for each other at will, without the need to change the application code.

The Eclipse open-source project **"Eclipse BaSyx"** realizes a reference implementation of the BaSys 4.0 middleware and makes this available free of charge. It is currently available for Java and will soon also be available in C++. It offers an implementation of asset admininstration shells and of the Virtual Automation Bus. In addition, various reference components are offered in order to enable quick transition to Industrie 4.0.

More about this can be found here:
https//eclipse.org/basyx

If, as a manufacturing company, I succeed in establishing changeable production with BaSys 4.0, will this result in further advantages for me?

Thomas Kuhn: Yes, for instance with regard to the issue of "Predictive Maintenance". Nowadays you usually only notice that a device requires maintenance when it is broken. With the help of the BaSys 4.0 middleware, maintenance dates can be predicted. In order to prevent downtimes, the configuration of the manufacturing process can already be changed in advance. This allows companies to save enormous costs.

Frank Schnicke: In addition, it is also possible to monitor the production process from the office floor. When a new device is to be added to a manufacturing cell today, the change on the shop floor has to be propagated across several levels until it reaches the systems of the office floor. This makes the maintenance of manufacturing devices and systems very inflexible. It is currently not possible to monitor the multitude of manufacturing data being created live at runtime. With BaSys 4.0, live monitoring of the manufacturing process becomes a reality. The big advantage is that the data is available for analyses – in addition to the required device maintenance, these include, for example, analyses for optimizing the manufacturing process or for assuring product quality and reducing the number of rejects.

The interview was conducted by Claudia Reis, Press Aide, Fraunhofer IESE.