Popular scientific abstract
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Title: Software Architecture for Industry 4.0 Middleware

The Industry 4.0 (I4.0) revolution is a transformation of current practices towards more connected production, impacting production, improvements, and distribution of products. Companies will integrate more advanced and versatile robotic and automated solutions, sensors, and technologies such as the IoT, CPS, big data analytics, cloud, AI, and simulation in their production system. Connecting all these heterogenous systems will give flexibility and opportunities to react and change production, accommodating more fluctuating customer needs. One solution to connect heterogeneous systems seamlessly is through middleware software which will be the glue between systems and facilitate information flows.

This Ph.D. thesis seeks to design, develop, and evaluate middleware software architecture for flexible production systems with a focus on quality attribute (QA) requirements. To do so, the SDU university I4.0 laboratory (I4.0 lab) will be used as the frame to analyze production equipment and technologies and to design, develop, and evaluate middleware software architecture for a production system.

The first step is to understand domain requirements for flexible production and QA requirements for supporting middleware software architecture. In this Ph.D. thesis, interoperability and reconfigurability have been found to be important for a middle-ware software architecture to support flexible production. Middleware interoperability is a fundamental QA to understanding how systems can exchange meaningful communication and a driver to exploit the potential of other technology solutions. Reconfigurability is an essential quality to a flexible production system to handle effective readjustment of the production flow and to accommodate changes in the physical environment.

First, multiple levels of interoperability have been analyzed from an asset and middleware software architecture perspective. Next, a reconfigurability definition has been proposed as well as capability and configuration concepts. A reconfigurability quality attribute scenario (QAS) template has been analyzed, developed, and evaluated to specify QA requirements for middleware software architectures. Lastly, a reconfigurability QA requirement has been stated from the template from which a reconfigurable middleware software architecture is designed, developed, and evaluated on production equipment in the I4.0 lab.

The Ph.D. thesis contributes to developing knowledge on interoperability levels for middleware software architectures and a promising QAS template to specify reconfigurability QA requirements for middleware software architectures, as well as a demonstration of a developed reconfigurable middleware software architecture to support further development flexible production systems in the context of I4.0.