OPC UA Interface for a BPM Suite to Enable Seamless Process Management

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Abstract. This demonstration presents an interface for the seamless integration of business processes and production processes. Specifically, the interface defines the data to be exchanged between the execution engine of the Metasonic Suite and the communication standard OPC Unified Architecture (OPC UA) that is widely used in industrial process automation. This allows business processes to trigger and react to changes in physical processes, thus increasing the scope and the real-world awareness of BPM. The BPM conference participants will learn how to model and execute such real-world aware business processes based on examples from an ongoing EU research project. The target audience of this demo includes BPM researchers interested in approaches to seamless process management in production enterprises.

Keywords: Seamless process integration; OPC UA; S-BPM

1 Introduction and Significance

1.1 Innovation

The benefits of business process management (BPM) have been recognized in many domains. Most of the approaches and tools in BPM are sufficiently generic to be applied to a large variety of domain-specific processes. One of the industries using BPM is manufacturing. While in this industry business processes are certainly considered important, they are not considered to be the core processes. It is the physical processing and movement of materials on the shopfloor, with associated manual or automated activities, that is the predominant concern of production managers and production workers alike. On the other hand, most physical production processes need to be smoothly embedded in the company's business operations; for example, production cannot start before raw materials are ordered and delivered, and products cannot be shipped before their production is completed. Seamlessly integrating processes across business and production is a major concern for next-generation manufacturing [1].

The issue of seamless process management can be described using the IEC 62264 control hierarchy [2] shown on the left-hand side of Fig. 1. This hierarchy represents the processes in production companies at four levels: field instrumentation control (Level 1), process control (Level 2), manufacturing operations management (Level 3), and business planning & logistics (Level 4). As these levels impose distinct requirements on processes with respect to real-time processing, data storage, safety and security, the development of models and systems at each level has been undertaken rather independently. This has resulted in poorly integrated applications especially between Low Level Control (LLC, i.e. Levels 1 and 2) operating in real time and High Level Control (HLC, i.e. Levels 3 and 4) operating in non-real time. Systems developed for LLC include Programmable Logic Controllers (PLCs), and systems for HLC include ERP, MES and BPM.

This paper presents an interface developed for the Metasonic BPM Suite that allows exchanging data with PLCs via the OPC UA [3] standard. OPC UA includes specifications for semantic data models that can be exchanged via web services or binary protocols. The interface presented in this paper is the first OPC UA interface for a BPM tool that uses the subject-oriented (S-BPM) approach [4]. S-BPM is unique in that it modularises processes by encapsulating the behaviour of process actors (called "subjects") and coordinating them via messages. Unlike most monolithic process models based on global control flow, S-BPM models can be easily modified as the effects of changes can be limited to the individual modules of the process. As shown on the right-hand side of Fig. 1, a generic "PLC subject" encapsulates an LLC process that uses the OPC UA standard to exchange data with a PLC. When changes in the LLC process become necessary (e.g. when low-level manufacturing steps need to be reconfigured for a new product variant), only the behaviour of the PLC subject needs to be modified (with potential renegotiation of its message exchanges with other subjects) rather than the complete process model. This reduces change effort and increases agility.

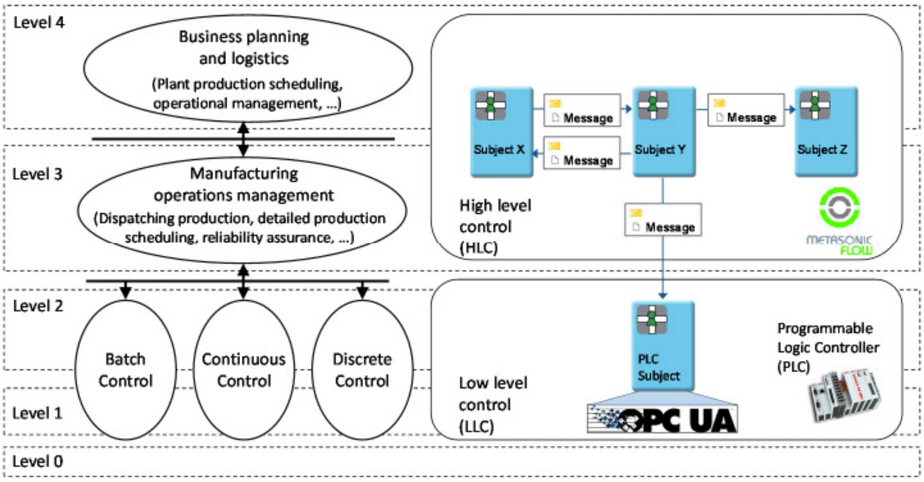

Fig. 1. Seamless process integration across the IEC 62262 control hierarchy (image on left-hand side adapted from [1]), based on S-BPM process models and OPC UA

1.2 Features

The features of the OPC UA interface have been derived from the structure of the OPC UA standard [3, 5]. OPC UA systems apply the fundamental client-server concept to implement the interaction between different communication partners, e.g. a workflow engine (client) and a plant floor PLC (made accessible via an OPC UA server). To allow requesting services provided by an OPC UA server or within a network of OPC UA servers, OPC UA defines an AddressSpace model. In such an AddressSpace an OPC UA server defines which contents (i.e. nodes representing objects, variables, methods etc. for real objects) are visible/editable for clients. Servers also allow clients to monitor attributes and events at the server. Every client can subscribe to the attributes and events it is interested in and will then be notified accordingly.

The following features have been developed: (1) configure the endpoint of the server, (2) configure the relevant node (e.g. variable, method, and event), (3) read/write variables from/to business objects, (4) invoke methods on the server, and (5) subscribe to attributes or events provided by the server. Features 3, 4 and 5 are schematically described in Fig. 2 using the example of a "PLC subject" in the Metasonic Suite interacting with a PLC. Fig. 3 shows the user interface (called "refinement template" in the Metasonic Suite) for configuring a process step, using a lighting control process as an example. In the example, the activity "Switch Light On" is configured to set the value of a variable provided by an OPC UA server based on the value of a field in a business object. The usage is illustrated in Fig. 3 using three highlighted steps. Step 1 defines the dedicated OPC UA server endpoint. For a valid server URL the available nodes are displayed in a tree, from which the desired node can be selected (step 2). Finally, the field of the business object value to be written to the selected node is selected (step 3).

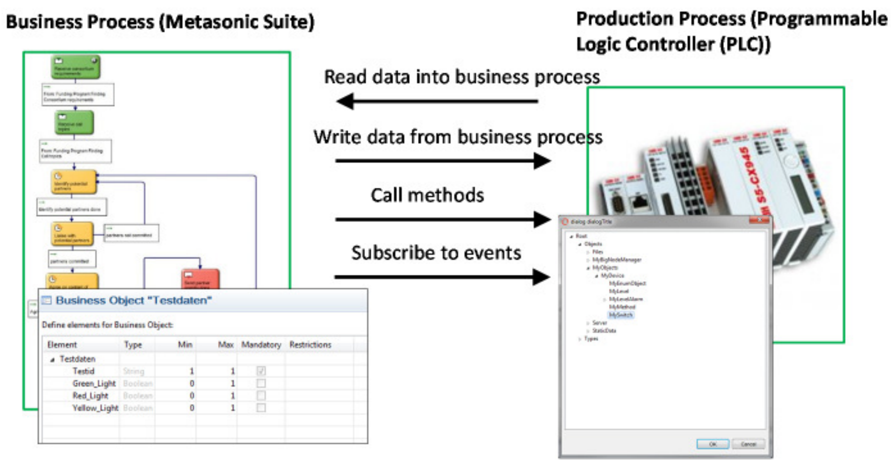

Fig. 2. Schematic feature presentation

After modelling and configuring all subject behaviours, the process can be executed in Metasonic's workflow engine. A screenshot of the user interface for executing the lighting control process is shown in Fig. 4.

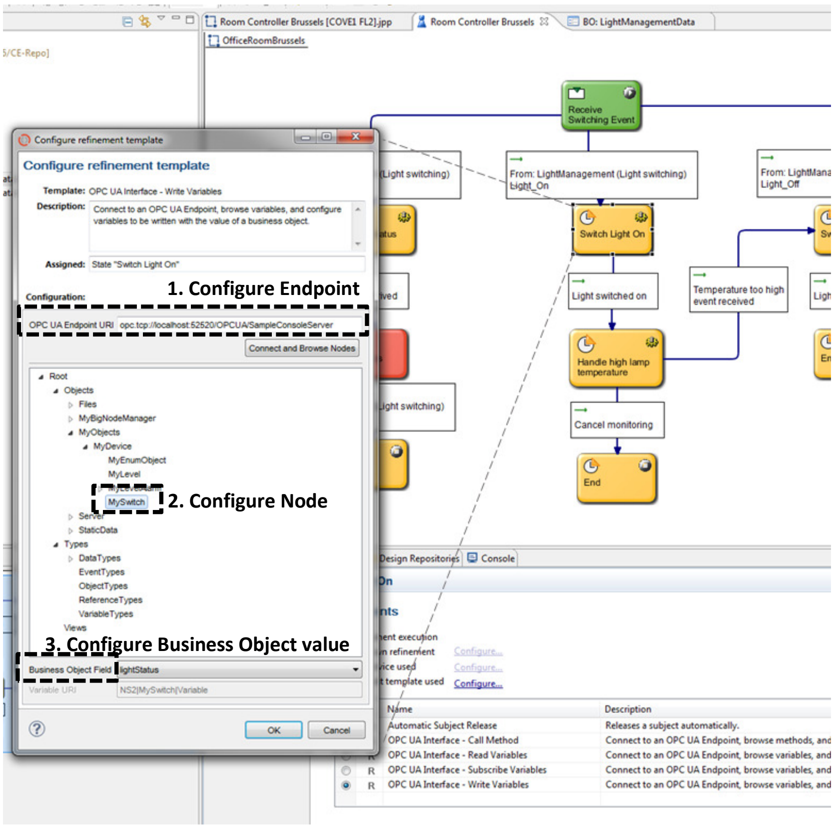

Fig. 3. Writing a value from a business object to an OPC UA server variable

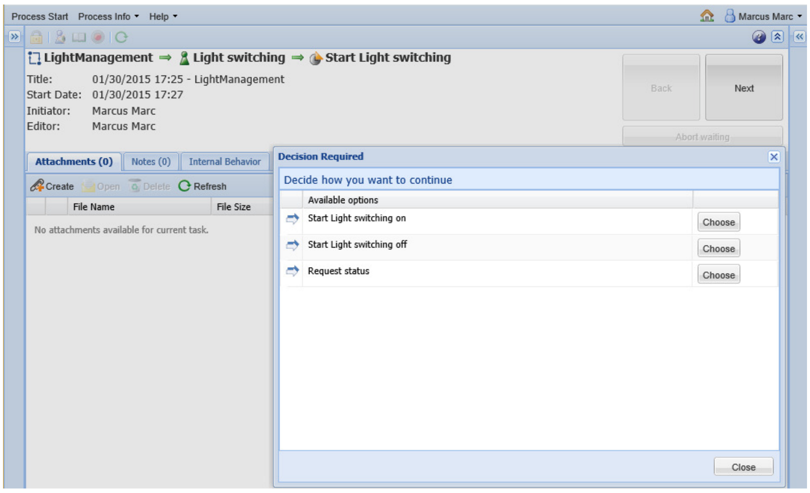

Fig. 4. Process execution – Lighting control example

2 Maturity

The OPC UA interface is currently at the prototype stage. It is a result of ongoing research in the *SO-PC-Pro* project (*Subject-Orientation for People-Centred Production*). It has been tested within four application scenarios. In the first scenario, a process for managing sun-blinds in a smart home has been modelled and executed. In the second scenario, the prototype has been used to manage room lights in offices at different locations. In the third scenario, the power consumption of production machines in a medium-sized manufacturing company has been measured and analysed for process control and improvement. In the fourth scenario, an assembly process has been modelled in which the stress level of a worker (measured using a wearable sensor) is indicated by LED lights (green | yellow | red). A video showing the interoperation between the Metasonic Suite, a PLC for controlling the LEDs and a wearable sensor is available at: https://www.youtube.com/watch?v=uBi7Alv-dpE

3 Conclusion

The tool presented in this paper represents a new feature for Metasonic's S-BPM modelling suite: an OPC UA interface for exchanging data between the workflow execution engine Metasonic Flow and PLCs. This feature allows modelling processes that span across all conceptual levels of production enterprises, making business processes able to respond to real-time events and trigger automated physical processes. Seamless process management capabilities are a key enabler of future production models such as internet-of-things (IoT) manufacturing.

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