A Service Bus Architecture for Application Integration in the Planning and Production Phases of a Product Lifecycle

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ABSTRACT

Constantly changing business conditions require a high level of flexibility in business processes as well as an adaptive and fully interoperable IT infrastructure in today's manufacturing environments. The lack of flexibility prevents manufacturing companies from improving their responsiveness and adapting their workflows to turbulent scenarios. In order to achieve highly flexible and adaptive workflows, information systems in digital factories and shop floors need to be integrated. The most challenging problem in such manufacturing environments is the high heterogeneity of the IT landscape, where the integration of legacy systems and information silos has led to chaotic architectures over the last two decades. In order to overcome this issue, the authors present a flexible integration platform that allows a loose coupling of distributed services in event-driven manufacturing environments. The proposed approach enables a flexible communication between digital factory and shop floor components by introducing a service bus architecture. This solution integrates an application-independent canonical message format for manufacturing events, content-based routing and transformation services as well as event processing workflows.

Keywords: *Adaptive Manufacturing, Enterprise Service Bus, Event-Driven Architecture, Product Lifecycle Management, Production Planning, Service Oriented Architecture*

INTRODUCTION

One of the major challenges that need to be faced by manufacturing companies is the increasing heterogeneity of their manufacturing environments. Multiple information systems manage data related to different manufacturing domains such as, products, processes, resources, shop floor layout, production orders, customer relations, supply chain, etc. Manufacturing companies execute processes that access het-

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erogeneous data across multiple sources on a daily basis. In order to enable the exchange of production data, equipment, systems and applications are interconnected following different approaches. A significant number of data exchange transactions are based on Extract, Transform and Load (ETL) processes, which shape manufacturing data flows across different production systems and digital factory applications. Many applications behave as information silos, that is, information systems that are in most cases proprietary solutions without standard interfaces. Thus, most integration solutions in current industrial manufacturing environments are based on point-to-point interfaces, which is partially due to the cost of replacing established legacy systems. This has led to chaotic architectures over the last two decades and to a lack of flexibility that prevents manufacturing companies to improve their responsiveness and to adapt their workflows to turbulent scenarios. This situation is the major problem that manufacturing companies need to address concerning their IT strategy.

In addition to this, today's manufacturing enterprises face increasing demand of responsiveness and adaptability. The agility and anticipation that enable flexible production determine what has been defined as adaptive manufacturing (Jovane & Westkämper, 2009). In order to be able to react to unexpected events and adapt the corresponding business processes, it is necessary to take into account the communication patterns for data integration in event-driven manufacturing environments (Constantinescu et al., 2005). However, a manufacturing company cannot reach real competitive advantage unless it can react in real-time to turbulent scenarios, defined by business events, which are distributed across different domains, such as shop floors, Enterprise Resource Planning (ERP) systems, supply chain, etc. Thus, manufacturing companies need to integrate their event-driven communication solutions for shop floor data integration into their production planning and business processes. Over the last few years, service-oriented architecture (SOA) principles of flexibility, loosely coupling of services and reusability have had a great impact on the execution of manufacturing business processes. The service-orientation ideal has sparked a movement that has positioned SOA as the next phase in the evolution of business automation (Erl, 2005). The standardization of Web Services (Weerawarana et al., 2005) has played a very important role in the penetration of the SOA paradigm. The Business Process Execution Language (BPEL) (OASIS, 2007) has become a best-practice standard recommendation for running business processes. Therefore a holistic integration approach needs to consider the requirements of both event-driven architectures (EDA) and SOA.

In most manufacturing domains there are nowadays no automated reaction processes that adapt business processes to a given turbulent scenario. In order to achieve this, we present an integration platform based on an Enterprise Service Bus (ESB) (Chappell, 2004) architecture that processes and reacts to events from multiple systems in a manufacturing environment. The first prototype of our reference model, the Manufacturing Service Bus (MSB) (Minguez, 2010), and the corresponding proof of concept are shown in this article. The proof of concept is given by the validation of the MSB prototype in a real manufacturing scenario and its operation under turbulent circumstances. In the validation chapter, we also show how the MSB concept can be extended to other phases of the product lifecycle and the corresponding workflow that coordinates reaction procedures to a turbulence involving the production planning phase and production phase of the product lifecycle. This gives an insight into the integration of the MSB into a product lifecycle management (PLM) architectural model. Finally, related work and conclusions are presented.

MOTIVATION

Nowadays, there are no automated reaction processes that adapt business processes to undesired shop floor events. State of the art in current production plants involves event

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