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ScienceDirect

Procedia CIRP 62 (2017) 199 – 204

www.elsevier.com/locate/procedia

10th CIRP Conference on Intelligent Computation in Manufacturing Engineering - CIRP ICME '16

Movement towards service-orientation and app-orientation in manufacturing IT

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Abstract

Current trends in production e.g. the shift to mass personalization lead to significant changes in manufacturing IT. The traditional automation pyramid is dissolving and manufacturing IT is moving towards service-orientation and app-orientation. To support especially small and medium-sized enterprises (SMEs) in mastering this challenge, an appropriate IT infrastructure and secure cloud platform have been developed. Based on this cloud platform, apps have been developed which provide the interface between humans and manufacturing IT as well as the integrated cyber-physical systems. Challenges concerning app development for manufacturing environments are illustrated using the example of an app collecting sensor data and sending this data to a cloud service for further processing.

Peer-review under responsibility of the scientific committee of the 10th CIRP Conference on Intelligent Computation in Manufacturing Engineering

Keywords: Digital Manufacturing System; Cloud platform; Service-orientation

1. Introduction

Social megatrends such as globalization, urbanization, demographic change, growth of population and sustainability have great impact on manufacturing enterprises and lead to a paradigm change for all production factors [1]. In addition, the trend towards personalized production leads to an enormous rise of product variants while quantities per product and variant are decreasing [2]. Simultaneously, manufacturing enterprises are forced to deal with highly volatile market conditions [3]. Therefore, the capability of rapid adaption has become a key factor in international competitiveness.

Rising market complexity also leads to more complexity in companies in the manufacturing sector. A propagated solution addressing this complexity by technologies of the fourth industrial revolution is the smart factory, the next evolutionary stage of the fractal factory. Key skill of the smart factory is decentralized and autonomous self-organization based on cyber-physical systems (CPS) providing real time data from the shop floor. In cooperation with humans, networked CPS are capable of solving problems within the factory [2].

To enable the smart factory, not only new IT architectures are necessary, but also new forms of interaction between humans and CPS as well as between humans and collected data in the form of services and apps. Therefore, this paper presents an approach to adapt manufacturing IT flexibly to changing and volatile conditions by using a cloud platform as well as services and apps deployed on this platform.

2. State of the Art

Nowadays, manufacturing IT is undergoing a fundamental change from the traditional automation pyramid to service-orientation, also indicated as Everything as a Service (XaaS), a paradigm, which originates from the three main cloud computing service layers Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). In order to identify diverse services, the terms service and app are divided into several subspecies. Below, the ongoing changes in manufacturing IT are described.

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doi:10.1016/j.procir.2016.06.079

Differentiation between the terms "service" and "app"
Services and apps are the building blocks of cloud applications and are capable of interacting with other services as part of a defined workflow. There are different types of services and apps:

1) Integration services: integration of systems linked to the cloud. (e.g. factory machines, equipment, etc.)
2) CPS services: services with special sensors and actuators that can form a highly dynamic part of processes. (e.g. work piece carriers, machines, etc.)
3) Back-end services: services that provide defined, clearly delineated features. (e.g. data archiving, specific analyses, scheduling mechanisms, etc.)
4) Web apps: operating system-independent apps, combination of front-end and one or multiple back-end services. (e.g. dashboard, task tracker, etc.)
5) Native apps: operating system-dependent apps, communication with one ore multiple back-end services. Especially used when high computing power or direct access to hardware layer is required. (e.g. sensor data acquisition, augmented reality, etc.)

2.1. Traditional manufacturing IT

Traditional manufacturing IT is characterized by a hierarchical structure integrated in the automation pyramid. The automation pyramid is divided in three levels: the operational shop floor level, the tactical manufacturing execution system (MES) level and the strategic enterprise resource planning (ERP) level (see Fig. 1). Various planning and control tasks are performed on each level [4, 5].

Fig. 1. Traditional automation pyramid [4]

Tools such as MES or ERP are centralized large software suites. Very often they are monolithic and stick to self-defined interfaces instead of open standardized interfaces. Therefore, separate interfaces between each component have to be developed, integrated and maintained. Due to this enormous effort, a holistic vertical and horizontal integration is usually not realized. This missing integration leads to delayed information about the factory which results in a gap between the physical factory and the virtual representation in IT systems. This lack of real-time data also often requires short-term and expensive intervention to production control [2, 4–6]. In addition, traditional software suites require a significant invest in license fees. Furthermore, the process from requirements analysis via implementation and customization to roll-out is very inflexible and takes months to years depending on the specific solution for a use case [4, 5].

2.2. Emerging concept for manufacturing IT

Today, the manufacturing IT is undergoing fundamental changes enabled by technologies such as cloud computing and associated concepts. The traditional automation pyramid is dissolving and manufacturing IT is moving towards service-orientation and app-orientation (see Fig. 2) [7, 8].

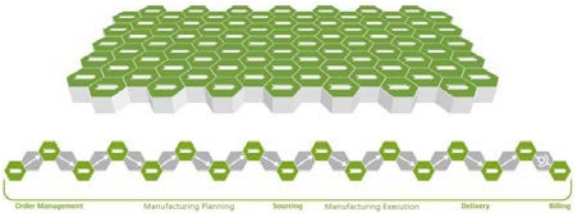

Fig. 2. Service-orientation in manufacturing IT [4]

Software functionalities will be divided into services and apps, decentralized offered by CPS and cloud platforms. Everything will be treated as a service. Due to this division of functionalities, communication between services, based on open standards will become a key factor for success. This also allows the communication of real-time information. Besides technical changes, service-orientation also enables new business models based on pay-per-use or subscriptions as well as flexible and upgradable processes of service introduction within minutes according to the customers' requirements [2, 4, 5, 7, 8].

According to forecasts, the introduction of mobile IT infrastructures in manufacturing companies will push business efficiency and transformation in production environments [9]. The simplified development of apps for the manufacturing sector by means of a standardized software and hardware infrastructure will thus strongly contribute to improve efficiency because it will be possible to aggregate cloud manufacturing concepts with individualized workflows. This trend is already widespread in the consumer world with established software products such as office suite products being offered on a yearly subscription service in connection to cloud-based services for online storage of documents or proprietary cloud storage solutions for document sharing. Many manufacturing companies have noticed this trend and have started to build their own cloud- based ecosystem and platform to offer additional services to their customers, for example the Axoom platform offered by Trumpf or Bosch