Chapter 8
Cloud-Based Manufacturing (CBM) Interoperability in Industry 4.0

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ABSTRACT

Cloud computing (CC) is generating new computing and business models because of its service-based nature, which enables collaboration and data exchange at higher level, more flexibility with better efficiency and parallel decreasing costs. Manufacturing environments can also benefit from cloud technology and follow fast changes in market demands. In these new scenarios, interoperability has vital importance in the operation and in the interaction among industrial realizations of cyber-physical systems. The chapter introduces the different cloud models and the interoperability issues concerning connected enterprise information systems. Various standardization frameworks have been developed for homogeneous integration of IT models in industrial environments: the IIRA and the RAMI 4.0 are the best-known ones. The chapter introduces both architectures; their methodological approach to industrial integration efforts and how integration can be realized through the OPC Unified Architecture. Finally, the authors propose a basic conceptual model for cloud manufacturing.

INTRODUCTION

Information and communications technologies (ICTs) have an extremely fast evolution tendency, which leads to creating new "digital" economy. Nowadays this evolution has reached a point where it can be called a revolution. The first industrial revolution was when mechanical production facilities were powered by water and steam (1784), the second one was the introduction of mass production with the help of electrical energy (1870), the third big turning point was the application of electronic and IT systems to further automate production worldwide (1969 first PLC).

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Now the world is already in the Forth Industrial Revolution phase where in Cyber Physical Systems (CPS) real and virtual objects and processes are interlinked. This phase can be featured as a deep inter-disciplinary integration of technologies in the digital, physical, and biological world (Schwab, 2015).

Also manufacturing industry belongs to those sectors which are changing basically in all of their component systems (control, ITC, fabrication) and governments are launching initiatives, global national (framework) research projects to support the research and implementation activities in the most important ITC fields (European Commission, 2016; NSF Program Announcements, 2017).

The high-tech ICT-based strategic program of the German government, called "Industry 4.0", essentially focuses on manufacturing and describes the up-to-date automation and data exchange in manufacturing technologies. Industry 4.0 includes CPSs, the Internet of Things and cloud computing. In the industrial sector the application of cloud computing is constantly growing. According to statistics from US (RightScale, 2017) 95% of firms use cloud computing technology, while 25% call security as a significant challenge. Based on a former opinion of industrial experts in cloud environments interoperability is a bigger problem than security. "The greatest challenge facing longer-term adoption of cloud computing services is not security, but rather cloud interoperability and data portability" say cloud computing experts from IEEE (Weissberger, 2011). According to the above examples it can be stated that interoperability and cloud-based manufacturing is really in the focus of the actual research topics.

Cloud-based manufacturing (CBM) make use of the cloud technology in the industry mirroring the service orientation approach of it by applying diverse cloud service- and deployment models that can easily convert and map manufacturing processes and assets into services.

The chapter, after a short overview on cloud manufacturing, provides a comparison of the most relevant features between traditional manufacturing IT systems and new Industry 4.0, cloud-oriented ones. Cloud technology is introduced in the next section with focusing on key fields of such architectures and cloud models, their combinations, and cloud interoperability. The forth section contains an overview on cloud manufacturing, highlighting its main characteristics, the different types, and a short description of interoperability challenges and how to convert traditional manufacturing to CBM through virtualization. A basic conceptual model for cloud manufacturing (CMCM) is also proposed by the authors. IIRA and RAMI 4.0 are two of the most known standardization frameworks for Industrial Internet environments: the aim of this chapter is also to present the two architectures and highlight their integration compatibility and functional interoperability. As cloud architectures become the basis of most innovative and competitive industrial IT systems, the future role of CBM and IoT in Cyber Physical Production Systems (CPPS) as part of the Industry 4.0 (or Smart Factory) has been discussed in the last section of this chapter.

MANUFACTURING ORGANIZATIONS, TECHNOLOGIES

In order to fulfil the actual market demands, production and manufacturing systems have been optimized in their structure, costs and fabrication technology. To be able to compare the different manufacturing systems a short overview is given, starting from traditional automated manufacturing system, towards the FMS (Flexible Manufacturing System), the networked, reconfigurable manufacturing systems (Virtual Enterprises), the CBM and finally the Industry 4.0 domain.

A short summary of the comparison showing the differences and the evolution of these manufacturing systems is presented in Figure 1. The qualifications of the categories are not absolute but are constructive in comparison with other manufacturing system categories.