Cloud Manufacturing: a proof of concept of Manufacturing-as-a-Service

G. Terrazas[†], D. Sanderson, E. Kelly and S. Ratchev

Institute for Advanced Manufacturing, Faculty of Engineering, University of Nottingham, UK

[†]University Park, Nottingham NG7 2RD, german.terrazas@nottingham.ac.uk

Abstract

The UK's economic prosperity increasingly depends on maintaining and expanding a resilient and sustainable manufacturing sector based on sophisticated technologies, relevant knowledge and skill bases, and a manufacturing infrastructure that has the ability to produce a high variety of complex products faster, better and more cheaply [1]. In this paper, we present *Cloud Manufacturing* – defined as an approach for enabling ubiquitous, convenient, on-demand network access to a shared pool of manufacturing resources and capabilities that can be rapidly provisioned and released with minimal management effort or service provider interaction. Inspired by the cloud computing architecture [2, 3], we present advances towards a *Manufacturing-as-a-Service* platform built upon a collection of industrial use cases, a preliminary conceptual architecture, and a prototype implementation.

Following discussion with the industrial project partners on their use case requirements, we identified four main categories of use case: those based on the *Cloud Manufacturing Service Platform*, which dealt with issues such as ordering, resource allocation, virtualisation, mass customisation/personalisation, platform access, and platform interface; those that were *Data-driven*, concerned with data analytics/management and supply-chain information; *Privacy and Security* concerns, which dealt with platform access and the linked, yet distinct, issues of data privacy and data security; and finally those that are related to the *Manufacturing Network*, globalising existing relationships into a social-like network of manufacturing companies and users, and dealing with the new business models that may arise from this change. As a result, we have designed a preliminary conceptual cloud manufacturing model in terms of independent but closely linked components – the *Platform Core*, *Data*-oriented components, *Social*-like networking, *Security* methodologies, *Business Models*, *Privacy* techniques, and the *Interface* – each derived to address the aforementioned industrial use case categories. In this piece of work, we focus on a four-layered architecture for the Platform Core composed of the *Physical Layer*, the *Abstraction Layer*, the *Business Logic Layer* and the *Front-end*. The *Physical Layer* refers to resources and capabilities within distributed manufacturing facilities. The *Abstraction Layer* defines software components embodying hardware, software and other type of resources seen at the Physical Layer along with interoperability strategies and high-level manufacturing descriptions. The *Business Logic Layer* outlines intelligent operational decisions such as optimisation strategies, constraint handling, and resource allocation methods. Inter-layer data-flow begins when a customer submits a product specification together with manufacturing constraints and customisations to the cloud through the *Front-end*. This manufacturing request is captured and processed by the Business Logic Layer which collects descriptive information from the Abstraction Layer and orchestrates virtualised resources and capabilities into a manufacturing process which is ultimately performed by geographically distributed entities at the Physical Layer. The aim of this paper is then to report on a proof-of-concept implementation of a Manufacturing-as-a-Service distributed platform built upon industrial requirements, resources and capabilities observed in manufacturing facilities, state-of-the-art computing technologies, and an open source cloud computing technology [4].

[1] P. Dickens, M. Kelly, J.R. Williams, What are the significant trends shaping technology relevant to manufacturing?, Foresight, UK Government Office for Science, 2013.

[2] The NIST Definition of Cloud Computing, National Institute of Standards and Technology. Last access on 23 May 2014.

[3] X. Xu, From cloud computing to cloud manufacturing, Robotics and Computer-Integrated Manufacturing, 28(1):75, 2012.

[4] K. Flanagan, S. Nakjang, J. Hallinan, C. Harwood, R.P. Hirt, M.R. Pocock, A. Wipat, Microbase2.0: A Generic Framework for Computationally Intensive Bioinformatics Workflows in the Cloud, Journal of Integrative Bioinformatics, 9(2):212, 2012.