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A novel cloud manufacturing service composition platform enabled by Blockchain technology

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In the near future, manufacturing industries will be mostly recognised with characteristics like IoT, and massive data transactions. To fulfil these characteristics, paradigms like Cloud manufacturing, Industry 4.0 and smart factory have passed their preliminary steps to become the primary inspirations. Considering the nature of Cloud manufacturing which consists of a vast number of service providers and Service demanders being introduced to the manufacturing cloud, service composition problem is introduced. However, there is a big challenge for fulfilling the dynamic behaviour of parameters which change rapidly over time in the service composition problem. This paper challenges the centralised mechanism of service composition problem and introduces a novel platform entitled Blockchain-based service composition model (Block-SC) based on the Blockchain technology. Block-SC as a novel manufacturing architecture conquers the centralised mechanism by dividing the original service composition problem into multiple sub-problems each of which contains a small fraction of the service/task pool. The capabilities of the proposed platform are remarkable from two perspectives; first, it provides an effective mechanism for collaboration of service composition service providers with a service-oriented approach and from the second perspective, the optimality of service composition problem is profoundly affected considering the dynamic behaviour of Cloud manufacturing.

Keywords: Cloud manufacturing; XaaS; service composition; Blockchain; IoT

1. Introduction

Cloud manufacturing, the Industry 4.0, and smart factory paradigm are about to pass their preliminary steps to become the primary inspirations for today’s manufacturing industries which are mostly recognised with characteristics like massive data, information and knowledge transactions (Liu and Xu 2017; Liu et al. 2017; Ren et al. 2017; Tao et al. 2017; Valizadeh et al. 2019b). Cloud manufacturing enables manufacturing systems to benefit from required resources and capabilities with an XaaS (everything as a service) approach by the least managerial costs and efforts by the help of a central decision-making mechanism in order to fulfil different demanded tasks simultaneously (Xu 2012; Valilai and Houshmand 2013; Delaram and Fatahi Valilai 2018; Delaram and Valilai 2018; Delaram and Valilai 2017). Cloud manufacturing entails many heterogeneous components in which they are distributed around the globe. These components are fulfilled by many distinct service providers in the manufacturing cloud (Houshmand and Valilai 2012; Houshmand and Valilai 2013; Delaram and Valilai 2016). Since each manufacturing resource comes with its own constraints (such as technical and technological limitations), one can assert that service providers possibly face with demands beyond their capabilities and limitations. To overcome this issue, a number of service providers can be combined to form a cluster of services capable of complying with customers’ requirements (Lu and Xu 2017; Vakili and Navimipour 2017; Assari, Delaram, and Valilai 2018; Zhou et al. 2018). Thus, service composition issues are one of the most paramount challenges in Cloud manufacturing literature.

As the Cloud manufacturing concept implies, a vast number of service providers would be introduced in the manufacturing cloud each of which is capable to render a distinct service. Therefore, the service composition problem in the context of cloud manufacturing is categorised as a mega-size problem (Gabrel et al. 2018; Zeng, Gu, and Yao 2018). Confronting the size of these problems in the manufacturing cloud, another issue to the main problem is the dynamic behaviour of parameters which change rapidly over time (Huang et al. 2016; Wang et al. 2017; Yang et al. 2017). Since there is a limited time interval between each cloud components’ updates, centralised decision-making mechanisms cannot cope with mega-size service composition problems in an acceptable time frame. As a result, a number of customers who cannot wait long enough would be considered as lost sell at the expense of the firm’s revenue and reputation. In addition, processing

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