Chapter 10
Blockchain Technology With the Internet of Things in Manufacturing Data Processing Architecture

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ABSTRACT

Modern manufacturing logistics and supply chain have transformed into highly complex value-creating business networks. It has become increasingly challenging to cross-check the source of raw materials and maintain visibility of products and merchandise while moving through the value chain network. This way, the high complexity of manufacturing business processes and the continuously growing amount of information lead to extraordinary demand to find an appropriate data processing architecture for the global manufacturing industry. The internet of things (IoT) applications can help manufacturing companies track, trace, and monitor products, business activities, and processes within the respective value chain networks. Combining with IoT, blockchain technology can enable a broader range of different application scenarios to improve value chain transparency. This chapter presents a hybrid (i.e., IoT, blockchain, service-oriented computing) data processing architecture for the manufacturing industry.

INTRODUCTION

Modern manufacturing has got a long history of evolution for several hundred years. The first industrial revolution began in the last part of the 18th century (Lukac, 2015). It symbolized production systems powered by water and steam, followed by the second industrial revolution, which started in the early part of the 20th century with the characteristics of mass labour deployment and manufacturing systems based on electrical power. The third industrial revolution began in the early part of the 1970s with automatic production or manufacturing based on electronics and computer data communication technology.

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The concept of Industry 4.0 was put forward for developing the German economy in 2011 (Pal, 2021). Industry 4.0 is characterized by cyber-physical systems (CPS) production based on heterogeneous data and knowledge integration. It is closely related to IoT, CPS, information and communication technology (ICT), enterprise architecture (EA), and enterprise integration (Pal, 2021).

In a typical manufacturing supply chain, raw materials purchase from suppliers and products manufactured at one or more production plants. Then the product move to intermediate storage (e.g., warehouse, distribution centres) for packing and shipping to retailers or customers. In this way, a manufacturing supply chain consists of business partners in the network, and these are the suppliers, transporters, manufacturers, distributors, retailers, and customers (Pal, 2019) (Pal, 2017). A diagrammatic representation of a manufacturing supply chain is shown in Figure 1.

In this way, a manufacturing supply chain creates a complex network of business processes. Due to globalization and business process decentralization, a manufacturing supply chain's efficient performance needs better visibility - defined as the capability to share on time and accurate data throughout the manufacturing supply chain network and coordination among supply chain business partners. In today's global business environment, companies recognize the strategic importance of well-managed manufacturing supply chains.

Manufacturers are trying to focus on the significance of changes taking place in enterprise integration initiatives (e.g., supply chains), and it is worth reviewing trends in production and operations management. Besides, the global extension of many supply networks means that their members are increasingly geographically dispersed, working across different time zones, many organizational boundaries, numerous types of organizational cultures, and related work practices. These teams are often brought together on short notice and coordinated in nearly real-time to complete a production project or a particular service within limited time and restricted resources. Very often, manufacturing supply chain business partners are engaged in many supply business activities simultaneously. In these situations, communications and real-time coordination between mobile and distributed supply chain members is complex, making the requirement for an efficient communication infrastructure that provides reliable on-demand access to both supply process information and related personnel more accurately.

Figure 1. Diagrammatic representation of a manufacturing supply chain network

Also, the change towards demand-driven production implies that not managing supplies but demands of the customer should trigger and influence the production processes. Consequently, logistics gets a new focus on optimizing the production process in a very dynamic environment. Besides, though there are different solutions and methods for regional business processes minimization (e.g., strategic manufacturing operations scheduling systems, inventory management systems, market trading optimization systems, and so on), generally, these local decisions do not assure the overall business optimization at the global level because of the conflicts between the local goals.