Chapter 27
Blockchain for Industrial Internet of Things (IIoT)

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ABSTRACT

Over the years, the industrial and manufacturing applications have become highly connected and automated. The incorporation of interconnected smart sensors, actuators, instruments, and other devices helps in establishing higher reliability and efficiency in the industrial and manufacturing process. This has given rise to the industrial internet of things (IIoT). Since IIoT components are scattered all over the network, real-time authenticity of the IIoT activities becomes essential. Blockchain technology is being considered by the researchers as the decentralized architecture to securely process the IIoT transactions. However, there are challenges involved in effective implementation of blockchain in IIoT. This chapter presents the importance of blockchain in IIoT paradigm, its role in different IIoT applications, challenges involved, possible solutions to overcome the challenges and open research issues.

1.1 INTRODUCTION

Industrial Internet of Things (IIoT) refers to the connected industrial applications such as asset monitoring, remote control of machinery and automated quality control systems, to name a few. Apart from these applications, connected cars, buildings and industries also play significant role in IIoT. This segment further spans over smart - retail, - supply chain, - cities, - energy and - agriculture (Schneider, 2017). Such wide array of IIoT applications face numerous challenges in terms of security and scalability. Billions of such connected online devices increase the attack surfaces and give rise to numerous weak areas through which the IIoT systems can be hacked. Current IIoT architecture also has characteristics such as centralized design, the legacy client-server model-based communication, lack of multi-vendor interoperability, and personal identifiable data stored and managed by entities that require trust. These characteristics of IIoT make it vulnerable to attacks and difficult to scale (Sengupta, Ruj & Bit, 2020).

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Use of blockchain in IIoT environments would help in achieving a tamper proof record of IIoT activities that is auditable in real-time. Blockchain enables in achieving decentralized architecture (thus eliminating single point of attack), distributed network, peer-to-peer communication model and ability to securely process transactions without involving infrastructure costs and risks of centralized model. Blockchain for IIoT can register, certify and track partnership between multiple parties through a supply chain, and verify it in a secure encrypted environment. It can maintain a truly decentralized and trusted ledger of all the transactions in the network. Blockchain allows to maintain a tamper proof record of IIoT device history, particularly for applications where information generation and exchange needs to be trustworthy (Huang et al., 2019).

While blockchain provides numerous advantages to IIoT, there are challenges in successful and effective implementation of blockchain in IIoT. Scalable and deployable blockchain based IIoT solutions still face numerous challenges such as distributed consensus algorithms and data analytics, with privacy preservation. The key challenge is that blockchain is computationally intensive, while the devices in IIoT platform (such as sensors and edge devices) are battery powered, with minimal data storage and processing power. In case of mobile nodes (as in the connected car environment) problem of intermittent connectivity persists. Private key generation and sharing also is a challenge (Zheng et al., 2018).

Numerous blockchain based IIoT solutions and applications have been proposed and developed by the researchers. However, wide adoption of the solutions is an issue in resource constrained IIoT environments. In this chapter, a comprehensive survey and review of the available blockchain based solutions for IIoT is presented. The limitations and challenges of blockchain implementation in different IIoT sectors is discussed. Based on this study, open issues and research avenues for adoption of blockchain technology in IIoT are presented.

The rest of this chapter is structured as follows. Section 2 presents brief introduction of IIoT and its applications. Section 3 introduces the role of blockchain in IIoT and its characteristics that blockchain useful for IIoT. The role of blockchain in different IIoT applications is also emphasized. While blockchain is important for IIoT, its implementation in IIoT poses numerous challenges. The challenges in adoption of blockchain in IIoT are discussed in Section 4. The research opportunities to support blockchain for IIoT are presented and discussed in Section 5. Section 6 concludes the chapter.

1.2 Industrial Internet of Things (IIoT)

The idea behind Internet of Things (IoT) is to enable the devices communicate and take appropriate action without human intervention thus achieving certain level of automation. Industry 4.0, the fourth industrial revolution, combines the customary industrial and manufacturing platforms with contemporary smart communication technology. Use of technology to connect and automate the industry and manufacturing process, obtain data and carry out analytics to augment these processes further, Industrial Internet of Things (IIoT) is used. The authors in (Weyer, Schmitt, Ohmer & Gorecky 2015) distribute the Industry 4.0 operation into three central paradigms as follows, with the aim of achieving reliable and productive industrial environment:

1. Smart product: This paradigm takes control of the resources and orchestrates the manufacturing process to its end