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Amalgamation of blockchain and IoT for smart cities underlying 6G communication: A comprehensive review

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ABSTRACT

Nowadays, increasing urbanization has necessitated the social, environmental, and economic development of cities to enhance the Quality of Life (QoL) significantly and introduces the "Smart City" concept. It integrates Information and Communication Tools (ICT), Internet of Things (IoT), and other technologies to resolve urban challenges. The key goal is to make the most acceptable use of available resources and technologies to develop smart cities. An IoT-enabled application plays a crucial role here, but it has various security, privacy, latency, and reliability issues with a single-point-of-failure problem. The evolving technology blockchain can handle the aforementioned security and privacy issues and provide high-quality services due to several features like transparency, trust-free, decentralization, immutability, and others. The 6G communication network takes care of latency and reliability issues in the smart city with their unique characteristics such as latency (10–100 μs) and reliability (99.99999%). Motivated by these facts, in this paper, we present a comprehensive review for blockchain technology and IoT together functional to smart cities. First, state-of-art-the works and contextual information are introduced. Then, we proposed a blockchain-based decentralized architecture for IoT-integrated smart cities covering different application perspectives, such as smart grid, Intelligent Transportation System (ITS), and healthcare 5.0 underlying 6G communication networks. Next, we describe the challenges of the proposed architecture respective to each application, as mentioned above. Finally, we collated the open research issues and future direction to efficiently integrate blockchain into IoT-envisioned smart cities.

1. Introduction

Over several decades, the rapid growth in world population explosively increases the urbanization worldwide, causing many environmental, economic, and social problems that remarkably affect people's everyday lives. According to the United Nations report, more than 70% population of the world will live in urban areas by the year 2050 [1]. The urbanization process has impressively improved people's living standards in several aspects, for instance, transportation, education, health, economy, working, and living atmospheres [2]. However, the population's high density brings noteworthy challenges to the distribution of available resources using advanced technologies. Then, the prompt increase of urban population also affects the environmental resource constraints like air pollution, traffic congestion, waste disposal, and greenhouse gas emission. All these problems and challenges necessitate intelligent approaches for enduring development of cities and bring the concept of "Smart City" [3–5]. It brings opportunities to solve the aforementioned challenges and provide a high-quality lifestyle using ICT and IoT intelligent services. Fig. 1 illustrates the different scenarios of smart cities; there are five scenarios; each scenario is depicting one particular IoT-envisioned application contributing to the improvement of the intelligent services in smart cities [6,7]. These scenarios are (i) Emergency Communication, (ii) Healthcare 5.0, (iii) Smart Agriculture, (iv) Smart Grid, and (v) ITS [8,9].

The recent advancements in ICT and IoT devices facilitate smart cities' sustainability like improved health, energy & basic facilities, encouraged citizens involvement, amplified openness of public government, optimal resource utilization, effective public transport and traffic management, better education services, and many more. However, IoT has extended Internet architecture as it interconnects computing devices (i.e., things) to establish communication for sending-and-receiving data with minimal human intervention. IoT data stored, processed, and accessed at a different server across the Internet (using cloud/fog computing), which is vulnerable to insecurity [10]. IoT data are susceptible to cyberattacks like data tampering and false data injection [11] and have a single-node-failure issue in existing cloud-based solutions [12–14]. Typically, cloud-based solutions cannot fully ensure data availability, integrity, and security for IoT-based smart cities.

To handle the aforementioned issues, the advanced and distributed technology blockchain can be used for the development and enhancement

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