


# Chapter 3

# Cyber–Physical Systems and Security in Smart Cities

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## **ABSTRACT**

*This chapter explores the integration of blockchain technology within cyber-physical systems (CPS), focusing on its application in smart houses, smart districts, and federated mechanisms. The chapter delves into the potential of blockchain to enhance security and privacy in IoT-enabled environments, particularly through blockchain-enabled IoT-embedded assets. A thorough examination of the challenges associated with current blockchain-based authentication systems is presented, highlighting issues such as security concerns, communication vulnerabilities, and inadequate authentication mechanisms. To address these limitations, the chapter proposes NFT-enabled solutions for the cyber-physical environment, leveraging permissioned networks and IBFT 2.0 consensus mechanisms to prioritize security services.*

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## **INTRODUCTION TO BLOCKCHAIN IN CYBER-PHYSICAL SYSTEMS (CPS)**

Apart from sensing, actuation, data processing, etc., smart devices have given rise to a network of smart interconnected devices that provide services from self-regulating smart grids to automated factories in automation, monitoring, and intelligent control. However, this complex dance between physical processes and digital data introduces vulnerabilities. Ensuring secure and reliable data exchange within CPS remains a paramount challenge. Here's where blockchain technology steps in, offering a potential revolution for CPS security. Blockchain, renowned for its secure and tamper-proof nature in financial transactions, holds immense promise for securing data and automating processes within these intricate systems. Its fundamental principles of distributed ledger technology and cryptographic security can create a vigorous and transparent infrastructure for CPS. This introduction explores the potential of blockchain to address security vulnerabilities and unlock the full potential of CPS, paving the way for a more secure and efficient future.

Blockchain technology has emerged as a pivotal innovation within the realm of Cyber-Physical Systems (CPS), characterized by its ability to securely integrate computing, communication, and control technologies in environments that interact with the physical world. CPS applications span a variety of sectors, including smart grids, healthcare, and autonomous vehicles, underscoring the importance of ensuring security and reliability in these interconnected systems. The unique properties of blockchain—such as decentralization, consensus mechanisms, and cryptographic security—offer significant advantages in addressing the inherent vulnerabilities of CPS, particularly regarding data integrity and resistance to unauthorized alterations (Keshk et al. 2020; Khalil et al. 2022; Letichevsky et al. 2017).

The integration of blockchain within CPS is notable for its potential to enhance data security, transparency, and operational efficiency. By creating immutable ledgers that securely log transactions across distributed networks, blockchain can safeguard critical data and foster trust among stakeholders, such as consumers, service providers, and regulatory bodies.

Noteworthy applications include peer-to-peer energy trading in smart grids and automated contract execution through smart contracts, both of which demonstrate how blockchain can transform traditional operational paradigms into more resilient and efficient systems (Shi 2011; Syahla and Ogi 2021). However, the implementation of blockchain in CPS is not without challenges. Concerns regarding scalability, interoperability, and security vulnerabilities related to blockchain technologies continue to pose significant hurdles to widespread adoption. Researchers are actively exploring solutions, such as enhanced consensus algorithms and privacy-preserving protocols, to mitigate these issues and ensure that blockchain can meet the rigorous

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