


Chapter 4

IoT with 6G in the Context of Industry 4.0

A. Prabhu Chakkaravarthy

 <https://orcid.org/0009-0000-3180-8051>

SRM Institute of Science and Technology, Chennai, India

Dhanalakshmi Jaganathan

 <https://orcid.org/0000-0002-3919-4469>

SRM Institute of Science and Technology, Chennai, India

ABSTRACT

Industry 4.0 is about to undergo a revolution because to the combination of Internet of Things (IoT) technology and sixth-generation (6G) wireless networks, which will enable previously unheard-of levels of automation, connectivity, and efficiency. With its ultra-low latency, high-speed data transfer, and vast device connectivity, 6G promises to facilitate smooth communication between cloud infrastructure, edge computing systems, and Internet of Things devices. These features facilitate autonomous decision-making, improved predictive maintenance, and real-time monitoring in manufacturing, supply chain, and logistics activities within the framework of Industry 4.0. Furthermore, opportunities for intelligent optimization and increased productivity are created by the integration of artificial intelligence (AI) and machine learning (ML) with IoT and 6G. To fully realize this promise, though, issues like energy efficiency, security, and the creation of scalable structures must be resolved.

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1. INTRODUCTION

1.1 Overview of Industry 4.0 and Its Evolution

Industry 4.0 represents the fourth industrial revolution, driven by the integration of advanced digital technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Machine Learning (ML), Big Data, Cloud Computing, and Cyber-Physical Systems (CPS). This transformation enables smart manufacturing, automation, and real-time data-driven decision-making, leading to improved productivity and efficiency (Xu et al., 2018).

The evolution of Industry 4.0 can be traced through four major industrial revolutions:

1. **Industry 1.0 (Late 18th Century):** Marked by the mechanization of manufacturing processes using steam power and water power (Mokyr, 1998).
2. **Industry 2.0 (Late 19th – Early 20th Century):** Introduced mass production, assembly lines, and electrical energy, significantly increasing manufacturing efficiency (Hirsch-Kreinsen, 2016).
3. **Industry 3.0 (Mid 20th Century):** Focused on computerization, automation, and robotics, reducing human intervention in production processes (Kagermann et al., 2013).
4. **Industry 4.0 (21st Century - Present):** Builds on previous advancements by incorporating smart factories, IoT, digital twins, and real-time analytics, enabling interconnected and autonomous production systems (Schwab, 2017).

The adoption of 6G networks in Industry 4.0 will further enhance real-time communication, ultra-low latency, and AI-driven automation, accelerating the shift toward fully autonomous industrial ecosystems (Dang et al., 2020). While Industry 4.0 has revolutionized manufacturing and logistics, challenges such as cybersecurity, energy efficiency, and interoperability remain critical research areas (Xu et al., 2021).

1.2 Role of IoT and 6G in the Fourth Industrial Revolution

The Fourth Industrial Revolution (Industry 4.0) is characterized by the integration of cyber-physical systems (CPS), artificial intelligence (AI), cloud computing, and the Internet of Things (IoT) into industrial operations, enabling smart factories and autonomous decision-making (Xu et al., 2018). The convergence of IoT and 6G is set to revolutionize this landscape by providing ultra-reliable, low-latency communi-

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