Chapter 5
Cyber Physical System for Enhancement in Security While Using Cyber

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ABSTRACT

Advancements in affordable computing and communication technologies have led to the widespread proliferation of interconnected devices, giving rise to a new era characterized by devices that sense, compute, and share information, forming loosely connected Cyber-Physical Systems (CPS). Managing data and making intelligent decisions are the primary areas of research within CPS. Traditionally, cloud-based centralized computation has been the dominant architecture due to its ease of implementation and enhanced control. However, the explosion of data, scalability challenges, and privacy concerns are increasingly highlighting the limitations of such centralized systems. Therefore, there is a growing interest in decentralizing control and distributing computing tasks among the devices as a more promising approach for sharing intelligence. Investigating novel decentralization mechanisms is a central focus of this chapter.

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1. INTRODUCTION TO CYBER PHYSICAL SYSTEM

Helen Gill coined the phrase “Cyber-Physical System” (CPS) in 2006, and it describes the fusion of the cyber (digital) and physical worlds. A theoretical framework called CPS treats each of its constituents as a model. It includes a wide variety of gadgets linked together through a network. In CPS, the software that manages and runs its physical counterpart is referred to as the cyber component. A CPS is created by the connectivity of different heterogeneous devices. These CPS components usually have constrained processing power and network capacity.

According to references, the first research roadmap for CPS included a number of core study fields, including computing and networking, security, and resource scheduling. Given the resource limitations, energy efficiency is another important issue in CPS research; as a result, CPS must make sure that participating devices are energy-efficient. Parolini et al. (reference) suggested a strategy to reduce data centre energy utilization while still fulfilling user demands. Scalable middleware or platforms that can adapt to the changing needs of CPS are becoming more and more important as the number of networked devices grows. Kim and Kumar are quoted (reference),

It is a significant challenge to design extensible, scalable, and adaptable software platforms that can operate in distributed, heterogeneous, time-critical, and safety-critical contexts because of the scale, structure, and behavioural complexity of today's and tomorrow's CPS. As they all include the fusion of digital and physical systems for diverse applications and industries, CPS has significant ties to modern paradigms including the Internet of Things (IoT), Industry 4.0, Networked Robotics, Machine-to-Machine (M2M) communication, and Edge computing.

Fog computing, Vehicular Networks (VANETs), Network of Things, and Web of Things are all related concepts in the realm of networked systems and Cyber-Physical Systems (CPS). According to Lee, CPS is a theoretical framework that is more enduring and adaptable compared to its specific implementations (such as IoT) and applications (like Machine-to-Machine or M2M communication). While CPS serves as a foundational term, industrial marketing standards have popularized the term “Internet of Things” (IoT) as the prevailing representation of networked devices. However, IoT can have different interpretations, often leading to overlaps with other paradigms and causing confusion.

Among the various definitions of IoT released by IEEE (reference), the one provided by the National Institute of Standards and Technology (NIST) in the US states: “Cyber-physical systems (CPS) - sometimes referred to as the Internet of Things (IoT) - involves connecting smart devices and systems in diverse sectors like transportation, energy, manufacturing and health care in fundamentally new ways.”