Chapter 17

Context-Aware Internet of Things-Based Service-Oriented Architecture for Industrial Applications

Kamalendu Pal
https://orcid.org/0000-0001-7158-6481
University of London, UK

ABSTRACT

Today, the industrial world has witnessed the fast development and popularity of the Internet of Things (IoT) based information systems. These information systems often use pervasive computing, ubiquitous computing, and unique data communication protocols to sense industrial applications in an environment where the physical and digital worlds work together. In this way, the new information system can serve various categories of business services through continuous symbiotic interactions. These interactions exchange data and information to create services that benefit the industrial world and smoothen supply chain operations. This chapter describes an information system architecture (i.e., Apparel Business Decentralized Data Integration (ABDDI)) that requires a description of a logic-based knowledge representation scheme for information modeling and reasoning to provide web services semantic interoperability with the help of ontology. The chapter also presents an example of the service composition ontology's similarity assessment.

INTRODUCTION

New generations of advanced information technologies (IT) are fundamentally transforming industrial operations and reshaping human society. Incorporating automation across many sectors in regular business activities, from smart factories to intelligent transportation systems, is not just a change but a revolution. Integrating business processes establishes a connection between operational technologies (OT), the hardware and software responsible for monitoring and controlling devices and processes, and the digital realm. The concept of convergence of IT with OT, often known as 'Industry 4.0', refers to the extensive integration of sensors and network interconnectivity, a depth

DOI: 10.4018/979-8-3693-7447-4.ch017

of technological advancement that facilitates data collection, analysis, and sharing with the industrial ecosystem. Comprehending these technologies is beneficial and crucial for understanding the industry's future landscape.

Business process automation thrives on innovative operational practices, experimentation, and, most importantly, sound decision-making. The research community plays a crucial role in this, often sparking innovative ideas that lead to new technology. This collective effort challenges the notion that innovation is solely the result of individual laboratory experiments. It is the secret that society hopes to witness—the magic that occurs when new ideas emerge. For example, creative breakthroughs can be seen in the discovery of millimetre radio waves by Professor Jagadish Chandra Bose (Sarkar, 2006), and its legacy is influencing a new generation of wireless communications technologies in daily activities. Three pivotal technologies profoundly impact modern wireless telecommunications, and the detailed scientific contribution came from James Clerk Maxwell (Mahon, 2004), the Scottish physicist who established the theoretical foundation for electromagnetic wave propagation; Jagadish Chandra Bose, the Indian polymath who successfully demonstrated the transmission of millimetre waves in his laboratory; and Tim Berners-Lee, the British computer scientist who invented the World Wide Web (Berners-Lee, 2000). Their contributions have significantly shaped the technological landscape. In addition, computer data communication networks are increasingly intangible and constantly evolving, growing more complex with each passing second. This incredible network of networks is the backbone of many global business community members, who rely on it for their daily operations and related services.

The advent of development and adoption of new technologies in recent decades is continuing. This continuation is driven by (i) the cumulative nature of technological change, (ii) the exponential nature of technologies such as microchips that are doubled in power every two years for more than half a century, (iii) the convergence of technologies into new combinations; (iv) drastic reduction in costs of production; (v) the emergence of digital "platforms of platforms" – most prominently the Internet; and (v) adoption of artificial intelligence (AI) techniques, the Internet of Things (IoT), and cognitive technologies have successfully been applied to various industrial applications (Zhao & Kumar, 2021). In addition, IoT has paved the way for many industrial application domains while posing several challenges as many devices, protocols, communication channels, architectures, and middleware exist. Big data generated by these devices calls for advanced machine learning (ML) and data mining techniques to understand, learn effectively, and reason with this volume of information, such as cognitive technologies. Cognitive technologies play a significant role in developing successful cognitive systems which mimic "cognitive" functions associated with human intelligence, such as "learning" and "problem-solving".

Moreover, advancements in Cyber-Physical Systems (CPSs) heighten the real-time demands on industrial networks. CPSs merge embedded systems with cybernetic control systems to govern the physical world through networked environments, imposing strict real-time requirements on their operations. Various safety and control considerations necessitate low latency and predictability, often on constrained embedded systems. When these systems are connected to more extensive networks and integrated into complex distributed systems, their real-time needs extend to the network. It creates a landscape where time-critical control tasks must be managed across a network, necessitating reliable and predictable packet routing.

The data packets traversing these networks consist of operational data collected from various devices. Currently, a broad array of devices, including sensor-equipped smart devices and wearables, connect to the Internet, facilitating innovative applications and solutions. The reduction in technology costs has democratized access to data collection capabilities. As a result, today's Internet serves as a vital conduit for real-time information across all domains. Furthermore, many platforms, such as social media, have migrated online, centralizing data in the Cloud and giving rise to concepts like Big Data, Cloud Computing, and the Internet of Things (IoT).

Recent advancements in radio-frequency identification (RFID), affordable wireless sensors, and web technologies have fuelled the IoT movement, which connects everyday objects to the Internet and enables communication between machines, humans, and the physical world. IoT devices are geared with embedded sensors, actuators, processors, and transceivers for this intelligence and interconnection. IoT is not a single technology but an agglomeration of various technologies that work together. In simple terms, sensors and actuators help interact with the physical envi-