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# Editorial "Industrial IoT as IT and OT Convergence: Challenges and Opportunities"

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During the last decade, the advent of the Internet of Things (IoT) and its quick and pervasive evolution have significantly revolutionized the Information Technology ecosystem. The IoT will consist of billions of interconnected Smart Objects generating and consuming a huge amount of heterogeneous data. This massive amount of information has the power to revolutionize how applications and services are designed and deployed allowing them to work more efficiently and profitably. In this context, the Industrial Internet of Things (IIoT) represents one of the main enablers of the fourth industrial revolution (also denoted as Industry 4.0) and it is disrupting existing approaches and creating opportunities for growth in terms of innovations, developments, and disruptive business models.

In industrial environments, Operation Technology (OT) has the role of supporting physical value creation and manufacturing processes involving devices, sensors, and software required to control and monitor plants and equipment. On the other hand, Information Technology (IT) combines all necessary information processing and technologies. Traditionally, industries have seen and handled OT and IT as two different specific domains, keeping separate technology stacks, protocols, standards, management, and organizational units. The advent of the IIoT is changing this vision and progressively these two domains started to share common approaches and technologies. The convergence of IT and OT together with the IIoT represents an appealing challenge both for the academic and the industrial research communities, to bring enhanced performance and gains in terms of flexibility and interoperability.

The Special Issue "Industrial IoT as IT and OT Convergence: Challenges and Opportunities" is composed of seven high-quality papers, selected by Guest Editors with the support of Reviewers providing valuable comments and useful improvement suggestions.

Stojanovic et al. [1] argue the need for systems engineering and management of Digital Twins (DTs). In particular, authors present a conceptual description of DTs, propose a DT lifecycle model, and present methodologies and tools for DT management. The proposal also considers the context of Industry 4.0 concepts, such as the asset administration shell (AAS), the international data spaces (IDS), and IEC standards (such as OPC UA and AML).

Morselli et al. [2] focuse on predictive maintenance, representing the opportunity to understand in advance possible machine outages due to broken parts and schedule the necessary maintenance operations. However, authors point out that in real-world scenarios predictive maintenance struggles to be adopted due to a multitude of variables and the heavy customization it requires. In this regard, authors present a novel framework for predictive maintenance, which is trained online to recognize new issues reported by the operators.

Lemus-Prieto et al. [3] introduce the CultivData project, adopting the convergence of IoT, big data, HPC, open data and artificial intelligence with the purpose of enabling High Performance Data Analytics in the specific context of the cultivation of agricultural data, with the primary goal of improving the efficiency and effectiveness of farms. The



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proposed system integrates access to data provided by IoT devices that are used as sensors farms with public and open data sources. In this manner, it is possible to support precision agriculture, providing benefit not only to farmers but also to agricultural decision-makers who plan species and crops based on data such as available water, expected weather, prices, and market demands.

Ullah et al. [4] focus on security issues the high number of insecure IoT applications and devices represent a threat, by allowing for the launch of multiple attacks via large-scale botnets. To address this issue, authors propose and implement a model for anomaly-based intrusion detection in IoT networks that uses a convolutional neural network (CNN) and gated recurrent unit (GRU) to detect and classify binary and multiclass IoT network data. The proposed model has been successfully validated using the BoT-IoT, IoT Network Intrusion, MQTT-IoT-IDS2020, and IoT-23 intrusion detection datasets.

Oktian et al. [5] consider that decentralization architectures are gaining interest among IoT adopters. In this regard, authors introduce an IoT architecture re-work to enable three spheres of IoT workflows (i.e., computing, storage, and networking) to be run in a distributed manner. In particular, the proposed solution employs blockchain and smart contract technologies to provide a secure computing platform. The distributed storage network maintains IoT raw data and application data, while Software-Defined Networking (SDN) controllers SDN switches provide connectivity across multiple IoT domains. The envisioned architecture is composed of separated yet integrated peer-to-peer overlay networks, accessed by IoT actors such as IoT domain owners, IoT users, Internet Service Provider (ISP), and governments.

Nițulescu et al. [6] present an innovative Supervisory Control And Data Acquisition (SCADA) solution based on Node-RED, recently evolved as one of the most important projects in IIoT able to replace, up to a certain level, classic SCADA applications. The main focus of the paper is to stress this aspect and to develop an application demonstrating the functionality of the concept, making use of protocols such as Modbus TCP for interacting with industrial devices and MQTT to interact with higher levels.

Aziz et al. present review paper [7] covering the adoption of IIoT solutions in mining environments. One of the primary achievements is that authors identify vertical fragmentation due to the technological variety of various systems and devices offered by different vendors, preventing interoperability, data distribution, and the exchange of information securely between devices and systems. Based on guidelines and practices from the major IIoT standards, authors also propose a high-level IIoT architecture suitable for the mining industry, addressing identified challenges and enabling smart mines based on automation, interoperable systems, data distribution, and real-time visibility of the mining status.

Finally, we would like to thank all authors and reviewers contributing to this Special Issue, the former for their original solutions and the latter for improvement suggestions. Their excellent work has allowed us to present novel and interesting contributions in the field of IT and OT convergence in industrial environments.

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