Chapter 6
Future Directions to the Application of Distributed Fog Computing in Smart Grid Systems

Arash Anzalchi
Florida International University, USA

Longfei Wei
Florida International University, USA

Aditya Sundararajan
Florida International University, USA

Amir Moghadasi
Florida International University, USA

Arif Sarwat
Florida International University, USA

ABSTRACT

The rapid growth of new technologies in power systems requires real-time monitoring and control of bidirectional data communication and electric power flow. Cloud computing has centralized architecture and is not scalable towards the emerging internet of things (IoT) landscape of the grid. Further, under large-scale integration of renewables, this framework could be bogged down by congestion, latency, and subsequently poor quality of service (QoS). This calls for a distributed architecture called fog computing, which imbibes both clouds as well as the end-devices to collect, process, and act upon the data locally at the edge for low latency applications prior to forwarding them to the cloud for more complex operations. Fog computing offers high performance and interoperability, better scalability and visibility, and greater availability in comparison to a grid relying only on the cloud. In this chapter, a prospective research roadmap, future challenges, and opportunities to apply fog computing on smart grid systems is presented.

INTRODUCTION

Unlike conventional power systems, smart grid today is a healthy amalgamation of multiple interoperable, scalable, efficient, sustainable and secure technological domains contributing holistically towards the availability, reliability, and quality of the power generated, transmitted, and distributed to consumers. These technological domains extend beyond power systems themselves, manifesting as data management, cyber-physical security, human behaviors, mathematics, communication, and even wireless sensors. Such an interconnected smart grid can provide sustainable and reliable power delivery, ensuring availability and eco-friendly means of generating power. Integrating many renewables into the grid, at both transmission as well as distribution levels, is expected to yield an unstable grid owing to their intermittent nature. This necessitates the need for smoothing as well as optimizing the cost of operation, production, and distribution (Popeanga, 2012). Consumers have now metamorphosed into "prosumers", wherein they have gained the ability to both produce as well as consume power. With the integration of more intelligent sensors and devices on the field, largely distributed across the grid, Internet of Things (IoT) has gained prominence in this critical infrastructure as well. These devices churn data points constantly, racing to the central servers bolstered by strong and resilient communication infrastructure (Dastjerdi & Buyya, 2017). Consequently, the significance of computing in the smart grid domain must be investigated. For this purpose, three sub-domains within the smart grid will be explored in this chapter: information management, energy management, and security.

Significance of Computing in Information Management

Currently, the deluge of digital data is centrally ingested and cleansed into useful information blocks that can be processed. Many critical power system applications such as Demand Response (DR), load flow and Optimal Power Flow (OPF) analyses, fault and reliability analyses, quality assurance models, customer billing processes, direct load control, active/reactive power control and distribution planning, to name a few, depend on the veracity and validity of the information gathered from the field. This warrants the need for effective and powerful computing technologies for smart grid.

Significance of Computing in Energy Management

The existing power grid needs an optimal balance of electricity demand and supply between consumers and the utilities. The smart grid can address this requirement. Such features in a smart grid are realized by the integration of various Energy

32 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/future-directions-to-the-application-of-distributed-fog-computing-in-smart-grid-systems/208712

Related Content

How to Survive in an Environment of Technological Changes: A Sustainable Technology Strategy for SMEs
Antonino Ardilioand Joachim Warschat (2011). *International Journal of Social Ecology and Sustainable Development (pp. 1-17).*
www.irma-international.org/article/survive-environment-technological-changes/58341

Corporate Social Responsibility (CSR): Theory, Regulations, and New Paradigms in the Framework of Sustainable Development Strategy
Adriano Ciani, Francesco Diotallevi, Lucia Rocchi, Anna Maria Grigore, Cinzia Codutiand Elisa Belgrado (2018). *Sustainable Development: Concepts, Methodologies, Tools, and Applications (pp. 1500-1525).*
www.irma-international.org/chapter/corporate-social-responsibility-csr/189956

MCDM Approach to Assess Dropping Out of Education by Children: A Study in the Indian Scenario to Take Appropriate Measures for a Sustainable Education System
Debesh Mishra, Abhaya Sanatan Satpathy, Tejpal Singh Parmarand Ashok Kumar Singhdeo (2022). *International Journal of Social Ecology and Sustainable Development (pp. 1-12).*
www.irma-international.org/article/mcdm-approach-to-assess-dropping-out-of-education-by-children/295965

Guideline for Environmental Impact Reduction From Donations of Religious Offerings in the Thailand 4.0 Era
Wisakha Phoochinda (2022). *International Journal of Social Ecology and Sustainable Development (pp. 1-12).*
www.irma-international.org/article/guideline-for-environmental-impact-reduction-from-donations-of-religious-offerings-in-the-thailand-40-era/290313

The Organizational-Level Analysis of Corporate Social Responsibility in Serbia in Light of the COVID-19 Pandemic

Nemanja Berber, Marko Aleksi, Agneš Slaviand Maja Strugar Jelaa (2022).

Handbook of Research on SDGs for Economic Development, Social Development, and Environmental Protection (pp. 272-301).

www.irma-international.org/chapter/the-organizational-level-analysis-of-corporate-social-responsibility-in-serbia-in-light-of-the-covid-19-pandemic/304788