Communication Technologies for Smart Grid Applications: A Survey

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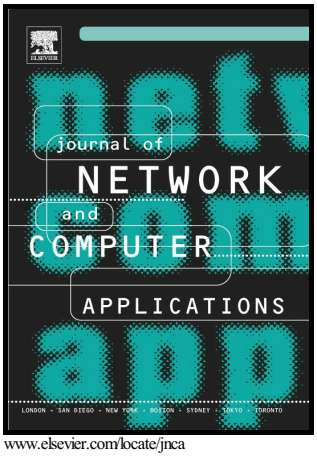

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Abstract

Modernization of the conventional power system is being driven by increased load, aging infrastructure and proposed legislation to increase taxation of greenhouse gas emissions. The evolving intelligent energy value chain known as the smart grid is an intricate system, which requires deliberate collaboration from various stakeholders. The smart grid is not a monolithic system but rather a collection of enabling technologies and applications with different Quality of Service (QoS) requirements. It is pivotal to any nation's economic advancement, global relevance and overall quality of life. In this article, a review of integral components of the emerging grid and communication infrastructures enabling the six smart grid applications is presented. In addition, this paper summarizes their communication and networking requirements such as payload (size and frequency), physical (PHY) and media access control (MAC) layer latency based on IEEE Guide for Smart Grid Interoperability and National Institute of Standards and Technology frameworks. Also, this article highlights the need for convergence into a common protocol platform to achieve interoperability of legacy and evolving communication protocols. Additionally, challenges of communication infrastructures deployed within the "unfriendly" power system environment and critical skill gaps that exist between the power and communication domains, which may create a 'silo unit' while integrating communication technologies into the legacy power system are presented.

Keywords: Smart grid, energy value chain, smart grid applications, payload, critical skill gaps.

1. INTRODUCTION

The need to add intelligence to the conventional power system in order to operate as a cognitive, adaptive, self-monitoring and self-healing system has become imminent [1], [2], [3], [4]. Integration and interoperability of the conventional electricity grid with communication technologies present critical constraints for the evolving smart grid [5], [6]. The reformation of the power grid system is likely referred to as the "Third Industrial Revolution" for energy [7]. The legacy power system typically operates in centralized manner with a radial topology, in which a group of consumers are fed from a single power source [8]. This topology has a very low reliability because any power failure or trip along the path will interrupt power delivery across the network [3]. Consequently, many utilities have resorted to a loop or hybrid network topology to

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