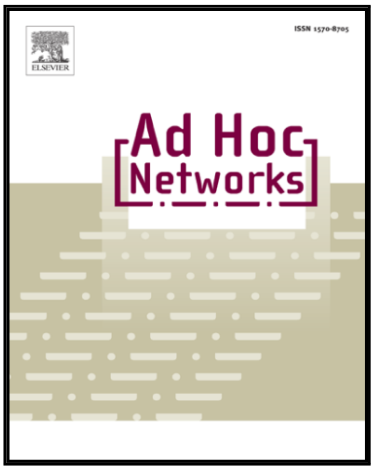

Spectrum Access in Cognitive Smart-Grid Communication System with Prioritized Traffic

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Spectrum Access in Cognitive Smart-Grid Communication System with Prioritized Traffic

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***Abstract*—Smart grid (SG) comprises heterogeneous characteristics of traffic such as control commands (safety, sensing, smart-meter readings) among power generation, transmission and end users. An effective and reliable two-way communication infrastructure between users and utility providers is important for improving the performance of smart grid. To support such traffic types in the smart grid, we have studied cognitive radio communication infrastructure-based smart grid. In this paper, we proposed a prioritized spectrum access scheme for cognitive smart grid communication systems to address the quality of service (QoS) requirements of heterogeneous traffic. SG traffic is categorized into two priority classes (high and low based on service requirements). We model the proposed spectrum access scheme (by considering the spectrum sensing error) using a multidimensional Markov chain. We have measured the performance based on the blocking probability, the dropping probability, the interference probability and the call completion rate for both the traffic types (high and the low class smart grid traffic). By Considering an environment where the traffic is heavy tailed, we have modeled the arrivals to follow a Pareto distribution, as the Poisson process model may under estimate the traffic especially when traffic is heavy tailed. The results illustrate that the proposed priority based scheme is able to significantly improve the QoS of high-priority traffic. It is also observed that the prioritized system is preferable over the non-prioritized system where all traffic types are treated the same in terms of SG data delivery.**

***Index Terms*—Cognitive Radio; dynamic spectrum access; Markov chain analysis; priority; smart grid (SG).**

I. Introduction

Existing electricity grid faces many problems and challenges such as energy waste minimization, electricity demand prediction, effective communication infrastructure to provide a reliable and secure channel for data transmissions between end customers and utility providers [1], [2], [3]. The utility providers are striving hard to address these challenges, including optimal deployment of expensive assets. It is apparent that all these demanding issues cannot be addressed within the line of the existing traditional unidirectional electricity grid. To address these demanding challenges, the "Smart Grid" (SG) paradigm has been introduced, which is a combination of various next-generation advanced technologies [4]. The future power system in the form of a smart grid (SG) is aimed to provide a unified structure of distributed power sources and consumers. Comparing with the centralized and conventional model of power generation, an SG offers several advantages from the perspective of both sources and consumers such as intelligent decision-making, and a bi-directional communication infrastructure between customers and utilities [5], [6]. To allow ubiquitous control and monitoring, novel information technologies should be integrated including power system engineering [7]. An effective data management and communication model plays a significant role for efficient functioning SG. The crucial problems that most of the utilities providers face are how to provide services at the minimum cost and how to get to where they need to be as soon as possible with satisfying their quality of service (QoS) requirements. An effective communication model is used to exchange real time critical information between customers and different utilities. With the help of these information exchange, many functionalities and services can be enabled in SG such as accurate energy supply and demand prediction [8], [6] and fault detection, etc. The information such as control commands, smart multimedia sensor's data, and smart meter reading are useful for controlling the SG. One strong motivation behind an effective communication model is to provide an advance infrastructure for transmission of the huge amount of data of meter reading, control commands and multimedia sensing data.

Information generated by different sources in the smart grid has different QoS requirements [9]. In order to meet the requirements of different traffic in SG, the congested free industrial, scientific and medical (ISM) frequency bands are not sufficient. Since, technologies such as Bluetooth, Zig-bee and Wi-Fi are operating in 2.4 GHz ISM frequency band may cause severe interference to SG services. However, it seems very difficult to license a portion of the spectrum band due to spectrum scarcity, and it may cause extra financial overhead to utility providers [10].

Moreover, the application of cognitive radio (CR) concept in smart grid communication has shown its excellent capabilities in providing a robust communication infrastructure. Due to the abilities of idle channel discovery and reconfigure ability, CR technology is well suited for smart grid applications. Reported works have already proven the capabilities of cognitive smart grid infrastructures to improve the spectrum utilization without compromising the performance of primary network [11], [12], [13], [14], [15]. Cognitive radio is a next-generation communication technology, which can solve the spectrum scarcity problem by accessing unused portion of spectrum and adopting its configuration capabilities [16]. In CRN, a cognitive