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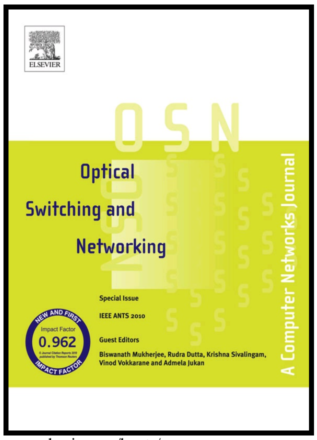

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LTE Smart Grid Performance gains with additional Remote Antenna Units via Radio over Fiber Using a Microring Resonator System

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Abstract:

Smart grid (SG) systems form the backbone of various services that provide comfort and efficiency enhancements. Increasing numbers of SG users cause additional demands by applications on the SG, and this trend eventually leads to the SG being unable to deliver services with sufficient quality. A system of optical and wireless access technologies, namely radio over fiber (RoF), is proposed here for adoption in SG systems (SG-RoF) in order to ensure provision of adequate capacity in line with transmission bandwidth service requirements. This paper details a microring resonator (MRR) system for use in SG-RoF systems, whereby the extra optical carriers are generated so as to increase the number of serviceable remote antenna units (RAUs). A number of very useful and widely used smart grid applications, namely video surveillances and advanced metering data, are also described in the context of the SG-RoF. The performance of well-known algorithms, such as proportional fairness, modified largest weighted delay first, exponential proportional fairness and exponential rule, are evaluated in this work to determine the optimal candidate for use in the proposed system.

Keywords— Advanced Metering Infrastructure, Smart Grid, ring resonator; radio over fiber.

1. Introduction

A smart grid (SG) provides valuable information regarding control and monitoring of power generators and substations, automatic damage detection, and power consumption of end users (Fang et al. 2012). Some of the SG key components include advanced meter infrastructures (AMIs) and phasor measurement units (PMUs). An AMI device collects data in relation to consumption, such as usage rate, time and type of devices, and transmits this data to a control center via a communication network. Additionally, an SG can utilize smart applications, such as video surveillance and voice (Saputro et al. 2012), for further real time monitoring. In order to collect the meter data generated within a smart metering system, SG utilizes both wired e.g. power-line communication (PLC), and wireless communication network technologies e.g. cellular wireless systems (Niyato,Wang 2012). Both of these technologies contain significant shortcomings: PLC suffers from interference during power loading in the network, while wireless technologies such as GPRS are expensive and require further improvements to their quality of service (QoS).

An approach of utilizing radio over fiber (RoF) in order to overcome issues related to wired and wireless technologies in optical communications and networking has been proposed by researchers recently (Ghassemi et al. ; Song et al. 2013; Lu et al. 2016; Li et al. 2015). RoF-based SG networks have compliance to spatial traffic variations and temporal also to hold potential to improve both spectral efficiency and coverage of SG wireless networks. One report (Ghassemi et al.) describes a proposed clustered architecture which provided signal diversity to improve the capacity and coverage of SG networks, while other researchers have used a WiFi terminal to distribute wireless signal to several remote antenna units (RAUs) over a RoF-based distributed antenna system (RoF-DAS) (Song et al. 2013). Fig. 1 illustrates the structure of RoF-based SGs, wherein the network uses optical fiber links to distribute radio frequency (RF) signals from a control section to RAUs. This mechanism allows for the transfer of complex signal processing functions from local base stations to control sections (Ye et al. 2012).

Data within this system is transferred along with the power current via optical fiber composite low-voltage cable (OPLC) to the distribution room, whereupon it is separated from the power current and transmitted towards RAUs. Types of RAUs tend to be offered simply by