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Resource Management on Smart Micro Grid by Embedded Networking

Aleena G.S[a]*., Sivraj P[a]., Sasi K.K[a].

[a]*Department of Electrical and Electronics Engineering, Amrita Vishwa Vidyapeetham, Coimbatore- 641112, India*

Abstract

Smart Grid, the next generation electric grid offers continuous monitoring and control which needs management of resources like measured data, control information, relays, switches etc. These resources will increase as the grid emerges and management of these scattered, bulk and highly complicated data will become difficult with conventional data storing and resource management mechanisms, which makes the cloud model of resource management relevant and significant. This paper deals with the formation of an embedded networking with six systems. Graphical User Interfaces (GUI) are created for different stake holders like consumers, energy traders, operators etc. through which they can access and control the grid assets. The proposed system will improve the performance of the grid by enabling various functionalities such as: analyzing energy usage, managing peak usage, demand management, trading of electricity between smart grid stakeholders such as consumers, operators, generators etc., which ensure efficient operation and management of the smart micro grid.

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Keywords: Smart grid, Cloud computing, Resource management, micro grid

1. Introduction

In conventional power system, central power stations generate electricity and it is distributed to consumers via power system networks. To improve flexibility, power quality, reliability, security and efficiency, the grid is to be made smarter by integrating information technology, automation, telecommunications and electric network control, etc. [1], [2]. As per the European Technology Platform Smart Grid (ETPSG) smart grid is defined as "an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies"[3].

* Corresponding author. Tel.: 919447769901.
E-mail address: aleenagopinathanm@gmail.com

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The grid becomes smarter by the use of modern technologies which permits bidirectional information exchange between the utility and its customers, and the control and automation provided [4]. For achieving this, the smart grid will consists of control units, sensors, actuators, computers etc. As the grid is becoming smarter, the amount of resources like smart meter data, measured data, control information, relays, switches etc. will grow at all levels of grid, and hence there is a need of powerful and cost effective information management system for management of these heterogeneous, bulk and complex data[3]. Here, the cloud model of data management becomes very relevant and significant. The National Institute of Standards and Technology (NIST), explains cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction"[3]. The big data centers with huge computational and storage capabilities forms the foundation for the concept of cloud computing. These data centers are managed by the cloud providers and delivers "computing as a service". Many resources are shared through the network and users can access them through connected devices. Merging cloud computing with the smart grid will enhance the performance and information management of the grid [5].

By combining smart grid and cloud computing various functionalities such as: balancing load with the demand/supply chain, the storage/transfer of generated power, keeping track of energy production from various energy sources and taking decision of switching between the high/low priority demands, analyzing consumer behavior (power usage) patterns to predict the demand in advance etc. can be achieved and thereby the performance of grid can be improved [1].

This paper deals with the design and implementation of cloud network for a laboratory scale 5 bus micro grid [6]. Measurements are taken from the buses and communicated to servers located remotely. Access to this data is provided with the help of GUIs created for different stake holders like consumers, energy traders, operators etc. according to the privileges. Distributed databases are created for smart metering, Wide Area Measurement System (WAMS) and Wide Area Control System (WACS) for wide area situational awareness of the micro grid.

2. Scope of Cloud Computing in Smart Micro Grid

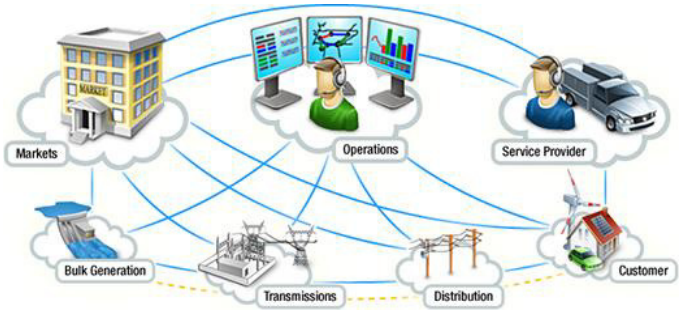

Fig.1. The NIST Conceptual Model for Smart Grid [5]

Smart grid (SG), shown in Fig. 1, the next-generation power grid, will combine improved power, IT and communication technologies to obtain a prompt and intelligent control system that manages highly distributed energy delivery over the network [5]. According to National Institute of Science and Technology (NIST), the various stakeholders of SG are the ones shown in figure1 [5]. Each domain in Figure1 [5] encompasses one or more SG participants, containing gadgets, systems, or software applications that take decisions and performs applications by exchanging necessary information. The summary of each fields and actors are given in [5]. Each of these stake holders are having different responsibilities and privileges.

Customers are the end users of electrical energy. Customers must have easy and flexible options to manage their power consumption, generation, and storage. In SG both IT and communication systems work hand in hand to support many user applications, such as real-time monitoring, and control of wide spread generation, providing real time information etc. for a better customer experience [7]. Energy traders take care of the selling and buying of grid