Real-Time Implementation of Demand Response Programs Based on Open ADR Technology

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Abstract. In the Demand Response (DR) concepts, we witness several barriers that need to be addressed such as, data transferring from promoting entities to demand side. The Open Automated Demand Response (Open ADR) standard specification is a solution for overcoming these barriers. This PhD work proposes a real business model for DR implementation based on Open ADR technology.

1 Introduction

The new and advanced technologies promote a revolution in the power system's implementation, aiming the enhancement of the wholesale market efficiency [1]. Interactive participation of the demand side, such as residential consumers, has a key role in this context [2]. DR is one of the concepts present in these technologies that begin to be widely used nowadays [3]. A DR event can be transmitted from the grid or market operator to the demand side, due to economic or technical problems [4]. The practical implementation of DR programs, raises the following issues: What is the framework for DR data transmission from the promoting entities to the end-user? Is there any standard for bidirectional communication between promoting entities and demand side? Open ADR is a comprehensive solution for these questions and is referred to a methodology for the transmission of DR events data between the utility operators, aggregators, and consumers [5]. Open ADR offers a data transmission framework for DR, allowing communication between the promoting entity (Virtual Top Node – VTN) and the consumer's end-node (Virtual End Node – VEN).

[6] implements an ADR solution for the home energy management system for dynamic pricing. [7] develops a software tool for Open ADR in the smart grid context. Additionally, [8] proposes the most complete tools for Open ADR, which includes the VTN and VEN behaviors. However, till the present, limited business models regarding the integration of Open ADR with real hardware resources have been carried out. Therefore, this limitation motivated the candidate to focus on this subject in order to develop software and hardware tools for implementing the Open ADR technology in the real resources.

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2 PhD Research Focus

The main objective of this PhD research is to develop an architecture for real implementation of DR programs based on Open ADR concepts and framework. The current project includes two main sections: grid and demand side infrastructures. The grid infrastructure contains the VTN, which is owned by the grid operator. This entity will be responsible for the DR event's definition and transmitting it down to the demand side infrastructure (VENs) via Open ADR standard. A MATLAB™ algorithm combined with a graphical interface will be developed for this system in order to define the DR events and sending them to the other subsets (including VENs) via Open ADR standard based on eXtensible Markup Language (XML). The demand side infrastructure consists of several end-node devices (VEN) merged with several hardware resources, which will simulate different types of consumers, such as residential consumers, commercial buildings, and office buildings. The VENs will communicate with upstream players of the grid (VTN) using Open ADR standard. The VENs are accountable for receiving the Open ADR payloads, obtaining the required information and practically executing them on their available controllable loads. Each player has an independent VEN associated with the VTN and Each VEN is configured to receive the XML payload transmitted by the VTN, convert it to executable commands and act on its controllable loads.

Currently, the hardware sections of this project have been implemented, which include the installation of Programmable Logic Controller (PLC) and other microcontrollers for load controlling in each VEN. Moreover, the elementary model regarding the graphical interface and MATLAB™ algorithm have developed, which causes to obtain the primarily results of this PhD work.

3 References

1. P. Faria *et al.*, "Demand Response Management in Power Systems Using Particle Swarm Optimization", IEEE Intelligent Systems, vol. 28, no. 4, pp. 43-51, 2013.
2. O. Abrishambaf *et al.*, "Real-time simulation of renewable energy transactions in microgrid context using real hardware resources", 2016 IEEE/PES Transmission and Distribution Conference and Exposition (T&D), 2016.
3. T. Samad *et al.*, "Automated Demand Response for Smart Buildings and Microgrids: The State of the Practice and Research Challenges", in Proceedings of the IEEE, vol. 104, no. 4, pp. 726-744, 2016.
4. P. Faria *et al.*, "Demand Response Programs Design and Use Considering Intensive Penetration of Distributed Generation", Energies, vol. 8, no. 6, pp. 6230-6246, 2015.
5. About OpenADR, 2017. [Online]. Available: http://www.openadr.org/overview.
6. S. Althaher *et al.*, "Automated Demand Response From Home Energy Management System Under Dynamic Pricing and Power and Comfort Constraints", IEEE Transactions on Smart Grid, vol. 6, no. 4, pp. 1874-1883, 2015.
7. C. McParland, "OpenADR open source toolkit: Developing open source software for Smart Grid", 2011 IEEE Power and Energy Society General Meeting, 2011.
8. EPRI OpenADR. [Online]. Available: http://www.epri.com. [Accessed: January 2017].