OpenADR Protocol of The Wireless Transmission

Lu Yi[1], Meng Fanbo[2], Wang Nan[1], Yu Miao[1], Wang Junnan[1], Cao Wangzhang[3]

[1] *State Grid Shenyang Electric Power Supply Company, Shenyang 110003, China*

[2] *State Grid Liaoning Electric Power Company Limited, Shenyang 110006, China*

[3] *School of Electrical and Electronic Engineering, North China Electric Power University, Beijing 102206, China*

direfish@163.com

Abstract—**This paper mainly introduces OpenADR(Open automatic demand response) transfer agreement. At the same time, this paper will introduce a new concept of wireless transmission in this protocol. The thesis also introduces the contents of protocol, such as the transfer mechanism and interactive mode. In this article, we based on OMNeT + + software to simulate the protocol communication behavior.**

Keywords-OpenADR; simulation; wireless network;, communication framework

I. INTRODUCTION

With the development of smart grid At home and abroad, the demanding of Intelligent Automation in substation, the client terminal of distributed energy resources communication and Power Grid Corporation are increasingly. The reliability design of communication protocol is an important approach to ensure the reliability of modern communication system. Relevant design and Simulation platform building have become an inevitable new trend, where user participation is to build one of an important component of the demand response automatic system. However the traditional way of Information interaction and non-intelligent distribution network system have become a serious impediment to the exchange of communications between grid companies and users. To solve the problem of the grid communications, related areas of DR Organization put forward multiple concept and application, which contain the OpenADR in agreement.

OpenADR protocol originated in 2002 California large-scale electricity crisis, which are Designed to solve electricity demand growth, peak electricity, power demand prediction and control problem by the United States government [1].The OpenADR protocol belongs to communication application layer. It also can be a great way of exposing functionality in providing a public, open, standardized interface about DR application.

A perfect and mature method of protocol is the key component to driving continuous improvement for demand response project, especially when wireless technology will be used for this protocol framework agreement .It will have the following advantages:

1) Mobility: without time and space constraints, the user can roam in the network.

2) Flexibility: we can freely add and configure a workstation without the restrictions of cable.

3) Low cost: the wireless LAN does not require extensive cabling project, while saving the cost of line maintenance.

4) Easy installation: comparing to a wired network, wireless LAN configuration is more easier to setup and maintenance.

II. PROTOCOL OVERVIEW AND EMULATION

A. Protocol Overview

OpenADR protocol has several versions, which can be divided into 1.0, 2.0a, 2.0b, 2.0c. The main information model adopts WSDL, but no specific certification. In addition, 2.0a, 2.0b and 2.0c version of the protocol application scope is demand response management [2]. Each version contains different information requirements and standards for information transmission.

OpenADR 2.0a basic communications architecture is shown in Figure 1[3]-[4]. In the overall Electric power system, the main functions of the grid side is the energy supplying, which also can send the instructions of Demand Response to the aggregators at set periodic times of the day. On the one hand ,the aggregators publish the message to user groups when they receive the instructions from grid side, the message content is mainly about resource allocation, task decomposition and so on .On the other hand, user groups can response to aggregators to varying degrees. Likewise, users can send some request message to express their purpose in the needs of the server through aggregators [5].
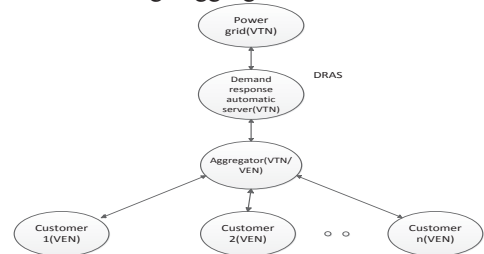

Figure 1. OpenADR relationships of VTN and VEN

B. Protocol Emulation

The wireless communication is based on OpenADR protocol framework. And we will use OMNeT ++ software to simulate the signal transmission between the Power grid, aggregators and user groups. Specific simulation content includes basic transport mechanism and application packet transmission. Software can establish a base structure model through refining several reusable components. With different elements combination and the different models created. We will achieve many useful function for the protocol what the platform can be.

III. EMULATION CONTENT

Specific content of this chapter is simulation. The simulation can be seen in the framework agreement, and has been established in a specific interaction between the two nodes, such as VEN (virtual end node) and VTN (virtual top node).These two nodes also separately represent different entity. Such as VEN can represents the aggregators or user, which subscribe demand response service from VTN. VTN represents the aggregators or grid side and DRAS (demand response automation servers) which release information about the power market to VEN. The interaction contains PUSH and PULL transfer mode [6]. Owing to the protocol agreement has PUSH and PULL mode. we decide that making simulation model for the PUSH and PULL transfer mode and interactive model.

Whereafter, considering the data transmission between multiple nodes and simulating basic communications function in wireless technology, we specifically build a model protocol of data packets. The data packets mainly contain detailed information. The VTN of the aggregators or DRAS send particular commands to VEN .And VEN give feedback on particular data information [7].

A. OpenADR Interactive Modeling

Due to we want to build a simulation platform to describe the interaction between different entities, this sections content is mainly about the different entities (servers, aggregators, customer) Interactive mode. In this section we offer specific details on these entities how to communicate and what the communication package contain about. For examples, the package may contain the source and destination address, electricity cuts indicators, priority or the time, priority, identifiers and so on [8]. In addition, we will consider the implementations of function in indispensable protocol standard. For example, essential information collection function in user side and the data analysis function in grid side.
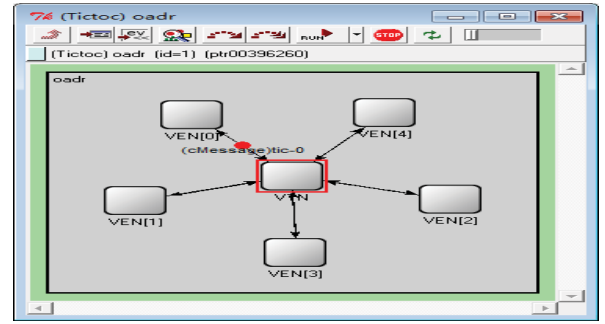

Figure 2.   OpenADR interactive mode

B. Protocol Transfer Mechanism

The simulation-based content is based on the customer energy habits of fast Detection, accurate forecasting, data analysis on time and space. The simulation mode also can support the current grid electric power automatic dispatching. Established model in this section is shown in Figure 3.
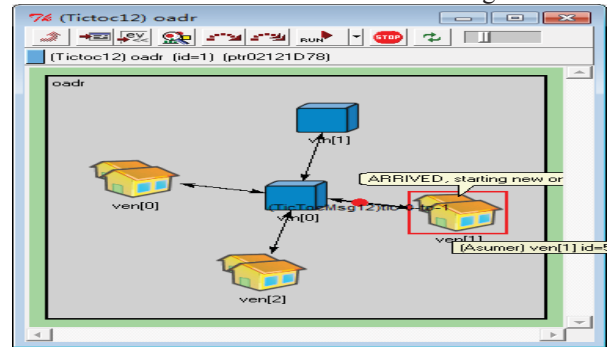

Figure 3.   OpenADR transfer mechanism

In this model we will find that VTN [1] and VTN [0] can be set to DRAS (demand response automatic server), power aggregator respectively. And VEN [0], VEN [1], VEN [2] can be set to the assumption of three user which customize business of demand response services. The model describes the behavior of the overall electricity grid in detail.

In this platform, we will achieve two modes, one is to push and the other one is to pull. They have different application scope. The main application of push mode is the side of the grid Demand response server or aggregators interact actively with user, just like aggregators send instructions and messages. Likewise, Pull mode is mainly used for the user interacts actively with side of the grid Demand response server or aggregators.

C. Simulation results

The simulation result of protocol transmission is show on Figure 3. The detailed content of simulation will be explained below.

```
new message
Forwarding message [cMessage]tic-0 on port out[2]
"" Event #13. T=    1.3 ( 1.30s). Module #5 `oadr.VEN[2]'
just VENresponse .
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #14. T=    1.4 ( 1.40s). Module #2 `oadr.VTN'
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #15. T=    1.5 ( 1.50s). Module #3 `oadr.VEN[0]'
just VENresponse .
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #16. T=    1.6 ( 1.60s). Module #2 `oadr.VTN'
Forwarding message [cMessage]tic-0 on port out[4]
"" Event #17. T=    1.7 ( 1.70s). Module #7 `oadr.VEN[4]'
just VENresponse .
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #18. T=    1.8 ( 1.80s). Module #2 `oadr.VTN'
Forwarding message [cMessage]tic-0 on port out[1]
"" Event #19. T=    1.9 ( 1.90s). Module #4 `oadr.VEN[1]'
just VENresponse .
"" Event #20. T=    2 ( 2.00s). Module #2 `oadr.VTN'
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #21. T=    2.1 ( 2.10s). Module #3 `oadr.VEN[0]'
VENresponse and oadrcreatedEvent.
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #22. T=    2.2 ( 2.20s). Module #2 `oadr.VTN'
"" Event #23. T=    2.3 ( 2.30s). Module #3 `oadr.VEN[0]'
new message will send out.
Forwarding message [cMessage]tic-0 on port out[0]
"" Event #24. T=    2.4 ( 2.40s). Module #2 `oadr.VTN'
```

Figure 4.   the result of transmission

VEN (user) receive the VTN (aggregators or demand response servers) message and according to their own need to make a decision whether giving the response message to VTN. In addition, maybe VEN will give extra demanding message to require some market news just like real-time price counting of electricity sometimes.

What's more, as mentioned above, we build this simulation platform to describe the interaction between different entities, and set up a function module to collect statistical data of   electrical peak demand management. For examples, VTN[1] (server) allocate demand curtailments(MW) to VTN [0] (aggregator), and we should detect the total curtailment information from VTN[0] and collect data from the VEN (use) respectively. As shown in Figure 5, the overall task curtailment amount of VTN [0] is 164(MW), and VEN [1] (customer 1) accomplish task distribution is shown Figure6, which has considered packet discard rate. And Figure7 result has no consider packet discard rate. The result of the curtailment target detection for the user side and aggregator side is shown in Figure 8.The detection of simulation main divide into two results. One is without taking into account any packet loss rate and another one is that considering the packet loss rate. The horizontal axis represents the time, vertical axis represents the degree of completion of curtailment. Each user has completed the electric curtailment, and the accomplishment fluctuates around a fixed value.

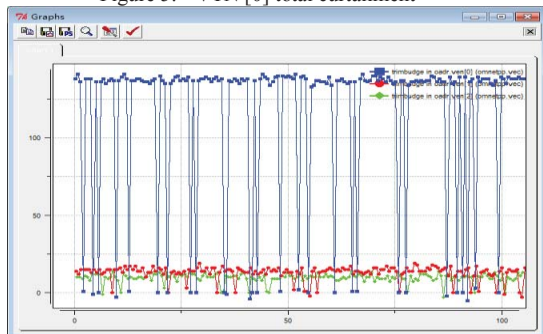Figure 5.   VTN [0] total curtailment

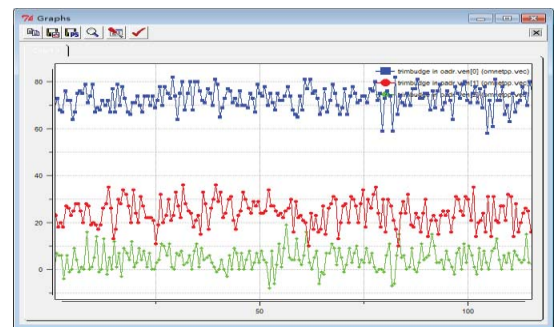Figure 6.   VEN[1] accomplish task distribution

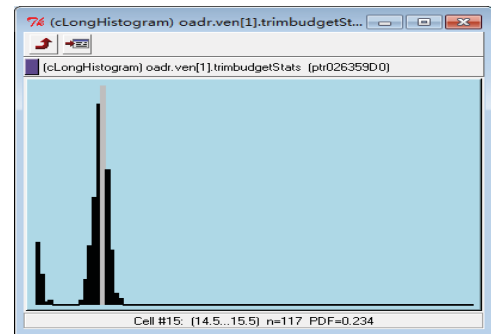Figure 7.   VEN[1] accomplish task distribution without packet discard rate

Figure 8.   VEN[1] accomplish task normal distribution

IV.   SIGNIFICANCE OF SIMULATION

With the current strong unified national power grid drives the smart grid projects and grid optimal allocation of resources, utilization of the power grid side has making more high requests. Generation and distribution have become important role in maintaining electric power system stability [9]. Grid communications is a decisive factor of promoting DR project development.

How to achieve a public, open and standardized interface about DR application is the one of the key technique problems .In this paper, we put forward a new idea about achieving OpenADR protocol through wireless network. In the OpenADR protocol communication framework, servers, aggregators and customer communicate with each other. the decentralization of certain reduction target to the electricity side, in order to achieve reduction of peak power load, optimize power resources, rational grid stability and greatly improve the electricity grid Load deploy space [10]. It can also avoid the peak periods of high electricity prices and high consumption of electricity, improving the overall effectiveness and efficiency demand side to achieve cost optimization.

Because of traditional electricity grid publish electric power dispatching information commonly uses backward technique ,such as Artificial bulletin, power supply website notice, local newspapers, television stations or telephone inquiries and so on. Acquiring information is too complicated and inconvenience, it is also not conducive to manage the scattered distribution, operation of the device more user groups. At the same time, Demand response management Need to cooperate actively with local customers in real-time and pay close attention. In order to improving previous power distribution method effectively and solve the problem of

power scheduling as flexible as possible. Only through carrying out the power control unit, the detection device, the information collection device access on the basis of the smart grid can we achieve success. The real demand response management. The communication system functions and consumer side service still need a lot of investment to improve and perfect. Developing communication project must be in combination with a complete set of protocol, only in this way can we achieve a more convenient and more flexible interactive pattern.

V. CONCLUSION

This paper introduces a concept for adopting the OpenADR protocol for demand response communication by using Wireless transmission. At the same time we establish a platform to simulate Information interaction by OMNeT++ software. Advancing this new concept can help us to understand and recognize how convenient and effective for us to drive the project forward, if we take into account the wireless Technology when we research demand response by Implementing the OpenADR protocol.

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