Power Data Network Dynamic Simulation Platform

Qian Guo, Xingchuan Bao and Gu Feng

Abstract Simulation is a powerful tool for research. In many cases, it is needed for realistic network simulation and the power of data prediction, modeling a large number of simple interactions electricity Statute, without attention to details of a particular Statute, to identify a key component or the whole network's support of power protocol and the ability of stable work under critical conditions such as data stream change, long-term transmission and critical states. This paper proposes and implements a model of power data network dynamic simulation platform to solve the dynamic and power protocol simulation problem in large-scale network simulation, through multi-threaded and multi-agent dynamic changing, the layered implementation of OSI model, and simplified simulation methods of the power protocol.

Keywords Power data network · Power protocol · Dynamic · Simulation

1 Introduction

With the rapid development of intelligent power system, power applications, and power data network environment is increasingly complex, power data applications increasingly high demand for the transfer of existing devices on the power of the Statute, in particular based on the multi-cast the lack of real-time transmission

Q. Guo (✉) · X. Bao · G. Feng
Chinese Electric Power Research Institute, Nanjing, Jiangsu, China
e-mail: guoqian@epri.sgcc.com.cn

X. Bao
e-mail: baoxingchuan@epri.sgcc.com.cn

G. Feng
e-mail: fenggu@epri.sgcc.com.cn

S. Patnaik and X. Li (eds.), *Proceedings of International Conference on Soft Computing Techniques and Engineering Application*, Advances in Intelligent Systems and Computing 250, DOI: 10.1007/978-81-322-1695-7_5,

performance of the Statute, are directly related to the stability of power control [1]. Therefore, how to simulate changes in the real network environment to determine the carrying capacity of the power application, clearly the real power data network the ability to work in the case of data flow changes, long-term transmission, critical state stability to predict the types of events that may occur, related to the long-term stability of the grid. Data networks and related communication member simulation testing process often require the interaction of the high-load application data to support capacity and transmission performance for a specific application, without the need for strict Statute data details. To this end, a power data network simulation platform model, this paper proposes a power data network simulation platform model OSI model-layered, multi-threaded, and multi-agent dynamic changes, and power Statute-simplified simulation to solve large-scale network simulation of dynamic change and power Statute simulation.

2 Introduction of Existing Simulation Technology

The existing network protocol simulation technology application layer pressure simulation, flow simulation, the packet simulation and the Statute of simulation to simulate different levels of network data contents, these means of simulation in a certain extent, to meet certain needs of the network testing requirements. The simulation and detecting unity are applicable to the detection of the experimental environment, and there are some defects in the large-scale simulation.

The pressure simulation application layer and application layer interaction, simulation a large number of users to access. This type of simulation is mostly used in application systems and Web performance testing of the system, for example Load Runnerm QA Load. The test and simulation process is totally dependent on a common protocol and unable to provide effective support for custom protocols.

Flow simulation simulates frame structure and data stream of OSI 2–3 layers as switchers, routers et. Most of this type of simulation for performance testing of communications equipment and safety equipment, typical flow simulation tools the Spirent TestCenter series, Xixia Ethernet test kits, test and simulation emphasis on test accuracy, simulation process to determine the content, flow and times for the center, the support capacity of the specific content of the data packet and dynamic movements [2].

Packet simulation is used mainly for packet interception and playback mode; the simulation is repeated reality by real packet network data traffic, and this type of simulation accuracy and data packet structure is complicated; usually rare in the general, communication device testing in the security equipment testing and on-site environmental analysis are more common [3]. Test and simulation process flow structure is usually a certain period of time to do the template, and the dynamic changes of weak cannot simulate the dynamic process, and also the lack of support does not support the application of static resolution.

The Statute of the simulation for the professional protocol Statute simulation and analog initiates and responds to the Statute of the standard process; specifically for the class of devices, Statute standardized the typical power Statute simulation. The Netherlands Kema Statute simulation series is the most common [4] and IEC101, IEC104, and IEC61850 international standard protocol support are better. Traditional test and simulation for a single device or a single protocol simulation is more focused on the analysis of the protocol conformance, not large-scale simulation [5].

On the other hand, the simulation for real-world applications of electricity or power data network environment, especially for the power protocols passing through industrial switchers, is only need to focus on real-world multi-application high loads and complex environment, but do not focus on specific details of the power within the statute. This requires a large flow simulation to simulate the power data network simulation platform.

3 Dynamic Simulation Platform for the Design of the Electric Power Data Network

3.1 Logical Structure

In this paper, through data exchange between the various distributed components, the Power Data Network Dynamic Simulation Platform constitutes a logical network application environment, which can simulate various types of electrical applications, in the physical network environment to simulate the real environment of each application and the power of the Statute of the interaction data streams, and to achieve more accurate and credible simulation environment providing strong support for predicting changes in network and application specific circumstances visible data.

The logical structure shown in Fig. 1 consists of three basic elements constitute: Controller, Agent, and DUT.

1. Controller: mainly responsible for the graphics display, data analysis, policy formation, coordination during the simulation of load sharing between the agent terminal thread dynamic control and the coordination of agent and terminal emulation thread.
2. Agent: analog equipment and related agreements impersonated thread simulation object is responsible for loading. The section is responsible for carrying internal analog thread and, according to the instructions of the Controller, to its corresponding dynamic control.
3. DUT: measured or need simulation test object. It may be provided for a physical network and may also be a business application, or more complex multi-application environment.

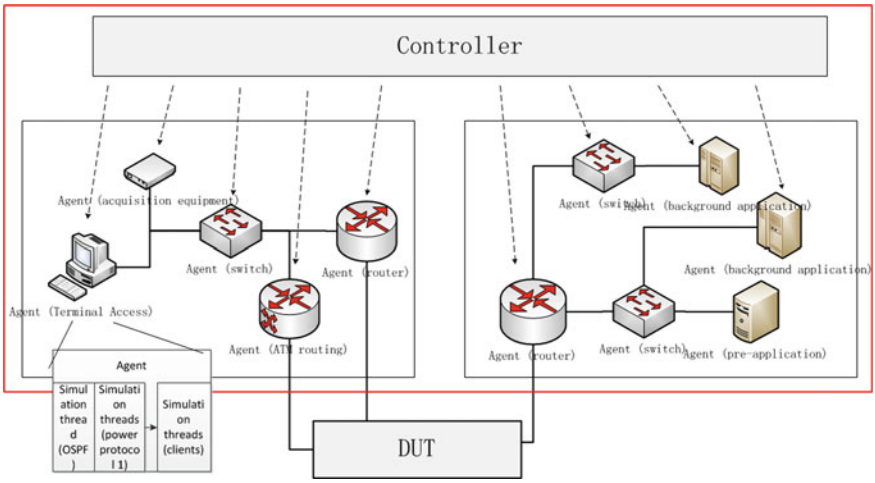

Fig. 1 Logical structure

In this way, the network model of the basic elements of the interaction together constitutes a realistic simulation of the application of the network environment.

3.2 Hierarchy

The power data Network dynamic simulation platform performs as four layers, the hierarchy shown in Fig. 2. Level functions are as follows:

1. Presentation layer: responsible for the performance of the test data shows the relevant data, including dynamic charts, bringing dynamic response test objects such as flow rate and changing data, simulation objects and the corresponding test object log data and a variety of error correction nuclear data.
2. Abstraction layer: responsible for all kinds of policy definition and summary of events functional layer reanalysis. Interaction is defined as each object layer mock objects carry data, logical relationships policy definitions, such as operating cycle and a special response status. Agent is responsible for the definition of the deployment of the Agent, type definitions, and management. Topology defined for each Agent object is the logical topology to achieve mutual relationship and form definition. Event analysis is a summary of events in the functional layer reanalysis.
3. Functional layers: the lower functional layer is mainly responsible for the management, including policy distribution, topology to achieve, time synchronization, event aggregation, and other functions.

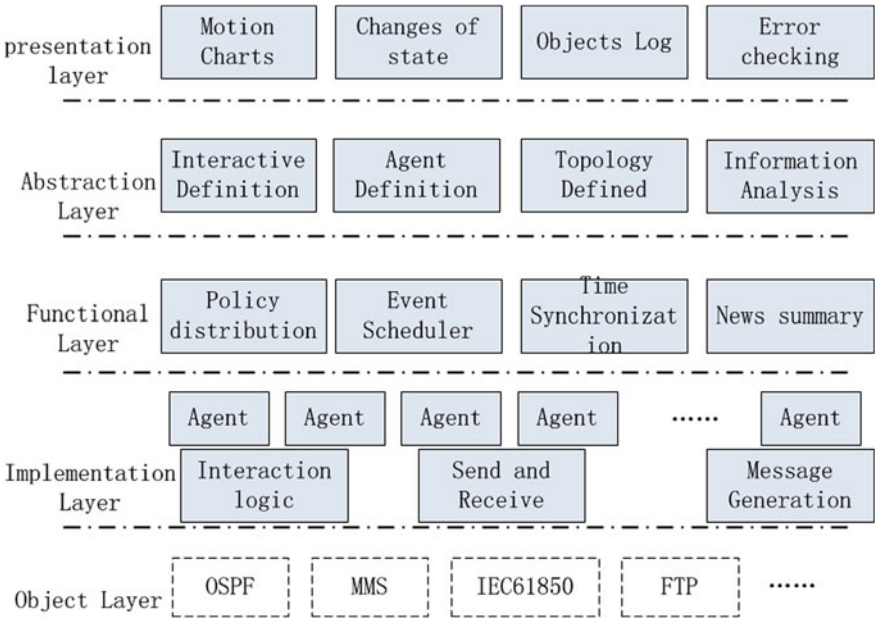

Fig. 2 Hierarchy of model

4. Implementation layer: agent through the achievement of specific interaction logic, data sent and received, as well as events related to the generation of test data for transmission to the upper layer.
5. Object layer: responsible for the Agent to specific protocols and applications simulation.

4 Working Mechanism of Power Data Network Dynamic Simulation Platform

According to this model, the power data network dynamic simulation platform should be dynamic while being able to meet the high-performance requirements.

4.1 Simulate the Dynamic Interaction Objects

For data network in the power dynamic simulation platform, each agent is independent of the individual objects are shown in Fig. 1. When an agent needs to communicate with another agent, its threads will interact within the simulation

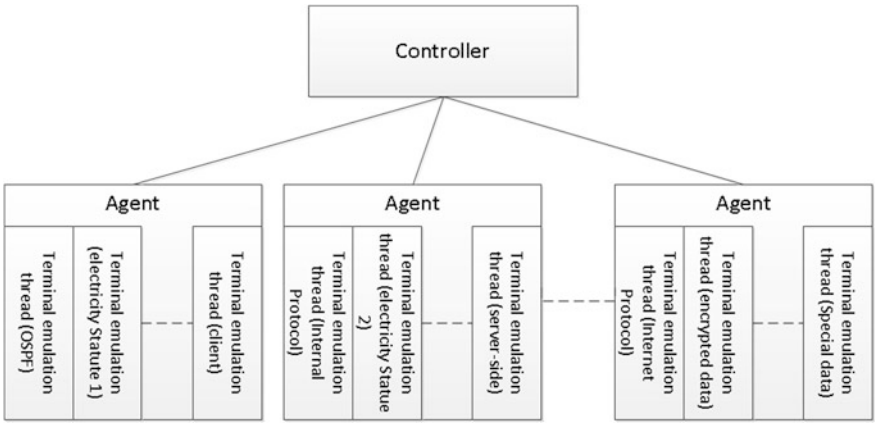

Fig. 3 Implementation of simulation object's dynamic changes

data in the form of event–event pushed to the functional layer for event scheduling, and different events will be forwarded to the target object and analog objects for dynamic interaction, to achieve dynamic changes such as OSPF, FEP acceptance, and forwarding dynamic response action.

4.2 Dynamic Mock Object

The platform is based on Remote Controller, Proxy Agent and Terminal Emulation Client Thread, shown in Fig. 3, making mock objects which can simulate a variety of dynamic changes typical situations.

1. Dynamic change proxy client Agent. Proxy Agent can simulate a number of interactive processes, and also can simulate a large network. Changing the amount of Agents, is actually increase or decrease a lot of simulated environments.
2. Change the dynamic simulation of thread. Each analog thread is designed to simulate the actual interaction of an application, the dynamic simulation of the thread change, changing the number of operational simulation, emulation communications network operator log, exit, operation, and other basic business operations.
3. Dynamically changing simulation threads. Threaded applications by changing the simulation process, changing the interactive process simulation, creating misuse, abnormal operation, etc.

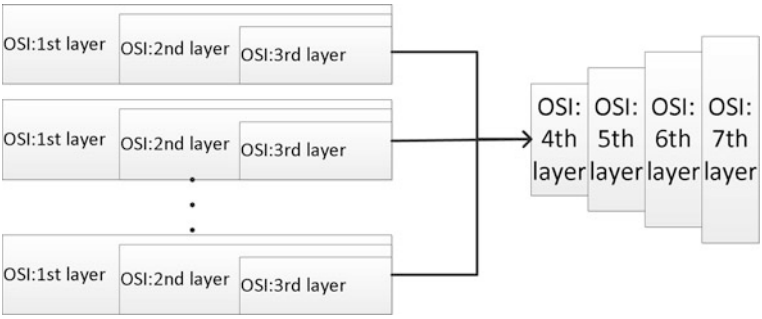

Fig. 4 Level constitutes of simulation protocol

4.3 Different Levels of Dynamic Change Agreement

With digital substation and smart grid in use the power of data transmitted over the Internet will not only include current common electricity protocols as IEC61850, but also include more complex protocols and applications, whcih will be more and more. The current mainstream flow simulation is mainly for OSI2–3 layer custom protocol emulation, usually by way of a data frame simulation, which uses OSI1–3 layer packet stepwise manner to construct. Such emulation mode cannot simulate OSI 4-7 layer protocols, such as IEC61850 mainly due OSI4–7 layer joined the interactive process, so that a complete OSI4–7 layer transmission requires multiple OSI1–3 layer packets combination is completed.

For data network in the power dynamic simulation platform model, OSI4–7 layer and 1–3 layers separated analog mode, see Fig. 4.

In the process of constructing the simulation protocol, when simulating IEC61850 class Statute [6], terminal emulation thread will call a type of OSI1–3-layer protocol packets matching a single-application process in order to provide support for such an agreement; And when simulating complex applications, then OSI1–3 layer protocol packet analysis section from recombination, while an application process is responsible for receiving data packets on the other hand reorganization, the application process for the corresponding packet exchange provides the underlying protocol support. As a result of such a separate analog mode, all 1–3 and 4–7 layer protocol interaction data can be run on the same analog thread; when you need dynamic switching, it does not need to be as similar to other simulation platform stop switch, only need to dynamically add, delete impersonated thread; you can achieve different levels of agreement dynamics.

4.4 Simulation Performance Improvements

Separating the application layer and the bottom, to solve the OSI layer protocol simulation problem, but it is complicated, and bulky Statute response protocol

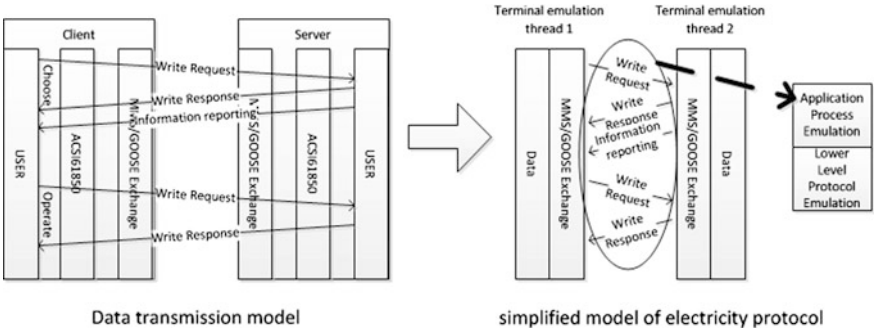

Fig. 5 Simplify the simulation of GOOSE

defined data definition and precision will inevitably lead to poor performance, and these parts will not be transmitted and the transmission network detailed device identification. In fact, the data network and transmission equipment only for electricity Statute underlying transport (i.e., OSI4 layer and below) [7] provide accurate identification of parts of the transmission path. Even the particular application layer filtering equipment, but also only the Statute otherwise specifically interested in the interactive process, those definitions specifically state the amount of data that only the final application will be specifically identified, and the entire transfer process will not be particularly concerned about. In view of this, we need to make the appropriate Statute of power cut, select the contents of concern, and discard irrelevant data in order to maximize performance and accuracy.

In case GOOSE message. According to IEC61850 standard, GOOSE messages directly mapped to the Ethernet protocol stack; but in a standard Ethernet header added a Tag, Tag contains a 12-bit virtual LAN identification code (IEEE802.1q) and 3 bit of packet priority code (IEEE802.1p), on priority tagging and virtual LANs details encoded in IEEE Std.802.1Q: virtual bridged Local Area Networks in detail [8].

Since GOOSE message is mapped directly from the application layer to the data link layer, message content just application protocol data unit (APDU) does not include other protocols such as TCP or UDP packet header. Format of the packet is based on the manufacturing message specification (MMS application layer protocol specification) and ASN.1 data to the correspondence between bits of code coding standards, so the Statute complies with the interactive part of the MMS interactive process. For simulation of the GOOSE message data transfer protocol based on GOOSE model, data can be simplified and application section to fill the data instead of, the individual packets, can be simplified as part of the underlying transport protocol OSI, GOOSE interaction protocols, and padding data part of the simulation, Client and Server, respectively, by a different terminal emulation thread simulation in Fig. 5.

5 Conclusions

With the gradual deepening of the development of the smart grid, smart meters and smart application of a large number of applications. The power data network and back-end applications, which support these smart devices running, will also play an increasingly important role in the stable operation of the power grid. Dynamic simulation predicted power data network will play an extremely important role. Power Data Network Dynamic simulation platform model proposes a clear and detailed platform solution. It makes electricity more operational data network simulation and related software for the development and application of reference.

Acknowledgments Thanks to Dr. Yu Yong. He spends a lot of time for this article and effort to provide guidance and assistance. Thanks to Dr. Yu Yuehai on the power of the Statute to provide technical support, and finally, thanks to Zhang Tao, who provided selfless help.

References

1. IEC 61850-8-1.: Communication networks and systems in substations-Part 8-1: Specific communication service mapping (SCSM)-Mapping to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 (2004)
2. Deng, Y.M., Xiong H.G., et al.: The computer simulation of switching ethernet. Comput. Eng. Appl. **04**, 167–169, 223 (2004)
3. De Lu, C. , L.V., Sui, Z, Jiang X.Z.: Development and application of simulation technologies in the power industry of China. J. Syst. Simul. **04** (1999)
4. Miao, W.G., Liu, F., Tang, K., Zhang, X.W.: Study on protocol testing technology in substation based on IEC61850. Jiangsu Electr. Eng. **08**(75–76), 82 (2007)
5. Zuo, Q.Y., Zhang, Y.L.: Study and application of IEC61850 protocol test technology. Relay **02**, 68–71 (2007)
6. Lin Z.M., Yang, F.P., Yu, Y.: Analyzing and implementation of mapping between IEC61850 and MMS. Relay **02**, 64–67 (2007)
7. Ren, Y.M., Qin, L.J., Yang, Q.X.: Study on IEC 61850 communication protocol architecture. Autom. Electric Power Syst. **8**, 62–64 (2000)
8. Ke, S.W., Liu, S.G., He N., Liu, Y.: Study of GOOSE messages on the substation transmission. Relay **35,** 308–310 (2007)