Research on stable control communication network platform for multi-source big data fusion

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Abstract. With the rapid development of large power grid, the demand for real-time, efficient and reliable applications of different services is also increasing. In this paper, based on the architecture of control and protection private network, we studied the new stable control test system and communication network scheme, proposed the multi-source data real-time transmission and interactive processing architecture of machine side, network side and load side. And we built a digital analog hybrid simulation test platform to verify its overall architecture, functions and key technologies in the test environment. Finally, we tested the reliability and rapidity indexes of communication network transmission protocol, interface and information transmission, at the same time gave some feasible suggestions for engineering application in actual power grid by taking business flow simulation as an example. It lays a foundation for engineering application and popularization.

1. Introduction

Along with power grid structure is complicated, especially the emergence of large-scale interconnected power grid, and long distance large capacity transmission and the application of ac/dc hybrid transmission, the stability of the power grid control mode has already can't rely on a single goal, a single type of stability control device or local control device to solve, and more dependent on the target, regional stability control device control mode of the Internet. At the same time, with the development of fast stability analysis method, computer and communication technology, it is possible to develop and apply power grid stability control system based on large system theory, hierarchical and decentralized control theory[1].

Existing power grid information system exists between all systems of divide and conquer, information transmission standards are inconsistent, is difficult to meet the problem of comprehensive utilization of real-time, key in design based on multi-source large data transfer mode of real-time control to protect private network architecture, to meet different business real-time, efficient, reliable and at the same time the application needs. The architecture based on the control and protection private network needs to solve the real-time transmission and interactive processing of multi-source data on the machine side, the network side and the load side. At present, there is no reference technology and experience, which needs to be further studied. In terms of information processing standardization, there is no unified standard on the interface between measurement and safety and stability control devices and the protocol of information transmission, which needs to be studied. For the key technologies of the control and protection private network architecture based on multi-source real-time
data transfer mode, it is necessary to verify its overall architecture, functions and key technologies in the test environment, and evaluate its engineering application and promotion application[2-4].

2. Construction of multi-source big data stability control platform

There are two schemes for constructing the experimental platform of the new stability control system with multi-source data fusion. As shown in the figure above, the SDN switching equipment of the control center is directly connected to the SDN controller of the substation through the service transfer scheduling platform to reconnect the SDN network[5-6]. The substation SDN switching equipment is connected with the stability control device, and the data of each substation stability device is transmitted to each control center through the SDN switching equipment, which is uniformly controlled by the control center. In addition, the SDN switching equipment of each substation is connected to the backbone network through TM/ADM, and the data can also be transmitted to the SDN controller of the control center through the backbone network.

![Figure 1. Test platform architecture Scheme 1](image)

Scheme 2 is shown in the figure. Two or more substations form a domain. Each substation's standing control device in the domain is connected with the SDN switching equipment in the station, and the SDN switching equipment in each station is connected through the domain SDN switch domain control center. Compared with the SDN switching equipment in scheme one station which can transmit through backbone network, the SDN switching equipment in scheme two stations can only exchange data with the domain SDN switch, which is connected to the control center through SDN network or backbone network.

![Figure 2. Test platform architecture Scheme 2](image)

3. SDN architecture based on big data transmission
The new stability control system based on multi-source big data fusion developed in this project only needs to be directly connected with the controller, so that all controllers can be uniformly scheduled. In this scheme, the interface technology involved is similar to the interface technology in the MULTI-controller SDN architecture, which is specifically described as follows:

- **I2 interface**: The interface between the convergence and core layer router and the network management system and the business system access layer switch, generally using RJ45 Ethernet interface (electrical port) or SFP/SFP+/XFP interface (optical port) interconnection;
- **I3 interface**: the interface between the access layer switch and the wireless AP and the business terminal and office terminal. The wired part is generally connected with R45 Ethernet interface, while the wireless part is generally connected with 802.11b/g/N/AC and other wireless protocols.
- **I4 interface**: The interface between the access layer switch and the network management system and the business system. Generally, RJ45 Ethernet interface is used for interconnection.
- **I5 interface**: OpenFlow protocol 1.0/1.3/1.4 and other protocols are used to realize the information interaction between controllers and SDN switches in the south control interface between domestic and foreign relatively standard controllers and SDN switches. Meanwhile, for controllers with network management functions, I5 interface still needs to support SNMP, NETCONF, Telnet and other protocols to realize the management function of SDN switching devices.
- **I6 interface**: It is the interface between the SDN-based power service flat dispatching analysis test system and all controllers developed in this project. The technology adopted in this project is protocol. See "Interface with Controller" in section 3.3 for details.

4. The establishment of stability control test system and communication network platform

The test platform of the new stability control system was divided into RTDS real-time simulation, SDN control and protection private network, and the new stability control system and its supporting equipment[7-9].

![Image](image_url)

**Figure 3.** Design scheme of stability control simulation test

4.1 Flow simulation and feature analysis

To realize the business flow simulation, several steps are required to add the flow generator node, configure the flow parameters, and start the flow generator to generate the simulated flow, as shown in the figure below.
Figure 4. Simulation flow chart

After adding a flow simulation node, namely a flow generator bearing node, to the topology diagram through the GUI interface, the flow parameters can be set through two interfaces of "simulation flow Management" and "simulation Flow setting interface" in the GUI interface. After the parameter setting, check whether the parameter format is reasonable. If it is not reasonable, prompt the user to reconfigure the parameter. If it is reasonable, save the parameter and proceed to the next operation.

The simulation software can store the relevant data to create simulation traffic in the following form:

\[
\text{T} \text{raffic} = \{
\}
\]

// Dictionary form stores data traffic generation node and its corresponding simulation traffic

"Node Name": \{
// The dictionary form stores the name of the simulated traffic on the node and its corresponding parameters

"Simulation Flow Name": \{
// Simulation flow related parameters such as source address, destination address, etc

Sour Add: 192.168.1.1, Dest Add: 192.168.2.15

In the above dictionary items, the innermost dictionary stores the specific parameters needed by the flow generator to generate the flow. The detailed description of parameters can be seen in the following table.

| Flow simulation parameter | meaning |
|---------------------------|---------|
| Sour Add                  | Source IP address for simulated traffic in a format similar to 192.168.1.1 |
| Sour Port                 | Source port to simulate traffic |
| Dest Add                  | The destination IP address of the simulated traffic in a format similar to 192.168.1.1 |
| Dest Port                 | The destination port for simulating traffic |
The protocol types used for simulation traffic include TCP, UDP, ICMP, etc.

The generation rate of simulated flow

The contents of the data carried in the simulation flow

The analysis of network traffic characteristics is one of the main problems to be solved in modern network research. In order to monitor network traffic in real-time and quickly find abnormal traffic through traffic monitoring during fault drill, it is convenient for operation and maintenance personnel to quickly lock the victim node, traffic type and data source, etc.

This paper provides two methods of data acquisition:

- **Method 1:** Data collection for the specified port of the specified device. In this way, the data packets of the port are directly captured to generate files in CAP format, which are opened through Wireshark tool. Users can conduct detailed analysis on the data packets forwarded through the port. This kind of view way is more flexible.

- **Method 2:** Synchronous acquisition of port data of a large number of simulation devices. In this way, SNMP protocol is required to be enabled in all simulation nodes. This project adopts the method of multi-thread concurrency when collecting data. Each thread collects data on all ports of a simulation device through SNMP tool, and the collected data is stored in a file in the format of RRD. After the analysis, the data in the stored file will be drawn to generate graphical results. At the same time, these data and pictures can be stored for users to use later.

### 4.2 Stability control system engineering example application

The system supports the creation and cancellation of channels reserved for specific businesses according to the time dimension. According to the management of QoS default setting policy supported by business, different time dimensions such as day, month and year are supported.

The statistical function can use histogram and line graph to display relevant data in the network, such as packet quantity information and speed information. Meanwhile, it can customize the time to display all data information in a certain period. The histogram is shown in the figure.

As shown in the figure, the real-time flow chart of the input and output data of port 2 of the device with IP address 192.168.1.89 in the simulation network is shown. You can observe them individually or compare them in a single graph. In addition, the data display form can also be selected according to user needs, can choose: column, polyline, etc.

![Figure 5. Input data real-time traffic graph](image)
According to the functional requirements applicable to power communication big data management, the main functions of the test system include the following aspects:

Network virtualization management, through flexible configuration of SDN switches to obtain any virtual logical topology network structure that meets the requirements of terminal access, service isolation and service quality;

Grid business scheduling, ensuring the flow scheduling strategy and priority control of grid business QoS requirements;

Network configuration management, acquisition of equipment and link information in SDN, and support functions such as add, delete, change and check;

Network fault management, real-time receiving alarm information from SDN and presenting it in the real-time monitoring interface;

Network performance management, acquisition of SDN equipment performance data, and support for query and statistics, etc.

Topology management: Support dynamic topology generation and management of SDN;

Policy management: support the creation and cancellation of channels reserved for specific businesses according to the time dimension; Management of QoS default Settings based on business support.

It is tested and verified by digital-analog mixed simulation test platform. The project has low cost, reasonable personnel allocation and low labor cost. Its economic feasibility can be further evaluated through the application in the actual power grid, which is conducive to the acquisition, development and mining of big data.

5. Summary

In this paper, the establishment of a new stability control system test platform based on multi-source data fusion, the design of a new stability control system test platform and the test method of communication network transmission performance are mainly carried out. In the scheme formulation, different networking schemes are designed according to the location difference of SDN switch in the network topology, and then the service system, service transfer scheduling platform, SDN switch and stability control device are deployed. The performance test method is used to test the delay performance of the built platform. The performance of the system is evaluated by the new service opening delay, the end-to-end transmission delay under uncrowded and crowded conditions. On this basis, this chapter also carries on the systematic practical and economic feasibility analysis, which proves the practical significance of this project research and the popularization value of the results.

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