DOI: 10.3969/j.issn.1673-5188.2015.03.005
http://www.cnki.net/kcms/detail/34.1294.TN.20150902.1610.002.html, published online September 2, 2015

Experimental Study on Cloud-Computing-Based Electric Power SCADA System

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Abstract

With the development of smart grid, the electric power supervisory control and data acquisition (SCADA) system is limited by the traditional IT infrastructure, leading to low resource utilization and poor scalability. Information islands are formed due to poor system interoperability. The development of innovative applications is limited, and the launching period of new businesses is long. Management costs and risks increase, and equipment utilization declines. To address these issues, a professional private cloud solution is introduced to integrate the electric power SCADA system, and conduct experimental study of its applicability, reliability, security, and real time. The experimental results show that the professional private cloud solution is technical and commercial feasible, meeting the requirements of the electric power SCADA system.

Keywords

smart grid; cloud computing; electric power SCADA; professional private cloud; virtualization; cloud storage; real-time industrial control

1 Introduction

An electric power system typically involves generation, transmission, transformation, distribution, consumption, and dispatching processes. Electric power is generated and consumed simultaneously, and is not available for mass storage or transportation. Thus, as the key to the electric power system, monitoring and dispatching guarantee the reliability and security of electric power generation, transmission, distribution, and consumption, and play a key role in providing high-quality and economic electric power. An electric power dispatching and monitoring system is often called a supervisory control and data acquisition (SCADA) system, energy management system (EMS), or distribution management system (DMS) globally. In this article, we call it the electric power SCADA system.

Monitoring and dispatching of the electric power system relied on simple automatic devices, phones, and operation personnel from the very beginning, then on computers in the 1960s. With the popularity of high-performance micro-computers in the 1970s, more power monitoring and dispatching functions became available, and gradually developed into the electric power SCADA system. In the early stage, the electric power SCADA system mainly used a multi-computer architecture, consisting of single-server and two-server cluster systems. Currently, the system uses computer systems with a distributed open architecture [1]–[3]. The electric power SCADA system provides SCADA, automatic generation control (AGC), automatic voltage control (AVC), EMS, DMS, dispatcher training system (DTS), geographic information system (GIS), and other useful functions [3]. The software application system is constructed and developed by using the standard CIM model, and software architecture has evolved from the Client/Server architecture to the current Browser/Server architecture. The new-generation Smart Grid dispatching and control system uses multi-core computer cluster technology to improve system reliability and processing capacity, and uses a service-oriented architecture (SOA) to enhance system interoperability and achieve "horizontal integration and vertical interconnection" [4] of power grid dispatching services.

Hardware infrastructure of these application systems involves high-performance servers, complex high-speed computer networks, high-performance and highly reliable data storage systems, and workstations. The SCADA software is developed based on the platform which consists of Windows, UNIX, and Linux operating systems, and is based on relational databases. The whole system is connected through computer networks for data exchange and sharing, and application programs share information through an enterprise service bus (ESB). With the development of the traditional IT application systems, IT-based applications have been expanding deeply to another industry field, and encountered various problems and bottlenecks. The same is true for the electric power SCADA system, which is a professional IT application system. Especially with the advancement of Smart Grid, the future electric power dispatching center should have high computing capacity, and powerful information acquisition, integration, and analysis functions. Existing centralized computing platforms of electric power systems can hardly meet the above requirements, which has become one of the major bottlenecks in the Smart Grid [5].

The major disadvantages are as follows:

1) Low basic resource utilization and poor scalability. A large amount of basic computing resources to meet the demands in peak hours are idle during off-peak hours. To ensure reliability, lots of resources are redundant, and cannot be fully utilized. Contradictions are growing between energy demands and conservation policies. Due to the upgrade of business, the existing IT infrastructure cannot be reused. Currently, analysis and computing in the electric power system rely on the centralized computing platform in the dispatching center. Due to limited computing capacity, poor scalability, and high upgrade costs, large-scale power systems suffer from insufficient data storage and analysis capabilities [5].

2) Poor system interoperability leading to information islands. Parallel application systems have their own architectural features, and therefore resources cannot be exchanged or reused, further hampering in-depth information and business integration. Due to parallel information island applications, computing resources cannot be shared, limiting the application of distributed computing, cloud storage, and big data.

3) Limited development of innovative applications, and long launch period of new business. Traditional business applications should go through a long period of design, project initiation, bidding, and procurement before they are launched, failing to meet the requirements of rapid business expansion. Compatibility with existing systems is achieved at the expense of functions, quality, and time. With the emergence of Smart Grid, Internet of Things (IoT), mobile Internet, and big data technologies, the existing architecture and technology can hardly meet the demands for new business development and application. With the development of Smart Grid construction, big data has been regarded as an important support for Smart Grid. Most of the current power data analysis systems are based on relational databases, with low analysis speed and poor scalability. Therefore, they can hardly meet the demands for big data storage and analysis in the era of Smart Grid, which has become a bottleneck for Smart Grid construction [6].

4) Increasing management costs and risks, and decreasing equipment utilization. For example, the installed capacity of data centers grows, rapidly increasing management and maintenance complexity. Management costs and energy consumption are increased. System reliability is lowered, while operational risks are increased. Upgrade costs are also increased.

Fig. 1 shows the relations between IT resources based on the statistical data of the Dongfang Electronics DF8000 dispatching master system in projects at different scales. Fig. 1 involves the number of services, storage space, energy consumption, availability, and operational costs.

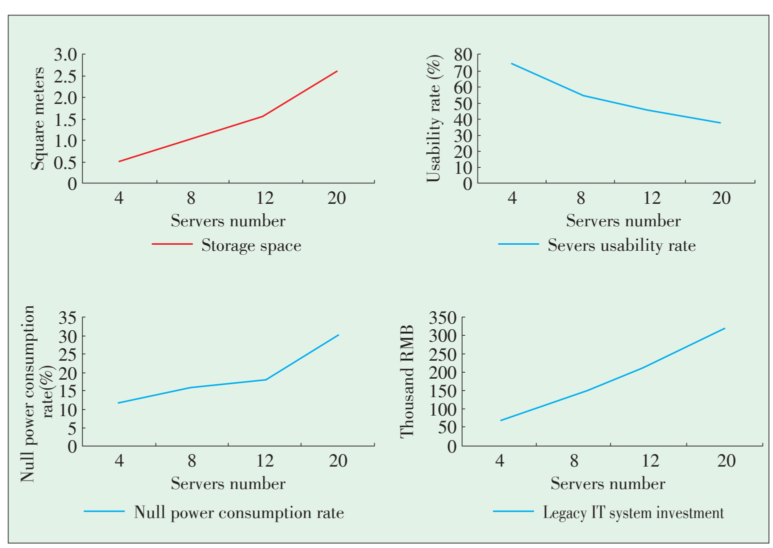
2 Cloud Computing Technology and Its Application in Electric Power Industry

2.1 Overview of Cloud Computing Technology

Since people proposed the Cloud Computing concept, cloud computing has been fully discussed and studied, and applied and developed in various scenarios in the past ten years. The major features of cloud computing are described in [7], including: 1) Use on demand; 2) Ubiquitous access; 3) Multiple users and resource pools; 4) Flexibility; 5) Measurement; 6) Redundancy.

Thanks to these features, cloud computing can be used to solve various problems occurred during application deployment, use, and innovation process of the electric power SCADA system.

The current cloud computing applications include public cloud, private cloud, and hybrid cloud, which are suitable for different application scenarios. A private cloud has advantages in application autonomy and security. However, the electric power SCADA system and other real-time industrial control systems have strong requirements for adaptability, reliability, security, and real time. A private cloud is applicable to common business scenarios, including office automation, enterprise resource planning (ERP), finance, and HR management,



▲**Figure 1. Relational graph of number of servers, storage space, energy consumption, availability, and operational costs.**

but is not suitable for specialized applications of industrial production. Therefore, a private cloud needs to be further improved. In this paper, we propose to use the professional private cloud solution to solve these problems. Professional private clouds are deployed in professional production control areas, which are logically or even physically isolated from non-control areas, to meet the strong requirements for adaptability, reliability, security, and real time.

2.2 Application of Cloud Computing in Electric Power Industry

In accordance with the *Power Monitoring System Security Regulations* (National Development and Reform Commission of the People's Republic of China <No. 14>), the field of electric power production and operations management is divided into production control areas and management information areas; and production control areas are further divided into control zones (Safety Zone I) and non-control zones (Safety Zone Ⅱ). The cloud computing technology has numerous practical applications in management information areas. The application scenarios include customer service, electric power marketing, video surveillance, collaborative office, and ERP; and the application areas include offices, maintenance companies, power plants, training schools, and business offices. The research of Zhejiang Provincial Electric Power Company (ZPEPC) on the application of enterprise management IT infrastructure in resource pool virtualization as well as related application results are described in [8]. The author describes the research and experimentation of Henan Electric Power Company on cloud computing-based data center platforms of power grid enterprises in [9]. The pilot construction and application results of cloud desktop technologies in State Grid Corporation of China are described in [10]. These applications of cloud computing technology in management information areas have greatly enhanced IT resource utilization and operation and maintenance efficiency of electric power enterprises, and achieved good economic and social benefits through exploration and practice of cloud computing application in the electric power industry.

Discussion and research of cloud computing technology are also conducted in production control areas. Because of the extreme importance of the electric power system to social and economic production and life, research and practice of cloud computing carried out in production control areas of the power system are conservative, with few research results and application cases.

The bottlenecks and limitations of traditional electric power dispatching systems are discussed in [5]. The author also describes the major features of cloud computing, and elaborates on the implementation of cloud computing platforms in electric power systems by focusing on physical components, system architecture, and software technology.

The advantages of cloud computing models, assesses potential risks are discussed in [11], the availability of popular cloud computing technologies in the electric power SCADA system are analyzed, and whether cloud computing models can be used in the electric power SCADA system are thoroughly explored. This article finally outlines an application architecture of cloud computing models in the electric power SCADA system based on four layers (including the infrastructure layer, resource management layer, cloud service layer, and application layer) and six applications (including models, data, searching, planning, calculation, and mutual backup).

The application of cloud computing in the Smart Grid dispatching system is studied in [12], and a task scheduling algorithm based on improved genetic algorithms are proposed in [12], aiming to improve distributed data processing capabilities and resource optimization capabilities of the Smart Grid dispatching system. Article [13] provides the cloud platform logic components and programming models of the Smart Grid operation and dispatching system.The Distributed Fusion Genetic Algorithm (DFGA) to cloud computing is also introduced in [13].

In [14], the author elaborates on innovative research and development and practical application of cloud computing in the electric power SCADA system, and describes the deployment solutions, function implementation, key technologies, innovations, applications, and economic and social effects of cloud computing-based electric power dispatching and online analysis systems. Pioneering research and development and practical application of cloud computing in the electric power SCADA system are described.

In accordance with the research results of these articles, common private cloud computing platforms cannot meet the requirements for security, reliability, real time, and adaptability of control areas (Safety Zone I). As of now, traditional electric power SCADA application systems are seldom deployed on cloud computing platforms, and production control SCADA systems are seldom used in the entire real-time industrial production field. Therefore, we use private cloud solutions in this experimental study to verify the technical and commercial feasibility of cloud computing platforms in the electric power SCADA system.

3 Goals and Solutions of Experimental Study on Cloud Computing-Based Electric Power SCADA System

3.1 General Idea and Goals of the Experimental Study

Based on the above analysis, the use of cloud computing technologies for new-generation electric power SCADA application systems will be a new development direction for Smart Grid. However, existing traditional electric power SCADA systems still have a large market share in the electric power dispatching market. The aforementioned problems will persist, and the new-generation Smart Grid dispatching application system based on cloud computing is still at an early stage of exploration, research, and development, with a large room for large-scale commercial deployment. It is very meaningful and valuable to use cloud computing technologies to solve the existing problems in the electric power SCADA system, and facilitate smooth transition and evolution of the existing electric power SCADA system before sophisticated application of the cloud computing dispatching and monitoring system. Therefore, ZTE together with Dongfang Electronics made attempts in this regard, built a research platform in the laboratory environment for experimental verification, and achieved the expected results.

The general idea of the experimental study is to complete operation tests of traditional electric power SCADA systems on cloud computing platforms, and integrate the main application modules of the electric power SCADA systems on the cloud computing platforms to verify their adaptability, reliability, security, and real time.

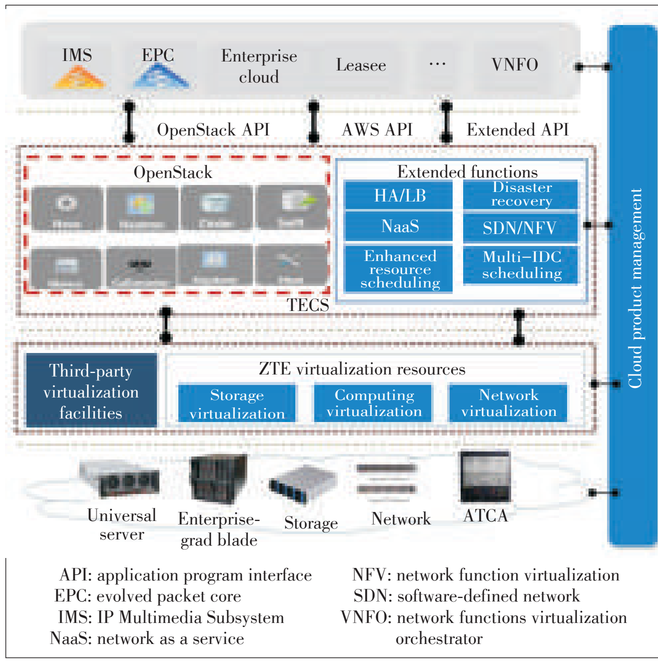
Major goals of this study include design and development of the solutions to integrating traditional electric power SCADA systems and cloud computing platforms, and test and validation of traditional electric power SCADA services on cloud computing platforms. This study assesses the adaptability, reliability, security, and real time of integrating cloud computing platforms and traditional electric power SCADA systems, thoroughly understands the differentiated requirements of electric power SCADA systems for cloud computing platforms, and proposes the development direction for electric power SCADA systems based on the cloud computing architecture.

3.2 Overall Solution to the Experimental Study

This experimental study uses the ZXTECS cloud computing platform developed by ZTE. The ZXTECS cloud computing platform based on computing, storage, and network virtualization provides resource management and scheduling functions. The ZXTECS platform based on the OpenStack cloud management platform integrates the network function virtualization (NFV) architecture, enhances the support for performance and high availability, and is an integrated ICT cloud management platform meeting both IT and CT cloud computing requirements.

Fig. 2 shows the system architecture of the ZXTECS platform. Major features of this platform include 1) Openness: open and unified resource pool management; 2) High performance: performance optimization of virtual computing to meet the requirements of NFV for high-performance virtualization; 3) High reliability: live migration of virtual machines, watchdog, exception recovery, remote resetting, and control node cluster functions; 4) High usability: automatic upgrade deployment, real-time alarms, and performance statistics.

The electric power SCADA system uses the DF8000 series integrated software of Dongfang Electronics for power dispatching. This is a new-generation power SCADA system developed



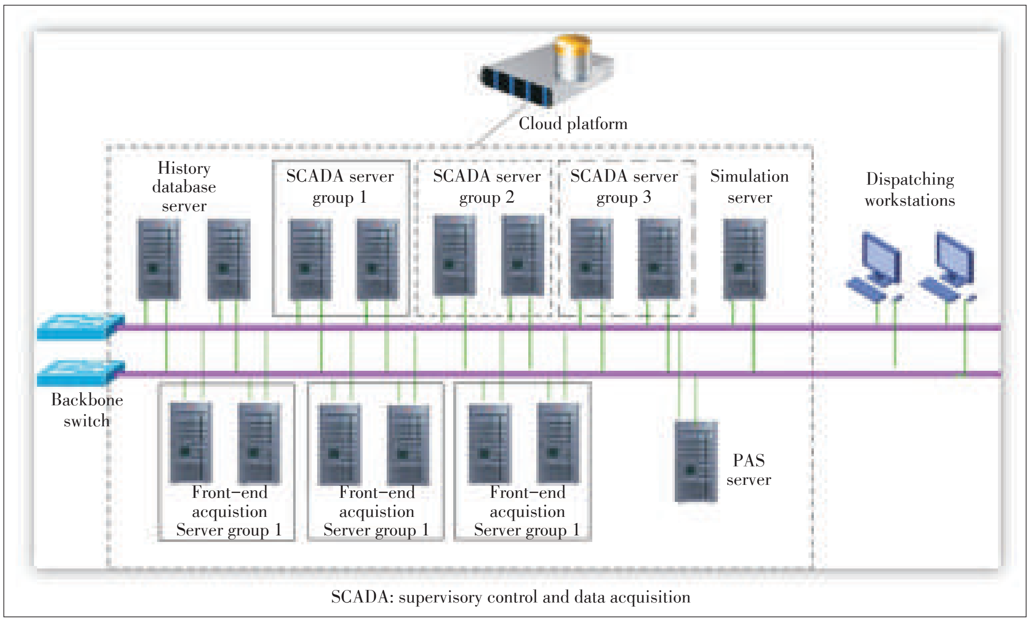
▲**Figure 2. System architecture of the ZXTECS cloud computing platform.**

by using the latest computer communications technology, database technology, object-oriented technology, component technology, Internet technology, and dynamic server technology, and following the CORBA middleware specifications, IEC61970 CIM/CIS, IEC61968, IEC61850, and international SOA standards. By using the SOA and loosely-coupled UI design, the DF8000 system achieves unified operations, monitoring, management, and maintenance of the entire system, following the trend for growing integration of dispatching information in the electric power system. The DF8000 system has been highly recognized in the international and domestic markets, and achieved an influential position in the industry.

The computing, storage, and network resources required for system tests are provided by the resource pools on the cloud computing platform, based on which the DF8000 system is integrated.

Fig. 3 shows the logical networking structure of the DF8000 system. Virtualization deployment of the history server, SCADA servers (multiple sets can be deployed as required, and one set is deployed in this experiment), front-end acquisition servers, and PAS server is implemented on the cloud computing platform. The system uses a dual-Ethernet architecture. To meet the reliability requirements of the system, two servers should be deployed for each of the aforementioned server type except the PAS server and simulation server. Two virtual servers are deployed on different physical machines, implementing the reliability function of traditional hot-standby clusters.

A simulation server is deployed in the system as the simulation data generation server for the experimental test. According to the dispatching master system of a provincial capital (in



▲Figure 3. Logical networking solution of the DF8000 SCADA application system.

which capacity of the power grid is more than 15 GW for 4.3 million users until 2015), the data size is 500,000 points. The simulation data generation server is connected to the front-end data acquisition server through the network provided by the cloud computing platform.

Restricted by the experimental resources, in order to ensure resource allocation to the servers, workstation scheduling resources are not provided on the cloud computing platform, and workstations are scheduled through ordinary PCs.

3.2.1 Physical Networking Solution

Fig. 4 shows that the system is divided into the computing plane and control plane. Two mutual-backup management servers are deployed on the control plane, and manage computing nodes through dual high-speed Ethernets. The control plane and computing plane (or the business plane) are isolated to ensure security. The control plane implements management and monitoring functions of the cloud computing platform. The computing plane consists of the computing server, storage server, high-speed Ethernet, and dispatching workstations, which are the basic physical resources of the cloud computing platform. This solution involves three computing servers, dual-plane high-speed Ethernet, a set of high-performance storage devices, and two dispatching workstations.

3.2.2 Integrated Logic Structure

Fig. 5 shows the logical integration architecture of the cloud computing platform and SCADA system. The cloud computing platform provides basic IaaS services, including cloud security, resource pool, operations management, and virtual machine scheduling management functions. The functions in the dotted red box are not involved in this experiment. In accordance with the logical networking structure shown in Fig. 3, the cloud computing platform provides the SCADA system with computing, storage, and network resources, as well as operating systems, databases, and other platform software through virtual machine scheduling management, and finally implements basic IaaS services of the cloud computing platform. The electric power SCADA software system deploys related application systems on the virtual machine in a conventional manner to achieve various functions of the electric power SCADA system.

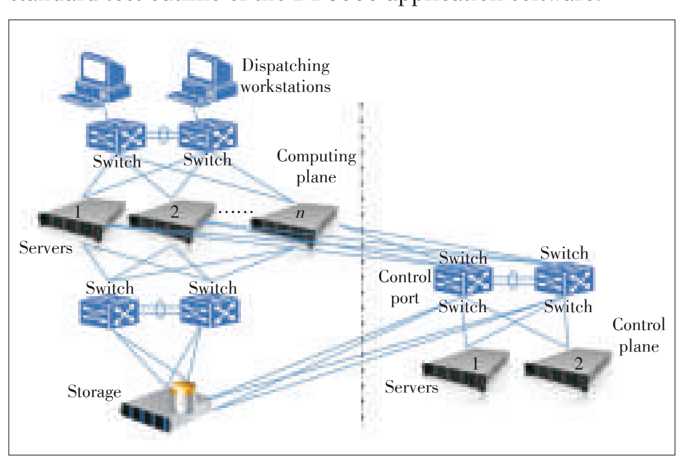
Tables 1 and **2** show the test platform environment and configurations.

This experimental test platform is built and deployed in a test lab of the Central R&D Institute in the ZTE Nanjing R&D Center. The professional electric power SCADA testers of Dongfang Electronics log in to the Dispatcher's Workstation through Remote Desktop, and perform tests in accordance with the test outline.

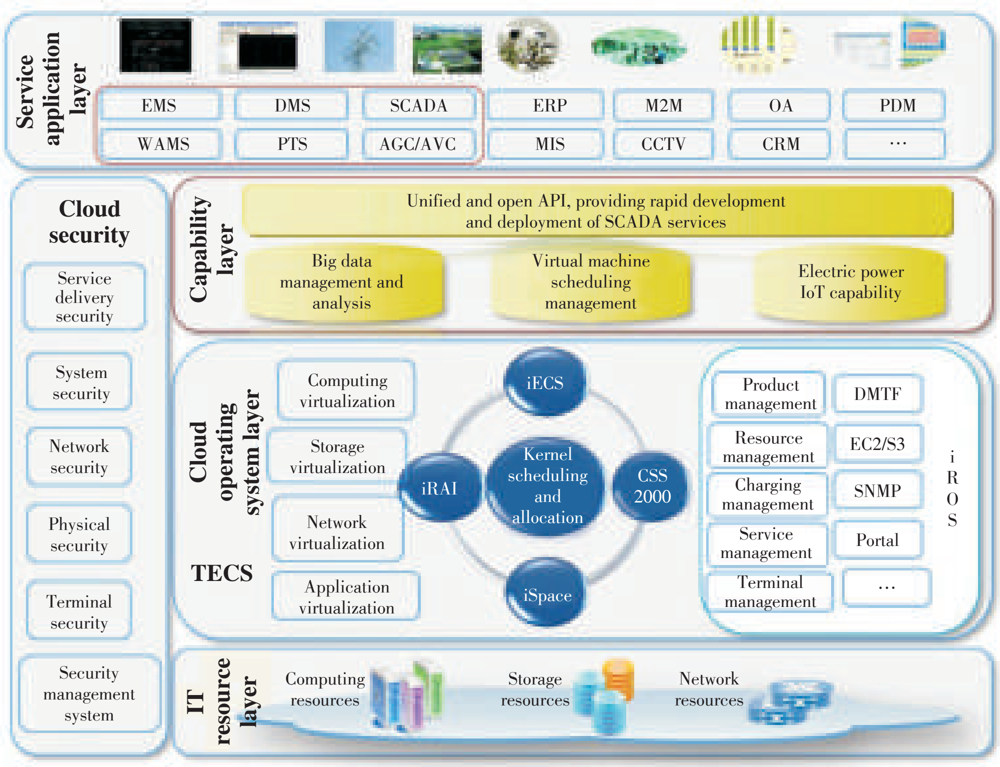
4 Content and Conclusion of the Experimental Test

4.1 Content and Analysis of the Experimental Test

The experimental test involves function, performance, and saturation tests, which are performed in accordance with the standard test outline of the DF8000 application software.



▲Figure 4. Physical networking solution of the cloud computing platform in the experimental environment.



AGC: automatic generation control
API: application program interface
AVC: automatic voltage control
CRM: customer relationship management system
DMS: distribution management system
DMTF: distributed management task force
EMS: energy management system
ERP: enterprise resource planning
MIS: management information system
PDM: product data management
PTS: dispatcher training system
SCADA: supervisory control and data acquisition
WAMS: wide area measurement system

▲**Figure 5. Integrated software architecture of the cloud computing platform and electric power SCADA system in the experimental environment.**

The function tests mainly verify the design functions to be implemented by the DF8000 on the cloud computing platform, and the integrity of its functions. As required by the test outline, the function tests involve four electric power dispatching functions (including SCADA, EMS, AVC, and AGC), with a total of 1343 function points and 59,389 I/O test points.

The performance tests are divided into two levels, with 66 level-1 test items and 206,104 I/O points, and 64 level-2 test items and 501,251 I/O points. The saturation tests are also divided into two levels, with 40 level-1 test items and 206,103 I/O points, and 64 level-2 test items and 501,251 I/O points.

Function tests of the above 1330 items in the 1343 function items were conducted, with a pass rate of 100%. The other 13 function items related to printing, GPS time calibration, and pulse meters were not tested because related devices were not deployed on the experimental test platform. These items are not directly related to the computing platform, and do not affect the test goals.

The performance and saturation tests were conducted at two different load levels: level-1 system load with 206,103 I/O points, and level-2 system load with 501,251 I/O points. One item failed in the level-1 load performance tests, with a pass rate of 98.5%. Two items failed in the level-2 load performance test, with a pass rate of 96.9%. These items failed because the simulation PC memory load on the dispatcher node exceeded 30%.

The saturation tests were also conducted at two I/O load levels, with full-load operations for 72 hours. A total of 40 level-1 items and 64 level-2 items are involved, with the pass rates of

▼**Table 1. Software platform configurations of the experimental test platform**

	Category	Version
Server OS	Red Hat Linux (64-bit)	6.2
Client OS	Windows 7	Flagship Edition
Database	Oracle	11g (11.2.0.1.0)
Network	1000 Mbps	

▼**Table 2. Logical server configurations and performance parameters of the experimental test platform**

Server name	Function	Number of virtual machines	Major performance indicator
History server	Saves historical data and electric power model data	2 × 1	CPU: 2.80 GHz, quad-core, Memory: 32 GB, Disk: 375 GB
SCADA server	Processes data and gives alarms in real time	2 × 1	CPU: 2.8 GHz, dual-core, Memory: 8 GB, Disk: 75 GB
Front-end acquisition server	Collects data and manages RTU communications	2 × 3	CPU: 2.80 GHz, dual-core, Memory: 8 GB, Disk: 75 GB
PAS server	Performs application computing and provides application services	1	CPU: 2.80 GHz, dual-core, Memory: 8 GB, Disk: 300 GB
Simulation server	RTU simulation	1	CPU: 2.70 GHz, dual-core, Memory: 8 GB, Disk: 75 GB

CPU: central processing unit   RTU: remote terminal unit   SCADA: supervisory control and data acquisition

97.5% and 96.9%, respectively. For the failed items, the memory usage on the dispatcher node exceeded 30%, and memory and CPU usage on the simulation server is high. Similar to performance tests, the dispatcher node is restricted by the experimental test platform. The simulation server is deployed only for the test, and is not needed in actual application deployment. Due to the limitations of test resources, the performance of the simulation server cannot be improved.

Table 3 is the detailed statistical results of experimental tests. **Table 4** is an analysis of the results of the experiment.

▼Table 3. Experimental test results

Test category	Number of test I/O points	Total number of test items	Number of tested items	Number of untested items	Number of failed items	Pass rate
Function test	59,389	1343	1330	13	0	100%
Performance test	206,103	66	66	0	1	98.5%
	501,251	64	64	0	2	96.9%
Pressure test	206,103	40	40	0	1	97.5%
	501,251	64	64	0	2	96.9%

▼Table 4. Test result analysis

Test category	Number of I/O points	Number of untested items	Number of failed items	Reason	Impact analysis
Function Test	59,389	13	0	Untested functions related to printing, GPS time calibration, pulse meters, and reports have nothing to do with the cloud computing platform.	Does not affect test goals
Performance Test	206,103	0	1 (Memory usage on the dispatcher node exceeds 30%)	The test item is the physical client, which is not related to the cloud computing platform.	Does not affect test goals
	501,251	0	2 (Memory usage on the dispatcher node exceeds 30%)	The dispatcher node test item is the physical client, which is not related to the cloud computing platform.	Does not affect test goals
Pressure Test	206,103	0	1 (Memory usage on the dispatcher node exceeds 30%)	The test item is the physical client, which is not related to the cloud computing platform.	Does not affect test goals
	501,251	0	3 (Memory and CPU usage on the RTU server is high)	RTU server test items are tested through distributed solutions.	Does not affect test goals

CPU: central processing unit RTU: remote terminal unit

- Suitability Evaluation

Through the whole tests, the SCADA system based on the ZXTECS Cloud computing platform are running very well, the test results have proved the professional private cloud platform are suitable to the power SCADA system deployment.

- Reliablity Evaluation

The reliablity test items such as Live Migration, Save/Restore, Fault Recover, Watch Dog, Fault Reset etc. are all passed successfully. All these tests are used to evalute the SCADA system reliable operation status, recover capabilties under the fault situations. The results have proved the SCADA system based on ZXTECS platform meet the power SCADA system reliability requirements.

- Security Evaluation

The cloud computing platform deployed for the electric power SCADA system is a professional private cloud platform, with the overall architecture deployed in the control zone (Safety Zone I), in line with the requirements of the Power Monitoring System Security Regulations. The system logic structure and security features of tested SCADA system are not changed. It provides the basic security. The professional private cloud provides comprehensive cloud securityprotection stucture.

- Real-time Evaluation

There are 12 items are related with the system real-time capabilities shown is **Table 5**. The test results indicate that realttime performance is meet the requirement of the SCADA system. The CPU load rate, memory storage rate tests result indicate the cloud computing platform has eough computing perfor-

▼Table 5. The real-time performance test results

No.	Test items	Evaluation standard	Test 1st	Test 2nd	Test 3rd	Average	Pass/Not pass
1	RTU host and backup channel switch automatically	≤ 30 s	25.15	27.19	23.52	25.29	Pass
2	RTU host and backup channel switch manually	≤ 4 s	2.71	2.45	3.11	2.76	Pass
3	Digital value change transmission	≤ 3 s	1.66	1.89	1.79	1.78	Pass
4	Operator interface telemetry update time	≤ 10 s	3.06	2.76	3.45	3.09	Pass
5	Remote command execution time	≤ 2 s	1.92	1.79	1.98	1.90	Pass
6	SOE alarm transmission time	≤ 6 s	2.62	2.14	2.01	2.26	Pass
7	Push Switch shift alarm frame to the Screen time	≤ 4 s	3.1	3.42	3.63	3.38	Pass
8	Remote control command processing time (with preset time)	≤ 3 s	2.22	2.31	2.35	2.29	Pass
9	Remote control command processing time (without preset time)	≤ 3 s	1.74	1.79	1.88	1.80	Pass
10	Historical data query time-data view query a remote measurement data of a day	≤ 5 s	1.71	1.49	1.8	1.67	Pass
11	MMI curves of the query time	≤ 5 s	1.52	1.12	1.14	1.26	Pass
12	The picture call response time (from the button to display the whole picture time)	85% picture call response time ≤ 3 s,the rest 15% response time≤4 s	2.97	2.93	2.58	2.83	Pass

mance margin. Professional private platform provide elastic computing resources allocation in time for the power SCADA system to gurantee the real-time performance adequately.

4.2 Results

Compared with the test results of the traditional IT architecture, the function, performance, and Saturation test results indicate that the indicators of the SCADA/EMS system based on the cloud computing platform meet the actual needs of power grid operations, and some indicators, such as the network load rate, are better than those of the traditional IT architecture. It can be seen from the function, performance, and pressure test results that the deployment of electric power SCADA system software on the cloud computing platform is feasible, with the applicability and real time of the system meeting commercial requirements. In addition, reliability function tests such as live migration of virtual machines, fault recovery, watchdog, and fault resetting were also conducted successfully, with the system reliability meeting the requirements of the electric power SCADA system. According to this experiment, the electric power SCADA system based on the cloud computing platform has the following advantages:

- Through the cloud computing virtualization technology, system platform resources can be flexibly allocated according to the data traffic of the power grid.
- Parallel data acquisition systems are used to significantly reduce hardware thresholds, improve data acquisition capacity, simplify future system expansion, and effectively improve system resource utilization.
- Parallel real-time data processing systems and distributed data storage are used to greatly improve data processing capabilities.
- Application software, storage, and data resources are provided as services, and resource utilization costs are decreased substantially by taking full advantage of cloud computing.
- The cloud computing virtualization technology reduces the coupling between resource users and resource implementation, so that users are no longer dependent on specific resource implementation, and the system administrator can reduce the impact of IT resource maintenance and upgrade on users.
- Throughout the experimental test, only a system administrator is needed for maintenance, significantly reducing the time required for maintenance.

5 Prospects of Cloud Computing Technology Application in the Electric Power SCADA System

5.1 Benefits Brought by the Cloud Computing Platform Deployed in the Electric Power SCADA System

The overall performance of the electric power SCADA system based on the cloud computing platform is much higher than that of the traditional IT platform. It can be seen from application analysis calculation of telecom operators that the average resource utilization of IT systems on traditional platforms is lower than 30%, and that on cloud computing platforms exceeds 60%. It takes 2–4 hours for terminal operation and maintenance through traditional PCs, and only a few minutes for VM maintenance based on cloud computing platforms. The average service launch period has also been shortened from 1–3 months on traditional platforms to 1–3 weeks on cloud computing platforms. The energy consumption of VM private cloud terminals is reduced by over 70% than traditional PCs. The cloud computing platform has higher data security than traditional IT platforms because of centralized data management and control. The customer experience on cloud computing platforms has been optimized significantly. Users only need to focus on business implementation, and corresponding hardware, software installation, operation and maintenance, and operating systems are maintained on the platform in a unified way, avoiding repeated work of professional users. In a word, the electric power SCADA system based on the cloud computing platform will help electric power industry customers reduce overall costs and improve efficiency.

5.2 Feasibility of Cloud Computing Platform Deployment in the Electric Power SCADA System

Technical feasibility: This experiment shows that the cloud computing platform meets the adaptability, real time, and reliability requirements of the electric power SCADA system, is in line with technological development trends and market demands, and therefore is technically feasible.

Economic feasibility: The features of the cloud computing platform, such as efficient resource usage, reduced energy consumption, and efficient maintenance, are in line with the requirements of power grids for upgrade, business continuity, rapid deployment of new services, and overall cost reduction.

Security feasibility: The security of electric power SCADA system based on professional private cloud platform is guaranteed and has been strengthened with cloud security functions.

6 Conclusion

In this paper, we describe the goals, contents, and results of the experimental study on the cloud computing–based electric power SCADA systems, and indicates that the professional private cloud computing platform meets the technical, economic, and security requirements of the electric power SCADA system, and has commercial feasibility. The electric power SCADA system is a typical application in the real-time industrial production control field. The results of this experimental study shows that industrial SCADA software systems can be deployed on similar professional private cloud platforms. The professional private cloud solution facilitates the application of cloud computing technologies in the professional real-time production control field, and brings economic and social benefits for industrial production.

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Manuscript received: 2015-07-01

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