Research on Holographic Evaluation of Service Quality in Power Data Network

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Abstract. With the rapid development of power data network, the continuous development of the Power data application service system, more and more service systems are being put into operation. Following this, the higher requirements for network quality and service quality are raised, in the actual process for the network operation and maintenance. This paper describes the electricity network and data network services status. A holographic assessment model was presented to achieve a comprehensive intelligence assessment on the power data network and quality of service in the operation and maintenance on the power data network. This evaluation method avoids the problems caused by traditional means which performs a single assessment of network performance quality. This intelligent Evaluation method can improve the efficiency of network operation and maintenance guarantee the quality of real-time service in the power data network..

1. Introduction
In recent years, the power data network is appearing a diversified and high information trend. The power data network is connecting to the various positions of the power production, operation and management departments, such as office system information system, high-definition conference television system and other different network needs service systems [1]. The traditional management method of the power data network is mainly through the network management system of the equipment to set and monitor, including according to the information reported by the network management system to achieve the fault detection and elimination. This method is concerned about performance of the network equipment. In the actual situation, phenomenon that services can’t be used while the network equipment is normal. This phenomenon is a thorny problem which the network operation and maintenance is faced. Based on the characteristics of the network and service in the power data network, this paper presents a comprehensive evaluation model for the network service quality. This model is more concerned with the quality of the service in the power data network rather than quality of the network. The model is designed to improve the efficiency of network operation and the speed of fault detection and processing by monitoring the network service quality.
2. Power data network and services

2.1. Network situation
The data communication network of the State Grid is divided into data communication backbone network and data communication access network two-level structure. The data communication network is divided into four main network levels: the core layer, the convergence layer, the backbone layer and the access layer. The core layer nodes form a fully interconnected structure. The aggregation layer forms a network structure in a partially interconnected manner. The backbone layer nodes and the access layer nodes form a topological structure that satisfies the double upper connection [2].

Take State Grid JiBei electric power company as an example, the data communication network of the JiBei company is the bearer network system for data, video, voice and other management information, service information of the company. The data network is based on IP technology to build MPLS data communication network, and is divided into core layer, convergence layer, backbone layer, access layer. The data network is mainly composed by the routers, switches and other equipment. This Network coverages of the company, the straight pipe units, the substation and related straight power plant. Many network equipment and a variety of fault alarm information is making the operation and maintenance efficiency in low efficiency.

2.2. Service situation
From the point of view of the service types of the power data network is carrying these services: Information network, substation video surveillance, integrated teleconferencing system, scheduling OMS system, Soft-switch system, IMS system, unified Internet export and integrated monitoring system and so on[3].

From the point of view of the service system architecture, the service systems use B / S architecture. Most users access the data network from within the network, and access from the external network through the isolation device. Most of the service system structure is WebLogic, and the database is mostly MySQL.

From the point of view of service data, power data network mainly transmits structured data more than unstructured data, including pictures, videos, data, etc. Therefore, the power data network requires efficient evaluation and monitoring of the service quality of the various types of services that are hosted.

3. Holographic evaluation for power data network

3.1. Traditional Evaluation Method
Traditional service quality evaluation is based on network quality of service (QoS), which focuses on network performance and relies on some simple, independent network indicators to evaluate. The main problems of traditional network service quality assessment are the following aspects:

(1) QoS evaluation is based on the network performance level, and QoS can’t reflect the user's service quality experience at the both sides of the end-to-end service. QoS is only a simple evaluation of objective parameters, so the service quality assessment is not comprehensive enough [4].

(2) The traditional quality evaluation concerns the performance parameters of the network. The goal of traditional approaches is to manage network performance metrics rather than manage specific service qualities. And the merits of network performance can’t fully reflect the quality status of the service.

(3) The traditional service quality evaluation is to monitor the network layer indicators. Because it is not for the service, it can’t evaluate the quality of specific services.

Compared with the traditional QoS-based network service quality evaluation, this paper presents an improved quality of service assessment, which increases the content of user's subjective perception of service quality, enhances the relationship between the various factors, and makes the evaluation model of service quality more comprehensive[5].
3.2. Holographic Evaluation Method

Based on the hierarchical thinking of the network, the holographic evaluation for the data network is also divided into four layers. The four layers include the infrastructure layer, the network layer, the application layer and the user subjective experience layer. The evaluation model is as shown in Figure 1.

The infrastructure layer, the network layer and the application layer are objective layers, the user layer subjective experience layer is a subjective layer.

The goal of the holographic evaluation model is to conduct a comprehensive multi-level assessment of the services, covering objective and subjective factors. For different services, its assessments at all levels of the assessment model will be different.

This means that in the service dimension the holographic assessment will be assessed according to the specific services and the indicators for different services will be different in each level.

![Figure 1. The hierarchical evaluation mode](image)

The infrastructure layer includes various types of servers, computers, switches, routers, electrical equipment and other related devices in the power data network. The quality indicators for the infrastructure layer include equipment capacity indicators, link capacity indicators, equipment processing indicators, equipment storage indicators, etc.

The network layer mainly studies the impact on the quality of the services, from the perspective of network operation quality. Its indicators mainly include access indicators, integrity indicators, capacity indicators, network quality indicators, etc. KPI (Key Performance Indicator) is a measure used to measure service resources or performance, such as network latency, packet loss rate and link utilization, etc. In The infrastructure layer and the network layer, KPIs are used to represent key performance indicators, usually measurable values.

The application layer directly reflects the objective quality of service operations. Its indicators of the application layer should be analyzed and designed according to different service types. Different service evaluation content will be differentiated based on the different services. Taking the video service as an example, in the application layer assessment, the corresponding service indicators need to be investigated, such as the video access delay, the number of pauses in the video playback process, the video buffer delay, the image mosaic phenomenon and so on. KQI (Key Quality Indicator) is the objective and quantitative measurement of service quality and is the assessment indicators for specific services (such as HTTP Internet, Email, games, etc.). At the application layer, KQIs are used to represent the corresponding service key quality indicators [6].
According to the holographic evaluation model given, the corresponding indicator are extracted at each levels.

In the infrastructure layer and the network layer, the KPI indicators are used; in the application layer, the KQI indicators are used; in the user subjective experience layer, QoE is used. The hierarchical structure of the service quality assessment indicators system is shown in Figure 2.

![Figure 2. The hierarchical structure of the indicators system](image)

4. Application of holographic evaluation model in power data network

Data services include data, files, reports, and EMAIL, FTP and other data services in the power data network.

The establishment of the quality evaluation indicators system for the financial system which is one of the typical data class service applications in the power data network, has a certain reference significance to the quality assessment of other similar services.

Based on the power data network financial control system service, this paper will use the holographic assessment model on its service quality and give the service quality indicators system.

The power data network financial control system is equipped with a number of servers as a database server and a number of servers as an application server. The network environment consists of several access layer switches. The logical structure of the financial control system is shown in Figure 3.

![Figure 3. The logical structure of the financial control system](image)

The financial control system is using B / S architecture as the service system architecture. Users access the system through the browser, which is based on the HTTP protocol process mainly from the internal network access. The system transmission content is structured information, and transmission
traffic is not large [7]. Because of a large number of users, the number of online users is large and the parallel instructions are large too. So we are more concerned about the application system average response time, the system healthy run time, the number of page session connections, the number of online users and other quality indicators.

Based on the assessment level described above, for the financial control system, the indicators and definitions for each level are given.

In the user experience layer, the average assessment score MOS (Mean Opinion Score) is the more widely used user subjective factor assessment method [8]. MOS uses 1 to 5 points in order to express the user's subjective feelings, while 5 is the best and 1 is the worst.

In the application layer, according to the characteristics of financial control system, the corresponding KQIs indicators are shown in Table 1.

| KQI                                    | Definition                                                                                                                                 |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Service certification delay            | The user name and password are issued from the user's browser to the server until the user-side browser receives an interval between the authentication responses from the server |
| Service access success rate            | The number of times the user successfully logs into the service system is the total number of times the service is initiated               |
| Number of online users                 | The number of users who successfully managed to connect to the financial control system                                                  |
| Service interruption rate              | The percentage of the total number of connections that the client/client service suddenly disconnected from the total number of connections established by the client and the server |
| Upload failure rate                    | The number of times a user has received a successful upload prompt after uploading a client request to the total number of times the client sends the upload request to the server |
| Download failure rate                  | The percentage of the number of successful download attempts received by the client/client after the request is downloaded to the total number of times the client sends the download request to the server |
| Service page error frequency           | Percentage of total number of times the user's client has been re-buffered during the provision of the financial system Service |

In the network layer and the infrastructure layer, the necessary performance indicators KPIs are shown in Table 2.

| Indicators name                        | Definition                                                                                                                                 |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Data service authentication delay      | From the client to the server to issue a user name and password until the client receives the authentication response from the server between the length of time |
| online users                           | The number of users who successfully establish access to the connection                                                                 |
| Number of uploaded files               | The total number of times the client sends the upload request to the server                                                              |
| Upload failed times                    | The number of times the client has requested an upload error message after uploading                                                      |
| Number of downloads files              | The total number of times a client sends a download request to the server                                                               |
| Download failed times                  | The number of times a client has requested a download error message after downloading                                                   |
| File download rate                     | Download file bytes / download file time                                                                                            |
| HTTP page open success rate            | (HTTP page open success / HTTP page open the total number of times) * 100                                                              |
| HTTP resolution delay                  | The amount of time it takes to parse the HTTP destination address                                                                    |
| HTTP connection setup delay            | The length of time that the HTTP server is connected to the success of the connection                                                  |
| First bag arrival time                 | The amount of time it takes from the client to request an HTTP resource to the first byte of a successful read resource                   |
| HTTP response delay                    | Analysis time + connection length + first bag arrival time                                                                         |
| HTTP page download rate                | HTTP page download total number of bits / HTTP page download total length                                                              |
| HTTP application response failure rate  | HTTP response failure number of packets in the total number of packages                                                                |
| DNS resolution success rate            | (DNS resolution success / DNS total number of times) * 100                                                                            |
| DNS resolution delay                   | Test the length of time that a client successfully sends a DNS resolution request packet to a DNS resolution response packet           |
| DNS application response failure rate  | DNS application response failure number of packets in the total number of packets sent                                                |
| Packet loss rate                       | Packet loss rate is the ratio of the number of packets lost in the test to the packets sent                                            |
| Jitter                                 | Jitter is the change of network delay in the process of network transmission                                                           |

Table 1. KQIs for the application layer

Table 2. KPIs for the network layer and the infrastructure layer
Through the analysis of key indicators of the four levels, the quality of service evaluation indicators system for the financial system is established, which is shown in Figure 4.

![Service evaluation indicators system for the financial system](image)

**Figure 4.** Service evaluation indicators system for the financial system

After obtaining the indicators system of the financial control service based on the holographic evaluation model, the network operation and maintenance management can have targeted monitoring and operation and maintenance for the targeted service, through focusing the changes of the corresponding indicators. The operation and maintenance system can make the right alarm timely and improve the efficiency of operation and maintenance effectively according to the indicators system.

5. Conclusion
This paper studies the characteristics of power network and service, analyses the shortcomings of the traditional service evaluation methods, propose a model for holographic assessment of service quality, and applies the model on the financial control system in the power data network to get the service evaluation indicators system for the financial system. Through the indicators system we can make the operation and maintenance for the network more comprehensive and efficient. Further, we will carry out the analysis of the data processing and weight of each layer of indicators system [9].

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