

# Study on the Efficiency Evaluation System of Distribution Communication Collaboration Network

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**Abstract**— Distribution network itself has a different from other network characteristics, the geographical distribution of the vast number of equipment is extremely large, the type of equipment varies, incomplete data and the actual change is not synchronized and other issues makes the distribution network maintenance, management, troubleshooting difficulty straight up, but with the rapid growth of distribution network users in various regions. The current manual maintenance work even more stretched. Under such circumstances, the construction of distribution network automation system becomes an effective way to improve the reliability of distribution network, the maintenance and management efficiency. Based on the analysis of the typical service data model of smart distribution network and its demand for network communication capacity to establish a data model. A network performance evaluation model system is designed to evaluate the effectiveness of the model.

**Keywords**—Collaboration Network; Evaluation System; Communication; Collaboration

## I. INTRODUCTION

In recent years, China's distribution network construction investment continues to increase, intelligent distribution network communication system undertakes a lot of business data transmission in the terminal[1]. Distribution network connected renewable power supply, the micro-grid system and the power access scheduling, control, management business inevitably need to pass through the distribution network communication system. How to assess the performance and stability of the current distribution network communication system under the circumstance of massive data and high concurrency, and analyze the bottleneck point existing in the current system or the area, which is relatively likely to cause instability[2]. Through comprehensive analysis and statistics, it can be concluded that this issue can not be considered only from the perspective of the traditional single communication ability. Otherwise, the factors of the actual operation of the system can not be fully described. The reason is that at this time the system nodes (including the distribution automation master station, sub-station, front-end machine, terminal, the business system servers, workstations) computing power will also affect overall efficiency and

performance, and if communication bandwidth is not a problem, and computational demands on massive data are overloaded, computing capacity bottlenecks will in turn affect the efficiency of the entire system, including communications[3-5]. Therefore, it is very important to study the method of network performance evaluation of distribution network communication and coordination.

## II. COLLABORATIVE NETWORK MECHANISM

Collaborative planning refers to the consideration and analysis of synergetic network system bottlenecks such as bandwidth and flow of intelligent distribution network systematically. It takes into account the systematic features, laws and influences of two abstract logic independent systems of computing system and communication system. It researches the qualitative and quantitative of nature interaction, the degree of impact, the systematic effect, and derivation and measurement and other means of combining the foundation. In the calculation and communication resources at the beginning and during the process, the synergistic effect of synergy and their own characteristics into a combination of to all aspects of construction and development. The effect of this planning method is to guide the construction of the risk and possible extremes as much as possible to avoid, compared to the traditional separate planning, affecting the extreme situation, resource adjustment and reconstruction, both to improve the stability and engineering efficiency, Reduce the cost and investment of post-recovery[5].

On the other hand, there is computational precision and boundary problems in the estimation and adjustment of bottlenecks, in both qualitative and quantitative planning of resources for computing systems or communication systems. Too high precision and small boundary requirements lead to computations over time, it is a mathematically solvable but not feasible problem. Similarly, qualitative and quantitative estimates and calculations of the coupling effects between computational and communications systems also have limitations on accuracy and boundaries. The high accuracy and the too small boundary requirement in the coupling calculation lead to the soaring computational complexity of time that it is not suitable for the calculation of the solvency. How to control the precision value and the boundary quantity

problem of calculating the influence degree of the coupling between the computing system and the communication system needs to accurately and objectively describe its influence degree law within the scope of the current computer ability so as to guide the coordination planning in the system construction and Collaborative operation.

Through collaborative planning, an effective communication computing collaborative model is established. The testing of the model proves the correctness and effectiveness of the collaborative planning and the guidance to practical engineering. However, the model only aims at the bottleneck problems of communication and computing to prove the divergence or the bottleneck point. That is to say, the function of the model is to provide guidance and standards for the optimization of the system and does not give any suggestions on how to evaluate the current distribution network System communication and computing bottlenecks. Therefore, while implementing the model design, a set of supporting efficiency evaluation system should also be implemented to realize the function of evaluating the current communication bottleneck and system performance of the distribution system. After the distribution system is guided and optimized by the model, the evaluation and optimization after the communication computing bottlenecks and system performance.

### III. NETWORK BOTTLENECK PERFORMANCE EVALUATION SYSTEM

The connotation of the synergetic operation of communication system is rich and the effects of uncoordination generally originate from the mismatch between the two systems. Mismatch includes time (rate) mismatch and space (buffer) mismatch. Time mismatch is the main reason for the problem. The time (rate) is represented in the master and the terminal as the computational power, speed (frequency), and occupancy of the system processor, which are reflected in the communication network as communication bandwidth, speed, and equipment busy degree. Bottleneck mutual influence is a process with dynamic conditions. Bottleneck reasons, node capabilities, busyness are the determining conditions, as well as the task dependencies appearing in the system. The task frequency is a random variable, and from the perspective of probability, it can be considered as a In line with the normal distribution of variables. The method of calculating the mutual influence result can be expressed as:

$$I = f(o, p, a) * g(r) \quad (1)$$

Mutual influence is:

$$I = (i_{cp}, i_{cm}) \quad (2)$$

From the design and analysis of the formula, it can be seen that the main index of the system is the performance bottleneck of the computing system icp and the communication system performance bottleneck icm, icp is the average CPU load rate of the computing nodes with bottlenecks in computing nodes, icm is mainly Is the product of the communication node's bandwidth occupancy rate and

the overrun packet rate. Bottleneck evaluation system for synergetic impact is divided into bottleneck source evaluation system and collaborative bottleneck evaluation system. Both evaluation directions should start with communication and calculation. The purpose of bottleneck source evaluation is to calculate the bottleneck node metrics Determine the bottleneck of the synergetic impact of the overall system, collaborative impact assessment is to know the bottleneck of the synergies of the current system under the premise of the measurement and calculation to analyze the communication and computing bottleneck source.

For the bottleneck source evaluation system, taking communication nodes as an example, we must first determine the bottleneck of the proportion of communication nodes, and then determine the node communication busyness and busy computing, and then through theoretical calculations to determine the bottleneck of synergies, including the computing system icp and icm, the actual obtained icp and icm compared with the theoretical value to evaluate the bottleneck of the entire model source, computing node bottleneck source evaluation methods and communication nodes. The picture below shows the bottleneck source evaluation system.

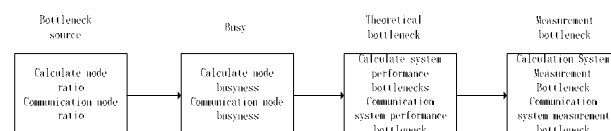


Figure 1 Bottleneck evaluation system

The overall system of evaluation system is mainly for communications computing collaborative model of the effectiveness of the evaluation. According to the ratio of bottleneck sources of communication node and computing node, icp and icm of synergistic influence calculation system before model optimization and optimization are calculated respectively, and bottleneck of communication node and bottleneck of computing node before transformation in a certain bottleneck area Degree ocm, and then through the coordination of communications and computing model planning and transformation, and then measure the synergy impact planning system after transformation icp and icm, and a bottleneck before the transformation of the computational node bottlenecks ocp and ocm, will Before the transformation and transformation of the numerical comparison, to evaluate the model and then evaluate the overall performance of the system.

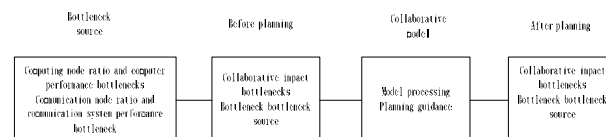


Figure 2 Overall system of evaluation system

Network performance model described in the indicators of network performance include: network response time, network throughput, packet loss rate, network latency, network bandwidth and so on. The packet loss rate, signal to noise ratio, throughput and so on are used to express the transmission capacity of the network system. The transmission delay, delay jitter and response time of the

network are used to characterize the transmission capacity of the network system. Through the method of layering, the network indexes to be obtained are divided into two aspects to describe the network performance.

#### IV. NETWORK PERFORMANCE EVALUATION ALGORITHM

Each network index in the network performance evaluation model has a different weight coefficient. The determination of coefficients can be broadly divided into three categories: subjective weighting, objective weighting and integrated weighting. The essence of the subjective weighting law is to determine the weight coefficient according to the relative importance of the evaluation index. The weighting coefficient obtained by the objective weighting law should be a measure of the degree of variation of each index in the overall index and the degree of influence on other indexes. The weighting method combines the two methods to make up for the shortcomings of the main and objective weighting methods so that the determined weighting coefficient can simultaneously reflect subjective information and objective information. The establishment of the network efficiency model selection method to determine the weight of various indicators.

Entropy weights are given to each of the network performance metrics obtained. The basic idea of entropy method is to determine the objective weight according to the size of the index variability. Generally speaking, if the entropy  $E_j$  of a certain index is smaller, it indicates that the greater the degree of variation of the index is worth, the more information it provides, the greater its contribution to the comprehensive evaluation and the greater its weigh. On the contrary, the greater the information entropy of an indicator is, the smaller the value of the indicator is worth of variation, the less the information is provided, and the less its contribution is to the comprehensive evaluation. After setting the weight value for each network indicator, the weighted result is calculated. The result is a decimal between 0 and 1. The closer to 1, the higher the network performance evaluation.

Entropy method specific steps flow chart is as follows:

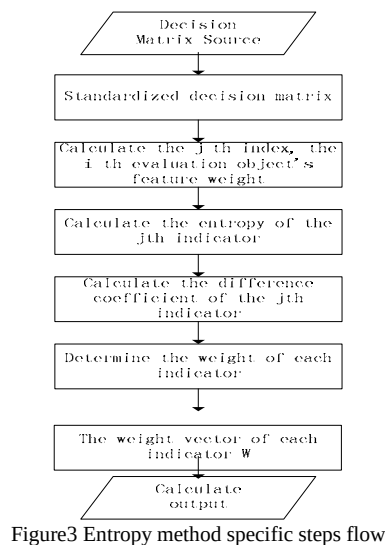


Table1 Performance indicators and their weights

| name             | Delay      | Jitter                | The corresponding time |
|------------------|------------|-----------------------|------------------------|
| Weights          | 0.1        | 0.1                   | 0.2                    |
| Packet loss rate | Throughput | Signal to noise ratio | Bit error rate         |
| 0.1              | 0.2        | 0.1                   | 0.1                    |

#### V. DISTRIBUTION COMMUNICATION COOPERATIVE NETWORK EFFICIENCY EVALUATION SYSTEM

Firstly, based on the topology of distribution network, the network topology is mainly divided into four layers, that is, the backbone layer, convergence layer and access layer. The backbone layer mainly includes the graphic station display and distribution network master server, the convergence layer includes the front-end machine and the communication channel, and the access layer mainly includes various actual power distribution terminals and analog terminals. Through the simulation platform to achieve network performance evaluation, set according to different scenarios to achieve the specific configuration. The following is a 6-scene (respectively named M1 ~ M6) the specific configuration:

M1: The original scene is high load + high resolution + set copy business.

M2: Change to medium load + low resolution + set copy business.

M3: change to high load + low resolution + set copy business (light).

M4: Change the distribution terminal access method.

M5: Increase the number of analog terminal nodes to 12.

M6: Terminal devices communicate in various ways (Ethernet, Power Line Carrier and GPRS), client the number of nodes increases to 104.

Select the raw data measured experimentally, use the entropy method to calculate the objective weight, and finally calculate the entropy and weight of each business performance index.

Table2 Entropy weight method to calculate the entropy and weight of each performance index

| classification | Delay  | Jitter | Packet loss rate | Link utilization | Throughput |
|----------------|--------|--------|------------------|------------------|------------|
| entropy        | 0.8163 | 0.7100 | 0.787400         | 0.6847           | 0.7743     |
| Weight         | 0.1497 | 0.2363 | 0.173200         | 0.2569           | 0.1839     |

For the performance of the M1 ~ M6 entropy method evaluation value  $S_i$  are: 0.2079, 0.5647, 0.4350, 0.9883, 0.1397, 0.7229.

Starting from the priorities demanded by the service for delay, jitter, packet loss rate and throughput, the relative comparison method and the entropy method are combined to make a comprehensive evaluation of the network performance. Considering that service 1 has the highest requirements on delay, the packet loss rate and throughput are

second, such as monitoring services and automation services; service 2 has the highest requirement on packet loss rate, secondly delay and throughput, 3 Highest throughput requirements, followed by latency and packet loss, such as video services. Using this model, take C1, C2 are 0.5. Comprehensive evaluation of different scenarios to get the scene and different business comprehensive evaluation values shown in Table 3.

Table3 Scenario and different business comprehensive evaluation value

| Scenes | Comprehensive evaluation value |           |           |
|--------|--------------------------------|-----------|-----------|
|        | Business1                      | Business2 | Business3 |
| M1     | 0.3373                         | 0.3258    | 0.4144    |
| M2     | 0.7776                         | 0.8082    | 0.8016    |
| M3     | 0.7347                         | 0.7692    | 0.8016    |
| M4     | 1.0000                         | 1.0000    | 1.0000    |
| M5     | 0.0690                         | 0.0805    | 0.0615    |
| M6     | 0.6829                         | 0.6909    | 0.5847    |

Different services have different priorities for network performance indexes, which lead to differences in evaluation results. However, there is not much difference in the overall performance requirements of each service for each service. That is, when certain indicators in the network are poor, inevitable Will result in the overall business performance decline or can not meet the actual needs of customers.

## VI. CONCLUDED

In order to fully realize the intelligent distribution network, through the use of advanced communication means and technologies, establish high-speed, two-way and highly integrated communication system to achieve efficient use of power grid resources and power supply security and stability. The coordination and analysis of distribution network communication and calculation and establishment of coordinated planning model. On the one hand, the model starts with the bottleneck source and analyzes the influence characteristics by combining with various parameters to calculate the impact results; on the other hand, the bottleneck source of impression is derived from the impact result form through the influence characteristics. The two methods have different functions and suitable occasions, but they all make full use of the characteristics that affect the interaction. The two forms of formula derivation and intelligent algorithm are established. The methods are validated accurately and more accurately and reflect the development of collaboration and interaction. Characteristics and solve bottlenecks in collaboration prediction and adjustment problems, forming a complete power distribution communication network efficiency evaluation system.

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