ISSN: 2414-1895 DOI: 10.6919/ICJE.202401_10(1).0022

Intelligent Analysis and Application Research on Power Communication Resource Data

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Abstract

To fully leverage the role of data and explore its value, this paper relies on TMS resource data to improve the quality of resource data through the establishment of a "source" and three optimization measures. Subsequently, data mining algorithms such as association rules are utilized to analyze the interrelationships between communication resource data, communication services, and communication channels by designing six standardized forms, thus forming rules for business analysis and the association between business and channels. This achieves coupled correlation analysis of power communication resource data and maintenance risk analysis, greatly enhancing the intelligent management of communication operation and maintenance and better supporting the overall development strategy of the company.

Keywords

Power Communication Resources; Intelligent; Association Rules.

1. Introduction

In recent years, with the continuous development of digital, informational, and intelligent technologies and the proposal of smart grids, how to extract valuable information from power communication resource data and apply it to business decision-making and optimization management has become an urgent issue. State Grid Corporation proposed at the "Two Sessions" in 2021 that it is necessary to fully leverage driving forces of all factors, continuously optimize management models and operating mechanisms, tap the value of power big data, and provide endless driving force for the high-quality development of the company.

The intelligent application of power communication resource data has become a current hotspot in the construction of power communication networks. Through the use of big data algorithms to mine the value of power communication network data, timely discovery of alarms, defect elimination, centralized monitoring methods and applications, as well as analysis methods for maintenance work of power communication networks under the big data processing technology have been realized to improve the intensity, intelligence, and efficiency of communication management. The accuracy of big data intelligent analysis and data mining depends directly on data quality. Since the launch of the Telecommunication Management System (TMS) in 2013[4], adhering to the principle of data sharing among national, provincial, municipal, and county levels, online recording of communication static resources (sites, optical cables, etc.) and dynamic resources (optical paths, services, etc.) has begun, accumulating a large amount of data. In actual work, whether it is the optimization of the entire data governance workflow[5] or the application of big data processing algorithms[6] and various data mining algorithms in data quality verification, it has to some extent improved the accuracy of the data, but the demand for intelligence remains insufficient.

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Starting from the current situation of multi-source maintenance of data, this paper creatively uses channel IDs to achieve a "source" for communication resources, and combines three optimization measures of collection tools, verification tools, and matching tools to solve the problems of data dispersion, low data quality, and insufficient data reliability, generating a "single account" for protective and security business. Based on this, the paper uses the interrelationships between data to carry out communication business channel analysis, achieve dynamic disclosure of business load relationships, and facilitate one-click filling in of communication maintenance impacts on business. Finally, through multiple route risk analysis and other functions, it further enhances the operational safety level of important production business channels.

2. Preservation and Management of Power Communication Resources Data

Currently, there are multiple sources of communication data, and the data is scattered. In response to the "multifaceted" maintenance problem of TMS, professional network management, provincial and local cloud, and national cloud services, this article adopts a "source-end governance" approach. By governing the resource data of the network management system, the accuracy of the resources is addressed from the source, minimizing the later manually maintained error-prone issues. The source end refers to using the network management data as the source, achieving the communication of resource data throughout the entire network through collection tools, verification tools, and matching tools, as shown in Figure 1.

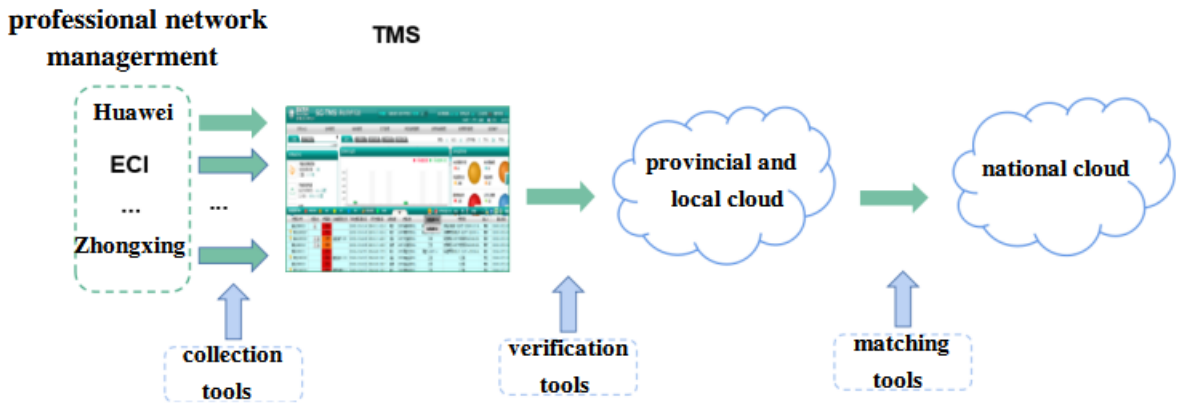

Figure 1. Flow chart of source-end governance

2.1 Optimize the Collection Mode to Ensure a "Single Source" of Data

The communication channels involve numerous network management systems spanning different levels and transmission brands. The channel names of each network management system are not standardized. By borrowing the concept of identity cards, a "cross-system" unique identity ID code is assigned to the business channel information, unifying the business channel names across different systems. Simultaneously, the existing collection mode of TMS is optimized and improved to form a new SNC collection method, which adds the function of collecting communication channel names and label IDs based on the original network management collection function module. The standard business names and channel IDs of the transmission network management channels are collected into the "network management business name" of TMS channel resource information, ensuring the data consistency between the transmission network management and TMS systems and solving the problem of inconsistent channel labels of different transmission brands that cannot be unified in TMS, thus ensuring a "single source" of data.

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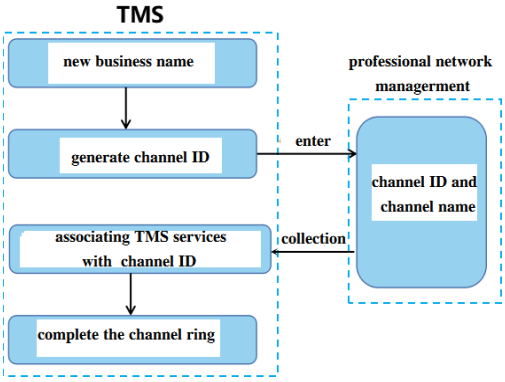

Figure 2. Flow chart of data preservation

2.2 Improve Verification Tools

After multiple network management business collections enter TMS, the TMS system data is used as the source, and data standardization and rule management, data verification management, data auditing management, and data statistics management function modules are established to ensure the integrity, accuracy, and standardization of communication data accounts, attributes, and various businesses, as well as the verification of data relevance and consistency. By configuring the verification rules for each type of resource, problems requiring governance are identified through algorithms in the self-check tool, and automatic maintenance or offline governance is carried out. After data governance and data auditing in the self-check tool, the properly managed data is fed back to the TMS system offline.

2.3 Design Matching Tools

Develop matching tools using the Python programming language to automatically extract key fields between communication resources and primary resources in the power grid for mutual matching. This matching tool first standardizes the pre-processed communication resource data formats, eliminates spaces, replaces the English letter “I” and the special symbol “I” with the Roman numeral “1”, and standardizes voltage levels, station names, and line names to 500kV certain station or 220kV certain line, used for matching stations with communication station IDs, and line with communication fiber IDs. In the business channel matching, the line name, protection business ID, and whether AB channels are configured are used as the unique judgment conditions to match all matching communication channel IDs, and special standards are applied to unmatched data and multiple duplicate matches to facilitate later manual verification. The matching tool can achieve one-click processing of many form data of communication resources and power grid resources, saving limited manpower and improving the efficiency and accuracy of cloud resource matching.

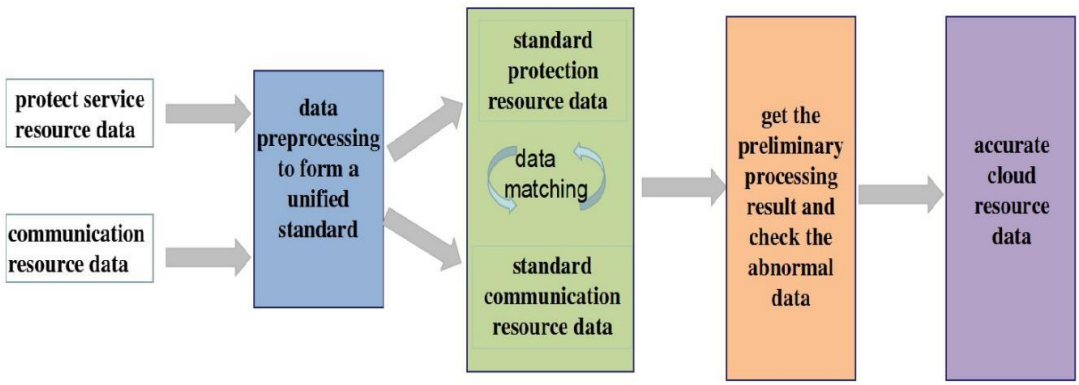

Figure 3. Schematic Diagram of Cloud Resource Matching

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3. Data Intelligent Analysis

Commonly used methods for data analysis using data mining include clustering, regression analysis, and association rules. The purpose of association rules is to find rules that describe the relationships between data items in a database, as well as the relationships between the data items. This paper applies the association rule analysis method to the analysis of communication resource data, by designing rules for the precise calculation of the impact of business using the "one-account" concept and the association rules between business and channels.

3.1 Develop Standardized Forms to Create a "One-account" Through Hierarchical Associations

Leveraging existing TMS resource data, intelligent analysis is conducted on communication management system business resources, optical resources, channel resources, and business channel associated resources, including business channel association analysis, channel route analysis, optical route analysis, etc., to identify their interrelationships. For example, optical cables carry optical routes, which in turn carry business, and equipment supports both optical routes and business. By setting up six standardized forms, such as the optical cable routing table, optical route routing table, protection routing table, security routing table, optical cable-carrying business analysis table, and equipment-carrying business table, and establishing their associations, a "one-account" is formed.

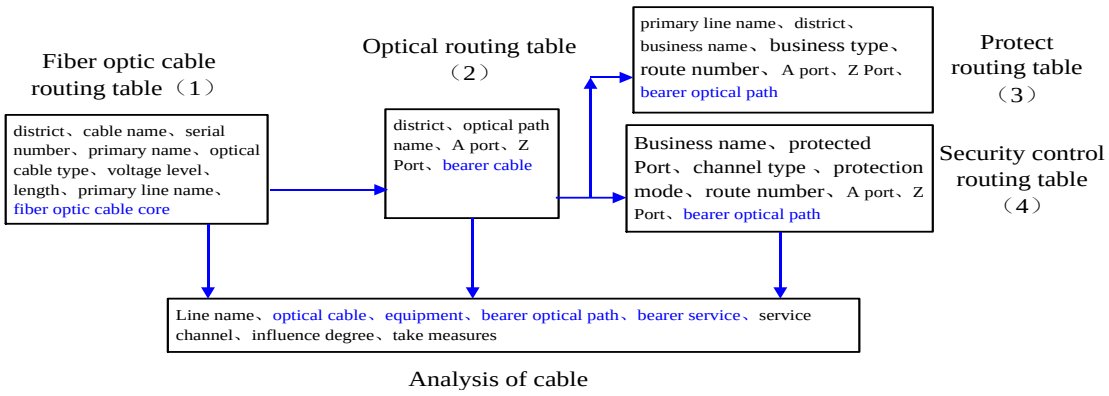

Figure 4. Business Form Association Diagram

3.2 Establish the Association between Communication Channels and Business

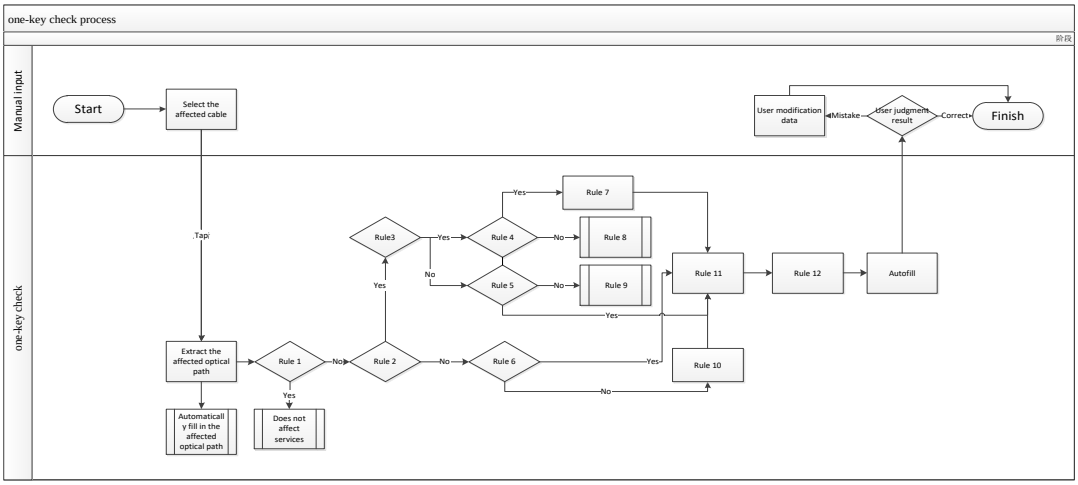

Figure 5. Flow chart of one-key check affecting service channel

The protection methods for communication channels can be classified as optical cut, multiplex section protection (MSP), SNCP protection, 2M1+1 protection, etc. To analyze the impact degree of

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communication channels, for example, the impact of optical cut routes and MSP 1+1 optical routes, information about primary and alternate optical routes is manually entered, and the impact on business interruption, momentary interruption, or non-impact is determined based on factors such as whether they share the same optical cable, primary and alternate optical routes, and whether 2M1+1 and SNCP protection are configured, as shown in Figure 5.

Additionally, for different types of businesses, the impact analysis of communication channels can be further analyzed for the degree of impact on the business system by extracting key fields such as "line", "equipment", and "system", as shown in Figure 6.

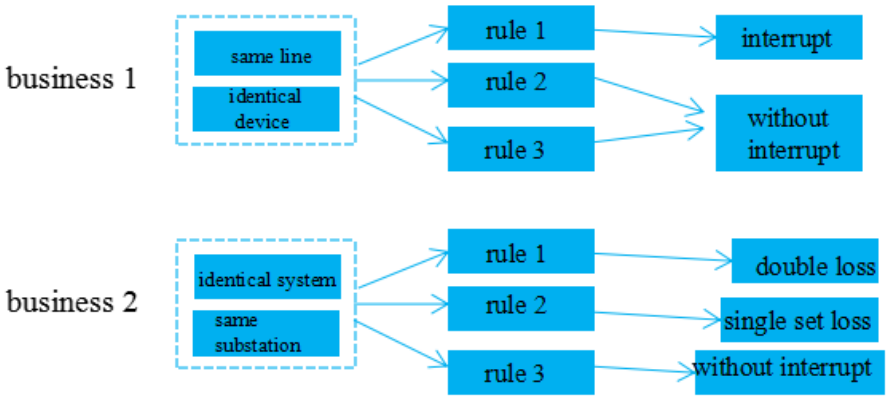

Figure 6. Discrimination of influence degree of business system

3.3 Designing Multiple-route Analysis Rules

Building on the single business channel analysis rules, a multi-faceted analysis of equipment ports, cards, devices, optical cables, and optical routes is conducted to make "N-X" determinations for the entire route and analyze the impact of multi-point interruptions on optical routes and business channels, as shown in Figure 7.

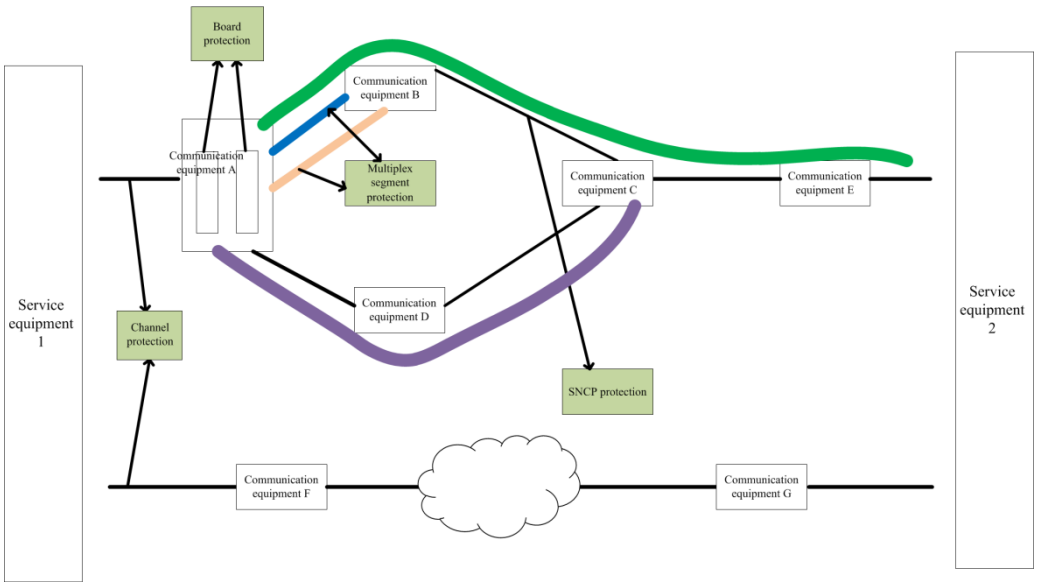

Figure 7. Multi-route analysis flow chart

4. Application Effects

4.1 Achieving Dynamic Disclosure of Business Carrying Relationships

Through the correlation analysis of communication resource data, on the basis of achieving "one account", we extend the routing to specific physical entities such as optical cables and equipment,

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constructing a new mode of "business disclosure for optical cables and equipment". By establishing an online business disclosure process and relying on "one account" to export the list of optical cables and optical transmission equipment carrying businesses with one click, the online disclosure list can be disseminated to local operation and maintenance units in real time. This breaks the traditional form of offline business routing disclosure, solving the issue of needing to collate offline business routing tables from headquarters, branches, and provincial companies, and distributing them monthly to operation and maintenance units. Additionally, the previous offline routing tables could not directly show the information of optical cables and equipment, as shown in Figure 8.

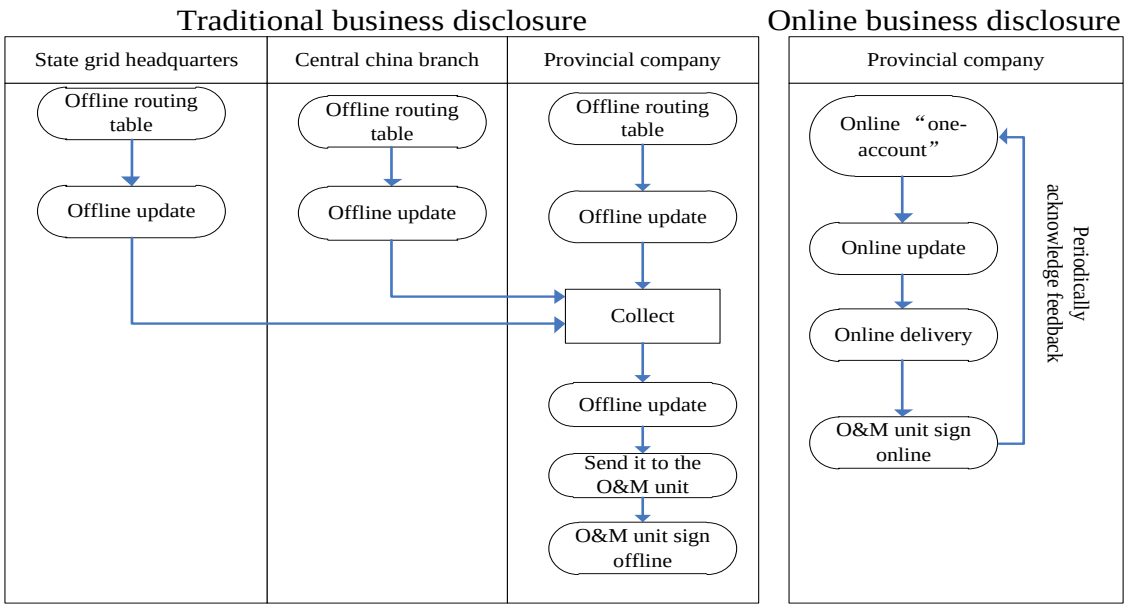

Figure 8. Flow chart of business disclosure

4.2 Achieving One-click Completion of Business-impacting Maintenance Tickets

Addressing the issues of business cross-carrying, dispersed data, low intelligence level of business verification, long verification time, and difficulty, which consume human resources. Based on the business routing information conducted above, an intelligent business impact analysis of communication equipment, optical cables, and optical routes is developed. A frontend display interface is created to implement the business impact analysis feature. By analyzing the impact of single-point maintenance of optical cables and equipment or single fault of communication networks on business verification, the one-click input of the impact analysis results into maintenance plans or tickets is enabled, assisting maintenance personnel in conducting communication maintenance impact on business reporting and approval, achieving a "one-click reporting" of communication maintenance impacting business. Meanwhile, routing details and manual maintenance measures can be viewed.

4.3 Multi-point Maintenance N-X Risk Analysis

By simulating the occurrence of multiple maintenance or fault interweaving in the communication network, the business-related analysis algorithm is used to assess the system's carrying capacity and the risk level of maintenance or faults in an offline state. That is, the correlation analysis mechanism of the impact of multiple maintenance working at the same time. Information such as the quantity, type, proportion, and degree of impact of the affected business is analyzed to achieve reliability assessment of the communication network and operational trend analysis. At the same time, in the case of multiple overlapping maintenance, N-X analysis of the communication network can rationally arrange communication maintenance tasks to achieve peak-shifting maintenance.

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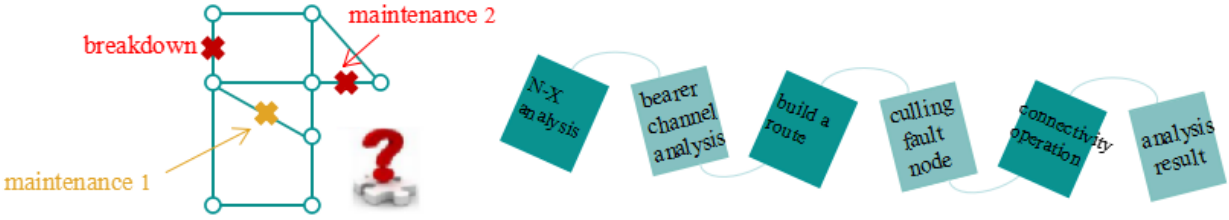

Figure 9. Multiple maintenance risk analysis diagram

5. Conclusion

The paper first analyzes the characteristics of power communication resources, and on the basis of improving data quality, carries out intelligent analysis of communication management system business resources, optical path resources, channel resources, business channel-related resources, etc., fully tapping the value of communication resource data, and transforming massive communication data resources into actual "productivity", automatically generating protection security business "one account", achieving cross-level, cross-network communication business channel routing management. Empower professional production through the value chain of data, using the correlation analysis method to conduct communication business and channel analysis, automatically determining the related business channels affected by communication equipment and cable maintenance, as well as the business information carried on this business channel, achieving dynamic disclosure of business-carrying relationships, maintenance impact protection, security business one-click verification, communication network N-X risk "one-click warning", effectively solving current problems such as low intelligence level of maintenance reporting and approval, and consuming a large amount of human resources, thus greatly improving the intelligent management level of communication operation and maintenance, further enhancing the safe operation level of protection security business channels, better supporting the overall development strategy of the company.

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