

Network Reform and Acceptance Technology Optimization of Telecontrol Device Based on Game Theory

Yarong Hu^{1,*}, Qiangxing Liu^{2,3}

¹Shenzhen Power Supply Co, Ltd, Shenzhen Guangdong, 518001, China

²Nari Technology Co, Ltd, Nanjing, 211106, China

³Nari Group Corporation (State Grid Electric Power Research Institute), Nanjing, 211006, China

Keywords: Game theory; telecontrol device; network transformation; acceptance technology

Abstract: At present, the networked transformation technology of telecontrol devices in China is more and more advanced. On the premise of game theory, the network transformation and acceptance technology optimization of telecontrol device are analyzed and discussed. And its application conditions and technical difficulties are analyzed, which have achieved good results in practical application. The existing telecontrol device capacity and processing capacity can no longer meet the demand. A complete upgrade and transformation plan should be designed. The expansion system optimizes the network and utilizes existing technologies without affecting real-time data acquisition and transmission.

1. Introduction

With the rapid spread of wireless network technology, especially due to wireless local area networks (technical and wireless personal area networks (fast technology popularization, countless people use wireless network technology to access the Internet [1]. In recent years, with China's economy High-speed development, voltage levels and grid complexity have also been greatly improved [2]. Due to the rapid development of wireless communication services, the unlicensed frequency bands in which these networks work have gradually become saturated [3]. The current development trend is mainly concentrated in computers. High-availability technology is used in dispatch automation systems. Most of these personal wireless networks operate on unlicensed wireless bands, because many wireless networks and devices work by default on the same wireless network without licenses and better radio performance. Frequency band [4]. Now the integrated automation technology used in substation is to integrate relay protection, monitoring system, signal acquisition and remote control system into a whole, so that hardware resources can be shared, and various functions of conventional equipment can be realized by different modes of software [5]. The remote control device at plant and station is an important part of power system automation system. The improvement of its automation level will provide accurate real-time information for production command and decision-making [6].

In addition, some wireless services (such as wireless broadcasting services) require wireless networks to provide some protection functions so that they are not affected by other wireless services [7]. With the continuous development of power grid, the demand for dispatching automation is also increasing, in addition to the new EMS system to meet the continuous automation technical requirements of Southern Power Grid [8]. It is also required that the remote control device at the end of the plant be reformed to improve its automation level. Local area network is used to replace cable and active mode is used to replace passive mode of conventional equipment [9]. It is reliable, safe and easy to maintain. In order to achieve better overall benefits, the company decided to use energy integration technology to optimize the process in the expansion and transformation, in order to reduce energy consumption and save operating costs. Compared with the licensed band, the spectrum resources of the unlicensed band are much smaller and most of the spectrum resources are used for the licensed band [10]. Data structure and data exchange based on the IEC61970 series of standards, and the widespread use of power-specific INTERNET

networks. Each industrial computer is equipped with a modem and dispatched for data exchange. The IEC1801 protocol is adopted. The background monitor uses Advantech IPC and CSC2000 monitoring system software. The measurement and control device uses the LON network to access the remote engine.

2. Methodology

Because the nodes of the cognitive wireless network cannot use the energy intensity of the received signal to distinguish whether the signal is from the primary user or other cognitive network users, the primary user's signal will also cause the cognitive network user's data packet to collide or packet loss. . Therefore, the mechanism of carrier sense collision avoidance used in traditional wireless networks cannot be fully applied to cognitive wireless networks. The characteristics of China Southern Power Grid are: large grid size, large regional span, obvious characteristics of power transmission and transmission network, large power transmission scale, long power transmission distance, multi-circuit AC/DC transmission grid running in parallel, and complex power grid structure. The substation integrated automation system currently adopts a distributed hierarchical distributed structure. This puts forward higher requirements for the reliability of network communication. Choosing a reliable and efficient network structure is the key to solve the problem. After several years of development, Ethernet technology is becoming more and more mature. However, the utilization of a considerable number of authorized spectrum resources is very low. Each industrial computer is equivalent to a telecontrol terminal, which communicates with each measurement and control device and protection device in the station separately, and exchanges data with the dispatch through modem, and uses the older IEC1801 protocol to communicate with the dispatch.

Fig. 1 compares the fairness of three cases. It can be seen from the figure that in Max-Min mode, the ratio of two users' rates is the same, which is the fairest case, but the efficiency is not high.

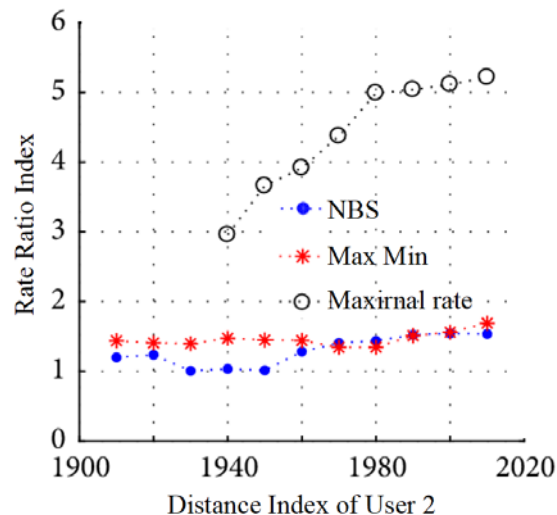


Fig.1. Fairness comparison of three algorithms

This scheme greatly increases the data processing ability of the integrated automation system of 500 kV Dangtu substation, and rationally distributes the network communication load to ensure that there is no "bottleneck" phenomenon of data. The hierarchical distributed star Ethernet communication structure is combined with the optical fiber ring network structure. Generally speaking, the joint work of formulating the comprehensive reforming scheme of catalytic reforming energy is successful, which not only reflects the great energy saving and economic benefits of high and new technology. Other communication services, such as television and broadcasting services, need some protection from other communication services. In order to provide good protection, the frequency management department specially allocates specific authorized frequency bands for specific communication services. Connect the newly installed monitoring computer to the remote engine that has just been replaced. After the dual network communication is normal, check the

remote information and telemetry information of the whole station; select a capacitor for each remote control operation test. Internationally adopted in Italy and Norway. At present, China Electric Power Research Institute Power Grid Branch, Eastern Electronics, and NARI Group are in a leading position in this field. In the future, the development of wireless networks will focus on broadening the reuse capabilities of these already allocated frequency bands, using more efficient frequency band sharing methods, making full use of idle frequency bands, and using potential wireless frequency band opportunities to solve the shortage of spectrum resources.

In order to verify the effectiveness of the algorithm, we simulated the algorithm using simulation tools. The parameters of the node, that is, the service configuration, are shown in Table 1.

Table 1 Simulation parameter

Parameter	Value
WiFi transmission mechanism	DCF (Distributed Coordination Mechanism)
Number of nodes	40
Application description	Data transmission
Data pack	Exponential distribution (1024 bytes)
Packet interval	Exponential distribution (0.3 seconds)
Grid size	300m×300m
Node distribution	Random distribution
The number of retransmissions is online	3
Channel transmission model	Free space propagation model

3. Result Analysis and Discussion

At present, game theory is generally considered as an effective theory to help decision-making choices. It will find so-called Nash equilibrium points for the game process between cognitive nodes, and generally Nash equilibrium points are the optimal strategy. The telecontrol device (including the RTU and the telecontrol workstation of the computer monitoring system) mainly communicates with the EMS system of the Southern Power Grid through the analog dedicated line. The part of the measurement and control device is changed from ring communication to star communication structure, reducing the number of devices on the ring network. The network structure of the substation integrated automation system is transformed from the fiber ring network to the star Ethernet and fiber ring network to ensure the smooth flow of the network. In addition, in the case of synthesizing heat exchanger networks by using narrow-point technology and the comprehensive improvement of energy obtained by using the principle of "addition and subtraction", only the design parameters of each heat exchanger Table are given, and no specific design calculation is made. For this reason, people put forward the concept of cognitive radio. IOLAN terminal server is used in the front-end system of the second generation dispatching and communication system. At present, the system is applied in the national power dispatching center. The hardware structure becomes simple and the price drops. Information in the control domain is not processed for the time being.

Cooperative game algorithm has also been widely used in spectrum sharing. Because all stations and factories communicate with the Southern General Dispatch by special line, the communication rate is low, which affects the real-time performance of information. At present, the project has been implemented and applied in 500 kV when painting transformer. After nearly two months of operation, the real-time transmission of information in the network of the painting integrated automation system has been greatly improved, and the transmission of information with all levels of dispatching is more stable. Based on the application of the topological method, on the basis of revealing some local energy structure characteristics of the process system, a series of simple and feasible comprehensive methods, which are approximate but practical in engineering, are proposed. The core idea of cognitive radio is to make wireless communication devices have the ability to find "spectrum holes" and make rational use of them. In particular, when receiving a message, the

remote control point number of the remote control message is consistent with the point number of the remote control Table, and some version devices can also check whether the remote control message is received, which greatly improves the correct rate of the remote control. Data unit identifiers often have the same structure in all application service data units. Information objects in an application service data unit often have the same structure and type, which are defined by the type identification field.

Figure 2 compares the performance of the three optimization algorithms. For the optimization goal of maximizing the total rate, users close to the base station will get a higher transmission rate, and when the distance between the user and the user is different, the rates of the two users are very different.

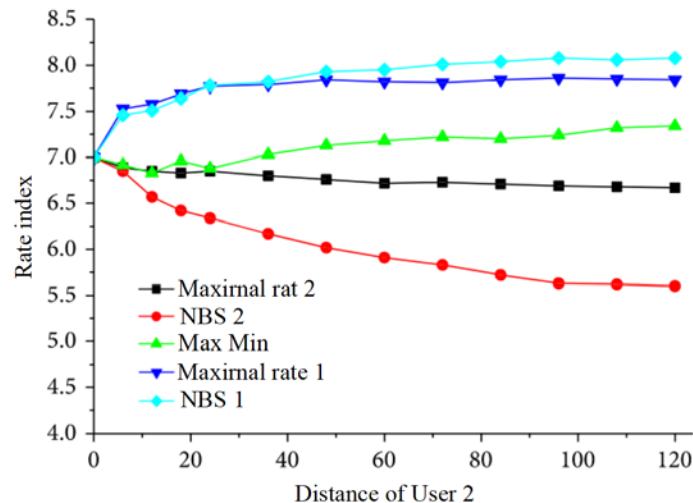


Fig.2. Rate comparison of three algorithms

4. Conclusion

In the retrofitting of old installations, in addition to the adoption of new processes, catalysts, solvents and equipment, energy integrated system optimization techniques must be employed. In this way, through the optimization of the process combination, equipment parameters, sub-units, and subsystems, the results of huge energy conservation and consumption reduction can be obtained. The continuous improvement of cognitive wireless point technology makes dynamic spectrum allocation access technology possible. Although the equipment manufacturers are different, the IEC104 protocol channel four remote function acceptance can be achieved by this method. The telecontrol device changes the traditional real-time data transmission using the serial communication mechanism in the power grid dispatching system, and instead uses INTERNET technology for scheduling. The transformation scheme and communication mode selection of telecontrol device network communication function should be based on the actual site situation of telecontrol device at plant and station, the construction progress of dispatching data network and the transformation plan of plant and station equipment, and can not be separated from reality. Pursue one step at a time blindly, so as not to cause waste of equipment and influence on the operation of equipment in the process of transformation. In the future, we can consider transforming all the measurement and control devices into star Ethernet communication structure, and putting the logic judgement on the new remote communication unit to reduce the intermediate link.

References

- [1] Dextreit C, Kolmanovsky I V. Game Theory Controller for Hybrid Electric Vehicles[J]. IEEE Transactions on Control Systems Technology, 2014, 22(2):652-663.
- [2] Halpern J Y, Pass R. Algorithmic rationality: Game theory with costly computation[J]. Journal of Economic Theory, 2015, 156:246-268.

- [3] Bacci G, Lasaulce S, Saad W, et al. Game Theory for Networks: A tutorial on game-theoretic tools for emerging signal processing applications[J]. IEEE Signal Processing Magazine, 2016, 33(1):94-119.
- [4] Easley D, Ghosh A. Incentives, Gamification, and Game Theory: An Economic Approach to Badge Design[J]. ACM Transactions on Economics and Computation, 2016, 4(3):1-26.
- [5] Liu X, Dong M, Ota K, et al. Service Pricing Decision in Cyber-Physical Systems: Insights from Game Theory[J]. IEEE Transactions on Services Computing, 2016, 9(2):186-198.
- [6] Zhou X, Li Y, He B, et al. GM-PHD-Based Multi-Target Visual Tracking Using Entropy Distribution and Game Theory[J]. IEEE Transactions on Industrial Informatics, 2014, 10(2):1064-1076.
- [7] Chen H, Li Y, Jiang Y, et al. Distributed Power Splitting for SWIPT in Relay Interference Channels Using Game Theory[J]. IEEE Transactions on Wireless Communications, 2015, 14(1):410-420.
- [8] Tian Y, Govindan K, Zhu Q. A system dynamics model based on evolutionary game theory for green supply chain management diffusion among Chinese manufacturers[J]. Journal of Cleaner Production, 2014, 80:96-105.
- [9] Esposito C, Ficco M, Palmieri F, et al. Smart Cloud Storage Service Selection Based on Fuzzy Logic, Theory of Evidence and Game Theory[J]. IEEE Transactions on Computers, 2016, 65(8):2348-2362.
- [10] Hummert S, Bohl K, Basanta D, et al. Evolutionary game theory: cells as players[J]. Mol. BioSyst. 2014, 10(12):3044-3065.