



Research on Heterogeneous Network Integration in Distribution Communication Network

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Abstract: Distribution communication network is the support and guarantee for the stable and reliable operation of various business in distribution network. According to communication requirements of the different business, the distribution communication network uses a variety of communication modes, which also causes complex network structure of distribution communication network. It has become the key of the study that how to optimize the network structure and improve the security of business data transmission. Through the research on the heterogeneous network integration technology, this paper designs the integration architecture of heterogeneous network in distribution communication network, and also puts forward the concept of intelligent heterogeneous terminal. At the same time, it also analyzes the main functions of intelligent heterogeneous terminals, and puts forward a feasible network selection method in intelligent heterogeneous terminals.

Keywords: Distribution communication network; heterogeneous integration; intelligent terminal

I. INTRODUCTION

Distribution communication network is an important part of the whole distribution network, and it is the support for the steady operation distribution network business. Traditional distribution network uses networking mode by combining the backbone network and access network, which uses a variety of communication technologies, such as power line carrier, optical fiber communication, wireless public network, wireless private network, and so on. Various communication networks have their advantages and disadvantages in capacity, coverage, data rate and reliable support-capacity, and the limits of actual physical space are also different. Distribution communication network cannot be achieved by a single-medium network at the present stage.

Heterogeneous network integration technology is a kind of network convergence technology, which provides a smooth and adaptive transmission of diversified business to ensure communication networks seamlessly connect with each other. With using heterogeneous communication network integration technology, it can build a heterogeneous integration of distribution network, provide high-quality business services, and facilitate the maintenance and expansion of the network.

Through the study of the existing heterogeneous communication network integration technology, this paper designs a heterogeneous network integration architecture of distribution network, and proposes a concept for intelligent heterogeneous terminal which is suitable for this architecture, according to the characteristics of distribution network and communication technologies. At the same time, it also analyzes the main functions and put forward a feasible network selection method in intelligent heterogeneous terminals.

II. THE INTEGRATION OF HETEROGENEOUS COMMUNICATION NETWORKS

The integration of heterogeneous networks integrates all kinds of communication networks as much as possible, and it can provide unified and integrated business through a universal network platform in the heterogeneous network environment. It can choose the appropriate network and provide better QoS for users according to characteristics of users, business and network [1]. Heterogeneous network integration includes business integration, network integration, access integration. The resource management and network choosing are two important parts in the integration of heterogeneous networks.

The business integration is mainly involved in the application layer, which uses a unified communication protocol, infiltrates and crosses in business, so that it can achieve the mobility of business. The network integration appears as achieving interconnection in the network layer. It can ensure the seamless roaming of user terminal in the heterogeneous network. The access integration realizes the access independence, shields the difference of different access technologies, and ensures the smooth switching of the network [2]. To meet the demand of future communication business system can learn from each other, make full use of their own advantages, and make up for their disadvantages, and through the integration of the system, by using multiple communication systems.



A. Heterogeneous Integration Pattern

The integration pattern of heterogeneous network determines the different access technologies to realize the network interconnection. At present, the research on pattern of heterogeneous network integration is divided into two directions: one is to design integration pattern according to the closeness degree of communication network, mainly divided into tight coupling mode and loose coupling mode; another direction is to optimize network structure and integrate heterogeneous network by using the dynamic cooperation between communication networks, such as network environment perception [3].

1) Tight coupling pattern

In the process of network integration, the tight coupling pattern is used to integrate communication network in owner-member relationship, which makes a network completely become a part of another network [4]. In this pattern, by increasing a small amount of network element or adding necessary function modules in the prior network, it can realize intercommunication between two networks, and make the network support all the functions of the access network. The two networks can be regarded as a unified whole, and can directly achieve interoperability without third party, with the advantages of small switching delay, but the design and implementation is more complex.

2) Loose coupling pattern

Loose coupling pattern refers that the access systems which form a heterogeneous network are combined together by the independent and parallel way, with no subordinate relationship [5]. The method can keep the independence between the different access systems to a maximum degree, and reduce the information exchange of system between different networks. When a new access system need be added into the heterogeneous network, need not modify deployment and business planning in original network. This approach can not only reduce the heterogeneous network construction cost and complexity, but also improve the network scalability, with advantages in use-range, complex degree, scalability, and so on.

3) Environment-aware network

Environment-aware network is a new network architecture which is based on the dynamic synthesis of heterogeneous networks [6]. Different from the traditional communication network structure, it does not extend the existing network system by patchwork way, but it is based on different technologies and the dynamic combination of network. Through the effective use of existing network infrastructure and means of access, it can constitute instant network protocols with avoiding increasing a new internet protocol in the existing network system, and provide access to any network for users. In order to realize the support of heterogeneous network integration and collaboration, the network management of the environment-aware network must be dynamic, distributed, self-managed and self-maintained, and can automatically respond to the network and the surrounding environment. equipment.

B. Resource Management of Heterogeneous Integrated Network

Resource management of heterogeneous integrated network is a key technology for unified integration and joint management of heterogeneous resources, but also the key to realize the integration of heterogeneous networks. So it plays an important role in ensuring the service quality of the users in the communication network. The purpose of resource management is to try to meet the requirements of different users for different service quality, at the same time, as far as possible to improve the utilization efficiency of communication resources on the basis of ensuring the reliability and validity. Resource management mainly includes connection admission control, load balancing, network selection and so on.

1) Connection admission control(CAC)

CAC is responsible for judging the user's access request, determines whether to allow the system to provide users with the requested service, is an important component of resource management of heterogeneous integrated network, and also is the primary factor affecting the utilization of system resources [7]. The difference between different access technologies brings a great challenge for access selection in heterogeneous network environment.

The principle of CAC is that the new connection should not be based on the cost of the service quality of the existing connection. Before accessing a new connection, CAC must check whether the access request will sacrifice the quality of the existing connection in the communication network. The objectives of CAC include two aspects, one is to meet the QoS requirements of users, another is to maximize the use of communication system resources. CAC needs to determine whether to accept or reject a new connection according to the comprehensive judgment of load conditions, resource usage, the level of service user's QoS, the priority and



QoS level of new access user and other parameters.

The traditional CAC algorithm mainly includes random access method, simple weighted method, grey relational analysis method and so on. Most of these algorithms are based on static network parameters, and do not take into account the dynamic characteristics of network parameters and the changing trend. The CAC method of heterogeneous networks is a multiple attribute decision making problem, which is oriented to the characteristics and needs of the terminal, the network and the user, and has a good dynamic performance and adaptability, and the processing is also more complex.

2) Load balancing

Load balancing is an effective way to improve the quality of network operation, which can be used to alleviate the problem of uneven distribution of resources in heterogeneous networks, thus the capacity and service quality of the system are improved. Network load is used to measure the utilization of network resources in a certain condition and environment, which can be measured by the number of users can carry and amount of available channel resource [8]. Improving the utilization rate of network resources is the goal of research on traditional network load balancing and control. But in heterogeneous networks, the utilization of network resources is no longer the only objective of resource allocation and load regulation because of the diversity of business types and service requirements. It is needed to provide load balancing algorithm suitable for heterogeneous integrated network according to the characteristics of heterogeneous networks.

At present, the research on load balancing in heterogeneous networks mainly includes two aspects. The one is to select the most suitable network for new business services based on a certain access selection and admission control strategy, to avoid the load differences due to the imbalance of business. The other is to adjust the load difference between light load and heavy load by the method of business transfer and switching to realize the balance of volume of business among different networks. The current load balancing algorithm of heterogeneous integrated network mainly includes the load balancing algorithm based on threshold value, the load balancing algorithm based on mathematical method and soft load balancing algorithm based on the shunt.

III. FEATURE ANALYSIS OF DISTRIBUTION COMMUNICATION NETWORK

A. Structure of distribution communication network

Distribution communication network is a bridge among the main distribution station, the slave distribution station and the terminal. It adopts hierarchical architecture design, and the networking model is shown in the Figure 1. Backbone network commonly uses SDH (Synchronous Digital Hierarchy), PTN (Packet Transport Network), and OTN (Optical Transport Network) communication technologies. The commonly used communication technologies in access network contains fiber communication, power line carrier communication, industrial Ethernet, wireless public network, and wireless private network. Traditional networking model in distribution communication networking has been relatively mature, but it still exists some problems that the traditional networking use different communication network to meet the QoS requirements of different services as a result of the complex networking, and at the same time, it also has some difficulty in maintaining and extending the network.

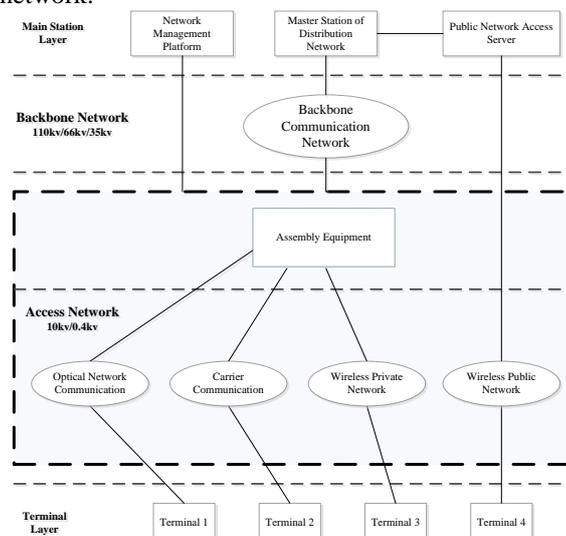


Figure 1. Networking model in distribution network.



B. Communication technology of distribution communication network

Due to the complexity of distribution network, the data communication mode is not unified in distribution network at present., which can be divided into wired communication and wireless communication according to the physical characteristics of the communication medium [9]. Wired communication mainly includes power line carrier communication and optical fiber communication. Wireless communication mainly includes wireless public network and wireless private network. Among them, wireless private network also includes GPRS(General Packet Radio Service), CDMA (Code Division Multiple Access),TD-LTE (Time Division- Long Term Evolution) provided by mobile operators, and the wireless network includes WiMAX (Worldwide Interoperability for Microwave Access), McWiLL (Multi-carrier Wireless information Local Loop). The performance comparison of wired communication network and wireless communication is shown in Table I.

TABLE I. THE PERFORMANCE COMPARISON OF WIRED COMMUNICATION NETWORK AND WIRELESS COMMUNICATION

communication mode	Transmission speed bits/s	Real-time	Reliability	Construction Cost
power line carrier	28.8k	lower	low	lower
optical fiber communication	100M	high	high	very high
wireless private network	300-4800	low	middle	high
Wireless public network	300-4800	low	middle	low

IV. INTEGRATION SCHEME OF HETEROGENEOUS COMMUNICATION NETWORK IN DISTRIBUTION COMMUNICATION NETWORK

A. The integration architecture of heterogeneous communication network

1) The integration architecture of heterogeneous communication network in distribution communication network

According to the distribution communication network structure and characteristics, we design the integration architecture of heterogeneous communication network in distribution communication network shown in the Figure 2. In the access networks, different communication schemes are put in a heterogeneous communication network, which realize the network interconnection through the router.

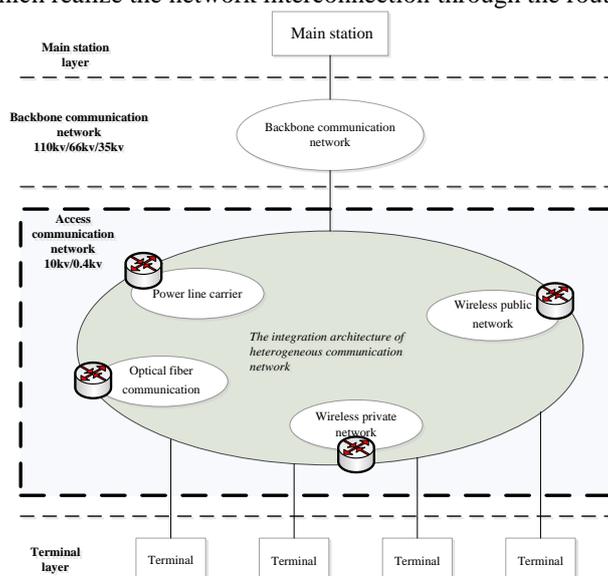


Figure 2. The integration architecture of heterogeneous communication network

The integration architecture of heterogeneous communication network is deployed between the terminal layer and the backbone communication network layer. Different distribution terminals realize the transmission of information through the way of ad-hoc network. On the one hand, the terminal is responsible for



collecting the performance parameters of the current access network, and selecting the most suitable communication route according to the business requirement; On the other hand, the terminal can also use other terminals to achieve the transmission of information in the way of relay routing.

2) Function structure of heterogeneous integrated network in distribution communication network

In the heterogeneous communication network, the service terminal has the resource control mechanism to shield the details of the network, which can help them to obtain satisfactory service quality in the process of using the network to realize the information transmission. In addition, the heterogeneous network can also interact in real time between the network and the network, the network and the terminal, and provide the corresponding reliable service according to the specific needs of specific business. The function structure of heterogeneous integrated network in distribution communication network is shown in the Figure 3.

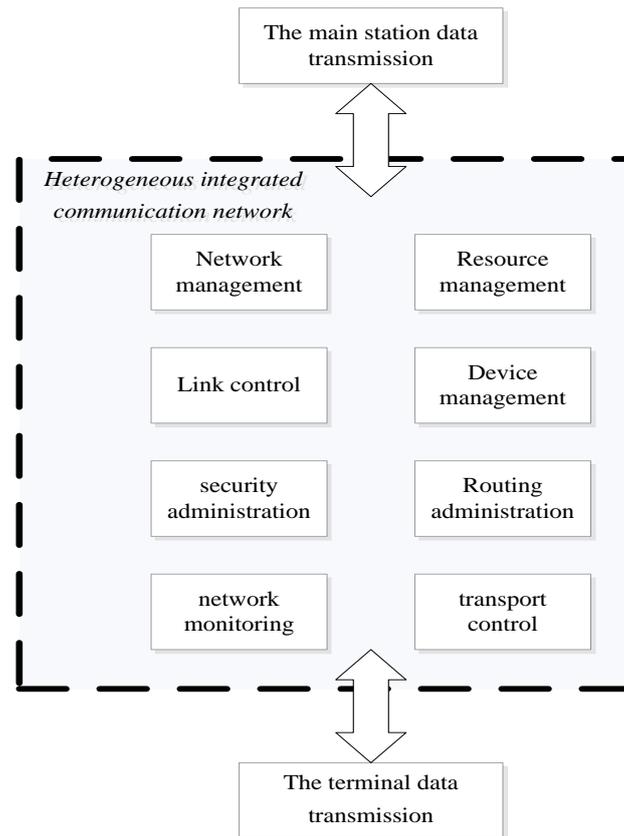


Figure 3. The function structure of heterogeneous integrated network in distribution communication network

The main function of heterogeneous communication fusion network includes network management, link control, safety management, network monitoring, resource management, equipment management, routing management, transmission control and so on. Among them, the network monitoring function is responsible for monitoring the network status of all connected networks, including the network utilization, load conditions, congestion and other information of the cable or wireless network wired networks and wireless networks. In addition, the wireless network also need to monitor the number of wireless network connection and connection status. Resource management is responsible for the management of network resources of the system, allocate and adjust the network resources of the system in real time according to the information provided by the network monitoring function, including bandwidth resources, network topology, routing resources to ensure network resource utilization rate is high. Link control function is responsible for the detecting new link in real time, and administrating new access links.

B. Intelligent heterogeneous terminal of distribution communication network

Traditional distribution terminal is common terminal with relay function. In distribution network, it can collect real-time data, detection data, fault identification, operating conditions of switch equipment, process and analysis them, upload information and receive control commands by wired / wireless communication



means. According to the characteristics of heterogeneous network, this paper proposes a kind of intelligent heterogeneous terminal which is suitable for heterogeneous communication networks. Its functions are shown in Figure 4. Intelligent heterogeneous terminal consists of eight functional entities which are data acquisition, data transmission and acceptance, security control, abnormal warning, network detection, network selection, heterogeneous module management, data processing. Each functional entity adopts a structured design method, and they process and integrate all kinds of power distribution terminal operation data in an independent, efficient, stable and safe way.

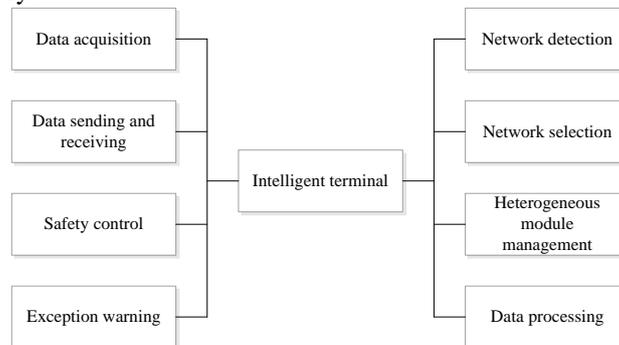


Figure 4. The function of intelligent heterogeneous terminal

The Traditional terminal is used to complete the collection of data and the control of the order of the receiver. Its main functions are as follows.

- Functions of data acquisition, data transmission and receiving control commands are mainly to complete the acquisition of electrical quantities (including the quantity of state information and analog information), sending data to master station in a timely manner after processing in terminal to realize telemetry functions. Similarly, the terminal receives the control information and data from the master station, and realizes the function of remote control.
- Equipment monitoring and safety control refers that the terminal equipment needs to monitor its state in order to deal with the equipment problems in a timely manner. When the equipment malfunction cannot complete the task of data collection or data transmission is failed, and equipment cannot correct execution control command, the equipment should send abnormal alarm information.

In addition to the above functions, this paper puts forward the application of intelligent heterogeneous terminals in heterogeneous communication network integration architecture, including the management and operation of the network. Details are as follows.

- In the integrated networks, the performance of each access network changes in real time. Intelligent distribution terminal monitors the state of all networks synchronously through the network state monitoring module, including network load, number of network connections, transmission rate of network time-delay and so on, to realize the function of network status monitoring, provides real-time data basis for network selection and load balancing in heterogeneous Networks.
- The function of network selection module is to select the most appropriate and effective load bearing transmitting and receiving data according to the analysis of different network states to ensure that the terminal can access the best network, so that the resource utilization of the whole network can reach the maximum. In addition, it also needs to change the network access of the distribution terminal according to the state of the network. The process also includes handover trigger, connection reconstruction, packet routing.
- Because of different networks adopt different network standards, it is necessary to process data frames which are transmitted or received according to the corresponding network structure, including the transmission protocol, package data frame.
- Heterogeneous module in intelligent heterogeneous terminal includes communication module of all kinds of communication network, which compose the heterogeneous modules of intelligent heterogeneous terminals, thus the terminal access heterogeneous fusion network is realized. Heterogeneous module administrates the communication module of different network, monitors the status of the module, and sends the abnormal issue in time.



C. The Communication Technology of Distribution Communication Network

The heterogeneous network integration layer is directly between the application layer and the physical device. The use of heterogeneous network integration makes physical devices transparent for application layer. The application layer uses the uniform communication interface provided by heterogeneous network integration to complete communication instead of selecting different ways of information transmission according to different ports of different physical devices. And the physical differentia will also be reduced by heterogeneous network integration in communication.

The heterogeneous network integration is mainly divided into three parts, just as shown in Figure 5.

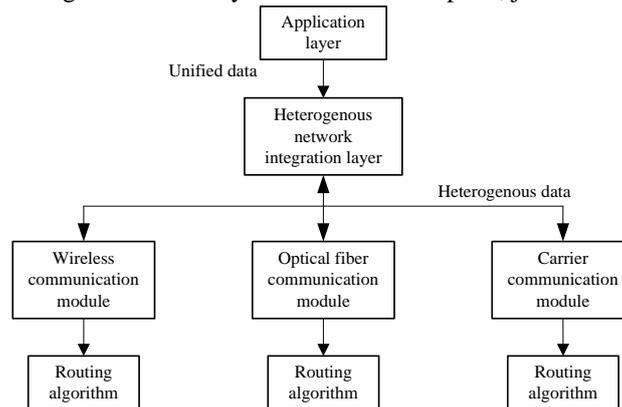


Figure 5. The selection of routing algorithm

1) The unified interface for application layer

This part is to make the underlying structure transparent to application layer, application layer does not need to realize the differences of the underlying structure, does not care about the specific physical device, and only need to call the unified interface provided by the heterogeneous network integration.

2) The identification and selection of physical device

Although the application layer does not need to know the difference of the physical device, the heterogeneous network integration layer needs to understand the underlying structure, and then adopt the method of differentiation. The identification and selection of physical device is one of the key issues in the heterogeneous network integration. Different strategies make heterogeneous network integration show the different intelligence and reliability, for example, using artificial recognition or intelligent recognition. Artificial identification requires the professional personnel to inform the heterogeneous network integration about the underlying structure in the form of parameters or another way. This method is of low intelligence, requires the implementation of professional personnel, but easy to achieve. The reliability can be fully guaranteed if the professionals can guarantee no mistakes. However, intelligent identification is the use of the program to perceive physical devices, and to identify the underlying structure. This method is highly intelligent, no need of professional personnel to implement, but hard to achieve. Reliability are closely related to the algorithms of perceiving physical structure. After perceiving different physical structure, if it is only a single physical device, then choose the routing algorithm directly, and if there is a redundancy of the physical structure, it is necessary to select the network. The principle of choice is to use the most rapid and the lowest error rate of physical device.

3) The selection of routing algorithm

After knowing the physical structure, the heterogeneous network integration layer will adapt the routing algorithm to different physical devices, so as to improve the communication efficiency and reliability.

V. CONCLUSION

This paper analyses the existing heterogeneous network integration, which include the heterogeneous network integration pattern, access selection, load balancing, network selection. According to the characteristics of distribution communication network and the main communication technology, the paper integrates power line carrier, optical fiber communication, wireless public network and wireless private network into a heterogeneous communication network architecture, and proposes a concept of intelligent heterogeneous terminals which is applicable to the architecture. At the same time, the paper analyses the main functions of intelligent



heterogeneous terminals, such as network monitoring and network selection. Finally, it puts forward a feasible method of network selection which is applicable to intelligent heterogeneous terminals.

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