



ISSN: 2454-9940



**INTERNATIONAL JOURNAL OF APPLIED
SCIENCE ENGINEERING AND MANAGEMENT**

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www.ijasem.org

Power grid emergency communication network design considering several networks

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Abstract.

Natural disasters and emergencies generally pose serious threats to power facilities. Therefore, it is necessary to establish an efficient electric power emergency communication (EPEC) system. Existing systems based on a single network carrier (for example, 4G, satellite, and Wi-Fi) may not meet the requirements of complex environments. We design a new EPEC system based on multi-network convergence technology by integrating the above three network carriers. It overcomes the limitations of single network carrier and improves the efficiency of power emergency communication. The test results show that the system can improve the transmission line bandwidth, automatically switch to the optimal signal network, and guarantee the security and stability of data transmission.

1.Introduction

Natural disasters and emergencies have caused huge threats and damages to power facilities [1], and there is an urgent need to establish a power emergency communication system that responds quickly to power emergencies and can efficiently interact. The current plan mainly uses a single communication network such as 4G, satellite communication [2] and Wi-Fi as the carrier, which is suitable for different application scenarios. 4G has a wide coverage area and low cost. Communication systems using 4G as a carrier are widely used in urban public power management. Satellite communication has a wide coverage area, stable and reliable signals, and systems based on satellite communication are widely used in large-scale power management. Wi-Fi is easy to operate, and systems based on Wi-Fi are widely used in household power management. In order to cope with the complex and changeable power emergency communication problems in the field environment,

this article adopts multi-network integration technology to achieve the integration of the above three network carriers, realize multi-network simultaneous transmission and automatically switch to the network with the best signal, to ensure effective power emergency Communication.

2. Power emergency communication system requirements based on multi-network integration

Different communication carriers have certain shortcomings. The electric emergency communication system with a single network as the carrier cannot carry out efficient and reliable communication in a complex and changeable environment. Wi-Fi cannot carry out large-scale and long-distance communication [3]; 4G has

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different signal strengths in different regions, and only 4G for mobile emergency communication is likely to have blind spots; satellite communication costs are high and cannot be widely promoted [4]. For example, transmission lines and facilities are widely distributed and large in number. Many facilities span mountains and forests and the on-site network signal is poor. Once damaged or malfunctioned due to a disaster, the command

the command center in real time; satellites have been used for a long time. The network cost is too high. The efficiency of the emergency communication system will determine the degree of loss and damage caused by the power accident in many cases, and its efficiency is reflected in the immediacy and mobility. Using a single network is difficult to resolve the contradiction between the unpredictability of emergencies and the immediacy of power emergency repairs.

To ensure the reliability of emergency communications, information must be transmitted in a redundant mode that integrates multiple communication methods. Multi-network convergence technology provides ideas for solving this problem. Multi-network integration refers to the integration of multiple network sub-systems through a certain mode to achieve multi-network interactive coordination and optimization of system effects. Multi-network integration technology has been widely used in fields such as communications, fire protection, coal mines, and agriculture [5-7].

3. Implementation framework of multi-network convergence technology The power emergency communication system based on multi-network integration is realized by using multiple networks such as wired, wireless and satellite communications for various complex geographic and network environments for power operation and maintenance. This scheme uses the multi-network access function to converge, merge and forward data, realize the data interaction of multiple networks and the interconnection and intercommunication of multiple network terminals [8-10]. By optimizing and transforming the network, the originally relatively independent multiple network carriers are integrated, and the technical functions and service carrying scopes tend to be consistent to achieve network interoperability. And resource sharing, to provide

center urgently needs to achieve stable and smooth emergency communications with the site as soon as possible. Real-time emergency response and command and dispatch. However, in these areas, there is very little Wi-Fi network coverage; emergency communication systems based on 4G networks are generally under covered by base stations in the field, and the communication flow rate is low, making it difficult to communicate with

users with more convenient and comprehensive services [11]. Different from the operation of a single network and a dedicated network, the multi-network convergence technology is richer in form, simplifies the system structure, and facilitates later management and maintenance.

3.1. Network protocol composition The main function of the H.248 /Megaco protocol is to control the media gateway and ensure the security and stability of the communication between the softswitch equipment and the media gateway. The main function of the SIGTRAN protocol is to regulate the transmission mode of PSTN signaling. Session Initiation Protocol The function of SIP is to build, repair and terminate sessions, and can provide multiparty sessions based on IP calls and multimedia. The H.323 protocol is based on packet switching, supports video and multimedia calls, can realize real-time audio and video interaction between the command center and the emergency scene, and provides reliable and efficient mobile emergency communications and overall command for the dispatch center.

3.2. Multi-network integration technology model The main transmission method adopted by the multi-network integration technology is to allocate a buffer queue (FIFO) to the corresponding sending thread to buffer the information to be sent in the current network. When data is read, data is obtained from the FIFO, and the data transmission method that is most suitable for the current situation is selected according to the current situation of the FIFO and the link transmission information. The adaptive data encoding algorithm is used to encode the data to be sent to ensure that the data receiving end can recover the transmission data [12]. After processing the data, use the current wireless transmission link to send the data to the

server. At this time, the available transmission links include Wi-Fi, 4G and satellite transmission. In this process, both the transmission rate and the failover link switching are realized by using multi-channel simultaneous interpretation and multi-network switching. The following will analyze the multi-channel simultaneous interpretation and multi-network switching.

3.3. Realization of multi-channel simultaneous interpretation and multi-network automatic switching strategy This article binds the three communication methods, and writes instruction scripts into the system using embedded methods to control the connection between Wi-Fi, 4G, and satellites and public networks, and synchronize the point-to-point protocol—16—to In the embedded system, multiple dial-ups are virtually constructed into multiple connection modes using multiple simultaneous interpretation.

3.3.1. Realization of multiple simultaneous interpretation. Write an embedded script method according to routing and multiple simultaneous interpretation algorithms, use at instructions to connect the wireless module to the public network line, and synchronize the point-to-point protocol to the embedded system, and use multiple simultaneous interpretation to virtually build multiple dials into Multiple connection methods. Configure a corresponding weight K for each network attribute, and then perform simple linear addition.

3.3.2. Realization of automatic switching of multiple networks. When multiple networks are online at the same time, test information is sent to the corresponding network at regular intervals to detect the status and signal strength of this network [13-15]. If the network is online, the amount of data that the module should bear is allocated according to the strength of the test signal. If a module is found to be unable to work normally, the online status value will be set to 0, and the module will not be assigned data. The automatic switching algorithm is adopted to select a suitable solution among multiple networks through the optimal decision criterion. The wireless network switching method is shown in Figure 1, and the specific switching process is shown in Figure 2.

Using multi-network automatic switching, when a transmission line fails, the data can be switched to

other lines for transmission. When the network returns to normal, communication is carried out through the original communication network, which ensures the security and stability of multi-network converged wireless communication.

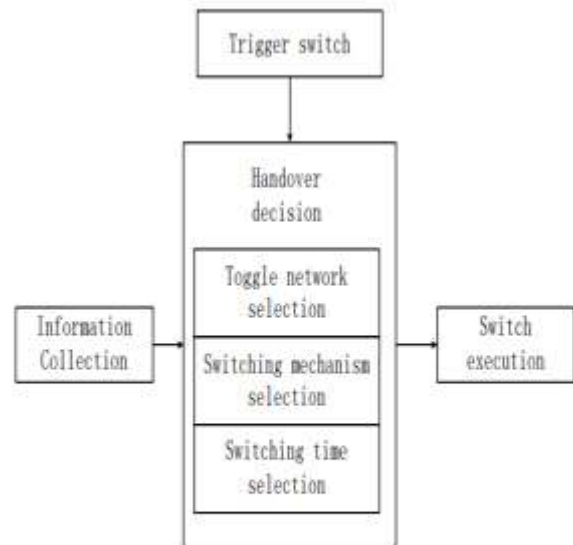


Figure 1. Schematic diagram of network switching

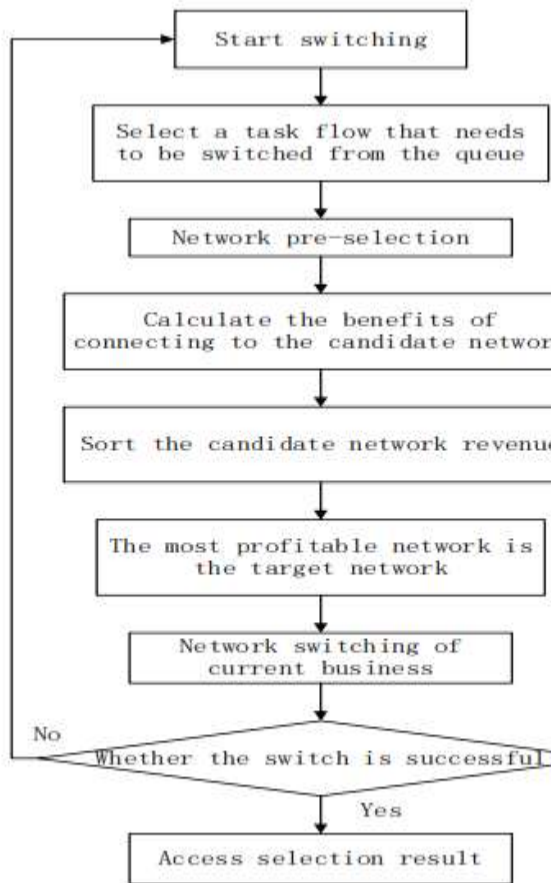


Figure 2. Wireless network switching flow chart

4. Design of a power emergency communication system based on multi-network integration technology

The designed power emergency communication system is implemented based on the above-mentioned multi-network integration technology and framework. The system is mainly divided into four parts: field collection and transmission equipment, network communication mechanism, emergency center main station platform and central access equipment.

① On-site collection and transmission equipment. The on-site audio, video and data are collected, compressed, coded and decoded, and transmitted to the emergency center master station in real time through multi-network integration technology. The field equipment can also receive the information sent by the emergency center master station and other terminal information forwarded.

② Network communication mechanism. The video, audio and data information at the scene of emergencies can be transmitted through the

operator's 4G public network line, 4G VPN private network line or satellite line. The multi-network integration mechanism can be applied to various complex onsite network environments, ensuring the smoothness and stability of emergency communications.

③ The main station platform of the emergency center. Use one or more servers, and install data processing software, power communication software, etc., to provide data storage, transmission and forwarding services for the host platform.

④ Central access equipment. The access equipment of the emergency center can display the scene of the incident, and the access users can conduct two-way audio and video consultation and multi-party interaction with the incident scene, and guide the on-site personnel to deal with emergencies in real time.

5. Test verification

The power emergency communication system based on multi-network fusion technology designed in this paper is experimentally verified, and it mainly includes two modules of multi-network automatic switching and multi-channel simultaneous transmission. Test the bandwidth of the transmission line when multiple channels are used for simultaneous interpretation and test the automatic switching of the network when a certain transmission line fails.

5.1. Multi-channel simultaneous interpretation test In a poor network environment, the actual bandwidth of the network was tested in three transmission modes: 4G, Wi-Fi, and multiple simultaneous transmission. The results are shown in Table 1.

Table 1. Bandwidth under different communication transmission modes

Communication transmission mode	Bandwidth (Mb/s)
4G	1.5
Wi-Fi	2
multiple simultaneous transmission	2.5

Through the bandwidth test, it can be seen that compared to 4G or Wi-Fi single network communication transmission, the use of multiple simultaneous transmission can increase the bandwidth of the transmission line and ensure the efficient and stable transmission of data

information. This is at the critical moment of power emergency communication. It is of great significance.

5.2. Multi-network automatic switching test

Do the following two sets of tests:
 ① Wi-Fi network interruption test. After 100 times, when the WiFi line fails, the network will automatically switch to 4G for data transmission; when the Wi-Fi communication is restored, the network will switch back to Wi-Fi again.
 ② 4G network interruption test. Perform 100 times. When a 4G line fails, the network will automatically switch to satellite communication for data transmission; when 4G is restored, the network will switch back to 4G. The results are shown in Table 2.

Table 2. Multi-network automatic switching test

Number	Test condition	Test times (times)	Switching result	State recovery	Switching success rate
1	Wi-Fi interruption	100	Automatically switch to 4G network	When Wi-Fi resumes, switch back to Wi-Fi	100
2	4G network interruption	100	Automatically switch to satellite network	When 4G resumes, switch back to 4G	100

The test proves the effectiveness of automatic switching of multiple networks. When a transmission line fails, the data can be switched to other lines for transmission to realize automatic switching of multiple networks. When the network returns to normal, communication is carried out through the original communication network to ensure the effectiveness of multi-network integration wireless communication. The reliability and stability provide a reliable guarantee for the efficient transmission of data and information in the power emergency communication system.

6. Conclusion

Natural disasters and emergencies have caused huge threats and damages to power facilities. The power emergency department urgently needs to respond quickly to various events and build an emergency communication system that effectively transmits information. This article uses Wi-Fi, 4G and satellite communications as carriers, and adopts multi-network integration technology and automatic switching strategies to better realize power emergency communications, overcome the shortcomings of a single network carrier, and provide a more reliable and effective power

emergency guarantee Emergency communication technology program.

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