Research on Distribution Network Monitoring and Fault Location Based on Edge Computing

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Abstract. The research of distribution network monitoring and fault location based on edge computing is a research, focusing on the design of low power consumption, high reliability and high fault tolerance distributed systems. The main purpose of this research is to develop a distributed system architecture for monitoring and locating faults in large-scale networks. The architecture consists of three components: fault location component (FLC), data acquisition component (DCC) and data analysis component (DAC). These three components are connected through an intermediate layer called the Service Interface Controller (SIC). SIC provides necessary interfaces between DCC, DAC and FLC.

Keywords: Distribution network monitoring · Edge calculation · fault location

1 Introduction

Whole power network, and directly contacts with electricity customers. Therefore, its reliable power supply capacity and power supply quality are the direct embodiment of the economic benefits of power enterprises, and correspond to the immeasurable social benefits [1].

The value is small, so it is not necessary to cut off the line immediately, and it is allowed to operate with fault for a period of time. In addition, abnormal over-voltage may occur when the fault occurs. When ferromagnetic resonance over-voltage occurs, its value can reach 4 times of phase voltage, and sometimes it can reach 3.5 times of phase voltage when intermittent arc grounding occurs. These high voltages affect the whole network. If they last too long, they will damage the equipment in the network, damage.

Most domestic people still use the method of manual line patrol. Due to the complex branches of the distribution network, in case of short circuit fault, only the circuit breaker at the outlet of the substation will trip, while in case of ground fault, it will not trip. In case of short circuit and ground fault, even if the trunk line is segmented by switches, only a limited number of sections can be isolated. It often takes a lot of manpower, material resources and time to find the specific fault location, It is difficult to adapt to the new requirements of distribution automation.

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2 Related Work

2.1 Research Status

Material resources and financial resources to study distribution network fault location methods, and have made many research achievements. In a broad sense, fault location includes fault line selection and accurate location. In terms of specific implementation, the fault location method can be divided into wide area fault section location method using multiple line terminals (FTU) or fault indicator (FPI), and fault location method that directly uses the electrical quantity information measured at the line outlet to calculate the fault distance [2]. The former is used for fast fault isolation of urban distribution network with convenient transportation and high automation level; The latter is used for multi town distribution network with long power supply distance and difficult patrol inspection to find fault points.

Short circuit fault in power system refers to the short circuit between phases or between phases and ground that causes sharp increase of current, sharp decrease of voltage and further damage to electrical equipment.

2.2 Research Status of Edge Computing at Home and Abroad

Therefore, as edge devices generate more data, network bandwidth will become the bottleneck of cloud computing. To solve these problems, edge computing technology came into being. Edge computing proposed by Cisco refers to the use of localized idle computing and storage resources to implement delay sensitive tasks. Specifically, edge computing can first pre process tasks by utilizing limited resources (such as computing and storage cells), and then transfer them to the cloud for further processing. At the same time, it can also independently deal with applications that consume less energy and have lower latency than cloud computing.

3 Distribution Network Structure and Network Model

3.1 Distribution Network Structure

The distribution network is mainly composed of distribution lines and switchgear. The network composition is divided into overhead lines and cable lines according to the types of conductors. The proportion of cable lines used in developed countries such as Europe and the United States is relatively high, while the proportion of cable lines used in China was very low. With the needs of urban network transformation and urban development, the number of cable lines used has increased year by year [3].

Network connection can be divided into radial network. In the planning principle of urban distribution network, it is pointed out that the overhead lines should adopt the wiring mode of multi section and multi connection, and the contact points should operate in an open loop during normal operation. Sectional switch and interconnection switch are used here, both of which belong to load switch. Figure 1 shows several typical connection forms of overhead lines. The cable network structure is similar to the overhead line, but the sectioning and liaison functions are realized through the ring network cabinet.

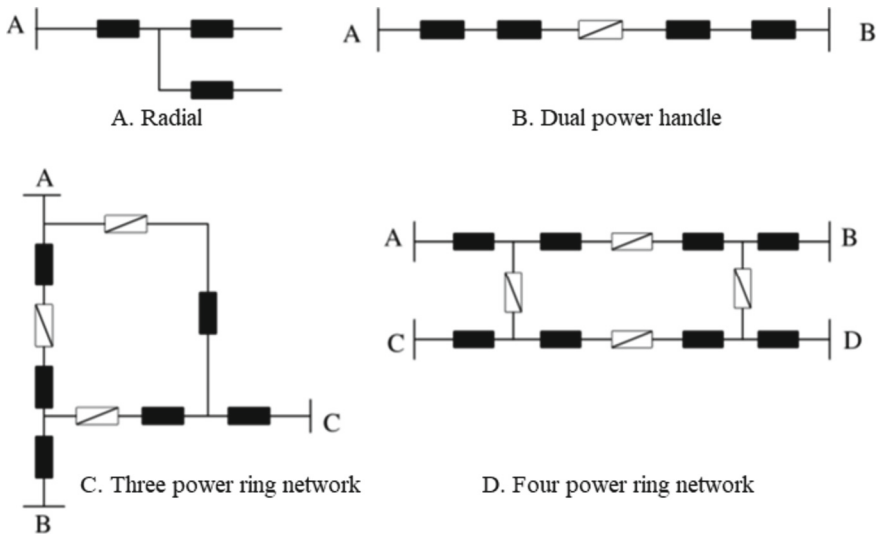

Fig. 1. Connection form of overhead line

In the process of design and optimization of distribution network, flexible connection mode shall be adopted according to the nature of load. Regardless of the connection mode, the following criteria shall be met: network connection shall be simple and flexible, with the purpose of improving system reliability and realizing automation;

The fault handling of distribution automation is closely related to the type of switchgear. Before discussing fault handling, briefly introduce some main switchgear in current distribution automation. Switches on distribution lines mainly include recloser, circuit breaker and sectionalizer. The recloser is a kind of equipment with high degree of automation.When it is confirmed that it is a fault current, it will automatically break the fault current according to the inverse time limit protection for a certain time, and automatically reclose for many times as required to restore power to the line [4]. If the fault is instantaneous, the line will resume normal power supply after reclosing of recloser; If the fault is a permanent fault, the recloser will complete the preset reclosing times (usually three times), confirm that the line fault is a permanent fault, and then automatically lock. The fault line will not be powered on until the fault is eliminated manually, and the recloser closing lock will be released again to restore to normal state.

3.2 Cable Network Fault Handling Mode

The possibility of transient fault of cable line is very small. Once the fault occurs, it is basically permanent.

However, in order to restore power supply in time, the circuit breaker at the outlet of the substation should still be configured with a reclosing function. The most common power supply mode of cable line can be roughly divided into ring network cabinet and switching post mode (this power supply mode can also be used for overhead lines, and multiple reclosing may be required at this time.

At present, most cable networks adopt the ring distribution mode of ring network cabinet. The ring network cabinet can be indoor or outdoor. The ring network cabinet generally has two incoming lines and multiple outgoing lines. The two incoming lines are supplied by two feeders led from two buses of one substation, or by two substations. Open loop during normal operation. In case of fault, fault location is carried out by relying on the information provided by the fault indicator, and then fault isolation is carried out by relying on the load switch of the ring network cabinet and power supply is restored to the non fault section.

4 Research on Distribution Network Monitoring and Fault Location Based on Edge Computing

The edge computing node simply processes some raw data generated by network edge devices and provides complex data to cloud service providers, thus reducing the relay of edge data, as shown in Fig. 2.

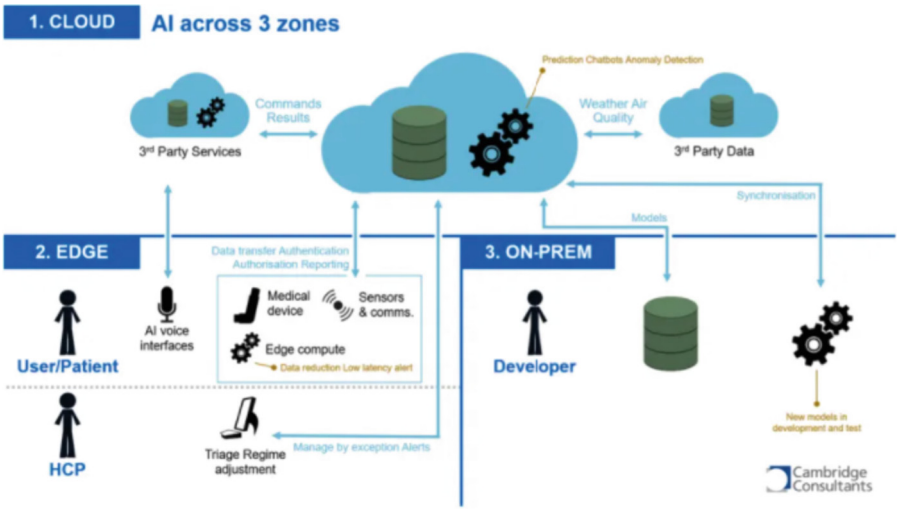

Fig. 2. Location of edge computing in OICT fusion

The fault transient and steady-state data obtained from each node will be very large. If all of them are uploaded to the master station for processing, not only will communication congestion and huge computing burden be caused to the master station. Compared with the traditional master station system and the cloud edge collaboration system designed, the effectiveness and reliability of the system are verified through simulation. The general framework of the edge computing collaborative system applied in the industrial field is shown in Fig. 3.

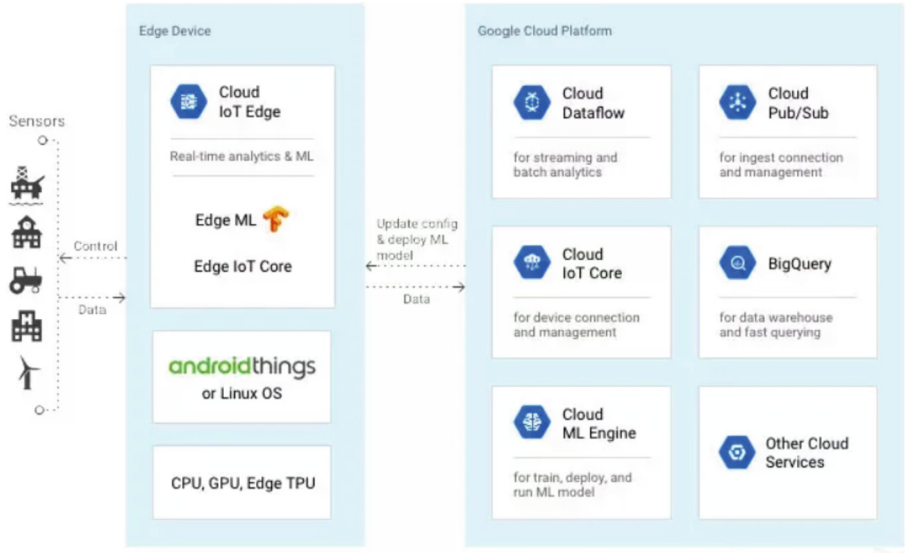

Fig. 3. General Framework of Edge Computing Collaborative System

5 Conclusion

Distribution network automation requires the capability of automatic fault location and pre-processing, and requires the reduction of fault processing time. However, the existing small current fault detection system only solves the problem of line selection. In addition, there are many branches of power supply lines in the distribution network in China, and the environment is complex, which increases the difficulty of fault location. Therefore, line current fault location has always been a blank in China's power system. According to the fault grounding phenomenon, this paper selects the wide area amplitude comparison and phase comparison method as the judgment basis, and combines GPRS communication technology and GPS time service technology to realize the collection of zero sequence vectors in the wide area, and automatically locates the small current grounding fault by judging the relationship between zero sequence vectors.

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