Overview of Enterprise IoT Security System based on Edge Computing

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Abstract: The topic of security runs through the development of human society, and it exists in all aspects of our lives and work. In order to better ensure the safety of the employees in enterprises, the enterprise IoT security system should be established. With the development of technology, the application of IoT in enterprise security has made some progress. Since more and more devices are connected to the Internet and generate big data, cloud computing is no longer sufficient to process and analyse IoT devices in real time. Especially the data is generated by different digital platforms involving enterprise production, management and safety. Therefore, edge computing can be taken into account. This paper briefly introduces the development status of Internet of Things technology and edge computing technology comparing with cloud computing. It should be helpful for us that edge computing is proposed to apply to enterprise IoT security system.

1 INTRODUCTION

The process of production in the enterprise is complex, the operation line is long and it has strong continuity. During the production process, it not only has the characteristics of high temperature, high pressure and high energy, but also involves the toxic, harmful, flammable and explosive substances in the production process. Meanwhile, there is also the hidden danger of mechanical injuries such as high-rise buildings, mechanical processing and so on, which are prone to fall from high places and objects to strike (Wang Shuming, 2016, Pan Zhixing, 2015). With the acceleration of China's modernization process, enterprises have developed at a high speed, but at the same time, the probability of serious accidents such as fires, explosions, poisonings, and leakages has also increased year by year. Starting from the regularity of accidents, effective early warning of accident symptoms has become an important way to reduce accident losses (Xu Yangguang, Chen Xuebo, Sun Qiubai, 2017).

With the increasing progress of technology, there have been many cases of Internet of Things (IoT) applied to enterprise security. However, because more and more devices are connected to the Internet and generate data, cloud computing is no longer sufficient to process and analyze data generated or to be generated by IoT devices and other digital platforms in real time, especially in the case of safe production in enterprises. In order to make up for the shortcomings of both the amount of data and the transmission rate of cloud computing in the security system, so that it can process the received data faster and more efficiently, it is necessary to "sink" some functions of cloud computing. Edge computing came into being at the historic moment.

2 IoT TECHNOLOGY RELATED RESEARCH

This section summarizes the development and application research of IoT technology.

2.1 Development History of Internet of Things Technology

The Internet of Things originated in the 1990s. In the early 1990s, the MIT Auto-ID Laboratory set the

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Electronic Coding Standard (EPC). The designation of this standard makes the radio frequency identification technology (RFID) more widely used in various fields. Build an EPC real-time tracking information system based on the EPC standard, which can virtually connect objects to the Internet (Liu Qibiao, Chen Zhiming, 2015, Gui Jinsong, 2013). In 1995, Bill Gates first proposed the rudiment of the Internet of Things concept connected by "thing to thing", which is the idea of interconnection. And it is also known as the "Internet of Things" in English (Bill Gates book, 1996). In 1998, the Massachusetts Institute of Technology put forward the concept of the Internet of Things. In the same year, the Automatic Identification Center put forward the preliminary concept of the Internet of Things. At the WSIS Information World Summit in 2005, the International Telecommunication Union formally proposed the concept of the "Internet of Things" in its report (ITU Internet Reports, 2005), stating that the Internet of Things includes the networking and application of all items.

Since its inception, the Internet of Things has sustained innovation and strong impetus, and its applications involve defense military (Furtak, J., Zielinski, Z., Chudzikiewicz, J., 2016,Wang J, Jiang F, Xie C, 2012), intelligent transportation (Zhang G W., 2013), smart grid (Zeng Li, Xu Xin, Zeng Dajun, 2017, Yang W, Peng Z, Yu H, et al, 2013, Liu B W, Zhou H, 2013), smart home, medical and health (Li Cuijin, 2017, Liu Qibiao, Chen Zhiming, 2015) and many other fields. It played an active role in them.

2.2 The Application Status of Internet of Things Technology

Sun Qibo et al. summarized the key technologies which are involved in the Internet of things and proposed the technology system model of the Internet of things (Sun Qibo, Liu Jie, Li Li Li, Fan Chunxiao, Sun Juanjuan, 2010). The architecture system of the Internet of things technology is shown in figure 1. Yan Tao and Lv Limin applied the Internet of things technology to the enterprise safety production monitoring system, and elaborated the design process from the aspects of the Internet of things architecture, the overall design of the security monitoring system, and the realization of functions (Yan Tao, Lv Limin, 2012). Literature (Chen Xuebo, sun Qiubai, 2015) established the framework of the behavioral safety management system consisting of people, things and environment, and established an early warning system for unsafe behaviors to dynamically track and monitor human behaviors by utilizing the Internet of things technology, complex system theory and behavioral safety management method. Liu Zude and Li Pengfei proposed to apply the Internet of things technology to the accident early warning system of metallurgical enterprises, and proposed the basic framework of the enterprise accident early warning system based on the Internet of things architecture, (Liu Zude, Li Pengfei, 2015). Based on the existing traditional video monitoring, the paper (Su Huo, Liu Xiaodong, 2016) used OpenCV visual library and C++ to realize face recognition, and implemented the judgment of suspicious persons in the prohibited area. Literature (Zhang Li, 2013) used video analysis technology and Internet of things technology to develop an intelligent video monitoring system with multiple functions including area invasion, object detection, smoke detection, direction and path detection of moving objects. In literature (Zhang Yi, 2010, Wang Yucheng, 2016), intelligent video recognition algorithm was studied in depth to improve the feature extraction algorithm of moving target detection. It also defined the abnormal behavior, recognized the behavior of moving objects, and rose them to the height of the event. Literature (Hu Dongtao, 2014, Qin Jianwang, 2012) respectively established a set of underground mine behavior safety monitoring and warning system based on Internet of things technology. The real-time dynamic detection subsystem was established to collect personnel positioning information and underground mine environment information in real time. Ground monitoring subsystem was built to analyze online information and warn timely. And it also designed personnel location, environment detection terminal software, hardware, and ground hand-held security information query terminal equipment. The above researches are the applications of Internet of things technology in video recognition, and the algorithm and model are given in detail. However, they are only one part of the whole enterprise security system, which needs to consider other subsystem.

In literature (Sun, E., Zhang, X., & Li, Z., 2012), the monitoring and early warning system (TDMPAS) of tailing dam based on Internet of things and cloud computing was realized, and the system structure of the early warning system was given to realize the real-time monitoring of saturation line, stagnant water level and dam deformation of tailing dam. In literature (Wu, Y., Chen, M., Wang, K., & Fu, G., 2019), the underground dynamic information platform of coal mine based on Internet of things technology was established. The platform was divided into six functional layers: support layer, perception layer, transmission layer, service layer, data extraction layer and application layer. This platform can monitor and record the working condition data of coal mine production system, as well as the location information of underground equipment and miners. Based on cloud computing technology, it can quickly analyze the big data related to underground coal mines and accurately extract the key data related to users' needs. Literature (Chen, L. R. Cao, J. F., 2018) described the architecture and key technologies of industrial Internet of things. Literature (2017) introduced outliers detection and spatiotemporal statistical analysis based on cluster analysis. It also presented a real-time monitoring, event reporting and early warning platform based on RSS distance weighted centroid localization algorithm. The platform used the Internet of things, cloud computing, real-time operation database, application gateway and application program interface to seamlessly integrate the monitoring, analysis and localization methods. In literature (Dong, L.J., Shu, W.W., Sun, D.Y., Li, X.B., Zhang, L.Y., 2017), a multiple key information system of tailing pond was constructed based on the Internet of things and wireless network, and also utilizing the sensor data including the stability indicators such as diving line, reservoir water level, internal and external deformation of tailing pond. The basic system was given and the simulation analysis was carried out. In reference (Bo, C., Xin, C., Zhongyi, Z., Chengwen, Z., & Junliang, C, 2014), a remote monitoring system was proposed based on the Internet of things, which made full use of wireless sensor network and combined with CAN bus communication technology to abstract the data and capabilities of underground sensors into WoT resources, and services were provided through representational state transfer (REST). The above researches are all based on the applications of Internet of things technology in enterprises, such as metallurgical enterprises, underground mines, etc., but they are all about the framework research, lacking in-depth study of specific models and algorithms.

3 RESEARCH ON EDGE COMPUTING TECHNOLOGY

In 2004, Pang (PANG H H, TAN K L, 2004) proposed edge computing in the open literature for the first time in the 20th IEEE International Conference. It mentioned that "Edge computing is to implement extensible and highly available web services, which will promote the logic and data processing center of the enterprise to the edge side of proxy services. Its advantage is that the operation of applications on the edge side reduces network latency and produces faster web service response". Shi Weisong and others systematically introduced the concept and principle of edge computing. It instantiated the concept of edge computing through existing cases as well (Shi Weisong, Sun Hui, Cao Jie, Zhang Quan, Liu Wei, 2017). Edge computing refers to a distributed open platform that integrates the core capabilities of network, computing, storage and applications on the edge of the network close to the object or data source to provide edge intelligent services nearby (SHI W S, CAO J, ZHANG Q, et al, 2016, HU Y C, PATEL M, SABELLA D, et al, 2015). Reference (Li Linzhe, Zhou Peilei, Cheng Peng, Shi Zhiguo, 2019) introduced the concept and general architecture of edge computing. Its general architecture is shown in Figure 2, which introduces the application of edge computing. The general architecture of edge computing is divided into three layers , that is terminal layer, edge computing layer and cloud computing layer. Each layer can communicate with each other and across layers. The composition of each layer determines the computing and storage capacity of each layer, and thus it determines the functions of each layer.

(1) Terminal layer

The terminal layer is composed of various Internet of things devices such as sensors, RFID tags, cameras, smart phones and the like, which mainly completes the function of collecting original data and reporting. In the terminal layer, only the perception ability of various IOT devices is considered, but not their computing ability. Billions of Internet of things devices in the terminal layer continuously collect all kinds of data, taking the form of event source as the input of application services.

(2) Edge computing layer

Edge computing layer is composed of network edge nodes, which are widely distributed between terminal equipment and computing center. It can be intelligent terminal equipment itself, such as smart bracelet, smart camera, etc., or it can be deployed in network connection, such as gateway, router and so on. Obviously, the computing and storage resources of the edge node are quite different, and the resources of the edge node are dynamic. For example, the available resources of the intelligent bracelet are dynamic with the use of people. Therefore, how to allocate and schedule computing tasks in dynamic network topology is worth studying. The edge computing layer realizes the basic service response by reasonably deploying and deploying the computing and storage capabilities on the edge of the network.

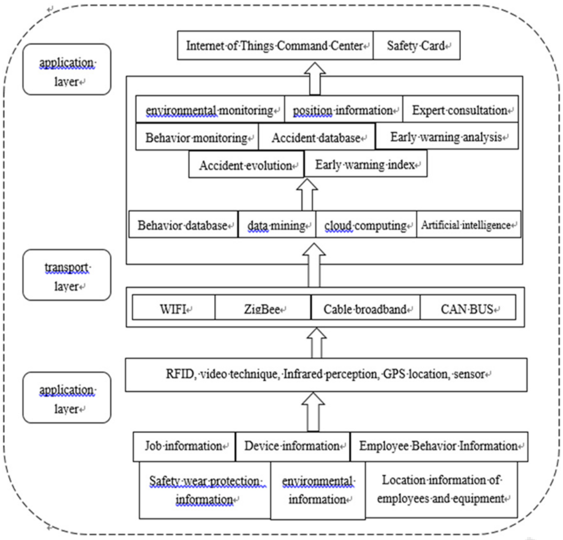

Figure 1: Basic structure of enterprise safety system based on Internet of Things.

(3) Cloud computing layer

In the joint services of cloud edge computing, cloud computing is still the most powerful data processing center. The reported data of the edge computing layer will be stored permanently in the cloud computing center. The analysis tasks and comprehensive global information processing tasks that cannot be processed by the edge computing layer still need to be completed in the cloud Computing Center. In addition, cloud computing center can dynamically adjust the deployment strategy and algorithm of edge computing layer according to the distribution of network resources.

In reference (Qi Bing, Xia Yan, Li Bin, Shi Kun, Xue Mingfeng, 2018), a family energy system framework based on edge computing was proposed, a four-tier architecture based on data fusion and operation collaboration between heterogeneous platforms was designed, and detailed design schemes of several common subsystems were given, which provides new ideas for the application of edge computing technology in the field of intelligent energy use. Reference (An Xingshuo, Cao Guixing, Miao Li, Ren Shubo, Lin Fuhong, 2018) introduced the basic concept, system architecture and the relationship with other computing paradigms of edge computing, analyzed the security threats existing in current edge computing, and discussed the corresponding security technology issues for various security threats. In reference (Sun Jie, Qian Lei, 2019), it was proposed to add moving object detection algorithm to the webcam to process the collected original video data, remove redundant information, and analyze the behavior in the video, and only transmit the most valuable data to the cloud computing center. Yu Tianqi and others proposed the monitoring system framework of the Internet of things based on edge computing (Yu Tianqi, Zhu Yongxu, Wang Xianbin, 2018).

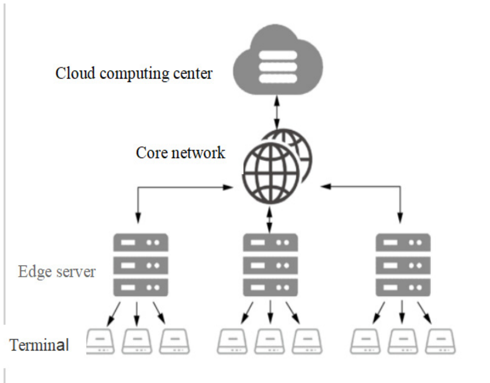

Figure 2: General architecture of edge computing.

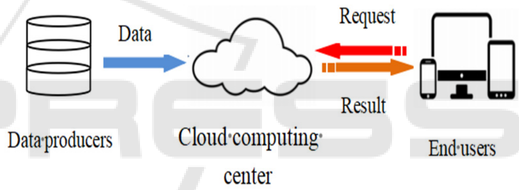

Figure 3: Cloud computing paradigm.

4 COMPARISON BETWEEN CLOUD COMPUTING AND EDGE COMPUTING

This chapter mainly compares cloud computing and edge computing from the models based on existing research.

4.1 Cloud Computing

Figure 3 shows the traditional cloud computing model. In this model, the source data is sent by the producers to the cloud computing center and the end users send the usage request to the cloud computing center (Shi Weisong, Sun Hui, Cao Jie, Zhang Quan, Liu Wei, 2017). In figure 3, The solid blue line represents the data producers sending the source data to the cloud computing center, the dashed red line represents the end users sending the usage requests to the cloud computing center, and the dashed brown line represents the cloud computing center feeding back the data result to the end users.

4.2 Edge Computing

Edge computing refers to an open platform that integrates network, computing, storage and application core capabilities on the side close to the objects or data source to provide the nearest terminal services. Its applications are launched on the edge, generating faster network service responses to meet the industry's basic needs in real-time business, application intelligence, security and privacy protection. Edge computing is located between the physical entity and the industrial connection, or at the top of the physical entity.

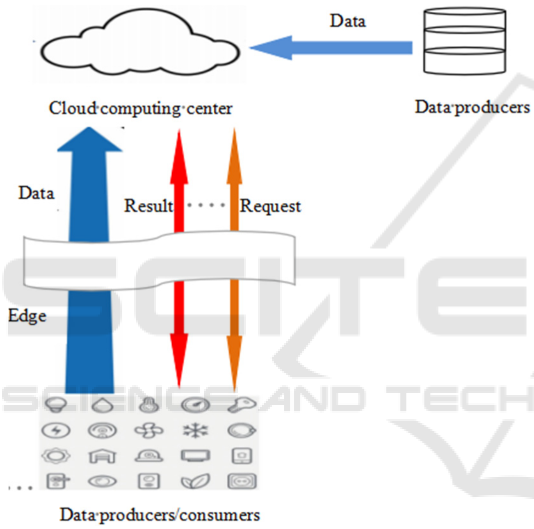

Figure 4: Edge computing paradigm.

From the above model, we can find that the edge computing model is to migrate some or all of the computing tasks from the original cloud computing center to execute near the source data. Therefore, it has advantages in some aspects, for instance, data transmission performance and real-time data processing. However, it has higher requirements on data privacy protection and security, service management, data abstraction and other aspects. These aspects deserve our in-depth study.

5 SUMMARY

With the rapid development of Internet of things technology, edge computing has been highly concerned and recognized by the government, industry and academia at home and abroad because it provides new solutions to the complex challenges in the field of Internet of things, such as massive data transmission and real-time service response. This paper introduces the development and applications of Internet of things technology and edge computing technology. Edge computing extends the computing and storage capabilities of cloud computing to the edge of the network, provides local computing services with low latency, high availability and privacy protection, and solves the problems of cloud computing such as high latency and network environment constraints. Therefore, we can apply edge computing to the enterprise IOT security system, providing a new method for the security of employees, environment and equipment.

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