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The Development Status of Edge Computing

Zhongkai Zhang, Tong Zhen, Zhihui Li*, Jianjun Wu
School of Information Science and Engineering, Henan University of Technology, Zhengzhou, Henan, China
*Corresponding Author.

Abstract:

It is the rapid development of the Internet and the Internet of Things technology that makes the cloud computing model of storing data in the cloud and using the powerful server of the cloud have many shortcomings and cannot solve the existing problems well. Therefore, the concept of edge computing is further extended on the basis of cloud computing. Edge computing is a special computing model. Its main body mainly acts on the edge of the network. By using edge nodes with computing and resource attributes between the source of the data terminal and the cloud center, the data source data is analyzed and processed under ideal conditions. , Save and reduce network traffic and response time. With the continuous progress and development of edge computing, the architecture of edge computing has gradually improved, but at the same time each has its own advantages and disadvantages. This article mainly compares the more popular edge computing reference framework 3.0 and EdgeX Foundry architecture.

Keywords*: Cloud Computing; Edge Computing; Edge Computing Reference Framework 3.0; EdgeX Foundry*

I. INTRODUCTION

The arrival of the Internet of Things and 5G communication era has accelerated the progress of the intelligent trend. In the white paper of the 2017-2018 China Internet of Things Development Annual Report, the number of Internet of Things devices surged to 8.4 billion for the first time, surpassing the total global population [1]. According to the data statistics company Statista predicts that the number of Internet of Things device connections in 2021 will exceed 35 billion. At the same time, the rapid growth of data volume brings an urgent need for optimization of computing models [2]. The advantages of edge computing, such as high response, high privacy, and throttling, have attracted wide attention from researchers [3]. After the concept of edge computing was put forward, it set off a rapid deployment boom in 2015, especially in security, smart city [4] and other fields. In computer international authoritative journals and related conferences, the hot research fields related to edge computing once climbed to 12.7% [5]. Taking the top publication INFOCOM in the field of communications as an

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example, 29 articles on related research directions were included in 2018, which shows how much attention is paid to edge computing in the academic research community.

II. Overview of Edge Computing

2.1 Background of Edge Computing

Cloud computing appeared before edge computing. It processed the data imported into the center by establishing a data processing mechanism. However, in the face of the explosive growth of data, cloud computing, which is known for its versatility, exposed many defects[6] . There are mainly the following aspects:

(1) Lack of real-time performance. The processing speed of the cloud computing model is mainly determined by various factors such as bandwidth, central computing capacity, task volume, etc., and the link needs to be requested to respond in time. Generally, cloud computing needs to wait for the data to be uploaded before processing, and the accumulation of time delay is directly caused The lack of real-time performance. For example, with the emergence of driverless cars, driving cars require millisecond-level responses, and the consequences of insufficient real-time performance will be unimaginable.

(2) High degree of dependence on the network environment. Network quality is closely related to whether data transmission is normal. Even though my country’s communication equipment is installed on a large scale and the 4G signal coverage rate exceeds 95%, the quality of the network environment cannot be guaranteed when encountering extreme environments such as caves, islands, and tunnels, making cloud computing lacking. Reliability [7].

(3) Huge resource expenditure. The increasing amount of data year by year makes cloud computing overwhelmed. It brings huge energy consumption and unavoidable traffic overhead. Take the monitoring system embedded in cloud computing [8] as an example, when shooting target images , Even if the target does not appear in the video, each frame of image will be transmitted, processed, and stored, which will cause serious resource overhead.

(4) Security and privacy are difficult to guarantee. Mass information often contains a large amount of privacy information of users[9]. Although the monitoring equipment installed in public places and even at home is marked with relevant privacy protocol information, there is still a certain degree of opacity during use, such as In 2017, Huawei automatically identified user chat content to load weather information, destroying users' private information.

The various deficiencies of cloud computing have led to the emergence of edge computing. Edge computing establishes an open distributed platform that parasitizes the edge of the data source. It

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integrates network, computing, storage and other functions, greatly improving the response speed and improving the user experience. The degree of privacy protection. At the same time, edge computing abandons the dependence on the traditional network environment, and can complete data processing operations in an offline state. The new computing model based on cloud-side computing combines the advantages of the two. As shown in Figure 1 below, the cloud-side computing model can be flexibly deployed and responded to services with different characteristic requirements. In addition, according to the international data giant IDC It is predicted [10] that by the end of 2022, more than 40% of cloud deployment structures will accommodate computing power.

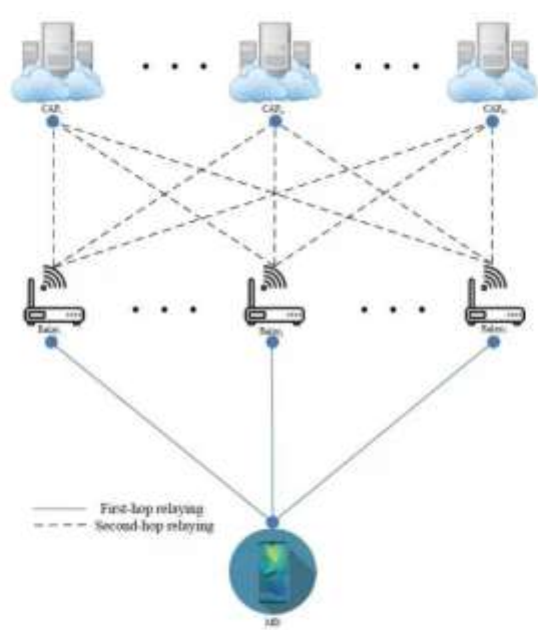

Fig 1: Cloud-side collaborative computing model

2.2 The concept of edge computing

The concept of functional caching in the distribution network CDN can be regarded as the predecessor of edge computing [11]. After the rapid transition of edge computing to the development period, the establishment of related associations and alliances are helping edge computing to establish its definition and standard specifications, and its ultimate goal They are all to promote the development of cloud operating systems. The Edge Computing Industry Consortium (ECC) composed of related companies and scientific research units in China has jointly defined and reached a consensus on edge computing: the core of edge computing is a kind of execution at the edge of the network. A special model of computing, where the edge can be specific to any resource from the data source to the computing center, including uplink and downlink data [12].

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Compared with the traditional cloud computing model, the difference is that the terminal device implanted in the edge model has also completed the feedback and response to the device in the process of submitting the request to the cloud computing data center[13] , With two-way nature, the terminal device can efficiently complete the computing tasks sent to the customer by the edge computing data center in the process of accepting the request from the cloud computing data center, and the cloud computing data center completes the response process in this way The data stream is automatically returned to the terminal device [13], and a cloud computing center and its edge two services respond to the network.

The core meaning of edge computing is to provide timely computing, storage and related application services for the side close to data sources and objects. It is not difficult to find that the fog computing model [14] has many similarities with the edge computing model. Fog computing sinks the cloud computing center capacity to the side close to the object by extending the cloud computing model. But different from edge computing, fog computing puts more architecture design on the side of things, improving the versatility of the overall algorithm. The disadvantage is still inseparable from the limitations of the network environment, but from the architecture level, fog computing belongs to the edge A kind of calculation.

III. Edge Computing Architecture

3.1 General architecture of edge computing

Implanting the powerful computing power of cloud computing into the edge network is the core direction of edge computing research [15]. Realize the communication between hierarchical calculations, and form the calculation and storage capabilities of the model through the stacking of layers, and then distribute them to the functions of each level.

(1) Terminal layer

The terminal layer refers to an integrated system composed of Internet of Things devices. The main function of this layer is to complete data collection and upload [16]. Usually the terminal layer is used to check whether the current device has the perceptual ability, and then the computing ability is considered. The data resources are summarized and collected through countless terminal devices, and finally they are provided to the port of the application service as input.

(2) Edge computing layer

The edge nodes of the network are widely distributed between terminal devices and cloud computing centers. These edge nodes [17] are like molecules combined into this substance. A computer layer itself can be regarded as a wireless terminal device. It can be regarded as a smart air conditioner, TV, or even

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as a router connected to a network port. In addition, the data resources of edge nodes are not all limited to dead, they can also dynamically change the current application scenarios flexibly, so it is necessary to properly configure the data resource calculation and storage functions of the edge computing layer. Research.

(3) Cloud computing layer

Cloud computing layer network as a data processing unit [18], whether it is to use the edge of the network to process the data from the upper layer, or to monitor other tasks and global information that cannot be processed and analyzed, the core of cloud computing is based on the current network Resource distribution, timely control the impact of network marginalization, and adjust strategy and algorithm level at the same time.

The emergence of the framework materializes the originally abstract and complex edge computing, and it clearly provides us with an implementation paradigm based on its edge computing. Therefore, the next two chapters will mainly introduce two reference architectures jointly launched by the Edge Computing Industry Alliance and the Linux Foundation.

3.2 Edge Computing Reference Framework 3.0

The Edge Computing Industry Alliance released the Edge Framework 3.0. The alliance believes that in the context of the current rise of the edge computing industry, it is necessary to reach an agreement on the framework of related edge computing services. Therefore, the following goals need to be achieved: To achieve the construction and construction of the system at the physical level Real-time cognition ability, real-time simulation and derivation on the digital level, to realize the coordination of the physical and digital levels; find the similarities in various industries and establish a reusable model system; realize the relationship between the system and the system, the service and the service Interface interaction; establish a complete life cycle to support model deployment and related data processing.

In Edge Framework 3.0 [19] has a basic service layer independently belonging to this model framework, as shown in Figure 2 below. Similar to EdgeX Foundry, the security service and management functions in the framework also include the Management of the entire life cycle. From the perspective of the vertical structure, the top-level network node is a service network framework driven by the physical world model, which allows us to freely implement the development and deployment of services, and the next layer is divided into field devices based on the edge computing network architecture. The edge layer consists of two parts: edge node and manager. In order to better adapt to the structural complexity of the physical world, the edge node abstracts itself into the three major parts of computing, network, and storage, and uses API The interface realizes the invocation of general capabilities, and realizes the control, analysis and optimization of the information transmission of the upper and lower layers, and the manager plays the role of realizing the specification between the service

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and the lower structure. In Edge Framework 3.0, the emergence of four developable frameworks, such as real-time computing systems and lightweight computing systems, enables full coverage of the link between the terminal node and the cloud computing center.

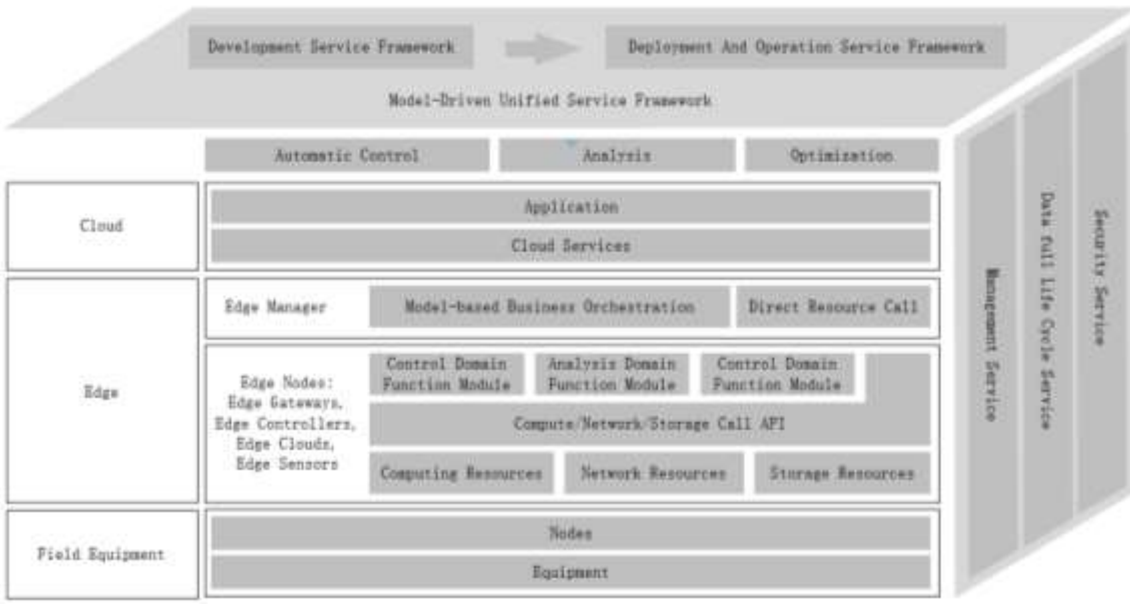

Fig 2: Edge Computing Reference Framework 3.0

3.3 EdgeX Foundry

Based on the original intention of interoperability, convenience, and manageability, the Linux Foundation created the EdgeX Foundry community, which innovatively proposed an ecological edge computing system. The framework was first applied to the Internet of Things middleware framework of dell company. Currently, developers can download according to the open source code address and refactor and deploy according to their own needs. As shown in Figure 3 below, the original intention of the architecture design did not consider the connection relationship with the platform, but it can realize the interconnection with multiple operating systems; any part of the architecture can be flexibly upgraded and replaced; the architecture not only supports offline It runs, and has storage and forwarding functions, and at the same time guarantees the superiority of its computing power.

EdgeX Foundry divides the flow of data into "south side" and "north side". The bottom of the architecture shown in Figure 3 is the "south side" of EdgeX Foundry, which contains various IoT objects in the physical world and a small edge network that organizes these IoT objects. EdgeX Foundry collects data from these devices. The top of the architecture shown in Figure 3 is defined as the "north side" of EdgeX Foundry, which refers to the cloud or enterprise system, and the network part that communicates

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with the cloud. EdgeX Foundry exports data to the cloud, and the data is stored in the cloud. Polymerization, analysis and transformation. EdgeX Foundry control data and commands are transmitted to the "north" or "south" transmissions as needed, and sometimes they are also transmitted horizontally within the architecture.Edgex Foundry [20] divides microservices into four main levels: core service, device service, support service, application and export service. The core service layer can use itself as a boundary to divide the entire service architecture into two modules. In the first module, the area to be included is mainly the cloud computing center and the network communicating with it. The divided module area It also contains the support service layer and the application and export service layer. The application and export service layer guarantees that Edge Foundry achieves a stand-alone work mode whenever it is running independently on the network. A large amount of data generated by edge devices is collected through the cloud computing analysis system, and the export service layer is also It is responsible for the login and management of key Internet clients, and analyzes and reads a large amount of data formats and rules transmitted on the cloud computing center in real time. The main body of information contained in the other module is all the Internet of Things objects that need to be included at the current physical level and the network edges connected to them. SDK software development and communication tools can be directly provided by the server layer of the Internet of Things devices. , Realize the mutual communication between physical devices. The intermediary body of the device can be either some devices with a strong ability to summarize a large amount of information, or an intermediary device that receives other service commands and transmits them to other devices. With the core service layer as the center, it bears the important key to realize the marginal ability. On the one hand, it uses its core data service to provide permanent storage and management of device data, and on the other hand, it manages and stores the original data to facilitate timely matching of devices and services.

In addition to these functions, EdgeX Foundry has innovatively developed a security and management system to provide the most basic services for the entire framework. The components that make up the security and management system provide protection and support for various devices in the current framework, such as AAA access control, AES data encryption and other protective measures. The system management tool monitors the framework's operational capabilities, and at the same time will continue to optimize in the later stage to improve the capabilities of the management platform such as providing information.

The emergence of Edgex Foundry is to refine and standardize edge computing based on the Industrial Internet of Things. By creating a better open source platform for the public to lower the threshold of edge computing, more small application providers can quickly build edges. Computing services.

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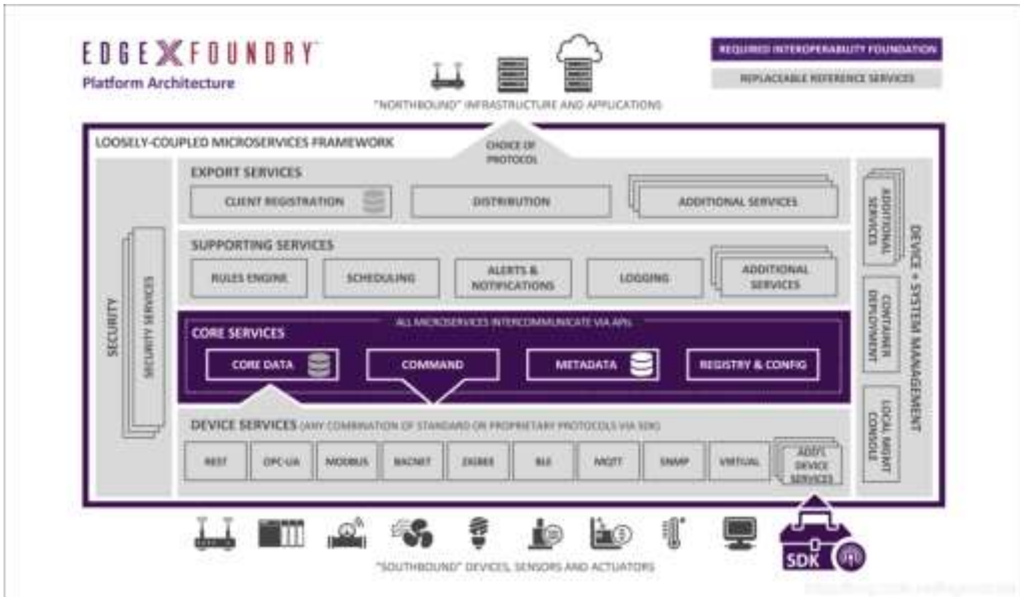

Fig 3: EdgeX Foundry architecture

III. CONCLUSION

This article first introduces the background, concept and overall architecture of edge computing, and expounds the Edge Computing Reference Framework 3.0 released by the Edge Computing Industry Alliance and the EdgeX Foundry architecture created by the Linux Foundation. Edge computing reference framework 3.0 emphasizes that edge devices have material autonomy and collaboration capabilities. For edge gateways, they must have certain network connections and lightweight connection management functions, and have good applications in industrialization; EdgeX Foundry architecture has It has good scalability and dynamic deployment capabilities, and does not rely on a specific operating system. Distributed deployment can be performed using containers, which can give developers more freedom and is more suitable for overall development.

Edge computing expands the ability of cloud computing to calculate and store data to the edge of the network, and develops a local computing service with low latency, high availability, security and privacy protection, which solves the latency of cloud computing and the network Limited constraints in the environment. We should believe that "edge computing" will vigorously strengthen and deepen the application of the Internet of Things in various industries and become an important key technology to promote the transformation and upgrading of global emerging industries such as smart manufacturing and smart cities.

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