

Research Article

Open Platform for Intelligent R&D and Technology Innovation Management Service Based on Edge Computing

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The rapid development of mobile Internet and Internet of Things makes the future network face higher speed, lower delay, and higher reliability. Because this edge computing becomes the most likely network architecture to realize the vision of intelligent R&D and technological innovation, it has attracted wide attention. Edge computing can meet the high computing needs of mobile devices with limited resources by using computing-intensive tasks from the mobile device open platform to nearby edge computing servers. This paper mainly studies the open platform of intelligent R&D and technology innovation management service based on edge computing, which can study the characteristics of edge computing more. The characteristics of edge computing will have a certain impact on the open platform strategy. This paper mainly uses the edge computing algorithm, model, edge computing time-to-time optimization open platform policy, platform function investigation experiment, platform module analysis, and other methods to study the open platform of intelligent R&D and technology innovation management service based on edge computing. This can better meet the actual application and improve the effect of the open platform which can better meet the different needs of the open platform. The results show that the number of users in the useful task open platform increases by 27.4% in the open platform of intelligent R&D and technology innovation management services based on edge computing. The platform can also meet the simulation of different scenes well, and the edge algorithm has some advantages in comparison with other algorithms.

1. Introduction

In November 2016, many technology companies led by Huawei jointly initiated the edge computing industry alliance, elaborating the functional design of the framework. Meanwhile, the International Electrotechnical Commission also issued a white paper on the intelligent application of the vertical industry, which introduced the important value of edge computing for vertical industries such as manufacturing. All kinds of signs show that the cooperation of all parties in “government, industry, university and research” is promoting development and application of edge computing in various industries.

Edge computing has been widely used in the commercial field. Among them, Internet enterprises hope to extend the existing cloud service capabilities to the edge network with the help of their own advantages in the service industry, improving the technical position of the enterprise in the

consumer Internet of Things and industrial Internet by strengthening the relevant performance of the access side network. Cisco, as the initiator of the concept of fog computing, has planned the overall framework of edge computing from its own aspects, including publishing edge side dedicated network hardware equipment for intelligent manufacturing or Internet of Things scenarios, building the IOS application framework by using software definition and other technologies to restructure edge side capabilities. Microsoft released edge products such as “Azure IOT edge,” and for Azure, cloud services enhance the ability of streaming data analysis; Amazon released “AWS Greengrass” edge side software, which seamlessly extends AWS cloud services to devices.

When edge devices are collecting and preprocessing data, if the current scene is a real-time system, the delay effect of the module for the subsequent data analysis needs to be considered. A data analysis system can be divided into

the delay-sensitive type and the delay-tolerant type. For the data analysis system with tolerable delay, the delay increase to a certain extent does not seriously affect the performance of such data analysis. Shi et al. believe that the popularity of Internet of Things and the success of enriching cloud services have promoted the emergence of a new computing paradigm called edge computing, which requires processing data on the edge of the network. Edge computing may solve the problems of response time requirements, battery life limit, bandwidth saving cost, and data security and privacy. This paper introduces several cases from the cloud open platform to the smart home and city and implements edge computing by collaborative edge. It puts forward challenges and opportunities in edge computing, but it lacks specific data [1]. Vallati et al. believe that the future smart R&D and technology innovation cellular network is expected to play an important role in the support of the Internet of Things because of its ubiquitous coverage, plug and play configuration, and embedded security. However, in addition to connectivity, the Internet of Things also needs to be calculated and stored near sensors and actuators to support time critical and opportunistic applications. Mobile edge computing is a new paradigm, which is in a standardized state. It is expected to enrich the future broadband communication network. With edge computing, traditional networks will enhance their capabilities by placing cloud computing functions in wireless access networks and in edge computing services near end users. This distributed computing and storage infrastructure will enable applications and services to be deployed on the edge of the network, enabling operators to provide virtualized environments for enterprise customers and industries to achieve near end applications and services, but they lack necessary experimental data [2]. Since the concept of bitcoin was put forward by Satoshi Nakamoto and then put into practice, Li et al. believe that bitcoin has completely changed the world economy in many ways by introducing scattered point-to-point transactions. These transactions do not require intermediary elements between traders, namely, banks; users can access their resources directly, while maintaining a comfortable Internet environment, but they lack numerical analysis content [3]. Shi and Dustdar believe that research on the adoption of intelligent R&D and technological innovation usually evaluates the functions users use when using these innovations. In this study, we identify internal factors that affect intelligent R&D and technological innovation defined by a medical information system, namely, electronic health records, and evaluate the results of the adoption of individuals and groups using the system. The multistatistical techniques such as communication, participation process, and innovation decision-making form, which are modeled by a structural equation, can effectively promote the adoption of intelligent R&D and technological innovation for reference, but some of the discussions are not accurate [4].

The innovation of this paper is to study the open platform of intelligent R&D and technology innovation management service based on edge computing by using the edge computing algorithm, model, edge computing open plat-

form policy, platform function investigation experiment, platform module analysis, etc., and it analyzes all aspects of the open platform mode of management services and the overall system frame. The research on frame design and special construction has certain scalability.

2. Edge Calculation Algorithm

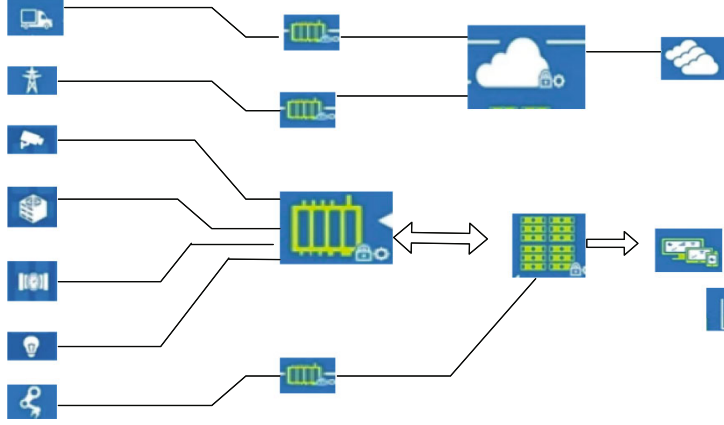
2.1. Edge Calculation. Edge calculation, which is the core idea of the paper, is used to sink computing, storage, and network services to the network edge. On the basis of not changing the original network architecture, a series of devices near the network edge are used for auxiliary computing, and the data open platform originally needed to be transmitted to the cloud computing platform to the place closer to the terminal for local processing can achieve the purpose of quick response and reduce the service response delay. In edge computing, edge computing equipment is usually an existing network device such as a switch, router, and gateway on the edge of the network or a private edge computing server connected by it [5, 6]. In addition, because edge computing is to make up for the deficiency of cloud computing, the combination of cloud computing and me can give full play to their advantages and provide better service quality for users. It is necessary to study a new cloud edge computing network architecture based on edge computing technology. It is necessary to consider that the computing capacity and storage capacity of edge computing equipment are usually limited, and a single cloud edge computing device is usually limited in computing capacity and storage capacity. Edge computing equipment may not be able to process a large amount of data in effective time; however, there are many edge devices in the network. Therefore, it is proposed to group multiple edge computing devices based on the idea of distributed computing to form a distributed mobile edge network [7, 8]. When the user needs to process the service, the service opening platform can be represented in the mobile edge network as shown in Figure 1.

2.2. Edge Local Calculation Model

2.2.1. Local CPU Execution. When the task open platform policy determines that an edge calculation is performed on the local CPU, the edge calculation does not need to be uploaded through [9]. The delay is the total time before the task plus the execution time of the task. The symbol t and symbol f are, respectively, the execution time and waiting time of task i , and h is the computing capacity of the local CPU. Then, the task execution time can be expressed as

$$t = \frac{f_i}{h}. \quad (1)$$

Suppose that after the decision of open platform policy, one edge calculation in the M edge calculation is performed on the local CPU, and two edge computations need to be performed on the edge computing server by open platform

FIGURE 1: Internet edge computing (<http://alturl.com/ga3ct>).

to meet the following requirements:

$$M_1 + M_2 = M. \quad (2)$$

Let i and j denote the task label and execution order executed on the local CPU and the task label and execution order executed on the edge computing server from the open platform, respectively [10]. Then, we can get the waiting time of task t as follows:

$$t = \sum_{j=1}^{i-1} t_j. \quad (3)$$

2.2.2. Cloud Computing Model. The data of edge computing needs to be sent to the edge computing server through the transmitting device of the mobile device [11, 12]. Here, we assume that the Tu unit can only upload one edge computing data to the edge computing server at the same time. If the transmission power of the Tu unit is expressed as $H(a)$, then the transmission rate can be expressed as

$$H(a) = r \log_2 \left(1 + \frac{g(a)^\theta}{Mr} \right). \quad (4)$$

For a given task open platform strategy, we can get the task set and execution order from the open platform to the edge computing server. For edge computing, the following two conditions need to be met before it can be executed by the edge computing server [13]. Firstly, the data of the edge computing has been uploaded to the task queue of the edge computing server; secondly, the edge computing server is idle and can execute a new edge computation. For the j -th task among all the tasks that need to be executed on the edge computing server from the open platform, if the symbol a and the symbol h , respectively, indicate the completion time of any upload and the completion time of execution, then we can get

$$t^j = \sum_{k \leq j} \frac{a}{h}. \quad (5)$$

For the task completion time, it is not only related to the upload completion time of edge computing but also related to whether the previous upload edge computation is finished [14].

2.2.3. Load Model of Edge Computing. The energy consumption and time required for edge computing to be executed on the local CPU and edge computing server are obtained. Next, we use these data to construct an edge computing load model [14]. The load can meet the personalized needs of different users and flexibly adjust the factors concerned. According to the above analysis, the time t needed to complete all edge calculation is as follows:

$$t = \max \{t_1, t_2\}. \quad (6)$$

The energy required to complete all tasks f can be expressed as

$$f = f_1 + f_2, \quad (7)$$

$$N_1 + N_2 = N. \quad (8)$$

We assume that the overall load of the system is expressed as follows:

$$H = \lambda t + \lambda f. \quad (9)$$

The coefficients t and f , respectively, represent the weight of edge calculation delay and energy consumption in an open platform decision. The two coefficients satisfy the above relationship [15, 16].

2.3. Edge Computing Model Cloud. The computing and storage capacity of edge computing equipment is usually limited, and a single edge computing device may not be able to process a large amount of data in effective time; however, there are many edge devices in the network, so it is proposed to combine multiple edge computing devices based on the idea of distributed computing to form a distributed mobile edge network. When users need to process services, they can open the service platform to the mobile edge network [17]. In the meantime, the edge computation submitted by users is

divided into multiple subtasks first, then each subtask is reasonably opened to each computing node in the mobile edge network for parallel computing, and the results are returned to the user, thus greatly reducing the transmission pressure of the backbone network, reducing the computing pressure of the cloud center, and reducing the service response delay [18]. At the same time, because of the different computing capacities and link communication speeds of each edge computing device, it is very important to study an open platform strategy for edge computing suitable for a distributed cloud edge computing network considering the computing capacity and communication resources of the equipment. The edge computing model cloud is shown in Figure 2.

Low latency is one of the most important characteristics of edge computing, which solves the problem of high transmission latency when data is transmitted to remote cloud servers for storage and processing [19]. Mobile devices get high quality and low delay data service by connecting the edge computing open platform to the nearby edge computing server, which avoids the problems of poor user experience caused by the lack of performance of mobile devices and the high transmission delay of cloud computing [20–22].

2.4. Time Delay Optimization Open Platform for Edge Computing. The assigned subtasks are opened to each edge computing device to obtain the minimum delay. In the edge computing architecture, subtasks of the open platform on each edge computing device can be expressed as r . Therefore, the subtasks on K edge computing devices can form a k -dimensional vector G . Assuming that the total task is received by the edge computing device w , the total service delay t can be expressed as follows:

$$f(G) = \max \left\{ \frac{r}{c} + w \right\}. \quad (10)$$

The solution of the task allocation coefficient f can be transformed into the solution of vector g , so it is modeled as the following optimization problem:

$$\sum_{i=1}^k G(i) = r. \quad (11)$$

I is the search space of feasible solution g , which is expressed as follows:

$$I = \prod_{i=1}^k [r_{\min}, r_{\max}]. \quad (12)$$

The fitness value of each dimension value is calculated by optimizing the objective function $T(g)$. The fitness value is used to evaluate the quality of dimension values and to calculate the edge calculation radius and the number of edge calculation results of each dimension value. The edge calculation radius and the number of edge calculation results s of

each dimension value G is calculated as follows:

$$S = A \times \frac{t_{\min} + \varepsilon}{\sum_{i=1}^N (t(G) - t_{\min}) + \varepsilon}. \quad (13)$$

The edge calculation results are generated by the calculated edge calculation results s and the edge radius a . When edge calculation occurs, a position offset will be generated within the radius of the edge calculation. The offset is added to z dimensions randomly selected from dimension value g , thus generating new edge calculation results. The selected z dimensions are calculated as follows:

$$z = \text{round}(d * S(0, 1)). \quad (14)$$

The selected A dimensions form a set G . Therefore, the k -th dimension of the result of the edge calculation in the set G is expressed as follows:

$$G = A \times S(-1, 1). \quad (15)$$

3. Experiments on Intelligent R&D and Technology Innovation Management

3.1. Functions of Intelligent R&D and Technological Innovation Service Platform. The intelligent R&D and technological innovation service platform is an organization system which is aimed at supporting industrial development and takes enterprises, especially small- and medium-sized enterprises, as its goal. It provides public services for common needs of enterprise intelligent R&D and technological innovation by effectively integrating advantageous resources such as universities, scientific research institutes, science and technology intermediary service institutions, and backbone enterprises. The concept of intelligent R&D and technological innovation service platform shows that the participants of the organizational system are diverse, so the intelligent R&D and technological innovation service platform has the characteristics of openness. The purpose of intelligent R&D and the technological innovation service platform is to serve for a theme of intelligent R&D and technological innovation, so it has the characteristics of service. The articles of association, decision-making procedures, technical cooperation and exchange, benefit distribution, and operation of the intelligent R&D and technological innovation service platform focus on the public service of intelligent R&D and technological innovation of social industry and strive to provide conditional resource services, technological R&D services, and technological innovation services for enterprises. The function of achievement transformation service and talent training service. Intelligent R&D and technology innovation service platform can achieve strong integration of research institutions in the industry; combine relevant industries, universities, and research institutes in the region; avoid vicious competition in scientific research projects of research institutes; avoid repeated investment among production enterprises; and ensure good relations among technology development subjects, technology application

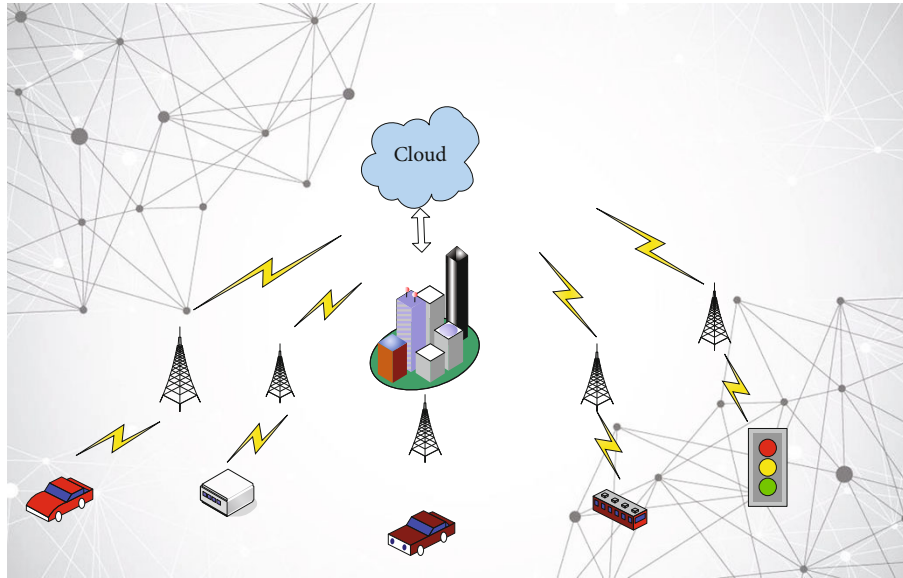


FIGURE 2: Edge computing model cloud (<http://alturl.com/f6i9y>).

subjects, and technology development and application subjects.

3.2. Functional Requirements and Expandability Investigation of Service Platform Construction. It is mainly designed around the functional requirements and scalability of service management platform construction. The first is to investigate the basic information and the cognition of the service management platform website. If you know nothing about it, the questionnaire you fill in will be regarded as invalid. The second is to understand the use of similar websites, expectations of the service management platform, participation motivation, usage habits, and interaction with the platform. The last is to understand the evaluation of the investigated objects on the current platform websites. In view of the fact that the first choice of website service users is the company's internal staff, the scope of this questionnaire is limited to the company's internal staff, who are the initial seed level users. A total of 60 questionnaires were distributed, of which 50 were valid. The basic information of the staff is shown in Table 1.

Node machine management module includes five sub-modules, including node machine basic information management, node machine status view, node machine log management, node machine power management, and node machine user management, as shown in Table 2.

3.3. Platform User Management Module. First, when the system initializes the service management platform, a default user will be automatically established with the administrator's permission. After the user logs in, you can select user management operation and establish, modify, or delete users. When a new user is established, the corresponding access rights to the user need to be assigned. Its access rights can involve each node machine. To simplify operations, the system will have default permissions: administrators and visitors. Administrators will have all access rights, including

managing operations on other administrator accounts. Visitors only have to modify their access password and view information on node machines (no user information for viewing node machines). Therefore, the corresponding user records will include basic information such as username, password, name, access rights, and the time of establishment of users. In addition to the statistical information such as the last visit, access times, and other statistics, a definition derived table will be included. The table associates the user with the node machine. The associated node machine is the machine that the user can access and operate as shown in Figure 3.

3.4. Innovation-Driven Development Strategy and Technological Innovation. Technology effectiveness refers to the continuous and in-depth research on technology effectiveness since the high-tech innovation expenditure is brought about by the high-tech innovation when the output is not reduced or the input is not added. The data envelopment analysis method establishes the evaluation model of the technical effectiveness of the discipline, observes the input data of many colleges and universities in the students and disciplines, and draws the corresponding technical effectiveness conclusion. Because the efficiency of technological innovation is a relative index, it is difficult to obtain an absolute value in the real technological economic activities, which reflects the efficiency of technological innovation comprehensively. This index of relative technological and economic activities mainly depends on the change of the input and output of scientific and technological innovation activities. Resource allocation plays an important role in the improvement of technological innovation efficiency. The concept of relative economic efficiency is given, and then, the relationship between the relative technological innovation efficiency and the relative price allocation efficiency is analyzed in depth. If the output level of one enterprise is higher than that of another enterprise, the efficiency

TABLE 1: Platform questionnaire survey personnel.

	Number	Proportion
Gender		
Man	20	40
Woman	30	60
Age		
10-19	10	20
20-29	30	60
30-40	10	20

TABLE 2: Node machine management module.

Serial number	User level
1	Node machine information management
2	Node machine state management
3	Node machine log management
4	Node electromechanical node source management
5	Node machine user administration

of technological innovation is relatively high when the input level is the same. If the income is higher than that of the other enterprise, the efficiency of technological innovation is higher.

4. Open Platform for Intelligent R&D and Technology Innovation Management Service

4.1. Platform Module Analysis. The platform module is mainly used to manage the basic information of each node machine that can be managed (with functions). The basic information includes the address of the node machine management port, the physical address of the network card of the node machine, and the username and password with access rights. It will also include the supported version, firmware version, and related gateway information in the node machine and will also include the information about the increase time and modification time of the node machine. After the first visit to the function module, the basic information of the managed node machine saved in the sweet management system will be displayed. Meanwhile, the operation of adding, modifying, and deleting can be performed as shown in Table 3.

According to Table 3, node machines (that is, managed servers) have management modules. Before being managed, they should be known by the management platform. Therefore, users with management authority must log in to the system and perform the new node machine function. The basic information of connecting the node machine includes the address of the node machine, and the connection username of the node machine is also the username and password that are recorded. In the user login function, users should fill in their own username and password on the login page to perform the login operation. After receiving the login request, the server will query the database to verify whether the data is correct. If it is correct, the software will

enter the main interface of the program. If it is wrong, the user will be prompted according to the specific situation. The common errors are that the username does not exist and the user password is incorrect. The flow chart of user login is shown in Figure 4.

In the process of software development of an intelligent R&D value-added service system, in addition to the requirement analysis of platform functions, we should also find out the actual business process of software. Clear and concise software business processes can help developers to better build the overall software architecture. The following establishes the software business process according to the results of the requirement analysis.

4.2. Simulation of Technical Innovation Management Service Platform. In the simulation experiment, we do many different experiments on each scheme. In each experiment, the number of mobile users n is $n = 20$ and 60 , and we assume that the MEC server can serve up to 30 users at the same time. For each n , we repeat the experiment 100 times and then select the average as the final result as shown in Table 4.

Table 4 shows the situation that the number of users in the useful task open platform in different schemes is shown under different user numbers. When all users do not have an open platform and only perform locally, the concept of a useful task open platform is meaningless. It can be seen that under different users, the proposed multiuser distributed task open platform algorithm can always have the most users in the beneficial task open platform state, which increases 27.4% of the users in the beneficial task open platform status than all the tasks executed on the cloud. When $n \leq 30$, the number of users in the platform is the same, while when $n > 30$, although the number of users in the beneficial task open platform state in IWD is greater than CC, it is still slightly smaller than TCO. This is because the only difference between the two is that TCO considers the computing limitations of MEC servers.

4.3. Reliability and Validity of Intelligent R&D and Technological Innovation Capability. The reliability analysis results of the technical innovation ability of high-tech enterprises show that the overall reliability of the technical innovation capability scale is 0.775, of which the reliability of the technical R&D capability is 0.822, the reliability of the production and manufacturing capacity is 0.935, and the reliability of the innovation marketing ability is 0.821, which is in conformity with the requirements as shown in Table 5.

Further reliability and validity analysis, extraction of relevant factors, and the number of factors extracted in reliability and validity can be seen from Table 5. The results show that the total variance of the original variables is explained by the factors, and the factors reflect most of the information of the original variables, with good reliability and validity. According to the corresponding items and factors, we can judge that they are the manufacturing capacity factor, innovation marketing capacity factor, and technology R&D capacity factor. The results of reliability and validity show that the measurement items contained in the factor are consistent with the assumption. Therefore, we can draw the

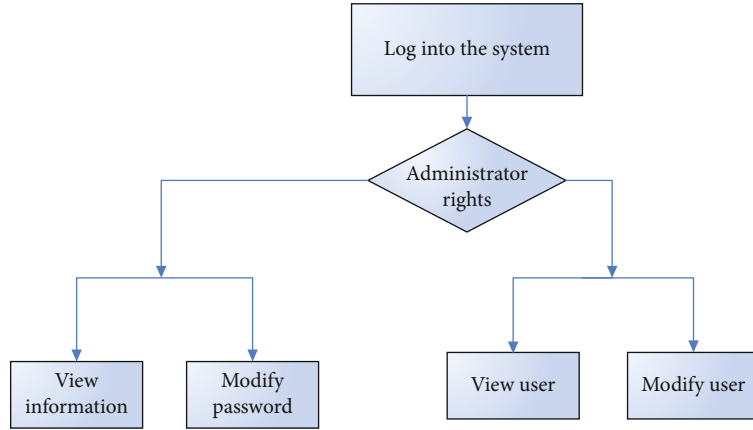


FIGURE 3: Platform user management module.

TABLE 3: Permission definition table.

User level	Administrator	Visitor	Normal user
1	Reject	With	Reject
2	User	Read only	User
3	Read only	With	With
4	With	Reject	User

TABLE 5: Reliability analysis of technological innovation capability of high-tech enterprises.

Variable dimension	Reliability and validity	Cronbach's alpha
Technology R&D capability	0.822	0.765
Manufacturing capacity	0.935	0.531
Innovative marketing ability	0.821	0.912

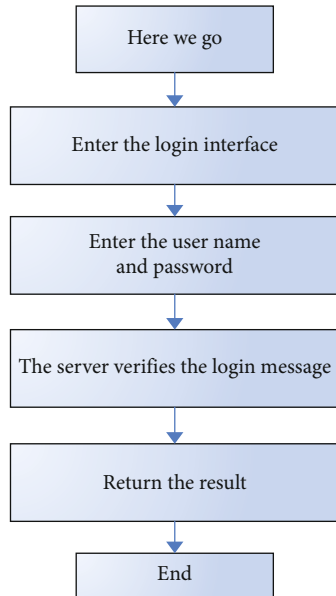


FIGURE 4: Platform user login.

TABLE 4: Number of users in beneficial task platform.

Number of users	Phase task	Queuing delay	Execution on cloud
20	10	12	21
30	8	11	23
40	12	16	12
50	15	15	23
60	13	17	15

conclusion that the technological innovation ability of high-tech enterprises can be composed of three dimensions: technological R&D ability, manufacturing ability, and marketing innovation ability. It is reasonable and feasible to measure this variable by the items of the assumption scale, and the validity of the measurement meets the research requirements, as shown in Figure 5.

In order to meet the personalized needs of different mobile users, four kinds of typical mobile edge computing are selected. Different tasks have different requirements for delay, and the amount of calculation and data of different tasks is also different. The specific parameters are shown in Figure 6.

It is not feasible to test some ideas of mobile edge computing in real scenes. Therefore, we need a simulation tool to adapt to multiple scenarios. CloudSim, a famous simulation tool in cloud computing, does not pay attention to some problems in mobile edge computing, such as the management of mobile devices and the management of network connection between mobile devices and cloud servers.

The task open platform service has a broad development platform because of mobile edge computing. Through the task open platform, mobile devices with limited resources can implement some delay-sensitive applications and computing-intensive applications on the server not far away. Relying on the computing, storage, and other resources that the server is far larger than the mobile device, they can provide users with various services, which not only has broad market application prospects from the perspective of operators but also has broad market application prospects from

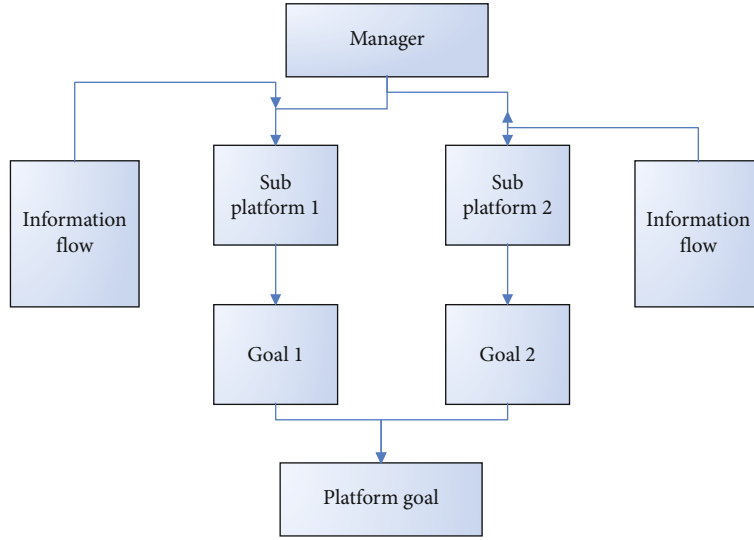


FIGURE 5: Platform collaborative management.

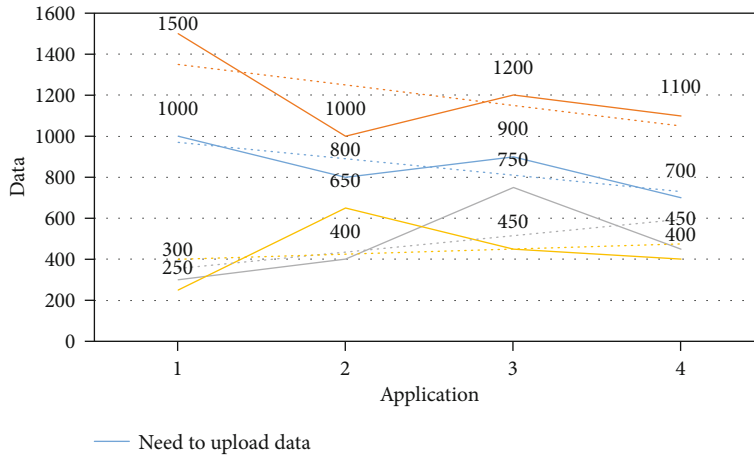


FIGURE 6: Parameter selection for different applications.

the perspective of mobile users It also solves the problem of limited equipment resources and has obvious performance improvement.

The rapid increase of intelligent networking equipment and explosive growth of Internet traffic have promoted the continuous development of the mobile communication network. Now, it has gradually moved towards the era of intelligent R&D and technological innovation. The rapid development of mobile communication in turn also leads to the emergence of various emerging applications, and the requirements for the network are also higher and higher. In order to meet the higher requirements of the network in the future intelligent R&D and technology innovation era, such as ultrahigh bandwidth and ultralow delay, mobile edge computing is the new network architecture which is most likely to realize the next generation network vision. By reducing some services to the range closer to users, a traditional wireless access network also has the conditions of service localization, close range, and multiple deployments. Due to being closer to users, the service servicing under this

network architecture can provide computing, storage, and delivery services for users nearby, greatly improving the user experience.

5. Conclusion

This paper uses the edge computing algorithm, model, edge computing time-to-time optimization open platform policy, platform function investigation experiments, platform module analysis, and other methods to study the edge computing based intelligent R&D and technology innovation management service open platform and edge data processing technology with edge computing as the core which can be produced and is widely promoted. Edge computing is defined as a distributed open platform which integrates the core capabilities of the network, computing, storage, and application near the source of objects or data. In fact, edge computing is a new ecological mode. By gathering five kinds of resources, such as the network, computing, storage, application, and intelligence on the edge of the network, the

network service performance and open network control capability are improved, thus stimulating a new mode and new business form similar to mobile Internet. Edge computing is the key technology to solve the problem of network delay in intelligent R&D and technological innovation. In recent years, it has been tried in the emerging fields such as the Internet of vehicles and Internet of Things. The problems in the above cloud computing can be solved by edge computing technology. The near intelligent service provided by edge computing technology can meet the key requirements of agile connection, data optimization, application intelligence, security, and privacy protection. An intelligent and flexible network is built on the edge of the network, which complements with the centralized cloud computing platform.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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