Mobile Cloud Platform: Architecture, Deployment and Big Data Applications

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Abstract. With the rapid development of technology, mobile devices have become the basic necessities of life. Mobile devices have a great advantage of rapid calculation and Transmission and containing a variety of sensors. So we can distribute some computing tasks to our mobile devices. However, mobile devices still face a significant bottleneck. Such as the upper limit of computing power. Mobile devices will be inadequate when dealing with large-scale operations. Lack of storage capacity, mobile devices can not save a large amount of data. Small battery capacity, Equipment can not guarantee a long duration of working. In order to give the users a good experience, We need to use the resources of the mobile cloud platform to solve these problems. Mobile cloud platform has become the most essential facilities. The mobile cloud platform will not only consolidate resources and optimize computing power, but also serve as a processing platform with strong storage ability and decision-making capability. In such a strong demand, build a mobile cloud platform has become an indispensable thing.

Keywords: Mobile cloud platform · Smart clothing · Smart home

1 Introduction

Nowadays, a variety of new technologies, such as edge clouds, micro clouds and ad hoc cloudlet, have been derived from the mobile cloud [1,2]. These techniques are suitable for different computing tasks in different environment [3–5], such as in the vehicular ad-hoc networks [6] or the heterogeneous telematics [7], where the mobile cloud can be integrated with the vehicle-to-vehicle or vehicle-to-infrastructure communications to improve quality of service in sensing and sharing vehicular information. This paper will give some brief introduction to these technologies.

Mobile Edge Cloud (MEC) is needed when mobile devices have strict requirements for short latency and complex processing content [8,9]. We need to move

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computing tasks to the wireless access point [10]. MEC will move the core function of the network to mobile device. The core functions and related applications deployed in the access side of the edge of the service. The edge cloud has the following characteristics: Localization, the edge cloud will be mounted on the access side of the task to the edge node, which greatly reduces the bandwidth of the backbone network traffic and avoids duplication of large amounts of data distribution [11–13]. It also saves a lot of network traffic. Low latency, when the 5G wireless communication network is proposed [14], the speed of data transmission data been greatly improved, which makes the traditional network architecture become a bottleneck in latency [15–20].

A cloud is a small, simple device near users in a space location that can download the data from the mobile cloud platform and process these data [21]. When finishes the job, the device sends the data back to Mobile cloud platform [22–24]. Users will not be aware of the whole process, but users can enjoy high-speed and low-latency services. These devices are collectively referred to as micro-clouds, which are generally at the edge of the network. Micro-cloud has the following characteristics: dynamic resource allocation, support for large-scale user-level computing, user rights, high confidentiality [25].

Ad hoc cloudlets are sub-classes of micro-clouds, which are the mobile devices consisted of all micro-clouds [26]. Such as a certain range of ten mobile phone, each phone uses D2D (Device-to-Device) Technology to carry out communication [27–33]. In this paper, the mobile cloud platform based on openstack is described [34,35].

2 Architecture of EPIC Mobile Cloud Platform

Mobile cloud platform in Embedded and Pervasive Computing (EPIC) Lab [36] is mainly to compensate for the lack of mobile computing power, responsible for receiving the instructions transmitted by the user and refers to these instructions to finish this task [19,37–39]. In order to achieve this goal, mobile cloud platform system architecture is designed for the following three parts, namely the interaction layer, management layer and virtual layer, as shown in Fig. 1 [40].

Interaction Layer: The interaction layer give a interface to interact with users, receive requests from users and send requests to control layer. And the mobile cloud platform transmits the HTTP respond to the user.

Control Layer: The management layer is responsible for processing the users' request, such as creating a virtual machine template, controlling workflow, loading balancing, etc. Control Layer is the most important part of the mobile cloud platform. In other words it is in charge of the whole network and computing resources of cloud platform.

Virtual Layer: The virtual layer consists of physical machines and virtual machines, which compose the compute nodes or storage nodes to serve the management layer. The mobile cloud platform handles web services and distributed

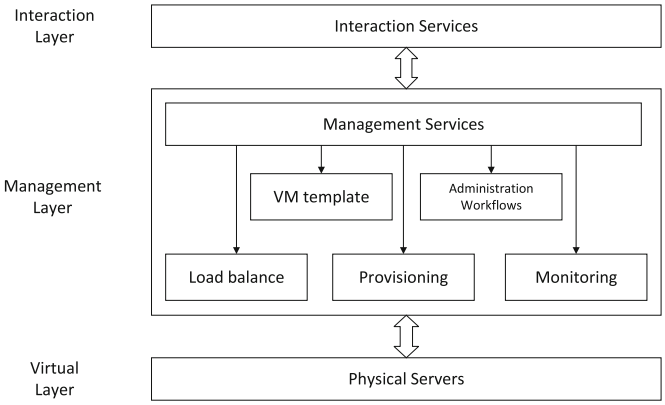


Fig. 1. System architecture

computing tasks. It also has the following characteristics: high performance, scalability, and reliability. It uses high-performance personal computers to meet the requirements of computing speed. The co-operation of hardware and software greatly improves work efficiency. Due to the mobile cloud platform architecture design, low coupling makes it easy to extend the other parts of the cloud platform. Mobile cloud platform architecture ensures its reliability and it can automatically make remedies for the failure.

3 Deployment Instructions of Cloud Platform

The key technologies mobile cloud platform uses are shown in Fig. 2.

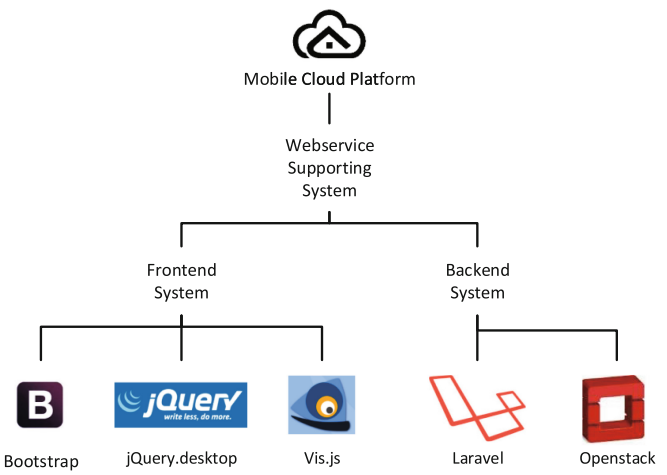


Fig. 2. Key technology

3.1 Build Web Service

Webservice is the foundation of the mobile cloud platform, so the first step in building a mobile cloud platform is to create a webservice. We determine to use the HTTP protocol to transfer data and encapsulate the data in XML format. We choice apache to build up our server.

3.2 Front-End Structures

We select the Bootstrap in our front-end technology, which is one of the most popular front-end frameworks currently. Bootstrap uses HTML, CSS, javascript programming language. It is simple and flexible, making Web development more efficient. We've added other technologies to this framework to make it easier for users to interact with our platform.

3.3 Back-End Structures

Laravel is a Value elegance, simplicity, and readability PHP Web development framework. This technology draws on the advantages of java and other frameworks and has great scalability and scalability. Laravel code is one of the most popular back-end technology. Besides Laraval, we also add openstack technology in our platform. When user choose a certain function, the platform will call the relevant openstack API to fulfil the task.

3.4 Openstack Technology

The core technology of cloud platform is openstack. This technology was developed by NASA and Rackspace. This project consists of multiple modules and can be seen as the cloud operation system of mobile platform. The greatest advantage of openstack is that it can create public and private clouds fast and it provides infrastructure as a service (IaaS) solution. Openstack is one of the best technique to build mobile cloud platform. Since the Openstack technology has been widespread all over the world, hundreds of communities or organizations to contribute to its source code, which makes this technology developed rapidly. OpenStack technology is mainly written in Python. Being modular makes Openstack has the characteristics of decoupling and excellent compatibility.

OpenStack technology can be divided into multiple components, and each component has its aliases. Such as Horizon is the module to manage the interactive interface. Nova is the module to control computing resource, Keystone is in charge of authentication. What's more, we have mirror service components Glance and storage components swift. Horizon components which is based on web framework Django development of the Web interface, is responsible for converting the user's requests to the command for virtual machine. Nova is the core modules of Openstack. Nova component can create, authenticate, schedule and terminate virtual machines. Message Queue is a module for communication between OpenStack nodes, mainly based on AMQP implementation.

Nova uses an asynchronous way to respond to user requests in order to prevent users from waiting too long. Nova-Compute is used to manage the lifecycle of virtual machine instances. An instance is generally a virtual machine. When Nova-Compute receive the creation, termination and other operation commands. It will call the libvirt API to process this command and return the results from the message queue. Nova-Network primarily provides network connectivity services for virtual machine instances. Network traffic and communication between virtual machines are handled by this module. Nova-Network's primary role is to assign an IP address to a virtual machine instance, configure VLANs and security groups. Nova-Scheduler is a kind of daemon in the Nova component. It begins to run when the cloud platform starts.

The keyStone component provides authentication and service tokens for users and virtual machines. In this openstack design, Keystone provides authentication and access policy services for all OpenStack components. It relies on its own REST system. When users provide their own authentication information to OpenStack [41,42], Keystone will match this information with the information in the database. If the authentication passes, Keystone will return a unique token to the user. This token can be used by the user as authentication information for subsequent sending of an operation request to OpenStack.

Mirror Components Glance is primarily responsible for storing and managing the virtual machine's operating system image, which is used when the virtual machine is created. Glance provides a standard REST interface through which you can query mirror-related information stored on different devices.

The storage component swift is responsible for object storage management and similarly there are cinder components (block stores) for local storage and network storage.

Figure 3 (http://www.dataguru.cn/article-8860-1.html) shows the architecture of openstack modules.

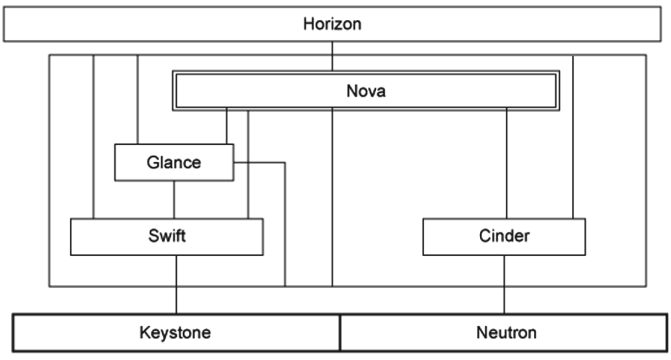


Fig. 3. Openstack module architecture

3.5 The Configuration of Openstack

We build openstack on Inspur machine. We use two compute nodes, one control node and one network node. Figure 4 show the picture of Inspur machine.

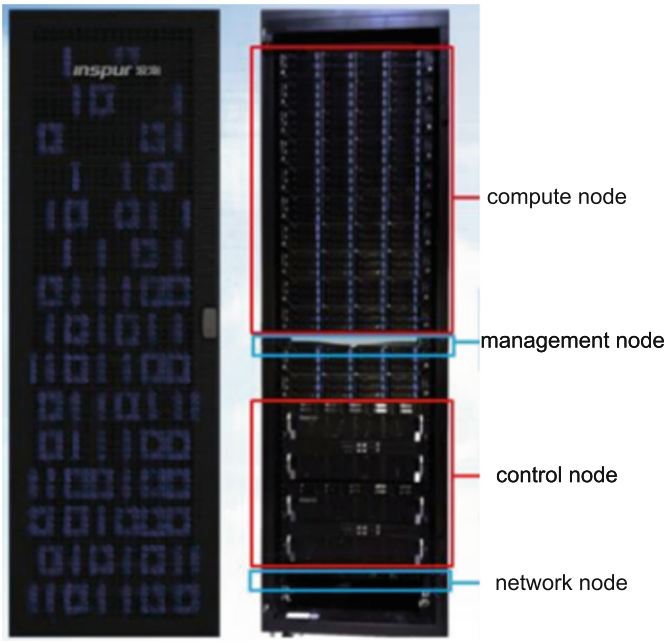


Fig. 4. Picture of Inspur machine

4 Vis.js

4.1 Introduction of Requirements

After deploying the openstack component on the mobile cloud platform, we can begin to build our own cloud host. The most direct method is to use the corresponding command to call the relevant functions, but this is very cumbersome for beginners. We need a very intuitive and convenient way to complete the process of creating a virtual machine. Openstack components in the dashborad module, which is responsible for providing a graphical user-friendly interface. So we also want to add a similar function in the cloud platform and make the process of deploying network and virtual machine become an extremely simple step, which is the important reason why we use vis.js library.

Vis.js is a browser-based dynamic visual library in the JavaScript library that makes it easy to process multiple types of data. The library is mainly divided into several sections: First, easily to draw graph of key-data value pairs.

You can flexibly add or delete nodes in the graph; Second, It is easy to facilitate the display of different types of time axis data. It can complete interactive mobile, zoom and other functions; Third, you can complete the graphics based on node and edge network.

4.2 Features in the Cloud Platform

To simplify the configuration procedure of virtual machine, we use the graphical operations to complete these step, because the use of mobile cloud platform to create a virtual machine in the process needs to customize the network parameters. First of all, in the process of drawing a topology network, we need operations of adding or deleting nodes which represents for deploying routers, switches and network. We need to connect nodes, such as connecting the nodes among routers, switches and virtual machines. Vis.js can save the user-selected router, switch, and virtual machine configuration attributes in the form of nodes. When a user connects two nodes, you can only add a edge in the network graph and save the data (format such as starting node number, ending node number). After completing the virtual machine creation operation, the cloud platform will convert the design scheme to the corresponding json data (including node attributes and connection edge properties) and send data to the back-end server, the data processing into openstack corresponding command, call the appropriate API to complete the operation. The use of vis.js technology greatly simplifies the complex operation of the command line, which also improves the user experience. Figure 5 shows the interface of the deployment of the virtual machine design, respectively, six virtual machines, three switches and a router.

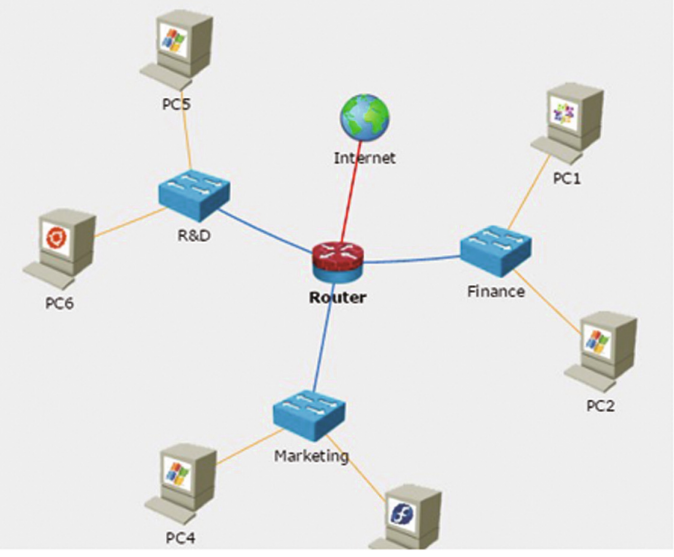


Fig. 5. Topology network example diagram

5 Introduction to Jquery.desktop

In order to give users a better experience, we use the web desktop components jQuery desktop in our cloud platform. The plug-in will make cloud platform interface similar to the graphical user interface of operating system. The appearance of our website becomes the desktop of our operation system. Each desktop icons represent a link to a webpage. In the realization of the mobile cloud platform, An desktop icon represents a specific project, you can double-click the icon to enter the specific project to view the data or complete some specified operation. jQuery desktop provides us with a similar windows desktop web interface, which will bring us a new experience of browsing web page. The jQuery desktop consists of three parts, the top menu, the desktop section, and the bottom menu. Which uses the c-z-index attribute to locate the elements of different levels, Fig. 6 is the screenshot of our platform, the upper left corner of the three icons represent three different operations. Figure 7 shows that the first step of building a

Fig. 6. The interface of mobile cloud platform

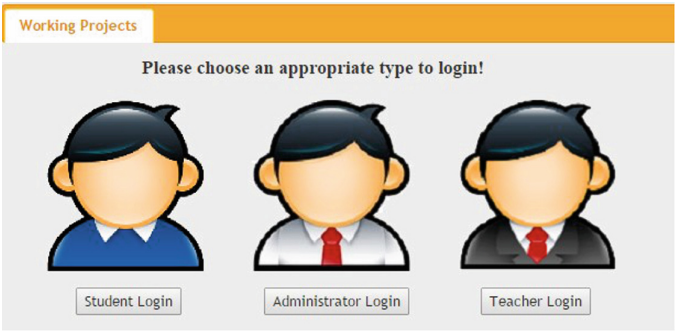


Fig. 7. Illustration of various data access priority for differentiated users

virtual machine. Each button represents the different type of virtual machine. Student can only set up the VM of default setting and the Administrator can custom the virtual machine configuration [43,44].

6 Related Projects

The lab relies on the mobile cloud platform to achieve two specific applications, namely Smart Home 2.0 and smart Clothing system. We will give a detailed description of the implementation of these two projects.

6.1 Smart Clothing System

Smart clothing integrates various types of physiological sensors to collect important physiological indicators of the human body [45,46]. Including body temperature, respiration, blood oxygen, heart rate and ECG and other data. The project uses cloud platform to store these physiological data while using cloud computing and machine learning algorithm to analyze these physiological data to obtain valuable information [47]. Smart clothing can be divided into three components: smart clothing, hardware and software communications systems and cloud platform. The cloud platform in this project has a pivotal role in providing the vast majority of the computing, storage and analysis functions [48–50]. The clothing consists of the textile dry electrode, electrode signal conduction buttons, flexible conductive fiber and an external wireless communication with the ECG processing module, which is an essential component for healtchcare Cyber-Physical systems [51,52].

The cloud platform provides the services and related functionality required for the entire project. The platform is the basis for the entire project. Android mobile APP is the bridge to connect these project services and users. APP terminal interface shown in Fig. 8 [53,54].

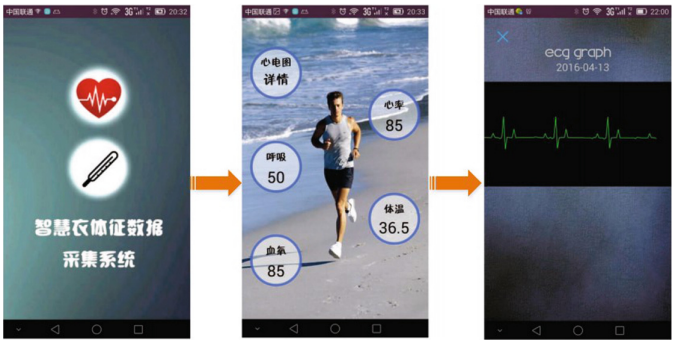


Fig. 8. GUI on mobile APP

6.2 Smart Home 2.0

Figure 9 shows the design framework of project Smart Home 2.0 [55,56]. The project has designed a complete smart farming solution, which realizes the independent design of farm environmental monitoring intelligent equipment, the data support service of cloud platform, the function of web terminal and android terminal display. At the same time, the project uses two real-world farming data as the reference to simulate the massive data. We figure out the large data analysis method based on Hadoop + Mahout to provides an intelligent data analysis solution for the plant growth related indicator data (temperature, Light intensity and air). Based on the analysis results, the author can give some suggestions for planting [57].

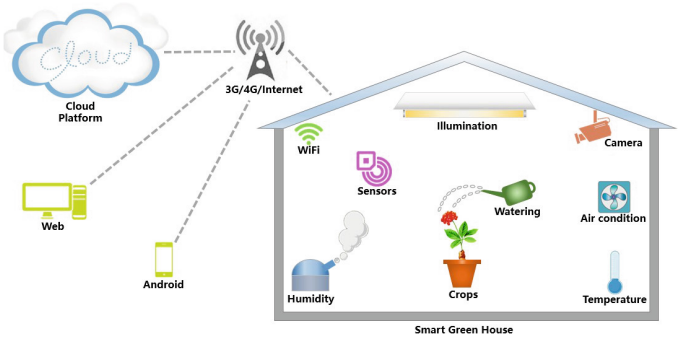
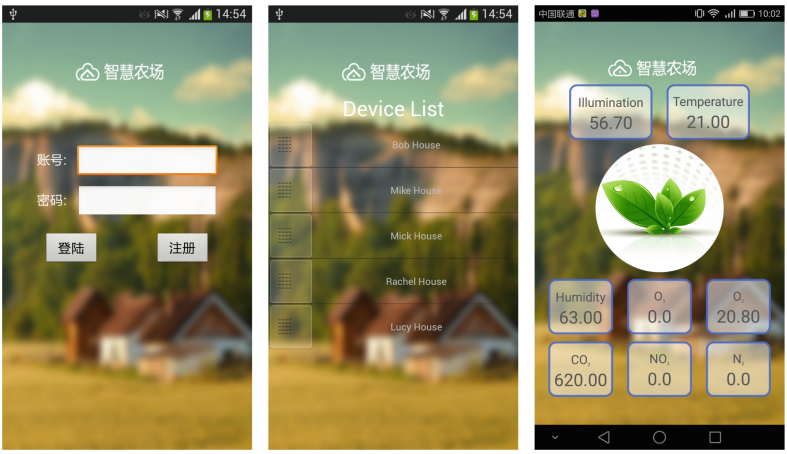


Fig. 9. Deployment diagram

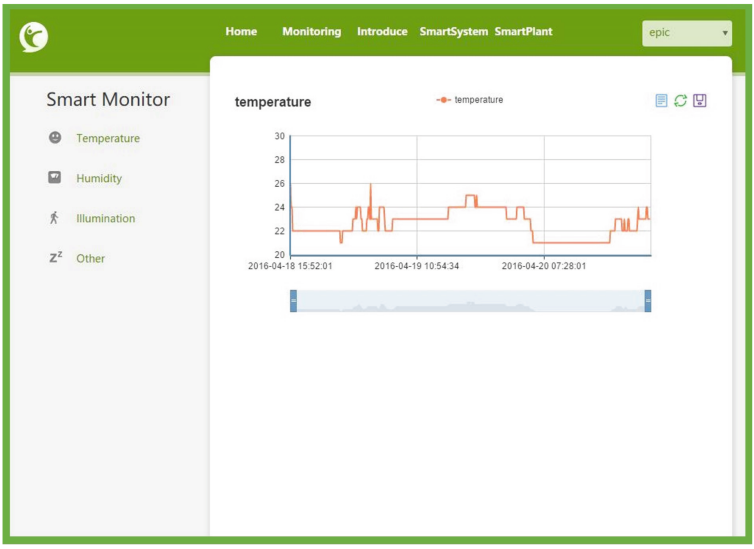
The Smart Farming project provides two access methods: Web and Android. Figure 10(a) shows the registration interface. New user needs to register, the old user enters the user name and password to complete the login, login successfully entered the interface Fig. 10(b), which is the relevant core interface. The interface displays the user-managed device. Click on the device to enter interface Fig. 10(c). The interface displays the real-time data of the farm monitored by the device. The data processing results will show in the website like Fig. 10(d). It display the indicator data in a period of time corresponding to the historical data records [58].

6.3 The Role of Cloud Platform in the Projects

The cloud platform uses the on-demand method to distribute the computing, storage, and network resources to the various projects [59]. By virtualizing the hardware resources, the cloud platform can quickly and easily allocate resources independently for each project. At the same time the cloud platform achieve the dynamic allocation of resources. It can easily according to the actual operation to upgrade and expansion.



(a) Login Page (b) Main Page (c) View Page of Real-Time Data



(d) View Page of History Data

Fig. 10. Android GUI and web interface

7 Machine Learning Algorithm Used in the Mobile Cloud Platform

The mobile cloud platform help client use programs and data in the cloud host to fulfil the tasks such as data mining, data analysis or machine learning [60,61]. In the machine learning aspects of the cloud platform can provide infrastructure support. In the mobile cloud platform, you can build a virtual machine using the

Linux operating system. And this operating system image contains mapreduce, Hadoop, spark and other large data processing software. The user can write the corresponding data analysis program. It also provide the function to upload the information to the virtual machine to complete the job. Upload procedures will be strong security and strictly encrypted.

8 Conclusion

This paper introduces the key technologies of mobile cloud platform and analyzes the importance of building cloud platform. Give a detailed description of the internal structure of the cloud platform. And discuss about the specific process of building a mobile cloud platform step by step, introduce the key technology of cloud platform and other front-end technology. Finally, combined with the smart clothing project and smart farming project, it describes the important role the cloud platform plays.

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