Progress and Trends in Mobile Cloud Computing Research

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Abstract: This paper briefly introduces the definition and characteristics of mobile cloud computing, expounds the research progress of mobile cloud computing, and conducts in-depth research and analysis on the development trend of mobile cloud computing. It has published some suggestions and hopes to play a certain reference the application and development of cloud computing and help to better meet people's needs in mobile cloud computing, improve the effectiveness and extensiveness of mobile cloud computing applications, and lay a good foundation for the sustainable and stable development of China's social economy.

1. Introduction
In the rapid development of the Internet, mobile applications are becoming more abundant, and mobile terminals have gradually become an important component of people's work and life. With the realization of mobile games, mobile payment, etc., mobile applications are becoming more complex, and more stringent requirements are imposed on the computing power, security, and storage capabilities of mobile terminals. However, due to factors such as heat dissipation, size, and weight, the resource storage capacity and computing power of the mobile terminal are still very different from those of the non-mobile device, especially the battery capacity limitation, which has a very serious impact on the user experience. In order to break the limitations of computing, storage and battery, and enrich the application experience of mobile users, it is of great value and significance to introduce cloud computing in the mobile environment. Based on this, this paper has carried out research and analysis.

2. Definition and Characteristics of Mobile Cloud Computing
Mobile cloud computing mainly utilizes the advantages of cloud in storage and computing, breaks the impact and limitations of mobile terminals in terms of resources, enriches mobile user applications, and brings better experience to users [1]. In terms of definition, mobile cloud computing can be expressed as a usage mode for acquiring resources or information such as software and platforms from the cloud through a mobile terminal, using a wireless network, and adopting an easy extension.
Figure 1 above shows the system framework of mobile cloud computing. Through wireless accounting and network operators, the effective connection between users and the Internet is realized. The data center can provide services such as storage and computing for users. Internet content providers can publish games, videos, and news resources in appropriate data centers to enrich users' content services [2]. If the user has high requirements in terms of security, power, and network delay, you can also use the LAN to connect with the local micro cloud to obtain the corresponding cloud service, which is characterized by scalability. The local micro cloud and the public cloud can be connected through the Internet to expand and optimize the storage and computing capabilities, and enrich user resources.

Based on cloud computing, mobile cloud computing has the advantages of cloud computing multi-service integration, user sharing, and resource expansion. At the same time, it also has the characteristics of user mobility and wireless network security vulnerability.

3. Research Progress in Mobile Cloud Computing
Mobile cloud computing involves many fields such as wireless networks, cloud computing, and mobile computing. In terms of technology, it includes computing migration technology, mobile cloud-based location services, mobile terminal energy-saving technologies, and data security and privacy protection [3]. Currently, mobile cloud computing is mainly used in mobile cloud storage, micro cloud applications, mobile cloud games, and mobile intelligent group applications, but it is affected by factors such as computing storage resource limitations, user mobility characteristics, limited battery energy, and illegal intrusion. There are still very large limitations in applications.

3.1 Computational Migration Technique
The computing migration technology mainly refers to the use of mobile terminal computing, storage, etc. to migrate tasks to servers with rich resources nearby. In this way, the requirements of storage, computing and energy of mobile terminals are minimized. In the development process of cloud computing, computing migration is applied in the cloud environment and other aspects, playing a very important value and role in mobile cloud computing. In terms of calculating the overall migration goal, it includes reducing service delay, saving mobile terminal energy consumption, and expanding CPU capacity.

Computational migration includes steps such as discovery, awareness, partitioning tasks, scheduling, and execution control. Execution control is the core component, including reliable remote proxy connection, information execution, and return calculation results. If the mobile app has migration requirements, the app sends a pause request and the local agent migrates the agent to the cloud agent after reading the state. The remote agent returns to the mobile terminal after the result processing.
3.2 Mobile Cloud Based Location Service
Location services are a very important technical content in mobile cloud computing and are currently receiving a lot of attention. The traditional positioning technology based on GPS has a very wide range of services, and the technology development is relatively mature. It has been widely used in military, transportation, construction, agriculture, etc., but because of the disadvantages of large energy consumption and weak penetration, it is already very inconvenient to user action recognition and precise indoor positioning and other mobile user needs, such as shopping guide. Introducing the mobile cloud computing model in the new location service construction can effectively solve this problem.

3.3 Mobile Terminal Energy Saving Technology
Mobile terminals are not very ideal in terms of battery capacity growth. In particular, mobile applications have become more abundant in recent years, and there are very big conflicts and contradictions between them and limited mobile terminal power. It has become a major influencing factor for user experience, the attention is getting higher, and it is developing towards energy saving in data transmission and energy saving in positioning services.

In terms of data transmission and energy saving: the current mobile terminal wirelessly transmits more data, and the energy consumption in the data transmission process occupies a very large proportion in the mobile terminal energy consumption. For example, the WiFi network is the most widely used wireless transmission technology. The energy consumption caused by the mobile terminal WiFi network is mainly concentrated in the idle listening state of the CSMA mechanism, and the function loss and data transmission generated by the mobile terminal in idle listening state. In the energy-saving scheme, the power consumption generated by the webpage loading is dynamically adjusted by the sensing network state mode, and the downloading strategy and the screen rendering mode are dynamically adjusted, thereby saving 24.4% of the energy consumption when the user experience is satisfied. In addition, the use of video tail traffic or channel dynamic allocation, etc., can save 29%-61% of video transmission energy consumption in WiFi networks [4].

In terms of location service energy conservation: In the mobile cloud computing environment, there are many applications that need to use location services, and the positioning process needs to generate very large computing and communication energy consumption. Positioning service energy saving is also an important development direction of mobile terminal energy-saving technology. Its energy-saving includes two aspects based on mobile terminal optimization and cloud-based optimization. The optimization of the energy consumption of the mobile terminal needs to predict and change the data source selection. The cloud-based optimization mainly achieves the corresponding energy-saving effect by migrating the positioning calculation to the cloud or sharing the cloud positioning data.

3.4 Data Security and Privacy Protection
As cloud computing services acquired by mobile users become more abundant, security threats such as data leakage and privacy exposure are becoming more serious.

First, in the cloud data security, in the mobile cloud computing environment, user data is migrated to the cloud data center using the wireless network, and services such as multi-user sharing and online query are also required. In this operation, not only is it easy to be attacked by an external attacker, but also it is easy to cause data leakage or loss due to improper operation or the like. These problems can be controlled and solved through a series of technical measures such as identity authentication and access control. Identity authentication belongs to an important technical content of cloud data security storage. Because mobile terminals calculate their own mobility and resource limitation characteristics, they design a cloud authentication platform, which combines implicit authentication with TrustedCube, implicit authentication is not taken. Traditional biometric information and user stored data are used for user authentication. Based on the mathematical statistical model, the user's legality is used to authenticate the user's legality. TrustedCube belongs to a cloud authentication infrastructure. A variety
of different authentication methods had been thought in order to ensure data security, cipher text is often used to store data in the cloud, which greatly increases data access. The user attribute can be used as the public key to associate the ciphertext with the user private key to achieve flexible representation of the access control policy, and the system has good scalability, which is an ideal control scheme.

Secondly, in terms of user privacy protection, mobile cloud computing should not only pay attention to the security of user data, but also need to pay sufficient attention to user privacy protection. In mobile cloud computing, privacy-related personal information, home address, activity location, etc., in terms of protection technology, include the following three types: First, identity privacy protection, multi-user data sharing, public the key encryption mechanism is based on the protection of user privacy and avoids the theft of user identity information in the process of verifying user identity. Second, location privacy protection, such as fuzzy location mechanism which is achieved by reducing the accuracy of user location information to effectively protect the user privacy; third, behavioral privacy protection, using security index and virtual query to protect query privacy.

Finally, mobile terminal security, mobile cloud computing not only faces the security threats which is faced by cloud computing, but also faces problems caused by malicious code and operating system vulnerabilities. The best way to detect and defend against these security threats is to install security software such as online updates, remote locks. The function and operation effect of the current security software are limited by the energy and processing capabilities of the mobile terminal. Based on the cloud-based security software platform, the user only needs to install a lightweight agent, and can use the cloud server to implement virus protection and effectively detect attacks, it is not only complete functions, but also save about 30% energy consumption.

4. Trend of Mobile Cloud Computing

4.1 Service Quality Assurance for Mobile Cloud Computing
On the one hand, efficient and continuous service, the current communication technology transmission rate on the market is as high as 100 megabytes, which can lay a good foundation for users to enjoy higher quality mobile cloud computing services. However, there are still major conflicts and contradictions in the explosive growth of mobile traffic and the availability of broadband resources. With radio technology, an effective enhancement of bandwidth utilization can be achieved. In addition, Cellular network traffic migrates towards the WiFi network, which can also effectively alleviate the problem of air interface resources [5].

On the other hand, the cloud data consistency guarantee and the wireless environment are more complex. By controlling the consistency of the user terminal and the cloud data, the mobile cloud computing service quality can be effectively guaranteed. The terminal data is transmitted by means of redundant backup, etc., and can meet the requirements of data consistency between the cloud and the multi-terminal.

4.2 Mobile Cloud Computing Enhancements
First, to calculate the efficient environment awareness and decision-making in the migration, in the process of popularization and development of mobile cloud computing applications, in order to improve the application of computing migration technology, it is necessary to accurately estimate the local execution and remote execution costs, and collect environmental information and systems, and fill and pay attention to the protection of user data security and privacy.

Secondly, mobile cloud computing services based on motion recognition and precise positioning, such as indoor positioning technology, have significantly improved in terms of positioning accuracy and system performance. From the previous positioning accuracy optimization is moving toward the direction of movement and motion recognition, and is expected to provide users with efficient and convenient and personalized cloud services.

Finally, mobile cloud computing services based on new communication technologies and network
architectures are enhanced. For example, 5G communication is almost the same, network access speed is significantly improved, and indoor positioning, micro base stations, etc. can be better supported, and the characteristics of 5G will be improved. And the characters and advantages in the mobile cloud environment have become a major research and development direction.

4.3 Secure and Available Mobile Cloud Services
On the one hand, cloud-based mobile terminal security protection technology, in view of the security threats to current mobile terminals, requires more in-depth research on intrusion detection and virus protection functions based on limited power and processing capabilities. The migration of password mechanisms and security protection functions in the cloud has gradually become a major development trend in the current mobile cloud security field. In addition, the solution to the contradiction between the encryption mechanism and the redundancy conflict needs to be fully considered in the research of mobile cloud computing security.

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5. Conclusion
Currently, mobile Internet and wireless data communication applications are becoming more widespread, and people are paying more attention to mobile cloud computing. With the emergence of applications such as smart homes and virtual reality, mobile cloud computing is also facing a severe test in terms of reliability, security and efficiency. In the future development of mobile cloud computing, we must first pay attention to the service quality assurance of mobile cloud computing. Secondly, we must pay attention to the enhancement of mobile cloud computing. Finally, we must pay attention to the security and availability of mobile cloud services. Through these methods, we can better support mobile cloud computing development to meet people's needs in mobile cloud computing.

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