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Improving Quality of Service Using Crowdsourcing Technique

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Abstract -*Quality of cloud service (QoS) is one of the important factors for the success of cloud providers in mobile cloud computing. Context-aware mobile cloud computing is a new idea that allows to improve user experience by exploring contextual information such as user location, time of the day, neighboring devices and current activity. Crowdsourcing is a practice to discover and select cloud services in order to provide efficient and stable discovering of services for mobile users based on group choice. Crowdsourcing-based QoS supports mobile cloud service framework by sensing their context information and providing appropriate services to each of the users.*

Key Words: **Mobile cloud computing, Crowdsourcing, Context-awareness, Quality of service, CQA(Crowd Sourcing Based QOS Adapter)**

1. INTRODUCTION

Mobile devices (e.g., Smartphone, tablet pcs, etc) are becoming an essential part of human life as the most effective and convenient communication tools not bounded by time and place. Mobile users gather experience of various services from mobile applications (e.g., iPhone apps, Google apps, etc), which run on the devices and/or on remote servers via wireless networks. The rapid progress of mobile computing (MC) becomes a powerful trend in the development of IT technology as well as commerce and industry fields. However, the mobile devices face many challenges in their resources (e.g., battery life, storage, and bandwidth) and communications (e.g., mobility and security). The limited resources significantly impede the improvement of service qualities.

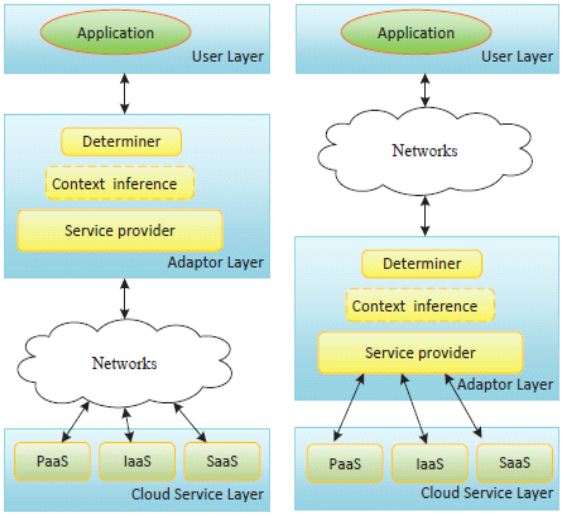
[1]Quality of Service (QoS) is the main concern largely due to the diversity of kinds of services and the complexity of the mobile environment. As the users' move, they often lack the knowledge of service providers and network environments in the different places and do not know how to choose the suitable cloud service on their own.

Mobile cloud computing make mobile devices more powerful by using distributed online computing resources. Delivery models like Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Software as a Service (SaaS) are the main interest in the commercial applications of cloud computing. Software and resources are present on the cloud instead of with the client, who pays for the required resources according to their resource usage. To increase the efficiency and stability of the cloud service for mobile users, the web service composition is introduced. QoS plays a key role in service selection and service composition. On the other hand, QoS can help users to avoid resource wastage and higher monetary cost, when the service requested by mobile application may exceed the capability of the device in its current context environment.

2. CONTEXT AWARENESS

Context-awareness is invented and roughly exploited in supporting Quality of Service. Context, as a research notion, has been invented and roughly exploited in many fields of informatics and refers to the idea that computers can sense, react and possibly adapt their functionalities based on the information they acquire from their environment. The term "context awareness" (CA) was first explicitly introduced in the research area of pervasive computing and refers, in general, to the ability of computing systems to acquire and reason about the context information and adapt the corresponding applications accordingly.

Based on context information, the service adaptor (SA) can understand mobile environments and intelligently make decisions to choose suitable cloud service without interrupting the user. To make SA more intelligent and efficient, all users need to involve solving this complex problem. Each user will update his or her usage history and context information to a third party platform, then collective wisdom will be used to achieve the intelligent cloud service chosen problem. Crowdsourcing system has been built to complete complex data collecting tasks.



(a) (b)

Fig 2.1 Configurations of Context-aware mobile cloud services.

3. CQA (CROWDSOURCING BASED QOS ADAPTOR)

CQA is a middleware approach that enables dynamic adaptation of cloud service, and safeguards emergency service request, efficient resource utilization, and savings in monetary provision costs. By monitoring quality of resource and quality of device, CQA will respond to cloud service request following QoS priority level. All of the actions are under control of context-reasoning component in CQA

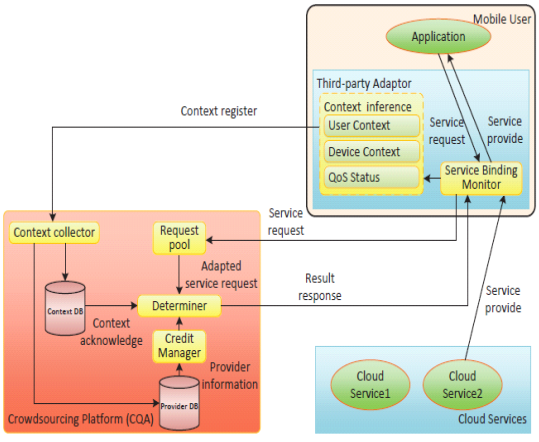


Fig 3.1 The architecture of crowdsourcing based QoS supported mobile cloud service.

As shown in the above figure, the CQA framework acts as an intermediate layer between mobile applications and cloud services. The adaptor layer is the middleware that receives service request and returns the suitable service to the requestor. A brief explanation of the most important components is provided below.

- **Context inference** - It senses the environment information: user context, device context, and resource context. Device context information contains network bandwidth, network load, wireless network model, signal strength, and battery life. User context contains information about activity, location, routine pattern, and social relationship. QoS status explains the availability of service, service cost, and response time for each cloud service. Context inference collects the information through the sensors on a mobile device.
- ***Determiner*** - This module is the core of the CQA. It has three main roles in the CQA: service request scheduling, environment matching, and provider selection.
  - Service request scheduling chooses the highest priority request to run. As the service request has different QoS needs, priority is given for each request to meet the demand.
  - Environment matching is, at runtime, triggered by a message from the request pool to find the records of some of the best match context environment descriptions. Based on the context environment described in the service request, the determiner will query the most similar context environments stored in context DB and generate the identity list.
  - Provider selection selects the most suitable cloud service providers in Provider DB to meet current service request.
- **Request pool** - This is a single queue whose requests basically follow first-in-first-out rules. Priority function is used to evaluate the importance of the new service request and add it to the right position of the chain. Some services will be held for a minute until the previous service releases the resource.
- **Service Binding Monitor** - This module takes charge of adapting a service request to the Broker and monitoring the service in use. When an appropriate service is available, the Service Binding Monitor

forwards the service request and responds to the requestor. It also gathers the resource usage by each service and reports it to the Determiner. It guarantees QoS for each service.

- **Service provider** - It merges different types of cloud service for a mobile device and supplies the profile information of each cloud service. After introducing the components in crowdsourcing platform architecture, the workflow of CQA platform has explained.There are three main steps to finish the whole system task as shown in Fig. 3.1:
    1) Context gathering
    2) Crowdsourcing computing
    3) QoS ranking.

After gathering enough context information from each user, crowdsourcing method can be adopted to model the context information into the knowledge database. Then, user's service request is respond by selecting the more suitable provider from the service pool under knowledge database's guidance.

3.1 Context Gathering

Every user will update their cloud service usage report to CQA platform. The context environment, the type of cloud service, and performance result will be sent to CQA center. As shown in Fig.3.2, crowd user updates their context information to the crowdsourcing platform CQA. The context information includes user's environment, cloud service provider and network provider. Context update can set interval to be 12 hours for each user. If one user dose not finds any context information for current location, the user will start a new aware task and update the result to CQA. All the context information is anonymous in order to protect user privacy. The new cloud service will also register on CQA platform. The more information they gather, the more suitable the cloud service they will select.

3.2 Service Discovery

The service discovery process is as a query for the most suitable result from gathering data. The workflow of crowdsourcing based service discovery is given in Fig. 3.2. Each mobile user's service usage update is considered as a sub task to meet service discovery process. The update data will be stored in a context data base, which describe the relationship between context environment and cloud service provider

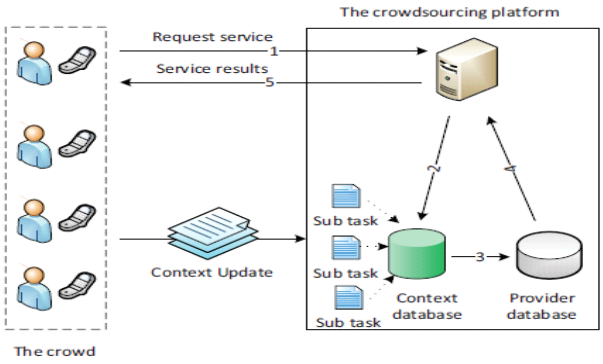


Fig 3.2 The workflow of the crowdsourcing based service discovery process

3.3 Service Selection Engine

When the user requests a cloud service, the two parameters [*User, Performance*] need to be provided to query the available results. Ranking model is used to calculate the QoS performance. The top-rank provider will be selected as the result and send back to the requestor. The more data collected, the more accurate the service can be chosen. Those steps are shown in the numbered line in Fig. 3.2. The service selection engine uses the similarity-based method to choose the most suitable providers. The similarity-based decision algorithm intends to determine the available mobile cloud providers in a given context environment by using the similarity distance.

3.4 Credit Manager

Credit manager component is in charge of evaluating the reliability of each service provider. The credit is the statistical results of the successful service times. After the context information is updated from users, the crowdsourcing platform will record the available service provider in provider database as shown in Fig. 3.1. Base on the provider's uptime and usage frequency, the credit manager calculates the reliability score for each service.

4. RESEARCH WORK

In mobile cloud environment the Quality of Service (QoS) measures service in availability, priority, cost and response time. For the different types of cloud service, an operator is needed to be developed to achieve different treatment within the environment for them to function properly.

4.1 Mobile Cloud Service

The mobile cloud computing services can be functionally grouped into two types

- **Storage Service:** This type of service aims to solve the problem of storage limitations on mobile devices. The applications need large data transmission between mobile client and server. Network availability, respond time, and throughout are the main concerns of this type of service. Mobile commerce, mobile healthcare, mobile learning, and mobile multimedia are the classic applications belonging to this kind of service.
- **Computing Service:** The computing services transfer the heavy computing task from mobile device to cloud and achieve the results. The applications offload the task and data to cloud, which is a suitable solution to address the issues of computational power and battery lifetime. Mobile designing, mobile online gaming, and mobile multimedia are common applications which require large processing resources.

In addition, there are a class of services that do not guarantee response time and priority. These are called best effort services, such as email, file backup, and status updates. As described above, different types of cloud services may need different QoS requirement.

4.2 Mobile Crowdsourcing

Crowdsourcing has been successfully applied in commercial applications. The mobile users may have some issues such as congestion due to the limitation of wireless bandwidths, network disconnection, and the signal attenuation caused by mobile users' mobility. To continue using cloud services, system setting need to be configured for different mobile environments. Furthermore, lack of provider's information is also a shortcoming to choose suitable cloud service. Context-awareness is the best solution to sense mobile environments and intelligently choose the best cloud service. In addition to crowdsourcing technology, the best cloud service to provide QoS for mobile device can be chose intelligently.

4.3 Quality of Service

Quality of service is the ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance

In MCC, mobile users need to access to servers located in a cloud when requesting services and resources in the cloud. However, the mobile users may face some problems such as congestion due to the limitation of wireless bandwidths, network disconnection, and the signal attenuation caused by mobile users' mobility. They cause delays when users want to communicate with the cloud, so QoS is reduced significantly. Two new research directions are CloneCloud and Cloudlets that are expected to reduce the network delay.

- **CloneCloud:** CloneCloud brings the power of cloud computing to your smartphones. CloneCloud uses nearby computers or data centers to increase the speed of running smart phone applications.
- **Cloudlets:** A cloudlet is a trusted, resource-rich computer or cluster of computers which is well connected to the Internet and available for use by nearby mobile devices.

Fig. 1.2 shows the structure of mobile cloud service can be divided into three parts: mobile users, network carriers and cloud service providers. The mobile users can freely choose different networks to use different cloud services. The quality of service on mobile device is affected by both the cloud service providers and network service carrier. There are different types of services in mobile cloud computing environment.

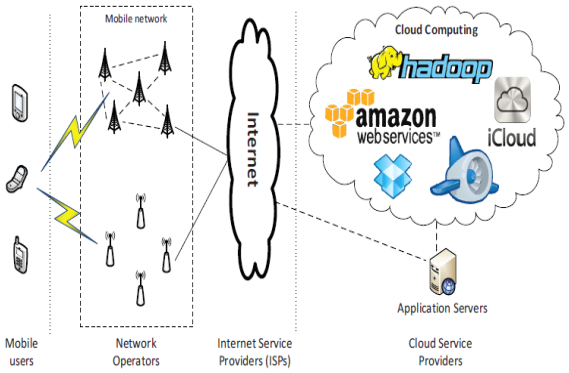


Fig 4.1 Mobile cloud computing architecture.

4.4 Context-awareness based Service

Discovery Model

The quality of cloud service at end user is affected by WS and NS as shown in Fig. 1.2. The context awareness method is to find a suitable service combination for mobile

user based on current network environment. It includes service discovery algorithm and quality constraints that need to be satisfied.

- **Service Discovery Algorithm**

  Confronted with a variety of network environments, an optimal combination service need to be selected based on application's requirement. The context-awareness based service discovery method can be viewed as two steps: context aware and QoS ranking. Given the information of cloud service providers and network providers (ISPs), Context Aware is collecting the QoS performance of each service combination. When the context collection is finished, QoS ranking searches for the optimal combination service by calculating QoS score *QMS*.

- **Quality Constraints**

  Due to the diversity of application requirements, quality of service can be measured in several aspects. Each application has its certain constraint on quality of service. Five main QoS constraints are considered for different quality requirements: bandwidth, response time, price, energy and security.

4.5 Crowdsourcing

Crowdsourcing is the process of getting work or funding, usually online, from a crowd of people.

By definition, crowdsourcing combines self-selected volunteers or part-time workers; each person's contribution combines with those of others to achieve a cumulative result. *Crowdsourcing* is distinguished from *outsourcing* in that the work can come from an undefined public (instead of being commissioned from a specific, named group) and in that crowdsourcing includes a mix of bottom-up and top-down processes. Regarding the most significant advantages of using crowdsourcing the literature generally discussed costs, speed, quality, flexibility, scalability, and diversity.

Well-known examples of crowdsourcing include Wikipedia, Linux, Yahoo! Answers, YouTube and much effort is being directed toward developing many more. As is typical for an emerging area, this effort has appeared under many names, including peer production, collaborative systems, community systems, social systems, social search, social media, collective intelligence, wikinomics, smart mobs, mass collaboration, and human computation.

There are many methods to reach QoS in mobile cloud computing for single mobile users. The local context-aware method can only aware limited environment knowledge and the device need to continually aware of the environments when they move to a new place. This cause battery issues and the suitable service with appropriate QoS may not be discovered due to limited context knowledge.

To overcome these drawbacks, users are hired to share the usage experience of choosing a suitable mobile cloud service in different context environments. The globe environment awareness task is achieved by crowd user.

Thus crowdsourcing improves a user's fulfillment of using cloud service. When there is more certainty of context information, the service adaptor (SA) will be more intelligible and efficient. Using crowdsourcing technology, user habits can learn from history. Then, we can supply more quality cloud services for a user. Crowdsourcing can help SA to understand more mobile environments and make the right decision. While there is no direct relationship between service quality and context information, several reasoning mechanisms need to be built to achieve qualified services for mobile users.

5. Applications

Many applications can be designed on top of CQA, among them two applications are:

- **Online Media:** online media is an application where multiple video files are downloaded from cloud servers. It requires high bandwidth and stable network environment to protect the quality of online video service. Those video files are stored in different cloud servers and mobile users randomly select which file to download.
- **Photo Backup:** The photo backup is a typical cloud storage application, which is usually impact by the network availability. With multiple sensors on mobile device, *e:g:* camera, GPS and temperature, more and more files are generated, and uploaded them to flickr, facebook, *etc*

Some of the emerging and future applications of mobile cloud computing:

- Crowdsourcing (crowd computing)
- Collective sensing
  - Traffic/Environment monitoring
  - Mobile cloud social networking
  - Mobile cloud healthcare

- Location-based mobile cloud service
- Augmented reality and mobile gaming

CONCLUSION

The crowdsourcing based awareness method can be used to reduce the cloud service discovery time than the traditional local context awareness method, especially for frequently moving user.
Crowdsourcing based QoS adaptor (CQA), and its key components and QoS control structures can be applied to mobile cloud computing environments in order to provide QoS management for cloud service. Crowdsourcing method is more stable than the traditional context-awareness method. The service discovery time is not influenced by the user's mobility. As the user is moving fast, the cloud service's quality may out of date after the traditional context-awareness sensing complete. The CQA platform can discovery an optimal result in a shorter time.

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