Cloud- Augumented Mobile Computing for Railway Emergency System

V.Sarala Devi
Assistant Professor, Dept Of Computer Applications,
Dr.M.G.R Educational and Research Institute University

ABSTRACT
Mobile computing is an ever-growing research area. Due to temporary drawbacks of current mobile hardware technology and intrinsic mobility, computation on mobile devices will always be a compromise in most research work. Mobile computing can seamlessly augment the cognitive and collaborative abilities of users by using interactive capabilities in computing system. With cloud computing technology emerging, mobile computing has wider solutions to support. In this paper, we propose a kind of c1oud-augment mobile computing (CMC) concept, and express the meaning of its implement. we discuss the railway emergency disposing system based on the CMC concept, and expatiated on its design and implement for mobile device to utilize the capability of cloud infrastructure and technology.

Keywords
cloud computing, mobile computing, railway application

1. INTRODUCTION
Cloud computing is still an evolving paradigm.Cloud computing definitions, use cases, underlying technologies, issues, risks, and benefits will be refined by the industry and academic.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction [1]. This cloud model promotes availability and is composed of five essential characteristics including on-demand self-service, broad network access, resource pooling, rapid elasticity, measured service, three service models including cloud software as a service(SaaS), platform as a service(PaaS), infrastructure as a service (laaS),and four deployment models including private cloud, community cloud, public cloud and hybrid cloud.

In the past year, the grid computing and cloud computing keep the attention on the centralized data processing, and have many differences[2]. But, with the increasing of mobile device, the mobile applications bring forward challenging target for the future direction of cloud computing. In other word, how cloud computing technology can leverage the mobile application is an interesting problem.

The primary constraints for mobile computing are limited energy, wireless bandwidth and interactive capability. In past several years, offloading computation to other computer is given more attention to improve energy consumption and network latency. Typical projects include Cyber foraging[II], eyeDentify [19] and etc. Many research works indicate that capability augment action of mobile device depends on wireless bandwidth, the amount of computation to be performed, the amount of data to be transmitted. The result is based on a fundamental assumption that mobile devices contain all the data in client-server model [18].With cloud computing technology, data can be stored in cloud, and virtualization can support application execution in virtual machine according to customer and application requirement. Due to user experience quality in different application scenarios, we think human-machine interaction requirement is also important factor to determine whether to utilize ambient device or other resources.

Currently, many works on cloud-based mobile application is on the way, such as in game design, transportation, and multimedia application and so on.

This paper discusses a novel cloud computing application paradigm to facilitate the mobile device for supporting compute-intensive and collaborative computing. The mobile device can serve as thin client or cloud node to form a resource-rich cluster or computer, and utilize the compute, store and network services provided by cloud. Using this mechanism also simplifies application system configuration and scalability, meets multiple users interaction and data sharing.

2. RELATED WORK
Currently, some research works explore the leveraging technology of mobile computing with the help of cloud computing technology.

Aiming to deal with crisp interactive response, VM based Cloudlet provides transiently-customized proximate infrastructure for mobile device to utilize the peripheral resource-rich computing environment[8], which can improve access latency of mobile device.

EyeDentify utilize the Ibis middleware to implement Multimedia system of smart phone in cyber foraging paradigm. This method increases the application's responsiveness and accuracy whilst decreasing its energy usage[19].

Hyrax provide a mechanism for applications to use distributed resources abstractly, and allows client applications to conveniently utilize data and execute computing jobs on networks of smartphones and heterogeneous networks of phones and servers, which take advantage of the physical nature of the cloud[18].

Those methods mainly emphasize leveraging technology for mobile access performance. The different point is our

method focuses on how to utilize storage, computing capability of ambient environment for business collaboration in distributed application of railway. In addition, most solutions regard the mobile device as web portal, but our thoughts regard the mobile device as parts of container of data and computing for distributed application.

3. MOBILE DEVICE APPLICATION PERSPECTIVE

Traditionally, cloud computing is used for mass data process or centralized computing task. Hardware has no energy, storage and network limits. But, it has long been recognized that mobile hardware is necessarily resource-poor relative to static client and server. So, resource poverty is a major obstacle for many applications with the potential to seamlessly augment human cognition and experience.

On the other hand, wireless technology development leverages interconnecting capability of all kinds of devices. Currently, mobile communication services evolve from 2G to 3G. Cellular mobile communication, next generation WLAN (Wireless Local Area Network), next generation WPAN (Wireless Personal Area Network), and 4th generation mobile communication service is high quality seamless broadband multimedia service which can be used by less cost and more convenience. This service should be possible with Anything, Anytime, Anywhere, AnyDevice, Anyone (AAAA)A. Through various mobile communication technologies, most mobile devices can link the static client or server device, furthermore, utilize their capacity.

Similarly, as pervasive computing paradigm addressed, mobile device play an important role in user task and computing evolving [20]. Mobile computing is confronted with effective use of ambient environment and localized scalability problem. In pervasive computing system, physical integration and spontaneous interoperation are two main characteristics. Physical integration emphasize Human administrative, territorial, and cultural boundaries that means user task takes place in more or less discrete environments, which is supported by sensor technology. Spontaneous interoperation is desirable system software mechanism, which intelligently manage software component interaction. Currently, mobile computing research has successfully addressed aspects of interoperability through work on adaptation to heterogeneous content and devices, but it has not discovered how to achieve the interoperability that the breadth of functional heterogeneity found in physically integrated system requirements[9]. So, Julie A. McCann puts forward the discussion that cloud computing is essential to the future of pervasive services[10].

With future mobile computing evolving, mobile device should utilize the ambient software and hardware resource in different administration environment. By this way, mobile device can achieve augmented computing, storage, network and interaction capability. So, cloud technology can leverage mobile device usage. In other word, cloud-augmented mobile application is promising technology direction.

4. CLOUD-AUGMENTED MOBILE COMPUTING DEFINITION AND MEANING

As a novel computing scenario, Cloud-augmented Mobile Computing (CMC) emphasizes collaborative computing with Heterogeneous devices in broad network environment by cloud technology. As figure 2 shown, CMC includes three aspects content:

1) Back-end Cloud: mobile device can implement the complex, configurable, computing-intensive data process with the help of large scale cloud service infrastructure.

2) Local Cloud: mobile device can cooperate with other end devices to implement collaborative interoperation of data and computing in small-scale group environment.

3) Mobile Application Model: novel end-to-end mobile application paradigm can be achieved by utilizing the back-end cloud and local cloud.

Figure 1. Cloud-augmented Mobile Computing (CMC) Scenario Concept

So, mobile device can achieve capability support of interaction, data and computing provided by local cloud by means of three ways.

- Mobile device can setup the new virtual machine by utilizing resources in local cloud. User mobile application can be migrated to virtual machine for application execution. It enable surrogate execution of mobile application and device.
- Mobile device can join the local cloud as local cloud node, and share own data and computing with other cloud node for specified distribute computing task.
- Mobile device can regard local cloud as proxy of distance resources by local low-Iantency, high bandwidth network. This pattern can be seen as typical mobile solution named as cyber foraging [11] in pervasive computing environment.

The cloud-augmented mobile computing concept is similar to cloudlet [8], and has more extended thoughts.

Service Modeling

According to CMC definition and cloud computing characteristics, we propose the service model to address relative implement technology. As figure 2 shown, network service, computing environment service and storage service are severally abstract for heterogeneous network, operation system, and storage media by means of virtualization technology. Data service expresses data operation and management provided by cloud for cloud user. Computing service is computing function acting on specified data set. Interface service emphasizes the human-machine interaction interface function provided by cloud via software or hardware. Based on service abstract, service composition

technology can integrate the service component into various application patterns. In the process of service composition, administration, quality of service and security is important factors for improving the execution performance of composition application.

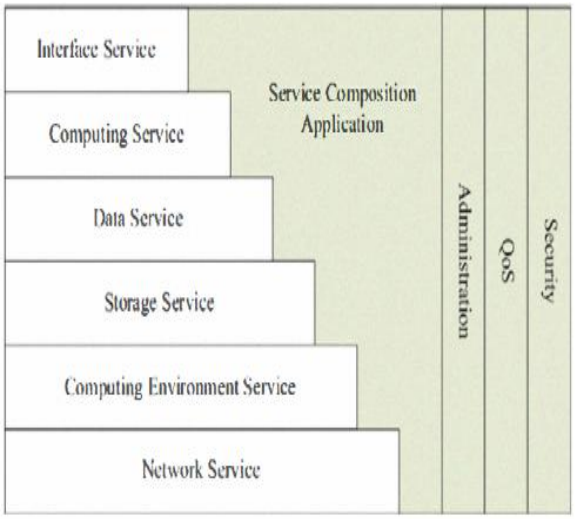

Figure 2. Service Model for Cloud-augmented Mobile Computing.

Interface Sharing

Mobile human-computer interface is a promlsmg research direction, which emphasizes multi-modal interaction or interface adaptation for improving quality of human experience. Beyond cyber foraging [8], mobile device should augment the interface capability, besides the computational and storage capabilities in virtue of cloud technology. User can utilize the ambient devices to augment input, output capability, implement collaboration of interaction modal for application.

Data Sharing

Many research work focus on improving data access latency by cache technology on surrogate server in cyber foraging scenario. But they do not take account of data sharing in surrogate server group and computing based on those data. So, utilizing the cloud infrastructure, we can implement the computing function on local data of mobile device and cloud node device, Such as multimedia data sharing among the mobile devices [16].

Resource Sharing

Owing to cloud resources are measured services, mobile device can integrate a whole cloud with ambient computing node. The sharing mode has two choices. One is mobile device, as an independent node, become a part of cloud. The other is use the cloud resource, as a virtual machine, execute mobile application. Virtual machine resource management should support single machine and cluster clone [7][17] for application usage.

Mobility Supporting

Mobility is an outstanding characteristic of mobile device. So, CMC should support mobile device to automatically join or depart cloud infrastructure. Meantime, mobile device can host partial application function to serve different mobile scenario.

5. CASE STUDY OF CLOUD-AUGMENTED MOBILE COMPUTING IN RAILWAY APPLICATION

Railway system includes the ministry of railway and eighteen railway bureaus. Those administration parts are physically distributed, and their information system is a complex distributed system. Every railway bureau manages their computing resource and information resource individually. The railway section is also same.

In any railway industry, We had already implemented a cloud computing-based architecture for freight system application, which explores the Tashi [13] and Hadoop [6] for virtual resource management and MapReduce-based[4] search technology.

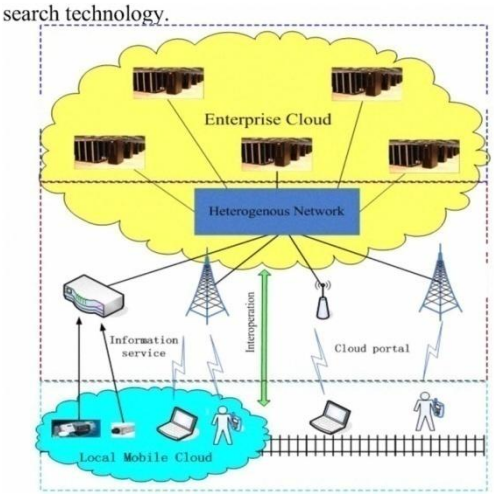

Figure 3. Railway Cloud-augmented Mobile Computing Scenario.

In railway application scenario, the railway staff need utilize the railway signal produced by information devices, sensor network, railway instrument, and railway meter. Traditionally, the railway information data store in the database after being collected. Centralizing process does not lend itself to local operation and collaboration, especially, for distributed data and computing management. Meantime, network delay and transient data process are not provided support in a certain extent.

A. Railway Emergency Disposing System Requirement

Railway emergency disposing system is distributed collaborative supporting system when train accident and railway overhaul. On-site railway maintenance personnel can use mobile terminal equipment to accept maintenance guide of the command officer. In railway information system, more and more computing devices with increasing resources was acted as collecting devices of railway information, which describes railway business status in distributed mode. The

railway business logic needs integrate information semantic of those devices.

The maintenance personnel can utilize the detailed information of the on-site maintenance environment. The detailed information includes audio and video, current and voltage information and sensor data. The information is distributed in geographical site, and use different collecting system individually. So, service-oriented characteristic of cloud computing can hugely improve scalability of system integration.

According to railway administration rules, the whole information of train and railway should save to multiple level data center or information device. As figure 3 shown, railway business information can transfer and save in data center of railway enterprise cloud for data management and analysis. In railway emergency disposing system, the enterprise cloud implements data analysis for railway accident confirmation and railway expert can give disposing suggestion based on the data analysis result for local maintenance personnel to reference. In local mobile cloud, many devices tend to smarter, more storage capability, and more intelligent. Those information and signal device can keep the real data information in short period of time. The railway maintenance personnel can execute instantly on-line data analysis for real time railway system debugging. Meantime, the railway personnel in different railway site should collaborate to share data and multimedia information for discuss accident disposing decision.

B. The Implement Technology Discussion

1) Name Space

According to figure 4, we setup the data management name space. It can be utilized to organize the distribute file system of local mobile cloud and lend itself to support loose-coupled service composition mechanism for railway-oriented business. Uniform business data expression can give facilities for flexibility and scalability of application interface.

2) Data analysis and Operation

Within local mobile cloud environment, the local emergency personnel can execute some data analysis and presentation according to different business semantic data source. We select some steady device as base infrastructure and implement data management mechanism based on open source project HBase abstract[14].

- Based on the railway business semantic requirement and emergency disposing rules, we use Bigtable [5] abstract to setup exception table which expresses railway data characteristic, time, failure device, Diagnosis and expert suggestion and so on.
- The implement uses distributed file system HDFS[3] as data file system. Owing to time-limit local data storage and restricted storage, computing capability of local cloud nodes, we reduce the data replica to 1 or 2.
- We utilize the HDFS file interface to implement data operation, such as copy, movement and etc. This function support some media files localization.
- For real-time multimedia information, we developed video service for railway monitoring and published it in service directory and distributed file system.

3) Media Sharing

In the process of railway emergency disposing, the collaboration is necessary, efficient means among multiple people. Video conference system and smart space system[15] keep the focus on exclusive subject, for example audio,courseware or etc. other interactive object is assistant and interaction requirement is not imperative. In our system, focus media is changed with business and collaboration requirement and hotspot is invariable for task. The video and data information for specified railway component is equally important for emergency personnel to diagnose exception. So, in our prototype system, emergency personnel need to sharing own focus with others in the same time. User can enable media component bootstrap in other device of environment or other people through simply operation.

4) Group Management

Similar to Tashi resource management infrastructure, we develop a light-weight group management tool for emergency group management (figure 5).The group manager keeps the application resource metadata, including device, user and other collaborative relation information, and provides group communication mechanism for node management. The collaboration manager application semantic relation among the computing service ,data, user task, and correlative soft status information for error resuming and collaboration support.

The on-site command officer, as management node, can keep group information, and use heartbeat information to monitor group member status. In this group, every group member can interactively share required focus with other member, such as video, photo, plot data and etc. Those focus objects' sharing and transferring is based on the file operation interface of HDFS. Among the group members, transferring object is only operation command, which simplifies operation complication.

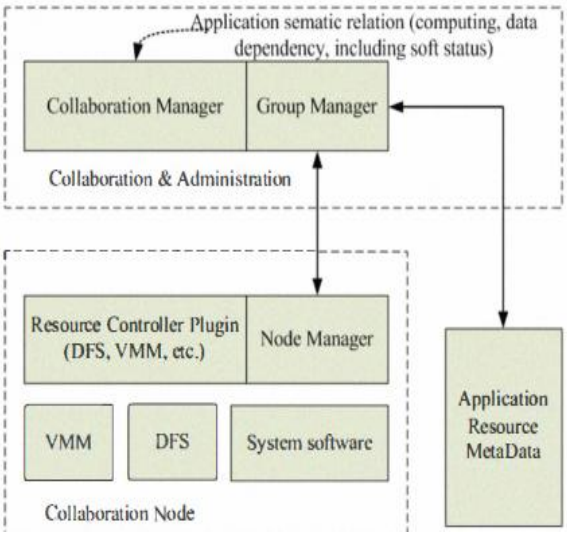

Figure 5. Light-weight Group Management Mechnism for Collaboration

5) Expert-supported system

Distance back-end cloud supporting for railway emergency disposing system is provides by expert experience of exception treatment. The back end cloud has large scale data information, which is utilized to do professional data

analysis. Through category of different exception modes, expert can give effective treat support. This process can be independently carried through by our implemented testbed, and periodically update to except table of relative local mobile cloud for reference.

6. CONCLUSION AND FUTUREWORK

Resource poverty and interaction coarseness is a fundamental constraint that severely limits the variety of applications that can be run on mobile devices. But the mobility of mobile device is an outstanding characteristic for portable computing. In this paper, we discuss a vision of cloud-augment mobile computing. In this vision, mobile user can seamless utilize resource of cloud computing, collaborate with device, data and other cloud service.

Along with cloud-augment mobile computing vision,much remains need to be done. We will carry out research work on service composition technology to support the CMC scenario and optimize the system performance.

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