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MOBILE CLOUD COMPUTING: A SURVEY OF RESEARCH ISSUES & CHALLENGES

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ABSTRACT

Mobile cloud computing (MCC) is a highly promising trend for the future of mobile computing. Mobile Cloud Computing Platform promises to be beneficial to both individual mobile device users and enterprises. We know that mobile devices are constrained by their processing power, battery life and storage. However, cloud computing provides an illusion of infinite computing resources. As with the cloud computing, most of the power of infrastructure, processing, data storage resides outside the mobile device. While mobile devices have the ingenuously made mobile apps within them, they rely on powerful outside cloud sources to process and deliver the requirement. In a typical cloud computing scenario involving IaaS, PaaS, SaaS, a PC acts as a client to make use of the cloud with a connectivity solution; in this case, the internet. With Mobile internet usage ever increasing, MCC is expected to be the next big thing.

INTRODUCTION

Cloud computing and mobile devices are two significant technology trends we have been observing for the last few years. Widespread adoption of these two is changing our lives, the way we do business and most of our day-to-day chores. Profoundly these technologies have created a reverberation in the technology landscape around the world. An explosion of mobile and handheld devices is also significantly contributing to world IP data traffic. To support such data demand, cloud computing seems to be the right choice because of its rapid scalability, ubiquitous network access, on-demand self-service and other features.

MOBILE CLOUD COMPUTING (MCC) is a new platform combining the mobile devices cloud computing, mobile computing and wireless networks to bring rich computational resources to mobile users, network operators, as well as cloud computing providers. Where by cloud performs the heavy lifting of computing-intensive tasks and storing massive amounts of data. The ultimate goal of MCC is to enable execution of rich mobile applications on a plethora of mobile devices, with a rich user experience. Mobile Cloud Applications move the computing power and data storage away from the mobile devices and into centralized and powerful computing platforms located in clouds, which are then accessed over the wireless connection based on a thin native client. MCC provides business opportunities for mobile network operators as well as cloud providers. More comprehensively, MCC can be defined as "a rich mobile computing technology" that leverages unified elastic resources of varied clouds and network technologies toward unrestricted functionality, storage, and mobility to serve a multitude of mobile devices anywhere, anytime through the channel of Ethernet or Internet regardless of heterogeneous environments and platforms based on the pay-as-you-use principle.

WHY MCC? We present some data to establish the need for cloud computing and mobile. Mobile devices face many resource challenges such as battery life, storage and bandwidth. Mobile Cloud Computing offers advantages to users by allowing them to utilize infrastructure, platforms and software by cloud providers at low cost and elastically in an on-demand fashion. Mobile cloud computing provides mobile users with data storage and processing services in the cloud, eliminating the need to have a powerful device configuration (e.g. CPU speed, memory capacity etc.), as all resource-intensive computing can be performed within the cloud.

FACTORS FOSTERING THE ADOPTION OF MCC:

- Trends and demands: customers expect the convenience of using companies' websites or application from anywhere and at anytime. Mobile devices can provide this convenience. Enterprise users require always-on access to business applications and collaborative services so that they can increase their productivity from anywhere, even when they are on the commute.
- Improved and increased broadband coverage: 3G and 4G along with WiFi, femto-cells, fixed wireless and so on are providing better connectivity for mobile devices.

- Enabling technologies: HTML5, CSS3, hypervisor for mobile devices, cloudlets and Web 4.0 will drive adoption of mobile cloud computing.

Mobile applications and devices leverage MCC architecture to generate the following advantages: Extended battery life, improvement in data storage capacity and processing power, improved synchronization of data due to "store in one place, access from anywhere" policy, improved reliability and scalability, ease of integration, more immune to crashes and deletions, it is easier to maintain your data, mobile devices have limited juice, it is easier to share content and assets, the brain of your service is in the cloud.

MCC ARCHITECTURE

Mobile devices are connected to the mobile networks via base stations that establish and control the connections and functional interfaces between the networks and mobile devices. Mobile users' requests and information are transmitted to the central processors that are connected to servers providing mobile network services. The subscribers' requests are delivered to a cloud through the Internet. In the cloud, cloud controllers process the requests to provide mobile users with the corresponding cloud services.

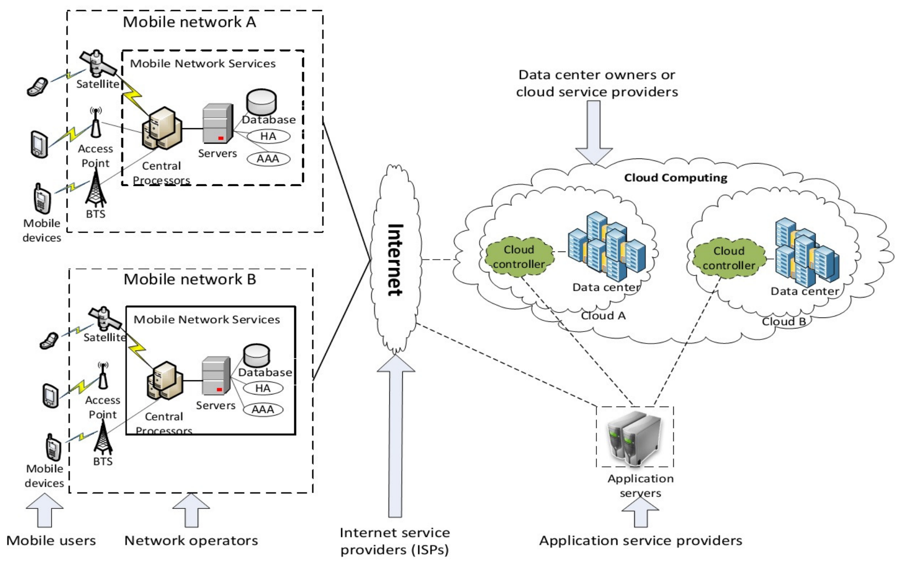

Figure 1: MCC architecture

The service oriented MCC architecture contains three layers, the Application layer (SaaS), the Platform layer (PaaS) and the Infrastructure layer (IaaS). Each of these layers provides a specific service for users, which are explained as follows:

Infrastructure as a Service (IaaS): Several types of virtualization occur in this layer. Among the other resources, computing, network, hardware and storage are also included. In the bottom layer of the framework, infrastructure devices and hardware are virtualized and provided as a service to users to install the operating system (OS) and operate software applications. Therefore, this layer is named Infrastructure as a Service (IaaS).

Platform as a Service (PaaS): In PaaS, mobile operating systems such as Android, iPhone, Symbian and other OS, as well as database management and IMS are included in this section. This layer contains the environment for distributing storage, parallel programming design, the management system for organizing distributed file systems and other system management tools for cloud computing. Program developers are the primary clients of this platform layer.

Software as a Service (SaaS): Analytical, interactive, transaction and browsing facilities are included in the Application layer. SaaS delivers several simple software programs and applications as well as customer interfaces for the end users. Thus, in the application layer, this type of services is called Software as a Service (SaaS). By using the client software or browser, the user can connect services from providers via the internet and pay fees according to their consumed services, such as in a pay as you go model.

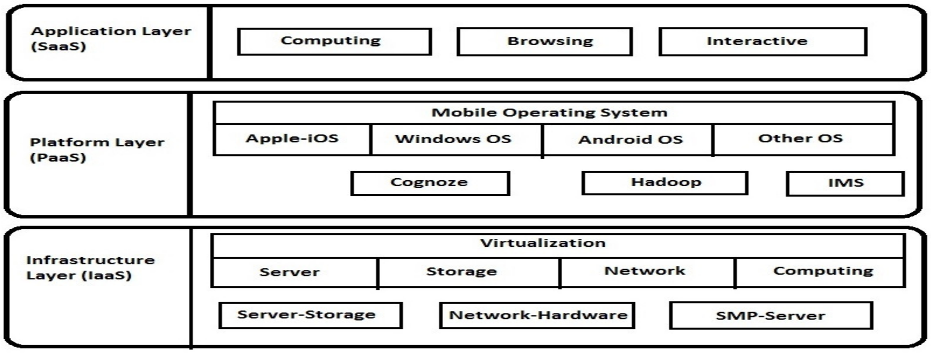

Figure 2: Service-oriented MCC architecture

MCC ADVANTAGES AND APPLICATIONS

ADVANTAGES:

- Flexibility: One of the major advantages of MCC is that you can access your data from anywhere in the world, using any mobile device. It does not matter where you are, as long as you connected to the internet you can access both applications as well as data from your mobile device.
- Real time data availability: Another advantage of mobile cloud computing is that you can get access to real time data, whenever you want and wherever you want. Given that the data and applications are managed by a third party, updating your data as well as accessing it in real time is easily possible. Moreover, it can be accessed by multiple persons simultaneously.
- Multiple platforms: Unlike traditional applications, mobile cloud computing allows for multiple platform support. In other words, whatever the platform may be, you can easily access the data and applications stored in the cloud.
- No upfront costs: In most cases, cloud applications have minimal or no upfront cost. It is very much a pay-for-use service which has helped to grow adoption of the model, especially for SMBs. Without hefty fees for licensing and upgrades, the cost of adoption is less of a barrier when cash flow is an issue.
- Extending battery lifetime: Computation offloading migrates large computations and complex processing from resource-limited devices (i.e., mobile devices) to resourceful machines (i.e., servers in clouds). Remote application execution can save energy significantly. Many mobile applications take advantages from task migration and remote processing.
- Improving data storage capacity and processing power: MCC enables mobile users to store/access large data on the cloud. MCC helps reduce the running cost for computation intensive applications. Mobile applications are not constrained by storage capacity on the devices because their data now is stored on the cloud.
- Improving reliability and availability: Keeping data and application in the clouds reduces the chance of lost on the mobile devices.
- Dynamic provisioning: Dynamic on-demand provisioning of resources on a fine-grained, self-service basis. No need for advanced reservation
- Scalability: Mobile applications can be performed and scaled to meet the unpredictable user demands. Service providers can easily add and expand a service
- Multi-tenancy: Service providers can share the resources and costs to support a variety of applications and large no. of users.
- Ease of Integration: Multiple services from different providers can be integrated easily through the cloud and the Internet to meet the users' demands.
- Mobility: With data and services in the clouds, then are always(almost) available even when the users are moving.
- Secure: MCC can be designed as a comprehensive data security model for both service providers and users. Protect copyrighted digital contents in clouds. Provide security services such as virus scanning, malicious code detection, and authentication for mobile users.

APPLICATIONS

- Industry / Line of Business: Boost efficiency and productivity by extending business processes to mobile applications. Mobile Could Applications includes a large number of applications dedicated to specific lines of business. You can empower almost any department in your company: HR, IT, Finance, Manufacturing, Sales, Supply chain, etc.
- Mobile Commerce: Mobile commerce allows business models for commerce using mobile devices. Examples: Mobile financial, mobile advertising, mobile shopping. Mobile commerce applications face various challenges (low bandwidth, high complexity of devices, security). Integrating or deploying these applications within a cloud environment can help address these issues
- Mobile Learning: Mobile learning combines e-learning and mobility to create m-learning. Traditional m-learning has limitations on high cost of devices/network, low transmission rate, limited educational resources. Cloud based m-learning can solve these limitations.
- Mobile Healthcare: Mobile Healthcare provides mobile users with convenient access to resources, such as medical records. It also offers hospitals and healthcare organizations a variety of on-demand services in the Cloud.
- Mobile Gaming: Mobile gaming is a high potential revenue generating market for service providers. Game engines requiring large computing resources cannot be offloaded to servers in the cloud. Saving energy and increasing game playing time. Rendering adaptation technique can dynamically adjust the game rendering parameters based on communication constraints and gamer's demands
- Other applications: Cloud Mobility offers much more than the typical workplace applications including sharing photos/videos; keyword, voice and tag-based search capabilities; monitoring houses and smart home systems; the opportunities are unlimited.

MCC OPEN RESEARCH ISSUES

- Architectural issues: Reference architecture for heterogeneous MCC environment is a crucial requirement for unleashing the power of mobile computing towards unrestricted ubiquitous computing.
- Energy-efficient transmission issues: MCC requires frequent transmissions between cloud platform and mobile devices, due to the stochastic nature of wireless networks, the transmission protocol should be carefully designed.
- Context-awareness issues: Context-aware and socially-aware computing are inseparable traits of contemporary handheld computers. To achieve the vision of mobile computing among heterogeneous converged networks and computing devices, designing resource-efficient environment-aware applications is an essential need.
- Live VM migration issues: Executing resource-intensive mobile application via Virtual Machine (VM) migration-based application offloading involves encapsulation of application in VM instance and migrating it to the cloud, which is a challenging task due to additional overhead of deploying and managing VM on mobile devices.
- Mobile communication congestion issues: Mobile data traffic is tremendously hiking by ever increasing mobile user demands for exploiting cloud resources which impact on mobile network operators and demand future efforts to enable smooth communication between mobile and cloud endpoints.
- Trust, security, and privacy issues: Trust is an essential factor for the success of the burgeoning MCC paradigm.

MOBILE COMMUNICATION ISSUES

- Low bandwidth: One of the biggest issues, because the radio resource for wireless networks is much more scarce than wired networks
- Service availability: Mobile users may not be able to connect to the cloud to obtain a service due to traffic congestion, network failures, mobile signal strength problems.
- Heterogeneity: Handling wireless connectivity with highly heterogeneous networks to satisfy MCC requirements (always-on connectivity, on-demand scalability, and energy efficiency) is a difficult problem.

COMPUTING ISSUES: Computation offloading is the main features of MCC. Offloading is not always effective in saving energy. It is critical to determine whether to offload and which portions of the service codes to offload. There are two types of offloading namely: offloading in a static environment and offloading in a dynamic environment.

COMPUTATION OFFLOADING APPROACHES IN A STATIC ENVIRONMENT.

- Chen et al. present an approach to decide which components of Java programs should be offloaded. First divide a Java program into methods and compute execution costs for these methods. Then compare the local execution costs of each method with the estimated remote execution costs to make an optimal execution decision.
- Li et al. present an offloading scheme based on profiling information about computation time and data sharing at the level of procedure calls. A cost graph is constructed and a branch-and-bound algorithm is applied to minimize the total energy consumption of computation and the total data communication cost.
- Wang and Li propose a polynomial time algorithm to find an optimal program partition. First partition a program into distributed subprograms by producing a program abstraction. Then, task allocations and data transfer of the abstract memory locations are determined subject to the control and data flow defined over the abstraction. The abstraction is divided into clusters and a heuristic algorithm is applied to find the optimal partition to minimize the execution cost of the program.
- Hunt and Scott present an automatic distributed partitioning system (ADPS) called Coign, which automatically transforms a program into distributed applications without accessing the source codes. Coign constructs a graph model of the application's inter-component communication through scenario-based profiling to find the best distribution.
- Xian et al. propose an offloading method which does not require the estimation of execution time. Online statistics of the comp time are used to compute optimal timeout and if the computation is not finished within timeout, it is offloaded to the server. Saves up to 17% more energy than existing methods.
- Kumar and Lu suggest a program partitioning based on estimation of energy consumption before execution. Optimal program partitioning for offloading is dynamically calculated based on the trade-off between the communication and computation costs at run time.

COMPUTATION OFFLOADING ISSUES IN A DYNAMIC ENVIRONMENT.

- Angin and Bhargava propose a computation offloading framework based on mobile agents. During installation of the mobile application on the device, it is partitioned by the application partitioner component. When the user launches the application, the offloading manager component of the framework first contacts a cloud registry to locate virtual machine instances in the cloud to offload application partitions to. Then these application partitions are packaged in mobile agents and sent over the network to the selected instances to start running, and the application task is completed with agent collaboration without further management by the mobile platform.
- Cuervo et al. MAUI is architecture to dynamically partition an application at a runtime in three steps. First, use code portability to create two versions of a mobile application (for mobile device and cloud). Second, use programming reflection to identify which methods are marked 'remote able' or not and type safety to extract only the program state needed by the 'remote able' methods. Then, send the necessary program state to the cloud.
- Chun and Maniatis present a system to partition an application in three steps: application structuring, partitioning choice, and security. Programs are structured to be seamlessly and dynamically executed between mobile and cloud. The application decides what modules to run at the client and at the server dynamically at a runtime. The system will choose a suitable partitioning policy so that the total energy consumption is minimized. Modules containing sensitive data will be executed locally.
- Ou et al. analyze offloading systems in wireless environments. They consider three circumstances of executing an application to estimate the efficiency of offloading: performed locally (without offloading), performed in ideal offloading systems (without failures), and performed with the presence of offloading and failure recoveries (re-offload after failure).

MCC RESEARCH CHALLENGES

The research challenges in relation to virtual network resource allocation (bandwidth allocation, virtual machine allocation) and distributed dynamic Multipath routing (priority and intelligent based) for hybrid and multi clouds in IaaS, Naas, Paas and SaaS environments under QoS constraints are mentioned. In particular, the following research problems are investigated

- Security: One of the major concerns with cloud computing is the security of data. Often mobile users will provide sensitive information through the network, and if not protected, can lead to major damages in the case of a security breach.

- Performance: Another major concern with mobile cloud computing is with regard to its performance. Some users feel performance is not as good as with native applications. So, checking with your service provider and understanding their track record is advisable.
- Connectivity: Internet connection is critical to mobile cloud computing. So, you should make sure that you have a good one before opting for these services.
- Fair bandwidth allocation for cloud based mobile computing networks.
- Scenario based fair amount bandwidth to virtual machines, applications and platforms: Dynamic bandwidth allocation mechanism comprises of two basic processes: allocating resources to overloaded servers to avoid performance degradation and allocating resources to under loaded servers to improve the utilization of resources and minimize energy consumption. A crucial decision that must be made in both situations is determining the best time to allocate the resources to minimize energy consumption, while satisfying the defined QoS constraints.
- Identification of virtual machines, applications and platforms to allocate the bandwidth: Once a decision to allocate bandwidth to a server, application or a platform is made, it is required to select one or more VMs from the full set of VMs allocated to the server, which must be reallocated to other servers. The problem consists in determining the best subset of allocation strategies that will provide the most beneficial system reconfiguration.
- Routing algorithms and bandwidth allocation: Determining the best placement of routing algorithm and bandwidth allocation schemes is a very crucial and essential aspect that influences the quality of allocation, service and energy consumption by the system.
- Physical nodes status: To optimize energy consumption by the system and avoid violations of the QoS requirements, it is necessary to efficiently determine when and which physical nodes should be deactivated to save energy, or reactivated to handle increases in the demand for resources.
- Distributed multipath routing and virtual dynamic resource allocation algorithms.

CONCLUSION

Mobile cloud computing is a combination, enhancement and development of cloud computing and mobile computing which has inherited scalability, robustness and high mobility. With the importance, this paper addresses various MCC advantages, applications supported by MCC, research issues and challenges related to mobile cloud with respect to wireless networks, mobile devices, mobile applications, architecture, vendors and mobile industry. A detailed survey of current MCC research has been presented in this paper and aims at motivation MCC. Also various approaches for offloading issues with respect to static and dynamic environments are summarized.

REFERENCES

[1] Le Guan, Xu Ke, Meina Song, and Junde Song, A Survey of Research on Mobile Cloud Computing, IEEE/ACIS 10th International Conference on Computer and Information Science (ICIS), pp. 387-392, 2010.
[2] Xiaopeng Fan, Jiannong Cao, and Haixia Mao, A Survey of Mobile Cloud Computing, ZTE Communications, 9(1):4-8, Mar 2011.
[3] Hoang T. Dinh, Chonho Lee, Dusit Niyato, and Ping Wang, A survey of Mobile Cloud Computing: Architecture, Applications, and Approaches, Wireless Communication and Mobile Computing. http://onlinelibrary.wiley.com/doi/10.1002/wcm.1203/abstract
[4] M.Rajendra Prasad, Jayadev Gyani, P.R.K.Murti, Mobile Cloud Computing: Implications and Challenges, Journal of Information Engineering and Applications, ISSN 2224-5782 (print) ISSN 2225-0506 (online) Vol 2, No.7, pp. 7-15, 2012.
[5] Pragya Gupta and Sudha Gupta, Mobile Cloud Computing: The Future of Cloud, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 1, Issue 3, pp. 134-145, September 2012.
[6] Waziri Onomza Victor, Joshua Abah, Olumide Sunday Adewale, Muhammad Bashir Abdullahi, Arthur Ume, A Survey on Mobile Cloud Computing with Embedded Security Considerations, International Journal of Cloud Computing and Services Science (IJ-CLOSER), ISSN: 2089-3337, Vol.3, No.1, pp. 53-66, February 2014.

[7] Gayathri M R and K. Srinivas, A Survey on Mobile Cloud Computing Architecture, Applications and Challenges, International Journal of Scientific Research Engineering & Technology (IJSRET), ISSN 2278 – 0882, Volume 3, Issue 6, September 2014.
[8] Karamjeet Kaur , Sugandha Sharma, Mayank Arora, Mobile Cloud Computing Techniques: A Review, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), Volume 3 Issue 4, April 2014.
[9] M. Satyanarayanan, Mobile computing: the next decade, in Proceedings of the 1st ACM Workshop on Mobile Cloud Computing & Services: Social Networks and Beyond (MCS), June 2010.
[10] M. Satyanarayanan, "Fundamental challenges in mobile computing," in Proceedings of the 5th annual ACM symposium on Principles of distributed computing, pp. 1-7, May 1996.
[11] http://www.mobilecloudcomputingforum.com/.
[12] White Paper, Mobile Cloud Computing Solution Brief, AEPONA, November 2010.
[13] K. Kumar and Y. Lu, Cloud Computing for Mobile Users: Can Offloading Computation Save Energy, IEEE Computer Society, vol. 43, no. 4, April 2010.
[14] Z. Li, C. Wang, and R. Xu, Computation offloading to save energy on handheld devices: a partition scheme, in Proceedings of the 2001 international conference on Compilers, architecture, and synthesis for embedded systems (CASES), pp. 238 - 246, November 2001.