Secure Mobile Data Offloading Model Using Cloud Computing

Sneha.N
MTech(Computer Science and Engineering)
Bapuji Institute of Engineering and Technology
Davangere, India
sneha2442@gmail.com

Azizkhan F Pathan
MTech(Computer Science and Engineering)
Bapuji Institute of Engineering and Technology
Davangere, India
apathan21@gmail.com

***Abstract*— Energy efficiency is a fundamental consideration for mobile devices. Mobile cloud computing is a technique or model in which mobile applications are built, powered and hosted using cloud computing technology. Advancement in technology has made smart phones as the future computing and service access devices. Users expect to run computational intensive applications on Smart Mobile Devices. Many applications are too computation intensive to perform on a mobile. Since applications consume more mobile resources, hence computation is performed on cloud. In this paper we propose a model for saving energy for mobile system, provide an overview of the motivations, techniques used to make offloading decisions and about security issues and privacy issues in cloud based application processing.**

Keywords— mobile cloud computing; offloading; cloud computing; virtualization.

I. INTRODUCTION

Cloud computing [1] [2] is a promising technology which can offer many benefits for mobile devices. It offers virtually infinite resources that are available on demand and charged according to usage. A cloud service provider owns and manages these resources, and users access them via the Internet. For example, Amazon Web Services allow users to store personal data via its Simple Storage Service (S3)[4] and perform computations on stored data using the Elastic Compute Cloud (EC2). Also cloud provides virtual machines that are used to deploy customized web services. The advancement in technologies shifted applications from desktop computers to a wide range of mobiles as embedded applications. The mobile applications and the support of cloud technology provides for a variety of services for smart phone users, so we define the integration of cloud computing with the mobile environment as Mobile Cloud Computing [6].

Mobile includes resources, such as battery life, network bandwidth, storage capacity, and processor performance. Mobile cloud computing allows to take the advantage of services and facilities for mobile users. As smart phones developers are building more and more complex applications, such as gaming, navigation, surveillance, autonomous robots, video editing, environmental sensing, GPS navigation augmented reality, and speech recognition, which consumes more computational power and energy. The intensive computational task needs to be performed on cloud. This is done by sending heavy computation to resourceful servers and receiving the results from these servers back to mobile with the help of cloud technology [3]. This helps in potentially to save mobile client energy by the savings from offloading the Computation [7] and extend battery lifetimes for mobile users. This type of computing provides many advantages for businesses and as well as mobile users [8].

II. RELATED WORK

The motivation of using cloud computing for mobile differs from the motivation of cloud computing with well-connected PC devices. A cloud service provider provides storage services for storing mobile data. Examples of cloud storage services include Amazon S3 and DropBox [5]. Cloud computing uses virtualization concept [9] to offer computing as a service; users can "lease" computing resources based on their requirements as shown in figure 1.

Virtualization technology allows sharing of servers and storage devices and increases utilization. Applications can be easily migrated from one physical server to another. Virtualization allows running multiple applications and operating systems on the same computer (or a set of computers) simultaneously and hence increasing total utilization and flexibility. Virtual machines (VMs) are often installed in a server in order to improve the efficiency of resource utilization.

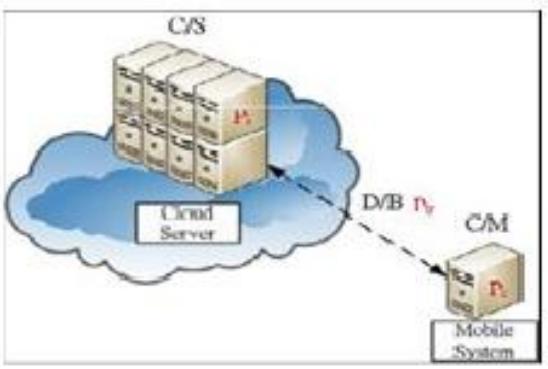

Figure 1.Virtualization

III. COMPUTATION OFFLOADING DECISIONS

Usually mobile systems have limited resources, such as battery life, network bandwidth, storage capacity, and processor performance. These restrictions are called as Computation Offloading. The advancement in virtualization

technology, network bandwidths and cloud computing infrastructures has shifted the intensive application direction of offloading to cloud [9] [10]. These developments have made computation offloading easy with two advantages save energy and improve performance on smart phone devices. The condition for offloading to improve performance divides a program into two parts: one part that must run on the mobile system and the other part that may be offloaded. Offloading may extend battery life by migrating the energy-intensive parts of the computation to servers either by Static or dynamic decisions.

Three types of tasks can be identified: (i) those which can be processed only locally in a mobile device, (ii) those which are processed in the cloud, and (iii) those which can be processed either in the mobile or in the cloud. For type (iii) tasks, it is of interest to consider when they should be processed locally and when in the cloud. The critical aspect for mobile clients is the trade-off between energy consumed by computation and the energy consumed by communication. The research on computation offloading to cloud includes: making it feasible, making offloading decisions, and developing offloading infrastructures [12] [13].

Offloading depends on few parameters such as the network bandwidths and the amounts of data exchanged through the networks. Also the computation off-loading is based on decision in which methods or modules or codes should be remotely executed, so that benefits can be achieved in terms of both time and use of resources of mobile that results in saving energy in smart phones. As shown in figure 2, it uses three major components Smart phone, Internet Wireless Technology and Computational cloud. Mobile devices usually use wireless network technology protocols such as 3G, LTE, or Wi-Fi to access the services of computational cloud in mobile environment. A combination of mobile and cloud allows cloud vendors to run arbitrary applications from different customers on virtual machines. Cloud vendors thus provide computing cycles, and users can use these cycles to reduce the amounts of computation on mobile systems and save energy. A cost/benefit analysis is focused on energy saving to off load computation to a server.

In this paper we provide an overview of the motivations, Techniques and surveys and the common methods used to make offloading decisions, and

- why to offload (improve performance or save energy)
- when to decide offloading (static vs dynamic)
- what mobile systems use offloading (laptops, PDAs, robots, sensors).
- types of applications (multimedia, gaming, calculators, text editors, predictors).
- Infrastructures for offloading (grid and cloud computing).

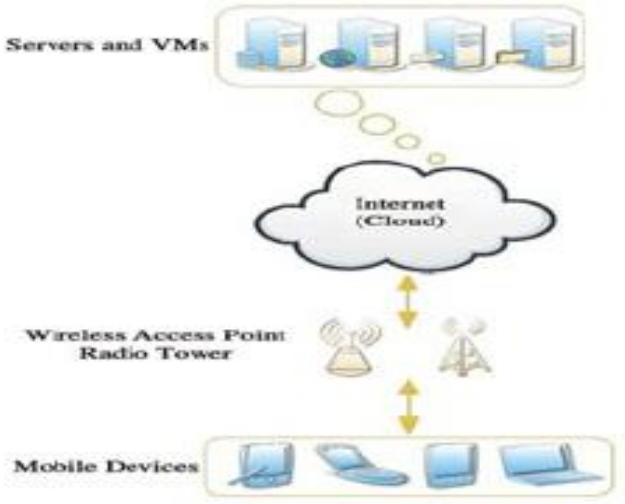

Figure 2.Mobile Cloud Computing

When making offloading decisions, it needs to consider few time factors like:

- a prediction of time required to execute the computation locally.
- a prediction time required to execute the computation remotely (once the data is available at the remote site), and
- a prediction of time required to move the input data from the local site to the remote site, and to gather the results back to the local site.

IV. PROPOSED SYSTEM ARCHITECTURE

A service provider owns and manages resources (such as processing, memory, storage), and users access them via the Internet. For example, Amazon Web Services provides,

1) Simple Storage Service (S3): users store personal data.

2) Elastic Compute Cloud (EC2): perform computations on stored data.

There are several benefits in shifting computation from the desktop to the cloud. The primary constraints for mobile computing are limited energy and wireless bandwidth.

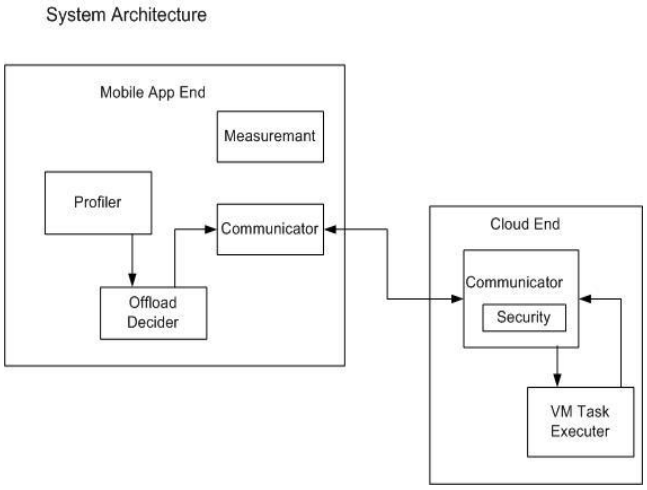

Figure 3.System architecture of proposed model

Figure 3 shows Proposed System architecture. In this model first each mobile device determines the portion of its service requests for remote processing in the cloud. Then cloud computing facilities allocate a portion of its total resources for service request processing depending on the request arrival rate from all the mobile devices. The objective of each mobile device is to minimize its power consumption as well as the service request response time. The objective of the cloud computing controller is to maximize its own profit.

As service-based implementation is adopted, for each service we can profile following metadata [15]:

- Type: whether can be offloaded or not.
- Memory cost: the memory consumption of the service on the mobile device.
- Code size: size of compiled code of service.
- Dependency information: on other services for each related module.

Also,

- Transfer size: amount of data to be transferred.
- Send size: amount of data to be sent.
- Receive size: amount of data to be received.

Offloading execution refers to a technique used to overcome the limitations of mobile phones in terms of computation, memory and battery. Such applications, which can be adaptively split and those parts offloaded are called Elastic Mobile Applications. The Elastic Mobile Applications [3]can run as standalone mobile applications, but also make use of more external resources.

Whenever the computation task needs to be offloaded, mobile communicator establishes a secure channel session to cloud, then computation tasks are remotely executed on cloud and the results are collected and stored back to mobile. The mechanism of outsourcing computational task to remote server is called Process Offloading.

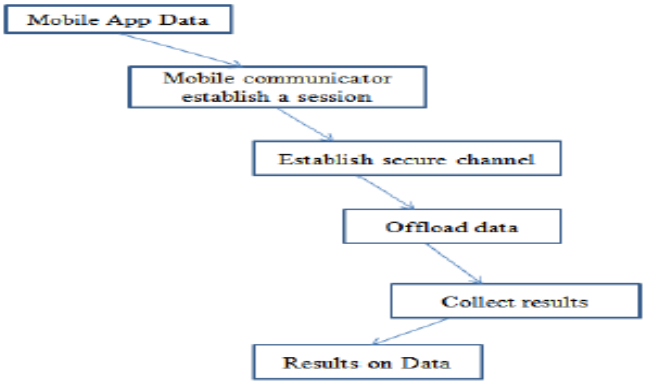

Figure 4.Control flow of offloading.

Initially consider an application model embedded on the smart phone (Android platform). The portions of the application are executed remotely and these portions are decided at runtime based on resource availability. The main objective is to extract the computation-intensive parts of the application that are developed as Android services, since the application consists of many parts or modules each of which encapsulates specific functionality. Second, the modules have different conditions/parameters, so the modules of application are divided into two portions such that, first portion of module runs locally, the other portion is run on the cloud side. This is decided by partition or decision algorithm. Third, based on the solution of the partition, the offload manager offloads parts to the remote clouds and returns the corresponding results back.

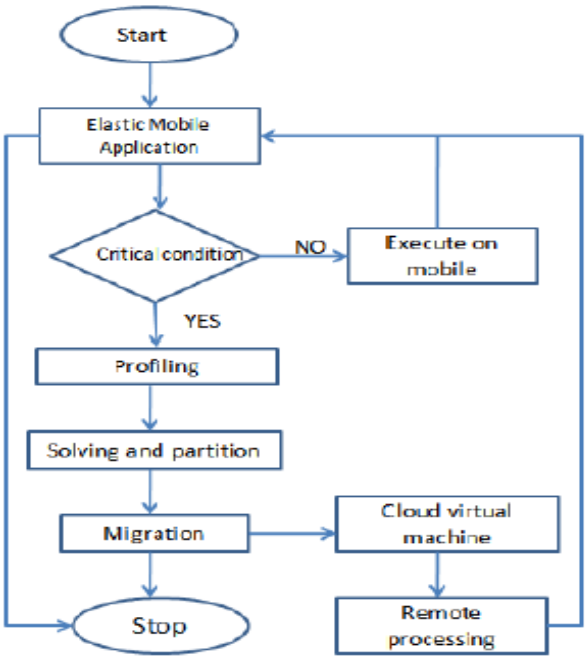

Figure 5.Partitioning Migration based Application Processing approach

STEPS:

1. Mobile applications which are attributed with the features of runtime partitioning are called Elastic Mobile Applications.
2. Critical condition: Critical condition decides the intensive parts. This critical situation indicates the unavailability of sufficient computing resources on Smart phone. Therefore, the computational intensive components of the application are separated.
3. Profiling: profiling mechanism evaluates computing resources requirements of mobile application and the availability of resources on smart phone.
4. Solving the partitions: partitions of the application are migrated to remote server node for remote processing. Upon successful execution of the remote components of the application result is returned to main application running on smart phone.
5. Finally it is important to be able to verify not only whether offloading guarantees real advantages with respect to the computing power needed for data transfer but also whether user requirements are satisfied with respect to the quality of service and the costs of using the clouds.

All the issues involved in the offloading decision, such as network disconnections and variability, data privacy and security, variations in load of the server, etc. needs to be evaluated carefully.

V. ENERGY ANALYSIS FOR COMPUTATION OFFLOADING

The analysis indicates that the energy saved by computation offloading [17] depends on the wireless bandwidth *B*, the amount of computation to be performed *C*, and the amount of data to be transmitted *D* as shown in figure 6.

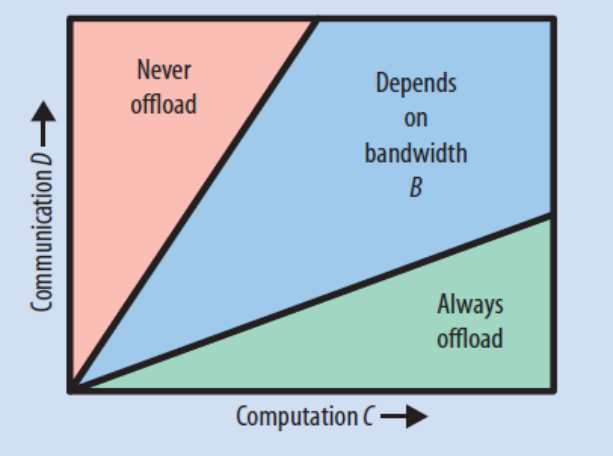

Fig.6: Analysis v/s band width, amount of computation, data transfer

Computation requires *C* instructions. Let *S* and *M* be the speeds in instructions per second of the cloud server and the mobile system respectively. Offloading is beneficial when large amounts of computation *C* are needed with relatively small amounts of communication. *D* is the minimum bandwidth required for offloading to save energy, determined by the ratio of (*D/C*). If (*D/C*) is low, then offloading can save energy.

Examples of offloading application

1. Gaming applications like chess are interesting candidates for offloading, because the amount of computation for the program to win the game depends on the skill level of the user; thus the computation depends on how the user plays the game.
2. In Mobile image processing [18] [19], image retrieval application retrieves accessing specific sets of images from the collection, and transmitting the images over a wireless network to other devices and servers for storage.
3. Context-aware computing which consists of multiple streams of data from different sources like GPS, maps, accelerometers, temperature and sensors.
4. Vision and recognition like Face recognition refers to the automatically identification of a person from a digital image.

VI. SECURITY AND PRIVACY IN CLOUD BASED APPLICATION PROCESSING

Security and privacy are very important aspects for establishing and maintaining the trust of mobile users in cloud based application processing. Privacy in the distributed platform and security of data transmission between mobile device and cloud server node are important concerns in cloud based application processing. A security mechanism is required for ensuring the integrity of communication between smart phone and Cloud server. Application is partitioned into weblets and migrated dynamically between mobile device and remote cloud server. A mechanism for the authentication and authorization of weblets migration and reintegration and provides support for synchronization between application on mobile device and weblets running on cloud node. Data transmission over the wireless networks is highly vulnerable to network security threats. Secure transmission of the entire components of the application is a challenging issue.

- One possible solution is to encrypt data before storage. This can prevent unauthorized access even when the storage is breached in the cloud; the cloud vendor cannot access the data.
- Another possible privacy and security solution is to use a technique called Steganography. Steganographic techniques [20] can be used to transform the data so that operations can be performed without exposing them.

Performing encryption or steganographic techniques before sending data to the cloud requires some additional processing on the mobile system and consumes additional energy. Image processing is computation-intensive and a good candidate for offloading.

VII. CONCLUSION

In this paper we have focused on computation offloading, which can be used to save energy for the battery powered devices. Cloud computing can potentially save energy for mobile users. In this paper we have proposed a model by using virtualization and application partition method and have provided the overview of offloading decisions regarding whether and what computation needs to be migrated to cloud and about energy analyzing factors. Finally we have explained issues about the Security and Privacy in Cloud Based Application Processing with encryption and data hiding to improve the security and reduce the size of secret data process.

REFERENCES

[1] R. Buyya, C. Yeo, S. Venugopal, J. Broberg, and I. Brandic, "Cloud computing and emerging it platforms: Vision, hype, and reality for delivering computing as the 5th utility," *Future Generation computer systems*, vol. 25, no. 6, pp. 599–616, 2009.

[2] A. Fox, R. Griffith *et al.*, "Above the clouds: A berkeley view of cloud computing," *Dept. Electrical Eng. and Comput. Sciences, University of California, Berkeley, Tech. Rep. UCB/EECS*, vol. 28, 2009. M. Creeger, "CTO Roundtable: Cloud Computing," *ACM Queue*, June 2009, pp. 1-2.

[3] S. Jeong, X. Zhang, A. Kunjithapatham, and S. Gibbs, "Towards an elastic application model for augmenting computing capabilities of mobile platforms," Mobile Wireless Middleware, Operating Systems, and Applications, pp. 161–174, 2010..

[4] Amazon s3. [Online]. Available:http://status.aws.amazon.com/s3-20080720.html

[5] Dropbox. [Online]. Available:http://www.dropbox.com

[6] S. Abolfazli, Z. Sanaei, and A. Gani, "Mobile cloud computing: A review on smartphone augmentation approaches," in *Proc. 1st International Conference on Computing, Information Systems and Communications*, 2012.

[7] WANG, C., AND LI, Z. A computation offloading scheme on handheld devices. *J. Parallel Distrib. Comput. 64*, 6 (2004), 740–746.

[8] R. Kemp, N. Palmer, T. Kielmann, and H. Bal, "The smartphone and the cloud: Power to the user," in MobiCloud, vol. 28, October 2010.S.

[9] Hung, T. Kuo, C. Shih, J. Shieh, C. Lee, C. Chang, and J. Wei, "A cloud-based virtualized execution environment for mobile applications," *ZTE Communications*, vol. 9, no. 1, pp. 15–21, 2011.

[10] G. Huerta-Canepa and D. Lee, "A virtual cloud computing provider for mobile devices," in *Proc. 1st ACM Workshop on Mobile Cloud Computing & Services: Social Networks and Beyond*. ACM, 2010, p. 6.

[11] Q. Liu, X. Jian, J. Hu, H. Zhao, and S. Zhang, "An optimized solution for mobile environment using mobile cloud computing," in *Wireless Communications, Networking and Mobile Computing, 2009. WiCom'09. 5th International Conference on*. IEEE, 2009, pp. 1–5.

[12] Esa Hyyti¨A, Thrasyvoulos Spyropoulos, J¨Org Ott "Optimizing Offloading Strategies In Mobile Cloud Computing" In Mobilecloud Computing, 2012.

[13] H. Dinh, C. Lee, D. Niyato, and P. Wang, "A survey of mobile cloud computing: architecture, applications, and approaches," *Wireless Communications and Mobile Computing*, 2011.

[14] S. Abolfazli, Z. Sanaei, and A. Gani, "Mobile cloud computing: A review on smartphone augmentation approaches," in *Proc. 1st International Conference on Computing, Information Systems and Communications*, 2012.

[15] Dejan Kovachev And Ralf Klamma , "Framework For Computation Offloading In Mobile Cloud Computing"In *International Journal Of Artificial Intelligence And Interactive Multimedia, Vol. 1, 2012*

[16] J. Liu, K. Kumar, and Y. Lu, "Tradeoff between energy savings and privacy protection in computation offloading," in *Proc. 16th ACM/IEEE international symposium on Low power electronics and design*. ACM, 2010, pp. 213–218.

[17] K. Kumar and Y. H. Lu, "Cloud computing for mobile users: Can offloading computation save energy?" IEEE Computer, vol. 43, no. 4, pp. 51–56, April 2010.

[18] J. Yang et al., "A Fast Image Retrieval System Using Index Lookup Table on Mobile Device," *Proc. 19th Int'l Conf. Pattern Recognition* (ICPR 08), IEEE Press, 2008, pp. 265-271.

[19] Y-J. Hong, K. Kumar, and Y-H. Lu, "Energy-Efficient Content Based Image Retrieval for Mobile Systems," *Proc. IEEE Int'l Symp. Circuits and Systems* (ISCAS 09), IEEE Press, 2009, pp. 1673-1676.

[20] D. Wu and W. Tsai, "A steganographic method for images by pixel-value differencing," *Pattern Recognition Letters*, vol. 24, no. 9, pp. 1613–1626,2003