IMPROVEMENT OF THE OFFLOADING DECISION IN MOBILE CLOUD COMPUTING

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***Abstract*—** Cloud computing could be an innovation that uses the web & local remote servers watch out to keep up the information & functions. Cloud computing licenses buyers & in addition organizations to utilize functions while not establishment & contact their own documents at any pc by web contact. Off-loading in its humble relations can be defined as the instrument of subdividing an submission into off loadable and non-off loadable segments seeing various structures and then at all executing the off loadable segments. Offloading has converted a hopeful technique to increase the competences of reserve controlled mobile strategies by permitting smart phones to offload computationally concentrated workload to servers. Request dividing separations the implementations into native and distant parts. Finished optimal partitioning, the man oeuvre can obtain the record profit from computation offloading. Due to uneven resources at the wireless network and at the package nodes (dissimilar speed of the mobile expedient and cloud server, memory, etc.), static subdividing resolutions in former work with motionless bandwidth and speediness traditions are unbenifitting for mobile offloading systems. In this thesis, we study how to efficiently and vigorously partition a given submission into local and remote parts, while possession the total cost as unimportant as possible. We offer EM algorithm that goals attendance the optimal partitioning plan (determine which portions of the application to run on mobile devices and which helpings on cloud servers by setting a threshold value) underneath dissimilar cost replicas and mobile surroundings.
The reproduction results show that the proposed algorithm delivers a stable technique with low time difficulty which can significantly lessen execution time and energy consumption by optimally issuing tasks between mobile campaigns and cloud servers, and in the interim, it can well acclimatize to environmental fluctuations, such as network agitation**.**

***Keywords*—** Mobile Cloud Computing, Offloading, Partition algorithm, Cost model.

I. INTRODUCTION

Mobile Cloud Computing is a grouping of cloud computing and mobile computing. In today's time where everything is in the development and growing phase, simple mobile phones are renewed to smartphones with lot of additional features helpful to users. As demand is increasing so is increase of number of applications to provide user a friendly atmosphere. A user can access all applications with the access of internet while moving from one place to another. There are wide variety of interfaces by which computation is done for example Android, Ios etc. They also come with certain limitations of high processing speed, huge battery and some more hardware constraints. Offloading has converted a hopeful technique to increase the competences of reserve controlled mobile strategies by permitting smartphones to offload computationally concentrated workload to servers. Though computational offloading, which appeared around 1970s, is not a brand new perception, its probable has never been so expansively discovered until innovative wireless communication and high-speed Internet can necessarily maintenance it without expressively corrupting the user knowledge. Cloud computing, which was a different method to explore the potential of universal Internet connectivity, simplifies and inspires inventions on computational offloading arrangement. Offloading calculation from reserve unnatural devices has been an area of attention for investigators. This purpose of this thesis development is to advance the supposed performance of mobile procedures by utilizing the broadband wireless connectivity of these strategies.

Types of off –loading

1. Static off loading : In standing offloading request is separated during development. In static environment, restrictions such as data size and accomplishment time which acts as determining factor for offloading are known previously. However, it is trying to know the correct completing time before the actual implementation takes place and the imprecise data can result into incompetent offloading consequence.[24]
2. Dynamic offloading : Dynamic system environment means varying assembly status and bandwidth that disturb the process of offloading. By the period dynamic offloading we uncaring that the modules may be relocated for completing onto cloud when the request is running. [25]

II. COMPUTATION OFFLOADING

By offloading computation to reserve rich cloud, energy consumption on the mobile device can be saved significantly and boundaries of mobile devices can overcome, this type of discharging is known as Computation Offloading. Calculation offloading, as one of the chief recompenses of MCC, is an example/solution to recover the capability of mobile services through traveling heavy calculation tasks to commanding servers in clouds. Computation offloading yields saving liveliness for mobile devices when consecutively intensive computational services, which typically reduce a device's cordless when are run nearby [26].

- Decision Making Algorithm

The offloading-decision creation algorithms make a divesting decision. It decides whether or not to offload calculation of the application from smart phone to cloud.

These optimization dividers mobile presentations, so that their force intensive functionality is performed in the cloud, deprived of demanding the battery. In other words, the offloading choices should be made enthusiastically at run-time and nonstop adjusted in response to the hesitancies in the mobile employment environment. In this thesis, we contemporaneous a novel offloading approach those associations the advantages of the prior state of the art both in untying mobile submissions and in vigorously adapting mobile execution targets in response to vacillations in network conditions. Cloud offloading is a mobile application optimization system that makes it conceivable to device the application's energy intensive functionality in the cloud, without hard the mobile device's battery-operated.[27].

III. PROBLEM FORMULATION

In Previous work, process is offloading physically by user thus static offloading takes place. Offloading choice depend on the previous task, that's why preserving the previous task information takes more time for processing and has to be maintained . Further we analyse that the offloading which depends on the prediction model and it gives some time error when we take wrong prediction.

In previous work, maximum offloading decision is static and does not depend on the task.

IV. RELATED WORK

Li.Z, Wang.C, Xu.R[16] largess an offloading arrangement founded on profiling info about calculation time and data sharing at the level of process calls. A cost graph is created and a branch-and-bound algorithm is functional to minimalize the total energy consumption of subtraction and the total data statement cost. However, the writers did not show the experimentation consequences in a dynamic situation such as network discontinuation and bandwidth variations (high to low bandwidth).

Ashok, Ashwin et al.,[17] presents a totalling offloading organization on mobile devices and proposes a polynomial time procedure to find an optimum program partition. Both the static info and the run-time material were used. The projected scheme partitioned a program into the disseminated subprograms (which run on a manoeuvre and a server) by creating a database abstraction. In this case, all corporeal memory orientations were charted into the positions of abstract memory locations. The program abstraction is generated at a runtime based on pointer examination techniques. The program concept is divided into clusters by gathering analysis and an experiential algorithm is real-world into bunches to find the optimal separator to diminish the performance cost of the package.

Miettinen.A, Nurminen .J[18] The writers replicate dynamism fitness problem. The reason behind this is that mobile strategies are energy compulsory and they lack enough capitals. They offer a check of the critical matters touching the vigour feasting of movable clients in cloud computing. More, they present dimensions about the central characteristics of current mobile handheld devices that outline the basic poise between local and remote figuring. They also define a concrete sample, which validates energy savings. They studied the energy feeding of mobile customers in cloud computing. There are many influences that make cloud calculating an attractive knowledge, but energy feasting is a central criterion for battery motorised devices and needs to be prudently measured for all mobile cloud computing setups. While energy can be a task for mobile cloud totalling, it is also as an occasion. Mobile cloud computing is therefore a prolific area for more study.

Kumar.K, Lu.Y[19]advise a program segregating based on the estimate of the energy feasting (announcement energy and calculation energy) before the database execution. The ideal program separating for offloading is planned based on the trade-off between the message and addition costs. The message cost depends on the size of communicated data and the network bandwidth, whereas the addition cost is impacted by the addition time. However, info such as the communiqué necessities or/and the calculation workload may change in different performance instances. Thus, optimum decisions of a program separating must be made at a runtime energetically.

Carroll.A, Heiser.G [20] Good liveliness management requires a good considerate of where and how the liveliness is used. They stem an overall energy classical of the device as a role of the main usage scenarios. This should offer a good basis for directing future energy-management research for mobile devices.

B. Chun, S. Ihm [21] Replica Cloud system mechanically transforms movable applications to advantage from the cloud. The organization is a lithe claim partition and execution runtime that allows unchanged mobile claims running in a submission level virtual machine to cleanly off load part of their accomplishment from mobile diplomacies onto device clones operating in a computational cloud. Clone Cloud is an amalgamation of static analysis and active profiling. It wall applications automatically at a fine granularity while reducing execution time and energy use for a target computation and announcement environment. At runtime, the application partitioning is enhanced by migrating a thread from the mobile device at a chosen point to the clone in the cloud, executing there for the outstanding part of the partition, and reintegrating the migrated strand back to the mobile device. Clone Cloud can adapt application separating to various environments, and can help few applications achieve as much as an execution speed up and a decrease of energy ingesting on the mobile device. Clone Cloud transports the power of Cloud Calculating to your smart phones. History based profiling is used. But real Network and device conditions cannot be generalized.Pre-calculated walls cannot cover all the unburdening setups.

H. Dinh,C. Lee [22]give a review of MCC, which helps over-all booklovers have an impression of the MCC counting the meaning, construction, and requests. The novelists list

numerous investigation issues in MCC, which are associated to the mobile communication and Cloud Calculating such as questions in mobile message side and in computing side**.** They incline to concentration on the operation of optimization practices such as virtualization and association on estimating cloud computing data centres characteristics that straight or circuitously have impression on liveliness matters.

V. DESIGN AND IMPLEMENTATION

In this offloading is done using optimal partitioning algorithm and EM (Expectation Maximization) is used for optimization. Three models are deployed namely cost model, energy model and weighted model.

Offloading is performed in all the three models and comparison on basis of energy consumption and time taken is calculated is analyzed.

a) Cost Model

In Cost Model, firstly the number of nodes are initialized and task is input in the graph form. This model does not have any information of the previous task and random partitioning is done. Results are analyzed and decision to offload task is taken on the basis of present cost of communication at the moment.

b) Energy Model

In this model , the input is provided in the graph form and the task is parsed for offloading . This model has previous task information in the form of energy and thus it reads the energy consumed and takes decision of offloading by applying partition algorithm. The tasks previously using more battery are offloaded on to cloud rest are processed on the mobile phone.

c) Weighted Model

In the Weighted time and energy model proposed in the paper the nodes are input of the task and graph and we have cost and resources requirement then the optimal partitioning algorithm is applied , threshold is set dynamically by EM approach to get the best optimized results after that the energy consumption of the mobile and the time taken is analysed.

Offloading is performed and results are shown on the genymotion emulator which develops the androis application and takes cloud as the PC of the user.

VI. RESULT ANALYSIS

In this paper we propose a technique for making the computation of applications running on smart phones to offload automatically from mobile to cloud via internet after analyzing the cost of offloading over the cost of running the application on the phone. The offloading decision is dynamically taken by adaptive partition of task using EM(Exceptional Maximization) algorithm and analysis the response time, energy consumption on mobile phone.

According to the proposed model the results are computed and energy and time consumed is shown . It also shows the results of the proposed model as the best results in comparison with other two models using different algorithm.

Comparison in three deployed models is done and analyzed that the proposed algorithm gives the best results.

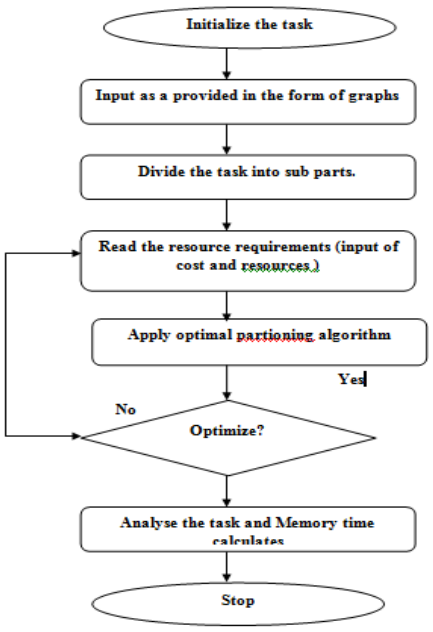
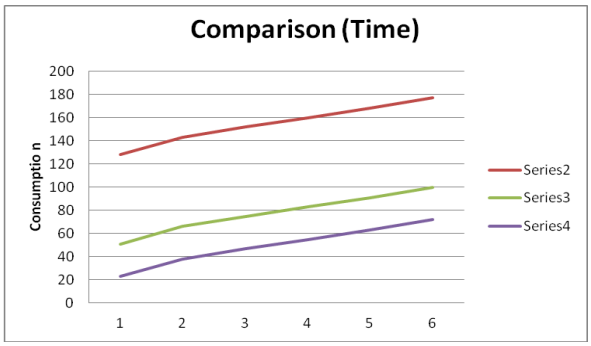


Fig 12 Flow chart of Weighted model

1. On basis of time Taken

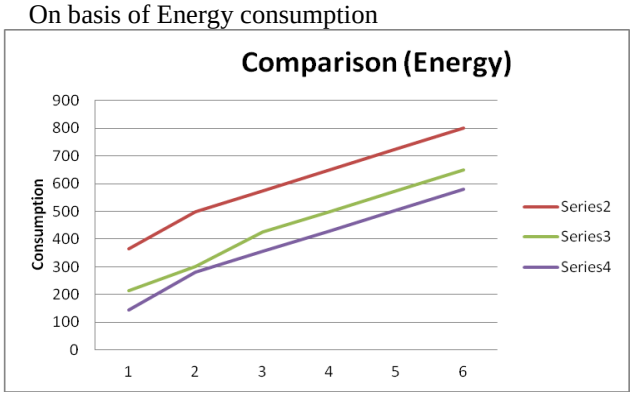


Series 2 shows time taken by the cost model in which the offloading is done completely independent to information of previous task and applying partitioning algorithm.

Series 3 shows time taken by the enrgy model which uses information of energy from previous task and thus better than the cost model.

Series 4 shows the time taken by the proposed weighted model which uses the optimal partitioning algo and the time is saved thus proving the computation speed on the processor of the mobile increases and tasks are offloaded to cloud .

2. On basis of Energy consumption



Series 2 shows the battery consumed by the cost model .
Series 3 shows the energy saved on mobile by the energy model.
Series 4 shows the results of the proposed weighted model on basis of energy and hence proved that maximum tasks are offloaded dynamically whn task is loaded and saves maximum battery on the phone.

VII. CONCLUSION

Spreading the competences of smart phones is conceivable by task offloading to the cloud. However, approximating the energy expended in task offloading is critical to making task offloading valuable, which chances only when the energy expended in the offloading process is less than the energy disbursed without it. Therefore, the main experiment in task offloading is to evaluation correctly the energy consumed and time consumption during the network events of *task offloading. In this work, we advanced accurate cost, energy and weighted models to estimate this energy consumption. This accurateness is further improved by the use of a weighted model that services probabilistic supply functions rather than the usually used fixed weight averages.
These purposes can be projected for numerous issues that may touch the offloading choice. These issues include the user's actions while interrelating with the request as well as the fundamental network circumstances. Using these purposes, an original offloading algorithm is also familiarized to optimally choice which mechanisms of the application can be offloaded to the cloud in order to adjust a given impartial. We apply for optimal partial algorithm to improve the performance parameters like; Time consumption, cost computation, energy consumptions. In the future , the Computation offloading can be done by selecting various other parameters like bandwidth, network situation , mobile requests . It can also calculate the memory used or optimize the results by using various hybrid algorithms. Different optimization techniques can also be used instead of EM algorithm.

VIII. REFERENCES

[1]. VasiliosAndrikopoulos, Zhe Song, Frank Leymann, "Supporting the Migration of functions to the Cloud through a Decision Support System", Institute of Architecture of function Systems, IEEE, pp. 565-672, 2013.
[2]. Haitao Li, LiliZhong, Jiangchuan Li, , Bo Li, KeXu, " Cost-effective Partial Migration of VoD Services toContent Clouds", 2011 IEEE 4th International Conference on Cloud Computing, pp. 203-110, 2011.
[3]. C. Ward, N. Aravamudan, K. Bhattacharya, K. Cheng, R. Filepp, R. Kearney, B. Peterson, L. Shwartz, C. C. Young, "Workload Migration into Clouds – Challenges, Experiences, Opportunities", 2010 IEEE 3rd International Conference on Cloud Computing, pp. 164-171, 2010.
[4]. Kangkang Li, HuanyangZheng, & JieWu . "Migration-based Virtual Machine Placement in Cloud Systems", 2013 IEEE 2nd International Conference on Cloud Networking (CloudNet, IEEE, pp. 83-90, 2013.
[5]. Jianxin Li, Yu Jia a, Lu Liub, TianyuWoa, " CyberLiveApp: A secure sharing & migration approach for live virtual desktop functions in a cloud environment, Elsevier, Vol. 29, pp.334-340, 2013.
[6]. R. Maggiani, "Cloud computing is changing how we communicate," 2009 IEEE International Professional Communication Conference, IPCC 2009,Waikiki, HI, United states ,pp 1, July 2009.
[7]. J.Srinivasan "Impact of information base security in Cloud Computing idée 2013236 2010.
[8]. Mehta, Piyush. "Data DeDuplication Using Optimized Fingerprint Lookup Method for Cloud Storage." Computer Engineering & Information Technology Journal 1.04 (2015).
[9]. Dongfang Zhao, KanQiao, IoanRaic, "HyCache: Towards Scalable High-Performance Caching Middleware for Parallel File Systems", Office of Science of the U.S. Department of Energy under contract DE-AC02-06CH11357, 2014.
[10]. Monjur Ahmed & Mohammad Ashraf Hossain, "CLOUD COMPUTING & SECURITY ISSUES IN THE CLOUD" International Journal of Network Security & Its Applications (IJNSA), Vol.6, No.1, January 2014.
[11]. Vasilios Andrikopoulos, Zhe Song, Frank Leymann , "Supporting the Migration of Applications to the Cloud through a Decision Support System", Institute of Architecture of Application Systems, IEEE, pp. 565-672, 2013.
[12]. Kangkang Li, Huanyang Zheng, & Jie Wu . "Migration-based Virtual Machine Placement in Cloud Systems", 2013 IEEE 2nd International Conference on Cloud Networking (CloudNet, IEEE, pp. 83-90, 2013.
[13]. Jianxin Li, Yu Jia a, Lu Liub, Tianyu Woa, " CyberLiveApp: A secure sharing & migration approach for live virtual desktop applications in a cloud environment, Elsevier, Vol. 29, pp.334-340, 2013.
[14]. Virendra Singh Kushwah*, Aradhana Saxena, "A Security approach for information Migration in Cloud Computing", International Journal of Scientific & Research Publications, Volume 3, Issue 5, pp. 1-9, May 2013
[15]. Vinodha, "Secure Migration of Various information base over A Cross Platform Environment, an International Journal Of Engineering & Computer Science ISSN: 2319-7242 Volume 2 Issue 4 April, 2013.
[16]. Li, Zhiyuan, Cheng Wang, and Rong 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, pp. 238-246. ACM, 2001.
[17]. Ashok, Ashwin, Peter Steenkiste, and Fan Bai. "Enabling vehicular applications using cloud services through adaptive computation offloading." In Proceedings of the 6th International Workshop on Mobile Cloud Computing and Services, pp. 1-7. ACM, 2015.

[18]. Miettinen, Antti P., and Jukka K. Nurminen. "Energy Efficiency of Mobile Clients in Cloud Computing." HotCloud 10 (2010): 4-4.
[19]. Kumar, Karthik, and Yung-Hsiang Lu. "Cloud computing for mobile users: Can offloading computation save energy?." Computer 43, no. 4 (2010): 51-56.
[20]. Carroll, Aaron, and Gernot Heiser. "An Analysis of Power Consumption in a Smartphone." In USENIX annual technical conference, vol. 14. 2010.
[21]. Chun, Byung-Gon, Sunghwan Ihm, Petros Maniatis, Mayur Naik, and Ashwin Patti. "Clonecloud: elastic execution between mobile device and cloud." InProceedings of the sixth conference on Computer systems, pp. 301-314. ACM, 2011.
[22]. Dinh, Hoang T., Chonho Lee, Dusit Niyato, and Ping Wang. "A survey of mobile cloud computing: architecture, applications, and approaches."Wireless communications and mobile computing 13, no. 18 (2013): 1587-1611.
[23]. Calheiros, Rodrigo N., Rajiv Ranjan, Anton Beloglazov, César AF De Rose, and Rajkumar Buyya. "CloudSim: a toolkit for modeling and simulation of cloud computing environments and evaluation of resource provisioning algorithms." Software: Practice and Experience 41, no. 1 (2011): 23-50.
[24]. Woods, Louis, Zsolt István, and Gustavo Alonso. "Ibex: an intelligent storage engine with support for advanced SQL offloading." Proceedings of the VLDB Endowment 7, no. 11 (2014): 963-974.
[25]. Kosta, Sokol, Andrius Aucinas, Pan Hui, Richard Mortier, and Xinwen Zhang. "Thinkair: Dynamic resource allocation and parallel execution in the cloud for mobile code offloading." In INFOCOM, 2012 Proceedings IEEE, pp. 945-953. IEEE, 2012.
[26]. Ou, Shumao, Kun Yang, and Antonio Liotta. "An adaptive multi-constraint partitioning algorithm for offloading in pervasive systems." In Fourth Annual IEEE International Conference on Pervasive Computing and Communications (PERCOM'06), pp. 10-pp. IEEE, 2006.
[27]. Flores, Huber, Satish Narayana Srirama, and Carlos Paniagua. "A generic middleware framework for handling process intensive hybrid cloud services from mobiles." In Proceedings of the 9th International Conference on Advances in Mobile Computing and Multimedia, pp. 87-94. ACM, 2011.
[28]. Barbera, Marco V., Sokol Kosta, Alessandro Mei, and Julinda Stefa. "To offload or not to offload? the bandwidth and energy costs of mobile cloud computing." In INFOCOM, 2013 Proceedings IEEE, pp. 1285-1293. IEEE, 2013.
[29]. Gu, Xiaohui, Klara Nahrstedt, Alan Messer, Ira Greenberg, and Dejan Milojicic. "Adaptive offloading for pervasive computing." IEEE Pervasive Computing 3, no. 3 (2004): 66-73.
[30]. Kumar, Karthik, Jibang Liu, Yung-Hsiang Lu, and Bharat Bhargava. "A survey of computation offloading for mobile systems." Mobile Networks and Applications 18, no. 1 (2013): 129-140.
[31]. Sinha, Kanad, and Milind Kulkarni. "Techniques for fine-grained, multi-site computation offloading." In Proceedings of the 2011 11th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing, pp. 184-194. IEEE Computer Society, 2011.
[32]. Lin, Ying-Dar, Edward T-H. Chu, Yuan-Cheng Lai, and Ting-Jun Huang. "Time-and-energy-aware computation offloading in handheld devices to coprocessors and clouds." IEEE Systems Journal 9, no. 2 (2015): 393-405.
[33]. Kemp, Roelof, Nicholas Palmer, Thilo Kielmann, and Henri Bal. "Cuckoo: a computation offloading framework for smartphones." In International Conference on Mobile Computing, Applications, and Services, pp. 59-79. Springer Berlin Heidelberg, 2010.
[34]. Klionsky, Daniel J., Fabio C. Abdalla, Hagai Abeliovich, Robert T. Abraham, Abraham Acevedo-Arozena, Khosrow Adeli, Lotta Agholme et al. "Guidelines for the use and interpretation of assays for monitoring autophagy."Autophagy 8, no. 4 (2012): 445-544.
[35]. Kaur, Kirandeep, Meenakshi Jain, Tarandeep Kaur, and Rahul Jain. "Antimalarials from nature." Bioorganic & medicinal chemistry 17, no. 9 (2009): 3229-3256.
[36]. Kwon, Young-Woo, and Eli Tilevich. "Energy-efficient and fault-tolerant distributed mobile execution." In Distributed Computing Systems (ICDCS), 2012 IEEE 32nd International Conference on, pp. 586-595. IEEE, 2012.
[37]. Han, Bo, Pan Hui, VS Anil Kumar, Madhav V. Marathe, Jianhua Shao, and Aravind Srinivasan. "Mobile data offloading through opportunistic communications and social participation." IEEE Transactions on Mobile Computing 11, no. 5 (2012): 821-834.
[38]. Xia, Feng, Fangwei Ding, Jie Li, Xiangjie Kong, Laurence T. Yang, and Jianhua Ma. "Phone2Cloud: Exploiting computation offloading for energy saving on smartphones in mobile cloud computing." Information Systems Frontiers 16, no. 1 (2014): 95-111.
[39]. Segata, Michele, Bastian Bloessl, Christoph Sommer, and Falko Dressler. "Towards energy efficient smart phone applications: Energy models for offloading tasks into the cloud." In 2014 IEEE International Conference on Communications (ICC), pp. 2394-2399. IEEE, 2014.