Journal of Theoretical and Applied Information Technology
30th June 2017. Vol.95. No 12
© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

DYNAMIC ENERGY OPTIMIZATION TECHNIQUE IN MOBILE CLOUDLET FOR MOBILE CLOUD COMPUTING USING EFFECTIVE OFFLOADING ALGORITHM

[1]P. PRIYA, DR.S.P.SHANTHARAJAH[2]

[1]Research Scholar, Department of Computer Science, Research and Development Centre, Bharathiar University, Coimbatore, Tamilnadu, India.
[2]Professor, School of Information Technology & Engineering, VIT University, Tamilnadu, India,
Email Id:[1] priyasarathy2002@gmail.com, [2] spshantharaj@gmail.com

ABSTRACT

In recent days, mobile applications are turning to be computationally intensive mainly due to its advancement, developing convenience, sophistication and reliability of the Smart phones. Mobile Cloud Computing (MCC) approach is utilized to enable mobile users in order to receive the advantages of cloud computing in a friendly manner through significant strategy for meeting the demands of the industrial requirement. However, the limitation of the device capacity and wireless bandwidth had leads to several issues such as latency delay, additionally energy waste and poor QoS while deploying MCC. To address these obstacles, we propose dynamic energy optimization in mobile cloudlet with offloading algorithm. It focuses on resolving the additional energy waste during wireless communication with minimum response time and moreover, it provides a unique approach with quality of experience/ quality of service that avoids the wastage of energy when mobile users are tolerating with complicated and unstable networking surroundings. The proposed energy optimization technique in terms of hardware (RAM & Display unit) as well as software components Wi-Fi for saving energy consumptions and decrease response time for mobile devices, clones and dynamic cloudlet. The proposed offloading algorithm is developed to decide which section offloaded can be done or whether clone or cloudlet in the devices while performing the task offloading for dynamic execution in MCC. The experimental evaluation of the Smart phones and Java server in the cloud are performed. It proved that proposed approach have saved the energy for enhancing the battery life time and improved the overall performances. The obtained results are efficient and effective for obtaining the better network type, data sizes, work load structure, computational time and energy optimization are better than the existing systems in MCC.

Keywords: *Mobile Cloud Computing (MCC), Dynamic Energy Optimization, Offloading Algorithm, Dynamic Cloudlet And Energy Model.*

1. INTRODUCTION

Mobile cloud computing (MCC) is an growth of multiple interest based technologies development, that facilitates mobile users to get the cloud computing advantages and accomplish green computing by utilizing their own mobile devices (sabharwal et al., 2013) [1]. Mobile cloud computing technology has developed from three hemispheres such as mobile internet, cloud computing and mobile computing. Merging the advantages of multiple technologies permits users offload the data processing and storage to the servers. Therefore, the disadvantages of utilizing such method, execution in the mobile cloud computing have lot of challenges and difficulties that restrict its performance like higher energy consumption when the signal is weak in the wireless communications (Guan et al., 2011) [2]. Searching the signal for reaching the mobile networks would leads to higher power consumption and extra wastage of energy required for the mobile cloud computing. It is the mixture of prototype in cloud computing and mobile computing. Many researchers have given effective techniques to offload certain jobs from the devices of the mobile towards remote cloud server for performance. This would also effectively minimize the job performance time due to the mobile devices and its energy consumption, counting whether offloading can improve the battery life cycle. Offloading must be applied whenever it is advantages to the mobile applications. Hence, jobs should only be offloaded before the servers in the cloud if the sum of the data transmission cost and energy

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

cost is very lesser while the tasks are performed based on the devices like mobiles [3].

We have investigated the existing mobile computing issues in the offloading features of the mobile applications. Several research works have been performed in this field, which is briefly divided into two types: (1) virtual machine selection and (2) job partition. In virtual machine selection requires selecting the exact virtual machine for partitioning the offloading function. For job partitioning, it needs to partition the mobile application into local partition and off-loadable partition [4]. Virtual machines are the important features of the cloud, as they give so many virtual resources like storage, memory, network interfaces and CPU in the same manner as physical resources performs. One common assumption in this research work relates to the good network connection and considering sufficient bandwidth between analysis of mobile devices and cloud servers virtual machines. This assumption is impossible in the wired networks, in which network bandwidth generally abundant in nature. Therefore, this approach is not applicable for the wireless networks [5], sometimes network considering certain amount of bandwidth is not sufficient and not even available for certain period, and these are the major issues in cellular networks like 3G.

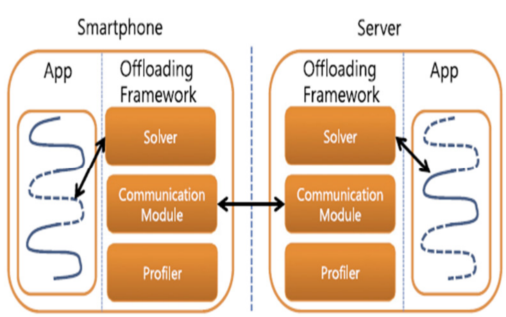

Figure .1 Offloading framework Methodology

For determining the exact accuracy in the offloading performance, we have to represent a normal offloading methodology, it is demonstrated in the figure .1. At first, the analysis of the offloading is implied to estimate which parts are remotely feasible. It is consists of two paths to discover the techniques. In first path utilize annotations inside the source code to separate these remotely feasible methods (RFMs) from the non-RFMs [3]. Next way to discover the methods is to utilize static analysis for finding the legal choices automatically for identifying migration in the code. After estimating the remotely feasible methods during an evaluation of a program on performing particularly for mobile devices, the proposed methodology freezes the running threads and determines whether to apply offloading scheme or not by utilizing solver in the present programming state. It would also estimates the overall cost, if the offloading performance is executed for cellular devices [2]. For sample, whenever a mobile user wants for faster performance, the solver estimates the costs and computational time as well as for remote and local performance time to determine a gain. Then solves concludes whether to apply the offload method only if the performance gain is greater than the cost. In case the solver determines to utilize the offload scheme, communication section for the cellular devices is preferred to add the different states of programs and then forwards as complete package to the server. While server-side communication section after obtaining the states and take out the states to renovate the runtime conditions and resume the efficiency of the proposed scheme. When the scheme accomplishes its final state, section gathers and forwards only the states, which seems to be different from original states that was obtained from the mobile device, therefore, reduction of data is required to be forwarded back to cellular devices. The communication section of the mobile devices obtains the different states output and equate them with the original states and employs the difference to its present program state [1]. At last, program is resumed with a migrated method, while a remote feasible method is performed, regardless of it being offloaded scheme; the profiler estimates the performance of the method. In offloading conditions, it estimates cost needed to transfer the state as well as the size in the transferred state [1].

Generally in local mobile clouds deals with offloading, it requires making the decision whether offloading the jobs for enhancing the advantages of offloading; also it referred as the task scheduling problems. The offloading decisions are commonly developed by examining parameters, including energy coefficients, computation speeds and job queues of all entering devices [5]. The main advantages of the offloading is applied to satisfy the stringent response time demand which is required for mobile devices, especially for real time applications like speech recognition, disaster forecast, object recognition and real-time video coding. This application normally includes larger computation utilizing small datasets. For sample, in real time moving object identification and tracking system [6], a robot needs to distinguish an object then adapt its speed and track the object direction for identifying its movement. In case the robot's processor is poor, the recognition computation would not be capable for completing the process before it cross surveillance range.

Another advantage of using offloading, it can gain the energy for the mobile devices. Though the battery life span has been constantly developing, it was insufficient of meeting the rapid development of energy consumption in those mobile networks. Hence, offloading is also utilized to preserve energy by transmigrating the computational jobs with greater energy consumption to numerous energy efficient devices [5-6].

Several scheduling algorithms have been introduced to establish offloading decisions to minimize job completion time, it meets requirement in QoS, or to preserve energy [7]. Mostly, the scheduler should be distinguished into two categories: centralized and decentralized. The centralized scheduler are used to decide central controller depend upon the knowledge of all the participating nodes. It endures from bottleneck, single point failure and unrealistic deployment for especially for mobile environment as proposed [6]. On the second hand, the decentralized scheduling architecture can make scheduling decision for each node, which turns to be anticipating method for the local mobile devices due to the flexibility and scalability [7].

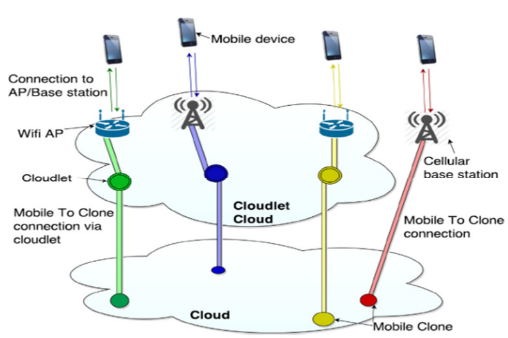

Figure.2 Cloudlet cloud architecture

2. LITERATURE REVIEW

Several scholars and researchers had done various analyzes for enhancing the energy efficiency for the mobile cloud computing. The research was various in different views (Gupta and Roy, 2013) [8]. As per to the Yang et al had presented real time applications based cloud computing that was developed to receive the energy- aware scheduling which was present in their old works. The recent solutions (Yang et al., 2014) [9] proposed to incorporate several energy- aware scheduling method based algorithm by applying a rolling- horizon optimization strategy. Moreover, this method would not take the mobility use and the related research concentrates on energy-aware cloud computing systems has been attained by various other researchers (Berl et al.,2010;Mezmaz et al.,2011;and Beloglazov & Buyya, 2010) [11-13].

Moreover, it was been important approach designed for mobile cloud computing, virtual machine is studied as an best method for developing up cloud-based data center to get the green computing (Aksanlirtal., 2012) [14]. However, virtual machine was only a service based technique that does not provide much technical innovations, even though virtual machine had been generally utilized in deploying green information industry, like green storage, data processing and transmissions (Xiao et al., 2013) [15]. The strategy behind the green computing model was used to reduce the energy consumptions, which corresponds to the very important characteristics of the green computing features like energy aware features (Mukherjee et al., 2014) [16].These techniques were accomplishing green computing, which was altered from software and hardware to management, legal issues and strategy. Our proposed methods concentrated on the technical prospects that leverage a few cloud-associated approaches such as wireless networks, virtual machines and dynamic programming.

MCC was the conceptual architecture that merges three technologies, includes mobile computing, cloud computing and mobile internet to connect mobile users to offload data collection and processing onto clouds via mobile devices and wireless networks (Lu and Kumar, 2010; Song and Su, 2011) [17]. The main aim of employing MCC was to receive the advantages in the cloud computing technologies by leveraging mobile features. The dynamic networking environment would leads more toughest implementations and deployments, equating with cloud computing.

In older method, the researchers had analyzed the advantages of various offloading applications, considering cloudlets and clone cloud. These previous works has demonstrated a system architecture to reduce the high energy utilization for the mobile device. Even though they analyzed performance analysis by using the benchmarks, the analysis of offloading policy is restricted [14-15]. On the other method, certain work has described about the offloading policy solutions, suggested the offloading policy to reduce the energy consumption in the static network for the mobile devices, that required to identify the network. MAUI [13] viewed a technique as the implementation unit and offered a more effective offloading policy. It has given a conceptualization of 0-1 integer linear programming to determine at compile time in which these strategies would be remotely performed to optimize the energy consumption. In the same manner, it estimated the evaluation of each module inside the applications, by determining a cut in the consumption of energy graph for the performance. It reduced the performance of the overall execution time and the complete time taken to exchange information, but the circumstance occurred due to mobile devices in terms of energy consumption is absent . It also demonstrated about the energy prototype for MCC of the mobile devices, but without delay consideration. In this [18] system, it also presented about the offloading strategy to decrease the energy consumption for mobile devices, but it lacks of the practical applications.

Lin et al [19] has described about the context-aware algorithm, it utilizes historical log data records to estimate whether the offload was possible is not. The offloading algorithm reviews about the user position at a particular time of day while jobs were offloaded for remote performance. Mobile devices and their energy consumption can be higher if the job is offloaded then previous offloading was smaller than current one. While it was performed locally for the same geographical location at the exact time. This methodology trust on the historical recorded data which would not be reasonable for the current conditions and could causes to inaccurate to offloading decisions.

Barbera et al [20] had represented about the architecture where mobile devices was associated to cloud computing especially in software clone, it has given a exact analysis regarding offloading costs and feasibility in order of extracting energy consumption and bandwidth for the mobile devices. The first foremost observation is that almost 50% of the time users were associated to a WiFi access point. Next, synchronizing back-clones (for backup functions) involved with lesser network traffic conditions and produce the less energy consumption than synchronizing off- clones (that deal mobile computation offload). In this method, they concentrate on toughest issue. Lu and Kumar had presented elementary but it is efficient formula for energy models associated in computation offloading [17]. As per that formula, offloading was effectively suitable for the energy evaluation including the cost compensation and its speed up transmitting data in the cloud.

Han et al. [21] had recommended migrating elements in the mobile applications, in which it obtains lower energy consumption completely resides on normal client-server architecture. Their performance was depend on simulations. However, their research work does not consider about cloud computing environment and have not represented how to obtain dynamic partitioning in the mobile application at any order. Liu and Lu et [22] had examined about the saving the energy in the mobile devices using the privacy preserving based offloading computational algorithm. They had utilized homographic encryption scheme for defending an image retrieval application that was processed on mobile cloud. They simulated results has concluded that obtained the energy saving and extra security mechanism does not inevitably compromise these gains. Their outcomes would not react dynamically performed for cloud computing environment.

Satyanarayanan et al [23] had analyzed the problems in broad range, how the problems can be transformed onto trivial jobs utilizing real-time mobile cognitive assistance where sensing data capacities were merged together with the compute-intensive process analysis of cloud especially due to mobile devices. Cloudlets were demonstrated as important elements for illustrating the middle tier of a three-tier hierarchy, which is demonstrated to receive mobile devices – cloudlet-cloud. It might be

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

conceived as information centers and main goal is to enhance latency for the cloud users. This kind of method needs deployed widely to make viable for the cloud of servers but in reality it is quiet impossible. The cuervo et al [24] had demonstrated about the advantages of tiered-clouds to enhance scalability and performance of smart phones. They also mainly consider the parameters like energy consumption, mobile device cost, and delay to determine an optimal partitioning approach between tiered cloud architectures and smart phones. They introduced an efficient heuristic algorithm for the two-tier mobile cloud with expensive mobile apps like MuSIC and testedon are executed for smart phones. They represents that MuSIC supports larger scalable functions and provides high performance of smart phones.

In corral [25], had represented about the cloud-hosted middleware layer, which was proposed to develop the mobile user communication with the cloud. This proposed layer was considered as the interface between the phone and the cloud. It provides additional features such as protocol transformation, message optimization and request/response development. Choi et al. [26] had demonstrated about the advantages of "cloud parallel process" methodology to handle significantly with higher volumes of unstructured data. The gadget and effectiveness of their proposed methods were verified through the design, execution, and experimental valuation based mobile cloud computing approach that used open sources for the distributed computing framework.

3. RESEARCH METHODOLOGY

In this research, we propose a dynamic energy optimization in mobile cloudlet with efficient offloading scheme concentrates on resolving the additionally energy consumption, it determines whether to offload to a cloudlet or a clone. The precise decision making methods includes energy consumption based on job performance and the network condition while performing the specific job response time constraints. In proposed efficient offloading scheme, it accesses its performance in the rejected tasks in order to obtain the energy consumption from the rejected jobs. Generally, rejected tasks are in capable to satisfy the energy efficiency and (QoE). By employing this method, it determines the precise power required for the application while performing on the remotely, locally or hybrid (that means it performs partly infrastructure based cloud and device).

Hence, offloading algorithm can subsequently be determined at run time depend on the estimation energy consumption, it also consider the required amount in terms of energy for the mobile devices-to-cloud communication over the wireless network. Additionally, we include the data caching mechanism at cloudlets, it minimizes the traffic overload and latency delay and traffic overload to enhance the overall performance based on mobile cloud computing.

3.1 Proposed Model

In this proposed methodology, we utilize the cloudlets that are widely deployed in the dynamic programming and it is represented as the dynamic cloudlet (DCL). In MCC, cloud users sends the request for the particularly service through the VM (virtual machine) associated to the client applications, therefore the request would be significantly accomplished in the closest cloudlet. The proposed method uses the dynamic cloudlet corresponds the access points to the open Wi-Fi. Before passing the service request to the mobile cloud, majority of the calculation for the resource allocation would be estimated in dynamic cloudlet as per the business strategy.

In our proposed model, we create the advancement deployment model, dynamic energy optimization in mobile cloudlet with an energy model in the offloading strategy, it provides a novel technique that it would avoids the wastage of energy when a mobile users are tolerating with complicated and unstable networking surroundings. This methodology concentrates on providing best communication between cloud servers as well as mobile users.

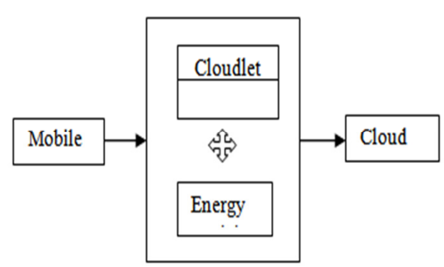

Figure .3 Block Diagram Representation

Journal of Theoretical and Applied Information Technology
30th June 2017. Vol.95. No 12
© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

In the figure .3, it represents about the block diagram. The important modules in the new design are given as mobile devices module, cloudlet with dynamic searching including energy model for the offloading scheme module and cloud computing module. The relationship occurring between the dynamic cloudlet and energy model based offloading scheme, it eliminates the energy wastage occurring due to the rejected jobs in the cloudlets and it makes precise decision in estimating the energy required applications in mobile with the help of offloading strategy.

3.2 Dynamic Cloudlet Searching

In this scenario, we consider that mobile users are utilizing an application that is a meant for the real time conversances alarm system when users are moving between two places. The system provides the services which permits the mobile user to understand about the conversances and that identifies the nearby users who utilize the same application for mobile phones. In older method, mobile devices would directly communicate to the server on the wireless networks. This method holds the communication in the box comprising the particular mobile devices and cloud services until the connections or signal becomes disconnected or weak.

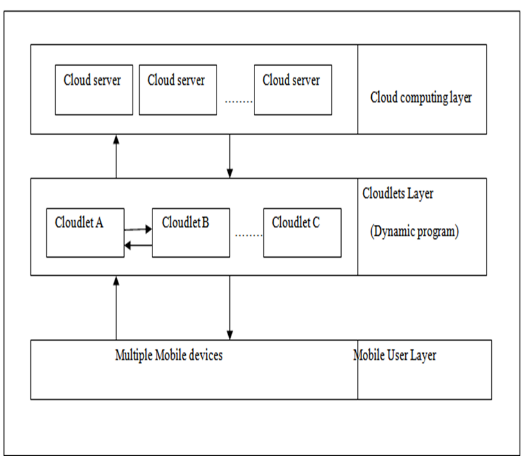

Figure 4. Proposed Architecture

The proposed idea provides the dynamic wireless communication that applies cloudlet Layers to dynamically choose and estimate the very nearby and significant cloud servers send on the business strategy. It is demonstrated in the fig.4, work flow of the proposed mechanism that demonstrates dynamic searching in the cloudlet and its relationship between the cloud servers and mobile devices.

As described in the fig. 4, mobile devices is generally termed as a mobile user layer, it intercommunicate with cloudlets layer by exploring the closest cloudlet layer when the mobile users are performing on the cloud services. Cloudlet A that is accepted the closest cloudlet from the starting of the service does the computation depend on the business logic and start anticipating other possible cloudlet services as per to the service contents like dynamic service request and various locations. Once cloudlet A affirms that cloudlet B can provide a best service execution especially due to criteria, like networking and geographical distance conditions, cloudlet B is proved to be an efficient service provider and hence the maximum connected are preferable switches in cloudlet B.

However, as we described in the earlier section, cloudlets are mainly reason for exploring the nearest cloud server for providing the best and significant performance so that the service overall energy consumption and cost would be minimum. The cloudlets layer communicates with the cloud computing layer, they service request and response would be held in dynamic manner. The cloud server would give physical services that is selected and fixed by the cloudlets. It is illustrated in the fig 4. The beginning or starting point indicates where the service request being forwarded with the position. The various positions in mobile devices would detect the users along with their location on the service delivery procedure.

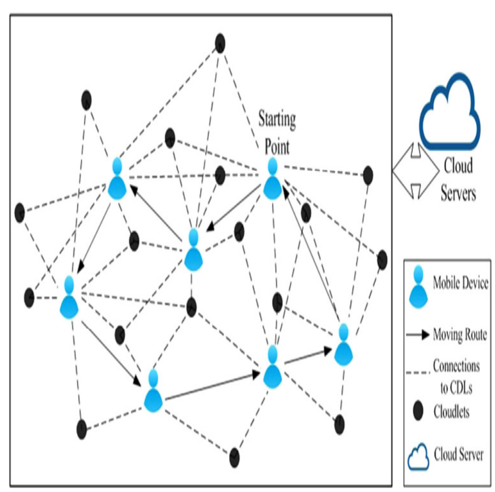

Figure .5 Proposed diagram

© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

The positions are indicated by the solid arrow lines, which represents the possible route to the users. Cloudlets are presented by the solid black dots that illustrates about the possible service providers by associating the mobile devices. They may be huge number of cloudlets available closer to the devices that is involving the dynamic environment. The possible communication in the cloudlets is represented by the broken lines, that connects straightly to the cloud- based service execution between the cloudlets and devices of mobiles and hence, it is demonstrated in the Figure .5, estimated by the dynamic programming for receiving the energy optimization as well as the best service performance.

3.4 Energy Model Based Offloading Algorithm In Dynamic Cloudlet

Generally the hardware elements required in the energy model design are CPU, RAM, display unit, sensors and the network interface. To estimate the precise energy required for the elements, the activity state of each elements should be the changed between the two utmost states when maintaining the consumption of energy steadily on other elements. We concentrates on hardware elements influenced by the offloading decision such as Wi-Fi, RAM (memory usage) and CPU, moreover it has some barred elements that cannot be considered for offloading (for example camera, Bluetooth, storage device, GPS and audio). In this proposed module of consumption of energy, overall cost $C_{total}(T, y)$ of the major elements are estimated below they are:

At first section, consumption in the energy of mobile users, cloud servers as well cloudlets particularly happens at a single route, is termed as a $E_i(t, y)$. A desired route is called as the preference choice of cloudlets performance. Furthermore, it includes the services execution, on the other method performance stage is indicated as $P_i(t, y)$ that placed on single route y for one particular operating time unit t. This scene is analyzed for avoiding the diminution of service quality when choosing an energy ware based route. The main goal of the newly designed system is to receive the very minimum energy consumption within a particular time duration that is most commonly called as workload designing time. Therefore, minimum energy consumption problem can be developed into the upcoming equation:

$$\text{Minimize} \quad C_{total}(T, y) \quad (\forall T \in R^{+}; \forall y \in N) \tag{1}$$

The complete energy consumption is defined as the sum of the products of the each elements energy cost along with the performance percentage categories. The equations 2 demonstrate about the technique of producing overall energy consumption. The majority of the symbols notations are explained in the table 1.

$$C_{Total}(T, y) = \sum_{x=1}^{n} f(P_i(t, y), E_i(t, y)) \quad (\forall i \in N; \forall x \in N; \forall t \in R^{+}) \tag{2}$$

The dynamic programming approach on the cloudlets intentions to choose the most significant communication between the cloud server's as well mobile devices. From the obtained results in the equation (2), we create the pour proposed offloading algorithm in this upcoming section.

The essential application of dynamic programming algorithm in the offloading strategies is to produce the algorithmic conceptualization, which minimizes the bigger issues into smaller sub problem for resolving the complete problem. By choosing the approximate solution to each and every sub problems is very important mechanism in the dynamic programming that is preferable for solving the highest complexity problems, like polynomial time issues. In this proposed methodology, is created to optimize the consumption of energy in a dynamical manner in the cloudlets.

Table 1: Variables Utilized in this Research Methodology

Variables	Description
T_{tf}	Process time for the data transmission
T_{pm}	Time required for processing in the mobile devices
T_{pc}	Time required for processing in the Cloudlet
T_{OT}	Overall time taken for the processing all the elements
E_{tf}	Energy consumption obtained from the data transmission
E_{pm}	Energy consumption obtained from

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

	mobile devices
E_{pc}	Energy consumption obtained from Cloudlets
E_{sm}	Energy consumption required for processing the mobile devices and cloudlets
E_{OT}	Energy consumption for processing all the elements
M	It represents the average speed of processing in the mobile devices
S_{CL}	It represents the average speed of processing in the cloudlet
D_{re}	Bytes of data received by the cloudlet
B_{re}	Bite rate for the receiving data packets
P_{re}	Power consumed during receiving the packets
D_{se}	Bytes of data send by the cloudlet
B_{se}	Bite rate for the sending data packets
P_{se}	Power consumed during sending the packets
C_{CL}	Amount of Computation complexity in the cloudlet
P_n	Power consumed to perform the C_{CL} in all elements
P_{idle}	Power consumed during its idle state
$E_{preserved}$	Energy preserved due to offloading strategy

At first, we illustrate with the equation 2, we consider that an efficient strategy is to constantly switch to some other cloudlet that would obtain the best service performance. As per the criteria given equation (3), so it would obtain the minimal energy consumption with better quality services can obtain from the algorithmic conceptualization. Each cloudlet performance is represented by the cost of cloudlets

Energy Cloudlet $((CL_{i,y}(C_1)) =$ cost cloudlet $[CL_{i,t}(C_1)]$

Energy cloudlet $((CL_{i,y}(C_2)) =$ cost cloudlet$[CL_{i,t}(C_2)]$ (3)

Energy cloudlet $((CL_{i,y}(C_n)) =$ cost cloudlet$[CL_{i,t}(C_n)]$

Then, with knowledge of the algorithmic conceptualization, we determine an energy unit cost function covering each dynamic cloudlet as energy cloudlet, which illustrates the complete energy costs for each cloudlet with service performance. The overall cost functions is developed is explained in the equation 4. In case scenario, they don't consider the energy cost that happened during the switching cloudlets for getting small amount of energy

$$f((P_i(t,y),E_i(t,y)) = \sum_{Y=1}^{n} Energycloudlet_{\min}(CL_{i,t}(M_i(x))$$

$$f((P_i(t,y),E_i(t,y)) = \prod_{y=1}^{n} P_i(t,x)$$

(4)

$$\forall i \in N; \forall y \in N; \forall t \in R^+; 0 < t < T$$

The consumption of energy in the elements are described in the following equations:

Time to forward, it is determined as

$$T_{tf} = \frac{D_{re}}{B_{re}} + \frac{D_{se}}{B_{se}}$$

Time to performance at mobile devices

$$T_{pm} = \frac{\sum_{n=1}^{A} C_{CL}}{M}$$

Time taken to perform in cloudlet

$$T_{pc} = \frac{\sum_{n=A+1}^{N} C_{CL}}{S_{CL}}$$

Overall time taken $T_{OT} = T_{tf} + T_{pm} + T_{pc}$

The given equations are equated with respective to energy consumption:

Energy to transmit $E_{tf} = \frac{D_{re}}{B_{re}} P_{re} + \frac{D_{se}}{B_{se}} P_{se}$

Energy to performance in the mobile devices

$$E_{pm} = \frac{\sum_{n=1}^{A} C_{CL} P_n}{M}$$

Energy to performance in the cloudlet

$$E_{pc} = \frac{\sum_{n=A+1}^{N} C_{CL} P_{idle}}{S_{CL}}$$

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Energy required for processing

$$E_{sm} = \frac{\sum_{n=A+1}^{N} C_{CL} P_n}{M}$$

Overall energy $E_{OT} = E_{tf} + E_{pm} + E_{ps}$

In this mechanism important goal is to decrease the consumption of energy by using the offloading strategy with security constraints. The following equations for saving the energy saving are given below:

$$E_{preserved} = E_{S_{CL}M} - (E_{tf} + E_{pc})$$

$$E_{preserved} = \frac{\sum_{n=1}^{A} C_{CL} P_n}{M} - \left(\left(\frac{D_{re}^n}{B_{re}} p_{re} + \frac{D_{se}^n}{B_{se}} p_{se}\right) + \frac{\sum_{n=A+1}^{N} C_{CL} P_{idle}}{S_{CL}}\right)$$

(5)

From the above equations (5), it demonstrates to the energy consumption on the mobile, if the offloading algorithm is performed on the locally (mobile data). The condition inside the digressions demonstrates the overhead obtained in the energy loss as mainly due to their offloading strategy especially for mobile cloud. The three important conditions represent to the energy loss of the forwarding data, waiting in the idle state in the cloudlet, receiving results and to finish its performance, respectively.

3.5 Energy Consumption Model

3.5.1 For Wifi

In the most of the cases the large amount in consumption of energy is happening due to the WIFI in smart phones. The energy consumed is mainly these following metric

- Number of the packets are transmitted
- Number of packets received per second
- Data rate
- Channel rate

We consider that data and channel rate are stable and constant during the experimental performance and then it is highly concentrates on the exchanged packets for per second to deduce the Wi-Fi model. It is discovered that energy model has restricted to certain condition that network connection should be stable and wireless communication's signal strength is larger enough in Wi-Fi model.

However, it is very harder to estimate the energy tradeoff in uncertain and unstable network surroundings. To overcome these issues, proposed energy model have stretched to perform in the worse network criteria, considering the observed signal strength as important parameter. By referring Ou et al (2015), Wireless Network Interface Model (WNIM) is applied in the consumption of energy module of WiFi, Where the signal strength lies under the threshold value of 80 dBm. The Wireless Network Interface Model is consists of five important energy transition states, they are Initial state, Idle state, Transmit state, Receive state and Bottom state.

In this Wireless Network Interface Model would perform based on the energy transition states for making effective consumption of energy in Wi-Fi. Generally, idle state remains to obtain low energy rate because no performance has been performed in this state. While entering from the idle state to initial state, it identifies the essential components required to transmit or receive the data. The transmit state is sub divided into two stages such as energy consumption, low and high energy state. It is relied on the total number of data packets size to be transmitted in WNIF model, where the energy state are selected accordingly in transmit state. If packet are transmitted within the given threshold value then the energy state remains to be lower rate in which it can directly transmit the date to the receive state or else data packet would be moved to the tail state, it incorporates with tail-timer for each data packets for transmitting or receive data in the model or it switches immediately from one state to another stages.

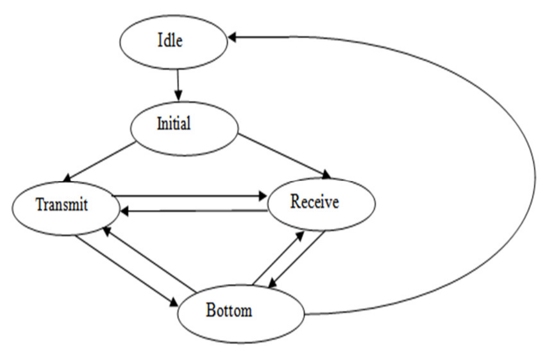

Figure. 6 Energy State Transition Model for Wi-Fi

Thus consumption of energy in Wi-Fi is represented $Energy_{wifi}$ different states are represented are given below table 2.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 2: Energy State Transition

STATES	SYMBOL
Idle state	$Energy_{wifi-idle}$
Initial state	$Energy_{wifi-init}$
Transmit state	$Energy_{wifi-T}$
Receive state	$Energy_{wifi-R}$
Tail state	$Energy_{wifi-tail}$

Thus the module for consumption of energy in Wi-Fi model is a combination of various states which would have impact on the exchanged packet overall in networks number with respectively to time period (per second) in the state, it result to the following equations

$$Energy_{wifi} = Energy_{wifi-init} + Energy_{wifi-T} + Energy_{wifi-R} + Energy_{wifi-tail} + Energy_{wifi-idle} \quad (6)$$

In this proposed system, we applied and implemented the energy model based offloading strategy in the dynamic cloudlet for obtaining the energy optimization based mobile devices. For achieving these efficient energy consumption through offloading strategies for cloudlet and WiFi model for performing mobile cloud computing.

3.5.2 For Ram

To decrease consumption of energy in the device memory (RAM) is studied by sklavos and Touliou 2007 [17]. Most of the cases, RAM has consumed higher energy due the memory access pattern application based mobile devices that utilizes the higher memory in accessing the pattern, we have estimated the approximate consumption in energy for device memory.

$$Energy_{memory} = \gamma_s \times U_{AU} + \gamma_m \quad (7)$$

Where γ_s and γ_m are determined as the energy coefficients, whereas U_{AU} is illustrated as aggregated resource utilization [13].

3.6 Energy Optimization Model Based On Offloading Algorithm

In our research methodology, we propose energy optimization model based offloading algorithm in dynamic cloudlet for obtaining the lower consumption in energy for devices. The proposed algorithm is designed for offloading the data; it decides whether which data offload can be done in the cloudlet or cloud server or mobile devices for selecting efficient energy utilization in MCC. The uniqueness of this algorithm is that includes the more than two offloading application at a same time for making decision process. In this work, we considered about cloudlet are placed near to WiFi APs with the help of cellular networks communication is taken place between mobile devices and cloudlet or cloud computing layer through internet that is demonstrated in the figure 4.

The proposed approach of dynamic offloading mechanism is depend on the energy development model is demonstrated in the fig. Hence the energy model would estimate the how much energy required totally for the hardware components for the various deployment of configuration of an mobile application in the networks. At first, the energy consumption for the mobile users, cloud cloudlets and servers particularly happens at a single route, is termed as a $E_i(t, y)$. The dynamic programming approach on the cloudlets intentions to choose the most significant communication between the cloud servers as well as mobile devices. This energy model provides the minimal energy consumption with better quality services for cloudlets that can obtain from the algorithmic conceptualization [17]. The equation (4) accomplishes the total cost for the consumption of energy particularly mobile device, cloud and cloudlet. Then for enhancing the lower consumption of energy, energy model is developed for WiFi and hardware components. However, novel method for the energy model with offloading algorithm is employed in this mechanism which contains Wireless Network Interface Model for the lower consumption of energy in WiFi with energy states particularly to estimate the consumption of energy in mobile devices which in turn makes then decision that whether to perform the applications in remote or local structure or dynamic cloudlet. Additionally, it estimate complete cost of the overall cloud server, mobile devices and cloudlet that would provides the solution for the making energy preserving in the equation [6]. The energy model for WiFi is estimated using the energy transition states that decides which application should be offloaded at runtime. To enforce the energy based offloading algorithm, we utilize dynamic offloading framework that helps to cooperate offloading framework between the cloud computing layer and Android smart phones.

3.6.1 Procedure For The Offloading Algorithm

At first, calculate execution time of the task over energy consumption as the conditions for the task offloading. Mainly because, if nodes are does not know their task execution or deadline, it is tough for accomplishing the quality of experience / quality of service. However, the execution time is directly proportional to the energy consumption. Whenever, the selected task is under the offloading process either for connected cloudlet or clone that cannot improve the overall execution time, the task would not be offloaded. When the cloudlet has high processing speed than the clone, obviously energy cost will be minimum than the clone so if the offloading have to carried out then evidently it higher preference for cloudlet than the clone for accomplishing minimum energy cost. Next, when mobile devices would conserve more energy by offloading to cloudlet instead of clone during the deadline conditions, cloudlet would be considered for the offloading process or else clone will be considered for the offloading destination. In case any above conditions are not satisfied, then task is performed on locally.

4. PERFORMANCE ANALYSIS

In the experimental set, we evaluate the performance evaluation of the proposed technique in designing mobile cloud computing architecture and energy based offloading algorithm. We execute the new developed algorithm by employing in the CloudSim 2.0, it used for stimulating and modeling of the cloud computing surrounding that is extensile tool kit for main purpose of accessing the VM on the simulated node for data servers. Hence, the efficiency and effectiveness of the newly introduced system is determined in terms of the energy consumption and the response time of the mobile devices. In our proposed method, we consider the cloudlet, clone and the devices for obtaining minimum consumption of energy for software and hardware components. For making best offloading decision in the mobile devices. The experimental analysis is evaluated for locally or remote or dynamically cloudlet based on these following parameters is represented in the simulation set up in the MCC.

1. Average consumption of energy for test cases
2. Average consumption of energy for computation cases
3. Average response time

In the proposed ideology is developed for saving the energy conservation while performing the offloading decision in cloudlet or clone of the devices, based on the three sub divisions such as consumption, computations and response time particularly over Wi-Fi as well as 3G. It also obtains the greatest level of accuracy around 97 %. The simulation parameters values are listed out in the table 3, which is given below:

Table 3: Stimulation Parameters

Parameter	**Value**
Cellular Network Layout	1 single hexagonal cell
Cell radius	550 m
Channel fading	Typical urban
Bandwidth	5 MHZ
Carrier frequency	2 GHZ
Mobile Bite Rate	600 Kbps<B<16 Mbps
Number of application activation	100
Traffic	Control message, information traffic
Mobile speed- clone	500 MIPS
Mobile speed-cloudlet	1000 MIPS
Inter arrival in seconds λ^{-1}	3,18, 54
Wi-Fi	802.11 abgn

We consider that offloading instance is always constant in the network environment,

Journal of Theoretical and Applied Information Technology
30th June 2017. Vol.95. No 12

© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

moreover, link latency for downlink and uplink are constant for the task during execution process throughput the complete stage. The proposed offloading algorithm, during offloading process the time taken to complete the task within the deadline for obtaining the QoS/QoE level. In this experimental set, we consider test cases of six modules such A to F. These developed modules are taken into account as the test cases with different work load size, in order to decision making algorithm, minimum–cut and maximum flow algorithm [22] effectively for decreasing the consumption of energy over 3G and Wi-Fi, it is demonstrated in the Table II. Fig. 7, illustrates about the energy consumption of the test cases is performed with respectively to the local, remotely or dynamic cloudlet execution process. However, Fig 8, demonstrates about the consumption of energy in various workload size is performed with respectively to the local, remotely or dynamic cloudlet execution process. Thus, the performance are evaluated for response time, average energy consumption in local, remotely and dynamically cloudlet. We have compared the energy model of 3G and Wi-Fi networks, for making the partial decisions for executing the modules in the locally or remotely or dynamically.

Table 4: Various Workload and Decision Making

Experiments results		Decision	
Test cases	Workload size (KB)	Wi-Fi	3G
A	9	All local	All local
B	92	All remote	All local
C	396	All remote	All local
D	874	All remote	All local
E	1792	Dynamic	All local
F	1975	Dynamic	All local

From figure. 7, it describes about the energy consumption modules for the test cases which is evaluated for the remote, local or dynamic cloudlet.

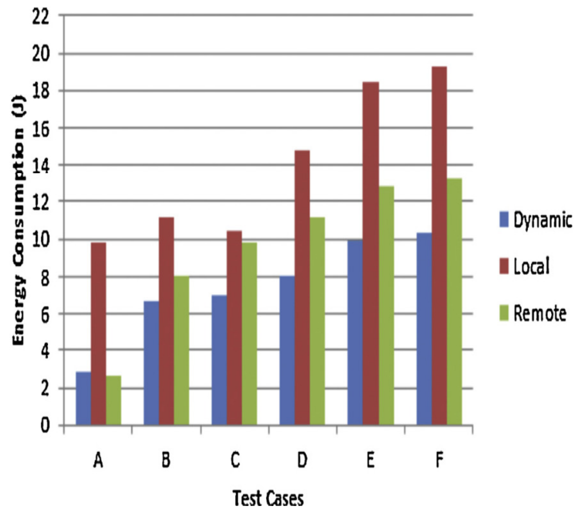

Figure 7. Energy consumption for test cases

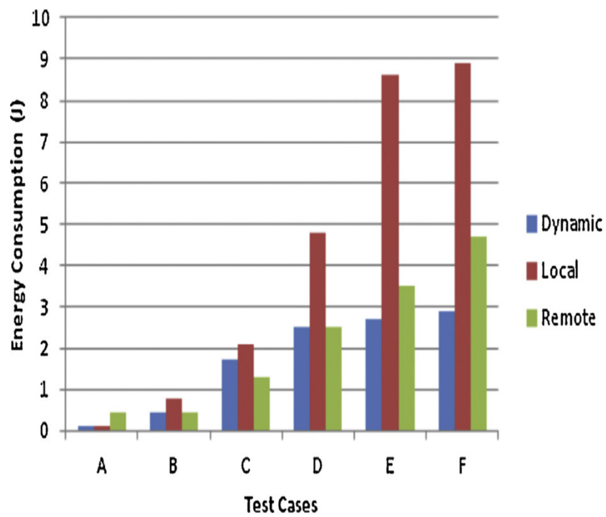

Figure 8. Energy consumption for Workload sizes

The energy based model with offloading algorithm for Wi-Fi model, it provides makes effective comparison between the Wi-Fi and 3G, for the description about the consumption of energy during the downloading the data over Wi-Fi and 3G. From the stimulated results, it is very clear that energy model for Wi-Fi is very efficient than 3G in the mobile cloud computing.

Table 5: Energy Model (for downloading X bytes of data over Wi-Fi and 3G networks)

© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Energy	Wi-Fi	3G
Transfer energy	0.006(x)+5.7	0.025(x)+3.6
Maintenance	0.02 J/s	0.05 J/s
Tail energy	NA	0.67 J/s
Tail- Time	NA	12.5 s

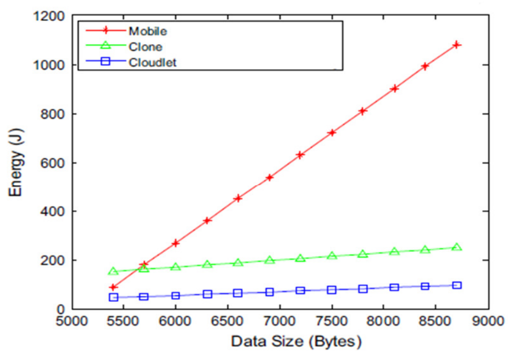

Figure 9: Energy consumption while offloading processing in the proposed system.

The simulated results for the newly developed offloading algorithm is illustrated in the Figure.9 , for evaluating consumption of energy while performing offloading task on the mobile devices, cloudlet and clone as the input size of data increase for the executing the same task. By comparison results, cloudlet is significantly efficient than the clone and mobile devices.

4.1 Response Time

The main goal of this proposed work, it is obtain the minimum response time even when the instructions number increases by the 50, 000 MIPS (million instructions per second), response time is estimated especially mobile devices, clone and cloudlets. Hence the comparison graph is demonstrated in the Fig 10, To review the proposed system, we consider the instruction gains 166 MIPS per byte, if the response time exponentially increased then it would be complicate to meet the deadlines conditions which would affect QoS/QoE of mobile application so it is very necessary for accomplishing lower response time.

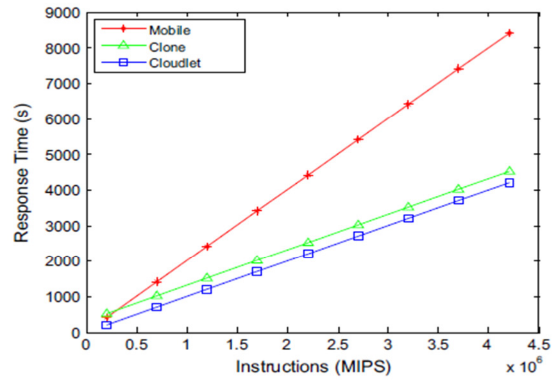

Figure.10 Response Time

5. CONCLUSION

In this research work, we propose dynamic energy optimization in mobile cloudlet with offloading algorithm to resolve additional energy waste and enhance the performance of the MCC. The proposed system deals with energy optimization in hardware as well as software components, offloading strategy and decision making for mobile applications. The experimental outcomes has illustrated that the proposed approach gives an optimal solution for energy consumption with quality of service/ quality of experience that avoids the wastage of energy when a mobile users are tolerating with complicated and unstable networking surroundings. The energy optimization model is designed for the memory access and Wi-Fi module in order to determine the energy required for running the mobile applications for their own purpose. The implementation has been performed for the various work load size, offloading task, decision making and energy consumption for downloading the data which minimized energy consumption response time than existing methods. In future work, we will incorporate security measures in the proposed methodology for obtaining highest security in the mobile applications.

REFERENCE

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[1] Sabharwal M, Agrawal A, Metri G, "Enabling green IT through energy-aware software", IT Prof: 19–27.doi:http://doi.ieeecomputersociety.org/10.1109/ MITP.2012.104, 2013.

[2] Guan, P. Maniatis, "Dynamically partitioning applications between weak devices and clouds", *in: Proceedings of the 1st ACM Workshop on Mobile Cloud Computing and Services* (MCS 2010), CA, 2011.

[3] Bakos B., Fodor S., and Nurminen, J. K., "Distributed Computing With Mobile Phones: An Experiment with Mersenne Prime Search", *Pervasive Computing systems*, 2012.

[4] Gitzenis S., and Bambos N, "Mobile to base task migration in wireless computing", *Proceedings of the Second IEEE Annual Conference on Pervasive Computing and Communications*, 2004.

[5] Kallonen T., and Porras J., " Use of distributed resources in mobile environment", The 14th *IEEE International Conference on Software, Telecommunications and Computer Networks* (SoftCOM 2006), September 29 - October 1, Split, Dubrovnik, 2006.

[6] Shiraz, M.; Gani, A.; Khokhar, R.H.; Buyya, R, "A Review on Distributed Application Processing Frameworks in Smart Mobile Devices for Mobile Cloud Computing", *IEEE Communications Surveys and Tutorials* , vol.15, no.3,2013, pp.1294,1313.

[7] X. Ma, Y. Cui, L. Wang and I. Stojmenovic,"Energy Optimization for Mobile Terminals via Computation Offloading", *2nd IEEE International Conference on Parallel Distributed and Grid Computing (PDGC)*, 2012, pp. 236-241.

[8] Gupta S, Roy , "Comparison of different energy minimization techniques in wireless sensor network. Energy", *IEEE transactions on network security,* 2013.

[9] Yang L, Zhu X, Chen H ,Wang J, Yin S, Liu X, " Real-time tasks oriented energy aware scheduling in virtualized clouds", *IEEE Transactions on Cloud Computer systems*, 2014; 2(2), pp. 168–80.

[10] E. Cuervo, A. Balasubramanian, D.-k. Cho, A. Wolman, S. Saroiu, R. Chandra, and P. Bahl, Maui, "Making smart phones last longer with code offload", *in Proceedings of the 8th international conference on Mobile systems, applications, and services*, New York, NY, USA: ACM, pp. 4962.

[11] Berl A, Gelenbe E, Girolamo MD, Giuliani G, Meer HD, Dang MQ, et al, "Energy-efficient cloud computing", Journal of Computing systems, Vol. 53, Iss. 7, 2010, pp. 1045–1051.

[12] P. Barlet-Ros, G. Iannaccone, J. Sanjuas-Cuxart, D. Amores-Lopez, J. Sole-Pareta, "Load Shedding in Network Monitoring Applications", 2007.

[13] Beloglazov A, Buyya R, "Energy efficient resource management in virtualized cloud data centers", *In: Proceedings of the10th IEEE/ACM international conference on cluster, cloud and grid computing, IEEE Computer Society*, 2010, pp.826–831.

[14] Aksanli B, Venkatesh J, Rosing T, "Using datacenter simulation to evaluate green energy integration. Computer", 2012, Vol.45, Iss.9, pp. 56–64.

[15] Xiao Z, Song W, Chen Q, "Dynamic resource allocation using virtual machines for cloud computing environment", *IEEE Trans Parallel Distributed System*, 2013, Vol. 24 , Iss.6, pp:1107–17.

[16] Mukherjee A, Gupta P, DeD, "Mobile cloud computing based energy efficient offloading strategies for fem to cell network", *IEEE transactions on Applications and innovations in mobile computing(AIMoC)*, 2014, pp.28–35.

[17] Kumar K, LuY, "Cloud computing for mobile users: can offloading computations have energy?., IEEE transactions on Computer systems, 2010, 43(4), pp. 51–6.

[18] J. Liu, Y.-H. Lu, "Energy savings in privacy-preserving computation offloading with protection by homomorphic encryption", *in: Proceedings of the USENIX Workshop on Power Aware Computing and Systems*, Vancouver, 2010.

[19] M.V. Barbera, S. Kosta, A. Mei, V.C. Perta, J. Stefa, CDroid, "Towards a Cloud-integrated mobile operating system", IEEE INFOCOM , in: Proceedings of 2013 .

]20] H. Wu, D. Huang, S. Bouzefrane, "Making offloading decisions resistant to network unavailability for mobile cloud collaboration, in: 9th International Conference on Collaborative Computing: Networking, Applications, 2015.

[21] T.-Y. Lin, T.-A. Lin, C.-H. Hsu, C.-T. King, "Context-aware decision engine for mobile cloud offloading", *in: 2013 IEEE Wireless*

© 2005 – ongoing JATIT & LLS
ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Communications and Networking Conference Workshop (WCNCW), pp. 111–116.

[23] M. Satyanarayanan, R. C. P. Bahl, and N. Davies, "The case for VM based cloudlets in mobile computing," *IEEE Pervasive Computing*, vol. 8, no. 4, 2013, pp. 14–23.

[24] E. Cuervo, A. Balasubramanian, D. Cho, A. Wolman, S. Saroiu, R. Chandra, and P. Bahl, "MAUI: Making smartphones last longer with code offload," *in International conference on Mobile systems, applications, and services*, 2012, pp. 49–62.

[25] D. Kovachev, T. Yu, R. Klamma, "Adaptive computation offloading from mobile devices into the cloud", *in: IEEE 10th International Symposium on Parallel and Distributed Processing with Applications* (ISPA, pp. 784–791.

[26] Chan HA, Yokota H, Xie J, Seite P, Liu D, "Distributed and dynamic mobility management in mobile internet: current approaches and issues", *Journal Communications*, 2011, Vol. 6, Iss. 1, pp.4–15.