Optimization energy consumption in mobile cloud computing by using an elastic framework

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***Abstract*— The mobile cloud computing (MCC) has become more and more present in our life and that is due to the wide availability of mobile devices in the world market (smartphones, tablets, etc.), however unlike the cloud computing has proven a big success and performance in communication technologies, the mobile devices are not able to a fully benefit from this development due to their resource's limitations such as the CPU, Ram, Battery life, etc.**

Today, due to heavy applications that are hosted in the cloud, the mobile devices consumes more and more energy, and it contributes greatly to the battery discharge in a very short delays.

To resolve this problem, we propose in this paper an implementation of an elastic framework for splitting a customer request between the others devices (best elected devices) for minimizing the processing time, the results have shown that the implementation of this framework contributes significantly to a considerable minimization of the request processing time and therefore minimizing the energy consumed.

Keywords— mobile cloud computing, energy, framework, agent

I. INTRODUCTION

The use of mobile devices has seen a great explosion of the last ten years and have become an indispensable way in our daily life for checking information in the internet; a user can now view his inbox anywhere and anytime while before it needs to be sitting at his desk for getting this information.

The mobile cloud computing has proven a big success by permitting a huge facility and flexibility to give an information faster and a powerful additional resources for devices that can run a very heavy applications (CPU, RAM, storage as a service).

Despite that, the mobile cloud computing (MCC) knows some problems and especially the high energy consumption problem and this is due to several factors: complexity of application, the strength of the wireless signal, distance to the base station, the constant mobility of mobile which contribute significantly to a quickly landfill of batteries

This paper propose a an implementation of a framework for dividing a customer request between a number of devices (best elected), this electing is based on the following criteria:(distance to the mobile concerned, the load of the battery, the utilization of CPU, RAM, storage, power signal), the obtained results showed that the installation of this framework contributes greatly to save energy to consumption.

The paper is organized as follows: Section (1) gives an overview to the mobile cloud computing, Section (2) describes the framework architecture, its algorithms and its results.

II. MOBILE CLOUD COMPUTING

Facebook, Whatsapp, YouTube, are the most application used by million people in the word, for example Facebook users have arrived at 1,393 milliard connected in January 2015.

This explosion in number of users is surely due to the large distribution of mobile devices in the word, a study conducted by Gartner (June 2014) showed that the number of Worldwide Device is reach 256 Million Units as shows the table I:

TABLE I. WORD DEVICE UNIT

Worldwide Device Shipments by (Segment Thousands of Units)	2013	2014	2015
Traditional PCs (Desk-Based and Notebook)	296,131	276,221	261,657
Ultra mobiles, Premium	21,517	32,251	55,032
Tablets	206,807	256,308	320,964
Mobile Phones	1,806,964	1,862,766	1,946,456

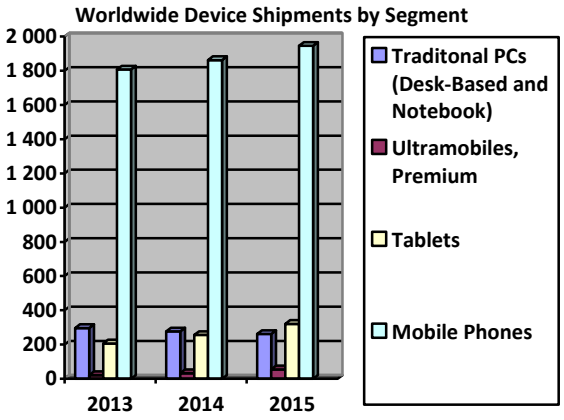

Fig. 1: Worldwide device units

The Fig. 1 shows this recent years an important number of users have emerged from the traditional computer to mobile devices because their performance become more efficient and sufficient for doing their majority tasks in internet, for example the SAMSUNG galaxy S5 have 2gb in memory, 2,5 GHz quad core of CPU and it capable to execute a several process in the same time.

This significant emerging from the fixed equipment to the mobile is due to the possibility of mobile equipment has exceeded the old and simplest communication tools (call / message) and can now guaranteed other interesting things service browsing in internet, install applications, share data, etc.

The cloud computing recently appeared in the IT word allows users to execute applications or store data without having the necessary resources in their terminals, the entire treatment of task is guaranteed by the cloud computing servers which are robust and powerful.

The multi task operation ensured by smartphones was introduce the cloud computing in the mobile environment, a simple user with his terminal can benefit from a several IT services as a model as shows the figure below:

Fig. 2: Cloud computing models

- IaaS(infrastructure as service): it is the lower level of cloud computing services, it permit to the client to benefit of hardware resources like as a remote RAM and CPU to execute heavy processing (image processing, software localization, etc.), it permit also a remote storage resources and virtual networks to connect to remote application.

PaaS (platform as a service): it is another model for the delivery of cloud computing services, allowing application developers to prepare libraries and prerequisites needed to program, test their applications in secured and reliable environment.

SaaS (software as a service): the user does not need to install any tool, the software and data are stored in cloud providers, and the user through a web browser can connect to the service to do the desired operations.

The connection of users to the cloud computing service is provided by wireless networks (3G, 4G, WiFi) as shown in the figure below, and this type of connection sometimes generates a fast discharge battery because of the weakness the signal, far distance between the base station and the mobile receiver,

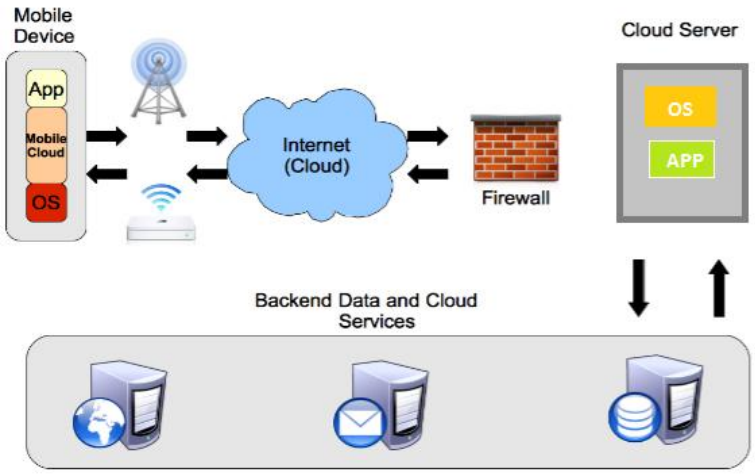

Fig. 3: mobile cloud computing architecture

The remarkable development of cloud computing in recent years, attracting more and more interest from various internet users and IT looking to enjoy the best services and applications available online through the web. This is a new business model that cloud computing promises to ICT. Indeed, the model promises a change in the mode of investment and operation of IT resources.

III. PROPOSED WORK

To resolve to the energy consumption problem for the mobile devices, we propose an implementation of a framework which is composed by several subsystems interconnected between them for a smart processing of the customer queries. This framework permits a splitting request of the cloud client between the idlest mobiles available in the network for minimizing the processing time and therefore saving the energy consumption for executing a concerned process.

a) Description

This framework is as an intermediate software layer between the mobile terminal and cloud providers: it receives the request from the client, communicates with the cloud servers and came back the result to the customer in a very short time than the normal case by splitting the request by many others mobiles devices . This framework is composed by

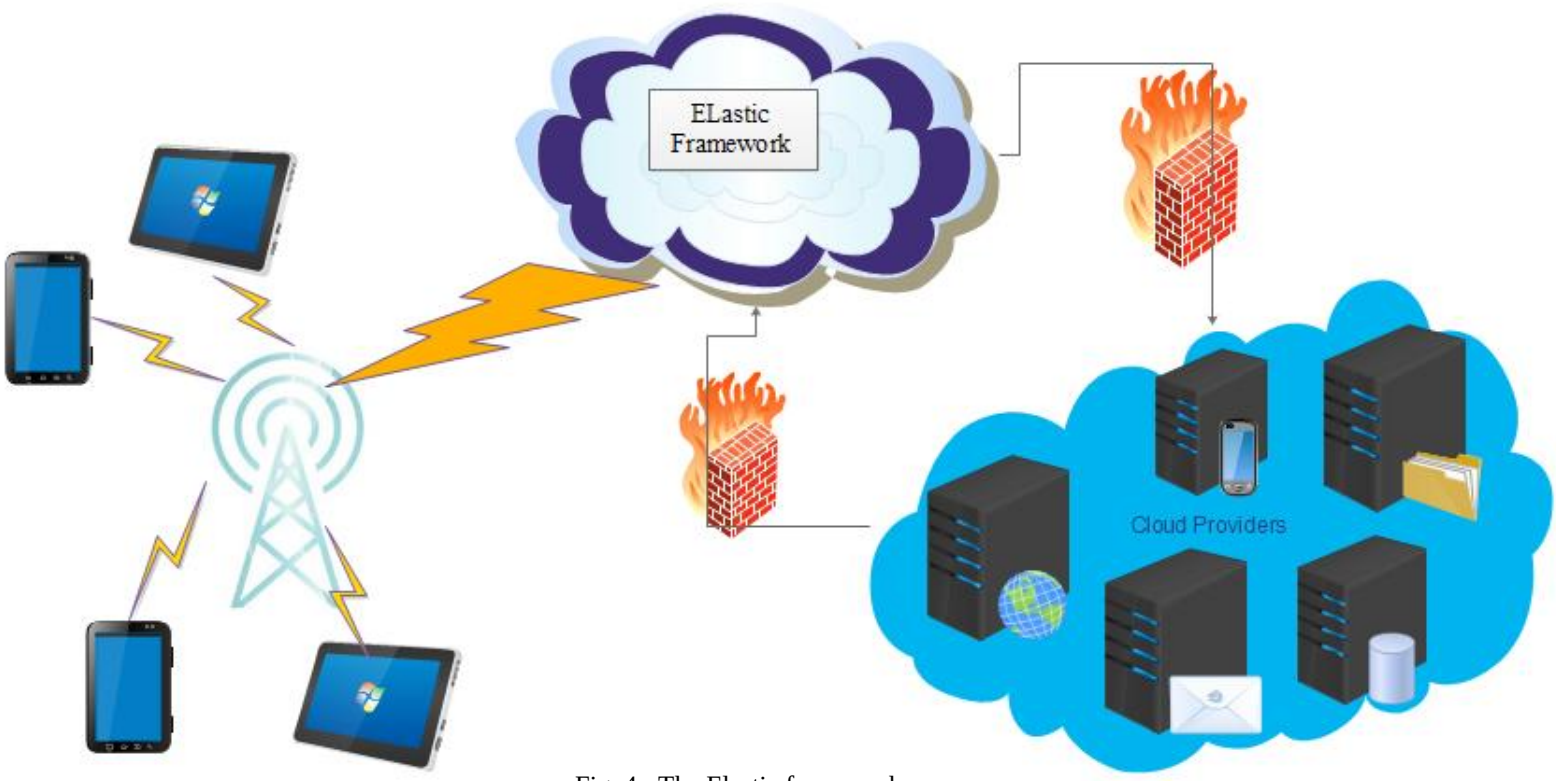

Fig. 4 : The Elastic framework

- Mobile agent: is an agent installed in the mobile for receive and send information to the other component of this framework.

- Job stat agent: It returns for the Job splitter agent the stat of the request processing and inform it when the operation if fails for choosing another device.

The main elements of this framework:

- Localizer agent: localize the mobile devices which are near to the client concerned.

- Resource monitor agent: It returns the resources allocation of mobiles devices that have be mentioned by the localizer agent (CPU, RAM, buttery life, storage, signal power).

- Job splitter agent: it splits the client request between the best elected mobile (less overloaded) returned by the resource monitor and store in his cache memory the state of the process executed in the mobiles devices.

c) Algorithm

The processing time of request client depends to the transfer data flow from the cloud providers to the terminal mobile and its resources CPU, RAM, so we have:

$$proc\_time = computation\_time + transfer\_time \quad (1)$$

With $proc\_time$ is the processing time for executing a tasks, $computation\_time$ is the total time required for compute the tasks by the mobile, $transfer\_time$ is the total time for the transfers the data from the providers cloud to the mobile.

$$computation\_time = \frac{Data}{CPU} \quad (2)$$

With CPU is the processor of the mobile

$$transfer\_time = \frac{Data}{Bandwidth1} \quad (3)$$

With bandwidth is data flow from the cloud providers to the mobiles of between the mobiles theme self.

From (2) & (3) we have

$$proc\_time = \frac{Data}{CPU} + \frac{Data}{Bandwidth1} \quad (4)$$

$$proc\_time = Data(\frac{1}{CPU} + \frac{1}{Bandwidth1}) \quad (5)$$

When we introduce the elastic framework the task client is divided by the best elected others mobiles.

$$proc\_time = \frac{1}{n} Data(\frac{1}{\frac{1}{n}\sum_{i=1}^{n} CPU} + \frac{1}{Bandwidth1}) \quad (6)$$
$$+ \frac{Data}{n.Bandwidth2}$$

Where $Bandwidth1$ is the bandwidth between the BTS and the mobile, $Bandwidth2$ between the mobile elected and the mobile concerned and n is the number of selected devices by the framework.

d) Result

To experiment our algorithm proposed in this paper, we set up a cloud platform composed of 3 servers and 10 mobiles devices with each one have 1.6 Ghz in its CPU and we found this following this results:

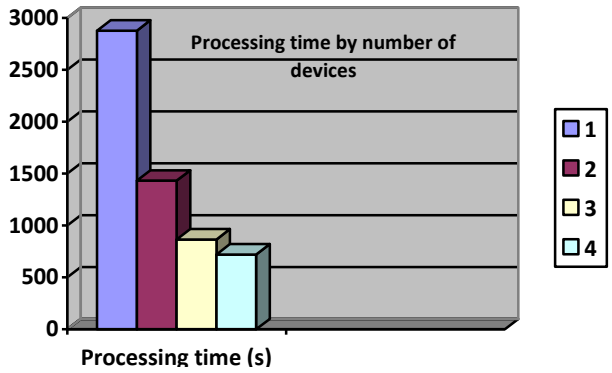

Fig. 5: The processing time

As we can see, when we introduce the elastic framework, the processing time decreases in a very meaningful way and this is because the response of the request client from the cloud is divided by the selected mobile those respond to the following criteria (CPU utilization is under 50% RAM usage is under 50%, the distance between this mobile and the client concerned is closer than the client with the BTS, the signal strength and the rate of the battery that exceeds 50%).

As shown the figure 6, this framework not only decrease the processing time, but also decreases the power usage and this is due to the CPU came more and more offload and therefore the mobiles use a little power for processing the task. For calculating the power usage of the mobile devices, we installed a software called Joulemeter a tool developed by Microsoft researchers and we found the following result as show the table I and the figure:

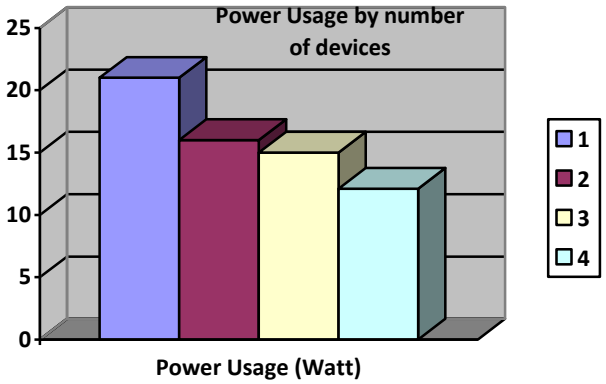

Fig. 6: Power usage by number of device

To ensure that the energy consumed by a mobile for processing the request's customer in the case without using the framework exceed the energy summation by all selected devices by the framework we calculated the energy by the following formula:

$$Energy = proc\_time * \sum_{i=1}^{n} power\_usage_i$$

In case of introducing the elastic framework the power usage come the sum of power of the different devices elected:

$$power\_usage = \sum_{i=1}^{n} power\_usage_i$$

Where n is the number of selected devices by the framework

So the energy consumption becomes:

$$Energy = proc\_time * \sum_{i=1}^{n} power\_usage_i$$

We have the following result :

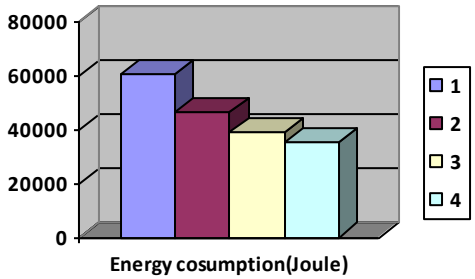

Fig. 7: Energy consumption by number of device

After this result obtained, we can say the implementation of this framework permits for client of mobile computing to minimize the response time with a very low energy consumption.

IV. CONCLUSION

The autonomy of batteries has become a serious problems for any person use a device mobiles, the lifetime of batteries has become very short due to the heavy applications hosted in the mobile cloud computing providers.

The utilization of the elastic framework proposed in this paper allows users to keep theirs batteries life longer by minimizing the processing time of their demands and offloading their resource's equipment allocations.

Thanks to this framework, the mobile cloud computing will become more robust, efficient and friend of environment because it offers a treatment in a very short time for a client task with a very minimal energy consumption and therefore the client wins some additional energy that he can use for other applications.

However, it should be noted that the volume of the experience remains insignificant to draw a generalized conclusions. It is desirable for validate our proposals work expand the tests on a large scale of use (thousands of virtual machines and mobile users)

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