Task Offloading Framework to Enhance the Computing Capabilities of Smartphone's

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Abstract -- Over the last years, cell phone have become popular among people, and their number is ever growing because of the computing functionality they over beyond primary voice communication. But Mobile systems have limited resources, like limited battery life, network speed, storage space, and processor performance. To overcome these limitations task offloading from smartphones to cloud is a trustable strategy to enhance the computing capability of smartphones and increase their battery life. However, task offloading introduces a communication cost for those devices. To make task offloading advantageous, challenge is to estimate the energy required in communication activities of task offloading. Exact energy estimation models will facilitate these devices to make the correct decisions as to whether to perform task offloading or not, based on the energy required for the communication activities. Only if the offloading procedure consumes less power than processing the task on the phone itself, then the task is offloaded to the cloud. To design an efficient offloading strategy, we develop energy models of the WLAN, Third Generation(3G), and Fourth Generation(4G) interfaces of smartphones. Models make smartphones capable of accurately estimating the energy cost of task offloading.

Keywords -- Mobile Computing, Cloud Computing, Smartphones, Offloading Decision, Energy Saving, WLAN, 3G, 4G, Energy Estimation.

I. INTRODUCTION

Smartphones are on to entirely change our day by day life. Now phones are used for a huge number of applications that go far ahead of the initial use as a cell phone. With the incredible achievements of smartphones, this technology evolved at a fast speed and is now enabling even more advanced applications counting games, video, time and contact organizing, e-mails, and obviously all kinds of social media services [1]. Smartphones have limited battery life, processing capacity, and memory.

Over the last few years, fast progresses in semiconductor technology have alleviated some constraints. Though, the limited battery power limitation has not been satisfactorily addressed [2]. Portability, memory space and battery power are the main uniqueness of a smartphone. The functionality and form-factor are dependent on each other as more powerful a smartphone is, bigger battery it needs. Processing speed and memory capacity is inversely proportional to battery power which limits phones as a substitute for laptops and tablets [3]. With powerful operating systems, memory and processors (*e.g. , Windows Mobile, Android, Apple iOS, BlackBerry, and Symbian*), smartphones are intelligent to execute advance applications that are as like to PC's and laptop applications [2]. Need to reduce the power expenditure of smartphones has been involving efforts from numerous researchers [4], [5], [6].

Task offloading is a promising practice to lessen energy consumption in smartphones, specifically, with the emergence of high-speed broadband wireless Internet access [2]. Using, Cloud Computing (CC), the energy inadequacy on smartphones can be eased off by offloading heavy tasks of smartphones to the cloud [7], [8]. For example, a smartphone can upload a video file to a cloud and request to encode the file into a preferred format appropriate for smartphone capacity with less energy consumption than doing the encoding on the device itself. Task offloading will become essential for the Information and Communication Technology (ICT) in the coming future because Cloud Computing will be a leading hand for mobile computing [9], [10]. To make the offloading helpful, the energy cost of offloading for a given task should be projected to measure against it with the energy cost of executing the task on the device. From a smartphone point of view, the energy consumed during task offloading is primarily caused by the networking actions [2].

II. RELATED WORK

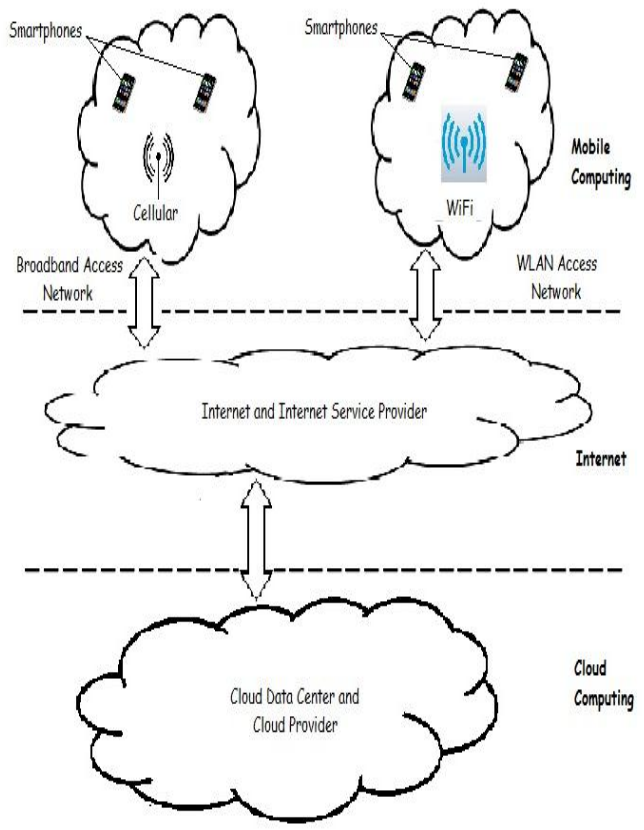
The offloading has been designed for some purposes such as load balancing, get better performance, and save power. The work of Othamn is the early knowledge for offloading a task to save energy on cell phone [11]. The offloading procedure can be categorized into three major approaches based on the type of the remote machine. The first approach is the offloading to a web proxy [11], [14], where a proxy works as an mediator machine between a web server and a mobile device. The mobile device sends a web request to the proxy and the proxy delivers the content to the mobile device after performing the preferred modification to the content, such as multimedia coding. The second approach is the offloading to a local powerful server [15], [16], where the server is located on the same or nearby network as the mobile device present. The mobile device sends a computation-intensive task to the server, requests to perform the given job, and then downloads the task outcomes. The third approach is the offloading to a cloud [19], [14], [17], [18], where the cloud provides its omnipresent computation resources, such as processing and storage, to a mobile device.

Thus, offloading to the cloud has been attracting the attention of many researchers [19], [14]. Kelenyi et al. [14] proposed a strategy to save energy of handheld devices using Cloud Computing. In their strategy, cloud servers are used as Bit Torrent clients to download torrent fragments on behalf of a handheld device. When a cloud server is downloading the torrent pieces, the phone switches to sleep mode until the cloud finishes downloading the torrent pieces and starts uploading the torrent file in one session to the phones [2]. This approach saves energy of phones as downloading torrent pieces from torrent peers requires additional energy than downloading a single burst of torrent pieces from the cloud [2].

Modeling the power utilization has been developed extensively in the literature for the use of energy saving methods such as task offloading technique Zhang et al. [12] and Jung et al. [13] profiled the energy utilization of smartphones hardware components mutually with the wireless interfaces. Profiling is developed by analyzing the access occurrence of the system to the part and the differ in the power state, which is given from the Battery Monitoring Unit (*BMU*) [2]. Their mathematical models are built based on the study of the experimental outcomes. As a result, the models be short of for system analysis and the feature of the protocols. In addition, the *BMU* can not trace actions that are shorter than *BMU* update time as in the case of wireless interfaces. So, the models are not precise and not extendible for modeling the energy utilization of the wireless interfaces [2].

III. SYSTEM MODEL

System consists of two main elements smartphones (*i.e.,* user equipment) and Cloud Computing (CC), both linked to the Internet, as depicted in Fig.. The smartphones are connected to the Internet through a WLAN access point or cellular data network to base station (3G/4G) [2]. These smartphones provide each and every mobile computing functionalities to the users via special applications. On the other side, Cloud Computing part consists of cloud data center and cloud provider, which are available through the Internet. Cloud provides the users (*e.g.,* smartphone users, tablets) with all of the Cloud Computing functionalities that are required for mobile computing [2]. the offloading practice, smartphones access the cloud through the Internet. Thus, offloading is well thought-out as a Network Related Application (NRA).



System Model

In At the start of studying NRA, system interfaces (*i.e.,* WLAN and 3G/4G) should be measured because each of these interfaces has its individual characteristics, such as hold up data rate. As a result, every network interface use unequal amount of energy. In addition, Internet protocols, Hypertext Transfer Protocol (HTTP) and the File Transfer Protocol (FTP) need to be taken into account [4]. The network interfaces and protocols are the main factors that influence the energy expenses of task offloading. We present an broad evaluation of the energy costs of smartphones with a large numeral of experiments.

IV. SCOPE AND OBJECTIVES

Expanding the potential of smartphones is promising by offloading heavy task to the cloud. The projected energy models of W-LAN, 3G, and 4G network interfaces let smartphones to make accurate offloading decisions. Furthermore, our techniques not only help for task offloading but also opens new door for energy solutions that necessitate predicting the power consumption.

V. EFFICIENCY ISSUES & OUTCOMES

Task offloading is a critical procedure because in several cases it raises the power consumption of smartphones. To show this, if a smartphone has to carry out a task computation where task data is present on the smartphone, there are two situations: either perform the task locally (*R1*), or offload the task to cloud (*R2*).

Suppose the smartphone uses energy equal to $K(R1)$ when the task is carried out locally. Likewise, assume that the smartphone uses energy equal to $K(R2)$ when the task is offloaded, which involves uploading of task and downloading of task outcomes to and from the cloud, correspondingly. In this cases, offloading is only advantageous if $K(R2) < K(R1)$.

This study extends our earlier work on exploration of the probability of task offloading to whether or not a smartphone can save power by offloading tasks to the cloud [18]. We carried out a large numeral of testing's on trendy smartphones and actual clouds with four different offloading situations. The outcomes open the potential of task offloading to the cloud and the advantages of offloading to the cloud in terms of power saving. The smartphone can save power between 30% and 70% by offloading heavy tasks to the cloud.

V. CONCLUSION

Expanding the potential of smartphones is promising by task offloading to the cloud. Though, estimating the power consumed in task offloading is essential for making task offloading advantageous, which take place only when the power consumed in the offloading method is less than the power consumed without it. Thus, the main challenge in task offloading is estimating accurately the energy consumed throughout the network actions of task offloading. In this technique, we developed mathematical models to estimate this power consumption. We considered the particulars of the network stack from lower networking layers up to top layers. Future energy models of W-LAN, 3G, and 4G network interfaces let smartphones to make accurate offloading decisions. Furthermore, our models not only facilitate task offloading but also opens new door for power solutions that are needed for calculating the energy utilization. Here, we experimentally confirm those models by conducting a set of testing's on set of smartphones and compute the energy inspired throughout task offloading. Experimental outcomes reveal that our energy judgment models can estimate energy cost with adequate precision. The models just required to recognize the amount of transferred data and some system parameters, and they can present good inferences of energy cost.

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