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A Survey to Augment Energy Efficiency of Mobile Devices in Cloud Environment

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Abstract: *Mobile devices such as smart phones, have gained enormous popularity over the last few years. Smart phones are now capable of supporting a large number of applications, many of which demand an ever increasing computational power. However, Battery life of mobile devices remains a key limiting factor in the design of mobile applications. This paper firstly emphasizes on reviewing various techniques used to enhance battery life of smart phones. At the end, on the basis of comparative studies, suggestions are given to extend the energy efficiency of smart phones.*

Keywords: Mobile Cloud Computing, MCC, Cloud Computing, Smartphones.

INTRODUCTION

Mobile Cloud Computing (MCC) integrates the cloud computing into the mobile environment to overcome the obstacles related to the performance, security and environment. By [2] , "Mobile cloud computing at its simplest, refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device." According to a recent study by ABI Research, more than 240 million businesses will use cloud services through mobile devices by 2015. Mobile devices such as smart phones are used for various resource demanding multimedia applications such as making voice/video calls, playing 3D games/audios etc. that drains battery swiftly. In 2009, Nokia poll found that battery life is one of the greatest concerns for users. Thus, it is important to analyze the current research on energy conservation in mobile cloud computing. By Satyanarayanan [3], the mobility feature of devices inherent problems such as, low bandwidth, low connectivity, resource scarceness and limited energy. To deal with these problems offloading and remote computation techniques are used. The Rest of the paper is organized as follows; Section-II refers to various techniques used to extend the mobile's battery. Section-III includes suggestions based on the comparative studies. Section-IV concludes the paper. At last, paper shows references in section V.

Approaches to Augment Energy Efficiency of Mobile Devices

Energy consumption is an important key concern in the design and implementation of mobile applications. Thus, there is a need to pay attention on improvement of energy usage in order to prevent mobile devices becoming stationary due to low bandwidth and resource-hungry applications. The goal of on-going research, hardware manufacturer and OS designers led to some positive solutions using augmentation approaches .The augmentation approaches can be classify into two major levels-Hardware and Software [4]. These approaches can increase computing capabilities of mobile devices and conserve energy. Following are some approaches that help to achieve optimal energy utilization at different levels.

Hardware oriented Augmentation

The hardware approach aims to enhance the capabilities of mobile local resources i.e. multi-core processors with high clock speed, storage and long lasting batteries [14]. Battery can't be renewed without the help of any external backup power source because energy is the only non-replenishable resource in mobile devices [16]. Generating powerful processor, large data storage, and big screen

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increases the power consumption due to additional heat, weight and size [14]. Resource-hungry applications drain battery swiftly. Therefore, the optimal usage of resources can make contribution in energy conservation of mobile devices.

Software oriented Augmentation

Resources that are used on software level can be traditional and cloud-based. Their major differences lie on resource provisioning and access strategies, security and resource characteristics [16].Software-level augmentation for mobile are classified into two major categories- 1) Energy Aware Operating System and Applications, and 2) Resource Aware Computing.

Energy Aware Operating Systems and Applications

Two type of programs run in a mobile device, Operating System (OS) and application. The applications can be computing-intensive such as speech recognition, data-intensive such as enterprise applications and communication-intensive applications such as online video applications [16]. But who is responsible for energy management? Application level energy management is not so best because main entity is responsible for monitoring and supervising all the resources consumptions by other applications [14]. Considering OS level management alone for energy management, can face a problem of scalability, that's why hybrid model is best [14], that says both the application and operating system should be aware of the resources utilization and supervision to achieve better performance. Examples of such systems are Odyssey [1].

Resource Aware Computing

Resource aware computing can be dividing into two categories- Reduce Resource Requirements and Resource conservation. In resource-aware computing, resource requirements of mobile applications can be reduced by utilizing the application-level resource management methods related to compiler, OS and lightweight protocols. Resource conservation can be achieved by efficient selection of available execution approaches and technologies.

Reduce Resource Requirements

Many mobile applications are unreasonably energy-hungry. To enhance the capabilities of mobile's resources along with manufacturing the high-end hardware devices; a parallel development of resource-efficient application plays a major role [1]. This approach focus on the design phase of software to form energy efficient applications.

Resource Aware Applications

To protect smart phones from power consumption it is essential to understand the energy need of hardware and installed software's. Many applications takes unnecessarily power. So better understanding of the power consumption of individual mobile components helps to develop a good energy aware system. For example, a resource aware application is needed to exploit 2G for voice communication and 3G for FTP services because of their different energy consumption requirement [7]. The compute intensive application occupied CPU for long time to process complex tasks that are directly suffering Mobile's battery. There are several efforts made [8][9]for energy aware memory management to reduce power consumption at the time of processing of data storage. The power management techniques in common mobile memories i.e. Ram and (PCM) Phase Change Memory (PCM) explored by [10]. In Ram, power managing unit sustains various power states like 'Page Down' and 'Self Refresh' to curtail power consumption while PCM influences three states 'On', 'Off', and 'I/O' to arouse energy effective data storage. During 'off' mode in PCM, the energy depletion is 0mW, whereas during 'on' state the energy consumption touches 74mW [1].

Cloud based Mobile Applications

Cloud based mobile applications are similar to Web-based applications. The similarity is both the applications runs on external servers and requires a browser on the client device to access the applications [11]. Native mobile applications are restricted by the battery and processing speed. The concept of cloud computing bridge this gap by offering cloud-mobile applications to have capabilities of connecting cloud servers for processing and remote storage[1]. The development of cloud-mobile apps accelerates high computational applications to cloud by offloading .It enhance the capabilities of wide range of mobile devices in dynamic environment with least processing overhead. The Clone Cloud service which uses a smart phone's internet connection to communicate with a clone of itself that exists on remote servers in the cloud. In case of compute intensive processing the mobile device needs to offload data to the clone for processing and get results back on the Client device's screen [12]. One of the major advantages of this research is the ability to enhance mobile battery life. Thus, mobile device will be free from longer use of its own CPU.

Resource conservation

Traditionally, local resources of mobile were conserved by reducing the workload on the local resources. But now there is a concept of remote execution, fidelity adaptation and remote storage to conserve local resources.

Remote execution (Offloading or Cyber Foraging)

In Remote execution, the resource hungry components of mobile applications are migrated to the resource-rich computing devices through a network to any local server machine called surrogate. The surrogate execute computational task and transfer the results back to the Mobile Client [1]. Satyanarayanan [3] proposed the concept of remote execution not only for conserving energy, storage and processing efficiency of local devices but also to make possible the execution of compute intensive apps, which are unable to be

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processed locally. According to the research, remote execution is highly effective to minimize power consumption of smart phones. The technique of remote execution is also known as process offloading or cyber foraging. [15]

Fidelity Adaptation

Fidelity adaptation is an alternative solution to augment mobile devices in the absence of remote resources and online connectivity. In this technique, local resources are conserved by decreasing quality of application execution, which is unlikely desirable to end-users. [16]. Fidelity is the concept of releasing CPU load, network bandwidth etc. The run time parameters can be adjust for an application to get lower quality for energy conservation, bandwidth and computational resources.

Remote Storage

Remote storage is the process of outsourcing of data storage at third location. It enables maintaining applications and data outside the mobile and provides remote access to them. A number of remote file storage services are available in cloud for example Google Docs. The remote storage allows the mobile users to store and access any kind of data, anywhere in the cloud and can retrieve it from any place by web browser. Big Data that is not needed in the near future can be stored remotely to reduce the power consumption.

SUGGESTIONS

On the basis of all the above approaches used to augment the energy efficiency of handheld devices it is clear that long lasting battery life is necessary to achieve the reliable service. In the context of mobile clouds, the cost of power consumption should be less than the benefit gained [5]. It will enable the mobile device to take appropriate component level action to minimize energy consumption, and hence, increase the life span of system by unloading unneeded software. For these reasons, being aware of a device's energy usage is essential [6]. To overcome the challenge of resource poverty of mobile devices, more research on reduction of battery consumption will leads us to some fruitful results. To minimize the battery, energy can be potentially saved with the help of cloud services. But this is not true for all of the applications when migrated to the cloud.

CONCLUSION

The popularity of smart phones creates a new rich user experience, but the hardware limitation in terms of memory, computation, and power capacity are still a big issue. Battery life is one of the main constraints of mobile devices because a mobile device operates on a finite supply of energy that is contained in its battery. The battery of smart phones needs improvement, as the explosion of new mobile applications drains battery swiftly which reduces the operational time of mobile devices. Augmenting energy of smart phones using cloud infrastructures is an emerging research area. With this importance, the approaches to augment the energy efficiency of cloud assisted mobile devices have been discussed in this paper. Finally, the suggestions have been outlined.

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