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LITERATURE REVIEW ON ENERGY CONSUMPTION AND CONSERVATION IN MOBILE DEVICE

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ABSTRACT

Mobile devices are increasing in number today. Consequently, computational resources are growing in tandem. Energy consumption has become a major issue all over the globe. On mobile devices (smart phones),there is a huge gap between battery power capabilities as well as innovations with other technologies (for example, developing and also memory space), this is especially the case with examining the rapid development in its consumed energy-lost mobile phone in different area (such as, multimedia streaming). Most of the insufficient power supplies and also the need for minimizing energy depletion offers the commitment for professionals to create energy consumption techniques or model for coming-generation wireless network. Based on the above, it is necessary to take the approach for energy consumption minimization and improvement of energy conservation into consideration. This could help achieve the desire of green technology for using less energy power in mobile devices. To gain this aim is it possible? Consequently, heterogeneous approach in energy consumption and conservation in mobile device which have been proposed by various researchers has been investigated in this paper. This would help to put in proper perspective the different energy consumption models directed at energy conservation.
Keywords: *Energy Consumption, Energy Conservation, Mobile Devices, Wireless Networks, Multimedia Streaming*

1. INTRODUCTION

Increasing network connectivity, today's mobile phone consider to the aim of the internet of things (IOT) or ubiquitous. Almost all networked equipment such as laptops, smart phones, handled PDA, even MP3 or MP4 possess some form of wireless connectivity. Recently, effective smartphone systems are becoming more inexpensive and powerful in its functionality, which causes a major increase in both varieties of advanced mobile users and also their data transfer usage needs.

Based on Cisco[1], the mobile application data traffic being received though different types of high end devices that's required to accomplish about 6.3 Exabytes per each month during 2015. Enhancing twenty six Fold which comes starting from 2010 stages of multimedia data usage. Determined through the growing level of popularity of the website as well as applications which includes a multimedia-sharing such as YouTube, social networks, and multimedia streaming. Multimedia-based apps have observed the highest growth rate of any application type.

Area of application in which minimal energy network will be able to effect significant benefits include battlefield, in which soldiers are working across an unknown terrain, as well as Multisensor systems, whereby sensors contacting each other without any base station nearby. Even with the employment of base stations, including smartphone devices, minimal energy network model enables more time battery lifespan as well as reduce interference [3].

With respect to energy efficiency, Information and Communications Technologies(ICT) seem to be observed in their solution to help minimize the carbon dioxide, however ICT themselves is required to get more power effective. The EU Commission is considered to be moving forward in order to minimize its own carbon dioxide by twenty percent in 2015. This could produce the information about energy usage to become the most major problems in the next generation cell phone multimedia systems for the purpose of successful power management remedies.

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Therefore, the battery, use of the cell phone is an essential factor that users as well as providers alike attention most about. Mobile phones can be used as mobile work and also entertaining centers designed for communication, hearing music or radio, capturing pictures, GPS services, playing games, by making use of all of the available 5,000,000 mobile phone application in the marketplace, as well as for multi-media playback or streaming. This approach places even more strain on battery power in which consumers are ready at least an entire day without the need of recharging. Additionally, for the most recent mobile devices (such as. IPhone 5) which actually simply continue for a long time of high usage, for instance, video streaming [3], rapid life of the battery acts one of the greatest contributing factors to end user unhappiness. Even without the battery enhancements acceptable in order to satisfy the particular growing demand for power applications, mobile phone end users demand better power and also battery management strategies to strengthen his or her battery efficiency. These kinds of energy powerful strategies need to probably maintain and minimize power consumption, even though achieving users' quality of experience objectives [2].

It is an important that energy is conserved whenever services and applications are used in useful resource restricted by mobile phones. Mobile phone multimedia services are a good looking Web service that the usage is predicted to improve very soon. On the other hand, the larger amount of network system traffic and sophisticated calculation necessary for mobile phone multimedia streaming can easily drain the actual battery in very little time. Because of this, there's a conflict found in end user need and also the service issues to assist the services by using existing methods. Consequently, power use of cell phone multimedia services is a fundamental study issue.

In [4] that they propose an energy usage analysis with mobile phone YouTube driven by energy measurements for the purpose of various use cases. These use cases originate from the real world YouTube service, since this top features of network access systems, download methods, plus memory space media applied.

Consequently, that they examine the energy usage working with WCDMA as well as WLAN technologies, while using the effective download and local playback correspondingly. Finally, depending on the outcomes, they review the power components of smartphone YouTube. Typically the disadvantage of the suggested approach is they do not consider the cost caused by handover that must be evaluated, in addition about the device side, storage cache optimization at the time of playback will be an alternative to help reduce memory accessibility and minimize energy reduction but they were not concerned that in this paper.

Within the current article [5], Vallina Rodriguez and also Crowcroft investigated mobile phone energy management solutions through the following perspectives: (I) energy aware operating systems, (II) useful resource management, (III) the impact of user interaction patterns using mobile phones in addition to applications, (IV) wireless connections as well as sensor management (V) advantages of setting up cellular devices along with cloud-computing services. They discussed a wireless communication characteristic, it was not the key target of this article instead of the survey. Additionally, they focus in multimedia streaming, they did not look at any sort of programs.

Additionally, another current article [6], analyzed energy consumption connected with various WiFi or 3G multimedia services using a wireless mobile device by using Multipath TCP or MPTCP and also typical TCP, correspondingly. A specialized kernel along with MPTCP support is actually implemented by using a Samsung Galaxy S3 smartphone. The actual measurement outcomes show that when using the same types of multimedia service, the energy consumption when using the same kind of multimedia service, the energy consumption whenever using 3G is greater when WiFi is used [39,40,41,42]. Upcoming, novel energy consumption styles are usually developed for various multimedia services using both of those MPTCP and also TCP.

Depending on the results of real-world measurements, they've already created a collection MPTCP as well as normal TCP based mostly energy consumption models with the four different kinds of services such as web browsing, video streaming, document download, VoIP is regarding deliveries across each WiFi and also 3G networks. The suggested energy consumption models allow for estimating the standard energy

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consumption of each individual service throughout WiFi plus 3G networks, correspondingly

In [7], they study a measurement of power consumption by using Bluetooth, WiFi as well as 3G communication techniques for Android mobiles. They start to examine relationships among energy consumption as well as the elapsed period, in addition to power consumption and actual number of transmitting information while working with above mentioned communication solutions. Depending on different kinds of measurements, they started to develop a power consumption model with regard to Android mobiles. Almost entire measurements have been completed for Htc Desire Mobile Phone running Android v 2.3.

In this paper they did not examine direct measurement, connected with mobile energy consumption by using measuring equipment. Although a number of studies completed around energy efficiency and conservation, not too much fully emphasis may be put on the effect while using multi-media stream communication situation. A good example is the energy consumption in wireless access network technology.

2. REVIEW PROTOCOL

Energy consumption and also power effectiveness in cellular devices can be performed in different stages. The papers according to study, depending on the kind of the particular optimization they've proposed. This kind of category is classified as following questions:

2.1 Research Questions

Typically the presented in the literature review is usually to provide an overview of the research reported in energy consumption and also conservation for mobile phone devices.

R1: who held responsibility of energy efficiency? Operating systems or applications?

This really is the most important issue related to energy conservation in mobile phones, and possibly the best answers are both. For the operating-system stage, typically the most important concept would reduce energy usage by unifying resource as well as power management and through the utilizing relationship between applications as well as the OS. Actually, an essential component of energy useful resources as well as management has the best knowing of insights on how resources are needed for consumers as well as apps within the system. This section identifies various efforts in the direction of energy aware mobile phone operating system, energy efficient resource management and also useful resource profile.

R2: Is it compulsory to Focusing on how energy is used by the hardware parts so as to design energy efficiency systems?
Absolutely yes, it is important so that they can develop energy aware technique to recognize how energy is going to be used through the hardware components, as well as makes this part to look strong within energy measurements and also determined power models for current Smartphone's.

R3: is battery depletion of mobile, dependent to the user's interaction with application and computing resources?

Battery lifetime became one of the high usability problems with mobile phone systems. For that reason, enhancing battery life time is extremely associated with the best understanding of the way customers communicate with their battery as well as their tools. Any type of energy aware device is required in order to have the ability to know when, where an individual drains battery as well as whenever there'll be near future charging alternatives. For that issue we tend to comprise various papers aiming to discover battery charging periods as well as users' resource needs.

R4: what is the major energy depletion on mobile systems?

Most wireless interfaces are power users with Smartphone devices. There are actually several methods for doing wireless interfaces more effective each and every layer of the standard protocol by getting the benefit of the several power states. On the other hand, they typically involve software, OS as well as network infrastructure co-operation.

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R5: what kind of effect makes sensor optimization in energy consumption of mobile systems?

Location aware programs evolved into one of the main well known services for mobile phone devices. The smart phone offers a sensor which includes network based positioning systems;GPS; accelerometer to get location with various solutions as well as energy needs. Consequently, there is also a tradeoff among energy consumption and trustworthiness. This makes to be released approaches to reduce the energy usage of continuous sensing in the application stage

R6: what is the effect Computation off-loading for energy consumption?

Cloud computing is actually opening up new opportunities for Smartphone systems in several ways. Working out off-loading can be efficient regarding improving the primary computational energy as well as the life of the battery with useful resource limited systems because in the late 90s. Actually, today's Mobile phone operating-system increasingly more via the internet services working in the cloud. Remote execution allows for moving computation through the battery power cellular phones to wall operated, much better efficiency devices hosted someplace via the internet. However, there can be elements which include network state in which can properly influence its own functionality.

2.2 Defining The Literature Body

The process of gathering appropriate literature had been performed. The journals have been determined because we were founded to become part of the research work. We reviewed each and every journal and also conference proceeding that address the goals and objectives of the study, therefore the responsibility of the researchers is always to search the related papers based on exclusion as well as inclusion criteria as described in this paper.

1. The ACM Digital Library (conference and journal paper)
2. IEEE Explore (conference papers)
3. IEEE Transactions
4. Selected Areas in Communications, IEEE Journal
5. IEEE Commun. Surveys Tutorials
6. International Journal on Advances in Telecommunications
7. ScienceDirect. (Ex. Elsevier)

2.3 Inclusion And Exclusion Criteria

The majority of papers which often summarize research about energy consumption and conservation in mobile phone devices are contained also the papers which are on a similar problem of energy depletion and efficiency in mobile devices are included as well. We tend to exclude the papers their solutions do not suggest any outcome on energy mater in mobile device issue. In addition, we ignored informal literature, for example, surveys that do not summarize any kind of research questions within the study.

A. The Source of Energy usage and conservation techniques

In this part, first provides the primary resources for energy usage with regards to a specific standard protocol. After that, it offers an introduction to the most important techniques and also rules that can be used to establish energy effectiveness network protocols.

1. Resources of energy consumption:

This kind of energy used, in the case of network processes, may be categorized directly into two categories: computation as well as communication linked.
Communication requires by using the transceiver for the source, destination and intermediate nodes.
A transmitter may be used for sending control, path require as well as effective, in addition to data packages originating in or directed with the transferring node. A receiver enables you to acquire data as well as handling packets. Many of which are intended to the receiving node plus some that can be sent. Having the power features within the mobile radio for wireless devices is essential for the effective type of communication standards.
The standard mobile radio might take place within three techniques: transmit, receive, as well as standby. The highest power of energy is used during the transmit option, as well as smaller during the on standby option. For instance, the actual Proxim RangeLAN2 for 2.4 GHz, 1.6 Mb per second, PCMCIA card

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typically takes 1.5 w with transmit, 0.75 w in receiving, as well as 0.01 w for standby option. Furthermore, turn-around among transmit as well as receive methods or vice-versa normally requires somewhere within 30 and 6 micro-seconds. Energy usage regarding Lucent's 15 dBm 2.4 GHz, 2 Mbps Wavelan PCMCIA card are 1.82 w in transmit option, 1.80 w in receive option, as well as 0.18 w in standby option. Therefore, some intention for standard method enhancement with regard to environments together with minimal energy resources requires for you to maximize the transceiver consumption with a given communication task [8].

There's a prospective tradeoff in between computation as well as communicating costs. Approaches which strive to reach lower communication charges could lead to greater computation requires, and vice versa. Consequently, methods which are designed by using energy-efficiency goals and objectives need to seek to affect balance in between both costs.

B. Energy Consumption Measurement

There are lots of programs that can measure the energy consumption of the smart phone. Nevertheless, they can't produce exact battery consumption measurements. Therefore, they choose Arduino Duemilanove board [17] to evaluate the power usage of multimedia in Samsung Galaxy S3.

Fig.1 (I), Fig.1 (II) present the actual setup associated with measurement in [6]. Voltage drop (VD) over resistor R1 is mentioned. The present intensity is counted by using formulation:

$$I = \frac{V_D}{R_1}$$

Voltage from the positive terminal associated with power can be analyzed, therefore power is considered by using an equation:

$$P = I \times V_p$$

This calculation is performed in this paper that is the Java application working on a Dell Inspiron N4030 laptop computer.

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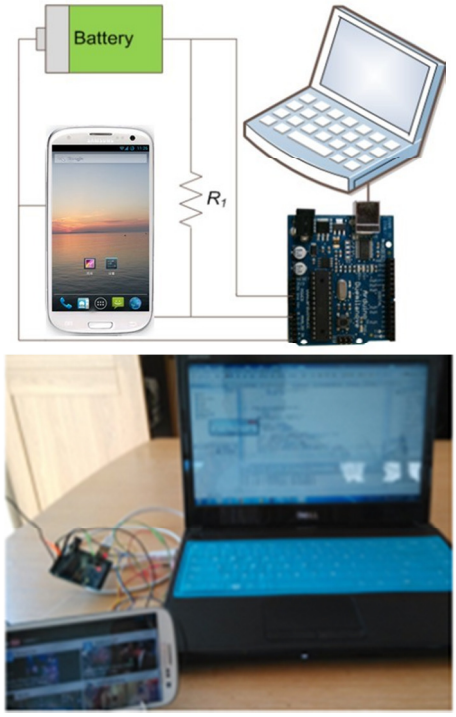

Figure. 1 (a) Schematic of Energy Consumption Measurement (b) Energy Consumption Measurement using Test-bed

3. ENERGY MEASUREMENTS METHODOLOGY

Most papers [32,33,35] designed for its measurement is known as a Nokia N 95 [33], that's functioning Symbian Operating-system 9.2. When creating the main measurement, they start to use piece of source code to manage the mobile phone. This approach ensured that they study the consumption without the need of connecting directly while using a mobile phone, eliminating in order to present keys also to include backlight for the display switched on, which may bring on misleading outcome.

In [32, 35], the authors applied Python language for S 60 just like programming language to develop the pieces of code for Testing, and also for the implemented python with S60 to handle the TCP data transfers since they are used to establish the voice calls. They start to identify that there's no important penalty fee in the case of energy as well as performance while implementing the Python platform compared to the standard Symbian or C++ while using energy stages, they address all through this paper.

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In [32,34,35], the authors perform the measurement study considering the following aims:
1. Examine the actual power usage features of 3G, Bluetooth, Peer-to-peer, GSM as well as Wi-Fi and evaluate the portion of energy used for transfer of data as opposed to overhead.
2. Examine the alternative for the power overhead together with a geographical area, mobility, time of the day, as well as devices.
3. Establish a basic power design in order to measure the energy usage across 3G, Wi-Fi, Bluetooth, Peer to peer as well as GSM to be a purpose of the inter transfer times as well as transfer size.

3.1 Energy Measurements Results

In [34], the measurable outcomes of the power usage mostly for the purpose of data transmission as well as other solutions usually are introduced while using testbed explained in the previous sections.The main objectives of this paper are always to retrieve the energy depletion of a single dedicated technology. The values regarding power and also energy stages presented in this paper are received by running the actual experiment for many times after calculating the result

3.1.1 Data communication:

The data communications can be Implemented WiFi, Bluetooth as well as mobile communication along with 3G or 2G technologies. Because the mobile technology is straightforward. There're simply concentrating on the short range systems which include WiFi and also Bluetooth [43] since there are different communication states.

3.1.1.1 Bluetooth (different states)

Bluetooth is defined as a widely spread short range communication technology applied in the majority of smartphones at present. When Bluetooth was launched, it was supposed to replace a cable in order to connect or attach devices easily. As opposed to a number of different wireless technology, Bluetooth includes embedded service mechanisms to support various services. Within table 1 energy usage for various kinds of Bluetooth states are provided, Through examining the energy with Bluetooth [44] while it is turned on as well as whenever it is turned off.

3.1.1.2 WiFi

In the following sections, they intestate WiFi technique, IEEE 802.11 regarding infrastructure as well as ad hoc setting.

3.1.1.2.1 Infrastructure Mode

These kind of measurement in a Nokia N 95 used to connect the WLAN Access Point (AP) using IEEE 802.11b/g within an architecture mode. The gap between AP as well as mobile phones in the range of 5 to 3 M. After the phone receives data from the access point, TCP/IP communication has been used. Table 1 presents the power values of WiFi while applied to infrastructure mode for Five different states, such as: Connection, Dicconnection, Idle, Idle power saving mode and Receiving.

3.1.1.2.2 Ad hoc mode

Using test to find an adhoc method, two Nokia N 95 were used; one working as a server another one as a client. Since the phone was communicated through the internal IEEE 802.11 b/g cards, that the amount of 2 Megabytes was probably transferred to the server into the client with the use of TCP. Additional circumstances influencing the data rate such type of an interference isn't considered in this measurement.

3.1.1.3 Different Wireless Technologies for downloading Data

In fig. 2 the energy for each bit used while downloading Five hundred KB with some technologies, such as Bluetooth, GPRS, HSDPA, as well as WLAN can be presented. The power or energy used is simply plotted through the data level. Whenever downloading, utilizing WLAN, the relationship was occurred infrastructure option. The space through the Access point is roughly 5-3 m.

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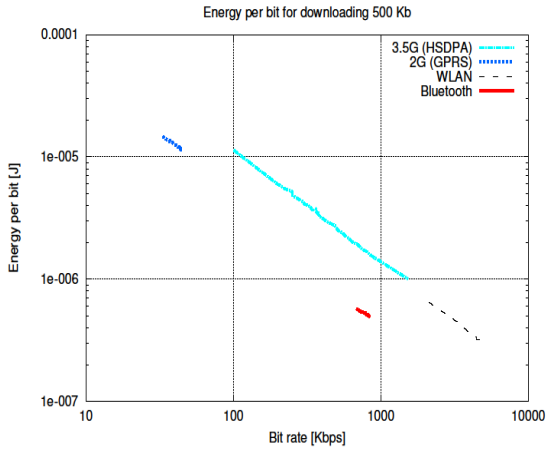

Fig. 2: Energy per bit for downloading 500 KB using different wireless technologies

3.1.2 Cellular Link Services:

3.1.2.1 Handoff

For table 1 energy as well as power values of creating a handful from 3G to 2G systems as well as vice-verse is provided. This measurement is used in Denmark, Aalborg through a SonofonSim card. Final results indicate the energy rates are higher for moving from 2G to 3G network types compared to the other way around.

3.1.2.2 voice call

The amount of energy of the phone calls is provided by using a mobile with voice call for five min among two mobile devices for each. After that, the average of the energy usage on both mobile phones for all the tests was computed.

3.2.2.3 Video call

The energy consumption for video call are provided by making or achieving a mobile video call of one minute. In addition to establishing the average of the energy rates. The average values of the result are provided in the Table1. Additionally, it may observe that there's no difference between initiating and receiving a video call.

3.2.2.4 SMS

Texts sent through the use of SMS are often secured in a different way: 16 bit UTF 16/UCS 2 alphabet, the 8 bit data alphabet and GSM 7 bit alphabet. Based on what alphabet of the message is written. The highest size for each SMS are 70 in 16 bit characters, for 140 in 8 bit characters or for 160 in 7 bit characters.

In [33], they applied various kinds of data resources. Considering that the performance on the data stream has effects on the final outcomes, they made an effort to discover representative test cases for end connectors, specifically, differ within the performance. The main test case was with the Machine in Apache. That it was attached both to public 3G network as well as to the WLAN. This situation, designed for 3G networks, became slower, approximately Fifty (50) kB per second at maximum. The test case known as "HIT" shown a general public web service With the voice call studies, before a data transfer rate they produced a voice call to a different phone with a various network operator together with a two directional flow of words in the analysis phase.

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Table 1: different parts Energy Consumption of the mobile phone.

Technology		Action	Power [mW]	Energy [J]
Wireless data	Bluetooth	BT off	12	
		BT on	15	
		BT connected and idle	67	
		BT discovery	223	
		BT receiving	425	
		BT sending	432	
	WiFi IEEE802.11 (infrastructure mode)	In connection	868	8.2
		In disconnection	135	0.4
		Idle	58	
		Idle in power save mode	26	
		Downloading@4.5Mbps	1450	
	WiFi IEEE802.11 (ad hoc)	Sending @ 700 kB/s	1629	
		Receiving	1375	
		Idle	979	
	2G	Downloading@44Kbps	500	
		Handover 2G->3G	1389	2.4
	3G	Downloading@1Mbps	1400	
		Handover 3G->2G	591	2.5
Miscellaneous	CPU usage	2%	55	
		25%	310	
		50%	462	
		75%	561	
		100%	612	
	Mobile TV	Watching Mobile TV with DVB-H	790	
	Display	Black background 20% intensity	63.0	
		Black background 60%	98.65	
		Black background 100%	259.65	
		White background 20%	196.56	
		White background 60%	254.16	
		White background 100%	527.05	
		Screensaver mode	13.86	
	Memory	Saving 1 Mb on drive C	587.7	56.2
		Saving 1 Mb on drive E	612.8	36.4
		Saving 1 Mb on drive D	560.0	2.2
Mobile	Voice	Making a voice call (3G)	1265.7	
		Receiving a voice call (3G)	1224.3	
		Idle (3G)	25.3	
		Making a voice call (2G)	683.6	
		Receiving a voice call (2G	612.7	
		Idle (2G)	15.1	
	Video	Making a video call (3G)	2210	
		Receiving a video call (3G)	2145	
	SMS	100 bytes length (2G)		1.72
		150 bytes length (2G)		2.35
		200 bytes length (2G)		2.52
		250 bytes length (2G)		2.64
		300 bytes length (2G)		3.15
		100 bytes length (3G)		2.24
		150 bytes length (3G)		3.22
		200 bytes length (3G)		3.42

The device became stationary over those measurements to minimize particular field strength variability in addition to reduce ultimate handovers due to the activity of the system.

Table 2: different connections and servers through TCP measurement.

		Power (W)	Speed (kB/s)	Time (s)	Energy (J)
Test	WLAN download	1.1	143.1	18.0	20.0
	WLAN upload	1.1	115.3	22.3	23.7
	3G download	1.3	48.3	53.3	69.0
	3G upload	1.3	43.2	59.7	75.6
Funet	WLAN download	1.4	435.1	50.0	71.3
	3G download	1.5	272.0	80.0	119.2
Hit	WLAN download	1.2	143.3	18.7	21.3
	3G download	1.5	128.7	20.3	29.4

In [32], they have different measurements (such as WIFI,GSM and 3G), for GSM as well as 3G measurements to evaluate the: I) Ramp energy: the power required to change to the higher power state, II) Tail power: the power put in higher power state after a finishing of the transfer,and III) Transmission energy. They carry out measurements to find data moves of various sizes (from 1-1000 KB) by using different intervals (1-20 seconds) among effective transfers. They evaluate power usage through performing NEP in the background, even although for creating data exchanges.
To find WiFi measurements evaluate the power: I) to be able to scan as well to connect an access point II) to exchange data.

They run 2 types of measurements. During the first type of measurement, every single data transfer usage, they find WiFi to provide an accessible access point in order to allow the data transfer. For the second type of measurements, they simply establish a single scan as well as connection for the whole data set exchanges in order to identify the transfer efforts. Also, these three networks, GSM, WiFi as well as 3G, get on a maintenance, the energy employed to maintain the interface. They approximate the maintenance energy for each second through calculating the entire power used in order to prevent the interface for a time period.

Additionally, they generate measurements to the side of accounting regarding idle power, they manage the mobile with the low energy mode, switch-off the display as well as unwanted network interfaces. The power profile by itself needs a small number of power, which use in the idle energy

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measurement. They evaluate idle power by allowing the power profile work device without additional application activity.

4. ENERGY CONSUMPTION:

Mobile devices are showing a promising trend, while using implementation devices in several problems have surfaced that should be handled so as to maintain the increase of mobile devices available in the marketplace. The main challenges involve power, capacity, security, as well as quality. The aim of this paper is to conduct a systematic literature review on energy consumption and conservation in mobile phone and study several aspects as well as components of mobile devices.

4.1 The Effects Of 3G And 2G Network Usage For Battery Consumption In Mobile Devices

The investigation of mobile phones in the last years has been significant. Within 10 years the mobile devices, applying text messaging and voice services, become real multimedia systems. This approach of evaluation is dependant on Moore's Low. Video and Music players, inbuilt GPS devices, large data level for Internet connection, short range communication technologies, high quality cameras are only a few examples of what mobile phones can provide. Several solutions are designed with these technologies. All of these services and applications are employing the wireless air interface of the phone for communicating. Energy consumption for various mobile phone services is clear that occurs. It is clear that all the characteristics that indicate using wireless air interfaces are power hungry, consequently, essentially for minimizing battery lifespan on the phone. It's an issue in which the phones' makers need to handle due to the fact sometimes all areas of computing technology development as reported by Moore's law, as well as the battery.

Some related works in [9,10,11], the authors designed a wide energy or power measurement strategies with a commercially produced mobile, like Nokia N 95. This paper proposed results of energy and power usage measurements performed on mobiles for 3G and 2G networks. The services under study are data, voice and text messaging. The paper studies larger power usage with voice services compared to energy consumption in 2G networks as well as 3G network for text messaging. However the 3G networks are more powerful if a bulk of data needs to download. The results suggest that smartphones have to change or switch the network in order to save the energy.

The purpose of the energy ineffectiveness of signaling with wireless networks is described in [15], through the tail and ramp energy elements. The tail and ramp power elements are a response to control protocol states in WCDMA. The 3G network protocol is responsible for channel allocation as well as the energy used by the radio depending on the time [16].

In [36], they consider the primary process in understanding efficiency as well as energy characteristic of 4G LTE systems. Using publicly implemented 4G Test, they discover that LTE provides significantly greater downlink plus uplink throughput, compared with WiFi and even 3G. To be able to define power usage for LTE, they derive the first comprehensive energy type of a commercial LTE network, having under 6 % error rate. By using the energy model to a comprehensive dataset, UMICH, they observe that LTE is much less power efficient than WiFi, and also the main factor is the tail energy, handled by Ttail.

Fig.3.Nokia N 95 connected to the agilent 66319d equipment.

4.2 On The Impact Of Wi-Fi Network Usage For Battery Consumption In Mobile Devices

With the need to remain connected these days, battery drain will become an essential interest for every mobile phone data user. Tablet or even Mobile phones have several tweakable

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data connectivity configuration settings. Wi-Fi hotspots tend to be shown everywhere, yet all of these appear to improve the confusion in regards to what kind of connectivity drains your battery much faster. In [12] they provide a detailed anatomy for the power consumption through several elements in WiFi based mobile devices. They investigated the power usage for a number of workloads from different elements. The effects of scan operations as well as related problems with the energy consumption on Wi-Fi phones tend to be quantified via specific measurements. A variety of inferences as well as guidelines are presented for enhancing the energy saving strategies using Wi-Fi- based mobile devices.

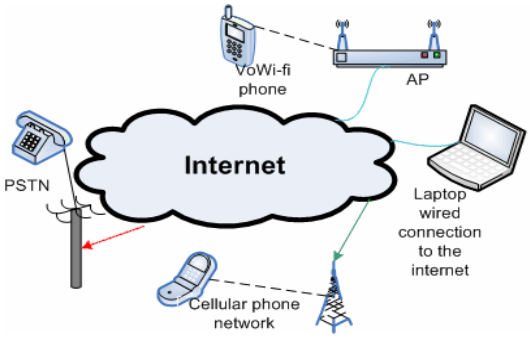

Figure. 4. Voice over internet Protocol (VoWi-Fi)

Also in [13] presented WiFisenseon Android Development Phones [14], an energy effective Wi-Fi sensing system which maximizes the use of Wi-Fi networks in mobile phone. They first analyze optimal sensing interval via analysis, which reveals important aspects, for example user's activity in addition to local Access Point density, to find energy effective Wi-Fi sensing. Then they recommend the WiFi sense design that covers each disconnected as well as associated cases of Wi-Fi sensing. Its main, WiFi sense works with the minimum power accelerometer to be able to infer user's activity, as well as additional finds local network information to decide sensing frequency. Flexible sensing triggering algorithms are introduced to enhance Wi-Fi sensing frequency also to minimize false triggering. They applied WiFisense in Android based mobile phones in addition to evaluated its efficiency extensively. In [37], they propose a powerful architecture known as cool-tether which employs the cellular radio links of one or more smartphones in the vicinity,also develops a WiFi hotspot on-the-fly, and gives effective energy, affordable connectivity. Prior methods for helping this type of tethered method operation have depended on the WiFi ad hoc mode, which restricts the main factor of conserving battery energy on mobiles.

The paper [38], the energy efficiency of WiFi tethering. They demonstrate a Wi-Fi tethering for pre-existing mobile phones are power hungry and wastes power or energy unnecessarily, however, there are various chance for energy saving by placing a mobile Soft Application to sleep. They suggest system called DozyAP, its ability to enhance the energy efficiency with Wi-Fi tethering. This application was implemented with light-weight in sleep request and response protocol for a mobile phone.

4.3 The Impact Of Bluetooth Network Usage For Battery Consumption In Mobile Devices

Nowadays, mobile phones are all equipped with Bluetooth, which enhance their cellular communication functions. The Bluetooth was initially placed in mobiles for personal area communication, for example wireless earphones, synchronization using a close by Computer system, as well as tethering. This kind of local communication may be possibly carried out through Bluetooth. Some could possibly be performed while relying on a common nearby access point. When it comes to this technology, the important issues to consider may include the accessible throughput as well as energy usage is an important factor. Because Bluetooth has been planned for personal area communication.

In [17], they present an energy as well as throughput review associated with Bluetooth for today's mobile phones, that they check out the relationship between energy or power as well as obtained throughput, and also the energy usage within the different states associated with the wireless interfaces.

4.4 The Impact Of P2P Network Usage For Battery Consumption In Mobile Devices

Systems are able to store gigabytes of digital content to become ubiquitous, which makes a perfect environment with Peer-to-peer content sharing and also delivery. Although, the always-on communication designs of peer-to-peer networks usually are not a perfect suit for energy limited mobiles [18].

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The purpose is that, they study a new approaches, ideas are simpler to work in the simulated environment compared to actual systems. Theoretical analysis and Simulations are normally adequate to display related developments derived from new algorithms. However, they aren't able to assess the practical application of these kinds of systems. The actual measurements are essential to enhance the simulation as well as theoretical. The quantitative value defines the energy usage are essential in examining the possibility of mobile Peer-to-peer strategies on today's systems [19].
In [18], they study a practical associated with implementing The structure that confers on mobiles from the viewpoint of power usage. This paper helps to make three advantages. First, the port of a second generation Peer-to-peer protocol onto an embedded computing environment like the HP iPAQ, as well as evaluate its power usage having a high precision measurement platform.

Figure 5. The small sensor network gateway for Stargate is running Linux, and is almost same as an HP-iPAQ.

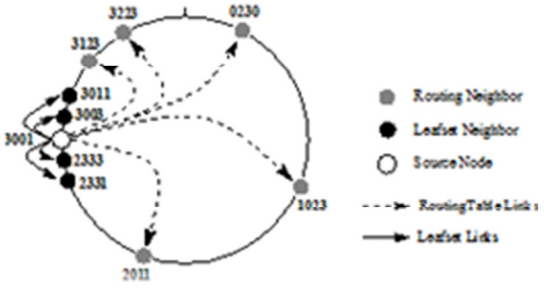

Fig 6: Prefix routing.

Each overlay nodes, for example 3001 maintains a leaf set of neighbors near by namespaces, in addition to the routing table that comes with choosing nodes delivered through the namespace. Names are displayed as base 4. This approach requires a first step by carrying out actual power measurements using a working application and its protocol. The original results signifies that it's possible to use light-weight Peer-to-peer protocols, and also applications for minimal power, embedded systems. Additionally, there's essential for energy savings when overlay messages may be batched and transmitted periodically.

Also in [19], they look at sharing files using the BitTorrent technologies. Since BitTorrent is popular and allow us to share useful information. This makes an opportunity to make a multimedia system in Bit-torrent can be an increasingly related application with mobile phone devices. This paper explains a number of experiments, which obtained a detailed measurements with BitTorrent power usage on mobile devices. The measurements that had been carried out with SymTorrent client about three different types of Nokia S 60 mobile phone devices indicate that P2P information sharing on Handhelds is practical from the power consumption opinion.

Table 3. Comparison of power consumption in different connections and phone models

Connection	Model	Download time	Active (W)	Passive (W)	Energy (J)
SymTorrent 3G	N80	4'55"	1.20	0.48	353.4
	E61	7'20"	1.11	0.37	490.3
	N95	2'25"	1.44	0.40	208.1
SymTorrent WLAN	N80	2'10"	1.10	0.18	142.4
	E61	2'16"	1.20	0.09	163.5
	N95	1'30"	1.51	0.12	135.5
HTTP 3G	N80	4'10"	1.17	0.05	292.1
HTTP WLAN	N80	0'48"	1.17	0.18	56.0

Final results indicate that acting as uploading contents for various users doesn't contribute to further power usage during effective downloading.

4.5 On The Impact Of Android Phones When Using Wireless Communication

Wireless communication technologies allow communication between the various systems in a certain radius. However, this radius is defined, communication when utilizing wireless communication technology is more flexible compared to when using wire-line approach.

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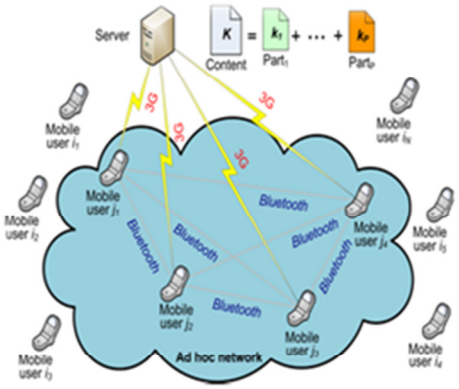

Figure 7. Collaborative Downloading service for the system model

In [7], they present a measurement study of power consumption as well as throughput when working with 3G,Wi-Fi and Bluetooth communication technologies within Android mobile phone.they consider relationships between elapsed time and the energy consumption, in addition to the amount of transferred data and power consumption when working with above communication technologies. Based on those measurements, they designed a power consumption model with Android mobile phones. For all measurements are implemented on the Htc Desire Mobile Phone working Android operating system v.2.3.

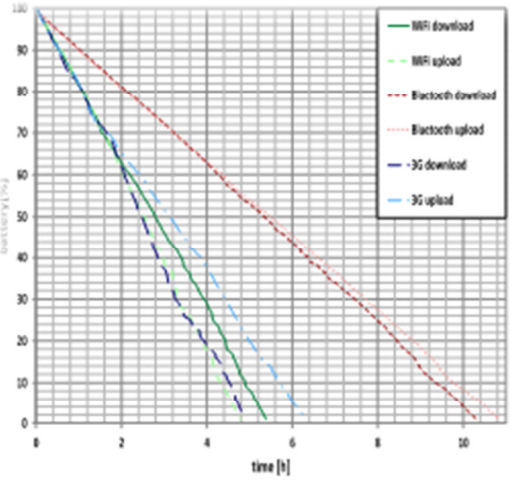

Fig. 8. Elapsed time compared to the Energy consumption

The measured data are received and examined. With the basic power consumption model for the Android mobile phone was designed. Applying their model, they proved the way to evaluate power consumption for the Collaborative Downloading service. Our primary strategy is to combine various communications while downloading into separate files, and minimize the number of power needed to move the whole file to a number of users in mobile phones.

Measurements were created having an android app that they were uploading or downloading data continuously.

In [2], examines the relationship involving the wireless environment and also the power usage for the video sending in mobile phones. This study presents the network load and the wireless link quality. The effect of the power usage from the Android mobile phone performing on demand streaming through an IEEE 802.11g network.

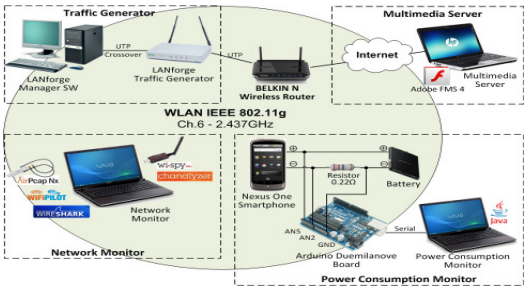

Fig. 9. Multimedia Server, Traffic Generator, Power Consumption Monitor and Network Monitor.

This research provides a better understanding of the device's power consumption as well as demonstrated the need for considering related network parameters, for example network load, link quality when building power efficient wireless video transmission strategies. Additionally, it shows power saving benefits derived from the use of an adaptive multimedia device.

5. ENERGY CONSERVATION IN MOBILE DEVICES

5.1 Middleware Design For Energy Conservation For P2P Network In Mobile Device

Usage of mobile phone in Peer-to-peer networking presents challenges that always don't relate to Peer-to-peer [47-49] networks which includes only stationary computer systems. A

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number of Peer-to-peer system optimizations associated with phones were offered by researchers. Specialized strategies for enhancing the resource by using phones are proposed. Resource considered in the studies may include data storage space, processing capacity, and network traffic capacity. Power consumption, because phones have limited battery capacity, is an essential part in the study of mobile computing systems. All operations of mobile device consume power, however the wireless network interface can affect the energy consumption significancy [20].
Additionally, the hardware level enhancements in energy effective are essentially trade for the maximize functionality of the systems [21]. Connectivity operations is a term for the control over the networking resources on the smart phone. Prediction of primary network situations may be utilized to make the data transmissions of an application more energy efficient [22]. Cross-layer collaboration within the device, helped by end to end network details, may be used for reducing the power consumption on the smart phone [23].

In [24], they study the energy-efficiency of a BitTorrent program, in which proxy servers being used as assistant nodes for the collaborating mobile nodes, from the perspectives on the smart phone by itself as well as the actual server structure. It's observed that home routers may behave as a distributed proxy system in a bandwidth-efficient and energy effective way.

The analysis by [24] provides measurements of power consumption for each bit in a smart phone to use of communication bit rate. A more significant bit rate contributes to better energy-efficiency. Although, the relationship between the amount of transmitted or received data and the power consumption is generally non-trivial.
The specific features of the mobile phone usage environment may be used for allowing various consumption examples for Peer-to-peer systems.

In [25] present a location based method for media sharing between mobile phone Peer-to-peer users. Additionally, in [26] present a software program infrastructure for social interaction in the framework of mobile phone Peer-to-peer apps. This program records as well as exploits social knowledge to enable social aware services, like functionalities such as inferring the social contexts and the involved communities. The program provides for user deployed services as well as eliminating the requirement for common parts that control the social data.

5.2 Global Context-Aware Power Management For Mobile Phones Balance Battery Life And User Experience.

Power conservation for phones has become more essential because of the increasing a benefit that mobile phones provide in our daily life. There's strategies already being used by researchers, however, this approach, whether directly focus on a specific subsystem of the mobile phone for example the phone display [30], sensor system [29] [45], or the positioning system [31] [46]. Those approaches are given voluble strategies to develop the power efficiency of each sub component for Smart phones, however, they did not provide a global platform to prevent power outrage with users instead of increasing the experience of the users.

In [27], they propose a good global context aware power management system, in order to estimate the lifespan of the battery while concessions end user experience as low as possible. They consider users' normal mobile phone usage, power consumption patterns, as well as user experience requirements for a number of smartphone components. Their strategy uses a Markov Decision Process (MDP), to manage the power usage of different elements. The main issue in developing their power management problem as an MDP would be to effectively determine power-saving actions, the user states and a reward per action in which reach their energy management objectives.

To prove this concept, they control the power usage of both the GPS and display on the phone. They incorporate user contex, such as location, mobile phone usage, and mobility, time of day as well as the current battery level as composite Status, and establishing different display brightness stage as well as GPS testing times as actions. The reward performs that maps every action with a reward value promotes greater user experience while sufficient power is present, and promotes power saving actions when required to ensure that the target battery

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lifetime can be obtained without interruption: when power outage arises prior to the end of the day they determine a reward of, also their reward power saving actions with a higher user experience values depending on their own classifications under various context in Table 2.

Table 4: Defined experience of the user under several contexts.

(a) $U_{display}$

Brightness level	Indoor space	Outdoor space
20%	1	-∞
40%	2	-∞
60%	3	1
80%	4	3
100%	5	5

(b) U_{gps}

Sampling interval	Low mobility	High mobility
60 secs	1	-∞
30 secs	3	-∞
10 secs	5	1
5 secs	5	3
1 sec	5	5

5.4 Energy Management Technique In Perspective To The Operating System.

Controlling power efficiency is essential in today's smartphone. The diverse range of sensors and wireless interfaces, and also make full use of these types of resources can minimize the life of the battery of mobile phone to a couple of hours of operation. Although, the state of the ability of lithium ion batteries clearly implies that energy-efficiency should be reached both at the software and hardware level.

In a very recent article [28], Crowcroft and vallina-Rodriguez investigated mobile phone power management techniques in the following viewpoints: (1) energy aware operating systems [47, 48, 49], (2) effective useful resource management, (3) the effect of users' interaction designs by using mobiles with cloud computing services. When they did talk about the wireless communication aspect.

6. CONCLUSION

In this symmetric literature review presented a detailed for the power consumption and energy conservation in mobile devices. This paper provides the reader a feeling in which energy or power is required, which allow as to design power aware protocols in order to minimize power consumption.

However, efforts performed by hardware manufacturers and operating system venders for example Android and IOS mobile phone are power hungry devices for the reason that they incorporates hardware resources for energy consumption for example touch screen, sensors, location, display, as well as the internet multimedia services usually communicate with the network. For this matter, we propose a complete research into the energy consumption of the current mobile phones that determine the energy consumption entities.

In our study, we introduced a lot of energy consuming elements for mobile phones in the wireless technology. The minimum energy consumption is best for data connection should be used by 3G technology, while voice calls should be used 2G network and For the Bluetooth should be used only for some data is required to be transferred. Also WiFi should be used When a large data need to transmit. This approach makes opportunities for new solutions that include the local communication together with cellular communication.

REFERENCES

[1] Cisco Systems, Inc., "Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2010–2015," 2011.

[2] Trestian, R., Moldovan, A. N., Ormond, O., &Muntean, G. (2012, April).Energy consumption analysis of video streaming to android mobile devices. In *Network Operations and Management Symposium (NOMS), 2012 IEEE* (pp. 444-452). IEEE.

[3]Rodoplu, V., &Meng, T. H. (1999). Minimum energy mobile wireless networks.*Selected Areas in Communications, IEEE Journal on*, *17*(8), 1333-1344.

[4] Xiao, Y., Kalyanaraman, R. S., &Yla-Jaaski, A. (2008, September). Energy consumption of mobile youtube: Quantitative measurement and analysis. In*Next Generation Mobile Applications, Services and Technologies, 2008. NGMAST'08.The Second International Conference on* (pp. 61-69). IEEE.

[5] NarseoVallina-Rodriguez and Jon Crowcroft. Energy management techniques in modern mobile handsets.IEEECommun. Surveys Tutorials, PP(99):1 –20, 2012.

[6] Ding, T., Yuan, Z., Chen, S., &Muntean, G. M. (2014, January). Smartphone energy consumption models for multimedia services using multipath TCP. In*Consumer Communications and Networking*

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

Conference (CCNC), 2014 IEEE 11th (pp. 239-244). IEEE.

[7] Kalic, G., Bojic, I., &Kusek, M. (2012, May). Energy consumption in android phones when using wireless communication technologies.In *MIPRO, 2012 Proceedings of the 35th International Convention* (pp. 754-759). IEEE.

[8]Jones, C. E., Sivalingam, K. M., Agrawal, P., & Chen, J. C. (2001). A survey of energy efficient network protocols for wireless networks. *wireless networks*,*7*(4), 343-358.

[9] F. Fitzek and M. Katz, editors. Cooperation in Wireless Networks: Principles and Applications – Real Egoistic Behavior is to Cooperate! ISBN 1-4020-4710-X. Springer, April 2006.

[10] G. Perrucci, F. Fitzek, G. Sasso, and M. Katz. Energy saving strategies for mobile devices using wake-up signals.InMobiMedia - 4th International Mobile Multimedia Communications Conference, Oulu - Finland, 2008.

[11] Perrucci, G. P., Fitzek, F. H., Sasso, G., Kellerer, W., &Widmer, J. (2009, May).On the impact of 2G and 3G network usage for mobile phones' battery life.In*Wireless Conference, 2009. EW 2009. European* (pp. 255-259). IEEE.

[12]Gupta, A., &Mohapatra, P. (2007, June). Energy consumption and conservation in wifi based phones: A measurement-based study. In *Sensor, Mesh and Ad Hoc Communications and Networks, 2007. SECON'07.4th Annual IEEE Communications Society Conference on* (pp. 122-131). IEEE.

[13] Kim, K. H., Min, A. W., Gupta, D., Mohapatra, P., & Singh, J. P. (2011, April). Improving energy efficiency of Wi-Fi sensing on smartphones. In *INFOCOM, 2011 Proceedings IEEE* (pp. 2930-2938). IEEE.

[14] Open Handset Alliance (Android), http://www.openhandsetalliance.com/

[15] N. Balasubramanian, A. Balasubramanian, and A. Venkataramani, "Energy Consumption in Mobile Phones: A Measurement Study and Implications for Network Applications", in, *ACM Internet Measurement Conference*, Chicago, USA, 2009, pp. 280-293.

[16] H. Haverinen, J. Siren, and P. Eronen, "Energy Consumption of Always-On Applications in WCDMA Networks," in, *IEEE Vehicular Technology Conference*, Dublin, Ireland, 2007, pp. 964-968.

[17]Friedman, R., Kogan, A., &Krivolapov, Y. (2013). On power and throughput tradeoffs of wifi and bluetooth in smartphones. *Mobile Computing, IEEE Transactions on*, *12*(7), 1363-1376.

[18] Gurun, S., Nagpurkar, P., & Zhao, B. Y. (2006, September).Energy consumption and conservation in mobile peer-to-peer systems.In *Proceedings of the 1st international workshop on Decentralized resource sharing in mobile computing and networking* (pp. 18-23). ACM.

[19]Nurminen, J. K., &Noyranen, J. (2008, January). Energy-consumption in mobile peer-to-peer-quantitative results from file sharing. In *Consumer Communications and Networking Conference, 2008. CCNC 2008. 5th IEEE* (pp. 729-733). IEEE.

[20] Pering, T., Agarwal, Y., Gupta, R., & Want, R. (2006, June).Coolspots: reducing the power consumption of wireless mobile devices with multiple radio interfaces. In *Proceedings of the 4th international conference on Mobile systems, applications and services* (pp. 220-232). ACM.

[21] Pentikousis, K. (2009, September). Pitfalls in energy consumption evaluation studies.In *Wireless Communication Systems, 2009. ISWCS 2009. 6th International Symposium on* (pp. 368-372). IEEE.

[22] Kalyanaraman, R. S., Xiao, Y., &Ylä-Jääski, A. (2010). Network Prediction for Energy-Aware Transmission in Mobile Applications. *International Journal on Advances in Telecommunications*, *3*(1 and 2), 72-82.

[23] Mohapatra, S., Dutt, N., Nicolau, A., &Venkatasubramanian, N. (2007). DYNAMO: A cross-layer framework for end-to-end QoS and energy optimization in mobile handheld devices. *Selected Areas in Communications, IEEE Journal on*, *25*(4), 722-737.

[24] Kelenyi, I., Ludanyi, A., &Nurminen, J. K. (2010, August). BitTorrent on mobile phones-energy efficiency of a distributed proxy solution.In *Green Computing Conference* (pp. 451-458).

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

[25] Kotilainen, N., Kriara, L., Vandikas, K., Mastorakis, K., &Papadopouli, M. (2008). Location-based media sharing in a MP2P network. *ACM SIGMOBILE Mobile Computing and Communications Review*, *12*(1), 62-64.

[26] Borcea, C., &Iamnitchi, A. (2008, October). P2p systems meet mobile computing: A community-oriented software infrastructure for mobile social applications. In *Self-Adaptive and Self-Organizing Systems Workshops, 2008. SASOW 2008. Second IEEE International Conference on* (pp. 242-247). IEEE.

[27] Xu, C., Srinivasan, V., Yang, J., Hirase, Y., Tapia, E. M., & Zhang, Y. (2014). Boe: Context-aware Global Power Management for Mobile Devices Balancing Battery Outage and User Experience. IEEE MASS.

[28] Vallina-Rodriguez, N., &Crowcroft, J. (2013). Energy management techniques in modern mobile handsets. *Communications Surveys & Tutorials, IEEE*, *15*(1), 179-198.

[29] Nath, S. (2012, June). ACE: exploiting correlation for energy-efficient and continuous context sensing. In *Proceedings of the 10th international conference on Mobile systems, applications, and services* (pp. 29-42). ACM.

[30] Dong, M., &Zhong, L. (2012). Chameleon: a color-adaptive web browser for mobile OLED displays. *Mobile Computing, IEEE Transactions on*, *11*(5), 724-738.

[31] Zhuang, Z., Kim, K. H., & Singh, J. P. (2010, June). Improving energy efficiency of location sensing on smartphones. In *Proceedings of the 8th international conference on Mobile systems, applications, and services* (pp. 315-330). ACM.

[32]Balasubramanian, N., Balasubramanian, A., &Venkataramani, A. (2009, November). Energy consumption in mobile phones: a measurement study and implications for network applications. In *Proceedings of the 9th ACM SIGCOMM conference on Internet measurement conference* (pp. 280-293). ACM.

[33] Nurminen, J. K. (2010, January). Parallel connections and their effect on the battery consumption of a mobile phone. In *Consumer Communications and Networking Conference (CCNC), 2010 7th IEEE* (pp. 1-5). IEEE.

[34] Perrucci, G. P., Fitzek, F. H., &Widmer, J. (2011, May). Survey on energy consumption entities on the smartphone platform. In *Vehicular Technology Conference (VTC Spring), 2011 IEEE 73rd* (pp. 1-6). IEEE.

[35] J. Scheible and V. Tuulos. Mobile Python: Rapid Prototyping of Applications on the Mobile Platform. Wiley, ISBN: 978-0-470-51505-1, 2007.

[36] Huang, J., Qian, F., Gerber, A., Mao, Z. M., Sen, S., &Spatscheck, O. (2012, June). A close examination of performance and power characteristics of 4G LTE networks.In *Proceedings of the 10th international conference on Mobile systems, applications, and services* (pp. 225-238). ACM.

[37] Sharma, A., Navda, V., Ramjee, R., Padmanabhan, V. N., & Belding, E. M. (2009, December). Cool-tether: energy efficient on-the-fly wifihot-spots using mobile phones. In *Proceedings of the 5th international conference on Emerging networking experiments and technologies* (pp. 109-120). ACM.

[38] Han, H., Liu, Y., Shen, G., Zhang, Y., & Li, Q. (2012, June). Dozyap: power-efficient wi-fi tethering. In *Proceedings of the 10th international conference on Mobile systems, applications, and services* (pp. 421-434). ACM.

[39]P. Mohan, V.N. Padmanabhan, R. Ramjee, "TrafficSense: Rich Monitoring of Road and Traffic Conditions Using Mobile Smartphones", 2008

[40] R. Friedman, A. Kogan, "Efficient Power Utilization in Multi-Radio Wireless Ad Hoc Networks", Proc. Int'l Conf. Principles of Distributed Systems, pp.159-173.

[41] R. Friedman, A. Kogan, "Power Aware Management Middleware for Multiple Radio Interfaces", Proc. Middleware Conf., pp.288-307.

[42] G. Ananthanarayanan, I. Stoica, "Blue-Fi: Enhancing Wi-Fi Performance Using Bluetooth Signals", Proc. ACM MobiSys, pp.249-262.

[43] P. Bonnet, A. Beaufour, M.B. Dydensborg, M. Leopold, "Bluetooth-Based Sensor Networks", SIGMOD Record, no.4, pp.35-40, 2003

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

[44] J.-C. Cano, J.-M. Cano, E. Gonzalez, C. Calafate, P. Manzoni, "Power Characterization of a Bluetooth-Based Wireless Node for Ubiquitous Computing", Proc. IEEE Int'l Conf. Wireless and Mobile Comm., pp.13

[45] D. Chu, N. D. Lane, T. T.-T. Lai, C. Pang, X. Meng, Q. Guo, F. Li, and F. Zhao. Balancing energy, latency and accuracy for mobile sensor data classification. In ACM SenSys, 2011.

[46] J. Paek, J. Kim, and R. Govindan. Energy-efficient rateadaptivegps-based positioning for smartphones. In ACM MobiSys, 2010.

[47] Noble, Brian, Satyanarayanan, M., Price and Morgan"A Programming Interface for Application-Aware Adaptation in Mobile Computing"*Proceedings of the 2nd Symposium on Mobile and Location-Independent Computing., pp. 57-66, 1995, Berkeley, CA, USA: USENIX Association.*

[48] C. S. Ellis"The Case for Higher-Level Power Management"*Proceedings of the The Seventh Workshop on Hot Topics in Operating Systems, ser. HOTOS '99, p. 162, 1999, Washington, DC, USA: IEEE Computer Society.*

[49] N. Vallina-Rodriguez and J. Crowcroft "ErdOS: achieving energy savings in mobile OS" Proceedings of the sixth international workshop on MobiArch, ser. MobiArch '11, pp. 37-42,2011, New York, NY, USA: ACM