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# Enhancing Energy Consumption in Wireless Communication Systems using Weighted Sum Approach

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## Abstract

Collaborative communication technologies have known a great development that allows achieving various communications. However, the uncontrolled selection of the communication technology spent more energy. The main goal of this paper is minimizing the energy consumed in accessing to data by users. To do so, we propose to integrate an efficient weighted sum selection approach in order to choice the suitable communication system that can be used by user. This smart selection considered a number of essential criteria. Implementation results confirmed that the proposed approach is more efficient than the traditional process of communication.

**Keywords:** Green Communication, 4G, Multi-Criteria Selection, Wireless, Weighted Sum

## 1. Introduction

The mobile applications are developed quickly in order to respond to our needs, thanks to the increased development of standards and wireless technologies as shown in Figure 1. These applications[1] offer great services for us such as social networking and medical monitoring and educational purposes and other purposes. However, these new applications dissipate more energy, which represent a critical issue that merit to be resolved efficiently.

The new devices offered in markets become tinier for responding to users' needs, which limited more the energy resource. Thus, there are two main problematic for resolution[2]:

- Hardwar design that can be adapted to the new mobile applications.
- Protocols' design, which allows supporting seamless applications.

Several works are investigated for resolving these problematic using radical improvements like the design of new mathematical models, which enhance the energy spent or enhancing some parameters considering other optimization methods such as genetic algorithms and switching methods.

This paper contains four sections: Section 2 reviewed the works done in studying the energy dissipation in communication technologies. Section 3 explains the method integrated and our novel approach. Section 4 detailed the implementation phase and compares our proposed approach and the traditional process of communication. Finally, Section 5 summarizes the proposed work.

## 2. Related Works

In order to overcome the constraints of wireless communication systems such as energy consumption some proposed idea have been designed, the related work represented bellow explains some studies.

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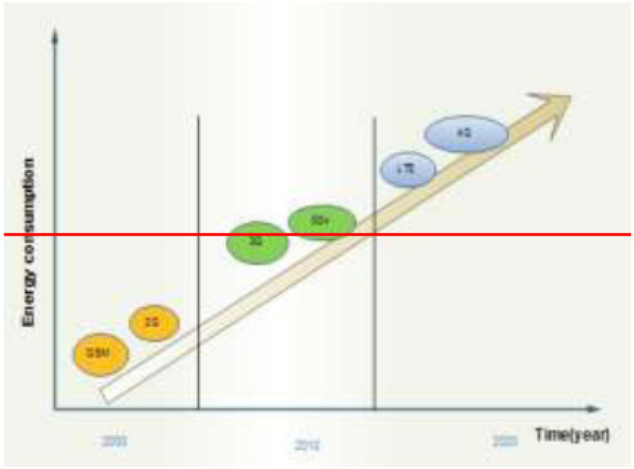


**Figure 1.** Energy consumption by existing wireless technologies

Authors in[3] present a new study that allows computing the aggregate energy exhausted in a smart phone, considering the component-based modeling. The aptitude of device to ensure 4, 7 % of error was showed in this article. Furthermore, Authors in[4] considered in their studies the duration of the WCDMA network and the impact factor of forms of notifications and messages. So that, considering the transfer of data by a high throughput is caused by forms of the network. The experiment of authors demonstrate, that how the control of the resource radio is influenced by the dissipated energy.

Also, in[5] Authors designed a new tool named Energy Box that permits measuring the energy dissipated in the devices using the 3G system of communication or the WIFI, where the energy consumed is caused by the traffic pattern. The analysis study has shown an improvement of 99% in energy calculation for both considered networks. In[6] and in order to evaluate the consumed energy during the use of the regular system networks and the Wi-Fi of GSM. The approach presented here is based on the design of a protocol, which called Tail Ender due to the objective of reducing the energy dissipated in applications used in smart phones.In another hand, and to overcome the problem of energy spent by mobile smart phones, Authors in[7] apply the approach of distribution hash tables.

The aggregation data was also applied in[8] to compute the energy spent during the use of phones, where the approach principle is based on the collection of the data active during the use of phones, to prolong the lifetime of the network. The Benchmarking approach was used in [9] in order to measure the effectiveness of the measuring the energy dissipated on phones during the run of many applications. In[10] Authors implement a tool, which allows computing the level of energy used in WCDMA networks by the control of the radio resource. In[11], authors have designed a new scheme based on the energy dissipated in smartphones. In[12] and[13], authors' studies are about the dissipation of energy in IEEE 802.11g network. In[14], authors present study about the energy efficiency in both 4G and WLAN technologies. They present a novel model, which test the impact of application layer's protocols on the energy consumption of a cellular phone.

Studies about cellular phones are occupied a great works such as studies about the role of the transport security layer on the energy dissipation in cellular phones[15] [16]. But, the last work has integrated an algorithm based on machine learning. In addition, it considers a cross-validation method in order to validate the effectiveness of the new technique. In[17], authors have confirmed the possibility of exploiting cloudlets to reduce the extra energy consumed in 3G and 5G networks. The new approach integrated the handoff technique with the full consideration of a number of criteria that are considered as important parameters: signal strength, which has shown its importance among various precedent works, bite rate and the number of interaction that strongly influence the network communication. Several works have been done exploiting other techniques such as in[18] and[19] where authors have the objective of minimizing the energy dissipation in 4G and Wi-Fi technologies using fuzzy logic approach.

Consequently, it is clearly seen that various number of research works about the problematic of the energy dissipated while accessing to information from devices exploiting different wireless networks such as 4G and 5G, etc… However, the majority of approaches are focused on the control of the radio resource without considering a radical control or selection methods. To do so, we propose a new selection method that will select efficiently the suitable technology for accessing to data. Next sections will detail and evaluate the new approach.

## 3. The Proposed Approach

### 3.1 Weighted Sum Approach

The picked method of system communication used in smart phones can make a difference on energy consumed which caused the increase or reduce the lifetime of the network.Weighted Sum Approach (WSA) [20] is a function

used in multicriteria analysis for decision-making. It allows selecting the optimal method considering criteria of interest. Mathematically, the principal objective of the weighted sum approach is based on a situation problem offered on alternatives M and a number of decision criteria called n and we accept that:

- The weight of criteria presented as $W_j$
- The value of performance presented as $a_{ij}$ considering the criterion $C_j$
- In addition, the total alternative presented as follows:

$$A_i = \sum_{j=1}^{n} W_j a_{ij}, i = 1,2,...m$$

In our case and for having the maximization one, the greatest alternative is the one, which have the maximum of the total value of performance.

### 3.2 Our Algorithm

Our algorithm is based on selecting the most efficient interface in terms of the energy drained in order to reduce the energy dissipated for users .To do so, we integrated the weighted sum method using a number of important criteria using the following equation:

$$Qs(z) = We_{ber}(z).ber(j) + We(z).K(j) + We_{bwd}(z).bwd(j) + We_d(z).d(j) + We_E.E(j)$$

Where:

ber(j): bite error rate threshold
K(j): Jitter threshold
bwd(j): bandwith threshold
d(j): delay threshold
E(j): energy consumed threshold
$We_{ber}$ and We and $We_{bwd}$ and $We_d$ and $We_E$ : weighted considered for all criteria with :
$We_{ber} + We_{bwd} + We_d + We + We_E = 1$

Our proposed algorithm is described below:

**Start**: the mobile verify the availability of networks ANS with RSS° > $RSS^{th}$
**If** CN exist then
**For** each interface z then
Calculate Qs(z) using Weighted sum approach

$$Qs(z) = We_{ber}(z).ber(j) + We(z).K(j) + We_{bwd}(z).bwd(j) + We_d(z).d(j) + We_E.E(j)$$

Select the efficient interface z
**End**
**End if**
Forward packet over interface selected

## 4. Simulation Results

For evaluating the performances of our new approach, we compare it using two different technologies WLAN and 4G. Our proposed work implemented is shown at Figure 2. and Figure 3., which present a comparative study analysis in terms of energy consumed, which compare the traditional Wi-Fi and 4G technologies and the use of the selection approach in such technologies.

From Figure 2 , we observe that the values of energy drained are high for 4G networks comparatively to 4G

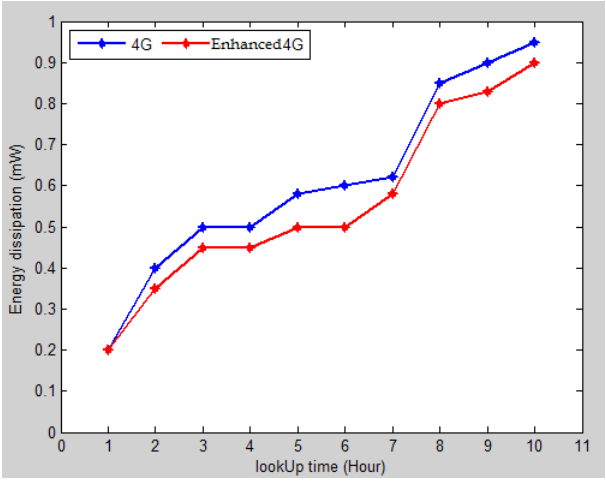


**Figure 2.** Comparative Analysis of 4G Network.

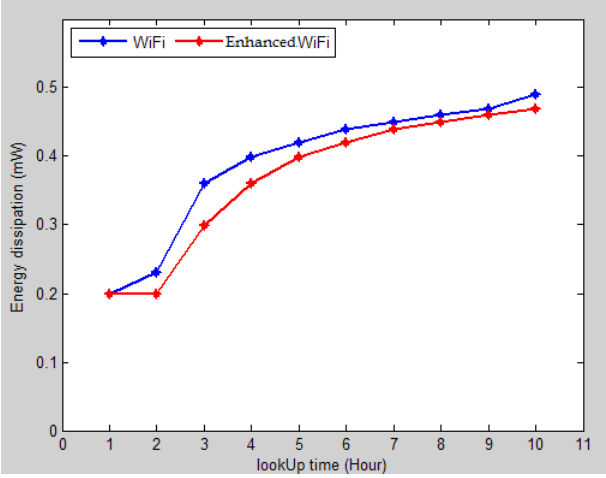


**Figure 3.** Comparative Analysis of Wifi Network.

networks after applying our approach proposed due to the efficient selection using a number of criteria.

Figure 3 shows that the energy consumed by the basic Wi-Fi networks is more comparatively to the Wi-Fi networks with the new selection approach because the interface selection is performed efficiently, which prolong the lifetime of phones.

## 5. Conclusion

Communications using wireless technologies have known a great development for responding to users 'needs. Several works have been investigated in this research field. However, it still suffers from the energy dissipation problem.In this paper, we propose the integration of an intelligent weighted sum selection in order to select the most efficient technology in a smart phone. This new approach focus on essential criteria, which influences the energy of communication systems.

Implementation results have confirmed the efficiency of the proposed selection method. Our future work will be presenting a new radical improvement of a mathematical model of the energy consumption in wireless technologies.

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