Maximizing Energy Efficiency in Wireless Network by Using Packet Dropping and Energy-Delay Tradeoff

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Abstract:
Traditionally, the mechanisms of MAC layer do not consider fading conditions of a wireless channel. The scheduling scheme used in this work uses fading conditions of the channel for improving the energy efficiency of the system. It makes use of the packet drop and packet delay parameter for reducing the energy consumption of a node. The work focuses mainly, on analyzing the effects of different parameters in order to improve the energy efficiency in a wireless network.

Index Terms: Packet drop, fading, energy-delay trade-off

I. INTRODUCTION
In wireless networks energy efficiency has become a very significant aspect over a past few years. The energy consumed by the users can be minimized by considering certain QoS parameters such as packet loss, throughput, delay etc. The amount of packet loss and packet delay that can be tolerated by the network can be utilized as parameters for increasing the energy efficiency in wireless networks. Due to the wireless nature of network, packet loss may occur because of fading. In this work we have considered fading condition of channel for scheduling of packets.

The rest of the paper is organized as follows. Section II provides a Literature survey on the previous work done for improving energy efficiency. The System architecture is described in detail in Section III. In Section IV the flow of system is described. The implementation results are shown in Section V. The System is analyzed based on different parameters in Section VI. In Section VII the main contributions of the work are summarized.

II. RELATED WORK.
In literature there has been a significant research for achieving energy efficiency in wireless network. The author in [1] has proposed a transmission scheduling scheme over fading channel for minimizing the energy required to transmit data over a fading channel considering the deadline constraints. The authors in [2] [3] have considered energy delay trade-off for increasing the energy efficiency. The authors in [4] showed that Proportional fair scheduling (PFS) performs generally better than the more restrictive HF system in the regime of low to moderate SNR, but for high SNR an optimized HF system achieves throughput comparable to that of system for finite K. In [7] a scheme is proposed which schedules the users based on their instantaneous channel conditions and backlog of packet stored in the buffer. As given in [5] by delaying packet in the buffer, the transmission power can be saved, but different users may have different QoS (i.e. delay) requirements, and too much delay can result in buffer overflows and packet dropping.

The packet dropping that is considered as a consequence of failing providing the required rate can be used as a parameter for reducing the energy consumption as given in [6]. The strategy used in [8] yields a logarithmic energy-delay trade-off as it uses intelligent packet dropping mechanism for energy efficiency.

III. SYSTEM ARCHITECTURE.
Fig. 1 shows the architecture of the system considered.

Fig 1. System Architecture settings for the problem
The System consists of three modules given below:

i. **Controller**: The controller receives data such as distance, transmission rate, delay, calculated gain from the node. It calculates the energy required to transmit the packet and sorts it. The node with the lowest energy will transmit first according to the scheduling scheme.

ii. **Nodes**: The nodes transmit data required to calculate energy to the controller and transmits the packet to the server according to the scheduling done by controller.

iii. **Server**: Server receives data transmitted from the node.

**IV. SYSTEM MODEL.**

In this work an uplink scenario where multiple nodes transmit packets to a single server is considered. Let k be the number of nodes in the network. Each node transmits its information such as distance (d) in kilometers, fading value (fk), transmission rate (R). Each node has a buffer (B) where the packets which are not scheduled for transmission are stored. The node information is given to the controller for calculation of energy to be assigned for each node. Each node is assigned an energy value according to which it will transmit the packet to the server.

\[
E_{\phi k} = \frac{Z0}{h_k \phi_k} \left(2\sum_{i\leq k} R_k \phi_i - 2\sum_{i<k} R_k \phi_i \right)
\]  

(1)

As given in [2], Let K denotes the set of users and h_k be the channel gain. The energy calculation done in [6][9][4] does not consider the delay that can be tolerated by each node.

\[
E_{\phi k} = \frac{Z0}{h_k \phi_k \times \text{delay}} \left(2\sum_{i\leq k} R_k \phi_i - 2\sum_{i<k} R_k \phi_i \right)
\]  

(2)

As mentioned in the previous researches [2][3] the energy-delay trade off which can be used for improving the energy efficiency can be added in the denominator. As delay (in milliseconds) is added in the denominator the energy value becomes inversely proportional to the delay value.

**Scheduling scheme:**

The newly arrived packets are stored in a temporary buffer. For scheduling of packet a threshold (Th) and fading value (fk) is considered. For transmission of packet the condition fk > Th must be satisfied. If the condition is not satisfied then packet is not scheduled and it will be stored in the buffer (B). If the buffer is full the oldest packet which is the head of the line (HOL) will be dropped in order to create space for the newly arrived packet.

**V. IMPLEMENTATION**

A system with 5 nodes is considered here. In the below figures three scenarios are shown:

As shown in fig 3. The nodes are initialized with the values of distance, fading, transmission rate. Gain(hk) is calculated by each node.

**Fig 2. Flow chart of system**

**Fig 3. Nodes Initialized and gain**

As shown in fig 3. The nodes are initialized with the values of distance, fading, transmission rate. Gain(hk) is calculated by each node.
As shown in Fig 4, Node data required to calculate the energy for each node is sent to the controller. Fig 5 shows successful packet transmission to the server and packet drop in case of buffer being full.

**VI. SYSTEM ANALYSIS.**

It has been observed that when the parameters other than delay i.e. rate, distance, gain, fading value are kept constant an increase in the delay causes reduction in energy consumption of a node.

![Delay vs Energy](image6)

Fig 6. Delay Vs Energy

As shown in fig (6) when the fading value increases gain the Gain increases. By equation (1) the energy value also depends on the fading value, as the fading and gain increases energy value will decrease.

![Fading vs Gain](image7)

Fig 7. Fading Vs Gain

Therefore, the depending on the parameters used, vary the energy consumed by each node.

**VII. CONCLUSION.**

The consequence of failing to provide the required rate can be utilized as a parameter for improving the energy efficiency. As certain packets are lost considering a packet loss tolerant application, the energy required to transmit those packets is saved. Increasing the delay according to the requirement can aid in maximizing the energy efficiency.

**References:**


