Performance Evaluation and Measurement for Energy Efficient Wireless Networks

Hemang Shah\textsuperscript{a}, Rajesh Bansode\textsuperscript{b}

\textsuperscript{a} PG Student, Thakur College of Engineering and Technology, Kandivali – East, Mumbai – 400 101, India
\textsuperscript{b} Associate Professor, Thakur College of Engineering and Technology, Kandivali – East, Mumbai – 400 101, India

Abstract

Growth of high-data-rate applications is increasing day by day, more energy is consumed in wireless networks to guarantee quality of service. The data rate expected to meet in latest 4G is up to 1Gbps. Increasing energy efficiency in wireless communications network has attracted the attention recently. In this research different performance metrics that are to be measure and analyze viz. no. of nodes used, power transmission by nodes, wireless channel type, energy efficiency (in bits/joule) data rate in bits per channel use, SNR(signal-to-noise ratio), power transmission (P_t), subcarrier bandwidth, protocol & throughput. The various performance measurements are on the basis of optimal metrics analysis for the wireless communication system to be selected. The parameters measured and reported are: power transmission of 5-10 dB, energy efficiency in bits per Joule as 4×10\textsuperscript{20}, data rate in bits per channel use as 4, SNR as 10dB, probability of error as 10\textsuperscript{-4}, distance between nodes as 100m, FFT size as 512, protocol as Medium Access Control (MAC), throughput as 50%.

1 Introduction

The idea of wireless communications is indispensable for the full "wiring" and the provision of various telecommunications services to users everywhere: at home, in the vehicle, in institutions, in universities etc.[1]. The data transfer rate in wireless networks is less than as compared to wired networks, and also suffer from problems such as security and protection, and the problems of overlapping waves Interference.

Wireless communication was founded at the turn of the 20th century with the invention of radio. Since then, the power of fastest communication over long distance has transformed society and made the world a smaller place. Most recently, cell phones have turned traditional radio broadcasting medium and one-way model into two-way...
conversations. With technologies like 4G LTE, Wi-Max, Wi-Fi etc., computer data networks have brought wireless communications into the 21st century [2].

1.1 Background

Increasing the energy efficiency in wireless communication networks has attracted the attention recently. New network architectures like heterogeneous networks, distributed antennas, multi-hop cellular, etc., as well as radio and network resource management schemes like various cross layer optimization algorithms, dynamic power saving, multiple radio access technologies coordination, etc. have been proposed to overcome these issues. More than 50% of the energy is consumed by the radio resources, where 50-80% energy is used by the power amplifier (PA), it is pointed out that the energy bill accounts for approximately 32% in India[2].

Energy-efficient circuit design, high-efficiency PA, digital signal processing (DSP) technologies, advanced cooling systems, adequate EE metric and energy consumption models, adaptive traffic pattern and load variation algorithms, and energy-efficient network resource management, as well as MIMO and OFDM techniques, are the highlights of energy-efficient wireless communications. The Fig 1 shows wireless communication network which has various wireless networks such as wireless mesh network, wireless sensor network, mobile ad-hoc network and how it can be interconnected.

Fig 1 Wireless communication network

1.2 Motivation

The motivation behind research work is to measure optimal performance of wireless communication network using various metrics. In wireless communication network there are many systems are available such as Bluetooth networks, Wi-Fi networks, cellular networks etc.
The various parameters such as power Transmission, energy efficiency in bits per Joule, data rate in bits per channel, signal to noise ratio (SNR), protocol, throughput will be measure and the optimal performance metrics will be find out[3]-[6].

There are some metrics which are used to reduce the energy consumption of the system. There are various other energy efficient wireless communication networks that are available of which the suitable network system is selected for the optimal performance measurement of the network [7]-[10].

1.3 Objectives

The objective behind the research is to design and analyze energy efficient wireless communication network and measuring various performance metrics.

a) Consider the nodes to measure various metrics such as throughput, latency of energy-efficient wireless networks.

b) Sectoring the nodes and check for handshake among nodes of different clusters.

c) Measuring various metrics such on simulation basis for power transmission, selection of wireless channel type.

1.3.1 The parameters to be measured are as mentioned below:

a) Throughput
b) Packet Drop
c) Delay
d) Data rate in bits per channel use
e) Protocol

2 Proposed Work

The existing system surveyed state that the optimal metrics such as mentioned below are to be measured to evaluate system performance.

2.1 Energy Efficiency in bits per Joule

Energy efficiency is a way of manage and restrain the growth in energy consumption of various nodes in wireless communication networks. Incase few devices deliver more services for the same energy input, or the same services for less energy input it is more energy efficient. Energy efficiency is measured as bits per joule in network systems.

2.2 Data rate in bits per channel

The speed at which data is transferred within a network or between network nodes.

2.3 Signal-to-noise ratio (SNR)

Signal-to-noise ratio is a measure compares the level of a desired signal to the level of background noise. It is measure in decibels.

2.4 Power Transmission

Power transmission is the energy consumed per unit time by the data packets from source node to destination in a network.
2.5 Protocol

A protocol is the special set of rules in the communication network which is use for effective communication. Protocols specify interactions between the communicating entities.

2.6 Throughput

Throughput is a measurement of how many units of digital information a system can process in a given amount of time. It applies broadly to systems ranging from various aspects of network systems. Related measures of system productivity includes the speed with some specific workload which can be completed and response time between the a single interactive user request and its receipt of response.

3 Expected Outcomes

The project implementation begins with simulation of 50, 100, 150, 200 and 250 wireless nodes and check for its network operation. After that sectoring the nodes and try for checking the handshake between them. To measure energy spent and power saving by each node in a sector along with the speed movement of the nodes in wireless network system.

Measurement of QoS parameters such as throughput, scalability, latency and packet loss ratio for data transmitted among nodes in each sector. Then, calculate the number of subcarriers used for transmission of data in a network of 1MHz bandwidth.

Table 1. Expected key parameters

<table>
<thead>
<tr>
<th>Key parameters to be measured</th>
<th>Existing parameters as per literature survey</th>
<th>Parameters to be measured as per requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Transmission</td>
<td>5-10 dB</td>
<td>10-15dB</td>
</tr>
<tr>
<td>Packet Size</td>
<td>256</td>
<td>512</td>
</tr>
<tr>
<td>Data rate in bits per channel use</td>
<td>4</td>
<td>5-6</td>
</tr>
<tr>
<td>Protocol</td>
<td>Energy Conserving-Medium Access Control (EC-MAC)</td>
<td>MAC</td>
</tr>
<tr>
<td>Throughput</td>
<td>50%</td>
<td>Up to 70%</td>
</tr>
</tbody>
</table>

4 Results

There are 8 mobile nodes in which 4 source nodes and 4 destination node. Each source is a CBR source over UDP. The transmitted packet size is set to 512 bytes. Transmission data rate of a node is 600 Kbps. It is assumed that the nodes are in transmission range at a constant distance of 195 m. The time of the simulation is lasted for 80 sec.

4.1 Throughput:

The Fig.2 describes about the throughput of the network where x coordinate shows the simulation time and y coordinate shows the packet loss ratio in which Node 1 starts transmitting at time t = 1.4 sec while node 2 starts transmitting at time t = 10 sec. During the period of time [1.4 sec, 10 sec] node 1 is the only transmitting node using the entire available bandwidth. This justifies the high performance of node 1 during the specified interval of time. At time t = 10 sec, node 2 starts transmission hence sharing channel resources with node 1. This explains the heavy reduction of bit rate. In addition, the bit rate plot experiences heavier oscillations and reduction as the number of transmitting nodes increases.
4.2 Packet Drop:

This Fig 3 shows a high packet drop rate whenever the number of nodes sharing network resources increases. It can be shown that the packet drop rate in the interval [1.4 sec, 10 sec] is 0. This can be easily justified since only one node is using the network during this time interval. However this high-quality performance is deteriorated as more nodes start sharing the network resources.
4.3 End to End Delay:

Fig 4 shows the end to end delay of the network, when the number of nodes that are sharing the network resources, the delay significantly increases and readjusting CW of each node takes longer time. The graph shows as the sharing of the network increases the delay also increases with respect to time.

Fig 4 End to End Delay

5. Conclusion

In wireless communication network several metrics which are used to calculate the performance of the network is measured by taking 8 mobile nodes in which 4 nodes are destination nodes. It is founded that performance of the network can be find out on the basis of throughput, delay, packet drop, protocol used. As the number of nodes increases which shares the same media for transformation in the same network and the packet size is larger than throughput is affecting.
References


