Performance Evaluation of Bluetooth and Zigbee Using Monte Carlo Simulation

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Abstract

Wireless networking technologies are being implemented in quite a few devices including phones, mobiles, mp3 players etc. The performance of these technologies varies from one to another. The aim of this paper is to analyze the performances of two different low power consumption technologies: Bluetooth and Zigbee. The performance parameters include data coding efficiency and transmission rate. For the analysis we used Monte Carlo simulation and conclusion is drawn on the basis of its results to find the optimum performance among Bluetooth and zigbee. A brief analysis of these graphs is presented in the paper and from this analysis. We propose which of these two technologies Bluetooth or Zigbee gives better performance for data transfer. This analysis will help engineers to select proper technology for their applications.

The results are carried out by using deterministic and stochastic models for evaluating the performance of Bluetooth and Zigbee in terms of transmission time and data coding efficiency. This paper draws a conclusion that Zigbee is superior at the low rate payload size than the misconception of Bluetooth in practical applications for data transfer, whereas Bluetooth is observed to perform efficiently at the higher end payload size. The simulation results verify that the stochastic model can effectively provide real time traffic with ideal performance. The analysis with random noise and jamming can be challenging future work.

Keywords: *Bluetooth, Zigbee, Wireless personal area networks.*

1. Introduction

The evolution of new technologies has brought a drastic change in the field of networking and mobile communication systems. With the introduction of wireless networks many new protocols have come into existence. Bluetooth and Zigbee are the two most prominent wireless technologies because of their low power consumption, easy implementation, low cost, etc[1]. These two technologies operate under an ISM (Industrial, scientific and medical) band in 2.4 GHz range and are mainly used for short range data communications where participating devices may have low battery power [2]. The performance of a network plays an important role in transferring the data. It also helps the users to have secure connections between the participating devices. The performance can be measured by using such parameters as coding efficiency, data transfer rate. The analysis of these performance parameters help to select appropriate technology for the data transfer in wireless personal area networks.

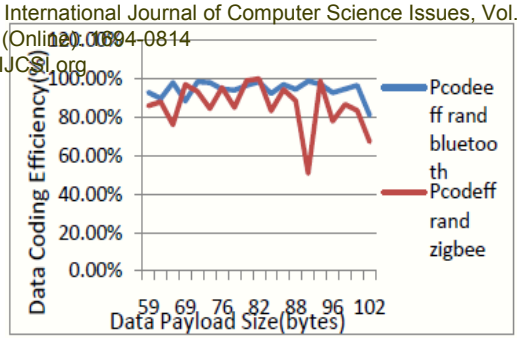
2. Review of State of the art

So far the research in analyzing the performance of these two technologies is based on analysis of coding efficiency, power consumption, complexity and data transfer. This is done based on deterministic models [1]. When these two technologies are built using deterministic model, the performance is stable and is also defined by standards [2]. But we feel that randomness is very important in real time performance evaluation and stochastic models should also be applied.

3. Problem Statement and Main Contribution

The performances of Bluetooth and Zigbee have been evaluated previously by using deterministic models. A deterministic model cannot provide the future prediction of performance. For real-time short range data transfer the exact output has to be given, this problem statement is related to our research question: How to evaluate the performance of the two technologies and to judge which one of these technologies is better for data transfer?

The performance of Bluetooth and Zigbee are defined by the data rate parameters like data coding efficiency and transmission rate. We use Monte Carlo simulation for different data sizes and data rate times which involves changing a deterministic model to a stochastic model to



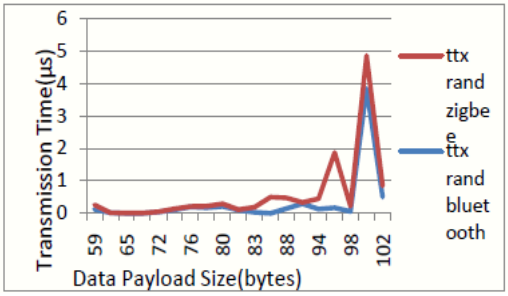
analyze the performance and from the stochastic model we try to deduce which of the two technologies is best suited for short range data transfer.
The main contribution in this paper is that, the performance parameters are given in two different models. The stochastic model is implemented on Excel by giving random inputs in place of expected inputs. The graphical analysis of the stochastic model provides the accurate results of the data rate for both the technologies.

4. Problem Solution

The problem solution involves the application of Monte Carlo simulation for the two data rate parameters we have taken to compare, in which a deterministic model is changed to a stochastic model and the results are analyzed from the stochastic model.

4.1 Application of Deterministic Model

The deterministic system is built by evaluating the transmission time and data coding efficiency. The transmission time is calculated from the data rate, message size and the distance between the nodes. The fo rmula for transmission time can be described as [1].
The data coding efficiency is the ratio of data size and the message size. The formula for calculating data coding efficiency is given as [1].
The performance is calculated using the formulae and the graphs deduced are shown for transmission time and data coding efficiency in “Fig. 1” and “Fig. 2”



respectively.

Fig.1. Comparison of transmission of Bluetooth and Zigbee in the deterministic model

“Fig. 1” indicates that the transmission time of Zigbee increases at a much higher rate than Bluetooth as the data payload size is increased.

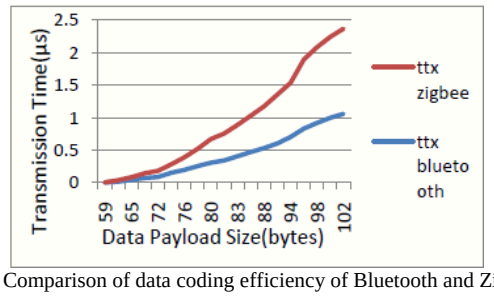


Fig.2. Comparison of data coding efficiency of Bluetooth and Zigbee in the deterministic model.

“Fig. 2” indicates the data coding efficiency of Bluetooth is higher when compared to Zigbee with the increase in data payload size.

4.2 Application of Stochastic Model

The stochastic model is built from the deterministic model by generating different sets of random numbers for each input distribution. The random simulations obtained are taken in a number of 400 and averages of these simulations are analyzed to obtain the output of the stochastic model.
“Fig. 3” and “Fig. 4” show the output for the transmission time and data coding efficiency respectively in the stochastic model.

4.3. Analysis of the Simulation Result

This section includes the analysis of performance by using two parameters transmission time and data coding efficiency. In comparison with the two models, the stochastic model shows increasing fluctuations for Zigbee beyond the payload size of 83 bytes in the transmission time when compared to Bluetooth. The data coding efficiency in Zigbee shows a consistency up to 83 bytes of data payload and decreased later.

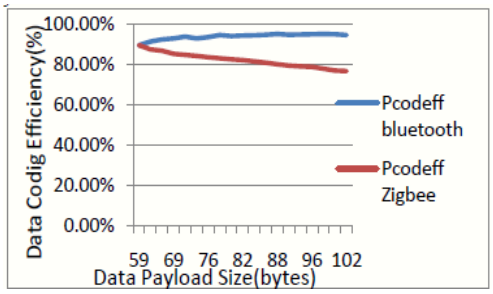


Fig.3. Comparison of transmission time of Bluetooth and Zigbee in the stochastic model.

Fig.4. Comparison of data coding efficiency of Bluetooth and Zigbee in the deterministic model.

5. Conclusion

This paper presents the results of using deterministic and stochastic models for evaluating the performance of Bluetooth and Zigbee in terms of transmission time and data coding efficiency. This paper draws a conclusion that Zigbee is superior at the low rate payload size than the misconception of Bluetooth in practical applications for data transfer, whereas Bluetooth is observed to perform efficiently at the higher end payload size. The simulation results verify that the stochastic model can effectively provide real time traffic with ideal performance. The analysis with random noise and jamming can be challenging future works.

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