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METHOD OF BER LEVEL CALCULATION IN 802.11 EROR-PRONE WIRELESS CHANNEL

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The authors present a model oriented method of BER calculation. BER calculation is performed using the mathematical model of wireless channel throughput. Experimentally measured throughput of the wireless channel was used as a basic metric for BER level calculation.

Keywords: mathematical model, wireless standard 802.11, BER level calculation

One of the main features of wireless networks is that they use as the transmission medium the radio channels that are affected by a lot of interference. In some cases it leads to a high bit error rate (BER) level in the channel (so called error-prone channels) and, as a result, to significant reduction of its throughput. Therefore to analyze the wireless channel performance correctly, we need to know its BER level. This problem is especially important for wireless local networks (WLANs) with the closed office environment structure (no direct line of sight between the access point and the station with many obstructions between them) [1]. As was shown in the research, carried out by Atheros, in closed office environment structures subscribers throughput even on the base of one access point (AP) may vary in 10 times depending of their BER level [1]. Therefore, we must calculate the throughput for each wireless channel according to its BER level.

In the article, a model oriented method of BER calculation is proposed. BER calculation is performed using the mathematical model of wireless channel throughput. Experimentally measured throughput of the wireless channel was used as the basic metric for BER level calculation. The method allows with high accuracy calculate the average value of BER level for the whole transmission cycle.

In the study, a mathematical model of channel throughput for the Base transmission cycle (BTC), which is most commonly used in 802.11 wireless channels is used. The procedure of frame transition in this mode can be represented as a following sequence of time intervals and blocks of information: DIFS → Back of period → DF → SIFS → ACK, where DIFS, Back of period and SIFS – time intervals defined by the standard, DF – data frame, ACK – acknowledgment frame [2].

Time of 802.11 Base transmission cycle can be written as

$$T_{\text{BTC}} = T_{\text{DIFS}} + T_{\text{BOP}} + T_{\text{DATA}} + T_{\text{SIFS}} + T_{\text{ACK}}.$$

where T_{DIFS}, T_{BOP}, T_{SIFS} – time of DIFS, Back of period and SIFS intervals, T_{DATA}, T_{ACK} – time of data and acknowledgment frames transitions.

Time of data frame transmission is defined in standard as

$$T_{\text{DATA}} = T_{\text{Preamble}} + T_{\text{PHeader}} + \lceil L_{\text{MSDU}}/DR \rceil,$$

where T_{Preamble}, T_{PHeader} – time of frame preamble and header transmission, L_{MSDU} is the length of data frame information field, DR is the data rate, $\lceil\ \rceil$ is the next highest integer.

ACK frame transmission time is defined in standard as

$$T_{\text{ACK}} = T_{\text{Preamble}} + T_{\text{PHeader}} + \lceil L_{\text{ACK}}/DR \rceil,$$

where L_{ACK} is the length of acknowledgment frame.

Using equations proposed in [3] we can calculate throughput of a wireless channel for the Base transmission cycle with retransmission as

$$CT_{\text{BTC}} = \frac{L_{\text{MSDU}} \cdot (1 - P_{\text{DF}})}{T_{\text{DIFS}} + T_{\text{DATA}} + T_{\text{SIFS}} + T_{\text{ACK}} + T_{\text{BOP}}}, \quad (1)$$

where P_{DF} is the probability of frame distortion in a wireless channel.
Probability of frame distortion in a wireless channel can be express as

$$P_{\text{DF}} = 1 - (1 - BER)^{\text{N}},$$

where $N = L_{\text{MSDU}} + L_{\text{ACK}}$.

We can use approximation to calculate P_{DF} [3]:

$$P_{\text{DF}} = N \cdot BER. \quad (2)$$

Using (2) from equation (1) we can express *BER* value as:

$$BER = \frac{\left(1 - \frac{CT_{\text{BTC}} \cdot T_{\text{BTC}}}{L_{\text{MSDU}}}\right)}{N}. \quad (3)$$

Using equation (3) we can calculate the BER level in a wireless channel. As a parameter for *BER* calculation we would use experimentally measured wireless channel throughput CT_{BTC}.

For experimental throughput measurements we can use open-source JPERF traffic generator, which has built-in tools for TCP and UDP packets generation and throughput measurements [3].

The model oriented method of BER calculation is proposed. BER calculation is performed using the mathematical model of wireless channel throughput. Experimentally measured throughput of the wireless channel was used as a basic metric for BER level calculation. Open-source JPERF traffic generator was used for experimental throughput measurements.

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Метод расчета уровня BER в беспроводном канале стандарта 802.11 с высоким уровнем помех

Предложен модельно ориентированный метод расчета уровня BER. Расчет BER выполняется с использованием математической модели пропускной способности беспроводного канала. В качестве базовой метрики для расчета уровня BER используется экспериментально измеренная пропускная способность беспроводного канала.

Ключевые слова: *математическая модель, стандарт беспроводной связи 802.11, расчет уровня BER.*