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ANALYSIS OF IEEE 802.11g WIRELESS CHANNEL MAXIMUN THROUGHPUT

Abstract. *The development of mathematical model for calculating IEEE 802.11g maximum channel throughput is carried out. With the use of the developed model a study of maximum channel throughput for all mandatory data rates of 802.11g wireless channel is carried out.*
Keywords:*mathematical model, wireless standard 802.11g, maximum channel throughput*

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АНАЛИЗ МАКСИМАЛЬНОЙ ПРОПУСКНОЙ СПОСОБНОСТИ БЕСПРОВОДНОГО КАНАЛА СТАНДАРТА IEEE 802.11g

Аннотация. *Проведена разработка математической модели для расчета максимальной пропускной способности беспроводного канала стандарта IEEE 802.11g. С использованием разработанной модели проведено исследование максимальной пропускной способности беспроводного канала стандарта 802.11g для всех обязательных скоростей передачи.*
Ключевые слова: *математическая модель, беспроводной стандарт 802.11g, максимальная пропускная способность канала*

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АНАЛІЗ МАКСИМАЛЬНОЇ ПРОПУСКНОЇ ЗДАТНОСТІ БЕЗДРОТОВОГО КАНАЛУ СТАНДАРТУ IEEE 802.11g

Анотація. *Проведено розробку математичної моделі для розрахунку максимальної пропускної здатності бездротового каналу стандарту IEEE 802.11g. З використанням розробленої моделі проведено дослідження максимальної пропускної здатності бездротового каналу стандарту 802.11g.*
Ключові слова: *математична модель, бездротовий стандарт 802.11g,максимальна пропускна здатність каналу*

The urgency of the problem. Wireless network technologies of IEEE 802.11 families are widely used in construction of modern computer networks [1 – 3]. As one of the main characteristics of the wireless channel developers of wireless devices indicates the data rate (DR) in the physical channel.This characteristic is used to estimate the maximum channel throughput (MCT) of the wireless channel. This approach may be used in the design of wired segments of computer networks.In this case the difference between the DR and MCT in wired channel does not exceed several percent.[4]. Wireless networks use substantially more complex transmissionalgorithms [5]. This leads to the fact that the DR of the wireless channel and MCT differ greatly.

The article describes the development of a mathematical model for MCT calculation of IEEE 802.11g wireless channel, which is widely used in modern computer networks.Using the proposed model MCT of 802.11g wireless channel for all mandatory data rates used in this standard are investigated.

Mathematical model. In the article a mathematical model for the Base transmission cycle (BTC), which is most commonly used in 802.11g wireless channel is proposed.The procedure of frame transition in this mode can be represented as the 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 [5].

Time of 802.11g Base transmission cycle we can write as

$$T_{\mathrm{BTC}} = T_{\mathrm{DIFS}} + T_{\mathrm{BOP}} + T_{\mathrm{DATA}} + T_{\mathrm{SIFS}} + T_{\mathrm{ACK}}, \quad (1)$$

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 transition.

Time of data frame transmission is defined in standard as

$$T_{\text{DATA}} = T_{\text{Preamble}} + T_{\text{PHeader}} + \lceil L_{\text{MSDU}}/DR \rceil, \quad (2)$$

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

ACK frame transmission time is defined in standard as

$$T_{\text{ACK}} = T_{\text{Preamble}} + T_{\text{PHeader}} + \lceil L_{\text{ACK}}/DR \rceil, \quad (3)$$

where L_{ACK}–length of acknowledgment frame.

Usinggiven above equations (1) – (3) we can calculatethe time of Base transmission cyclesfor the IEEE 802.11g standard.

Using equations proposed in [6 – 8] we can calculate throughput of a wireless channel for Base transmission cycle with retransmission as

$$CT_{\text{BTC}} = \frac{L_{\text{MSDU}} \cdot (1 - P_{\text{DF}})}{T_{\text{DIFS}} + T_{\text{DATA}} + T_{\text{SIFS}} + T_{\text{ACK}} + T_{\text{BOP}}}, \quad (4)$$

where P_{DF} – probability of frame distortion in a wireless channel.

This expression (4) is a mathematical model for calculating the throughput of the IEEE 802.11g standard wireless channel for the Base transmission cycle with retransmission.

Maximum channel throughput *MCT* is a throughput in a channel without frame distortion and retransmissions ($P_{\text{DF}} = 0$). So, it is a throughput of ideal wireless channel [9 – 11].

Taking into accountequation (4) wecan write an expressionfor calculating maximum channel throughput *MCT*for the Base transmission cycle

$$MCT_{\text{BTC}} = \frac{L_{\text{MSDU}}}{T_{\text{DIFS}} + T_{\text{DATA}} + T_{\text{SIFS}} + T_{\text{ACK}} + T_{\text{BOP}}}. \quad (5)$$

In 802.11g standard determines the set of mandatory data rates: 54, 48, 36, 24, 18, 12, 9, 6 Mps. Using equations (1 – 5) we can analyze 802.11gwireless maximumchannel throughput*MCT* for all mandatory data rates, which determines in 802.11g standard. The values for all parameters in equations (1 – 5) are determined in 802.11g standard [5].

At first we would analyze *MCT* for maximum data rate 54 Mbps which supports in 802.11g standard (Fig. 1).

Analysis of *MCT* dependences for Base transmission cycle at Figure 1 shows thatmaximum throughput 31,4 Mbps is provided at the maximum frame size 1500 byte and is 58 % of the data rate.

Maximum channel throughputgraphs for Base transmission cycle for all mandatory data rates are show at (Fig. 2). Analysis of *MCT* dependences for Base transmission cycle at (Fig. 2) shows thatmaximum throughput for all mandatory data ratesis provided at the maximum frame size 1500 byte.

It is possible to calculate what percentage *K* of the data rate is the *MCT* for all mandatory data rates

$$K = [MCT/DR] \cdot 100\%.$$

Analysis of *K* graph (Fig. 3) shows that for low transmission rates (6 and 9 Mbps) maximum channel throughput is approximately equal to the data rate.

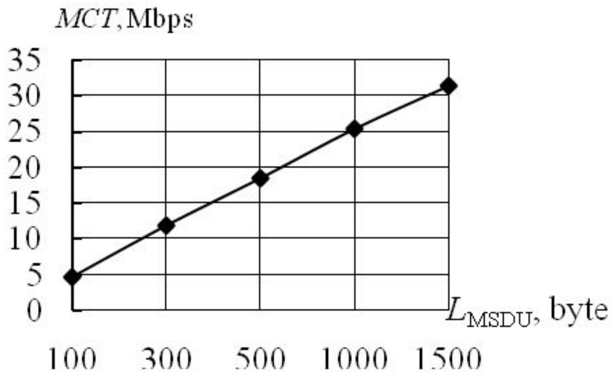

Fig.1.*MCT* graph for Base transmission cycle (*DR* = 54 Mps)

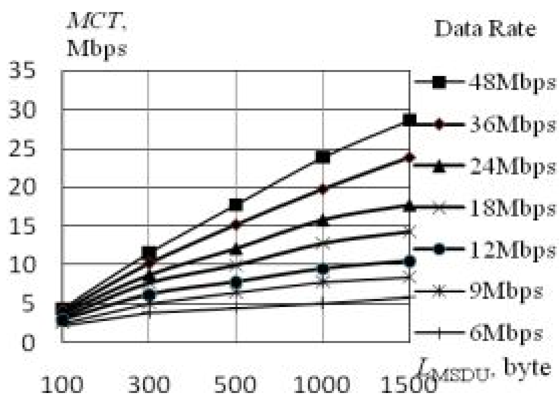

Fig. 2: MCT_{BTC} graphs for mandatory data rates of 802.11g standard

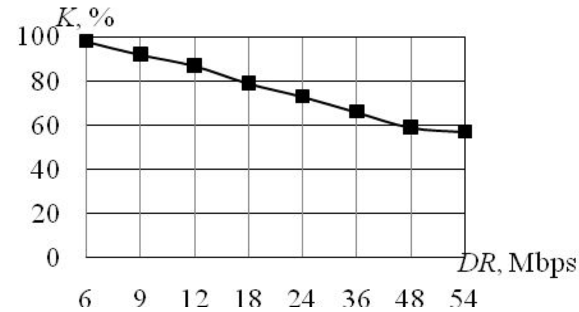

Fig. 3. *K* graph for all mandatory data rates

For high data rates (54 and 48 Mbps) maximum channel throughput is about 60 % of the data rate.

Conclusions. Analysis of maximum channel throughput for ideal wireless channel shows that for lowest mandatory data rate 6 Mbps maximum channel throughput is approximately equal to the data rate (difference between data rate and maximum channel throughput is above 2 %).

For the next mandatory data rate 9 Mbps difference between data rate and maximum channel throughput is above 8 %.

For high data rates (54 Mbps and 48 Mbps) maximum channel throughput is about 60% of the data rate. Therefore, in calculating the characteristics of the wireless networks with a lowest data rate 6 Mps as the value of the maximum channel throughput we can use the value of it data rate.

When the data rates are 9 Mps and more we must calculate maximum channel throughput in accordance with equation (5).

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