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ANALYSIS OF IEEE 802.11 CHANNEL THROUGHPUT FOR CLOSED OFFICE NETWORK INVIRONMENT STRUCTURE

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Analysis of the environment structures of wireless networks was conducted. It is shown that the most commonly used structure is closed office structure. The development of mathematical model for calculating IEEE 802.11g channel throughput for closed office environment structure is carried out. With the use of the developed model a study of channel throughput for all mandatory data rates of IEEE 802.11g wireless channel for closed office environment structure was conducted.

Keywords: mathematical model, wireless standard 802.11g, closed office environment structure, error-prone channel throughput.

Wireless LANs (WLANs) of IEEE 802.11 standard are widely used in modern distributed information systems of different levels from the level of corporate network to the level of SOHO networks. On the throughput of the wireless channel is significantly affected the structure of WLAN environment. Analyses show that a large number of modern WLANs have closed office environment structure, which is characterized by high levels of interference and high bit error rate (BER) in the wireless channel [1]. Most studies of wireless channel throughput are devoted to analyzing the performance of an "ideal" channel or a channel with a low interference level less than 10^{-5} [2].

In this report the throughput of IEEE 802.11g wireless channel with high BER level typical for WLANs with closed office environment structure, so called error-prone wireless channels, was analyzed. Model for calculation 802.11g wireless channel throughput that takes into account BER level and mechanism of damaged frames retransmission determined in 802.11g standard was proposed. Using the proposed model the throughput of error-prone 802.11g wireless channel for all mandatory data rates used in this standard are investigated.

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 are time intervals defined by the standard, DF is data frame and ACK is acknowledgment frame [3].

Time of 802.11g Base transmission cycle can be written as

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

were T_{DIFS}, T_{BOP}, T_{SIFS} — length of DIFS, Back of period and SIFS time intervals, T_{DATA}, T_{ACK} — time of data and acknowledgment frames transition.

Time of data frame transmission is defined in standard as

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

were 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 highest integer.

ACK frame transmission time is defined in standard as

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

were L_{ACK} — length of acknowledgment frame.

Using equations (1) — (3) we can calculate the time of Base transmission cycles for the IEEE 802.11g standard.

Using equations from [4] we can calculate throughput of 802.1g error-prone wireless channel for Base transmission cycle with retransmission as

$$CT_{BTC} = \frac{L_{MSDU} \cdot (1 - P_{DF})}{T_{DIFS} + T_{DATA} + T_{SIFS} + T_{ACK} + T_{BOP}}, \quad (5)$$

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 error-prone wireless channel for the Base transmission cycle with retransmissions.

In 802.11g standard determines the set of mandatory data rates: 54, 48, 36, 24, 18, 12, 9, 6 Mps. Using equations (1—4) in this report make analyses of error-prone 802.11g wireless channel throughput CT_{BTC} for all mandatory data rates, which determines in 802.11g standard, and the range of BER level variation from 10^{-5} to 10^{-4}. The values for all parameters in equations (1—4) are determined in 802.11g standard [3].

On the basis of throughput analysis for error-prone wireless channel the following conclusions can be formulated.

1. For all mandatory data rates in error-prone wireless channel, throughput can be several times smaller than at a channel without interference. When BER value changes from 10^{-5} to 10^{-4}, the range of throughput variation for mandatory data rates changes up to 30 times. So we must calculate the throughput for each subscriber of the wireless channel, taking into account its BER level.

2. For all mandatory data rates in error-prone wireless channel if the BER level is less or equal to 10^{-5} maximum throughput provided by transmission frames of maximum size 1500 bytes. If the BER level in error-prone wireless channel is more than 10^{-5} maximum throughput provided by the transmission frames with sizes smaller than 1500 bytes.

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Анализ пропускной способности беспроводного канала стандарта IEEE 802.11 для структуры сети «закрытый офис».

Проведен анализ типовых структур беспроводных сетей стандарта 802.11. Показано, что наиболее часто используемой структурой является структура «закрытый офис». Проведена разработка математической модели для расчета пропускной способности беспроводного канала стандарта IEEE 802.11g для сети со структурой «закрытый офис». С использованием разработанной модели проведено исследование пропускной способности беспроводного канала стандарта IEEE 802.11g для сети со структурой закрытый офис для всего набора скоростей передачи, которые применяются в данном стандарте.

Ключевые слова: *математическая модель, стандарт беспроводной связи 802.11g, структура сети закрытый офис, пропускная способность канала с помехами.*