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An analysis of BSS coloring mechanism in IEEE 802.11ax dense networks

Marek Natkaniec, and Natalia Bieryt

***Abstract*—The paper presents an analysis of BSS coloring scheme defined in IEEE 802.11ax standard. The efficiency of dense networks for different scenarios was analyzed and compared. This analysis covers various topologies and work configurations through the use of multiple parameters of the PHY and MAC layers. A positive impact of the coloring mechanism on the QoS was observed. The study also analyzed the impact of the RTS/CTS mechanism on the obtained network performance and adequate prioritization of various traffic classes. It was shown that the proper selection of the coloring mechanism parameters in the IEEE 802.11ax standard has a strong impact on QoS and the performance of dense networks.**

***Keywords*—BSS coloring; dense networks; IEEE 802.11ax; QoS**

I. INTRODUCTION

IN recent years, applications offering video and audio streaming services have gained enormous popularity, thus causing increasing demands on the quality of transmission. It has been estimated that by 2022, IP traffic carried over WLANs (Wireless Local Area Networks) will reach 51% of all IP traffic (43% in 2017) [1].

The work on the standardization of wireless local area networks dates back to the 90s of the last century. These activities led to the publication of the first IEEE 802.11 standard in 1997. To this day, this area has been dynamically developed and further extensions of this standard are systematically approved every few or several months. Wi-Fi networks have gone through a long development path, which results from the naturally increasing requirements in the field of transmission quality. Each subsequent extension of the standard proposes changes to the physical layer (PHY) and/or medium access control layer (MAC), the purpose of which is primarily to ensure greater throughput and a wider range of radio coverage [2]. The need to constantly improve the Quality of Service (QoS) is also caused by the dynamic development of the so-called Internet of Things (IoT), which uses the most important functionality offered by wireless networks, which is mobility. However, applications often have different requirements for traffic prioritization, necessitating a large variation in the QoS provided. The situation is worsened by the fact of existence, especially in highly urbanized places, the so-called dense networks, i.e. networks with a very large number of stations and access points located in a relatively small area. This causes serious problems as the number of wireless devices generating multiple data streams increases the frequency of collisions. The first extension to the standard that supports the QoS is IEEE 802.11e [3]. It defines four traffic categories, which are Voice, Video, Best Effort and Background, by setting the priority in the frame. Each of them has adequate guarantees regarding delays, jitter, frame loss or throughput. Additional mechanisms ensuring QoS transmission are Block Acknowledgments, which eliminate the protocol overhead and the QoSNoAck option which allow not to confirm specific frames [4]. The IEEE 802.11ax standard, apart from further increasing the transmission possibilities, also offers a number of new functionalities allowing for the improvement of work efficiency in the conditions of coexistence of a large number of network devices [5].

The aim of this work is to analyse the network coloring mechanism defined in the IEEE 802.11 standard and to determine the impact of its parameters on the QoS provided. The work consists of six chapters. Chapter 2 provides an overview of the literature. Chapter 3 briefly introduces the IEEE 802.11ax standard, and the next chapter discusses the network coloring mechanism. Chapter 5 contains the simulation results of three different scenarios. The article ends with Chapter 6, which summarizes this work.

II. STATE OF THE ART

The paper [6] presents the advantage of the IEEE 802.11ax standard in terms of achieved throughput, both with a small and large number of users in the network, compared to the IEEE 802.11ac extension. In the article [7] a two-fold increase of throughput in the 2.4 GHz frequency band and a gain of 25% in the 5 GHz band was observed, which was achieved only with a few functionalities offered by the IEEE 802.11ax extension. The work [8] analyzes the impact of the coexistence of stations operating according to the IEEE 802.11ax standard with older standard extensions. It was observed that the network efficiency increased with the higher percentage of stations supporting the latest standard extension. The authors also drew attention to the phenomenon of better treatment of users located closer to the access point due to greater interference of stations located on the edge of the network with neighboring

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M. Natkaniec and Natalia Bieryt are with Faculty of Computer Science, Electronics and Telecommunications, Institute of Telecommunications, AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Krakow, Poland (e-mails: natkanie@agh.edu.pl, bieryt.natalia@gmail.com).

Wireless Local Area Networks (WLANs). Subsequently, in [9] it was concluded that using the network coloring mechanism and higher modulation indexes and coding schemes, we do not always achieve higher throughput, which results from high Signal-to-Interference-plus-Noise Ratio (SINR) requirements for these modulation modes. The authors also proposed an algorithm that sets the appropriate OBSS/PD threshold, which is to ensure fair treatment of users in the network. As a result of its use, a gain in throughput of 57% was observed. The work [10] was also devoted to two aspects of the IEEE 802.11ax network, namely 1024-QAM modulation and the network coloring mechanism. The article is presented in the form of a comparison to the IEEE 802.11ac standard. The main studied scenario covered a network consisting of 3 access points and over a dozen of stations in the case of disabled and enabled coloring mechanism. An increase in the throughput by 14% was observed when using the 1024-QAM modulation and up to 47% with the MCS 5 and coloring mechanism enabled. The article [11] examines the impact of changing the OBSS_PD threshold value on the achieved throughput in the network for seven access points, each of which is associated with ten stations. The gain for the given topology was 13% for the OBSS_PD threshold value equal to -72dBm, which was found to be the most favorable for the given scenario. According to the authors, work [12] is the first work in which it was possible to create an analytical model to determine the optimal parameters of coexisting networks at short distances using the mechanisms introduced by the IEEE 802.11ax standard. It has been observed that the throughput and its degradation are directly related to the level of network interference. The authors analyzed the OBSS_PD parameter and the transmitting power of the stations in order to determine their optimal value. In order to maximize the profit, the authors took into account parameters such as MCS, and traffic direction when selecting the transmission power. The algorithm was designed in such a way as to maximize the total throughput of many BSS networks transmitting on the same channel. The study showed that the station should set the transmitting power level so that the interference level for both stations transmitting simultaneously was at a similar level. This makes it possible to set the appropriate OBSS_PD threshold, which is strictly dependent on the interference. The use of an additional algorithm presented by the authors, with the appropriate network configuration, may contribute to a gain in throughput equal to 26%, compared to the traditional network coloring mechanism.

To the best of our knowledge, the results presented in this paper are the first that include QoS analysis in IEEE 802.11ax dense networks with BSS coloring mechanism. In the following chapters, we present the performance results for three typical network scenarios with two and three APs.

III. IEEE 802.11AX STANDARD

The new IEEE 802.11ax standard introduces many changes aimed at improving spectral efficiency. However, it is still compatible with other versions of the IEEE 802.11 standard. The frequency bands it can operate in are both 2.4 GHz and 5 GHz. As in the previous IEEE 802.11ac standard, four channel widths are available: 20 MHz, 40 MHz, 80 MHz and 160 MHz. A significant change is the fourfold reduction in the distance between subcarriers in OFDM (Orthogonal Frequency-Division Multiplexing). As a result, four times as many radio channels are available that have been spaced apart at 78.125 kHz. This procedure also resulted in a fourfold extension of the symbol duration, amounting to 12.8 µs, which resulted in increased resistance of the network to various interferences. A longer symbol requires an appropriate value of the Guard Interval (GI), which, in accordance with the new standard, assumed the values of 800 ns, 1600 ns and 3200 ns [13].

The physical layer also introduces another modulation scheme which is 1024-QAM, where one symbol is able to carry 10 information bits. Until now, the list of available modulation modes was 9. The new modulation extended this range to 11. The new indexes 10 and 11 are 1024-QAM modulations, applying the efficiency of the correction code respectively 3/4 and 5/6.

IEEE 802.11ax has defined two operating modes: Single User (SU), i.e. a mode in which one station can transmit simultaneously, and Multi User, which allows simultaneous transmissions of many clients. Multi User (MU) broadcasts have been recognized as crucial in solving the problems of dense networks. The mechanisms that allow for the simultaneous transmission of many users are, among others, Multi-User MIMO and the Orthogonal Frequency Division Multiple Access (OFDMA) technique, not previously used in the IEEE 802.11 family standards. The previous extension of IEEE 802.11ac was also able to transmit in the MU-MIMO mode, but this transmission could only take place in the ”downlink” [14]. The latest enhancement has overcome this limitation by allowing MU-MIMO to be used for both downlink and uplink transmission with eight parallel streams. The newly introduced OFDMA technique has made it possible to divide the channel into Resource Units (RU), which may consist of several subcarriers, which in turn are allocated to a specific user.

The IEEE 802.11ax extension further defined four PHY Protocol Data Unit (PPDU) frame formats. The first one is intended for SU transmission, the next, the so-called Extended Range SU PPDU for transmission over longer distances only in the band with a width of 20 MHz, and the third one, MU PPDU, is presented for transmission to multi-user and the last Triggered Based PPDU, designed for uplink transmission by multiple users [15].

The IEEE 802.11ax standard introduces several changes in the scope of aggregation [15]. The maximum size of the aggregated frame for the A-MPDU is 8,388,607 bytes, while the A-MSDU can contain 11,398 bytes [2]. Another change is the extension of the Target Wake Time (TWT) mechanism, already available in the IEEE 802.11ah standard, which allows the device to be put into sleep mode if it does not participate in the transmission. This resulted in a significant reduction in the level of power consumption, and thus extending the life of the battery. The station is woken up every Service Period (SP) segment for a specified reserved time, during which it gets the opportunity to exchange information with the access point. The device is then not woken up even to receive Beacon frames, which is to significantly save energy [15].

IEEE 802.11ax also has the ability to virtualize the network [15], which consists in creating Virtual Access Points (VAPs). Thanks to this, it is possible to have up to a dozen BSSIDs, which gives the opportunity to separate, for example, a network intended for guests, without the need to have two physical access points. However, it is required that each of them has the same network color.

IV. BSS COLORING MECHANISM

The network coloring mechanism is a method that allows for the effective use of the available bandwidth. It makes it possible to distinguish transmissions from different Basic Service Set (BSS) areas, taking place on the same channel, by color. By color, we mean the six-bit value contained in the preamble of the physical layer as shown in Fig. 1. The maximum number of possible colors is thus 63, where the color 0 means that the mechanism is turned off. In addition to the CCA threshold parameter, another threshold has been defined, which is the Overlapping BSS Preamble Detection (OBSS_PD) threshold. Its purpose is to allow for the possibility of parallel transmissions and at the same time to control their number, because too many of them increase the level of interference.

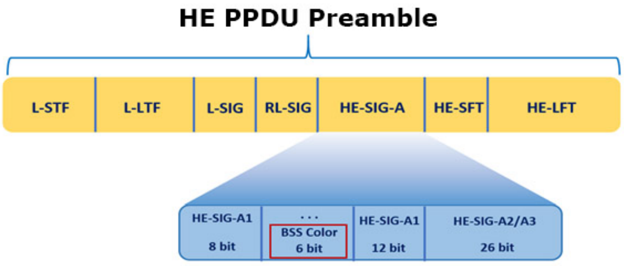


Fig. 1. The PHY Preamble of IEEE 802.11ax stanard

The first step for the recipient is to compare the preamble color of the incoming frame with the color of their network. If the color is not identical to its own network, the receiver does not decode the frame, saving energy. Then the signal is compared with the newly defined OBSS_PD threshold. If the detected power level is higher than the preset threshold, the channel is considered busy. Otherwise, the signal is so weak that a parallel transmission in the channel [9], [16] is allowed. Fig. 2 presents the algorithm of the network coloring mechanism.

The IEEE 802.11ax standard specifies a condition regarding what values the OBSS_PD threshold can take:

$$OBSS_{PD} \le max(OBSS_{PDmin}, min(OBSS_{PDmax}, OBSS_{PDmin} + (TX_{PWRref} - TX_{PWR}))) \tag{1}$$

where $OBSS_{PDmin} = -82dBm$, $OBSS_{PDmax} = -62dBm$, $TX_{PWRref} = 21dBm$, and TX_{PWR} is the station's transmit power in dBm [2].

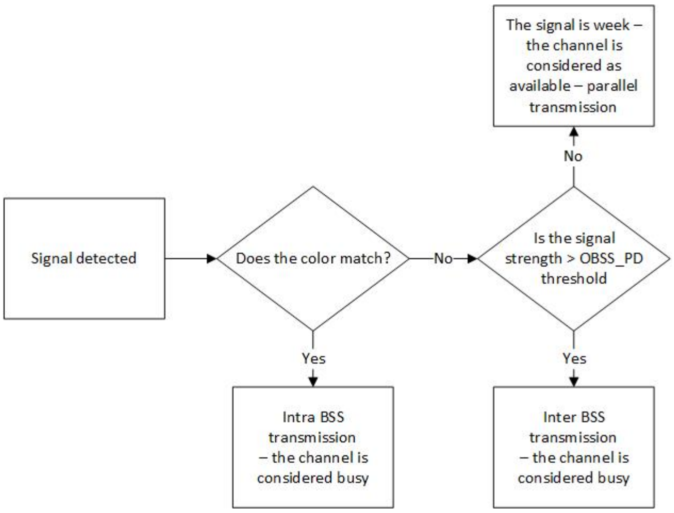


Fig. 2. The BSS coloring algorithm in the IEEE 802.11ax standard

To support of network coloring, two types of Net Allocation Vector (NAV) have been introduced in IEEE 802.11ax, one for transmissions from the current network, and another for transmissions from other BSS areas. A channel is considered free when both NAV values are equal to zero [15]. Additionally, Access Point (AP) has the ability to detect a color conflict, i.e. a situation of repeating the same color in overlapping networks. The station can also inform the access point it is associated with about it. The access point changes the color by sending a dedicated BSS Color Change Announcement frame, or by informing about it using Beacon, Probe Response or Reassociation Response frames.

V. PERFORMANCE EVALUATION

This chapter presents the simulation results performed with the Network Simulator (NS) version 3.31 [17]. It is primarily intended for educational purposes and therefore is free under the GNU GPLv2 license. This tool enables highly realistic network simulations, including WLAN networks. In order to ensure QoS, the Enhanced Distributed Channel Access (EDCA) function was used, which is still one of the most important radio channel access functions in the IEEE 802.11ax extension. The most important simulation parameters common to all scenarios are summarized in Table I. In all figures, the error of each simulation point for the 95% confidence interval did not exceed ± 2%.

A. *Scenario 1 - Two APs*

The topology (Fig. 3) consists of two APs and two STAs. Station number one (STA 1) belongs to the network with the BSS identifier 1, while station number two to the network with the BSS identifier 2. STA 1 transmits to AP 1 and consequently STA 2 transmits to AP 2. The d2 parameter is the distance between two access points (AP1 and AP2), while d1 is the distance of the station from the access point to which it is transmitting.

The scenario analyzes the impact of the distance d2 between AP1 and AP2 as well as the impact of changing the OBSS_PD

TABLE I
SIMULATION PARAMETERS.

Parameter	Value
Frequency band	5 [GHz]
Channel width	20 [MHz]
Station's transmission power	15 [dBm]
AP's transmission power	20 [dBm]
Receiver sensitivity	-92 [dBm]
Number of antennas	1
MCS	2 (QPSK ¾)
CCA ED threshold	-62 [dBm]
CCA SD threshold	-82 [dBm]
OBSS_PD	(-82 dBm, -62 dBm)
Guard interval	800 [ns]
RTS/CTS	Disabled / Enabled
Fragmentation	Disabled
Traffic classes	BK, BE, VI, VO
TXOP limit	BK = 0, BE = 0, VI=3, VO=1,5 [ms]
Transport protocol	UDP
Traffic type	CBR
Offered load	20 Mbps
Frame size	1500 B
d1	20m
d2	(50m, 400m)

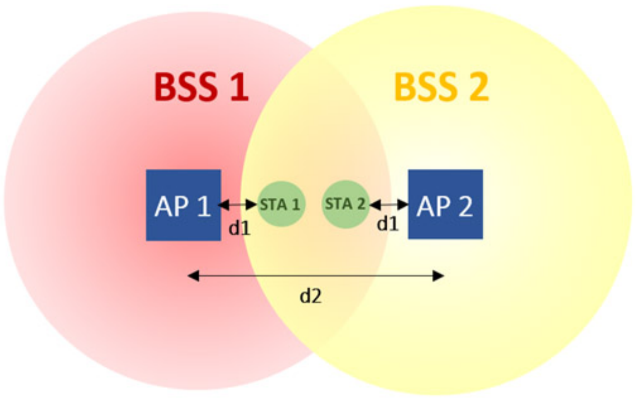


Fig. 3. The network topology with two APs

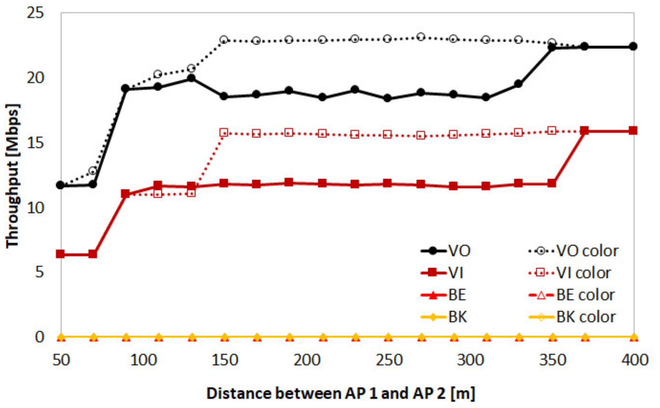


Fig. 4. The total throughput for both networks and four traffic classes as a function of the distance d2

parameter on the total throughput of both networks. Both these networks work in saturation conditions to best observe the operation of the network coloring mechanism, and they also use the same transmission channel. The coverage of the network was established by gradually moving the stations away from the access point and observing the fluctuating throughput. For both BSS 1 and BSS 2 it was about 180 meters using QPSK modulation. Thus, to completely isolate both networks, the distance between AP1 and AP2 must be at least 360 meters.

For the given simulation, the OBSS_PD threshold parameter has been set to -72dBm, which means that when a signal from another network is received, it must be weaker than the given threshold for parallel transmission to take place. Fig. 4 shows the total capacity for both networks and four traffic classes depending on the distance between access points.

The simulations show that when the distances between the BSS 1 and BSS 2 networks are small, their ranges overlap significantly, and thus numerous interferences and collisions occur. It has been observed that after the access points are moved for a distance of about 90 meters, the level of interference is so low that the achieved throughputs are much higher. The same level of throughput is maintained until the stations are moved over a distance of 300 meters, and then gradually increases until the maximum throughput of about 38 Mbps (for all traffic classes) is reached, in total for both networks. It was also noticed that with the coloring turned on, the bandwidth clearly increases near the 150-meter distance. Then the power levels of the signals coming from the neighboring network are weaker than the predetermined OBSS_PD threshold, as a result of which parallel transmission is allowed. The percentage profit from the use of the network coloring mechanism for the given research scenario was about 20%. All traffic classes behave similarly. For the given parameters, the profit resulting from the use of the coloring mechanism, both for the Video and Voice classes, was very similar, i.e. from the 150th meter the bandwidth level that networks would achieve in isolation was observed. This proves that the traffic that has different priorities is handled correctly by the coloring mechanism. Unfortunately, under saturation conditions, the capacity values achieved by the BE and BK classes fluctuate around zero, which means that these traffic classes are not properly handled in the case of a dense network.

The impact of changing the OBSS_PD threshold value on the achieved throughput for different distances between AP1 and AP2 was examined next (Fig. 5). It has been observed that the shorter the distance between the networks, the higher the threshold is required to observe the gain from applying the coloring mechanism. This is due to the inability to perform parallel transmissions at a low OBSS_PD threshold value. For example, for a distance of 100 meters between networks, the signal strengths from the foreign network are higher than -82 dBm, and at the same time lower than -70dBm, which for this distance requires setting the OBSS_PD threshold to a value equal to at least -70 dBm, in order to achieve higher throughput. For a distance of 350 meters, we can use any threshold value in the range (-82 dBm, -62 dBm), because the network ranges overlapped slightly and the gain from the coloring mechanism was noticed using any OBSS_PD threshold value.

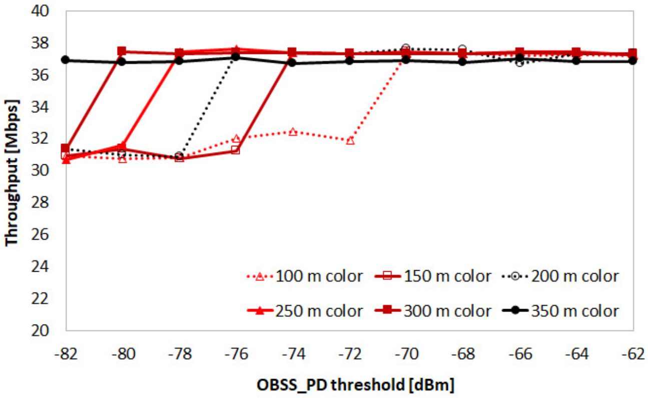


Fig. 5. The total throughput for different values of the distance d2 as a function of OBSS_PD threshold

It was also observed that at a short distance between AP1 and AP2 there is a decrease in throughput for OBSS_PD threshold values greater than -66 dBm (Fig. 6). This phenomenon is due to an increased level of interference which in turn results from a large number of parallel transmissions on the channel and hence an increased number of packet losses. An important observation is also the appropriate treatment of traffic classes, which is appropriate to their priority for any value of the OBSS_PD threshold.

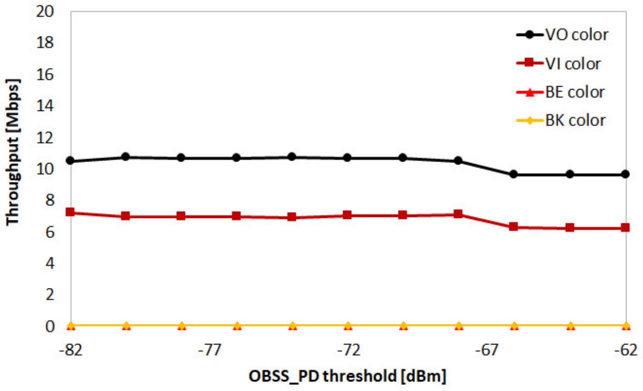


Fig. 6. The total throughput for both networks and four traffic classes as a function of the OBSS_PD threshold and d2=50m

B. *Scenario 2 - Three APs*

The second scenario extended the topology presented in the previous selection with another network with the BSS 3 identifier. All three networks were set in the configuration with coordinates forming an equilateral triangle. The stations were placed within the triangle created by the access points, as shown in Fig. 7. All three networks were using a common channel. The range of each of them was about 180 meters. In the given scenario, the impact of changing the distance d2 between networks and the OBSS_PD threshold value on the achieved network throughput and the profit resulting from the use of the coloring mechanism was investigated.

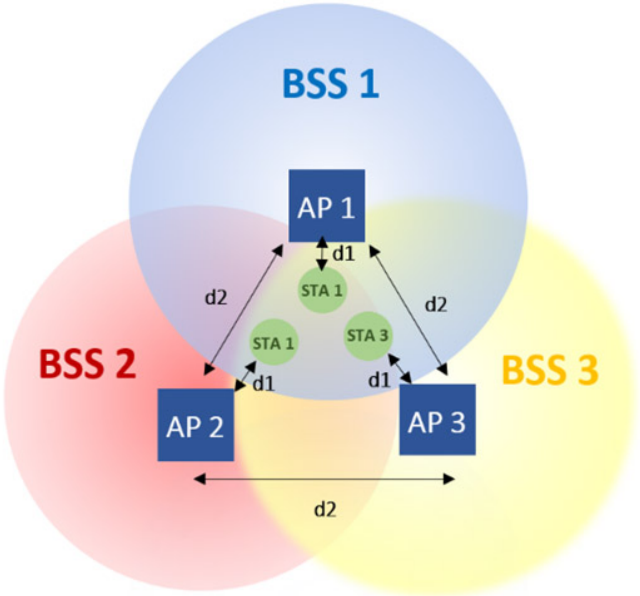


Fig. 7. The network topology with three APs

As the first one, the influence of the change of the OBSS_PD threshold value on the total capacity of the three networks was investigated (Fig. 8). As in the previous scenario, by reducing the value of the OBSS_PD threshold parameter, the profit resulting from the use of coloring is visible for larger distances between the networks, which for the given topology was about 4%. It has also been observed that traffic classes, with distances between access points greater than 150 meters, are treated according to the priorities assigned to them.

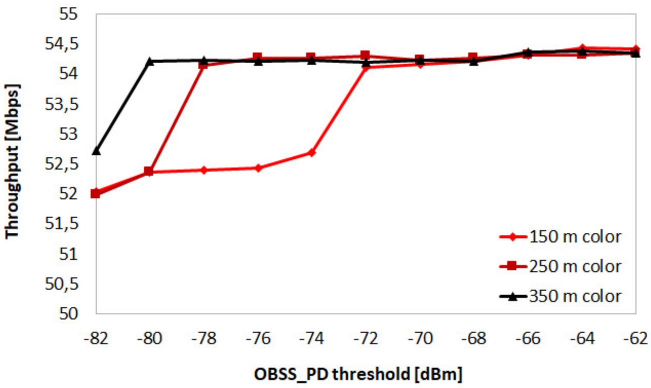


Fig. 8. The total throughput for three networks and different values of the distance d2 as a function of OBSS_PD threshold

In the discussed scenario, the effect of setting too high value of the OBSS_PD threshold is also visible, allowing more parallel transmissions on the same channel. At a distance of 100 meters between each access point, the use of the OBSS_PD threshold parameter greater than or equal to -64 dBm, results in a decrease in throughput by even 10 Mbps (Fig. 9).

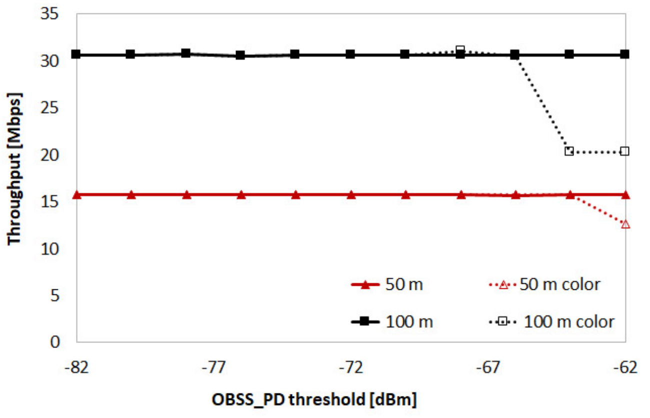


Fig. 9. The total throughput for three networks as a function of OBSS_PD threshold and distance d2 equal to 50 and 100 meters

Moreover, it has been observed that the effect of setting such a high threshold is inappropriate treatment of traffic class priorities, causing them to be completely inverted, as shown in Fig. 10.

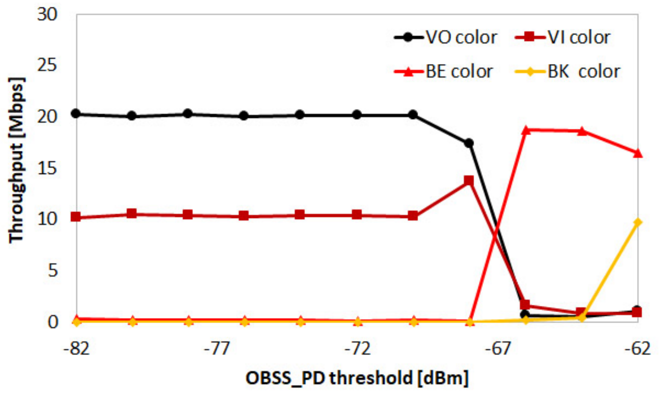


Fig. 10. The total throughput for three networks and and four traffic classes as a function of OBSS_PD threshold and distance d2 equal to 100 meters

A similar phenomenon has been observed in ad-hoc networks with hidden stations that use the EDCA channel access mechanism to give different priorities [18]. In the mentioned paper, a tendency of ”mixing” of traffic class priorities in the presence of hidden stations was observed. The authors indicate that the best known mechanism for dealing with the problem of hidden stations is the use of the so-called four-way-handshake mechanism, which is based on the exchange of Request to Send (RTS) and Clear to Send (CTS) frames before sending the data frame. The authors also mention the disadvantages of such a solution, which reduces the network throughput, which results from the overhead introduced by control frames.

Following the conclusions from the above publication, the RTS/CTS mechanism was turned on in order to try to eliminate the unequal treatment of traffic classes. Fig. 11 shows the total throughput for three networks, belonging to four traffic classes using the RTS and CTS control frames. It was observed that the mechanism coped with the phenomenon of mixing traffic classes, however, this solution decreased the efficiency of the network for all traffic classes.

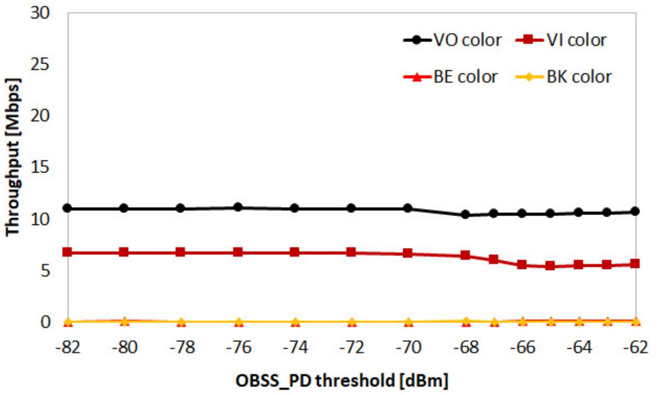


Fig. 11. The total throughput for three networks and four traffic classes as a function of OBSS_PD threshold and distance d2 equal to 100 meters with RTS/CTS mechanism enabled

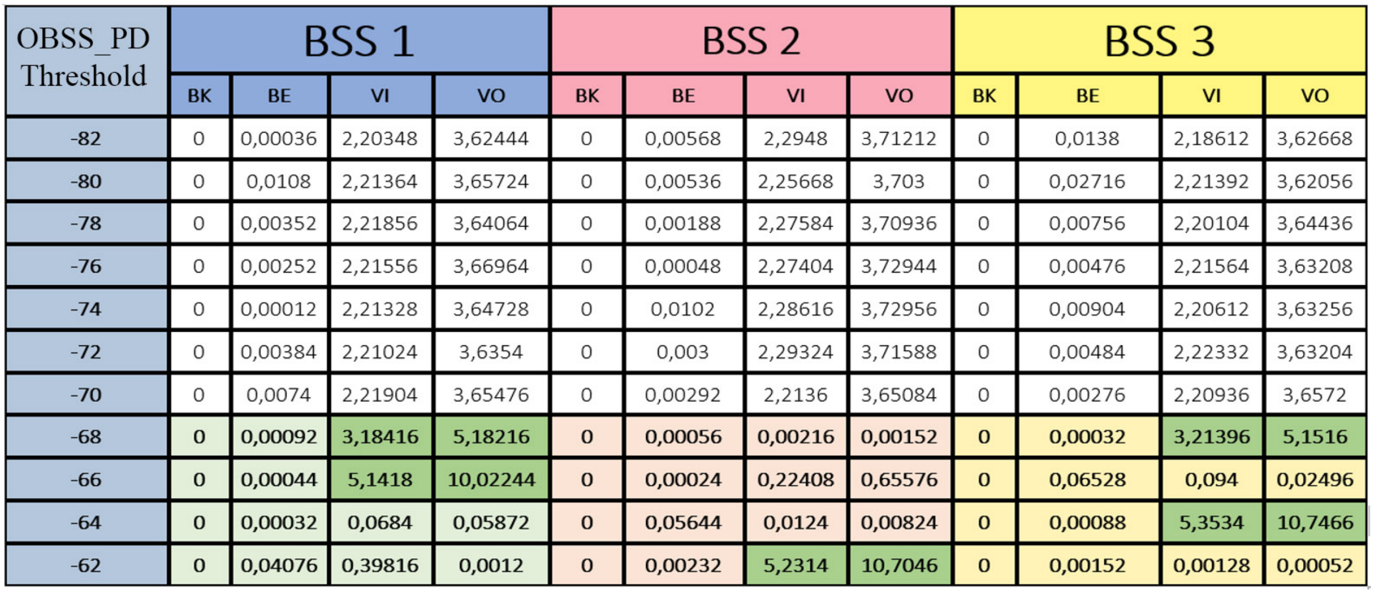
This has also been shown in Fig. 12 , where the throughput achieved by the greedy network(s) are marked in green. Moreover, the use of this mechanism significantly reduced the total throughput achieved by the networks, which in a given configuration dropped by as much as a half.

C. Scenario 3 - Three APs in line topology

The last scenario is the extension of the configuration presented in previous subsection with an additional network with the BSS 3 identifier, which this time were set in one line. As in the previous scenarios, the impact of changing the OBSS_PD threshold value, as well as the d2 distance between networks, on the achieved throughput and the resulting profit from the use of the network coloring mechanism was investigated. The stations are positioned over the access points at a distance of d1, as shown in Fig. 13.

The profit resulting from the use of the coloring mechanism is visible only when the OBSS_PD threshold parameter is set appropriately. In the graph presented in Fig. 14, a decrease in throughput for the 200-meter distance was also observed for the OBSS_PD value equal to -62 dBm, i.e. the highest possible. This is because too many transmissions in parallel result in a higher level of interference on the channel. For the given configuration, the gain in the achieved throughput was about 10%, with appropriate selection of the value of the OBSS_PD parameter. Subsequently, the treatment of different traffic classes was analyzed, using all possible values of the OBSS_PD parameter.

Exactly as in the previous scenario, the network improperly prioritized phenomenon was observed for the distance between access points equal to 100 meters (see Fig. 15). The simulations also show that the total throughput, despite the ”mixing” of classes, is still higher with the use of the coloring mechanism than without it. This gives a false belief that the use of this low threshold is correct, but when looking at the



OBSS_PD Threshold	BSS 1				BSS 2				BSS 3			
	BK	BE	VI	VO	BK	BE	VI	VO	BK	BE	VI	VO
-82	0	0,00036	2,20348	3,62444	0	0,00568	2,2948	3,71212	0	0,0138	2,18612	3,62668
-80	0	0,0108	2,21364	3,65724	0	0,00536	2,25668	3,703	0	0,02716	2,21392	3,62056
-78	0	0,00352	2,21856	3,64064	0	0,00188	2,27584	3,70936	0	0,00756	2,20104	3,64436
-76	0	0,00252	2,21556	3,66964	0	0,00048	2,27404	3,72944	0	0,00476	2,21564	3,63208
-74	0	0,00012	2,21328	3,64728	0	0,0102	2,28616	3,72956	0	0,00904	2,20612	3,63256
-72	0	0,00384	2,21024	3,6354	0	0,003	2,29324	3,71588	0	0,00484	2,22332	3,63204
-70	0	0,0074	2,21904	3,65476	0	0,00292	2,2136	3,65084	0	0,00276	2,20936	3,6572
-68	0	0,00092	3,18416	5,18216	0	0,00056	0,00216	0,00152	0	0,00032	3,21396	5,1516
-66	0	0,00044	5,1418	10,02244	0	0,00024	0,22408	0,65576	0	0,06528	0,094	0,02496
-64	0	0,00032	0,0684	0,05872	0	0,05644	0,0124	0,00824	0	0,00088	5,3534	10,7466
-62	0	0,04076	0,39816	0,0012	0	0,00232	5,2314	10,7046	0	0,00152	0,00128	0,00052

Fig. 12. The throughput achieved by four traffic classes in three networks

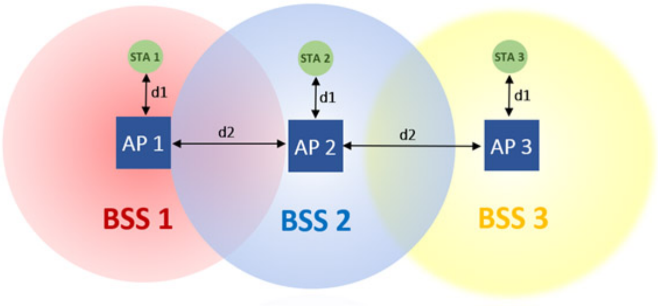


Fig. 13. The network topology with three APs

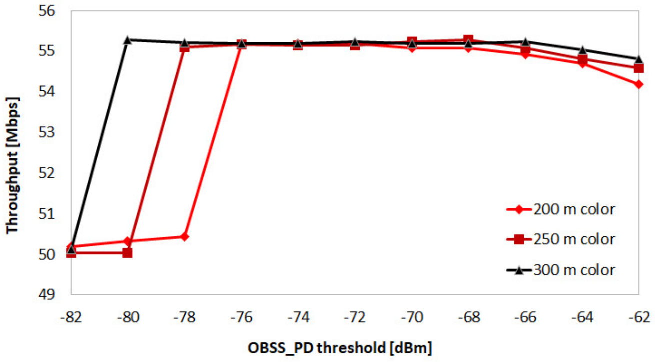


Fig. 14. The total throughput for three networks in line topology as a function of OBSS_PD threshold and different distances d2

traffic coming from the individual classes, it was found that for the given scenario, using the OBSS_PD threshold parameter greater than -72dBm leads to the degradation of traffic classes.

Once again, an attempt was made to deal with the problem described above by using RTS and CTS control frames (Fig. 16). The traffic classes are then treated more fairly, but still the efficiencies achieved are lower than in the case of the coloring mechanism disabled, which makes this method of dealing with the problem useless in terms of the transmission throughput achieved.

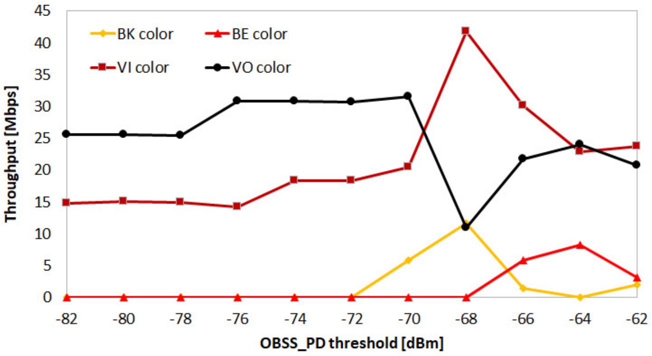


Fig. 15. The total throughput for three networks in line topology as a function of OBSS_PD threshold for distance d2 equal to 100m

VI. CONCLUSION

The 802.11ax standard offers a new 1024-QAM modulation with two coding schemes. This resulted in the possibility of achieving high throughput, but it should be remembered that their use requires good channel quality due to the proximity of symbols in the constellation diagram, which significantly reduces the network coverage. However, this is inline with the IEEE 802.11ax standard which assumes existence of dense networks where large number of networks are located at small areas. The possibility of MSDU and MPDU aggregation also contributed to the improvement of the QoS provided in the network. According to the literature, network capacity can then almost be doubled, but this is at the expense of deteriorating other metrics, such as delay and jitter. Therefore,

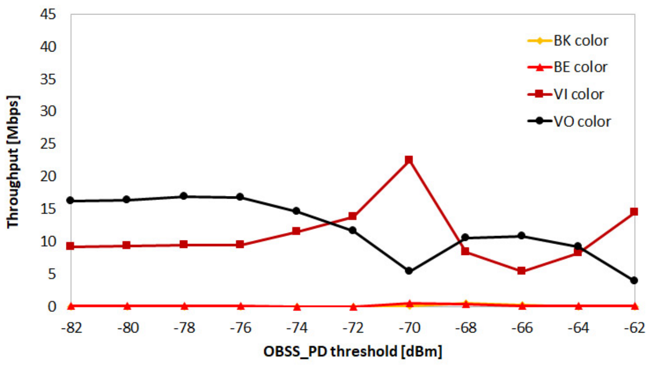


Fig. 16. The total throughput for three networks in line topology as a function of OBSS_PD threshold for distance d2 equal to 100m and RTS/CTS mechanism enabled

it is important to carefully choose the number of aggregated frames in the network, especially when the channel is characterized by high error rates. Correct treatment of network traffic, and thus ensuring appropriate transmission quality to end users, is ensured by the EDCA channel access function, by means of appropriate setting of its parameters for each of the priorities. These values, however, should be changed in exceptional situations, because their improper setting may lead to a complete degradation of traffic with specific priorities.

Network coloring is a mechanism offered by the IEEE 802.11ax standard, which in the right circumstances and with the right parameters setting, brings measurable benefits in terms of the achieved throughput. This profit is significantly influenced by the network topology itself, i.e. the positioning of stations and access points, especially the distance between them. Performed research shows that the greatest profit was achieved in the case of simultaneous operation of two networks in one channel, and it amounted to about 20%. Manipulation of the OBSS_PD threshold also gives a great opportunity to gain profit from the use of this mechanism, because its high value allows for a greater number of parallel transmissions. However, it should be remembered that this can lead to significant interference, which can reduce the achieved throughput. The network coloring mechanism with low OBSS_PD threshold values correctly copes with the traffic priorities handled, and therefore treats classes defined by the EDCA function appropriately. However, there are cases when the order of traffic classes is completely disrupted. Therefore, it may be necessary to enable the RTS/CTS mechanism, so that the services are provided in accordance with the priority assigned to it. The OBSS_PD threshold should also be appropriately selected, which must be high enough to allow for parallel transmissions in the channel, thanks to which we can observe a gain in the achieved throughput, but at the same time low enough to reduce the level of interference in the transmission channel.

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