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Research Article

Aggregation-Based Dynamic Channel Bonding to Maximise the Performance of Wireless Local Area Networks (WLAN)

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Channel bonding is considered by the IEEE 802.11ac amendment to improve wireless local area network (WLAN) performance. In this article, the channel bonding and aggregation method were proposed to increase wireless local area network performance (WLANs). It combines many channels (or lanes) to boost the capacity of modem traffic. Channel bonding is the combination of two neighbouring channels within a certain frequency band to increase wireless device throughput. Wi-Fi employs channel bonding, also known as Ethernet bonding. Channel bandwidth is equal to the uplink/downlink ratio multiplied by the operational capacity. A single 20 MHz channel is divided into two, four, or eight power channels. At 80 MHz, there are more main and smaller channels. Performance of short-range WLANs is determined through graph-based approach. The two-channel access techniques including channel bonding proposed for the IEEE 802.11ac amendment are analysed and contrasted. The novel channel sizing algorithm based on starvation threshold is proposed to expand the channel size to improve WLAN performance. Second-cycle throughput is estimated at 20 Mbps, much beyond the starvation threshold. Our test reveals access points (AP) 1, 2, and 4 have enough throughput. A four-AP WLAN with a 5-Mbps starvation threshold is presented. C160 = 1 since there is only one 160 MHz channel. MIR (3, 160 (a, a, a)) =0, indicating that AP 3's predicted throughput is 0. The algorithm rejects the 160 MHz channel width since ST is larger than 0. The channel width in MHz is given by B =0,1 MIR. The MIR was intended to maximise simultaneous broadcasts in WLANs. The authors claim that aggregation with channel bonding outperforms so all WLAN APs should have a single-channel width. It usually outperforms fairness-based measures by 15% to 20%. Wi-Fi standards advise "channel bonding," or using higher frequency channels. Later standards allow channel bonding by increasing bands and channel lengths. Wider channels enhance average WLAN AP throughput, but narrower channels reduce appetite. Finally, it is concluded that APs are more useful than STAs.

1. Introduction

Short-range wireless local area networks (SR-WLANs) transmit data at fast speeds while using little power. Network configurations that include desktops, rooms, and car networks are all widespread. Additionally, by building many SR-WLANs, channel reuse may be maximised [1]. To address the performance requirements of multimedia applications on SR-WLANs, IEEE 802.11ac WLANs are considering channel bonding, which has already been tested in practice. By merging many basic channels, a larger channel with higher transmission rates and throughput may be created. It uses DBCA to dynamically modify channel width to meet the available bandwidth. The main channel is used to transmit control and management frames to devices that do not support channel bonding. Other channels are called "secondary channels" in this context. Transmitter-receiver pairs at each end of a transmission line may bind together to form one or more basic channels. If the receiver can only use one channel, there is no data transfer. The increased bandwidth offered by channel bonding may be particularly useful for SR-WLANs to carry multimedia data without interfering with neighbouring WLANs. External interference from WLANs running at greater power levels on the same channels may affect SR-WLANs [2]. There is a risk that WLANs that interfere with SR-transmissions may begin broadcasting before the SR-transmission WLANs have finished, leading to data loss. Due to the increased number of interfering WLANs that are exposed to the SR-WLANs due to channel bonding, the situation is aggravated. As SR-WLANs are subjected to external interference, we explore this trade-off directly by investigating the performance of SR-WLANs when channel bonding is enabled [3].

Analytical models can be used to look at the effectiveness of each channel access method, including how many channels are bonded together and how much wireless network activity interferes with each other. The target SR-primary WLAN's channel must be located within a certain channel width to be effective [4]. Accordingly, the analytical model offered provides sufficient depth to explain and analyse how different parameters are linked together and how they affect network performance, as well as the adverse effects of external interference. There have been a lot of academics interested in how quickly the number of devices competing for limited wireless bandwidth has grown. They have started to spend more time and money on the problem. We found that bandwidth consumption was not efficient in the 2.4 GHz area, where more devices and protocols work together. We found that using bandwidth is very inefficient in places like apartment complexes, where there are a lot of people and things are spread out. Another strategy is to better decentralise or centralise network coordination by using existing standards and protocols. Transmission devices use channel allocation algorithms to reduce interference while increasing capacity. IEEE 802.11 Wi-Fi performance can be even better if you use channels with more bandwidth than the standard 20 MHz for each of the IEEE 802.11 channels. Each of the 11 protocols that can be used with channel bonding solutions comes with its own set of benefits and drawbacks [5].

For a 2.4 GHz wireless standard known as IEEE 802.11n, experts, for their part, typically oppose 2.4 GHz channel bonding due to the possibility of interference from employing larger, overlapping channels. However, even though higher maximum bit rates might be good, this could be a problem [6]. So, most of the time, tests were done at frequencies like the 5 GHz range. However, more recent research has used the 802.11ax standard to automatically connect channels. People think that North America only has 11 channels of the 802.11 spectra, even though many other places around the world have more channels (like Europe and Japan). In this case, it has been shown that using orthogonal channels does not account for these interferences. This is because interference between neighbouring channels and the number of wireless stations (STAs) and their exact location makes it hard to account for these interferences. One of the themes covered here is how channel bonding impacts Wi-Fi 4 situations that are dense and spread out, such as those seen in houses. To find out how Wi-Fi 4 dense decentralised networks could operate, use a graph-based scenario model. We do not think this is the first time this model has been used in this way [7]. This allows us to compare the performance of 60 different STA densities and locations. We found that having 11 Wi-Fi 4 channels with channel bonding made a difference in average throughput in our tests. There is a possibility that certain STA clusters may earn more money than others, raising concerns about equality. In terms of channel bonding, it is basically consistent with what people now assume. Contrary to popular belief, when 13 channels are involved, channel bonding outperforms other approaches. Using orthogonal channels in this scenario does not account for the interferences. Because of the large number of wireless stations (STAs) and their disparate locations, it is difficult to account for these interferences. One of the issues covered is how channel bonding impacts dense and spread-out Wi-Fi 4 environments, such as those seen in houses. To comprehend Wi-Fi's dense decentralised networks, use a graph-based scenario model. This is not the first time this model has been used in this manner [7]. This enables us to compare the density and placements of 60 distinct STAs. Having 11 Wi-Fi 4 channels with channel bonding enhanced average throughput in our testing. The potential of certain STA clusters getting more funding than others raises equity concerns. It satisfies contemporary requirements in terms of channel bonding. Channel bonding, contrary to common opinion, wins when there are 13 channels involved.

Internet access and too many devices have made IEEE 802.11 networks popular. Almost any device can connect to these networks. Frame aggregation improves throughput by lowering transmission overhead. A single 802.11 transmission delivers a large number of data packets, enhancing performance. Reduced congestion, interframe gaps, and protocol headers all help to increase performance. Frame aggregation is the process of combining many frames into a single frame. The overhead of the fixed MAC layer and medium contention is decreased. The words MSDU and MPDU are crucial. This feature is useful for transferring huge datasets (for example, large file downloading). It must send a certain number of frames to the A-MPDU aggregate. It is not supported by all real-time applications. On a regular basis, these programmes generate tiny volumes of data. So, the MAC must keep delivering frames and accessing channels. When numerous networks use the same medium, the collision rate rises. To prevent clashes, channelise the available WLANs. Small routes in busy areas decrease overhead. Included are back off, PPDU, and acknowledgement overhead. The duration of the backoff overhead slot time remains constant.

Regardless of channel width, receipts are always transmitted over a 20 MHz channel [8]. Several independent broadcasts over small channels outperform a single transmission over many channels. Throughput is analysed in three ways: aggregation alone, aggregation with or without channel bonding. In the simulations, channel bonding surpasses aggregation alone. IEEE 802.11b and 802.11 g employ a core frequency of 22 MHz. In principle, if channels 1, 6, and 11 (and, if available, channel 14) do not overlap, numerous networks may coexist without interfering. Neither the channel width is specified in 802.11b or 802.11g nor the core frequency or spectral mask of the channel. This implies that a signal at 11 MHz must be 30 decibels (dB) lower than a signal at 22 MHz. Some assume that since the spectral mask only restricts power production up to 22 MHz, the channel's energy does not extend beyond that point, although it does. A powerful transmitter may send out a signal that is significantly higher in frequency than 22 MHz. They do not cross each other. Given the distance between channels 1, 6, and 11, each channel's signal should have little effect on the others. But not usually. Unstable transmitters on separate channels may soon outnumber each other. In a lab test, a file transfer on channel 11 slowed down while a file transfer on channel 1 started. This shows that channels 1 and 11 may interact with each other, then comes 802.11ac. Section 2 talked about other work, Section 3 came up with a method, Section 4 looked at results and performance, Section 5 talked about it, and Section 6 came up with a conclusion.

2. Background

Early IEEE 802.11, including the base and variant specifications, employed a fixed 20 MHz. IEEE 802.11 versions 2 and 3 have configurable widths. To avoid AP interference, CA algorithms assign nonoverlapping channels to access points (APs) [9]. IEEE 802.11n supports channel bonding by bonding. 40, 80, and 160 MHz channel widths in 802.11n, or 2, 4, or 8 in the newest may be achieved by bonding. Less bandwidth causes greater interference and AP conflicts. Carrier aggregation (CA) exacerbates the conflict between interference and throughput. Combinations have exploded. Channel bonding (CB) is another name for CA. Carrier aggregation is the process of distributing numerous frequency blocks (known as component carriers) to a single user. The maximum data rate per user increases with frequency blocks. CA enables mobile operators and devices to combine several LTE carriers into a single data transaction. The use of fragmented spectrum increases network capacity and data throughput. Carrier aggregation (CA) is the process of combining two or more carriers to get substantially greater internet rates. Advanced carrier aggregation (CA) is a critical method for the high data rates of 4G. There are three CB solutions: to discover the best tasks, one of the earliest innovative solutions to the CB problem (model-based). The authors suggested distributed optimization, and the method minimises AP interference while considering AP channel width preferences. Assisting performance in high-traffic regions may cause collisions and overlaps [10]. Despite the small dataset, several of the suggested ML models performed well. As a result, trained ML models may be able to offer near-real-time answers. Denser and more complicated deployment models work better because they more closely match training situations. Traditional deep learning approaches may overlook the link between interference and WLAN performance in smaller deployments. The end result is a set of hybrid model-driven techniques based on well-known WLAN models. Third, GNNs are capable of recording complicated WLAN interactions such as interference and neighbour activity. We recognise the significance of preprocessing through data collection for particular problems (i.e., signal quality, interference). Online optimization options are based on precise WLAN performance forecasts. WLAN installation should be simplified by MLaware architectural solutions.

They made it an optimization issue and provided their heuristic, which also determined WLAN performance based on basic topologies [11]. Simulators are used in more complex scenarios. It outperforms single-channel transmissions. A Markov network with node-to-node contact depicts the consequences of starving WLANs of resources. An IEEE 802.11ac model and simulation simulate crowded WLANs using their fundamental topological results, and the authors can assess these two adjustments' channel bonding [12]. A channel selection heuristic was constructed using these findings. The second set of algorithms adjusts channels in real-time because of these measurements. This data is tracked by a controller and updated in a matrix that indicates the estimated utilisation of a channel by an AP. Another way to solve this problem online is to come up with a way that makes the most of all the channels.

The approach uses channel activity. The quantity of data delivered through the channel per unit of time determines its satisfaction score. So, if the score is great, it stays here; otherwise, it changes. Their CA approach strives for better bandwidths and hence higher throughput. By employing a neural network and a Markov chain, machine learning (ML) can help CB. It aids AP forecasting. It then distributes the channels and points across two reinforcement learning algorithms. Then, in real-time, a crowded WLAN is investigated [13]. A graph convolutional network retrieves AP carrier sensing interactions. The CA is then applied to the neural network data. The authors employ Thompson sampling and multi-armed bandits to find novel combinations. It controls the CA and AP/station exchanges to consider many assignments and channel widths. Students seldom work on such improvements. Experimenting with alternative online or machine learning settings, some of which perform worse, is costly. The solution space has two dimensions: channel and breadth. Our approach simplifies the CA problem at the expense of research. Remember that the possibilities are being evaluated using an analytical model.

This capability may be crucial in safeguarding a functioning network. Then, they provide suggestions. The spectrum is missing one channel. They did not mention 802.11ac in their research. Channel bonding is useless in 802.11ac for small frames. Because overhead transmission time does not vary with channel width, it has a considerable impact on overall efficiency. A revolutionary approach to concurrently broadcasting on the main and secondary

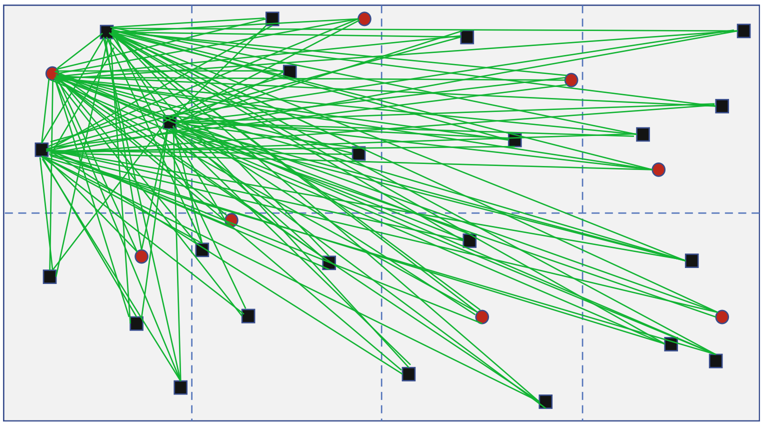

Figure 1: A graph representation of a Wi-Fi network.

channels was invented. For example, Figure 1 shows a 2D Wi-Fi setup for a floor with 8 flats, 8 APs, and 24 STAs. Each AP has three STAs. STAs are black squares, and APs are green circles. Interfering signals are indicated as red AP-STA segments [14].

This strategy aims to contact people in many ways. When numerous small channels are joined, the study evaluates how much traffic each channel can handle. It also exaggerates the frequency of spectrum use in emergency situations, which is unfavourable. It summarises research on 802.11n/ac mobile phone interference and energy consumption by studying channel bonding with four phones (up to 80 MHz). Another study provides important empirical evidence, but only under restricted settings. These two investigations show that widening the channel increases data transmission, assessing one's own abilities. It focuses on the most common Wi-Fi 4 frequency band, 2.4 GHz.

3. Proposed Methodology

The 802.11AC Networks may now operate at frequencies beyond 20 MHz. A 20 MHz channel may be divided into two, four, or eight channels that power the system. This approach works well for 20 and 40 MHz channels as shown in Figure 2. At 80 MHz, there are more main and minor channels (Figure 2). 802.11ac has two main channels and two minor channels. It will stop by a canal. To begin with, make sure the secondary channel is not in use [10].

Several radio stations compete for the same 40 MHz listening region. The auxiliary channel was heavily used in prior PIFS. As indicated, BT2 is transmitted at 40 MHz. Channel bonding is a Wi-Fi technique that increases capacity by using bigger frequency channels. There are only two 40 MHz channels available on the 2.4 GHz frequency band. According to the findings, channel bonding is not suggested at this frequency.

A 40 MHz WLAN requires channel access and transmission; the following steps are required by a station: So the second channel is probably empty. A 40 MHz backup frame was transmitted as shown in Figure 3. It shows how WLAN is operating at 40 MHz, channel access and transmission are taking place, and it does not mix up other networks' main and secondary channels. Avoid using a 20 MHz backup Wi-Fi network. Thus, all WLANs must utilise the same primary and auxiliary channels [15, 16]. After entering the primary channel, you may access the others. Alternatively, the network connection should be temporarily unplugged. We can only hope for the best. Adding two or more channels lowers the number of nonoverlapping channels. North America will be our first stop, with 11 channels separated by 20 MHz. For clarity, this option will be referred to as the 2.4 GHz USA. We investigate and analyse the situation. "2.4 GHz Europe" will be the final configuration. Its fairness is also being assessed. This study assessed channel bonding using a five-story residential building model. The structure's length, breadth, and height are all 40 metres; each level is 3 metres high. A 4 x 2 layout has eight flats per floor. In this scenario, STA density varied from less than one to over twelve per AP. This model restricts all APs and STAs to a flat surface, with x- and y-axis placements distributed randomly along both axes [17]. A normal distribution of 1.5 metres with a standard deviation of 0.5 metres is used to randomly distribute APs and STAs along the z-axis. In all cases, 85 flats and 40 APs are utilised, with STAs varying from 40 per acre (where one) to 12 per acre (when twelve are used). For each of the 60 possible layouts, we examined five different combinations of Wi-Fi components. For clarity, the AP and STA connections in each situation are illustrated for clarity. The NS-3 simulator helped us achieve our goals. One AP and one STA are used as examples. Even with low user density, employing higher bandwidth channels is less advantageous than having fewer orthogonal channels. It may be possible to boost performance by using two 40 MHz channels (even if they are not orthogonal). So, network managers may opt to broadcast on 40 MHz channels at the cost of neighbours. However, network administrators may use channel bonding when demand on neighbouring networks is minimal (because of the utilisation of more bandwidth). The survey closes by examining STAs' views on throughput nationwide. This study's main goal is to determine how to channel bonding impacts network fairness.

"Winning" STAs have substantially higher throughput gains than "losing" STAs. Several studies have confirmed this. Channel bonding benefits STAs as well as the network.

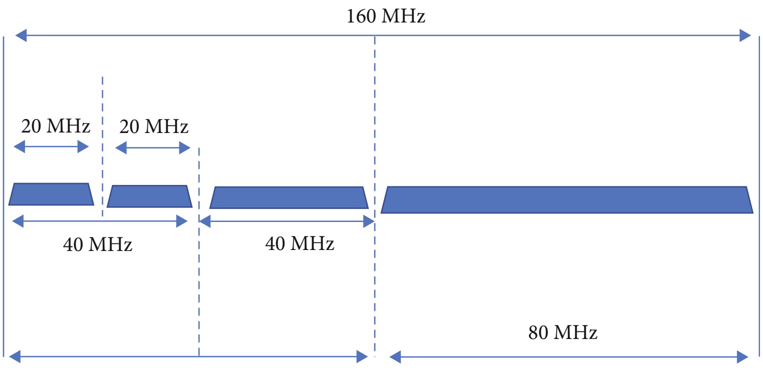

Figure 2: In 802.11ac, there are two main channels and two other channels.

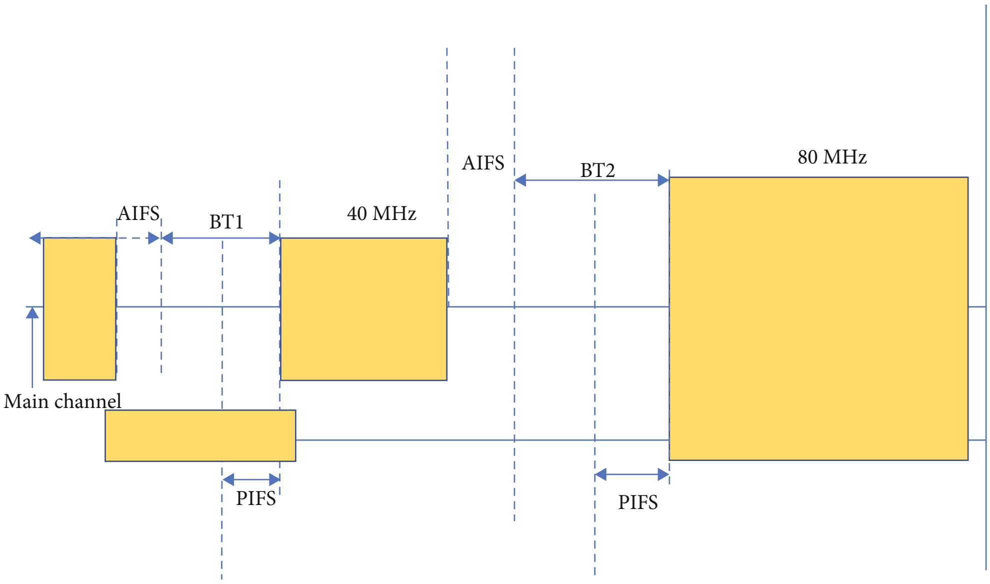

Figure 3: WLAN operating at 40 MHz, channel access, and transmission.

If APs employ channel bonding, STAs benefit. Therefore, we plan to outsource decision-making to STAs (and hence users) in the future. In turn, a more democratic and customer-focused workplace may develop the relative fairness of the various criteria [18–21]. This is the total of five parameters plus 10 executions. With channel bonding, a larger range of throughput is available than without it. STAs can offer up to 135 Mbps while channel bonding is engaged, but only 65 Mbps when it is disabled. Therefore, channel bonding may increase STA discrepancies. Because it uses two 40 MHz channels, the US option is more equal than the EU version. Using two 40 MHz channels in the US achieves more impartiality than in Europe. Winning STAs have much greater throughput. Several studies support this channel bonding. It also benefits the network. STAs benefit from channel bonding. We want STAs (and hence users) to make choices in the future, increasing the democratic and customer-focused nature of employment, and objectivity of different criteria. It is five parameters multiplied by 10 executions. Throughput is increased through channel bonding. With channel bonding, STAs can offer up to 135 Mbps. As a result, channel bonding has the potential to magnify STA gaps. In the United States, there are two 40 MHz channels and one in the European Union. In the United States, using two 40 MHz channels is more neutral.

Here is why we adopted a graph-based technique in our research. The impacts of adjacent channel interference, which are not insignificant in dense Wi-Fi networks, make it difficult to reproduce studies using discrete-event simulators. Except for those in the same cluster as the device I, all network devices receiving a signal from device I are generally interfered with. A cluster is a grouping of all STAs associated with an AP. The strength of the interfering signal received from device j at the device I is equal. Now there is a channel. The choice of Wi-Fi channel is one of the most difficult things to choose. Various Wi-Fi networks have been studied to discover how channels are shared [22–27]. This asynchronous technique changes the sequence in which each access point analyses its surroundings. It is common for consumers to choose “Auto” channel selection rather than a particular channel when setting up an AP. Because of this, we only allow the use of orthogonal channels that have been demonstrated to not interfere with each other while transmitting data [28–30]. For lack of space in North America, we looked

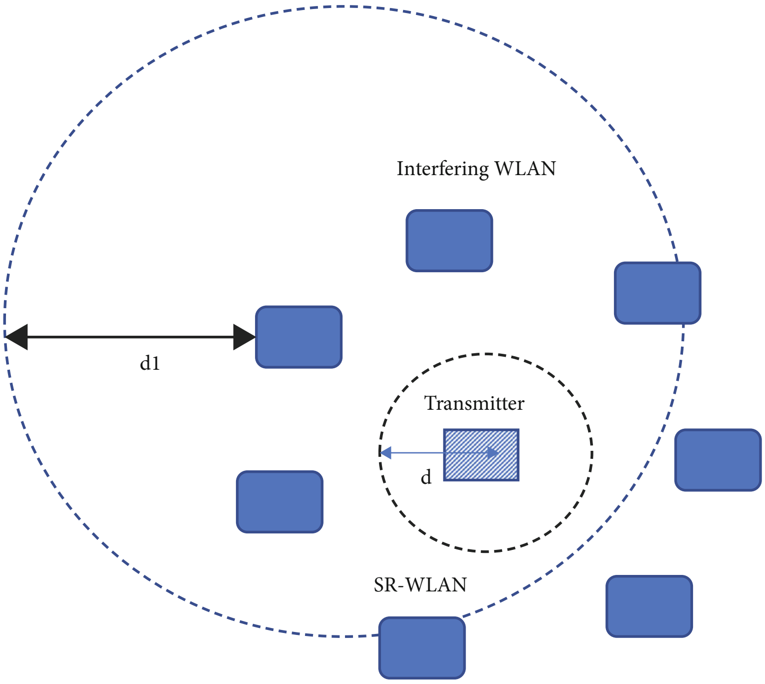

Figure 4: The interfering APs (blue) utilise a different channel than the target SR-WLAN (hatched square).

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1. An $N$-vertex conflict graph with a hunger threshold
2. A channel width $w$ is selected and assigned.
3. Find MIR $(n, w(v)), n1, \cdots N = 4 : 12 : k| Cw$ If $ST > 0$, return $(w, v)$.
4. The finish is 15 and the return is 16. $(w, v)$
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Algorithm 1: The channel sizing algorithm.

into a situation where the two furthest channels in the spectrum talk to each other.

Figure 4 indicates that interfering APs (blue) utilise a different channel than the target SR-WLAN. Our method uses physical and conceptual conflict graphs created by multiple WLAN channel allocations. It prioritises the placement of APs in high-traffic areas and areas prone to graph placement disputes [26, 27]. Take, for example, a W-MHz SR-WLAN. A normal-range WLAN surrounds the SR-WLAN (that is, using more power than the target WLAN) [31–34]. The SR-WLAN should be able to discover an open basic channel. Interfering WLANs have taken over W. The benefits (increased transmission rates) and drawbacks (higher packet error rates) of channel bonding may be easily analysed. There is no interference from outside sources in the reference case, and the main channel is thought to be empty. As a result, packets are always available on the target WLAN. Because the channel of the target SR-principal WLAN will never conflict. Some fundamental graph-theoretical definition vertices that have no neighbours and cannot be enlarged are the Maximum Independent Set Ratio (MIR). As a new study statistic shows, the MIR of a vertex is 1400 bytes of graph payload and 3200 ns of the guard. The ns–3 discrete-event network simulator calculates Bn for each AP [35–40].

Algorithm 1 explains about the channel sizing algorithm, a large data collection may cause algorithm failure assuming APs are hungry, APS rejects valid channel assignments, and APs in need of data may be ignored or assigned to the wrong channel. In Algorithm 1, a four-AP WLAN with a 5-Mbps starvation threshold is presented. C160 = 1 since there is only one 160 MHz channel. MIR (3, 160 (a, a, a)) =0, indicating that AP 3's predicted throughput is 0. The algorithm rejects the 160 MHz channel width since ST is larger than 0.

4. Result and Performance Assessment

The MIR values in Figure 4 are acquired by connecting all four APs in our test network to a single 160 MHz channel. MIR (4, 160 (a, a, a)) = 1. MIR (1, 160a), MIR (3, 160a), MIR (3, 160a), MIR (3, 160a), MIR (3, 160a), MIR (3, 160a) (3, 160a), and MIR (3, 160 (a, a, a), 0). The MIR of a vertex affects its real throughput. Suppose, we have 52 physically conflicting (10–25 APs) with AP degrees of 2 apiece. To accomplish so, we utilise linear regression: The channel width in MHz is given by B =0,1 MIR. The MIR was intended to maximise simultaneous broadcasts in WLANs. Figure 5 shows the AP's throughput for two-channel widths: 20-160 MHz. We find a link between MIR and Bn. The 40 and 80 MHz correlations are comparable. In this way, we

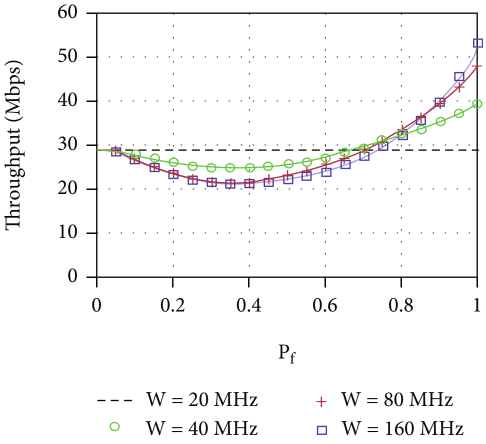

FIGURE 5: SR-WLAN throughput vs main channel location, k. The W =20 MHz curve indicates no channel bonding.

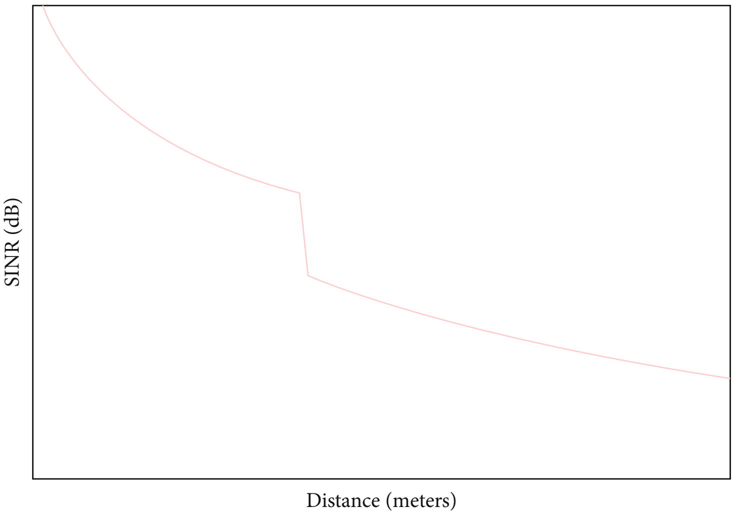

FIGURE 6: Simulator ns-3 SINR obtained.

can calculate each AP's MIR and estimate its probable throughput. A vertex may be created using the Bron–Kerbosch technique [19]. In turn, higher MIR APs communicate more, enhancing throughput. It is not ideal to calculate throughput with MIR =0 or 1. Figure 5 shows SR-WLAN throughput vs main channel location, k. The W =20 MHz curve indicates no channel bonding.

Even with these two high MIR levels, the simulation results show that when all APs are saturated, the channel assignment is discovered (needing to access the channel permanently). As illustrated, wider channels enhance average WLAN AP throughput, but narrower channels reduce appetite. Beginning at 160 MHz, we iterate on all possible channel widths. Using Tabu Search, we generate a k-colouring of the physical conflict graph for each channel width. In summary, the Tabu search discovers a channel assignment that lowers the edges of the logical conflict graph. Each AP's MIR and realised throughput are calculated using a linear regression model. The number of hungry APs may now be determined. When ST exceeds 0, half of the available channels are utilised. We colour the graph, then compute the AP MIRs and the ST metric, before dividing the channel width if there are hungry nodes. When no hungry APs are found or the channel width is reached, the operation terminates. Algorithm 1 provides the pseudo-algorithm for the whole solution.

The approach produces the following results when w =80 MHz. The complexity of the proposed solution varies greatly depending on the methodologies utilised. The Bron–Kerbosch approach [19] is used to compute them. Because the remainder of our technique is easier, the answer is O. (3N). Other objective functions, such as decreasing logical conflict graph edge counts, may be used. This design, when combined with the ability to set a hunger threshold, can easily adapt to a wide range of WLAN performance needs. ns3 is a way of measuring throughput as shown in Figure 6. The payload size was determined to be 1500 bytes. Throughput is measured differently for each modulation coding scheme (MCS0-MCS10).

The graph in Figure 7 shows the connection between throughput and distance for HT MCS0 BPSK 12 when frame aggregation, channel bonding, and aggregated with channel bonding are used. As seen in the diagram below, channel bonding outperforms both frame aggregation and aggregation with channel bonding. At 50 metres, channel bonding

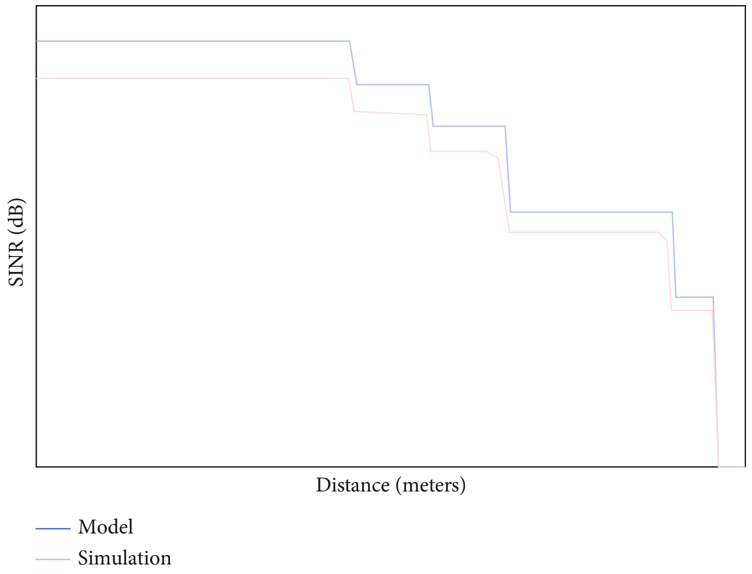

Figure 7: Simulator measures outcome while the model gives physical layer throughput (application layer throughput).

has a throughput of 12.09 Mbps, frame aggregation has a throughput of 6.26 Mbps, and aggregation with channel bonding has a throughput of 2.31 Mbps. Throughput against distance for HT MCS8 BPSK1/2 is shown using frame aggregation, channel bonding, and aggregation with channel bonding. The performance of frame aggregation and aggregation with channel bonding improves as the distance between devices increases.

At 50 metres, channel bonding reaches a speed of 23.55 megabits per second, compared to 3.13 megabits per second for frame aggregation and 19.27 megabits per second for aggregation. This chart depicts the throughput against distance for HT MCS1 QPSK 12 utilising frame aggregation, channel bonding, and aggregation plus channel bonding. As the distance between the nodes rises, channel bonding outperforms both frame aggregation and aggregation with channel bonding. Channel bonding yields a throughput of 23.87 Mbps at 50 m, while frame aggregation achieves 11.91 Mbps and aggregation with channel bonding achieves 2.84 Mbps. Frame aggregation, channel bonding, and aggregation with channel bonding in HT MCS9 QPSK 1/2. Channel bonding outperforms both frame aggregation and aggregation with channel bonding.

In this case, channel bonding delivers 47.82 Mbps of throughput at 50 m, compared to frame aggregation's 4.04 Mbps and aggregation with channel bonding's 9.82 Mbps. As illustrated in Figure 6, he obtained SINR. We can observe that both curves are the same, confirming our model and the NS-3 simulator. Then, as shown in Figure 7, we look at the STA's throughput with our model and the simulator. Channel bonding outperforms both frame aggregation and aggregation with channel bonding. At 50 metres, channel bonding reaches a speed of 23.55 megabits per second, compared to 3.13 Mbps for frame aggregation and 19.27 Mbps for aggregation.

Table 1 shows that channel bonding in the 2.4 GHz USA frequency range is not recommended in congested situations. Channel bonding may lead to inequity and misalignment of network management incentives as shown in Figure 8 which demonstrates the density of channel bonding throughput increases in 2.4 GHz Europe by using two orthogonal 40 MHz channels. "It is important to note that the average gain for the STAs that are getting better even when they use channel bonding."

Table 1: 2.4 GHz USA scenario, how many STAs gain (+) or lose (-) throughput by channel bonding two nonorthogonal 40 MHz channels.

η	+	% STA	—	Increase (Mbps)	Decrease (Mbps)
1	37.60	9.60	76.00	31.30	−24.38
2	34.86	8.86	79.61	31.53	−23.50
3	32.94	10.61	79.78	20.11	−23.47
4	29.49	10.36	83.49	20.21	−22.95
5	28.11	22.21	82.11	31.13	−22.67
6	26.94	24.19	82.19	28.60	−22.01
7	17.30	25.47	70.47	28.81	−22.19
8	25.86	24.99	82.49	28.62	−11.56
9	24.67	26.94	81.72	28.42	−21.90
10	23.06	28.51	70.76	28.77	−21.90

Expanding the channel size may improve WLAN performance. On the other hand, the number of nonoverlapping channels is decreasing. Many users may struggle to connect to high-channel WLANs [19–21]. Using two orthogonal 40 MHz channels boosts 2.4 GHz European channel bonding density. Because they could not engage, they were not all visible on TV. 802.11n has 65535 bytes. The VHT update increased the file size by 1048575 bytes (about 1 MB). PPDUs now have a time restriction. It used to be a 65535-byte A-MPDU. This is due to the VHT upgrade adding 1048575 bytes (about 1 MB). It now lasts 5484 seconds. We used MSC0 and MCS1 modulation coding. We investigated throughput vs. distance with and without aggregation.

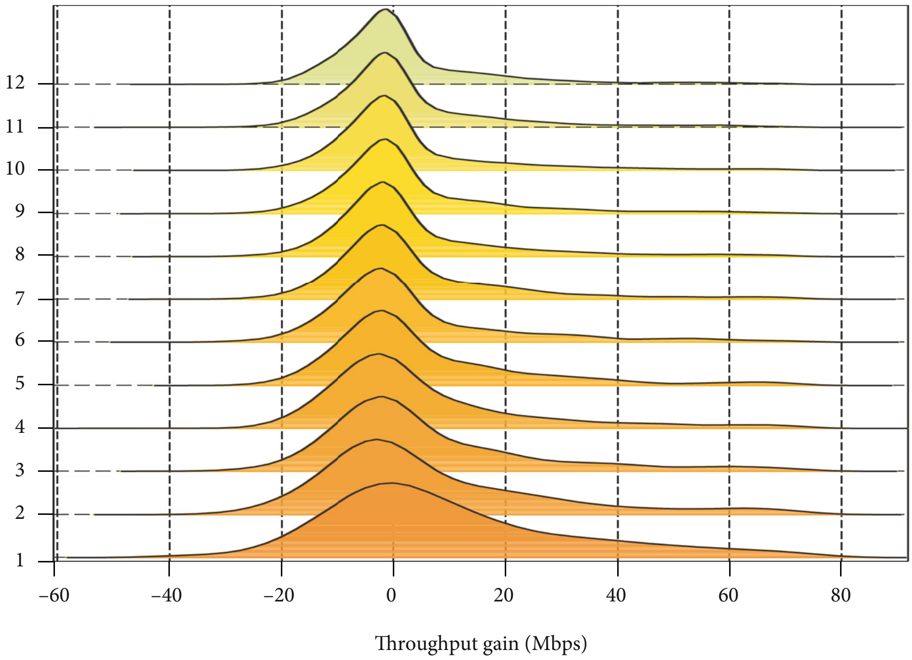

Figure 8: Density of channel bonding throughput increases in 2.4 GHz Europe by using two orthogonal 40 MHz channels.

5. Discussion

Channel bonding is a concept considered by the IEEE 802.11ac amendment to improve WLAN performance. Increasing the number of channels used provides a variety of advantages, as can increase transmission rates. Channel bonding improves throughput when 13 or more channels are available, as in Europe and Japan. IEEE 802.11ac WLANs are considering channel bonding, which has already been tested in practice. Channel bonding merges many basic channels to create a larger channel with higher transmission rates and throughput. Increased bandwidth offered by channel bonding may be particularly useful for SR-WLANs to carry multimedia data. Wi-Fi performance may be boosted even more by employing channels with bandwidths greater than the standard 20 MHz. We discovered that bandwidth utilisation is particularly inefficient in congested, decentralised contexts such as apartment complexes. Another strategy is to better decentralise or centralise network coordination by using existing standards and protocols. Having 11 Wi-Fi channels with channel bonding had an influence on average throughput. There is a possibility that certain STA clusters may earn more money than others, raising concerns about equality. When A-MPDU is disabled, several independent broadcasts over narrow channels outperform one transmission across vast channels. Channel bonding may be used to produce 40, 80, and 160 MHz channel widths in 802.11n, or two, four, or eight in the latest versions (ac/ax). Less bandwidth means more interference and access point conflicts (APS). Ca exacerbates the challenge of balancing interference and throughput. An AP's satisfaction score is determined by the amount of data that can be sent over the channel per unit of time. In online and machine learning systems, experimenting with different configurations, some of which perform worse, is expensive. This challenge may be solved by finding a strategy that optimises total channel use. Channel bonding is a waste of time in 802.11ac for tiny frame sizes. Authors devised a novel method for simultaneously broadcasting on both the main and subsidiary channels. It exaggerates how often the spectrum is used in emergency situations, which is not good.

6. Conclusion

Aggregation with channel bonding provides more throughput for MCS2 than the other two scenarios After analysing the results of our experiments, we determined that employing channel bonding alone for lower and higher modulation schemes gives better throughput than using aggregates alone or aggregates + channel bonding as the distance between the transmitter and receiver increases. The channel bonding condition improves as the distance between the two locations increases. We showed how to leverage channel bonding in 802.11 WLANs to swiftly choose and allocate channel widths. To decrease hunger, all WLAN APs should use a single-channel width. We provide a scalable strategy for overcoming the frequent complexity problems associated with traditional channel assignment schemes. It may be adjusted to match any performance requirement since it is a collection of diverse algorithms. The proposed technique is proved to be traffic and network density robust using the NS3 discrete-event network simulator and the most recent IEEE 802.11ax standard amendment. Most of the time, it beats fairness-based measures by 15% to 20%. Since the publication of the IEEE 802.11n standard (Wi-Fi4) in 2010, Wi-Fi channel bonding has been presented as a technique for leveraging bigger frequency channels and obtaining better throughputs. It is designed to deal with the fairness issues that develop because of channel bonding. Wi-Fi standards recommend "channel bonding," which refers to the use of higher frequency channels to solve capacity constraints. IEEE 802.11n (Wi-Fi 4) recommends using 40 MHz channels rather than the normal 20 MHz channels. In noisy situations, a single 20 MHz channel is more stable. In busy locations, however, the 40 MHz channel width is less reliable. However, interference is not always an issue. This will help to improve performance even more. Channel bonding is enabled in later standards by adding more bands and channel lengths of up to 160 MHz. We use a graph model to illustrate how dense Wi-Fi networks seem to consumers and how channel bonding works. As a result, our models portray a collection of Wi-Fi networks scattered over the world. We will continue to improve the fairness of AP radio channel width choosing. We will examine what we can do regarding more equitable WLAN stations. Several issues have arisen because of the fairness research. We discovered significant research concerns. They certainly are. Instead of a single dynamic resource, consider a network of mobile nodes. It is because of this that more research is needed to find those who have been unfairly punished. Inequalities may be corrected by reallocating resources. Weights are used to prioritise resources. Variables should be considered when allocating weights to people. How should resources be weighed? Individual weights, rather than distribution techniques, are utilised to distribute resources. Weighting strategies, on the other hand, should be investigated.

Data Availability

The data that support the findings of this study are available on request from the corresponding author.

Conflicts of Interest

No potential conflict of interest was reported by the authors.

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