A New Perspective on Channel Allocation in WLAN: Considering the Total Marginal Utility of the Connections for the Users

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ABSTRACT

The channel allocation problem consists in defining the frequency used by Access Points (APs) in Wireless Local Area Networks (WLAN). An overlap of channels in a WLAN is the major factor of performance reduction for the users in a network. For this reason, we propose a new model for channel allocation that aims to maximize the total quality of the connection of the user by considering their marginal utility. The results show that an allocation model that does not take into account the total utility of each connection tends to prioritize the quality of connection of a few users and lead to a large unbalance in the distribution of connection speed between users. Thus, the new model can handle the importance of degradation caused by the levels of interference in the user connection separately.

CCS Concepts

•Networks → Wireless local area networks; •Mathematics of computing → Evolutionary algorithms;

Keywords

Channel Allocation, Wireless Local Area Network, Marginal Utility, Genetic Algorithms

1. INTRODUCTION

In recent years, there has been a rapid growth of the utilization of wireless networks following the standard IEEE 802.11, given their easy installation and use, reduced costs, and high data transfer rates. With these factors combined, Wireless Local Area Networks (WLAN) have become attractive to companies, institutions, residences and even in public environments. A set of Access Points (AP) can be densely installed and interconnected on a single local network, leading to a WLAN whose topology is referred to as Extended Service Set (ESS).

The increasing demand of users and APs inserted in the network, the proximity of different WLANs, the intensity of the signal transmitted by APs and the intensity of the signal perceived by the users are some examples of the characteristics that make the design of an efficient WLAN a very complex task. The channel allocation problem for the APs in the WLAN (Section 2) is very important, specially if the network is of a larger scale. Most projects are oriented only towards the minimization of signal interference in the network. Nevertheless, solutions oriented towards the global reduction of interference usually neglect the quality of the connection for the users individually. This allows that users with low connection speeds are deliberately overlooked, which is compensated by an increase in the quality of the connection for users already well served.

Channel allocation models that focus only on the summation of connection speed do not contribute effectively to the balance of quality for the users in the network. Usually, those designs do not consider estimates of the utility of establishing a new connection between a user and an AP in a given channel. As a consequence, users tend to connect to the closest AP instead of an AP that maximizes the quality of their connection.

In this context, we present in this work: (i) A channel allocation model that maximizes the total utility of the connection for each user (Section 3); and (ii) an Evolutionary Algorithm [6] and related genetic operators for the proposed channel allocation model (Section 4).

This work is structured as follows. The problem of utility to the users in IEEE 802.11 networks is first discussed in Section 2. In Section 3, we propose a channel allocation model in WLANs using the total marginal utility of the connection for the users. Details on the Evolutionary Algorithm developed for the experiments are presented in Section 4. In Section 5, we compare the solutions found by using the proposed model with the results obtained by using a channel allocation model that does not consider the total utility of the connections. The solutions obtained with the pro-

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posed model generate a greater balance in the distribution of connection speeds in the whole network and the quality of service perceived by all the users. In Section 6, we present the conclusions and ideas for follow-up studies.

2. THE UTILITY OF CONNECTIONS

The quality of the connection offered to the user by an AP is highly influenced by the number of users connected to this AP and by the interference in the network. Attending a user involves establishing a connection that favours the utilization of the network capacity. For this reason, channel allocation mechanisms should consider the utility of that connection for the users with the goal of balancing the distribution of the capacity of the network. A balanced distribution of connection speeds is an important factor affecting the perceived quality of the network, since it is directly related to the satisfaction of users.

Networks IEEE 802.11a, 802.11b, 802.11g and 802.11n operate in ISM (Industrial, Scientific and Medical Band) with 2,4 GHz bandwidth, making a total of 11 channels of 22 MHz bandwidth. However, only three channels do not interfere with each other (channels 1, 6 and 11). These channels are termed non overlapping channels since there is a separation of 3 MHz between them.

In environments with many users, the network requires dozens of APs and finding solutions that maximize the connection utility for the users becomes a non trivial task. In large wireless networks, it is virtually impossible to find a channel allocation in such a way that no user will experience some interference, given the severe restriction of non overlapping channels and the overload of the AP attending on it. Therefore, the mapping of channels in a WLAN requires additional strategies to maximize the quality of connections.

2.1 Related work

Akl and Arepally [1] proposed a method in which each AP periodically runs the allocation mechanism. Each AP determines the maximum interference that it can suffer. If the current allocation causes an interference greater than this threshold, the proposed method allows that each AP defines its channel trying to minimize the interference from neighbouring APs by using an attenuation loss model. In the channel allocation model proposed, there are not any users in the environment, i.e., interference is calculated only between APs. Sometimes users are far from the APs and moving towards the coverage area of another APs. The impact of these on the connection of the user is not considered. These characteristics can be noticed in other works, such as in Hills [10], Hills and Schlegel [11], Mahonen, Riihijarvi and Petrova [15], and Vanhatupa, Hännikäinen and Hämäläinen [20].

Drieburg et al. [5] proposed some modifications to the distributed and dynamic channel allocation method proposed by Luo and Shankaranarayanan [13], with the goal of making it simpler, more efficient and with lower computational cost. In their new method, each AP calculates the best channel to be used in the next time slot in order to maximize the network throughput, along predefined time slots. The simulation results showed that the proposed modifications improve the network throughput in dynamic environments when opposed to the original version. However, the interference level affecting users and disconnections caused by the movement of users is neglected.

Lima, Carrano and Takahashi [12] addressed location and coverage problems of the APs, load balance and channel allocation. The channel allocation problem was treated separately by using a greedy heuristic consisting in a weighted variation of a sequential algorithm, commonly used in channel allocation and proposed by Brélaz [4], known as Degree of Saturation (DSATUR). The algorithm developed considers the demand of the APs and the interference level generated by those operating in the same channel. However, they adopted a channel allocation model that estimates the interference as the percentage of users affected by APs sharing the same operating channel. The model could become more realistic if it had used another estimation of interference, for instance, the intensity of conflicting signals received by a user at a region of overlapping spectra. Additionally, the absence of a mechanism for ensuring the quality of connections for the users is another critical point.

Handrizal et al. [9] proposed a graph coloring algorithm known as Vertex Merge to perform the channel allocation. The algorithm is designed to minimize the number of colors needed to color a graph such that adjacent nodes use different colors. This characteristic makes the algorithm incapable of solving some instances. Another important factor is that, in the channel allocation problem in a WLAN, minimizing the number of colors does not lead necessarily to a scenario with low interference, due to the proximity of some neighbouring APs. The frequency allocation involves the reuse of some channels in an efficient way, with as low as possible interference or greater balance in the connections of the users.

A tool capable of optimizing critical problems related to the design of WLANs was proposed in Yao et al. [21]. Among these problems, the channel allocation problem is discussed using a strategy based on adjusting the transmission power. The goal is to reduce the overlapping region between neighbouring AP operating in the same channel. According to this strategy, if two APs use the same channel, both should adjust their transmission power as recommended in Bae, Choi and Chae [2]. Moreover, it is suggested that this strategy can become more efficient if a mechanism to force disconnection is adopted. In this case, after an adjustment, a user is disconnected and then reconnects with the AP having the strongest signal, according to Park, Bea and Kwon [18]. However, this method focusses on decreasing the probability of collisions given the reduction of the overlapping region. Users can have their signal intensity reduced and be located at an overlapping region at the same time. There is no relationship between the signal intensity offered to a user and the effective loss of quality with the subjected interference level.

The distributed method with the presence of heterogeneous users, proposed by Gong, Zhao and Yang [8], considers the crucial points mentioned before. However, it was not established a relationship between the signal intensity received by a user, caused by the AP to which it is connected, and its submitted interference level. For this reason, there is no mechanism for reallocating this user to another AP capable of attending it with better connection quality. In the same way, did not adopt any mechanism to verify if all the users have quality in their connections, only the global index is considered. In this approach, users can be subjected to high levels of interference and with connection failures.

In this paper, we introduce a new channel allocation model that maximizes the total utility of the connection for each user. In this approach, solutions related to a better balance in the distribution of connection speeds can be found and the quality of the connections for users individually is not disregarded. The proposed model is outlined in the next section.

3. CHANNEL ALLOCATION MODEL

3.1 Marginal Utility

The concept of Utility is related to the satisfaction of an individual after acquiring a unit of a good or service. Utility cannot be directly observed or measured but we know the utility that an item or service generates to an individual is greater or smaller according to the action taken (acquiring it or not). Whereas the individual alone is responsible for defining his/her satisfaction according to the goods or services he/she has. If an individual understands that his/her satisfaction increased, then the utility of the goods or services acquired also increased. For this reason, the utility is a relative measure employed to inform if something is preferable compared to another (ordinal utility) instead of determining an absolute measure of how much it is preferable (cardinal utility).

The utility that acquiring an extra unit of a good or service provides to the individual is known as marginal utility. Due to the scarcity of resources, one cannot obtain an unlimited amount of a good or service, thus one should save the use of the means in order to achieve one's goals. First, one's means should be allocated to serve the most desired goal. The next mean will serve the second most desired goals and so forth. This is to say that each additional unit of a good or service will satisfy relatively less of a goal and hence, provide us with less marginal utility. This behaviour defines the Law of Decreasing Marginal Utility [7]. More details can be found in Mankiw [17].

3.2 Allocation model based on utility

The channel allocation model proposed in this paper considers criteria that favor the utilization of the network by all users, without any priority due to its location in the environment and the current traffic. The model consists of the following variables:

- n: number of users.
- m: number of APs.
- $c_i \in \mathrm{C}$: client i.
- $p_j \in \mathrm{P}$: access point j.
- e_{ij}: quality of the connection offered by AP p_j when connected to c_i.
- l_{ij}: percentage loss in the quality of the connection for the client c_i if p_j is using the same channel of its AP.
- $u(v)$: decreasing function that returns the utility of having a connection at speed v.

The utility is related to the law of decreasing marginal utility discussed before. The utility is used in the model to allow that a user being served with slow connection speed is not damaged even more because of the interference level.

The decision variables are:

- g_j: operating channel of the AP p_j.
- d_{ij}: 1, if c_i is being attended on by p_j, and 0 otherwise.

The decision variable d_{ij} is used to inform if the user i is connected to the AP j and, to guarantee that every user is connected to an AP, we should have: $\sum_{j=1}^{m} d_{ij} = 1; \forall i \in \mathrm{C}$.

Let μ_i be the index of the AP attending client c_i. μ_i can be formally defined by (1).

$$\mu_i = \{j | d_{ij} = 1\} \tag{1}$$

We can now refer to the AP attending client c_i as simply p_{μ_i}. From this definition, the function $h(c_i, p_j)$ in (2) can be defined as:

$$h(c_i, p_j) = \begin{cases} 0, & \text{if } d_{ij} = 1 \\ 0, & \text{if } d_{ij} = 0 \wedge g_j \neq g_{\mu_i} \\ l_{ij}, & \text{if } d_{ij} = 0 \wedge g_j = g_{\mu_i} \end{cases} \tag{2}$$

This function $h(c_i, p_j)$ indicates if client c_i is subject to some level of interference from AP p_j.

Equation (2) refers to the effective loss that AP p_j causes to the connection of client c_i. This function gives $h(c_i, p_j) = 0$ if the AP p_j is attending on client c_i. In the same way, $h(c_i, p_j) = 0$ if p_j is not operating on the same channel that p_{μ_i} is.

If the AP p_j does not attend client c_i and, at the same time, operates in the frequency of the AP p_{μ_i} to which c_i is connected, then there is interference, which is given by $h(c_i, p_j) = l_{ij}$.

Equation (3) corresponds to the multiplying factor of the final quality of connection for client c_i due to the interference from other APs, that is, it is the total percentage loss that the user will experience in its connection for the given channel mapping.

$$q(c_i, P) = \prod_{j=1}^{m} (1 - h(c_i, p_j)) \tag{3}$$

Finally, Equation (4) represents the overall problem statement, which corresponds to maximizing the utility of having a connection at speed v, considering the given channel allocation, the quality of connection between a client i and the AP p_{μ_i}, and the possible losses caused by connections of users to the APs in the network.

$$\max f(x) = \sum_{i=1}^{n} \sum_{j=1}^{m} d_{ij} u(e_{ij} q(c_i, P)) \tag{4}$$

4. EVOLUTIONARY ALGORITHM AND GENETIC OPERATORS

4.1 Representation of solutions

In the Genetic Algorithm (GA) developed for the problem, a candidate solution (individual) is represented by the vectors a and b, which correspond to the decision variables g_j and d_{ij}, respectively. To obtain the value of g_j (channel used by the AP p_j), one can simply access the position j in the vector a and check the stored value. Supposing the

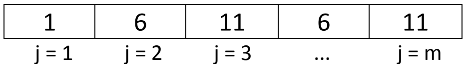


Figure 1: Representation of the variable g_j, $j = 1, \ldots, m$.

utilization of non overlapping channels {1, 6 and 11}, a possible mapping could be such as the one in Figure 1 for m APs.

On the other hand, in the representation of d_{ij}, each position i of the vector b corresponds to a client c_i and the index j stored in each position represents an AP p_j. Figure 2 illustrates the representation of d_{ij} for n users.

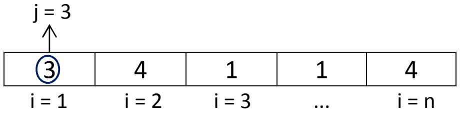


Figure 2: Representation of the variable d_{ij}.

With these two vectors, it is possible to obtain the channel mapping that an individual represents and which AP is attending on each user. There are many ways of creating the initial population in this case, for instance, vectors a and b can be generated at random, through heuristics or extracted from a database, among others.

4.2 Genetic Operators

In the Evolutionary Algorithm developed, we adopt uniform crossover. In this operator, a binary random vector of the same size of vectors a and b is generated. Figure 3 illustrates two candidate vectors a, showing how the crossover between them is performed. The crossover for the vector b is analogous. The values on those positions in the binary vector corresponding to 1 are exchanged between the parents.

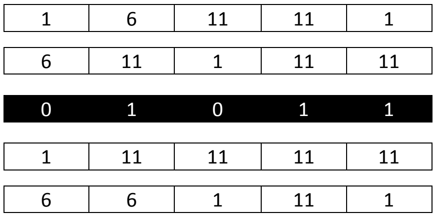


Figure 3: Example of a uniform crossover.

In addition to the crossover operator, each child is subject to mutation. Each position j of the vector a has a probability $1/m$ of being changed. Assuming a mutation at the position j, this change consists in exchanging the channel of the AP p_j for any other channel available. If the APs utilize only non overlapping channels, a modification in the position j corresponds to exchanging the channel 1 by either channel 6 or 11. Figure 4 presents the mutation operator with the available channels.

Still considering the individual under mutation, each position of the vector b has a probability $1/n$ of being modified. The modification in the position i of the vector b consists of assigning another AP to attend on user c_i. The AP is chosen according to a Gaussian distribution in such a way that closer APs have a higher probability of being selected for the new assignment. Figure 5 illustrates the possibilities for each position j of the vector b under mutation.

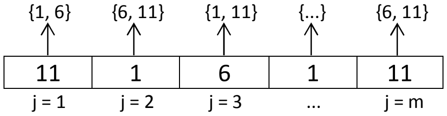


Figure 4: Example of a mutation in the vector a.

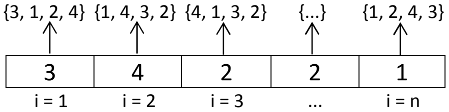


Figure 5: Example of a mutation in the vector b.

4.3 Configuration and parameters

The values for the control parameters of the Genetic Algorithm are presented in Table 1.

Table 1: Parameters of the GA

Parameter	Value
Execution time	90 seconds
Population size	50 individuals
Crossover rate	0.9
Mutation rate per gene (a_j)	$1/m$
Mutation rate per gene (b_j)	$1/n$
Selection method	Binary tournament

5. EXPERIMENTS

5.1 Instances

The scenario initially used for the experiments has real characteristics of a WLAN, with 400 users in an environment of 160,000 m^2. The scenario was created with two Gaussian clusters of 100 users each. Other 200 users are distributed randomly with a uniform distribution. All these characteristics follow guidelines given in Lima, Carrano and Takahashi [12]. A multi-objective algorithm minimizes the quantity of APs and the load imbalance of the APs. In this way, the method proposed by Lima, Carrano and Takahashi [12] was used to determine the number and location of the APs in our scenario. Therefore the network is created with 18 APs. The communication range of each AP is 100m.

Apart from this most representative scenario, we also analyse 300 other instances with slightly different planning features that were generated ad-hoc for our experiments. In this set of instances, each scenario has a different number of clusters (between 1 and 5) and a proportion of users per cluster (between 75 and 125 users). The users were randomly distributed around clusters with a Gaussian distribution, as it was done for the first test scenario we presented. The centers of the clusters were chosen randomly and the standard deviation of the users is 30. The number of users randomly distributed was set between 200 and 300 users. On the other hand, the scenarios have between 15 and 30 APs and the position of the APs was determined by a k-means clustering algorithm [14].

We define the quality of the connection e_{ij} provided to the user c_i by the AP p_j as the bandwidth of the AP, in Mbps (Megabits per second), divided between the number of users connected to it. However, due to the distance between a user and the AP, the decrease in the quality of the connection follows the decrease of the signal intensity received by the user. The loss in signal intensity is estimated with the log-distance path loss model. More details on the path loss model can be found in Gong, Zhao and Yang [8].

The loss l_{ij}, with $0 \leq l_{ij} \leq 1$, is zero for the conditions presented before. It is also zero if the distance between the user c_i and the AP p_j is greater or equal to 100 m. It is one if the distance is inferior to 1 m. Otherwise, the loss l_{ij} in the connection of the user c_i caused by the AP p_j is given by the Log-distance path loss model.

The bandwidth of the AP range from 54 Mbps (protocol 802.11g) to 600 Mbps in the best case. Nevertheless, we define the bandwidth of the AP as 54 Mbps.

5.1.1 *Utility function*

As discussed in the previous section, we use the concept of Marginal Utility to determine the quality of the connection for a user. As a strict measure of ordinal utility would not allow interpersonal comparisons of value, we define a function that gives the cardinal marginal utility of a solution, see (5). This is a possible quantification of the marginal utility with respect to the connection speed. In this equation, $m(v)$ represents the marginal utility, u_0 is the initial utility, d is the utility loss in the next Mbps and v is the connection speed.

$$m(v) = u_0 \times (1-d)^v \tag{5}$$

The initial utility u_0 represents the utility of a connection to the user when he/she does not have any. Changing the constant u_0 would simply linearly transform the objective function and we would have an equivalent problem. The utility loss $0 < d < 1$ is a parameter that indicates how much the marginal utility decreases as the user increase 1 Mbps in the speed. When the parameter $d = 0$, this model corresponds to the summation of conection speed. When d approaches 1, the model focuses on equity in the distribution of connection speed. The loss of utility is associated with the connection speed v, because the higher the speed of the connection, the smaller is the impact in its connection and the smaller is the marginal utility. For this reason, users with low connection speed should be protected from a high interference level. Figure 6 illustrates the marginal utility of a connection using $u_0 = 100$ and $d = 0.1$.

The total utility is the area from speed zero up to the speed v, and it is shown in Figure 6. After some point, there is no significant increase in the total utility, i.e., allocating a user with high connection speed to an AP that provides even more speed does not cause a significant increase in the total utility. On the other hand, allocating a user with low connection speed to an AP that provides better service causes a more noticeable increase in the total utility. The total utility $u(v)$ is given by the integral of the marginal utility, see (6).

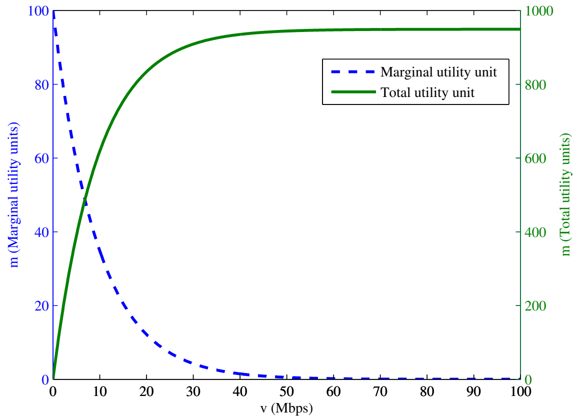


Figure 6: Marginal utility and total utility of a connection.

$$u(v) = \int_0^v m(v) = \left[\frac{u_0}{\ln(1-d)}\right] \times \left[(1-d)^v - 1\right] \tag{6}$$

5.1.2 *Channels*

Using just the three non overlapping channels is a solution often adopted by network designers and administrators, given the difficulty in considering a systematic approach to deal with the interference between overlapping channels. For this reason, we consider the channels $\{1, 6, 11\}$ in the channel allocation problem as in Bae, Choi and Chae [2], Balbi et al. [3], Lima, Carrano and Takahashi [12], Manitpornsut, Landfeldt and Boukerche [16] and Park, Bea and Kwon [18].

5.2 Model used for comparison

The channel allocation model proposed in Section 3 has the goal of maximizing the total utility of the connection for the users. Removing the decreasing function $u(v)$ from (4) in Section 3, we have a model that maximizes the global quality of connection, similarly to the models usually found in the literature. Solutions found by using the proposed channel allocation model are compared with solutions obtained by using the model as in (7).

$$\max f(x) = \sum_{i=1}^{n} \sum_{j=1}^{m} d_{ij} e_{ij} q(c_i, P) \tag{7}$$

The Genetic Algorithm developed for the problem was executed 33 times on each model. From these executions, we extract the best, worst and average results. In the figures illustrating the solutions found, the blue, green and red colors correspond to the channels 1, 6, and 11, respectively. Squares and dots represent the APs and the users in the network respectively. The line joining a dot to a square indicates the connection between a user and an AP.

5.3 Results

Figure 7(a) and Figure 7(b) illustrate, respectively, the best solution found by the GA when maximizing the global quality of the network and when maximizing the total utility of the connection for the users. One can see from Figure 7(a) that most APs are overloaded, while five APs provide service to only one user. These users are getting a quality of connection close to 54 Mbps, while the other users have to share this speed with another 40 users in addition to suffering from the effects of interference. This is the classic behaviour obtained by adopting the channel allocation models that disregard the satisfaction of the user in the formulation of the optimization problem.

Users under low connection speeds are also subject to some level of interference, damaging even more the utilization of the network and causing a large scale imbalance in the distribution of the quality of service. The same is not observed in Figure 7(b). By using the proposed channel allocation model, the satisfaction of all the users is taken into consideration. Some users who are inevitably subjected to high levels of interference should receive more bandwidth. In this way, the negative impact provoked by the interference in these users is compensated. Figure 8 presents the evolution of the best solution in the GA until converging to the solutions shown in Figure 7.

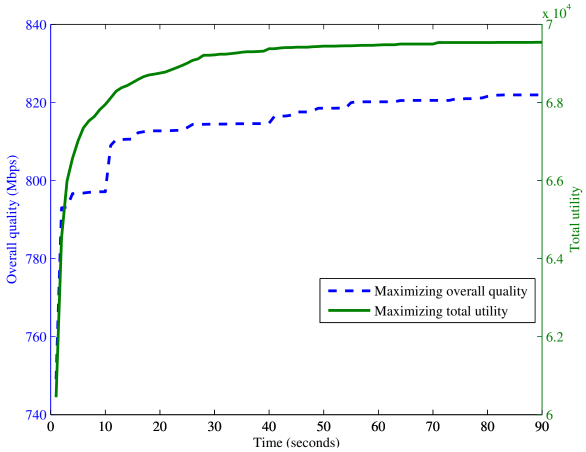


Figure 8: Evolution of the best solution in two Genetic Algorithms. The first GA considers the total utility as fitness function and the second GA uses the total quality of connection to the users.

Table 2 details the solutions found by the GA for the test scenario when adopting the model for the maximization of the global quality. Considering that 18 APs were set up in the environment and each one of them provides 54 Mbps, we have an available speed equivalent to 972 Mbps. That means that about 15% of the available capacity was lost due to interference.

Table 2: Solutions found by maximizing the global quality.

	Quality (Mbps)	% of users with interference	Total utility
Best	821.93	27.25%	56977.49
Average	818.85	30.11%	56083.65
Worst	814.33	33.00%	53731.78

In the worst case, there was a loss of 16% of the total capacity, affecting one third of the users. However, channel allocation models with this global perspective of the problem do not provide useful information about the quality of each user individually, not even if there are users without connection. Even for those solutions with small losses in the available global quality, there is no guarantee of satisfaction of the users. The percentage of users with interference means in practice the quantity of users subject to some damage, but no conclusion about the impact on the connection speed of this user.

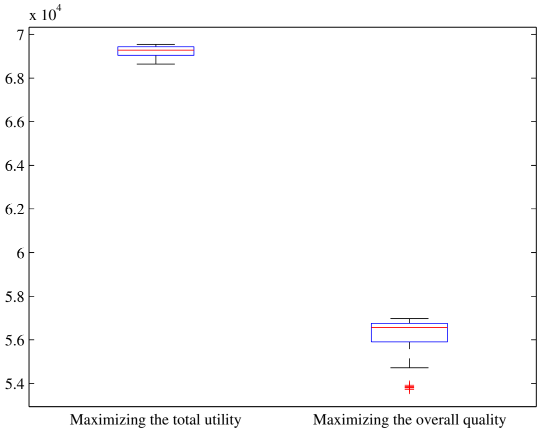


Figure 9: Distribution of the solutions in terms of total utility.

Table 3 details the solutions found by the GA when adopting the proposed model. When the objective is to maximize the total utility of the network, one can notice that the global quality is decreased, compare with Table 2.

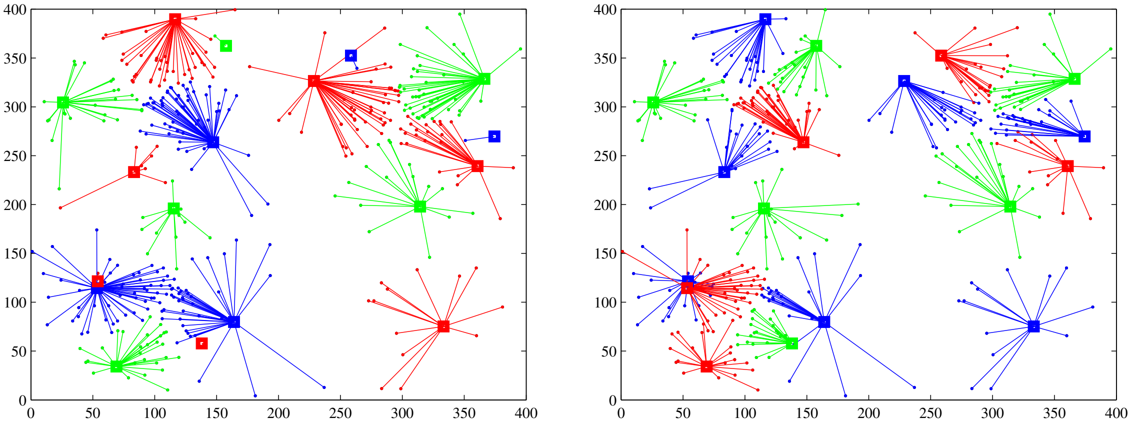
Table 3: Solutions found by maximizing the total utility.

	Quality (Mbps)	% of users with interference	Total utility
Best	785.78	25.75%	69539.76
Average	781.84	29.17%	69217.51
Worst	773.79	34.25%	68238.19

Figure 9 shows the distribution of the solutions in terms of total utility. One can conclude that, despite the fact that the used capacity of the network is greater when maximizing the global quality, the users are more unsatisfied with their connections. The satisfaction of a user is not related to the global quality of the network, instead, it is more related to the quality of the connection provided to the user. Given that most of the capacity is concentrated on few users, the majority of the users are not satisfied.

In order to demonstrate the variability in the distribution of the network capacity, we calculate the quality of the connection, in Mbps, of each user in the network according to the best solution found by the GA on each model. Figure 10 presents the number of users with up to a certain connection speed. The disadvantage of maximizing the global quality is apparent when compared with the maximization of the total utility.

It is possible to see in Figure 10 that about 250 users have a connection speed inferior to 1 Mbps when the total quality is considered. In other words, few users receive high connection speeds and most users get low quality service. On the other hand, with the proposed model, the distribution of the



(a) Maximizing the global quality.

(b) Maximizing the total utility.

Figure 7: Best solutions found by the Genetic Algorithm.

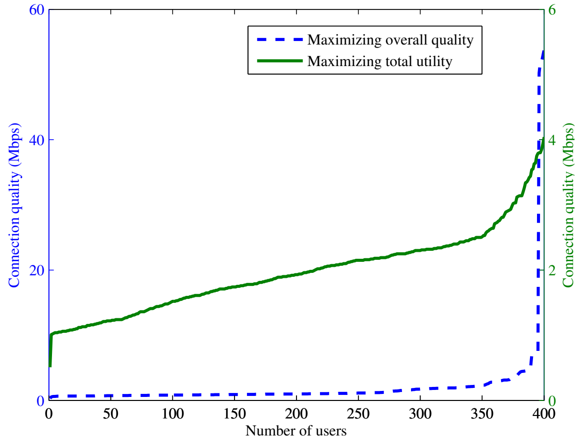


Figure 10: Quality of the connections for the users.

quality of service to the users is more homogeneous. There are no users deliberately damaged in order to compensate for the satisfaction of already well served users. Only two users experience connections inferior to 1 Mbps while other users are served with connection speeds between 1 and 4 Mbps.

For each scenario in our set of 300 instances, we executed the GA for each model of channel allocation. The average total utility obtained for these test instances was approximately 7% higher when using the GA with the allocation model that maximizes the total utility. As in the first test scenario, user satisfaction was higher in the proposed allocation model. Similarly, the global average speed of the connection was smaller in our proposed model only by approximately 1% when compared with the usual model that maximizes global speed.

In order to investigate the statistical difference between the allocation models, we used a Friedman test [19]. The test had a p-value$=0$, indicating that the difference between the two models is statistically significant, as presented in Figure 11.

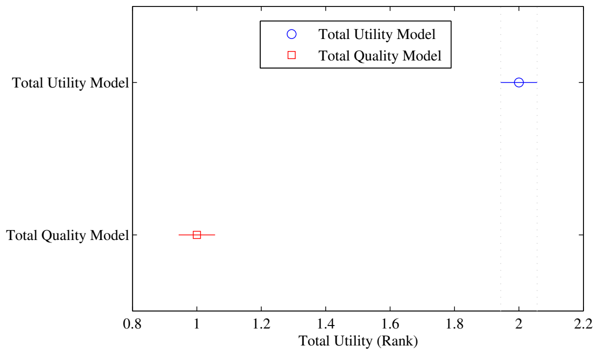


Figure 11: Multiple comparison of mean column ranks.

The satisfaction of the users is directly related to the quality of the connection experienced by each user. For this reason, the higher the number of satisfied users, the higher is the total satisfaction of the network. This characteristic justifies the overall satisfaction of the users when the total utility is considered in the optimization problem, as proposed in this paper.

6. CONCLUSIONS

Channel allocation models in WLANs usually do not consider the quality of the connection for each user individually. Motivated by this, we proposed a new channel allocation model that incorporates the total utility of the connection for a user. The model has the goal of maximizing the satisfaction of all the users in the network.

The proposed channel allocation model estimates the utility of establishing a connection between a user and an AP given the channel mapping. Therefore, the goal is to find the AP that best serves the user in addition to determining the operating frequencies of the APs. This characteristic is an essential contribution of this work to the balance of quality of service in the network, as illustrated in the experiments.

The scenario tested in the simulation has real characteristics of a WLAN but in the future we plan to consider obstacles in the environment such as walls and floors. Experiments performed with the Genetic Algorithm showed that models that consider a global objective generate imbalance in the distribution of the quality of the connections, favoring some users in detriment of a majority. As future work, we mention the comparison of the proposed model with additional channel allocation models in the literature and the study of conflict between users in terms of connection quality. Moreover, only non overlapping channels were considered in this paper. It would be interesting to evaluate the utilization of the additional available frequencies and the effect of this arrangement on the performance.

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