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QoE-Based Algorithm to Assign Channel using Distributed Method for IEEE 802.11 WLANs

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ABSTRACT: The main issue with deployment of IEEE 802.11 WLANs in the same hotspot is assignment of appropriate channels to the Access Points (APs). The number of channels is limited and most of the channels are overlapping in 802.11 and hence the proper reuse of these overlapping channels become a complex problem with respect to QoS and traffic load. Therefore over here QoE defined by the user is targeted. QoE defines the overall acceptability of the service perceived by the user which represents the user/service requirements. In this paper a performance index which takes into account both the user level fairness and aggregate QoE, is defined and the channel assignment is formulated as the optimization problem. The objective is to enhance the experience of user by finding the bandwidth used by each and every node connected to the AP. To achieve the objective we consider Distributed channel assignment algorithm for uncoordinated WLAN's where AP's will self configure their channels to reduce the interference level with their neighbouring AP's and find the bandwidth used by each and every node connected to the network.

KEYWORDS: IEEE802.11k, distributed channel algorithm, Quality of experience

I INTRODUCTION

IEEE 802.11-based wireless technology is widely been used in WLANs. There are two different types of deployments for infrastructure of 802.11 networks: centrally managed and uncoordinated. In centrally managed deployments, a management entity will be responsible for configuring and managing the APs that is installed by the service provider. Whereas in uncoordinated network they are mostly deployed in private hotspots (e.g. homes) where the AP is owned by independent users/providers.

Due to the rapid growth of Wi-Fi enabled devices, demand for new WLANs are expected to rise in future and these WLANs share some common features. They tend to be uncoordinated, independently owned and managed, small in size and deployed in areas where access points (AP) density vary greatly. Although IEEE 802.11b/g defines a total of 14 channels, only three (namely, channels 1, 6, and 11) are nonoverlapping and can be used simultaneously without causing interference. With the limited number of nonoverlapping channels, channel assignment becomes a critical performance factor for uncoordinated WLANs[2].

Compared to conventional or traditional WLAN deployments, the uncoordinated WLAN deployment has the following challenges to be considered during the design of channel assignment algorithm.

1. Network non specialist: uncoordinated WLANs are usually set up by inexperienced and independent users who are not having any knowledge about network configuration. They will not know how to configure the appropriate channel to minimize interference in their neighborhoods.



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2. Unplanned topology: In uncoordinated WLANs, APs are placed without any concerted planning; some areas may have high AP density and hence may experience high interference with poor performance.

In communication networks, the Quality of Service (QoS) is substituted by Quality of Experience (QoE) measure which is defined as the overall acceptability of the service as perceived by the user. Here a new method for admission control in IEEE 802.11 networks is proposed that estimates the QoE of users associated with APs and controls the admission of new traffic flows based on it [1].

II RELATED WORK

Channel assignment mechanisms are classified into two categories: central assignment methods that are applied to centrally managed environments and distributed assignment methods that are applied to uncoordinated environments [2].

Much work has been done with the objective to reduce interference and increase system throughput. However, this section only takes a review on recent channel assignment mechanisms that are suitable for uncoordinated WLAN deployments.

The Least Congested Channel Scan (LCCS): M.Achanta[3] proposed this system where each AP searches for the most lightly loaded channel, e.i., the channel with the fewest number of wireless clients associated with it. It switches to operate on that channel until the next scan finds a less congested channel. To achieve this, an AP first scans each channel for beacons published by neighboring APs, Each beacon contains information such as the number of wireless clients associated with each AP, the AP then determines from each beacon how many clients are associated with each of its neighboring AP's. After scanning all available channels, the AP knows how many clients are associated with each channel, and will choose to operate on the channel with the fewest number of associated clients. The LCCS algorithm also implicitly deals with load balancing with the assumption that every wireless client carries the same amount of traffic. That is, the higher number of associated clients indicates the higher amount of traffic. Instead of choosing the channel with the fewest number of associated clients it will choose to operate on the channel with the least amount of traffic, irrespective of how many clients are associated with it.

Mi, P., & Wang, X.[4] Proposed a distributed heuristic channel assignment method where each and every APs evaluate the load of nonoverlapping channels and employ it in a threshold based decision algorithm but the actual interference imposed to the clients is not determined and the fairness has not been guaranteed here.

K. K. Leung and B.-J. Kim.[5] proposed MinMax approach The objective of this approach is ,an AP's effective channel utilization is defined as the fraction of time a channel assigned to an AP is used for transmission by the AP, or is sensed busy because of interference from its co-channel neighboring AP. Here two classes of neighboring interferers are considered. For each AP i , cochannel APs are said to be in a class-1 interferer set $C_i(1)$ if their interfering signals are above a certain threshold that can cause enough interference for AP i to sense its channel busy. A class-2 interferer set $C_i(2)$ is defined as a set of pairs of co-channel interfering APs in which transmission by any pair of APs in the set can cause enough interference for AP i to detect its channel busy. This approach is mainly used to minimize the maximum effective channel utilization at the most heavily loaded AP, given a different fixed traffic load at each AP. It is done by starting with a random channel assignment to all the APs in the network, the algorithm randomly readjusts the channel assignment of the bottleneck AP's interfering neighbors such that the effective channel utilization of the bottleneck AP is minimized, resulting in a least congested network.

CACAO (Client Assisted Channel Assignment Optimization): Xiaonan Yue et al.[6] proposed a distributed algorithm for channel assignment in uncoordinated WLANs which will find the load of channels as the measure of

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interference level will improve the overall throughput of the AP. Here clients will periodically switch to other channels to find the load they require from those channels. Moreover, the load is evaluated in term of bit rate observed from other nodes within a particular range of the reporting node. But here the clients also suffer from the interference when they are within carrier sensing range of interfering nodes which is neglected using this method.

Mishra et al. [7] proposed a distributed channel assignment scheme for uncoordinated WLANs which improves both fairness value as well as aggregates the throughput. This method uses MAXchop algorithm which uses the idea of channel hopping where APs synchronously switch their channel according to their hopping sequence. The interference graph is calculated from detection of interfering APs without addressing the actual interference imposed to the clients by the AP. Moreover the overhead of channel hopping is low.

Channel hopping approach: A.Mishra et al.[7] In this is a method distributed channel assignment algorithm is proposed based on the concept of channel hopping for an uncoordinated WLAN. In particular, each AP is assigned a unique sequence of channels, and hops through this sequence over time so as to average out the throughputs of all APs in a long run. Each AP is within the transmission ranges of other neighboring APs. The sequence is assigned to each AP in such a way that each AP hops to the next channel at the end of each time slot.

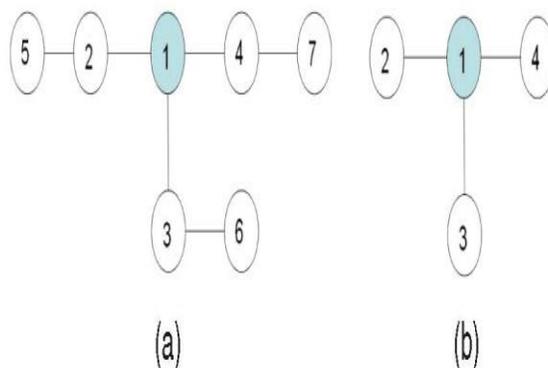


Fig.1. An example that represents the graph of every AP. (a) An example of graph G,(b) The graph of G(api)

Fig.1 is an example that illustrates G(api).Fig 1(a) contains seven vertices and is a complete graph where vertices 2,3 and 4 are directly connected to vertex 1. Using Fig. 1(b) is a graph where \mathbf{api} can be obtained locally based on channel condition reports from clients.

III PROPOSED ALGORITHM

In this paper distributed algorithm is used to gather the information by APs and clients on interference conditions to compute and minimize a local objective function by switching to a channel that has least expected interference value. The algorithm is very simple, and requires no direct communication between neighboring APs. The networks that has stable traffic pattern, CACAO(Client –Assisted Channel Assignment Optimization) adaptively settles the global objective function value to a local minimum. The uncoordinated WLAN has following features:

1. The APs are placed in an uncoordinated manner and there is no central administrator to decide on the number of APs to be placed and where they should be deployed.
2. Each AP belongs to and is managed by a different individuals or organization. Since the APs belong to different authorities ,load balancing by device association among APs is not allowed.

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3. Channel assignment decisions must be made based on only the information gathered by the AP and its associated clients.
4. The clients associated with an AP only send data to or receive data from their own AP.

Since the measurement of each AP and its clients can only discover its nearby nodes that are within the interference range, the weight calculation and channel assignment are done locally based on distributed algorithm.

1. Initialization – Initial Assignment
api.c -> rand(k)
2. Optimization – Repeated for each AP
 - a) GatherStatistic()
 - b) Ct = ComputeInterference()
 - c) SwitchTo(Ct)

In this Algorithm First, every AP runs the initialization routine when it boots up. During the boot-up period, each AP randomly assigns itself to a channel chosen from the k nonoverlapping channels. Next, each AP periodically runs the optimization routine to retrieve its clients interference statistics and then computes the sum of the expected interference levels with regard to each nearby BSS for each channel for the next time interval. Because many online applications like video streaming,online banking,online gaming etc we have steady data transfer rate, the amount of traffic observed for the current time interval is a proper estimation for the traffic in the next time interval. Therefore, after optimization routine calculates and compares the expected interference level of each channel, the AP will choose the channel that has the least expected interference, and switches to that particular channel. At the end of every time interval, each AP independently chooses the appropriate channel assignment to locally minimize the objective function. Clearly, the APs operate independently and the whole network does not need any synchronization.

GatherStatistic() is a procedure that is used to gather statistics from clients. It returns the traffic information collected by the clients. Then the AP's optimization routine performs computations and comparisons to decide which channel the AP will use for the next time period by procedure ComputeInterference(). This routine computes the expected interference level that the entire BSS will experience for the next time interval. The channel with the least expected interference level will be chosen. Finally the SwitchTo() routine assigns the AP and its associated clients to the chosen channel.

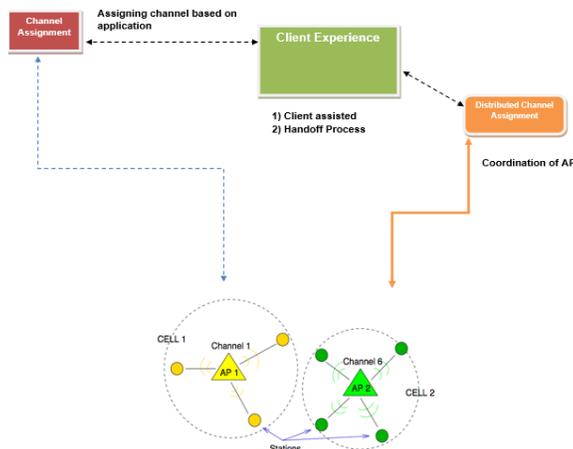


Fig.2.architectural diagram of channel assignment based on clients experience.



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In Fig 2. The channel is assigned to each every AP connected to WLAN. When the user requests the AP for channel ,the AP will check if it has a channel that can satisfy the user requirements based on user experience and availability of channel, if it cannot satisfy the requirement of user then by using distributed channel assignment algorithm handoff process is performed where the AP will handoff the user to its neighboring AP.

IV CONCLUSION

Channel assignment is one mechanism to improve the performance of WLANs. Here distributed channel assignment algorithms for IEEE 802.11 deployments is used which are executed by APs. AP's using this algorithm collect channel interference condition statistics with the help of their associated clients. This information helps the APs to make better decisions on channel assignment to reduce interference. Using QoE feedback from the users, the actual interference level applied to each of the connections is assessed and used along the satisfaction level of the user for more efficient channel assignment. The proposed methods could not precisely distinguish the QoE degradations that are due to high interference from the degradations that are due to low received signal strength. Therefore, using other state information from the environment in more intelligent learning mechanisms will be considered and the bandwidth of each and every user accessing the AP is determined in this paper to improve the performance of the proposed methods.

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BIOGRAPHY



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