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Effective Access Point Selection for improving Throughput in Wireless LAN

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ABSTRACT

In recent years, WLANs are widely deployed everywhere due to the low-cost and easy installation. Selecting the best access point is the major research problem. The stations in the network should get associate with the suitable access points that results in higher throughput. In IEEE 802.11 wireless networks, the simple association strategy is to get associate to the AP with the strongest RSSI value, which may cause load imbalance and may eventually leads to traffic overhead. Access point selection is still a critical problem.So, a new metric or combination of metrics has to be derived that facilitates the effective selection of an AP to achieve better throughput.

Index Terms – **Access Point (AP) Association, Decision Metrics, RSSI(Received Signal Strength Indication), Wireless Local Area Network(WLAN).**

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1. INTRODUCTION

Driven by internet explosion, there has been a tremendous increase in the popularity for wireless LAN.They have been widely deployed at homes,offices,and public hotspots to provide internet access with nearly comparable performance to that of Ethernet.The stations in the network should get associate with the suitable APs that results in higher throughput. Many AP selections have been proposed from both industries and research point of view.The basic method is to associate with an AP with the strongest signal, but it may cause the degradation of overall throughput[1].

Several other strategies by different authors have been proposed that make use of the metrics like load information in the network,packet delay, position of AP, bandwidth,round-trip-time[4]. Previous work is on improving the user performance in terms of throughput through various association metrics. Minimizing the association delay is the work missing previously. While this assumption may get valid in some scenarios, it may result in very poor performance in some WLAN cases[3]. Also, with bulk number of clients using the network, issues like interference and congestion may occur [5].

The final goal of any association strategy is to maximize the minimum throughput among all clients. Hence, a selection strategy has to be proposed that deal with all the dynamic topological changes of the network [6]. The other strategy proposed is an online association strategy that implements an online association protocol by employing a ‘Smart Assoc’ protocol. It facilitates the online algorithm to run independently on each client.This strategy might perform well compared to RSSI based approach in terms of load balancing and reducing interference and congestions to a considerable factor. However, there is a need of some other association strategy that considers the delay time of association along with the consideration of other factors like signal strength, load in the network etc., [9]
The rest of this paper is structured as follows. *Section 2* discusses related work .*Section 3* illustrates proposed work. *Section 4* presents results obtained through simulating proposed metric in comparison with RSSI and load information as the metrics. Finally we conclude in *Section 5*.

2. RELATED WORK

In recent years, several association metrics have been proposed to choose the AP that can provide better service to the users in terms of throughput.A number of techniques has been proposed that considers network load rather than just RSSI as the association metric for WLANs [14] .These strategies also need to consider the association time needed to get associate with an access point along with other factorssuch as the overhead of protocol modifications on AP side.Some of these basic association strategies are discussed below.

2.1 RSSI as the Association Metric:

The first basic decision metric called RSSI(Received Signal Strength Indication) is introdued to perform the AP association, which considers the available signal strength of the beacon frames to get associated with an AP . The higher the RSSI number, the stronger will be the signal. However, this method is proven to be inefficient as it does not consider the other parameters such as channel conditions;access point load etc., In 802.11 WLAN, the metric RSSI can be replaced with the other metric called RCPI(Received Channel Power Indicator). However, a power level metric like RCPI in general cannot consider the

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other parameters such as the quality of the link. Hence, there is a need of much more research that present much more efficient AP association techniques[2].

2.2 Load of an Access Point as a Metric:

To solve the problem caused by the RSSI based approach, the other work (FengyuanXu and Xiaojun Zhu ,2013) presents a metric that considers the load information of an AP as the decision metric to perform the AP association . Load information can be calculated from the total number of frames,channel busy time,available bandwidth,delay time etc., . There are various load balancing approaches.The present strategy is an online association strategy that implements an online algorithm as follows:
The load of an AP a, La can be computed as:

$$La = \sum_{i\epsilon Ua} IL_{ia} = \sum_{i\epsilon Ua} \frac{1}{R_{ia}}$$
(1)

Where, IL_{ua}s the reciprocal of the transmission rate of user u on AP a.
However,this strategy also includes some overhead in terms of AP association delay that may happen, but performs well than the RSSI approach. So, some other metric need to be identified that considers the total delay time which includes all the phases of an successful transmission of data between the selected access points and the corresponding users [15].

3. PROPOSED METRIC: S-ATDM

This section discusses our new association policy ,Scanning based Association Time Delay Minimization (S-ATDM). The disadvantages of the existing solutionsfor effective association in wireless local area networks or Wi-Fi (wireless fidelity) networks are:

- In WLAN, access point selection plays a very important role in determining the user performance.An unwise selection hurts the client's throughput.Most strategies are not considering all the association parameters in performing the AP association [10].

- Several strategies are not in a position to consider the overall delay that occurs in association process in terms of phases like AP discovery and AP access.Hence,the association should be minimized and it has to be focusedon.

To solve these issues,we propose an another AP association metric, which combines the elements of the current existing strategies along with much focus on the overall association delay that may occur [11].The proposed metric is combined with the existing metrics such as RSSI, load information and it can be named as Scanning based Association Time Delay Minimization (S-ATDM).The proposed metric is expected to minimize the association delay and hence maximizes the overall performance in terms of resultant throughput.

3.1 A Study on WLAN model:
A WLAN is made up of multiple Access Points (APs) with overlapping cells to provide a wide coverage and offer high transmission rates. In current implementations, each user associates with an AP with the strongest signal strength.WLAN can be of ad-hoc type or infrastructure type, in which ad-hoc model does not include any form of access point and infrastructure model include one or more access points.Hence, the term of association delay will considered only in the case of infrastructure type WLAN[13].

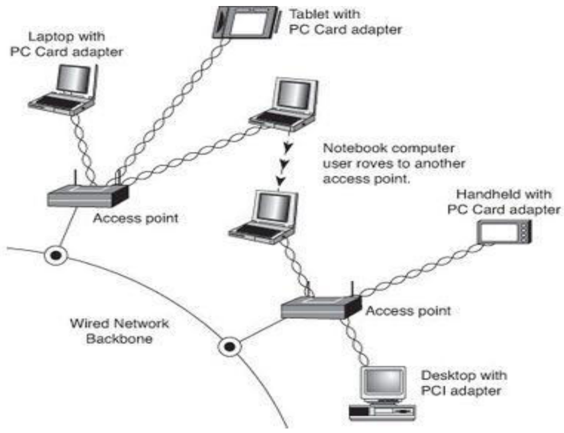

Fig 1: Infrastructure type WLAN

A typical WLAN network includes multiple access points as shown in the above figure, in which an efficient access point needs to be selected.An unwise selection of an access point not only hurts the corresponding clients throughput,but also effects the overall performance of the network.As the present existing strategies are not that able to estimate the total association time delay which may also include the effect of re-association to an AP [12], a suitable strategy need to be developed to cope up with the drawbacks of previous work that is done on the effective access point selection.

3.2 Scanning based Association Time Delay Minimization(S-ATDM)technique:
This technique is based on the association delay cost in the process of associating to an AP in a wireless LAN.The association cost of one AP is compared against the association cost of other working APs in the network. Generally, the process of AP association includes the following phases.
1)AP discovery phase,in which a suitable access point has to be identified by running an algorithm.
2)AP authentication phase, in which the user gets the surety that it is going to associate with the correct AP.
3)AP association phase,in which the user gets connected to the discovered AP.
4)AP re-association phase, in which the connected AP will be changed as per requirements.

In real-time processing, the capability of estimating time delay to perform AP association has to be enhanced by

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employing a suitable algorithm and the algorithm should consider the overall association delay.
The above discussed effective form of APassociation can be achieved with the use of the following steps of algorithm.

Scanning based Association Time Delay Minimization Algorithm:

1.Monitor the AP selection cost of current AP.
2.Monitor the AP selection cost of other APs through periodical background scanning.
3.If the cost of current AP is less than the cost of other APs in the network,associate with the current AP.
4.If the cost of current AP is more than the cost of other APs,get associate with one of the other APs whose selection cost is below a given threshold value, T.
5. Repeat the steps until a best access point is found to get associate with.

3.3 Estimation and Optimization of Access Point Association Delay:

Several metrics can be combined effectively in order to achieve better throughput results in performing the AP association. As the proposing strategy combines the elements of three metrics i.e., RSSI,Load and Association Delay, a mathematical formula need to be evaluated which should be minimized or optimized in order to carry out the AP association with no delay time and it should be preceded by an overall estimation of the delay [12]. In this technique,we make use of special frames called probe frames instead of data frames for performing the periodical scanning and thus the network load can also be minimized. The Probe requests during the discovery phase are used to observe the states of all the adjacent channels to decide on the best AP to achieve balanced load and timely handoff [15].

Total association time includes the overall timing for the discovery, authentication, association, and a successful data frame transmission. In order to obtain the most appropriate back off time and thus provide timely handoff, the total delay D_{total} between when the first probe request is transmitted and when the association response is received needs to be known, which is given as,

$$D_{total} = D_{\ probe} + D_{auth} + D_{\ assoc} \quad (2)$$

Where,$D_{\ probe}$represents the probing delay, $D_{auth}$is the authentication delay, and$D_{\ assoc}$ is the association delay.

$D_{\ probe}$is defined by the following equation:

$$D_{\ probe}=n*(DIFS*d + RBO + PT)+n*(t_{tx} + t_{prop} + t_{ch} + t_{switch}) \quad (3)$$

Where n is the number of channels, d is the average number of DIFSs(Distributed Inter Frame Space), RBO is the average random backoff time, PT is the average pause time during the discovery phase,t_{tx} and $t_{prop}$are the transmissions and the propagation time of the probe frame, respectively, t_{ch} is the channel time, and $t_{switch}$is channel switch time.
Using the techniques of differentiation , the equation (2) needs to be optimized, in order to minimize the overall association delay.

4.SIMULATION RESULTS

This section discusses the simulation results obtained by evaluating above discussed association metricusing NCTUns6.0 simulator [7]. The simulation scenario beingused and the resultant performance issues has been discussed below.

4.1 Simulation Scenario:
In this simulation, we consider a wireless network which is a 5x5 square grid topology of 25 access points(APs) with grid space of 200m.
A grid topology has been chosen due to its facility to create a fully connected mesh network,which is a popular type of wireless lan currently. It is also possible to create a large variety of other topologies by manipulating certain nodes and the access points. All nodes employ IEEE 802.11b MAC protocol. The wireless transmission range is 250m.
The propagation model is two way ground.OSPF (Open Shortest Path First) has been used as routing protocol during simulation, since it is widely used for internet applications. Simulation time is set to 160 seconds. The network performance is evaluated by plotting a graph. Throughput is the simulation parameter being compared among the strategies.

4.2 Performance Evaluation:
To evaluate the performance of proposed metric in comparison with existing metrics, the following variables are analyzed using NCTUns simulator.

Throughput: It refers to the data rate that is delivered by WLAN layers(MAC+PHY) to upper layers in the OSI model**.** More is the throughput, more effective the strategy will be.With a decrease in the association delay during the process of AP selection, an user can connect to a best AP which can offer better throughput.

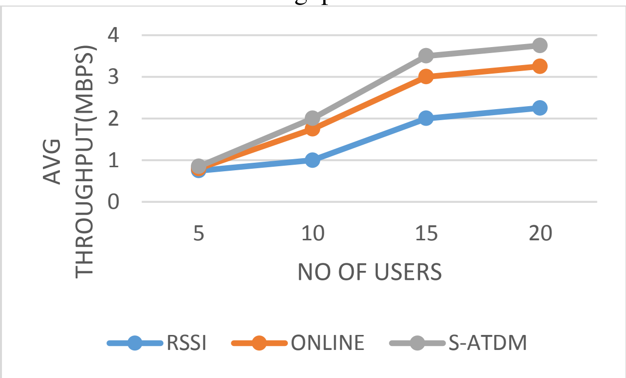

Figure 3: Resultant average throughput for RSSI,Online and S-ATDM techniques.

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From figure 3,the comparison among the RSSI,Online and S-ATDM strategies can be done in terms of throughput. Here, the throughput can be analyzed in view of all other parameters such as efficient utilization of bandwidth, increase in packet delivery rate, effective association to the access point etc., which in turn leads to the improved performance in terms of throughput.Considerable increase in the overall throughput using S-ATDM technique can be observed from the graph obtained.

5. CONCLUSION AND FUTURE WORK

In this paper,we introduced an enhancement to the current existing AP association strategies.In this metric, we attached another metric to the already existing metrics like RSSI and Load information in order to minimize the overall delay that can occur in the process of AP association. The metric is termed as Scanning based association time delay minimization(S-ATDM). Results presented in this paper show that the user can select the optimal access point with less association delay.Simulation results show that performance of S-ATDM strategy in terms of throughput, packet delivery ratiohas been improved in comparison to the previous metrics. The network load also get decrease as we are making use of the probe frames instead of data frames.

As a future work, the proposed metric can be combined with other possible metrics also as done in our presented work and hence end up with the better throughput results. Several other performance metrics such as PDR(Packet-Delivery Ratio) and BER (Bit-Error Rate) can be evaluated using the NCTUns simulator and it can be considered as the future work. Thus, access point association is an endless research area in which one can identify the several association strategies that can effectively deal with all the dynamic topological changes of the network with much better throughput results[8].

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