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Optimizing the 802.11 hotspot performances by using load and resource balancing method

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Abstract. The 802.11 networks have been commonly used for public internet access. Most 802.11 hotspots have more than one access point in an area. When these access points belong to the same network, users may choose anyone it connects to. In order to enhance the access services, some methods have been proposed. The methods allocate users to certain access point to avoid crowded and collided access. The method is referred to as load balancing. The existing work in load balancing are usually based on traffic balancing as well as cell breathing. The first one is the most common method as the cell breathing applies power reduction while electromagnetic wave travels anywhere and access point are usually in distance of low power transmitter. This paper proposes load and resource balancing where the client allocation is not only based on its load but also the access point resource. The simulation evaluation shows that the proposed method outperforms the existing one by reducing delay by 0.9%, increasing throughput up to 715 kbps and the collision probability reduces by 0.068% in average.

1. Introduction

Wireless local area network (WLAN) is the 802.11 based network infrastructure that connecting (computer) clients to the internet. WLANs have been daily need both in houses or offices. It is easy to find wireless local area networks (WLANs) anywhere now [1], [2].

The WLAN area is called the hotspot. The hotspots usually contain more than one network access point. When access points belong to the same network operator, access point migration and roaming are possible. Incoming users can be connected to any access point while the existing client that experiences network disturbances or congestion can be reallocate to other access point [3]. These network connection is arranged automatically by the network infrastructure by using certain network balancing algorithm. Without this connection management, users may choose the preferred network access point (that could be overloaded), while the non-popular ones may experience under loaded.

Some researchers propose the load balancing methods. Among them, Velayos [4] performs load balancing by connecting access points to a backbone network so that each access point can interact to others sharing their load information. The software within access point calculates its load and compares it to the average load belongs to all access point. If it is under loaded, new client is allowed to connect through it. This method improves previous work where the processing centralized server manages the load balancing [5]. The weakness of [4] idea is the low network capability is treated similarly. The other method [6] implements cell breathing where the overloaded access point reduces its transmitting power. By doing that, the lost connection users should find other access point. However, this may interrupt the existing communication. Work in [7] overcome the problem by separating beacon and data transmitting power, so that existing communication keeps flowing but changes connecting access point afterwards.

The main weakness of cell breathing is that multi power level transmitter is required within the access point transmitter. This also affects the advance technique which the adaptive code and modulation (ACM), where signal level determines the rate of modulation. Clients may experience speed reduction as the connecting access point reduces it transmitting power.

This paper focuses on improving load balancing without cell breathing by considering the network resources. As 802.11 network advances, there are many variants exist, including 802.11a, 802.11b, 802.11g, 802.11ac, 802.11n and other standards. By these technology existences, access points may have different capabilities. So that the same load balancing treatment without resource consideration does not optimizes the network performances.

2. The proposed method

This paper focuses on developing AP selection for the newly joining user. The proposed method expands the lowest method proposed by [4]by considering the maximum throughput in each AP. It is aimed at accommodating the variety provided by the 802.11 standards, which offer various speeds (bitrates).

As in the lowest load [4], AP shares the balance index through the network backbone which is defined as :

$$\beta = \frac{(\sum B_i)^2}{(\sum B_i^2)} \tag{1}$$

where B_i is the current through put of the i^{th} of APs. The balance index is 1 if all Aps havethe same load. The P load is classified into 3 types: *overload*, *balance* or *under load* based on average load L:

$$L = \frac{\sum_{i=0}^{n} B_i}{n} \tag{2}$$

The proposed method expands the criteria by considering the maximum throughput offered by the AP. If it is assumed that $B_i$is thecurrent throughput of the i^{th} AP, and the maximum capability of the current AP is B_iMax, then the utility is given by:

$$\mu_i = \frac{B_i\text{Max}}{B_i} \tag{3}$$

The AP allocation is based on the smallest utility, $\min(\mu_i)$.

3. Research method

In order to evaluate the proposed method, simulation code and simulation scenario designed. The simulation code was assembled by using Java programming language. The nodes created as well as their traffics. Transmission number and rates were defined in each node. Simulation time divided into slots. In each slot, random selection defined randomly to choose the transmitting nodes with given back-off time. The successful transmitting node selected, and the number transmitted bytes calculated based on the node speed. Delay, collision rate and throughput recorded though out slot execution. The process is following the graph shown in figure 1. The existing methods to compare were the random selection and the lowest load methods.

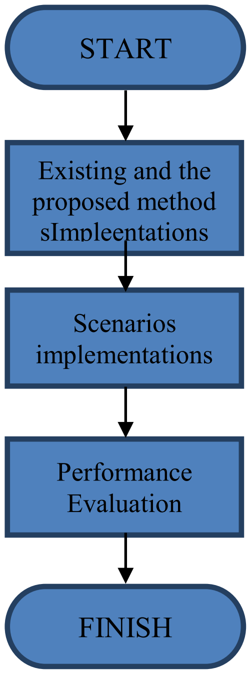
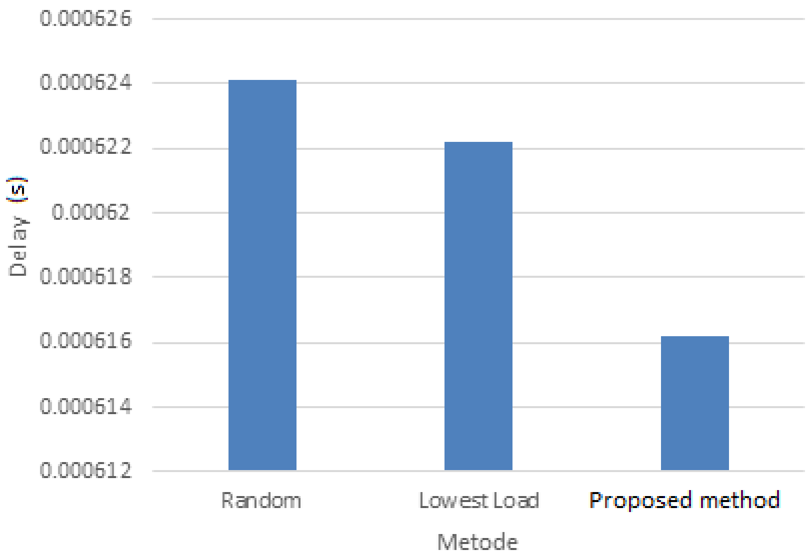


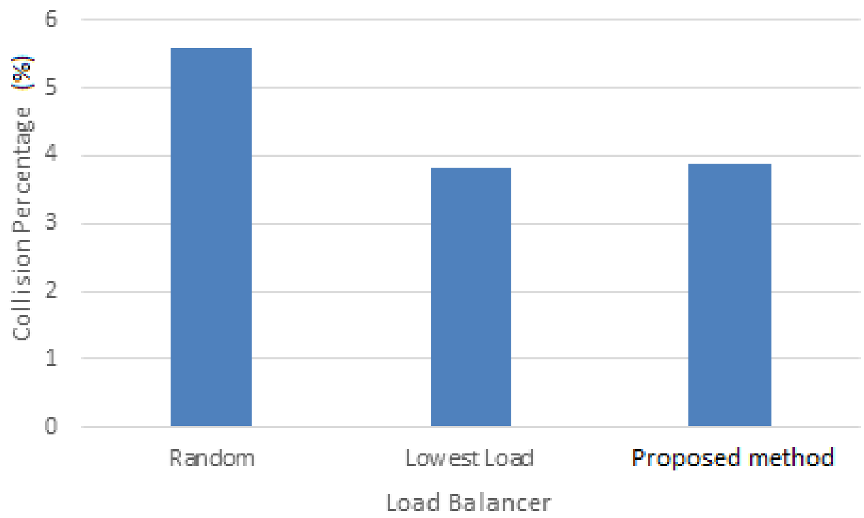
Figure 1. Research flow process

4. The evaluation results

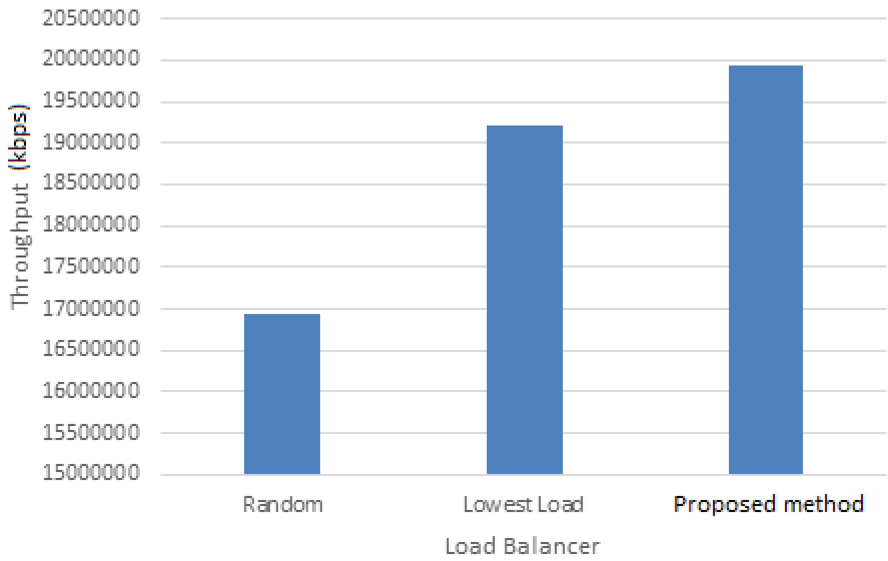
The overall performances shows that the average delay of the proposed method outperforms the previous method by achieving 0.9% reduction. The collision probability reduces by 0.068% in average and throughput increases at least 715 Kbps. The performances plotted in figure 2.



(a) Delay characteristic



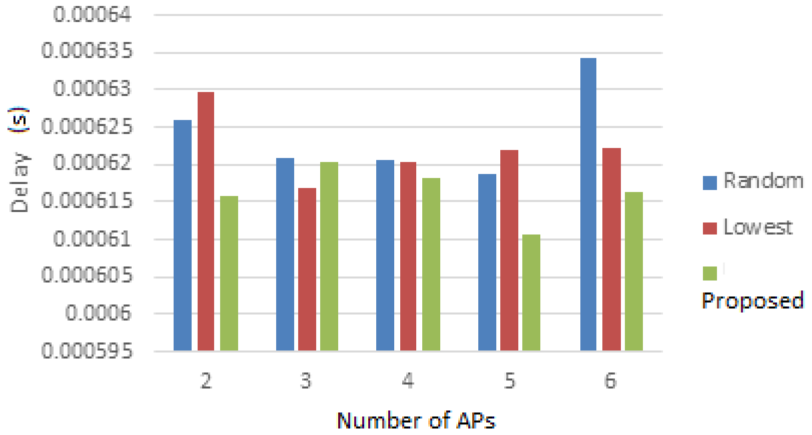
(b) Collision characteristic



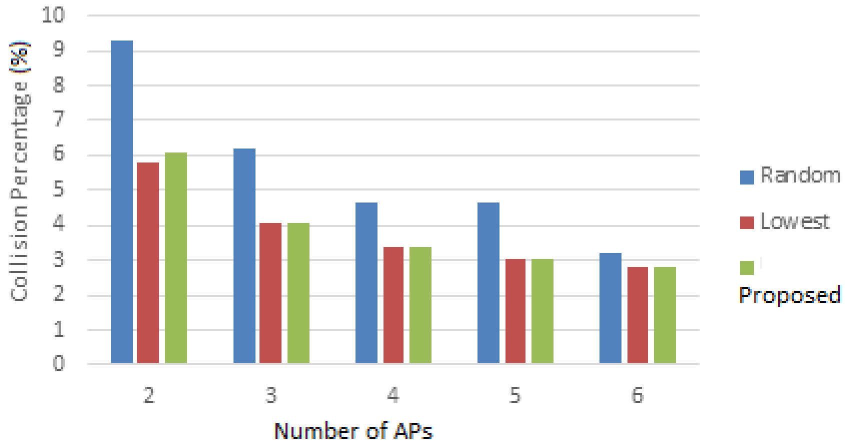
(c) Throughput characteristic

Figure 2. Overall performance

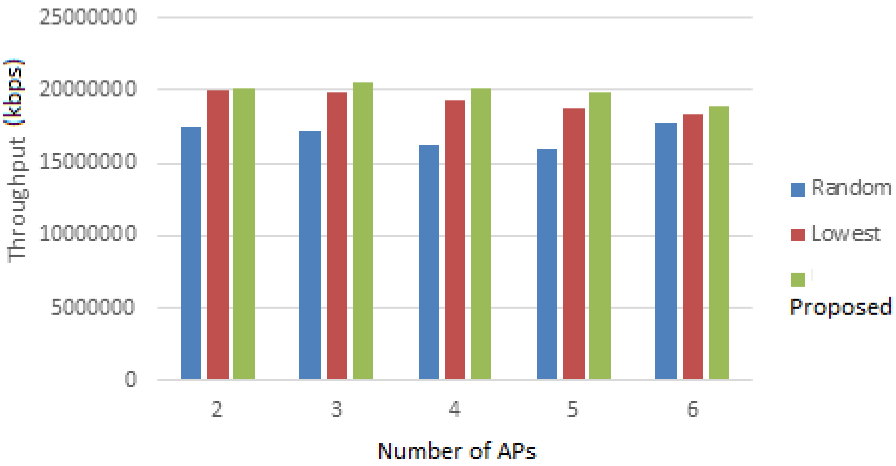
By varying the number of active APs, the performance pattern is depicted in figure 3. Delay varies on AP numbers. The proposed method is table for various AP number, but the lowest load tends to have increasing delay. Meanwhile, the collision rate of the proposed method increases higher than the existing method, however, it does not influence the throughput as the successful transmitting ode sends data at higher speed as offered by the AP.



(a) Delay characteristic



(b) Collision characteristic



(c) Throughput characteristic

Figure 3. Load balancer performances against number of AP

5. Conclusions

This paper has proposed the expansion of the lowest load method in balancing access point allocation in 802.11. The methods add maximum throughput consideration of the pointed AP.

The results show that *delay*and throughput performances of the hotspot with multiple AP have been successfully improved. The proposed method reduces the average delay by 0.9%, increases the average throughput up to 715 kbps and reduces the collision probability reduces by 0.068% in average.

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