22nd IMEKO TC4 International Symposium & 20th International Workshop on ADC Modelling and Testing
SUPPORTING WORLD DEVELOPMENT THROUGH ELECTRICAL&ELECTRONIC MEASUREMENTS
IASI, ROMANIA, September 14-15, 2017

"Intelligent" Controller Algorithm for Load Distribution Enhancement of IEEE 802.11 INTER-WLAN Traffic

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***Abstract* – This paper analyses the possibility to have a dedicated signaling channel for triggering load balancing mechanism based on relevant specific traffic parameters analysis (e.g. throughput, EIRP, Antenna Gain). Compared to classic algorithms, the signaling channel brings the advantage of distributed "effort" between Access Points and Controllers. Experiments were performed with Matlab and the results show the network performance enhancement in terms of Load and Throughput. The proposed signaling channel shows effectiveness of the load distribution enhancing also the network performance.**

***Keywords* –WLAN, Algorithm, Controller, Antenna gain**

I. INTRODUCTION

The load balancing mechanism is one of the technical solutions that allows network traffic enhancement through predefined QoS parameters. The usage of "number of clients" as primary deciding factor is part of most commercial COTS solutions [1, 2, 3, 6, 7]. However, this criteria doesn't fully analyze the complexity of the wireless environment. We propose an alternative solution in order to enhance wireless network performance. The proposed mechanism covers the Wi-Fi complexity by adapting a specific algorithm [4, 5] which applies the concepts of EBO (Effects-Based Operations) and KM (Knowledge Management). From this perspective, is a multidisciplinary approach.

II. SIGNALING CHANNEL STRUCTURE AND APPLIED PREDICTIVE METHODS

The algorithm in this paper calculates the AP load after the initial phase of client association to a specific AP. Once the Controller takes the decision to disconnect the client, it will "communicate" it to the affected AP.

AP_Load=BW/Sum(ABSGain_Client1+ ABSGain_Client 2+..+ ABSGain_Client N) (1)

$$AbsGAIN\_Client = g - losses \quad (2)$$

where:

-*g:* the client gain without considering the associated load of the channel

-*losses:* client losses value due to the load of the communication channel

-*AbsGAIN:* Absolute gain value per client which includes the associated losses

Access Point level threshold definition is the following:

$$LB\_Threshold > alfa * ABSGAIN\_AP \quad (3)$$

where:

$$ABSGAIN\_AP = Sum(AbsGAIN\_Client\_1 + AbsGAIN\_Client\ \_2 + .. + AbsGAIN\_Client\_N)/n \quad (4)$$

ABSGAIN_Client_i = Normalised values of client competences (throughput, Channel width, Tx, Antenna Gain) for client i associated to an AP)

ABSGAIN_AP- is the absolute gain value per AP

-AccessPoint_Number shows the AP that sends the signaling information;

-*Priority:* field with potential usage but not used in this paper

-*Accept/Reject:*the Controller decides for the client in the signaling channel if it is accepted for the load balancing (Accept) or rejected (Reject). In the end, that indicates if the client will be part of the Load Balancing mechanism or not.

-*Associated client:* is the client to which the Controller applies "Accept/Reject" policy

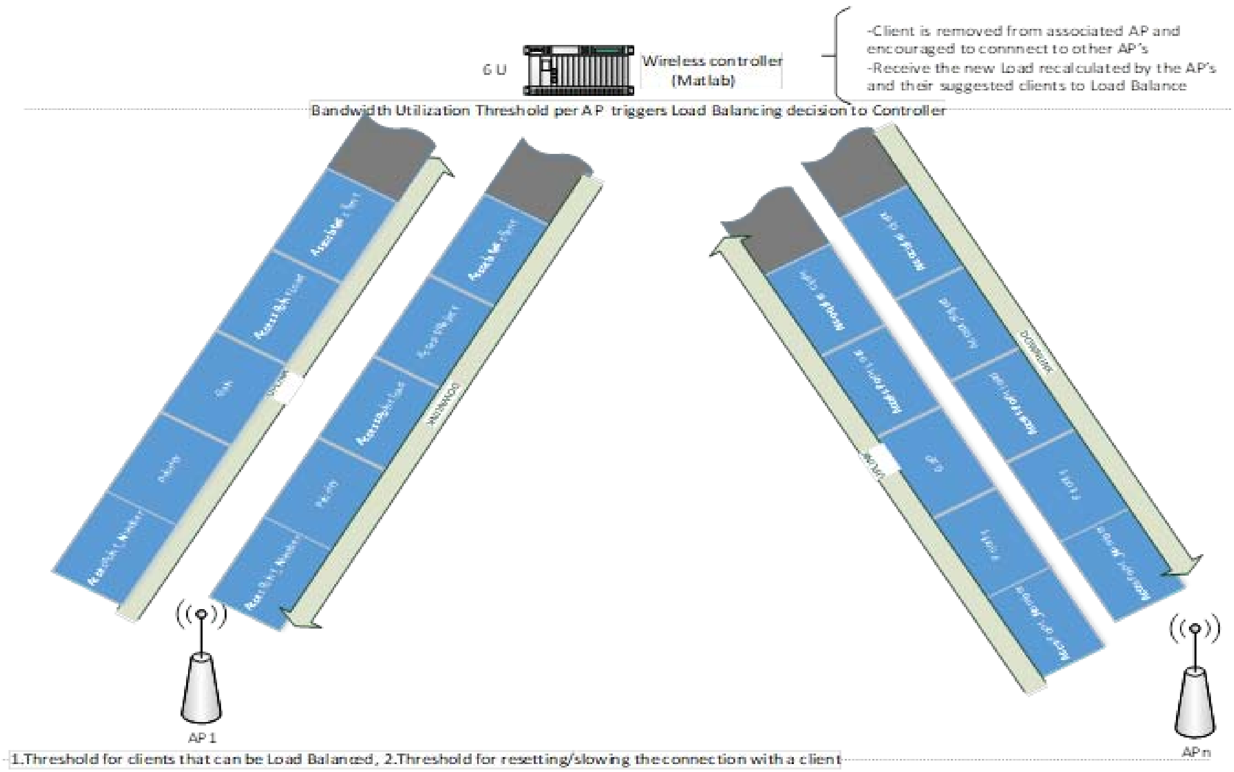

Fig. 1: Structure of the signaling channel for the proposed algorithm

III. ”INTER-CLUSTER” LOAD BALANCING EXPERIMENTAL SCENARIOS ANALYSIS

The following initial scenarios were considered: AP1:6 initial clients, AP2:8 initial clients. 3 variable parameters (Channel Bandwidth, Antenna Gain, Tx (Transmitted Power)) were involved in order to detect load balancing algorithms behavior. For the above scenarios, the following settings were implemented:

-2 Access Points: AP1 and AP2 “logic” are coordinated by the controller (a computer running Matlab and the FTP server);

- AP2 initially assigned 8 clients will generate FTP traffic limited to 100 kbps per client; by simultaneously downloading a file on the laptop containing the Matlab software;

-AP1 clients have no throughput limitation on the FTP download;

- Each AP has an open source DD-WRT type firmware installed;

- All wireless clients were HP Laptops with similar physical features (Intel Core I5 processor, 4GB RAM).

The above mentioned scenarios will not trigger any load balance for the compared commercial algorithms (e.g. “Cisco aggressive load balancing”, “Juniper”) which have “number of clients” as load balancing triggering factor.

IV. RESULTS

Variation of bandwidth:

BW=5 MHZ:

- Throughput AP1 (6 clients) = 13.312 Mbps, Throughput AP2 (8 clients) = 0.8 Mbps

The situation of throughput and allocated clients per AP becomes:

- Throughput AP1 (4 clients) = 7.92 Mbps, Throughput AP2 (10 clients) = 9.23 Mbps

After the balancing, the load distribution between AP1 and AP2 is improved with 79% (figure 3). Total throughput (AP1+AP2) is improved as well with 21.5% (figure 2).

BW=20 MHZ:

- Throughput AP1 (6 clients) = 14.088 Mbps, Throughput AP2 (8 clients) = 0.8 Mbps

The situation of throughput and allocated clients per AP becomes:

- Throughput AP1 (4 clients) = 11.01 Mbps, Throughput AP2 (10 clients) = 6.22 Mbps

After the balancing, the load distribution between AP1 and AP2 is improved with 51% (figure 3). Total throughput (AP1+AP2) is improved as well with 16% (figure 2).

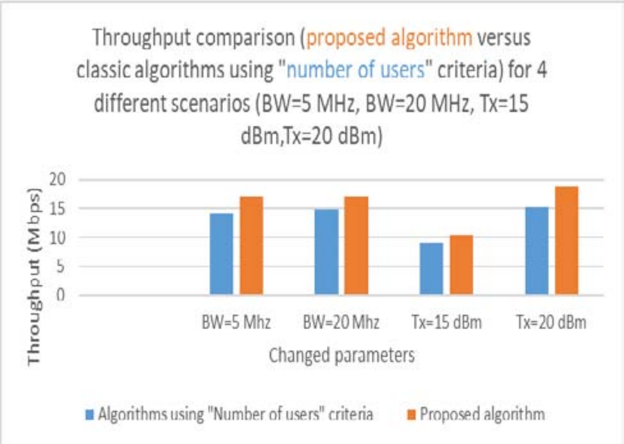

Fig. 2: Throughput enhancement through studied scenarios

Antenna Gain Variation

Variations of antenna gain at 0 dBi and 2 dBi are not perceived by the algorithm.

Balancing must be done only under conditions that do not affect the functionality of the network and only under the conditions of benefits.

Tx power variation

Tx= 15 dBm

- Throughput AP1 (6 clients) = 8.336 Mbps, Throughput AP2 (8 clients) = 0.8 Mbps

The situation of throughput and allocated clients per AP becomes:

- Throughput AP1 (4 clients) = 6.432 Mbps, Throughput AP2 (10 clients) = 3.921 Mbps

After the balancing, the load distribution between AP1 and AP2 is improved with 51% (figure 3). Total throughput (AP1+AP2) is improved with 13.3% (figure 2).

Tx= 20 dBm

- Throughput AP1 (6 clients) = 14.464 Mbps, Throughput AP2 (8 clients) = 0.8 Mbps

The situation of throughput and allocated clients per AP becomes:

- Throughput AP1 (4 clients) = 12.41 Mbps, Throughput AP2 (10 clients) = 6.47 Mbps

After the balancing, the load distribution between AP1 and AP2 is improved with 47% (figure 3).Total throughput (AP1+AP2) is improved with 24% (figure 2).

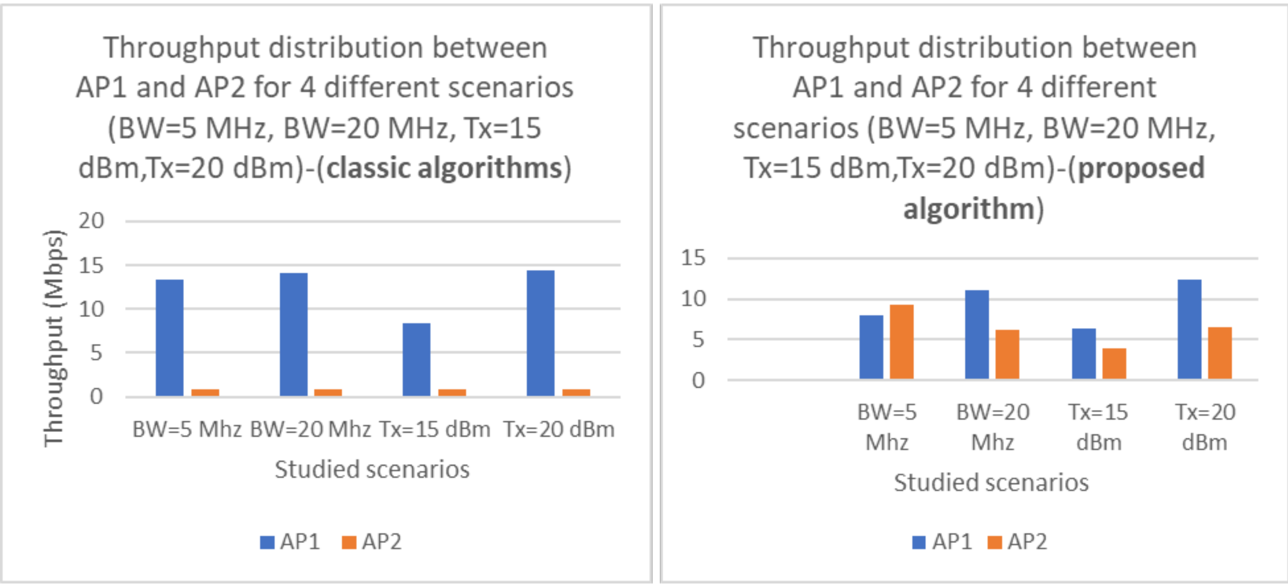

Fig. 3: Throughput distribution enhancement through studied scenarios (proposed versus classic algorithms)

V. CONCLUSIONS

The proposed signaling channel structure is used for creating a new load balancing mechanism on an “inter-cluster” layer. This mechanism includes in the algorithm acquired parameters such as throughput, Bandwidth, which are converted into so called gain and losses [4, 5]. Compared with the signaling channel of wireless commercial load balancing algorithms, having number of users as triggering criteria, the proposed algorithm presents:

- ✓ Better load distribution up to 79%
- ✓ An overall throughput improved up to 24%

The scalability of the algorithm allows to use other parameters for load balancing criteria as long as they are converted to gain and losses abstract values. The main reason for load distribution improvement is the fact that both AP and Controller are involved in the traffic analysis so the traffic load calculation is distributed. Also, the load distribution avoids the challenge of maintaining a complex database. The logic of the signaling channel is based on a specific hierarchy initially defined in these papers [4, 5].

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