Wi–Balance: SDN–based load–balancing in Enterprise WLANs

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***Abstract*—The high demand for wireless connectivity and the increase in the applications bitrate have lead to deploy denser and heterogeneous networks. However, an inefficient management of the network resources may arise poor performance and collision issues, therefore presenting a new set of challenges. In this demo, we will leverage on the Software Defined Networking (SDN) paradigm to show *Wi–Balance*, an algorithm able to achieve an effective balance of the traffic load in Wi–Fi networks with the aim of providing an optimum distribution of the network resources and improving the global performance.**

***Keywords*—SDN, WLANs, 802.11, load balance, scheduling.**

I. Introduction

Nowadays wireless networks can be found in many diverse places such as universities, hotels or airplanes. Among them, the IEEE 802.11 [1] WLANs are the most widely deployed. Furthermore, networks composed of several Access Points (APs) and a considerable number of users are becoming more common. However, in these scenarios, the unequal traffic distribution may cause performance losses.

Normally, in Wi–Fi networks, the stations try to connect to the closest AP or the one offering the strongest signal. This may lead to situations where several clients are connected to the same AP, while some other APs are idle. As a consequence, some of them may have a greater traffic volume than they could properly handle. Moreover, the collision ratio in these APs would increase, in particular, in the presence of hidden nodes. This situation would also affect the users, who would experience delays and errors in the delivery.

The problem has steadily worsened due to the growth in the traffic volume of different applications, including, for example, video or P2P services. Classical solutions to solve these issues make difficult the introduction of improvements at the radio access layer. Furthermore, they usually require to reserve a part of the resources of the network devices to carry out management strategies, which would make them less efficient upon the increasing traffic load. On this basis, Software Defined Networking (SDN) is presented to simplify the network management by decoupling the forwarding hardware from the control decisions. The network intelligence relies on a logically centralized controller that allows it to introduce high level abstractions that can be programmed via interfaces such as OpenFlow [2]. However, this protocol is not completely suitable to address the requirements of the wireless access networks and, in fact, only a few SDN–based solutions have emerged in the wireless domain [3], [4].

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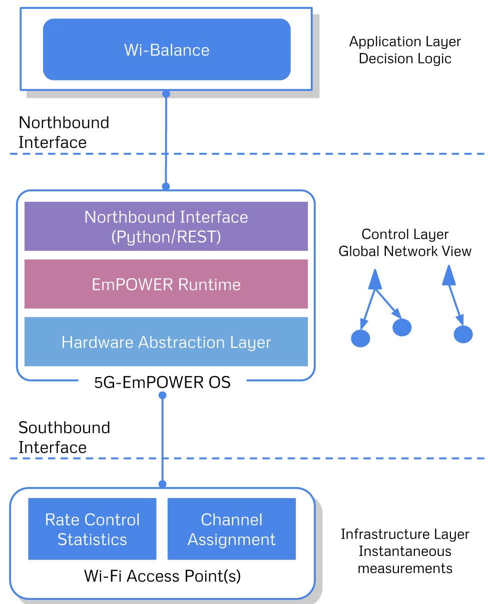

Fig. 1: *Wi–Balance* System Architecture.

In this demo we will show a new SDN approach based on the 5G–EmPOWER platform [3] to ensure an effective balance in both the applications and the users distribution. To resolve these problems, this solution provides a heuristic able to combine the requirements of the transmissions, in terms of both bandwidth and channel isolation, as well as the quality restrictions of the clients. In this way, the channel occupation ratio is reduced, while improving the performance and the quality of the applications.

II. 5G–EmPOWER

The implementation of *Wi–Balance* has been deployed on the 5G–EmPOWER platform [3]. However, it can be easily transposed to any other SDN–based architecture given that it is run as a management application that takes advantage of the network status information gathered by the controller.

In Fig. 1 can be seen how the network intelligence is shift from the network devices and decoupled into the infrastructure, control and application layers. These devices are found in the infrastructure layer and just follow the operations from the EmPOWER Runtime controller, which holds a global view of the network. Conversely, this Operating System allows the design of Network Apps through a Python–based SDK to simplify the network management.

III. *Wi–Balance* Design

Wi–Balance is designed as an Network App situated on the Infrastructure Layer of an SDN platform. This algorithm aims to perform a load-balancing of the network traffic in order to maximize the global performance and reduce the interference and the number of collisions in the network.

To achieve the target, the algorithm follows a strategy that allows it to converge to the optimum network distribution. In this regard, *Wi–Balance* gathers the information related to the ongoing transmissions and the channel status of the clients in the network from the rate control algorithm running in the APs. In our case, we have used the Minstrel [5] algorithm, which is presently available in the Linux kernel. This information is periodically obtained by the controller and analyzed by the algorithm in order to identify possible performance drops and poor quality reception.

After a deep information analysis in search of potential collision zones, the application first estimates the number of concurrent transmissions in the same AP. In this case, it evaluates if the handover of a client connected to one of these affected APs to another available one (and offering a proper signal quality for the client) may isolate the flows and improve the performance. By contrast, if an idle AP is not found, the clients may be redistributed in order to provide balance and fairness according to the bitrate of the applications. However, the collision domain problem could still remain and be caused by transmissions in different APs using the same channel. In this situation, the algorithm intends to perform a channel reassignment of the involved APs. Notice that due to the use of Light Virtual Access Points (LVAPs), available in the 5G–EmPOWER architecture, the client information can be transparently shifted between APs without losing the connectivity. This architecture uses the LVAP concept introduced in Odin [4] in order to allow transparent handovers.

IV. Demonstration

In this demo we will show how *Wi–Balance* is able to balance the network traffic and the clients distribution according to the ongoing transmissions bitrate. In Fig. 2 the deployment used for the demo scenario is presented, which is composed of the 5G–EmPOWER controller, two Wireless Termination Points (WTPs), WTP_1 and WTP_2, and a group of clients, Cl_1-Cl_3. Notice that WTP is the term used by the 5G–EmPOWER platform to refer to an AP. Some of the clients receive a downlink flow from the WTP to which they are currently associated. In this scenario the bitrate, and starting and finishing times of the transmissions may differ.

Initially, the clients Cl_1 and Cl_2 are attached to the WTP_1, whereas the client Cl_3 is connected to the WTP_2. Both WTPs operate at the beginning in the same channel, regardless of the band type. The clients Cl_1 and Cl_2 receive a downlink flow from the WTP_1, while there is no traffic targeted to the the client Cl_3. This intends to demonstrate how the transmissions bitrate cannot be the only input for an appropriate balancing heuristic and also other factors must be considered.

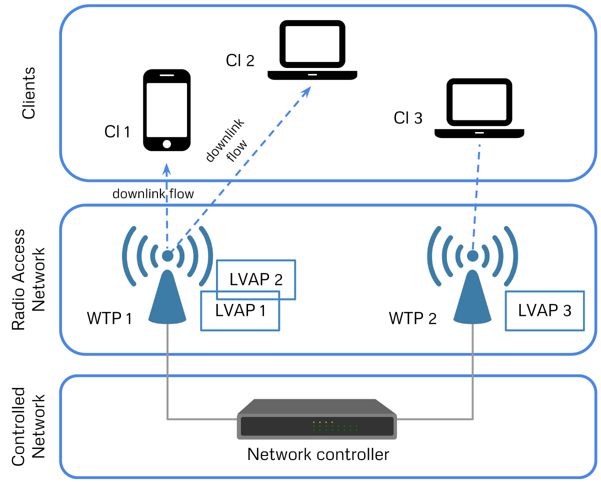

Fig. 2: *Wi–Balance* System Demonstration Deployment.

On this scenario, a handover of one of the two active clients is performed to the WTP_2 with the aim of balancing the network traffic load and increase the transmissions performance. However, the flows will still share the collision domain, and hence, the throughput issues will not be addressed. After that, a channel switch is carried out in order to isolate the flows. Nevertheless, when at least one of the transmissions is finished, the algorithm updates the network configuration, and reverts the previous handover given that the traffic load is again balanced and it allows the aforementioned client to perceive a stronger signal quality from the first WTP.

Acknowledgment

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