MU-MIMO throughput Enhancement for Enterprise Networks

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1. INTRODUCTION

Multi-user MIMO (MU-MIMO) introduced in the 802.11ac amendment came to the market through products like iphone 6 and Nexus 6. However, they can only support 2x2 MIMO instead of the 8x8 proposed by the amendment. MU-MIMO support depends on the sounding process to gather channel information before every transmission. This information is used to build channel matrix in order to minimize interference between multiple devices.

Sounding process starts by sending a null data packet announcement (NDPA) followed by NDP from the AP to tell the devices in range to get ready, then send a set of Beamforming Report Poll (BF-P) frames to inform each device when to reply with his channel information. The devices then reply with a Beamforming Action Frame (BF-R). AP uses this information to build the channel matrix used to deliver messages to devices with minimal interference [2]. Sounding process is measured to occupy $\approx 70\%$ of the air time without frame aggregation, and $\approx 40\%$ with frame aggregation [1].

Enterprise networks with multiple overhearing APs interleave their sounding processes. APs sends their NDPAs and NDPs in order, then start receiving feedback each device to his AP. This process shows a lack of coordination between AP, that leads to higher processing periods. Our work proposes a solution for this problem.

2. ENHANCED SOUNDING PROCESS

We are proposing a collaborative sounding process to support MU-MIMO that complies with 802.11ac. In an enterprise environment it is very likely to have a dense deployment of APs with ethernet connection between them. We are proposing a system that uses the background ethernet communication to exchange messages in order to save some control packets in the 802.11ac sounding process (i.e NDPA, and NDP).

APs location setup differs according to the enterprises' floor plans, they can be either overhearing or not. The dynamic nature of clients (e.g. smartphones, laptops) will result in three scenarios: APs and clients are overhearing, APs only are overhearing, and not all APs are overhearing. To design an efficient sounding process we need to handle all these scenarios, given that the 802.11ac amendment is only concerned with how a single AP can handle its clients.

Scenario1 APs & Clients are overhearing: Since both APs and clients are overhearing we can utilize the interconnection between APs to establish AP collaboration, APs can share their associated users information selecting an AP called m-AP (manager-AP) to broadcast both NDP-A, and NDP to all available clients. m-AP after receiving all its clients' BF-R can select other APs in turns to send BF-P to their clients. This approach saves redundant sending of control packets NDPA, and NDP decreasing the time used by control messages.

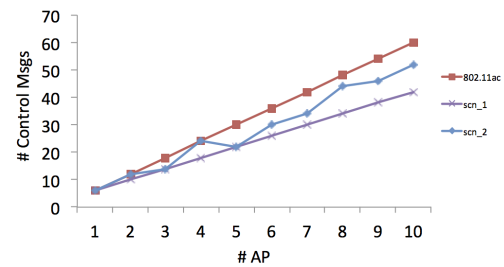

Figure 1: Sounding Overhead

In reality not all APs and clients are overhearing which leads to the next scenario where APs are overhearing and clients not.

Scenario 2 APs only overhearing: Our main goal is to avoid redundancy in sending sounding process control packets. In this scenario we select the minimum number of APs that can cover the clients to sounded, given that 8 is the maximum number of clients 802.11ac allow the AP to serve.

AP selection is the result of a collaborative work between interconnected APs sharing their clients' information forming clusters of APs and clients, each cluster will perform its own sounding process. Details were omitted for space limitations.

Scenario 3 Not all are overhearing: In a large scale network not all APs overhear each other, the proposed approach is meant to be scalable. Hence, AP inter-connection is used to dynamically cluster APs willing to communicate. These clusters will be in the form of one of the two previous scenarios. Furthermore, clusters can use CSMA between them to avoid collision that might decrease the overall throughput of the network.

3. PRELIMINARY RESULTS

Fig.1 depicts the number of control messages required for the sounding process based on the AP density. The plot shows the difference between 802.11ac sounding process compared to our protocol. It is clear that scenarios 1 (scn_1), and 2 (scn_2) outperforms the standard one.

Meanwhile, we are building a testbed to express various components of 802.11ac and enhance network collaboration.

4. REFERENCES

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