Poster: *Twirl*: On the Benefits of Adapting Orientation of a WiFi Access-Point

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1. OVERVIEW

The position of a wireless access point (AP) in wireless networks has been found to have a considerable impact on the overall network performance in indoor scenarios. Recent work has investigated the impact of the AP's location on the received signal strength of clients [1], and has shown that a 1.7x throughput improvement can be achieved by simply moving the AP in a 2ft. x 2ft. region. The benefits of small scale AP mobility is chiefly caused by mitigating multipath effects. In fact, the multipath effect has a significant impact on network performance, and can be dramatically altered even with mere centimeter level movement of a Tx or a Rx. In this work, we investigate how network throughput performance can be improved if the AP *is able to adapt its orientation*. We consider two types of orientation changes - that of the AP's base platform (base orientation), and that of its antennas (antenna orientation). We show using experimental analysis that network throughput performance can be improved 1.8x by simply adapting AP's orientation.

2. EXPERIMENTAL SETUP

To validate the impact of AP orientation on network performance, $three$ different environments are studied; namely, a research lab, a home, and a classroom. In each environment, we measure the throughput performance for a single AP and a single client (on weekends or at nights to reduce the impact of interference). The specifications are as follows: AP - *Netgear AC 2350*; Client - *Lenovo Y700*; Traffic Direction - *Downlink*; Channel between AP and its client - *NLOS*; WiFi type - *802.11ac*; Duration - *20s * 3*; Throughput Measurement tool - *Iperf3*. The metric used is the *Average Gain*, which is the ratio of the maximum throughput to the average throughput.

3. ANALYSIS AND INSIGHTS

Impact of Base Orientation: We evaluate the network performance with 12 different base orientations that are obtained by rotating the AP with a 30° step size belonging to the set: {0°,30°,...,330°}. From Fig. 1, changing only the base orientation can improve the network performance up to 1.5x. Also, it is clear that the performance improvement varies across the different scenarios. This can be attributed to the fact that multipath is very site-specific.

MobiSys'17 June 19-23, 2017, Niagara Falls, NY, USA

ACM ISBN 978-1-4503-4928-4/17/06.
DOI: http://dx.doi.org/10.1145/3081333.3089318

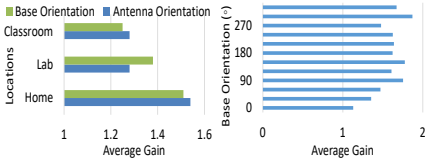

Figure 1: Base vs. Antenna Orientation

Figure 2: Joint Orientation

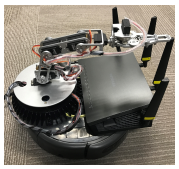

Figure 3: Robotic Platform

Impact of Antenna Orientation: There are 4 antennas, and each antenna has a 45°or a 90°antenna orientation configuration; there are therefore 16 different antenna orientation configurations for which the network performance is investigated. Similar to the results of changing base orientation, changing the antenna orientation is capable of improving the network performance up to 1.5x as shown in Fig. 1.

Impact of Joint Orientation (Twirl): The impact of changing both the antenna and base orientation, defined as *Twirl* orientation, is also evaluated. We evaluate the network performance in the lab environment with 12 different base orientations, and at each base orientation, we evaluate 16 different antenna orientations; for a total of 192 different configurations. The average gain is calculated as the ratios of the maximum throughput of all 192 configurations over the average throughput for each base orientation. Fig. 2 shows that Twirl can deliver network performance improvement of up to 1.8x.

Summary: The results show that the network throughput performance can be improved by as much as 1.8x through simply adapting the orientation of the AP. This is comparable to the improvement achieved by AP relocation [1]. This indicates that multipath effects can be mitigated without physically relocating the AP using large-scale movement. The results also indicate the promising potential of orientation adaptation of AP.

4. ROBOTIC PLATFORM

We show a possible platform for Twirl in Fig. 3. Base orientation can be achieved using *iRobot Create 2*, which can be programmed to rotate and move in a specific trajectory in a 2D space. Antenna orientation can be achieved using *Global Specialties R700 Robotic Arm*, which is a 6 degree-of-freedom programmable robotic arm.

5. ACKNOWLEDGEMENTS

This work was funded in part by the National Science Foundation under grants CNS-1513884 and CNS-1319455, and the Wayne J. Holman Endowed Chair.

6. REFERENCES

[1] M. Gowda, A. Dhekne, and R. Roy Choudhury, "The case for robotic wireless networks," in *Proceedings of International Conference on World Wide Web*, 2016, pp. 1317–1327.