Extending Cell Tower Coverage through Drones

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1. INTRODUCTION

This poster explores a future in which drones serve as extensions to cellular networks. Equipped with a WiFi interface and a (LTE/5G) backhaul link, we envision a drone [1] to fly in and create a WiFi network in a desired region. These drones can offer on-demand network service, alleviating unpredictable problems such as sudden traffic hotspots, poor coverage, and natural disasters. While realizing such a vision would need various pieces to come together, we focus on the problem of "drone placement".

Our system, *DroneNet*, uses 3D models of the buildings in an area, and then simulates how signals would scatter [2] from the drone to various clients. While such simulations offer coarse-grained results, we find that they can still be valuable in broadly guiding the drone in the right direction. Thereafter, the drone can physically move in a reduced search space to quickly select the best hovering location.

Figure 1 illustrates the challenges in finding the best hover location amongst multiple possibilities. Observe that moving closer to the ground improves client proximity, however, the multipath and shadowing effects get severely exacerbated. Moreover, the line of sight (LOS) to the cell tower also gets disrupted. Moving vertically higher offers better LOS to clients and the cell tower, at the expense of longer distance to the clients, reducing data rates. Lateral movements also pose tradeoffs—the left and right-most positions in the Figure 1 both offer LOS paths to only one of the clients.

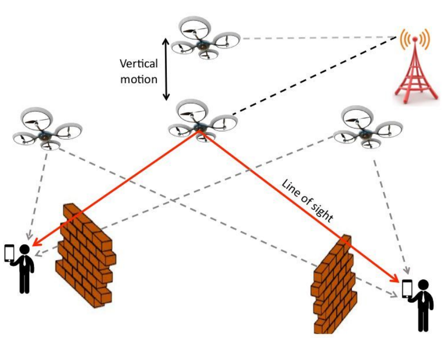

Figure 1: Drone locations present tradeoffs

2. OUR SOLUTION

Given a set of client locations and the terrain model, *DroneNet* first runs a low fidelity, light weight ray tracing [3] simulation to compute SNR at each client as a function of drone location producing a 3D heatmap (Figure 2(a)). We observed promising correlation between the simulations and actual measurements taken during drone flights (Figure 2(b)).

DroneNet then conducts a quick scan of physical measurements around the regions of high throughput in the heatmap determining the best location to hover.

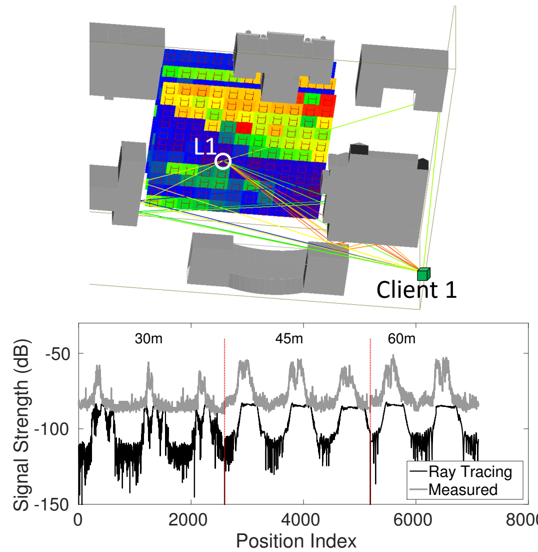

Figure 2: (a) 3D SNR heatmap (b) Ray tracing simulations generally agree with actual measurements

3. RESULTS

Measurement results from a WiFi [4] mounted drone, communicating with 7 clients scattered in the UIUC campus, are encouraging. Figure 3 quantifies throughput gains over a random drone location. *DroneNet* gain varies from $1.2x$ to $4.2x$ across various clients. Since we are using only coarse building models, simple ray tracing falls short of the best possible gains (the *Oracle*). However, *DroneNet*'s quick local search achieves gains reasonably close to those of the *Oracle*.

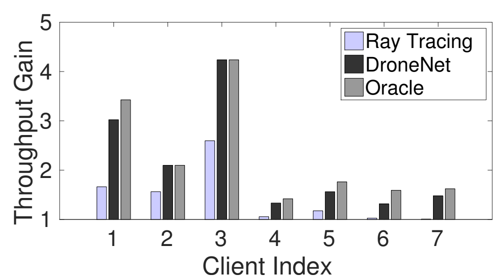

Figure 3: *DroneNet* gains are comparable with the *Oracle*

We see definite promise in this approach, though, a lot needs to be done to take this idea to fruition.

4. REFERENCES

[1] "3d robotics - x8+ drones." https://3dr.com/wp-content/uploads/2016/02/X8-Operation-Manual-vC.pdf.

[2] "Wireless insite." http://www.remcom.com/.

[3] Z. Yun and M. F. Iskander, "Ray tracing for radio propagation modeling: principles and applications," *IEEE Access*, 2015.

[4] "Securifi almond." https://www.securifi.com.