60 GHz Modeling Study for an Access Point in a Residential House

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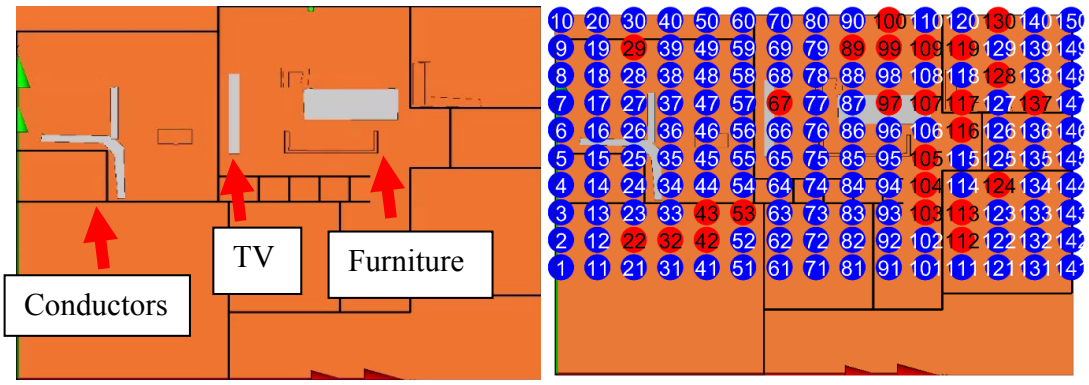
With the advancement of technology, there is an increasing need for the ability to transport large amounts of data. Commercial Wi-Fi typically uses 2.4GHz or 5GHz. While those bands have maximum bandwidths of around 240 MHz and 600 MHz respectively, they are still too narrow if there are more than a few users with 4K high definition videos or virtual reality systems on the same network. Some of the newer 5G cellular systems utilize 60 GHz technology. A network using this resource can increase the bandwidth by over 10 times. The problem with this 60 GHz system, however, is the propagation range of the router. As frequency increases, the wavelength becomes shorter and decreases the practical range for power reception. Ideally, whenever a 60 GHz system needs to be installed, one should test every potential position and direction for optimal coverage.

In this paper, an exhaustive search of received signal strength indication (RSSI) with 150 positions for access points (AP) evenly spaced throughout the ceiling of a residential, two-story model house (slightly larger than the US average) is performed in simulation. The model house has metal conductors in the kitchen representing the appliances and a TV. A wide range of furniture is tested using the same calculation model, which consisted of a maximum of 5 reflections, 4 transmissions and 1 diffraction. A convergence test is preformed to ensure that this model is accurate, and that there is little influence from the furniture. Figure 1(a) shows the layout with the appliances in the upper left corner. Every AP is pointed towards the center of the living room. The receivers are placed as a grid through the floor plan to test power levels. The reception level threshold for signal input is measured to be -87.5 dBm for RSSI, which corresponds to 1 Gbps data rate. After running the simulation, 25 locations are found to have full coverage, their locations are found in Figure 1(b) and are represented by red circles. This means that every receiver location is above -87.5 dBm for 1 single high-mounted 60 GHz AP Transmitter, and thus have a bandwidth greater than 1 Gbps. The optimal position has a minimum received power of -80.4 dBm, which is significantly higher than the minimum threshold. As seen in Figure 1(b), the likelihood of a position to have full coverage increases as the position moves further away from the conductor as opposed to being in the center. Also, there are few walls between the receivers. This implies that there is a balance between the distance from the conductor and the number of walls that are traveled through.



(a) (b)

Figure 1. Model of the residential house (a) without AP locations, and (b) with AP locations.