Wireless channel sounding

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In recent years, the use of smart phones, tablets, smart watches and other wireless devices has increased dramatically. The way that mobile devices are used have also changed, from previously being used for only voice calls and text messaging, cell phones are now also used for eg. web browsing and video streaming. This has resulted in that the wireless systems that are used have seen an major increase in both the number of users and the amount of data each device uses. Since older systems, such as GSM or 3G, don't have enough capacity to handle the increase in traffic, newer systems, such as 4G, have taken their place. One technique that is becoming increasingly more common is to use multiple antennas at both the receiver and the transmitter, which can increase the data rate for eg. cell phone networks or WiFi networks. This technique is referred to as MIMO (Multiple-Input Multiple-Output).

When radio signals are transmitted between antennas, these signals will be distorted in different ways, depending on the environment they travel through. If they operate on the same frequency, different wireless systems can interfere with each other. Also, since it is common for an antenna to transmit in many directions at once, the transmitted signal can take many different paths to the receiver. This leads to that the receiver receives multiple copies of the transmitted signal with different delays, as seen in Figure 1. If either the transmitter or the receiver is moving, the frequency of the signal will change due to the Doppler effect. These distortions are generally referred to as the wireless channel.

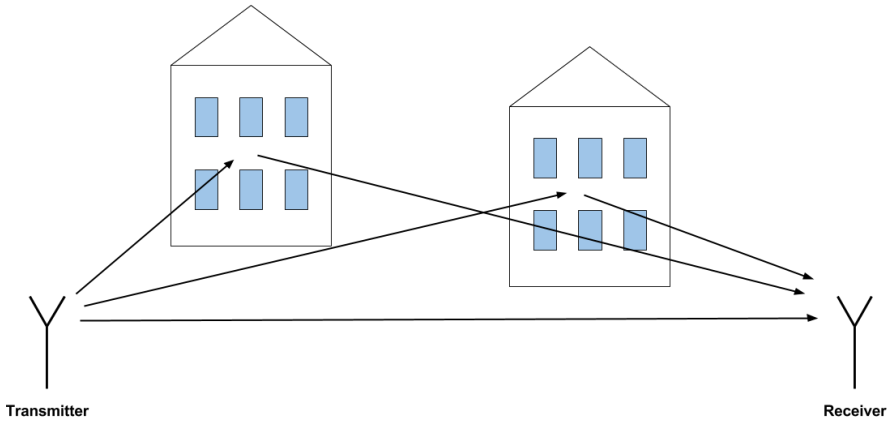

Figure 1: Transmitted signals being reflected by objects in the environment.

When designing, eg. the next generation cell phone network, it is necessary to know how the wireless channel will impact the transmitted signal in the environment that it will operate in, eg. in an urban environment or a forest. This makes it possible to take the appropriate measures in the design stage of the system so that it will work once it's deployed. In order obtain this knowl-

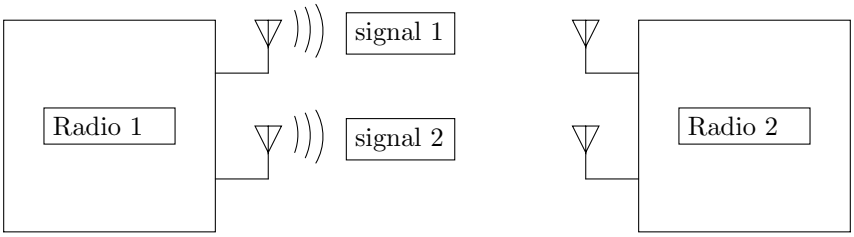

Figure 2: Visualization of the MIMO channel sounding process

edge, measurements can be carried out in those environments prior to designing the wireless system, and one type of measurement that can be performed is known as channel sounding. The idea of channel sounding is quite simple. The transmitter transmits a specific sequence of numbers. The receiver receives the transmitted sequence and compares the original transmitted sequence to the received sequence. The difference in similarity between them is the estimated wireless channel. This information can then be used to get an overview of how the channel behaves, which is useful when designing wireless systems.

In our thesis we have implemented a channel sounder for MIMO systems with two antennas at the transmitter and two at the receiver. The equipment we used was two radio transceivers with programmable hardware, which allowed us to perform the processing of the received signal needed at the receiver in real time. We were able to obtain satisfying measurement results, which would make it possible to use our implementation in the type of measurements described in this article.