# Analysis WSN Localization

## Setting

Our tests will be done in two different locations. An indoor and an outdoor location. The indoor tests will be done in a living room. This presents us with an environment with a considerable amount of multipath and shading effects. Laptops and Bluetooth equipped GSMs will be turned on to provided some interference on the radio channel.

Nodes will be randomly distributed as compared to regular topologies.

The outdoor test will be done on a local basketball court. Interference, multihop and shading will be much less than in the indoor setting. Nodes will put at an elevated position of about 1 meter. Again, nodes will be placed in an irregular topology.

The difference between these two tests will hopefully demonstrate the impact of environmental effects on our algorithms and show which one is more robust.

## Position ERROR

Question: how do we measure the absolute and/or relative position error?

Answer:

* The absolute position error is calculated by subtracting the real position from the estimated position
* The relative position error is more complex, the main question here is what should be taken as the range?
  + The average range from the actual position of the blind node to the anchor nodes is taken. This range is divided by the absolute position error to calculate the relative position error.

## Antenna

We will test the influence of the external antenna on the RSSI. We will measure the RSS while rotating the node. Samples will be taken at every 10 degrees. This will be measured at two distances: one meter and five meter.

The purpose of the experiment is to prove the effect the onboard antenna has on the orientation of the node. By equipping the nodes with external, more omni-directional antennas we hope the RSS measurements will be more indifferent towards node orientation. The orientation will still be restricted to a single plane as the external antenna does not transmit its power in a spherical shape but more in a donut-like shape.

**X-axis:**

* Orientation in degrees

**Y-axis:**

* RSS

**Plot:**

* 1m
* 5m
* [Other distances]

## Filtering

This will be a rather small test. We will test the difference in accuracy depending on the selected filtering & the amount of samples taken. So the Y-axis will plot the accuracy. The X-axis will be plot the number of samples. Different graphs will be plotted for each ranging/algorithm combination.

Question: Plot this in the graph of the next test or in a dedicated graph? (This would lead to a total of 12 graphs on a single plot, this is perhaps a bit too much)

## Main graph: Trilateration & Min-Max, Centroid Localization

We will evaluate our own implementation of these two algorithms. On the y axis we will plot the relative position error as described in the first section. The mean and the standard deviation of this parameter will be plotted.

On the X-axis we will show three different parameters. These are: amount of anchor nodes, network density (expressed in nodes/meter), node spreading (expressed in meters).

This test will be performed in two environments. (indoor/outdoor) TODO: Describe these settings.

## Propagation model calibration

When anchor nodes are in reach of each other we can measure the RSS between them. With this measurement we can evaluate the propagation model in use. This model has two important parameters, np and Pd0. Because we know the distance between the anchor nodes we can extract these parameters from the propagation power-loss formula.

Doing so, we hope to adapt our model to the environment. However this can lead to negative results when the anchor node is located in a space different from the rest of the environment. Our calibration algorithm will need to account for these outliers. The exact implementation is yet to be determined.

We will test this algorithm on min-max and trilateration. This will be tested in different environments as the effects of this algorithm differ on the used setting. Finally we should conclude the positive or negative effects of this algorithm on the positioning accuracy/error. Results will be plotted for each node as the local environment is different for each node. This could be done by plotting the variance as well.

It could be worthwhile to test for the X-parameters of the main test, as this feature will probably be heavily dependent on network topology/density.

## Multihop

Our two range-based algorithms supported multihop localization. Now, what does this mean? When a blind node is in range of three nodes with known positions (not necessarily anchor nodes, this will be explained shortly hereafter), the node becomes a virtual anchor node as well (VAN). As of that moment the node will start broadcasting to other blind nodes as well.

The user can then choose whether he or she wants to use the localization data from these VAN’s. If the user decides to use this feature and there are less than three *real* anchor nodes available the localization algorithm will use the data from the VAN’s.

You may wonder why this data is not used at all times. Our hypothesis is that VAN’s always have less accurate localization data than AN’s. Thus, ANs are the preferred nodes to use. Augmenting them with VANs would only decrease the quality of the data. This statement however has yet to be verified.

In this test we will evaluate the usefulness of our multihop implementation. The relative accuracy and amount of BN’s that could be positioned will be tested. When the accuracy is acceptable, this will surely be a useful feature.

X-axis:

* Relative position error

Y-axis:

* Amount of VANs