WirelessLab WS 2016/17

Assignment 3: Tools of the Trade - Data processing and Performance Evaluation

Group - 6
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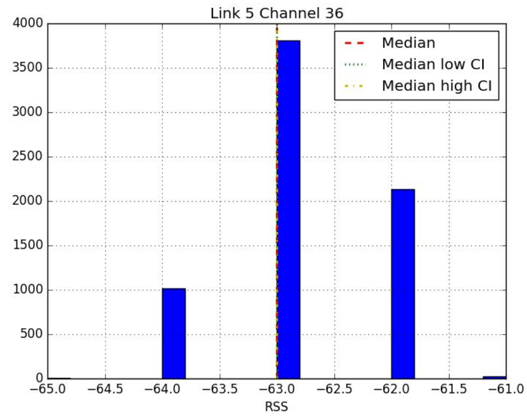
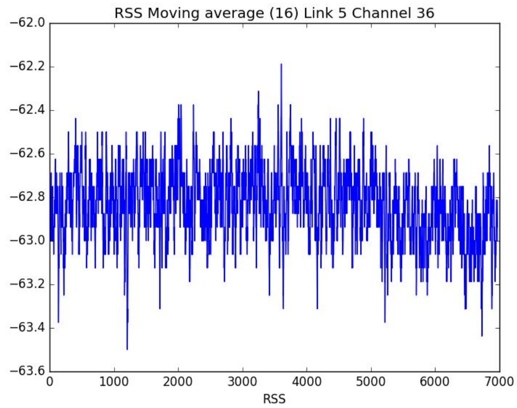
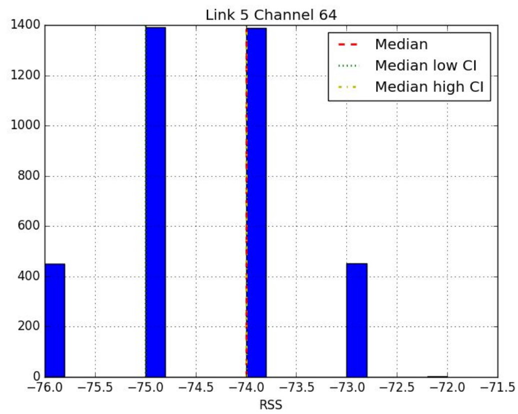
a)

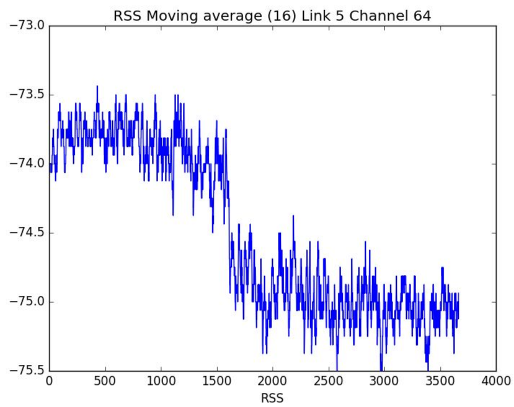
For the links 5, 14 and 35, for channels 36, 64 and 165, plot the following:

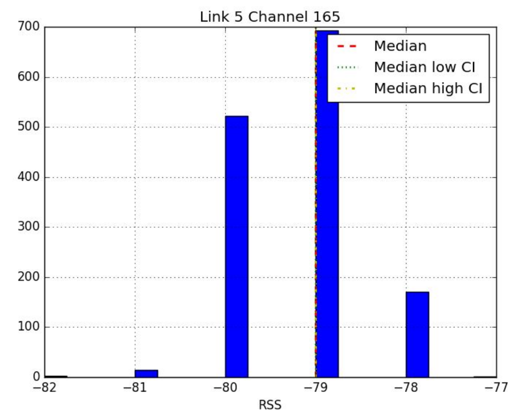
- A histogram of the RSS with the median and its confidence interval. Please make one plot for each combination, so nine plots altogether.
- A moving average (with window length of 16).
  Please make one plot for each combination again and put it next to the histogram

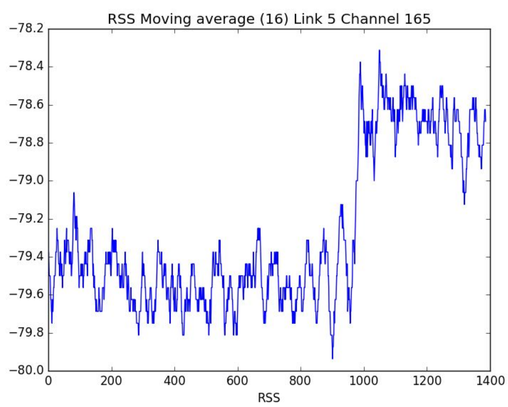


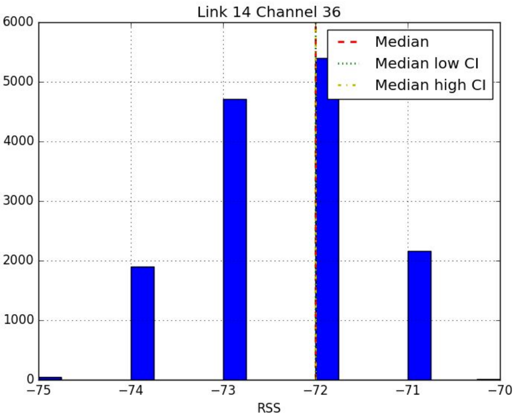


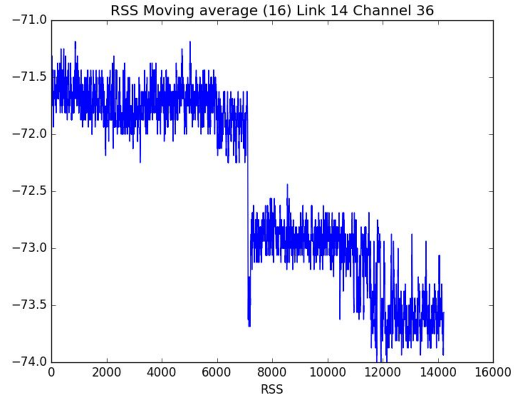


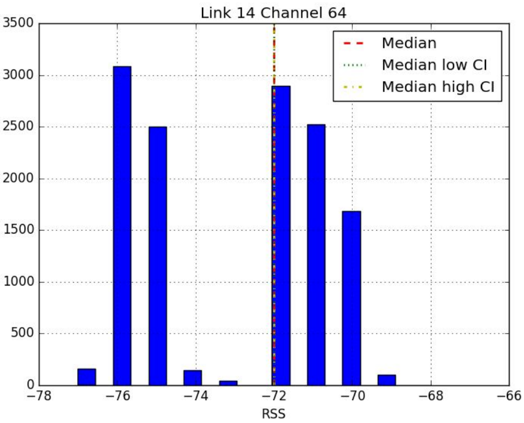


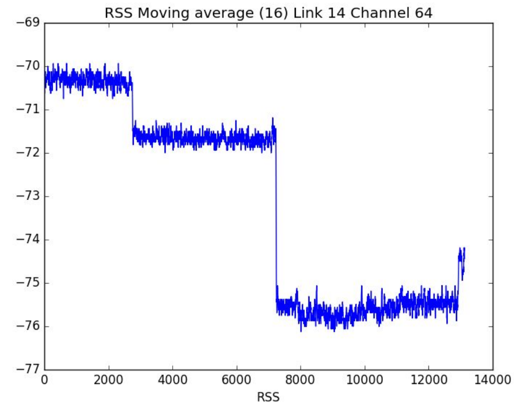


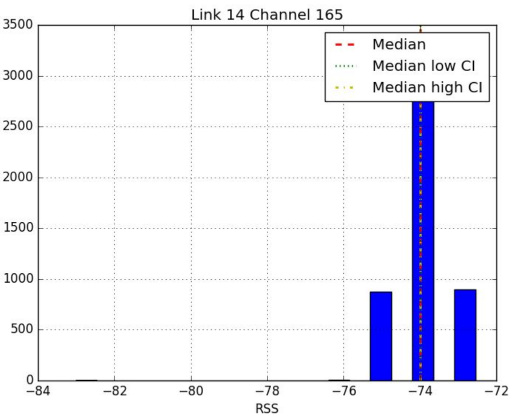


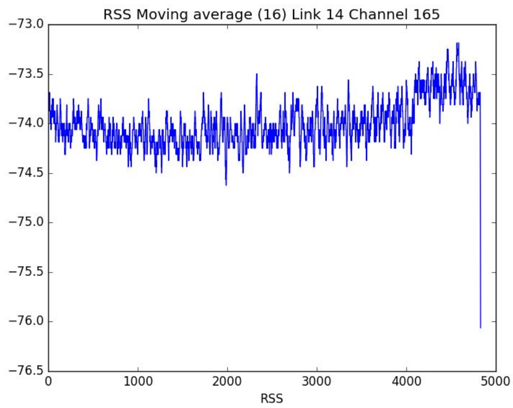

Link 14 Channel 36
Median
Median low CI
Median high CI
RSS

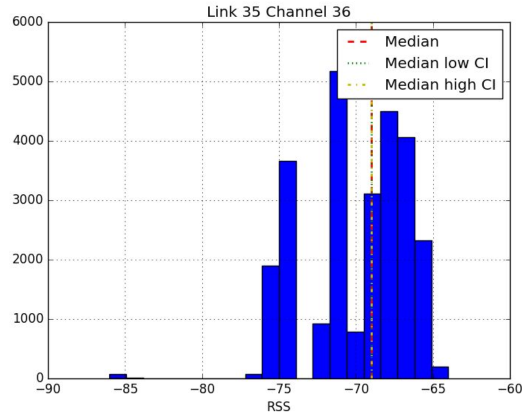

RSS Moving average (16) Link 14 Channel 36
RSS

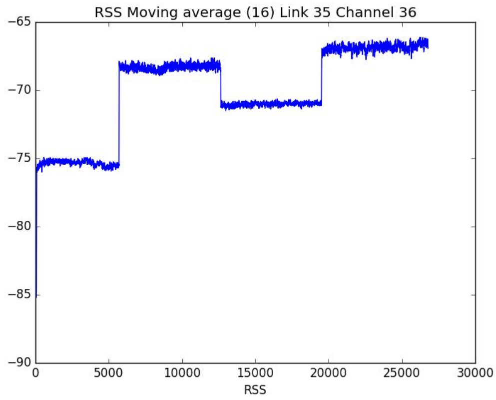

Link 14 Channel 64
Median
Median low CI
Median high CI
RSS

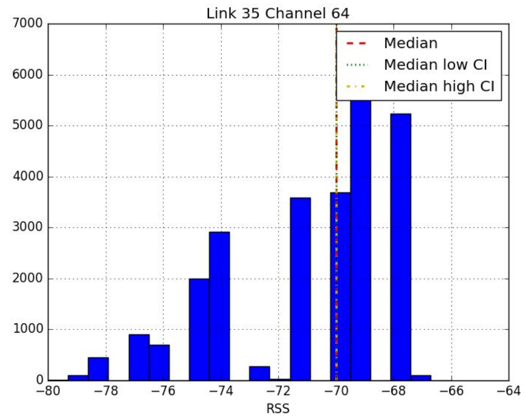

RSS Moving average (16) Link 14 Channel 64
RSS

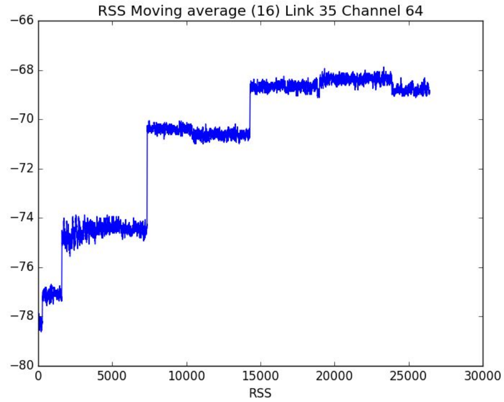

Link 14 Channel 165
Median
Median low CI
Median high CI
RSS

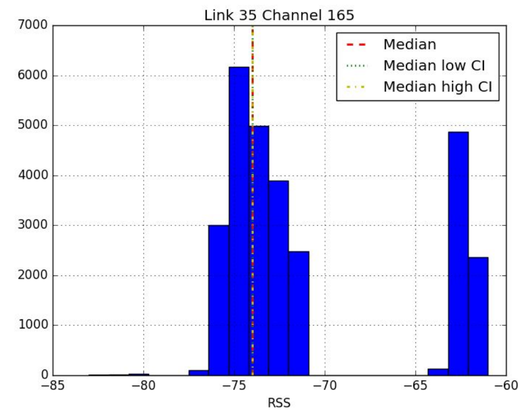

RSS Moving average (16) Link 14 Channel 165
RSS

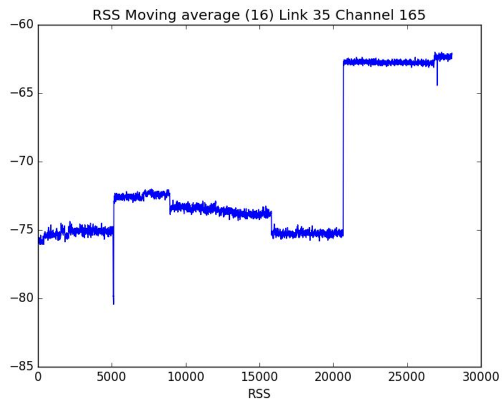

Link 35 Channel 36
Median
Median low CI
Median high CI
RSS


RSS Moving average (16) Link 35 Channel 36
RSS

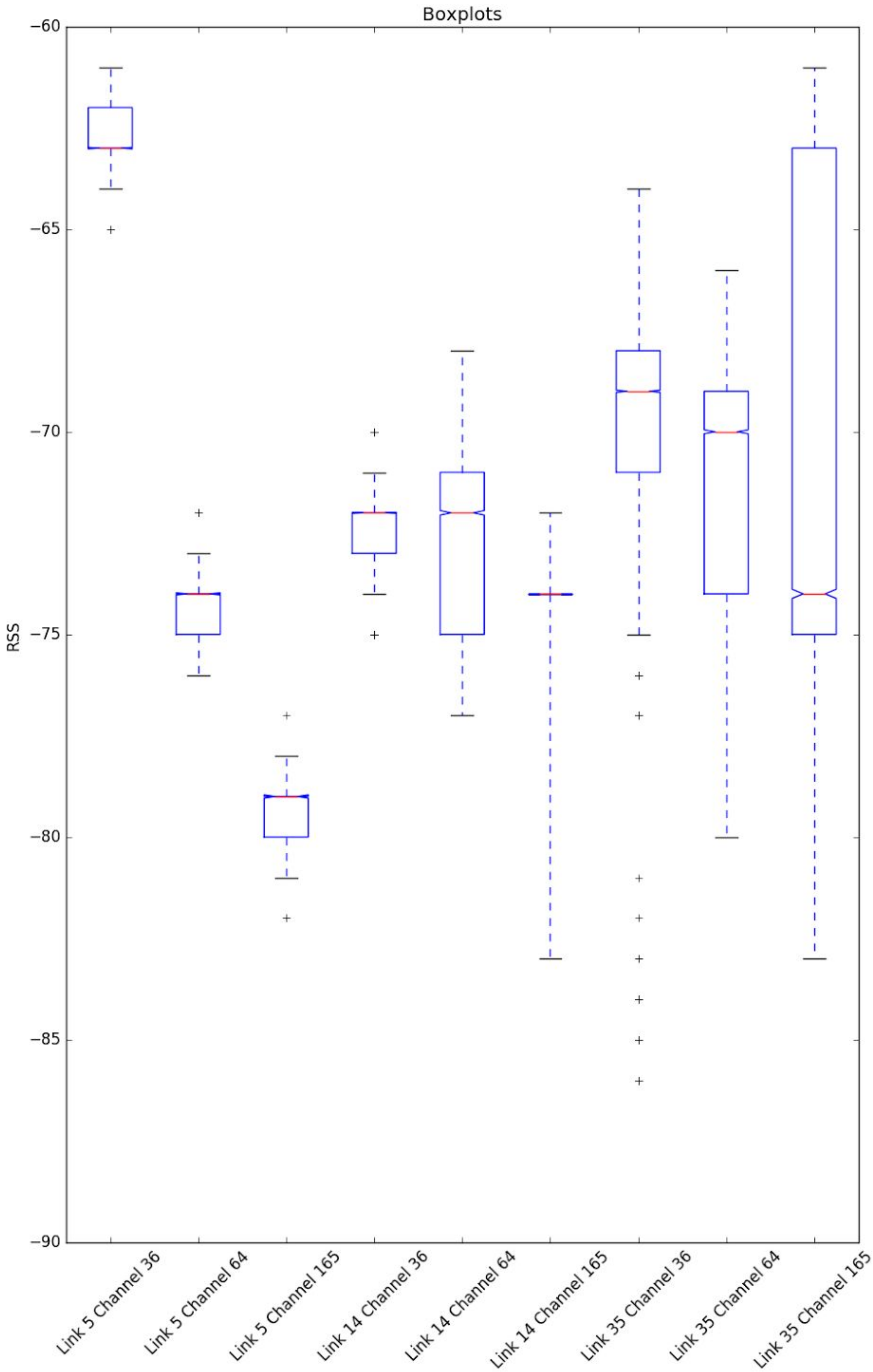

Link 35 Channel 64
Median
Median low CI
Median high CI
RSS


RSS Moving average (16) Link 35 Channel 64
RSS


Link 35 Channel 165
Median
Median low CI
Median high CI
RSS


RSS Moving average (16) Link 35 Channel 165
RSS

- A single boxplot that shows all nine combinations next to each other.



Which link is the best, which one is the worst? What else can you see in the plots?

It is hard to say which link is the best and which is the worst, as that depends on our needs and channel availability. On each channel, link 5 appears to be most stable, while link 14 appears to be most stable across all 3 channels. Link 35 has distinct jumps of RSS value through time. The reason for those jumps could be different power modes of transmitter or something similar.

If we can pick the channel, link 5 on channel 36 is the best, on the other hand if there is a possibility that we could need to switch to channel 165, link 5 becomes the worst option. Link 35 could be the best performer across all three different channels, but it’s quite unstable in time. Link 14 is quite good, with good consistency across different channels, but it doesn’t have the lowest nor the highest RSS values.

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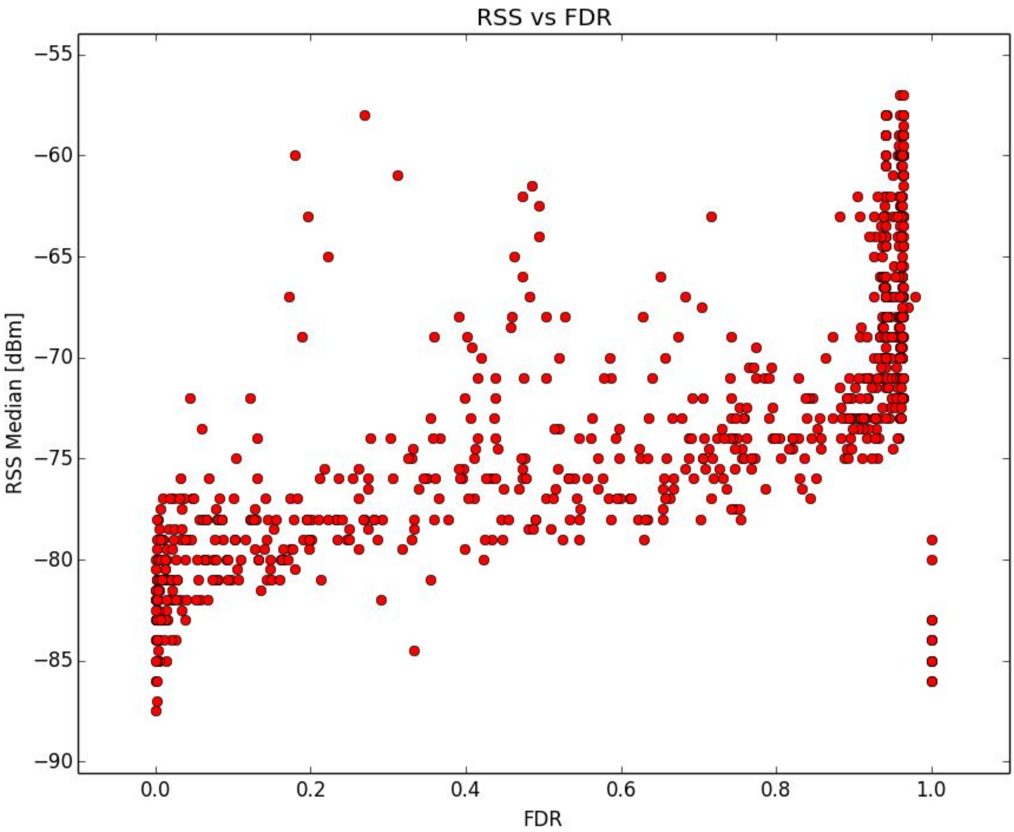
b)

For each combination of link and channel (yes, that means 1014 combinations, 78 links and 13 channels), compute the MAC frame delivery ratio and the median RSS.

Now make a single plot in which each data point corresponds to one combination's median RSS versus the delivery ratio for this combination.

What observations about the performance can you make? Can you explain them?



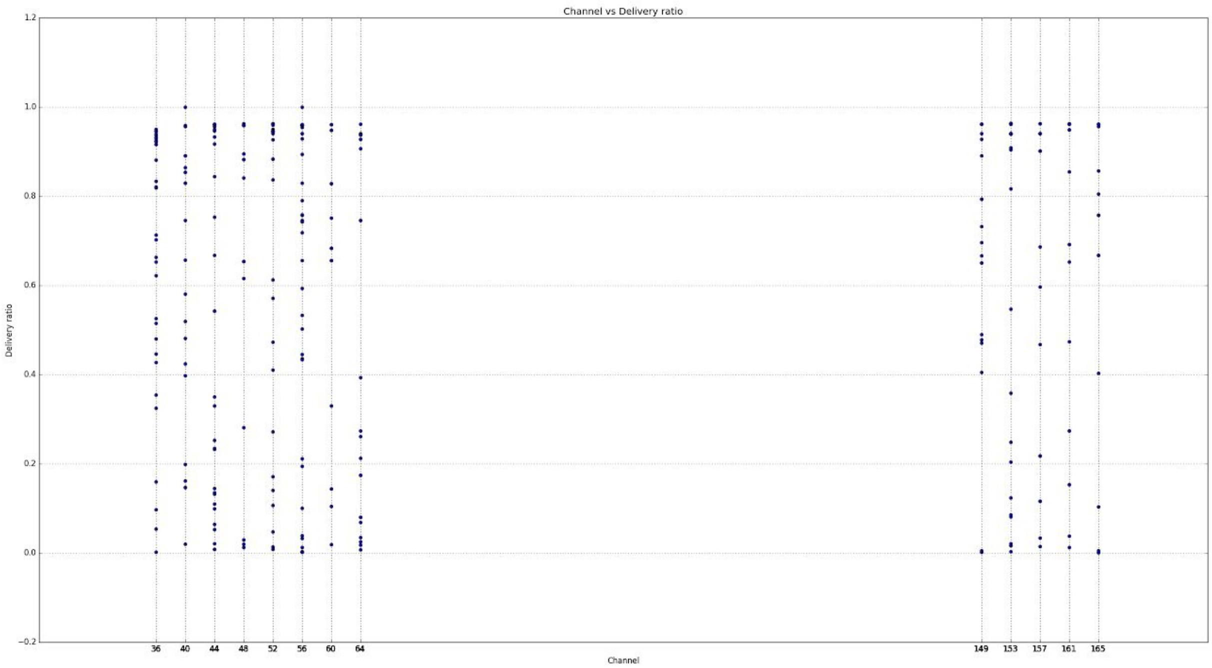
This plot shows the correlation between the RSS Medians and the FDR (Frame Delivery Rate). Each Point represents the combination of 78 links and 13 channels. A FDR of 1 means that all frames were delivered, whereas 0 means no frame was delivered. On the y-axis the RSS indicates the signal strength captured by the wireless hardware. Lower values are more influenced by noise and therefore are more prone to transmission errors.

For RSS values higher than -73 dBm the FDR is mostly over 90 %. From -73 to -78 dBm the FDR is spread over the whole range. Mostly all data points below -78 dBm have a FDR of less than ~8 %. The points don't show a linear proportional correlation between FDR and RSS but a jump within the range of -73 and -78 dBm RSS.

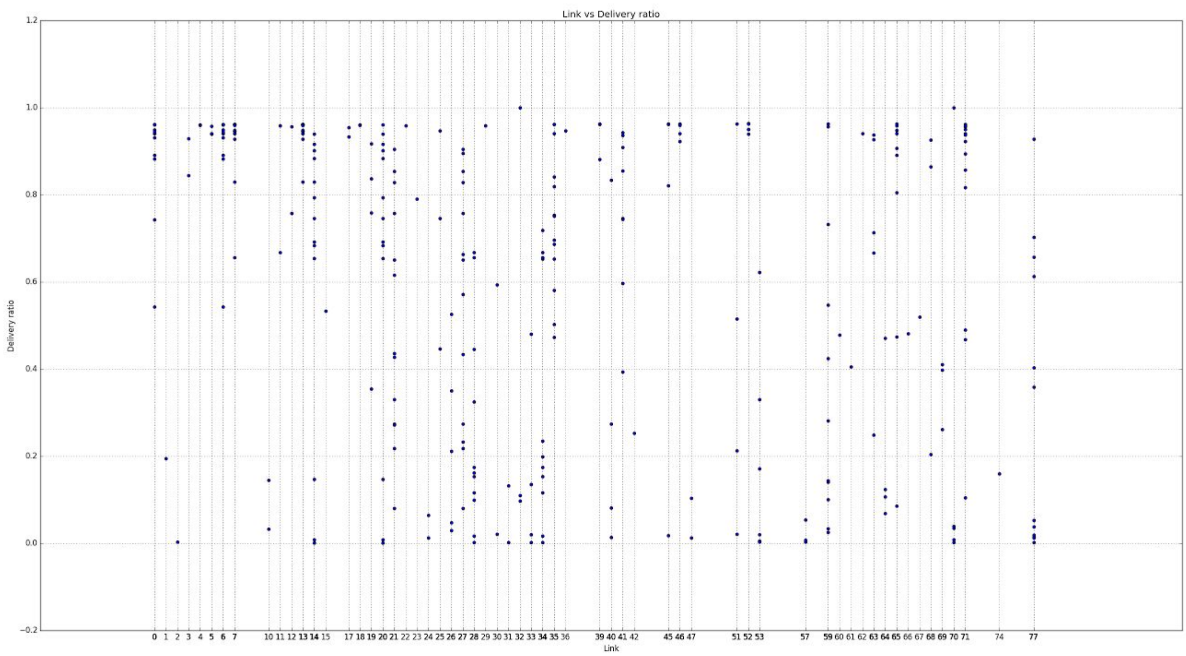
There are some exceptions from that observation. That are in particular points that have a good signal strength but bad FDR. Those links or channels might be subject to a higher external noise, that is not visible in this plot. Even if the signal strength is reasonable enough factors like interfering Bluetooth waves can have a noisy impact on the signal.

c)
Plot

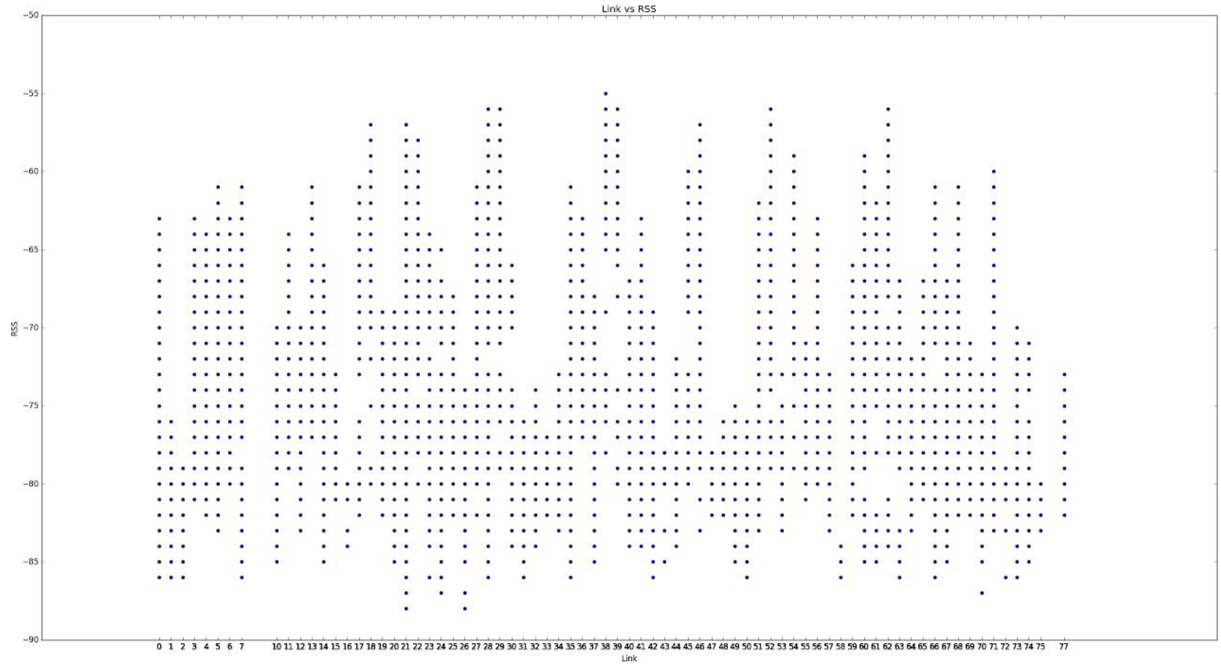
- the channel versus all corresponding delivery ratios, i.e., you have the channel number on the x-axis and delivery ratios on the y-axis.



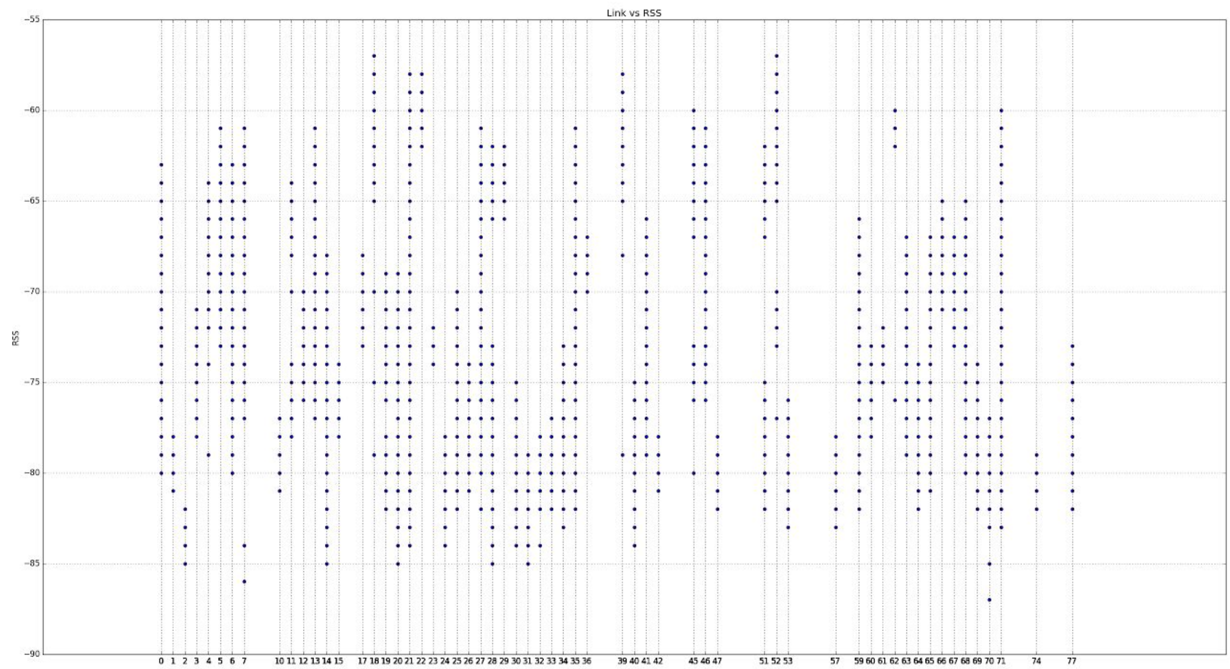
- the link versus all corresponding delivery ratios.



● the channel versus all corresponding RSS.



● the link versus all corresponding RSS.



(1 plot each)
Are there any correlations? Any other observations? Can you explain them?

The data used to produce above plots was filtered and includes only values from after 2009.

We can see no obvious correlation between channel RSS values and the delivery ratio, which could mean that channel selection bears no impact on delivery ratio. That may not be true, as we don't have the information about frequencies of RSS values with this graph type, we only see which RSS values were recorded.

When we compare link recorded RSS values with delivery ratios, we can see a correlation between these two values. Links that have only low RSS values (below -75 dBm) recorded produce a low delivery ratio (below 0.3 mostly), for example links 1, 2, 10, 30-34, 47, 57, 69, 70, 74. Links that have only high RSS values recorded (above -65 dBm) produce a high delivery ratio (above 0.8), for example links 29, 39, 62. Links that have RSS values ranging from -80 dBm up generally produce a range of delivery ratios, from 0 to 1.

This means that channel selection has less impact on delivery ratio than different links, as we can see no single channel to consistently perform better than other channels across different links. This was expected, as the measurements were taken in isolation, independent of one another. If we took measurements in a busy environment, we would expect different channels to perform differently, depending on saturation of each channel.

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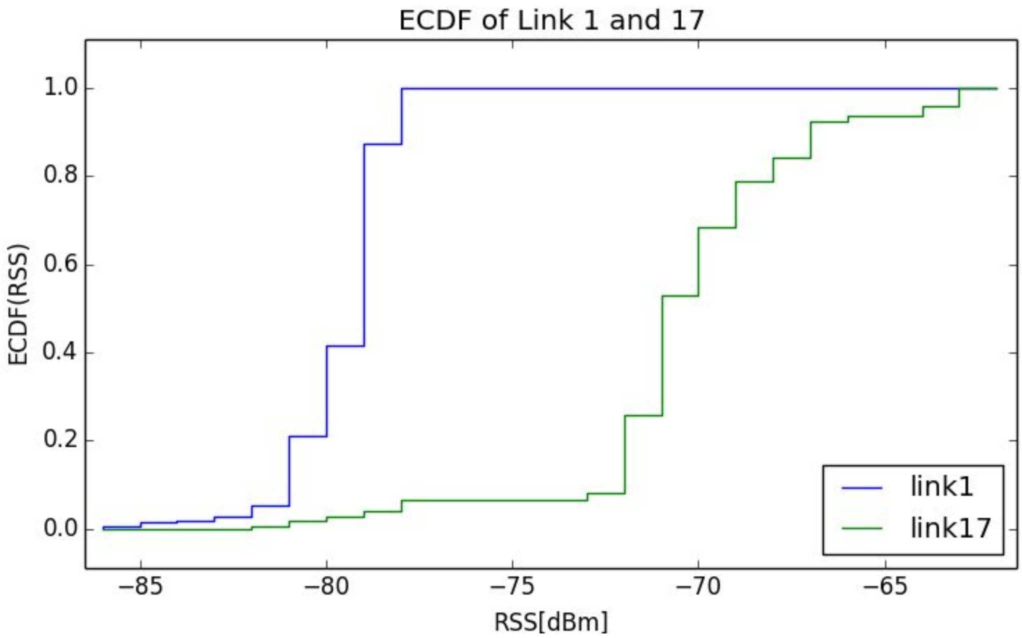
d)

Consider the data for the links 1 and 17. Plot the ECDFs for all the RSS values of both links (i.e., two lines into a single plot). What do you observe?

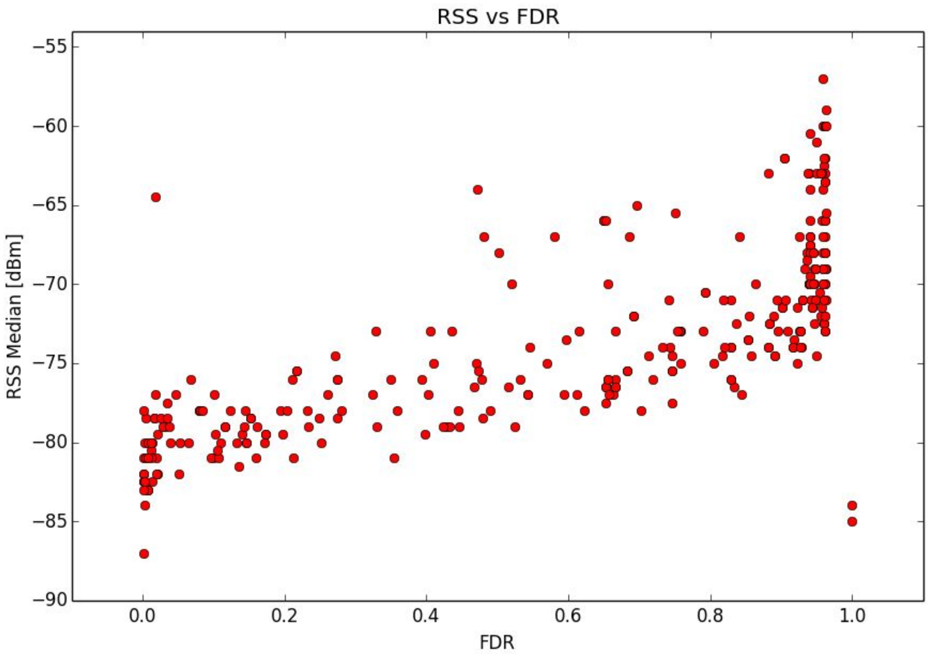


The higher the RSS value the stronger the signal. 20% of the captured frames of Link 1 have less than -81 dBm signal strength, whereas Link 17’s 20 % is only under -72 dBm. The RSS of Link 1 is mostly never higher than -78 dBm. The top 10% of Link 17 have a RSS of -67 dBm and more. Overall Link 17 receives a stronger signal strength than Link 1.

Comment to the thread from the discussion forum
(https://isis.tu-berlin.de/mod/forum/discuss.php?d=112736#p227141)

In a second run I filtered out all timestamps before 1230768000. But the data set got really small and I concentrated on the unfiltered set. Anyway here are the plots of the filtered set:

Filtered timestamps from question 1.b



Filtered timestamps from question 1.d