Computer Networking 2016-2017

Assignment 1

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This report aims to address coursework 1 of the course Computer Networking (2016-2017). This coursework involves running various simulations to compare the performance of various rate adaptation algorithms for 802.11 a/b/g wireless networks using the ns-3 simulator. This involves altering the transmission bit-rate in the physical layer.

The methods explored in these experiments are:

AARF – Adaptive Auto Rate Fallback [2]

CARA – Collision Aware Rate Adaptation [3]

The general parameters common to all experiments are as follows:

- Log Distance propagation loss model.

- Constant Bit Rate traffic of 20 Mbps over UDP

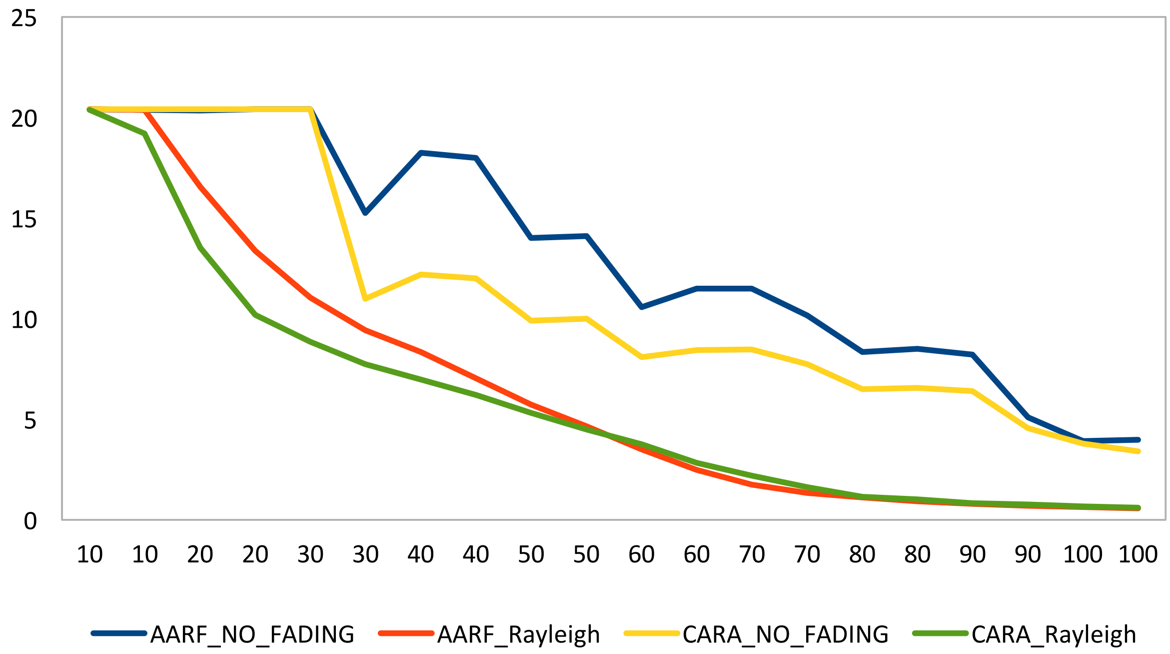
- 1 KB packet size

Note: The scripts used to run experiments print the average (out of 5) aggregate throughput for each individual experiment to the terminal. (Output files are simply created by copying the throughputs and converting them to the desired units)

Part 1

This experiment involved two nodes, the access point and the station node. With the station node as the sender and the access point as the receiver, values of throughput have been recorded as we increase the distance from 5m to 100m, in instalments of 5metres. The parameters for this experiment are exactly as defined in the coursework handout and are constant for the two rate adaptation methods used, with and without Rayleigh fading. [1] The datapoints used are an average of five runs each with a different seed.

The resulting plot is shown below: (Throughput in Mbps on y-axis, Distance in metres on x-axis)



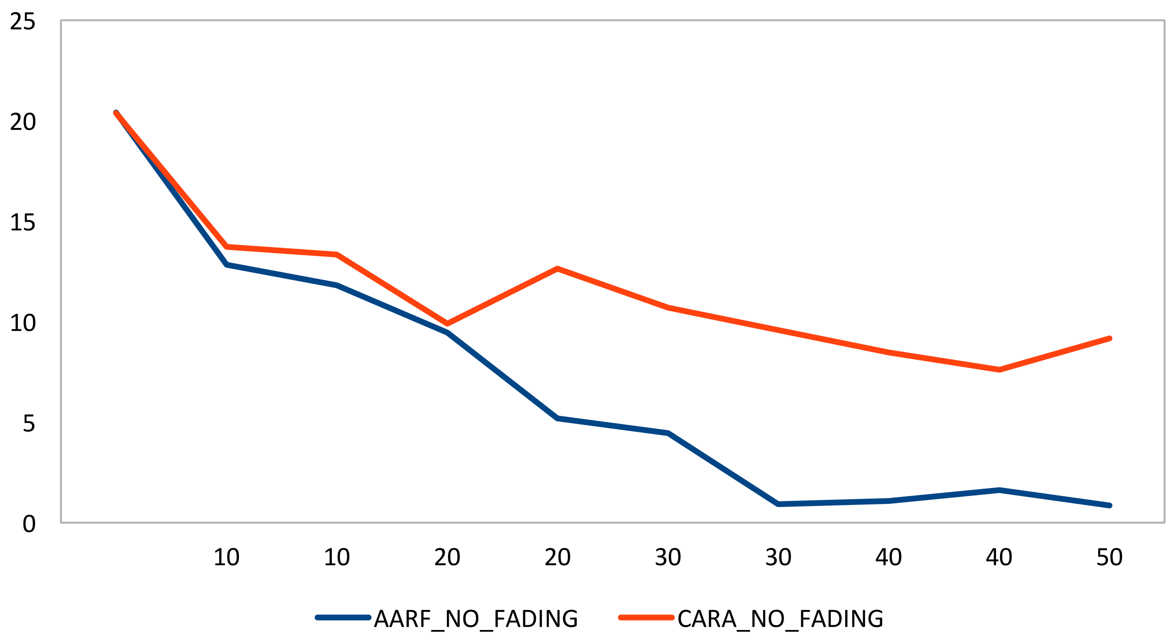
As one would expect that the signal-to-noise ratio would decrease with distance exponentially, therefore a general downward trend is expected. [4] It is observed that the throughput achieved from using AARF, (with and without fading), work better than their CARA, (with and without fading) counterparts. The cause of this is that when transmission of a frame in AARF fails, it returns to a lower rate but also increases the threshold for the number of required successful transmissions by two times. However, in the case of CARA, it uses a rate fallback method similar to ARF (auto rate fallback) and every time a probing frame fails, it doesn't increase the threshold and keeps trying and failing again after the set threshold is hit, thus decreasing the overall throughput. [2] [5]

Even in the case of fading, when channel conditions are changing quickly, CARA cannot adapt effectively because the the optimum rate changes from one frame to next and requires 1 to 2 frame failures and upto 10 succesful transmissions to fail, it never synchronises with subframe transmission changes. [5]

Part 2

This experiment involved changing the number of station nodes from 1 to 50 in instalments of 5 (therefore, the last number would be 46) without Rayleigh fading for the two rate adaptation algorithms. The access point is fixed at the centre, whereas the nodes are placed at a fixed distance / radius of 10 metres at the circumference of the circle. The parameters for this experiment are exactly as defined in the coursework handout and are constant for the two rate adaptation methods used. [1] The datapoints used are an average of five runs each with a different seed.

The resulting plot is shown below:

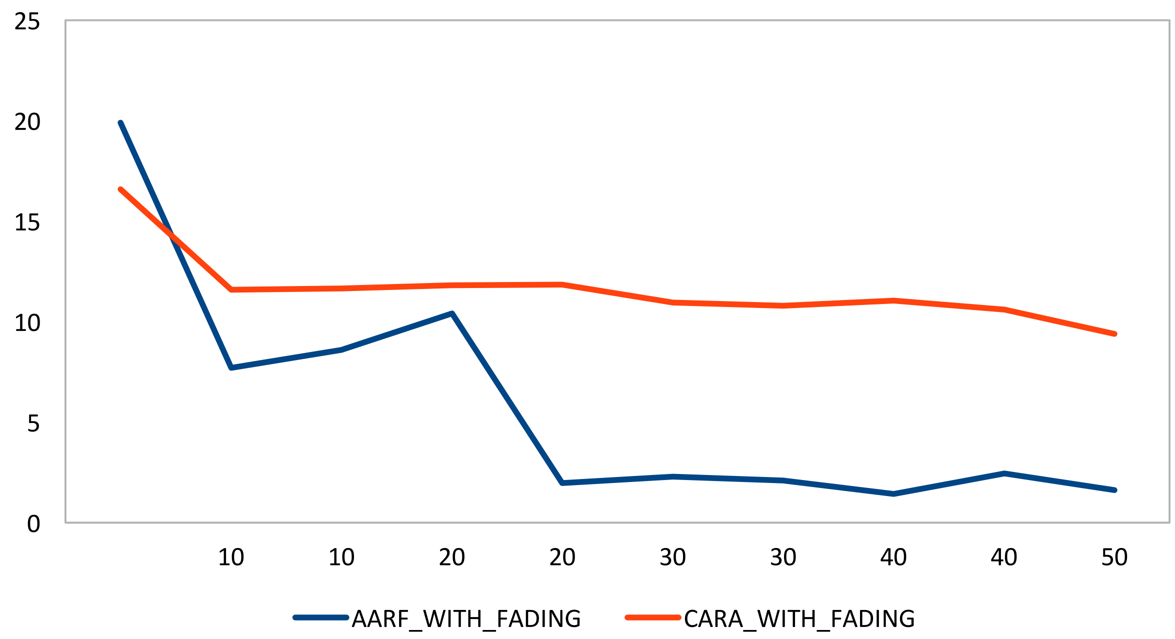


It is observed that the throughput achieved by using CARA is higher than that achieved in the case of AARF. Since all the nodes are equi-distant from the access point (AP) the noise resulting in both cases isn't a factor in the comparison. The transmission failures occuring in this case is mainly due to collisions and not transmission errors. The reason that CARA adapts the transmission rate better than AARF is that it is robust against collisions. This is attributed to the fact that when two nodes collide, CARA only detects the node with the shortest transmission time as a failure and not both. [2]. AARF chooses a suboptimal rate whenever the number of nodes is greater than 2 (in this case we have executed the experiment at 6). It is due to the fact that it assumes that all frame losses(including collisions) are due to transmission errors and rate isnt updated. Also, whenever the rate changes, the RTS/CTS mechanism of CARA is turned off, whereas AARF keeps probing, hence affecting the throughput.

Part 3

This experiment involved changing the number of station nodes from 1 to 50 in installments of 5 (therefore, the last number would be 46) with Rayleigh fading for the two rate adaptation algorithms. The access point is fixed at the centre, whereas the nodes are placed randomly within a radius of 25 metres. The parameters for this experiment are exactly as defined in the coursework handout and are constant for the two rate adaptation methods used. [1] The datapoints used are an average of five runs each with a different seed.

The resulting plot is shown below:



As observed in Part 2, CARA, over the course of this experiment works better than AARF. The difference in this experiment is that we have added Rayleigh Fading, a distribution model to emulate the variation in attenuation due to certain factors. Also, the fact that the nodes are randomly scattered in a confined 25m radius means that the interference from other nodes will contribute to additive noise resulting in more collisions, which as we explored in part 2, will make CARA work better as it is robust towards collisions.

Further Discussion

It can be observed from the plots of part 2 and plots of part 3 that there is a noticeable difference in performance of AARF, with it underperforming a lot in Rayleigh Fading conditions. This can be attributed to the fact that the signal to noise ratio is lowered as with fading, signal strength weakens whereas the noise levels remain the same. One possible reason for the underperformance of AARF could be that the channel conditions are changing faster than the respective adaptations can be made. The throughput based performance for CARA is observed to be similar with and without fading, although only slightly worse with fading which is natural as there will be weakening of signal.

References

[1] https://dl.dropboxusercontent.com/u/2916351/CN/assignments/CN-Assignment_1.pdf

[2] http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=4625680

[3] http://dx.doi.org/10.1109/INFOCOM.2006.316

[4] https://dl.dropboxusercontent.com/u/2916351/CN/lecture-slides/wireless_comms_overview.pdf

[5] http://delivery.acm.org/10.1145/1030000/1023687/p126-lacage.pdf?ip=129.215.2.50&id=1023687&acc=ACTIVE%20SERVICE&key=C2D842D97AC95F7A%2EEB9E991028F4E1F1%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&CFID=733629933&CFTOKEN=38552490&__acm__=1488413694_1d428b38ebdc2e5789ca4b94a25e97a6