

MASARYK UNIVERSITY
FACULTY OF INFORMATICS



Edu-hoc: Experimental and educational platform for wireless ad-hoc networking

MASTER'S THESIS

Lukáš Němec

Brno, Fall 2016

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Declaration

Hereby I declare that this paper is my original authorial work, which I have worked out on my own. All sources, references, and literature used or excerpted during elaboration of this work are properly cited and listed in complete reference to the due source.

Lukáš Němec

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Abstract

TODO abstract

Keywords

keyword1, keyword2, ...

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1 Introduction

2 Problem analysis (testbed, not general WSN)

2.1 Creating WSN network

2.2 Possible challenges

3 TESTBED deployment

3.1 Network design

3.2 JeeTool (mass management and communication)

3.3 HW (Arduino, JeeNodes, RF12B radio ...)

4 Research use

4.1 Keys from radio signal

4.1.1 Quantization principle (bits from signal strength)

Quantization enables to extract bits from individual values of signal strength. There are many different approaches to this problem two main approaches here are: lossless quantization CITE and contrary to that we have lossy quantization.

Main difference between these is number of generated bits per original signal strength measurements, while lossless quantization produces bit value from every measurement of signal strength, which is usefull for high performance demands, but it requires guaranteed varinace in the radio channel (e.g. the nodes are constantly moving, or the nevironment is changing) during the key establishment phase. CITE Otherwise the resulting keys could possibly be very weak. CITE

Lossy quantization on the other hand does not have guaranteed output lenght per number of measured values, which can lead to very limited length of output. However this kind of quantization is expected to have better results in static enviroments because its nature is to drop such bits, that fail to differ from others.

Since our network is static and without any moving nodes, we implemented lossy quantizer algorithm designed by Mathur et.al., which shoved promissing results for the of the shelf wireless devices simmlar to ours, and also contained experimental results from several different scenarios, where some of these were comparable to our conditions.

4.1.2 RSSI version

Quantization princeple designed by Mathur et.al. CITE works as follows:

1. both nodes send n messages to each other in alternating pattern, both nodes send counter value inside these messages, which is used to synchronize messages on individual nodes. For ev-

4. RESEARCH USE

ery one of these messages signal strength is measured upon repection.

2. when n messages have been succesfully exchanged, both nodes can proceed to the computational part.
3. both nodes calculate mean m and standart deviation sd for signal strength values of all received messages.
4. both nodes calculate q^+ and q^- values, which are upper and lower quantizer bin boundaries, as follows:

$$q^+ = m + \alpha \cdot sd$$

$$q^- = m - \alpha \cdot sd$$

5. every signal strength measurement is then processed and it is rejected, if it lies within q^+ and q^- boundaries, values above this range are assigned with bit value of one, values below are assigned with bit value of 0.
6. nodes then synchronize their measurement by exchanging couner values asciated with those messages, where signal strength measurements were asigned either one or zero bit values.
7. those couner values that match on both nodes are expected to be excursions in the same direction and are used in the final outcome.

4.1.3 CSI (channel state) version

4.2 Cooperative jamming (can it improve our situation?)

4.3 Performance Evaluation (results from experiments)

4.3.1 Entropy of data

4.3.2 Speed (bits of key per time)

4.3.3 Possible errors

4.4 Discussion, is it achievable and under what conditions?

5 Education use

5.1 motivation for educational WSN network

The current state of the art WSN devices usually uses specialized hardware and software in order to achieve the best performance available. This, unfortunately, is not the ideal prerequisite for an easy to learn matter. In fact, most of WSN devices have rather complicated setup and are quite challenging for novices.

Because of such discouragement, it is difficult to teach how to work with WSN's; few hours (at least) are usually required to explain the basics, which is reasonable for research project or something similar, but for class exercise, this would turn out to be not the most effective use of time, if it would be achievable at all. And we have not yet mentioned more advanced topics in this area, such as common encryption or message authentication techniques.

Issue of this nature can be solved in various ways, in case of Eduhoc we decided to sacrifice performance 3.3; which is not that much important for network with educational purpose. On the other hand,

5.2 Scenario approach (attack and repair) + iterative higher difficulty

5.2.1 scenarios

- 5.2.5 individual scenarios

5.3 Evaluation principle

5.4 Web interface and auto run

5.5 PA197 use and results

6 Summary

A An appendix