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Final thesis

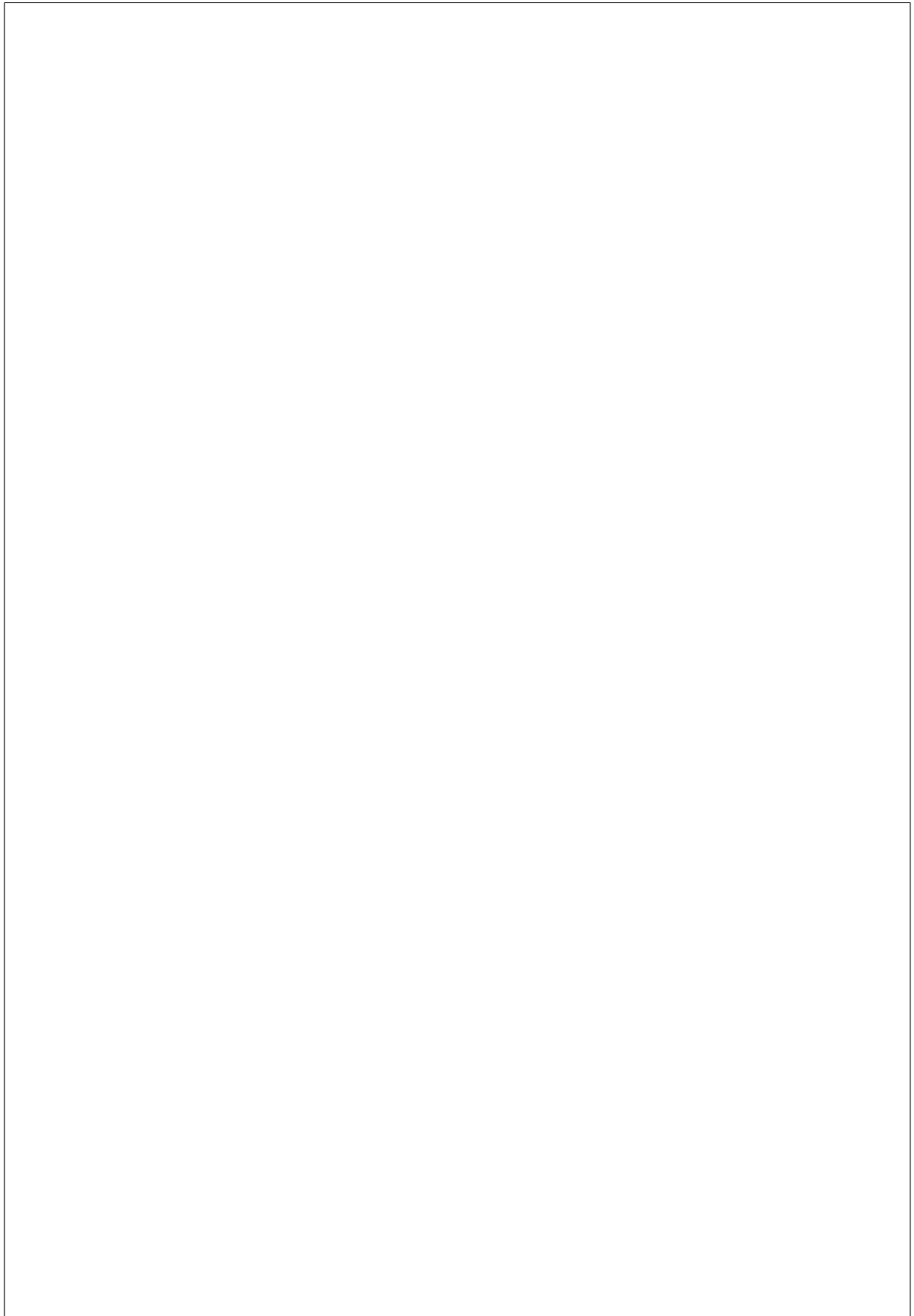
Test Data Post-Processing and Analysis of LA & HARQ

by

Paul Nedstrand & Razmus Lindgren

LITH-IDA-EX-2015/THESISNUMBER

November 6, 2014



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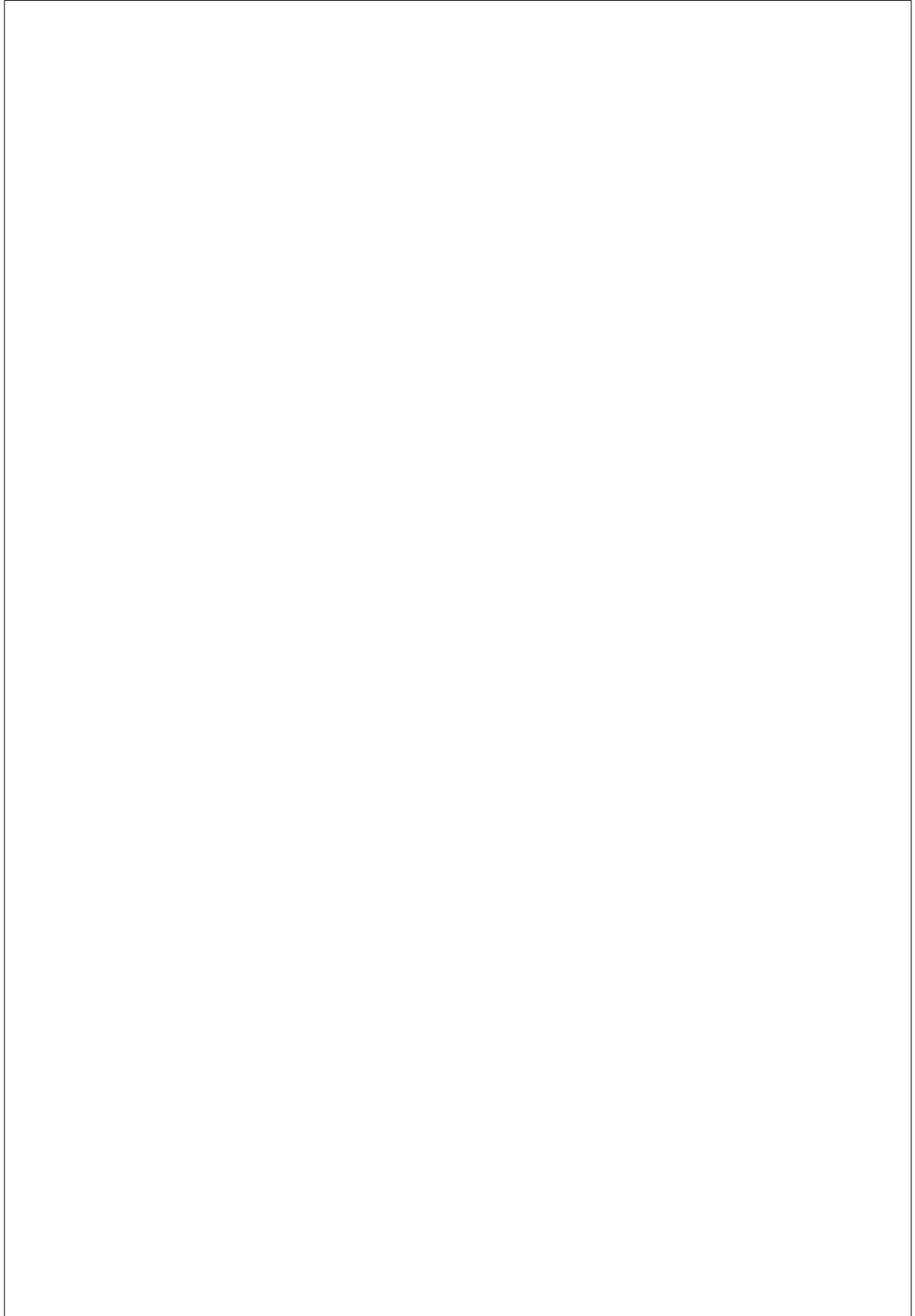
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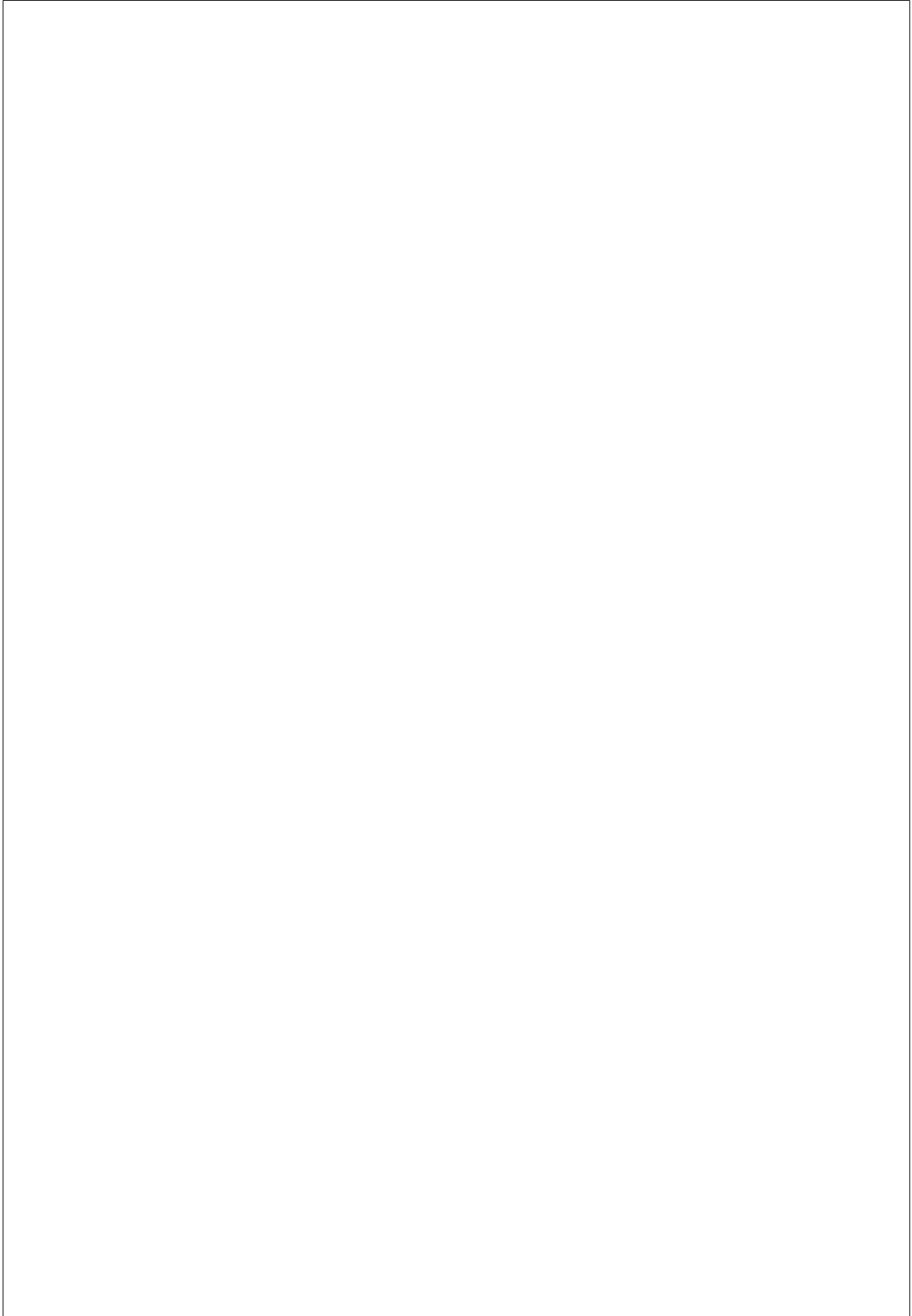
Supervisor: Ola Leifler

Examiner: EXAMINER



Abstract

§ This Master thesis involves developing a lightweight analyser that produce statistics from the communication between a cell phone and a E-UTRAN base station. The analyser tool will produce graphs with information about the correlation between a signal throughput and the interference in the channel that the signal is sent through. From the statistics produced by the analyser tool, the testing personal at Ericsson can more easily deduce where the interference in signals arises from.



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Chapter 1

Introduction

1.1 background and Motivation

The purpose with this master thesis is to help Long Term Evolution Interoperability Development Testing (LTE IODT) Data analysis. LTE IODT wants to automatically generate analysis of Link Adaptation (LA) and Hybrid Automatic Repeat Request (HARQ) tests where we sweep through Signal to Interference plus Noise Ratio (SINR) for different channel models. The LTE IODT lab test logs gives a unique opportunity to look into detailed behaviour of link and rank adaptation for both downlink and uplink.

Ericsson needed a tool for allowing the testers to better analyse the performance in UE-to-eNodeB implementations. The performance in this sense is whether Ericsson and/or their customer had implemented their system according to the minimum criterion of the specification for said implementation or not. To be able to judge where in the implementation the loss of performance had occurred, Ericsson needed a tool to plot the values of signal-variables that are most affected by HARQ and LA, so that their own personnel could use that information to further analyse the algorithms. To be able to plot relevant values for debugging we first had to gain vast knowledge about how LTE, HARQ and LA.

The visualization tool which we used in this project was an Ericsson internal project called Logtool. We implemented our program as a plugin project to Logtool. The Logtool project is built upon the eclipse framework and we also developed the plugin in eclipse development environment in Java.

1.1.1 Link Adaptation

Link Adaptation is a way to enhance the performance in systems with wireless signals yes dependent on the channel condition the modulation scheme

1.2. PROBLEM FORMULATION CHAPTER 1. INTRODUCTION

and code rate is changed. The better channel condition the higher modulation scheme and higher code rate [source on this]?. The modulation scheme used in the LTE systems are QPSK, 16QAM and 64QAM. The codes used is QPP (quadrature polynomial permutation) turbo codes [source on this]?. When data are/is sent from a base station to a UE (DL) the UE will report a CQI (channel quality indicator) value to the base station indicating how good the channel is. CQI can take values from 0 to 15 (4 bits) where 0 represent a very bad channel condition and 15 a very good one. Out from this value The ENodeB decides a MCS (modulation and coding scheme). For downlink MCS can take values between 0-28 and uplink 0-22. Each one of this value represent a Modulation scheme and code rate.

1.1.2 HARQ algorithm

skriver vi something here eller ar denna section bara massa skit

1.1.3 Modulation scheme

A modulation scheme is a way to map digital bits to analog signals. it is a way to represent the bits in the air. In LTE the modulation schemes that are used are 4QAM (QPSK), 16QAM and 64 QAM. The signals are modulated in the following way

(bild pa 4QAM 16QAM and 64QAM over i-phase and q-phase).

The I-phase is basically a Sinus wave and Q-phase is a Cosine wave. This way orthogonality occur. What the points on the two axes represent is the amplitude. So in the QPSK case. What the different signals that actually will be is $A \cdot \sin(f \cdot t)$, $A \cdot \cos(f \cdot t)$, $-A \cdot \sin(f \cdot t)$ and $-A \cdot \cos(f \cdot t)$. So in this case the it fits 2 bits in each signal. I.e e.g signal 1 = 00, signal 2 = 01, signal 3 = 10, signal 4 = 11. In 16QAM and 64QAM each signal point is represented by 4 and 6 bits respectively. 1

1.1.4 Coding

A code rate is a way to

1.2 problem formulation

The purpose of this master thesis is to help LTE IODT Data Analysis to see how well the LTE system is performing when the HARQ (Hybrid Automatic Repeat Request) and LA (Link Adaptation) is activated. To perform such an analysis we needed to gather vast knowledge regarding how signals are treated in LTE and how the protocols implemented are constructed. With this tool we shall help LTE IODT be able to different analyses on our tool.

1.3 The analysis

Paul skriver nedanstaende

what our analysis is intended to do is to look at how well performed the different mcs values are in the AMC (adaptive modulation control) protocol. this is dependent on the different CQI values in downlink, and from this value, the BLER (block error rate) value the enodeB choses a MCS 5-bits. What our analysis is intended to study is to see of the optimal MCS is chosen according to the sinr value. This way we can see if some mcse might be redundant och that some mcs value should be at other cqi reports.

Uplink:

Data is sent from the UE to the enodeB. The EnodeB is calculating SINR and from this value and block error rate (and maybe something more) the enodB decides which MCS the UE shall send at. MCS in uplink varies between 0-22, where mcs = 0 in the worst channel conditions (lowest SINR's) and mcs = 22 in the highest SINR's.

Downlink:

Data is sent from the enodeB to the UE. When the data is sent from the enodeB the UE is calculating a CQI value (0-15) which represent the channel condition. 0 is the worst channel condition and 15 is the best channel conditions. this value is sent back to the enodeB and from this value and some other parameters (BLER) an MCS is chosen. In this case this value varies between 0-28 where 0 is the modulation and coding scheme for the worst channel conditions and 28 is the modulation schemes for the best channel conditions.

what we have looked at is both uplink and downlink. in the downlink we did 30 different simulations. 29 simulations where we have hardcoded the enodeB to run at a specific MCS, 0-28 and one where did not hardcode a mcs. We compared all these curves to each other look at which SINR / CQI value they intersect each other and if the hardcoded mcs value were higher than the actual value it had.

TODO: write about all web pages and libraries which contained information about LTE

The analyzer should be able to plot several graphs, save them and read them again such that the user can compare different traces.

1.4 Goals and Methodology

Our task from Ericsson was to develop a lightweight analyzer tool that:

- simply produces statistics
- Handle multiple input sources

We also had the following criteria:

- Study and understand the 3GPP standards and Ericsson Research
- Analyzfrom processing for the final graph
- Evaluate a suitable data le tool for the processing of data, e.g. MATLAB or other tools
- Capability to correlate the graph to logs in order to facilitate troubleshooting

TODO: write about why and how we did a focus group

1.5 Thesis Outline

This thesis is divided into the following Parts

- part 1 we planned stuff here
- part 2 we implemented stuff here
- part 3 we reviewed stuff here

Chapter 2

Body

text...


2.1 Mainline

text...

Chapter 3

Closing

text...

 Avdelning, Institution Division, Department DIVISIONSHORT, Dept. of Computer and Information Science 581 83 Linköping		Datum Date November 6, 2014
Språk Language <input type="checkbox"/> Svenska/Swedish <input checked="" type="checkbox"/> Engelska/English <input type="checkbox"/> _____	Rapporttyp Report category <input type="checkbox"/> Licentiatavhandling <input checked="" type="checkbox"/> Examensarbete <input type="checkbox"/> C-uppsats <input type="checkbox"/> D-uppsats <input type="checkbox"/> Övrig rapport <input type="checkbox"/> _____	ISBN ISBN ISRN LiU-Tek-Lic-2015:THESISYEARNUMBER Serietitel och serienummer ISSN Title of series, numbering - _____
URL för elektronisk version http://XXX		Linköping Studies in Science and Technology Thesis No. THESISNUMBER
Titel Title TITLEBIBPAGE Författare Author Paul Nedstrand & Rasmus Lindgren		
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