**Planning report for examination thesis at IDA**

**Authors**

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**Preliminary title**

Test Data Post-Processing and Analysis of LA & HARQ

**Problem formulation**

Ericsson does not currently have any tool or functionality to make analysis of layer 1 data in an advanced way. The way IODT works is that the they manually looked at log files of potential problem in the link between UE and EnodeB, these files often contains a lot of data. The other way they could study the signal data is to look at the data in real time in a command window. This way of working was quite inefficient and also put lots of constraints on what the testers could analyze in the link. To make a proper analysis for signal data Ericsson needed a new visualization tool that would allow the testers to study large amount of data effectively and more in depth.

This master thesis involves developing a tool to visualize different data that’s transmitting in the physical layer (the air). The tool will consist of graphs that can show the dependencies between signals in layer 1. The graphs will be 2 dimensional, with e.g. interference on one axis and throughput on the other. Ericsson thinks this is convenient because they have done this way in previous documents[[1]](#footnote-1) in the same area of study.

This master thesis involves developing a tool to visualize and measure the efficiency of LA and HARQ in LTE in comparison to not having them. Are they both meeting the 3GPP standard in aspect to SNR (Signal-to-Noise-Ratio), SINR (Signal-to-Interference-plus-Noise-Ratio) and throughput? The visualization will consist of graphs that show how the throughput and SINR is affected by interference and noise at different levels. The graphs will be 2 dimensional, with e.g. interference on one axis and throughput on the other. Ericsson thinks this is convenient because they have done this way in previous documents[[2]](#footnote-2) in the same area of study

In order for us to choose a suitable tool for presenting data we used the following guide lines:

* Can our tool provide functionality that is useful to the testers?
* Can a tester perform a set of tasks faster with our tool than without it?
* Can the testers perform some work with out tool
* Is our tool easy to use?

How can it be verified how efficient The HARQ (Hybrid Automatic Repeat Request) and LA (Link Adaptation) algorithm is? There is no good current way to see the efficiency of it and how well they are meeting the 3GPP standard for different channel models.

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If we have time we will create a dynamic tool that visualizes the throughput, SNR and SINR at real time.

**Our approach**

We will receive data from Ericsson in form of a log file, on a disk. We will analyze this data (with the help of i.e. Matlab or some other suitable tool) in the perspective of SNR, (Signal-to-noise ratio), SINR (Signal-to-interference-noise ratio) and throughput amongst other things to see if the algorithms are meeting the requirement of the 3GPP standards. We will interview relevant employees at Ericsson and ask them what the most important tasks are to accomplish, how they will use our work, the purpose etc. We will do the interviews in focus group because there is a lot of knowledge spread out over different staff at Ericsson that are involved in the thesis work and they also might have different opinions of what they think we should accomplish. Therefore we believe that this method will be the most effective in the sense that we can both ask them how they want things to be done and also ask about technical difficulties that we might get stuck at. When the work is done we will compare the result with the 3GPP standard.

**Literature base**

The main source of information will come from Ericsson’s internal documents, lectures and online lectures. The online lectures are accessible from Ericsson’s web page with learning material. The lectures will be held at Ericsson in Linköping. To find information that will not be handed out by Ericsson, and that we feel is necessary to complement, we will use the [IEEE Xplore : digital library](https://login.e.bibl.liu.se/login?url=http://ieeexplore.ieee.org/) and [Electronics and communications abstracts](https://login.e.bibl.liu.se/login?url=http://search.proquest.com/electronicscomms?accountid=12109) databases because these have relevant articles in the LTE area. For information related to MATLAB (functions and other documentation) we will use <http://www.mathworks.se/>.

Possible keywords: HARQ , up/downlink, Link Adaptation, SINR, SNR, QAM, eNodeB, Channel Layers, CQI, Throughput, FDD, TDD, Scheduling, OFDM, OFDMA, Channel Models.

We will need literature that explains the LA (Link Adaptation) and HARQ (Hybrid Automatic repeat request) algorithms. For this we have the document 36.300-C20, Part V, p. 42-53. This section describes the HARQ and LA algorithms. This information is important for us to understand when we develop the analyzer tool.

We will look at the SINR, SNR, and throughput for different channel models so we will have to find information about different channel models. Since we haven’t got enough literature about this from Ericsson we will search the databases mentioned earlier for more information.

We will need manuals about how to use the UE’s (user equipment’s) when connecting a UE to a base station. This will be handed out by involved test engineers at Ericsson.

Lists of commands how to configure the lab equipment. This will be handed out by involved test engineers at Ericsson.

We need to find literature of evaluation and efficiency of algorithms in the air interface (HARQ and LA). For this we will also use the [IEEE Xplore : digital library](https://login.e.bibl.liu.se/login?url=http://ieeexplore.ieee.org/) and [Electronics and communications abstracts](https://login.e.bibl.liu.se/login?url=http://search.proquest.com/electronicscomms?accountid=12109) databases.

We will use the article <http://ieeexplore.ieee.org.e.bibl.liu.se/stamp/stamp.jsp?tp=&arnumber=6692708> and <http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1490770> , to learn about the efficiency of harq algortihms.

We will use the article

<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=797134>, to understand more how CNR (carrier to noise ratio) and delay spread are effecting the throughput when different modulation schemes are used.

We will use the article <http://ieeexplore.ieee.org.e.bibl.liu.se/stamp/stamp.jsp?tp=&arnumber=6692708>, to learn about the efficiency of harq algortihms.

The literature we will use to determine how to run the focus group(s) is

Zane K. Quible, A Focus on Focus Groups, Stillwater, Oklahoma State University, 1998.

(<http://eds.b.ebscohost.com.e.bibl.liu.se/eds/pdfviewer/pdfviewer?sid=3b9035f3-a423-49c9-bf6c-b4d3c2eb8e06%40sessionmgr114&vid=1&hid=104>)

Books available at Ericsson:

Academic Press 3G Evolution HSPA and LTE for Mobile Broadband 2nd Edition Oct 2008 eBook-DDU, Part IV

This part describes more in depth the transfer protocols in the physical layer. It also lists the requirements for LTE under different circumstances.

Ericsson Academy LTE L11 Air Interface

This compendium gives us all information about the physical layer (transmission between UE and eNB).

It will also give us an understanding about how signal are sent in the physical layer.

**Time plan**

Preliminary halftime report date: 2014-11-19

Preliminary Oral presentation: 2015-02-27

By the end of the halftime report we expect to have a not complete (but mostly working ) analyzer tool. We expect to have deep knowledge about mostly all LTE knowledge that is useful to us in our project.

We also expect to have written around half of the final report.

See attached file “Project Time Plan” for the actual time plan in excel format.

1. Downlink Link Adaptation Analysis - LTE Verizon Testbed.doc [↑](#footnote-ref-1)
2. [↑](#footnote-ref-2)
3. Downlink Link Adaptation Analysis - LTE Verizon Testbed.doc [↑](#footnote-ref-3)