KTH ROYAL INSTITUTE
OF TECHNOLOGY

Degree Project in

Second cycle, credits

This is the title in the language of the thesis

An subtitle in the language of the thesis

GLENN OLSSON

San Luis Obispo, California, USA, 2022

This is the title in the language of the thesis

An subtitle in the language of the thesis

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Master's Programme, Computer Science, 120 credits
Date: January 26, 2022

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Host company: Cal Poly
Swedish title: Detta är den svenska översättningen av titeln
Swedish subtitle: Detta är den svenska översättningen av undertiteln

Abstract

Write an abstract that is about 250 and 350 words (1/2 A4-page) with the following components::

- What is the topic area? (optional) Introduces the subject area for the project.
- Short problem statement
- Why was this problem worth a Bachelor's/Master's thesis project? (*i.e.*, why is the problem both significant and of a suitable degree of difficulty for a Bachelor's/Master's thesis project? Why has no one else solved it yet?)
- How did you solve the problem? What was your method/insight?
- Results/Conclusions/Consequences/Impact: What are your key results/ conclusions? What will others do based upon your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

Choice of typeface with \textit, \textbf, and \texttt: x, **x**, and x

Text superscripts and subscripts with \textsubscript and \textsuperscript: A_x and A^x

Some useful symbols: \textregistered, \texttrademark, and \textcopyright. For example, copyright symbol: \textcopyright Maguire 2022, and some superscripts: ^{99m}Tc, A*, A^{\textregistered}, and A\texttrademark : ©Maguire 2022, and some superscripts: ^{99m}Tc, A*, A$^{®}$, and A™. Another example: H\textsubscript{2}O: H_2O

Simple environment with begin and end: itemize and enumerate and within these \item

The following macros can be used: \eg, \Eg, \ie, \Ie, \etc, and \etal: *e.g.*, *E.g.*, *i.e.*, *I.e.*, *etc.*, and *et al.,*

The following macros for numbering with lower case roman numerals: \first, \second, \third, \fourth, \fifth, \sixth, \seventh, and \eighth: (i), (ii), (iii), (iv), (v), (vi), (vii), and $(viii)$.

Equations using \(xxxx \) or \[xxxx \] can be used in the abstract. For example: $(C_5O_2H_8)_n$ or

$$\int_a^b x^2\,dx$$

Even LaTeX comments can be handled, for example: % comment at end

Keywords

Canvas Learning Management System, Docker containers, Performance tuning Choose the most specific keyword from those used in your domain, see for example: the ACM Computing Classification System (https://www.acm.org/publications/computing-classification-system/how-to-use), the IEEE Taxonomy (https://www.ieee.org/publications/services/thesaurus-thank-you.html), PhySH (Physics Subject Headings) (https://physh.aps.org/), ...or keyword selection tools such as the National Library of Medicine's Medical Subject Headings (MeSH) (https://www.nlm.nih.gov/mesh/authors.html) or Google's Keyword Tool (https://keywordtool.io/)

Mechanics:

- The first letter of a keyword should be set with a capital letter and proper names should be capitalized as usual.
- Spell out acronyms and abbreviations.
- Avoid "stop words" - as they generally carry little or no information.
- List your keywords separated by commas (",").

Since you should have both English and Swedish keywords - you might think of ordering them in corresponding order (*i.e.*, so that the n^{th} word in each list correspond) - this makes it easier to mechanically find matching keywords.

Sammanfattning

Nyckelord

Canvas Lärplattform, Dockerbehållare, Prestandajustering

Acknowledgments

I would like to thank xxxx for having yyyy.

San Luis Obispo, January 2022
Glenn Olsson

Contents

List of Figures

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Listings

List of acronyms and abbreviations

OS	operating system
SDG	Sustainable Development Goal
UN	United Nations

Chapter 1

Introduction

1.1 Background

As one can find in RFC 1235 [1] multicast is useful for xxxx. A number of different operating systems (OSes) have been used in this work, such as the following OSes: UNIX, Linux, Windows, etc. The main focus will be on one OS, namely Linux.

1.2 Problem

Longer problem statement
If possible, end this section with a question as a problem statement.

1.2.1 Original problem and definition

Some text

1.2.2 Scientific and engineering issues

some text

1.3 Purpose

1.4 Goals

The goal of this project is XXX. This has been divided into the following three sub-goals:

1. Subgoal 1
2. Subgoal 2
3. Subgoal 3

1.5 Research Methodology

1.6 Delimitations

1.7 Structure of the thesis

Chapter 2 presents relevant background information about xxx. Chapter 3 presents the methodology and method used to solve the problem. ...

Chapter 2

Background

This chapter provides basic background information about xxx. Additionally, this chapter describes xxx. The chapter also describes related work xxxx.

2.1 Major background area 1

There are xxx characteristics that distinguish yyy from other information and communication technology (ICT) system, as shown in Figure 2.1. Table 2.1 summarizes these characteristics.

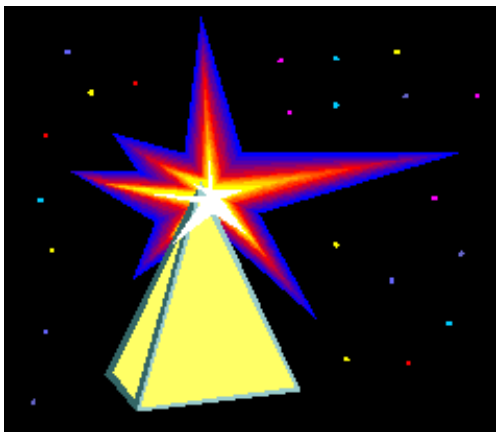

Figure 2.1: Lots of stars (Inspired by Figure x.y on page z of [xxx])

Table 2.1: xxx characteristics

Characteristics	**Description**
α	β
1	1110.1
2	10.1
3	23.113 231

2.1.1 Subarea 1.1

Entangled states are an important part of quantum cryptography, but also relevant in other domains. This concept might be relevant for neutrinos, see for example [2].

2.1.2 Subarea 1.1.2

Computational methods are increasingly used as a third method of carrying out scientific investigations. For example, computational experiments were used to find the amount of wear in a polyethylene liner of a hip prosthesis in [3]. ...

2.1.3 Subarea 1.1.2

Using the nearest data center may improve performance, see [4]

2.1.4 Link layer Encapsulation

2.1.5 IP packet headers

2.1.6 Test for accessibility of formulas

As can be seen in these equations: $c = 2 \cdot \pi \cdot r$ or

$$\int_a^b x^2 \, dx$$

a chemical formula: $(C_5O_2H_8)_n$ ...

2.2 Major background area 2

...

2.2.1 WLAN Security

2.3 Related work area

2.3.1 Major related work 1

Carrier clouds have been suggested as a way to reduce the delay between the users and the cloud server that is providing them with content. However, there is a question of how to find the available resources in such a carrier cloud. One approach has been to disseminate resource information using an extension to OSPF-TE, see Roozbeh, Sefidcon, and Maguire [5].

2.3.2 Major related work

2.3.3 Minor related work 1

...

2.3.4 Minor related work n

2.4 Summary

Chapter 3

Method or Methods

content, Methodologies and Methods. Use a self-explaining title.
The contents and structure of this chapter will change with your choice of methodology and methods.

The purpose of this chapter is to provide an overview of the research method used in this thesis. Section 3.1 describes the research process. Section 3.2 details the research paradigm. Section 3.3 focuses on the data collection techniques used for this research. Section 3.4 describes the experimental design. Section 3.5 explains the techniques used to evaluate the reliability and validity of the data collected. Section 3.6 describes the method used for the data analysis. Finally, Section 3.7 describes the framework selected to evaluate xxx.

3.1 Research Process

Figure 3.1 shows the steps conducted in order to carry out this research.

Figure 3.1: Research Process

3.2 Research Paradigm

3.3 Data Collection

3.3.1 Sampling

3.3.2 Sample Size

3.3.3 Target Population

3.4 Experimental design/Planned Measurements

3.4.1 Test environment/test bed/model

3.4.2 Hardware/Software to be used

3.5 Assessing reliability and validity of the data collected

3.5.1 Validity of method

3.5.2 Reliability of method

3.5.3 Data validity

3.5.4 Reliability of data

3.6 Planned Data Analysis

3.6.1 Data Analysis Technique

3.6.2 Software Tools

3.7 Evaluation framework

3.8 System documentation

Chapter 4

What you did

4.1 Hardware/Software design . . . /Model/Simulation model & parameters/. . .

Figure 4.1 shows a simple icon for a home page. The time to access this page when served will be quantified in a series of experiments. The configurations that have been tested in the test bed are listed in Table 4.1.

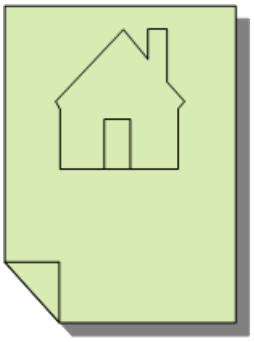

Figure 4.1: Homepage icon

Table 4.1: Configurations tested

Configuration	Description
1	Simple test with one server
2	Simple test with one server

4.2 Implementation . . . /Modeling/Simulation/. . .

4.2.1 Some examples of coding

Listing 4.1 shows an example of a simple program written in C code.

Listing 4.1: Hello world in C code

```
int main() {
printf("hello, world");
return 0;
}
```

In contrast, Listing 4.2 is an example of code in Python to get a list of all of the programs at KTH.

Listing 4.2: Using a python program to access the KTH API to get all of the programs at KTH

```
KOPPSbaseUrl = 'https://www.kth.se'

def v1_get_programmes():
    global Verbose_Flag
    #
    # Use the KOPPS API to get the data
    # note that this returns XML
    url = "{0}/api/kopps/v1/programme".format(KOPPSbaseUrl)
    if Verbose_Flag:
        print("url: " + url)
    #
    r = requests.get(url)
    if Verbose_Flag:
        print("result of getting v1 programme: {}".format(r.text))
    #
    if r.status_code == requests.codes.ok:
        return r.text           # simply return the XML
    #
    return None
```

Chapter 5

Results and Analysis

In this chapter, we present the results and discuss them.

5.1 Major results

Some statistics of the delay measurements are shown in Table 5.1. The delay has been computed from the time the GET request is received until the response is sent.

Table 5.1: Delay measurement statistics

Configuration	Average delay (ns)	Median delay (ns)
1	467.35	450.10
2	1687.5	901.23

Figure 5.1 shows and example of the performance as measured in the experiments.

Given these measurements, we can calculate our processing bit rate as the inverse of the time it takes to process an additional byte divided by 8 bits per byte:

$$bitrate = \frac{1}{\frac{time_{byte}}{8}} = 20.03 \quad kb/s$$

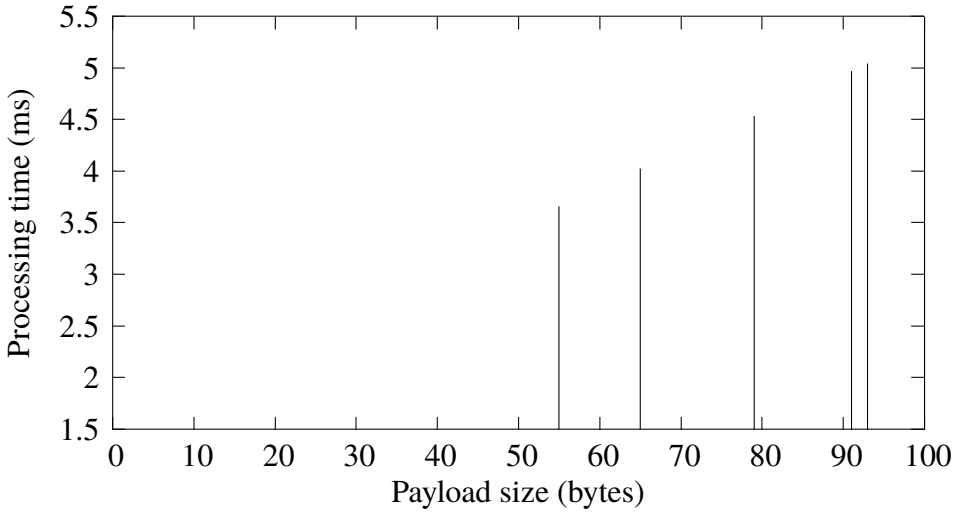

Figure 5.1: Processing time vs. payload length

5.2 Reliability Analysis

5.3 Validity Analysis

Chapter 6

Discussion

Chapter 7

Conclusions and Future work

7.1 Conclusions

7.2 Limitations

7.3 Future work

Due to the breadth of the problem, only some of the initial goals have been met. In these section we will focus on some of the remaining issues that should be addressed in future work. ...

7.3.1 What has been left undone?

The prototype does not address the third requirment, i.e., a yearly unavailability of less than 3 minutes, this remains an open problem. ...

7.3.1.1 Cost analysis

The current prototype works, but the performance from a cost perspective makes this an impractical solution. Future work must reduce the cost of this solution, to do so a cost analysis needs to first be done. ...

7.3.1.2 Security

A future research effort is needed to address the security holes that results from using a self-signed certificate. Page filling text mass. Page filling text mass. ...

7.3.2 Next obvious things to be done

In particular, the author of this thesis wishes to point out xxxxxx remains as a problem to be solved. Solving this problem is the next thing that should be done. ...

7.4 Reflections

One of the most important results is the reduction in the amount of energy required to process each packet while at the same time reducing the time required to process each packet.

The thesis contributes to the UN SDGs numbers 1 and 9 by xxxx.

References

[1] J. Ioannidis and G. Maguire, "Coherent File Distribution Protocol," *Internet Request for Comments*, vol. RFC 1235 (Experimental), Jun. 1991. doi: 10.17487/RFC1235. [Online]. Available: http://www.rfc-editor.org/rfc/rfc1235.txt [Page 1.]

[2] Y. S. Kim, G. Q. Maguire, and M. E. Noz, "Do Small-Mass Neutrinos Participate in Gauge Transformations?" *Advances in High Energy Physics*, vol. 2016, pp. 1–7, 2016. doi: 10.1155/2016/1847620. [Online]. Available: http://www.hindawi.com/journals/ahep/2016/1847620/ [Page 4.]

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[4] K. Bogdanov, M. Peón-Quirós, G. Q. Maguire, and D. Kostć, "The nearest replica can be farther than you think," in *Proceedings of the Sixth ACM Symposium on Cloud Computing - SoCC '15*. Kohala Coast, Hawaii: ACM Press, 2015. doi: 10.1145/2806777.2806939. ISBN 978-1-4503-3651-2 pp. 16–29. [Online]. Available: http://dl.acm.org/citation.cfm?doid=2806777.2806939 [Page 4.]

[5] A. Roozbeh, A. Sefidcon, and G. Q. Maguire, "Resource Monitoring in a Network Embedded Cloud: An Extension to OSPF-TE," in *2013 IEEE/ACM 6th International Conference on Utility and Cloud Computing*. Dresden, Germany: IEEE, Dec. 2013. doi: 10.1109/UCC.2013.36. ISBN 978-0-7695-5152-4 pp. 139–146. [Online]. Available: http://ieeexplore.ieee.org/document/6809350/ [Page 5.]

Appendix A

Something Extra

A.1 Just for testing KTH colors

You have selected to optimize for print output

- Primary color
  - kth-blue
  - kth-blue80
- Secondary colors
  - kth-lightblue
  - kth-lightred
  - kth-lightred80
  - kth-lightgreen
  - kth-coolgray
  - kth-coolgray80

black

TRITA-EECS-EX- 2022:00

For DIVA

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  conclusions? What will others do based upon your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

€€€€,
"Keywords[eng]": €€€€

Canvas Learning Management System, Docker containers, Performance tuning €€€€,

"Abstract[swe]": €€€€
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Canvas Lärplattform, Dockerbehållare, Prestandajustering €€€€,

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