KTH ROYAL INSTITUTE
OF TECHNOLOGY

Degree Project in Technology

First cycle, 15 credits

This is the title in the language of the thesis

A subtitle in the language of the thesis

FAKE A. MANFREDI

Stockholm, Sweden, 2024

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A subtitle in the language of the thesis

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Bachelor's Programme in Information and Communication Technology
Date: February 28, 2024

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Host company: Företaget AB
Swedish title: Detta är den svenska översättningen av titeln
Swedish subtitle: Detta är den svenska översättningen av undertiteln

Abstract

All theses at KTH are **required** to have an abstract in both *English* and *Swedish*.

Exchange students may want to include one or more abstracts in the language(s) used in their home institutions to avoid the need to write another thesis when returning to their home institution.

Keep in mind that most of your potential readers are only going to read your `title` and `abstract`. This is why the abstract must give them enough information so that they can decide if this document is relevant to them or not. Otherwise, the likely default choice is to ignore the rest of your document.
An abstract should stand on its own, i.e., no citations, cross-references to the body of the document, acronyms must be spelled out, ...
Write this early and revise as necessary. This will help keep you focused on what you are trying to do.

Enter your abstract here!

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 on your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

The following are some notes about what can be included (in terms of LaTeX) in your abstract.

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 symbols that you might find useful are available, such as: \textregistered, \texttrademark, and \textcopyright. For example, the copyright symbol: \textcopyright Maguire 2022 results in ©Maguire 2022. Additionally, here are some examples of text superscripts (which can be combined with some symbols): ^{99m}Tc, A*, A^{\textregistered}, and A\texttrademark resulting in ^{99m}Tc, A*, A®, and A™. Two examples of subscripts are: H\textsubscript{2}O and CO\textsubscript{2} which produce H_2O and CO_2.

You can use simple environments with begin and end: itemize and enumerate and within these use instances of \item.

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

The following commands for numbering with lowercase Roman numerals: \first, \Second, \third, \fourth, \fifth, \sixth, \seventh, and \eighth: (i), (ii), (iii), (iv), (v), (vi), (vii), and $(viii)$. Note that the second case is set with a capital 'S' to avoid conflicts with the use of second of as a unit in the `siunitx` package.

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

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

Note that you **cannot** use an equation between dollar signs.

Even LaTeX comments can be handled, for example: % comment. Note that one can include percentages, such as: 51% or $51\,\%$.

Keywords

Canvas Learning Management System, Docker containers, Performance tuning

Choosing good keywords can help others to locate your paper, thesis, dissertation, …and related work.

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 (ht

tps://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/)

Formatting the keywords:

- 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

Inside the following scontents environment, you cannot use a \includefilename as it will not end up in the for diva information. Additionally, you should not use a straight double quote character in the abstracts or keywords, use two single quote characters instead.

Enter your Swedish abstract or summary here!

Alla avhandlingar vid KTH **måste ha** ett abstrakt på både *engelska* och *svenska*.
Om du skriver din avhandling på svenska ska detta göras först (och placera det som det första abstraktet) - och du bör revidera det vid behov.

If you are writing your thesis in English, you can leave this until the draft version that goes to your opponent for the written opposition. In this way, you can provide the English and Swedish abstract/summary information that can be used in the announcement for your oral presentation.
If you are writing your thesis in English, then this section can be a summary targeted at a more general reader. However, if you are writing your thesis in Swedish, then the reverse is true – your abstract should be for your target audience, while an English summary can be written targeted at a more general audience.
This means that the English abstract and Swedish sammnfattning or Swedish abstract and English summary need not be literal translations of each other.

Do not use the \glspl{} command in an abstract that is not in English, as my programs do not know how to generate plurals in other languages. Instead, you will need to spell these terms out or give the proper plural form. In fact, it is a good idea not to use the glossary commands at all in an abstract/summary in a language other than the language used in the `acronyms.tex file` - since the glossary package does **not** support use of more than one language.

The abstract in the language used for the thesis should be the first abstract, while the Summary/Sammanfattning in the other language can follow

Nyckelord

Canvas Lärplattform, Dockerbehållare, Prestandajustering
Nyckelord som beskriver innehållet i uppsatsen eller rapporten

If you are an exchange student, use the relevant language or languages for abstracts for your home university, as this will often avoid the need for writing another thesis for your home university.
If you are fluent in other languages, feel free to add the abstracts in one or more of them.

Note that you may need to augment the set of languages used in `polyglossia` or `babel` (see the file `kththesis.cls`). The following languages include those languages that were used in theses at KTH in 2018-2019, except for one in Chinese.
Remove those versions of abstracts that you do not need.
If you add a new language, when specifying the language for the abstract, use the three-letter ISO 639-2 Code – specifically the "B" (bibliographic) variant of these codes (note that this is the same language code used in DiVA).

Sommario

Sommario in italiano.

parole chiave

5-6 parole chiave

Acknowledgments

Författarnas tack

It is nice to acknowledge the people that have helped you. It is also necessary to acknowledge any special permissions that you have gotten – for example, getting permission from the copyright owner to reproduce a figure. In this case, you should acknowledge them and this permission here and in the figure's caption.
Note: If you do **not** have the copyright owner's permission, then you **cannot** use any copyrighted figures/tables/.... Unless stated otherwise all figures/tables/...are generally copyrighted.

I would like to thank xxxx for having yyyy. Or in the case of two authors: We would like to thank xxxx for having yyyy.

Stockholm, February 2024
Fake A. Manfredi

Contents

List of Figures

List of Tables

Listings

List of acronyms and abbreviations

This document is incomplete. The external file associated with the glossary 'acronym' (which should be called `thesis.acr`) hasn't been created.

Check the contents of the file `thesis.acn`. If it's empty, that means you haven't indexed any of your entries in this glossary (using commands like `\gls` or `\glsadd`) so this list can't be generated. If the file isn't empty, the document build process hasn't been completed.

Try one of the following:

- Add `automake` to your package option list when you load `glossaries-extra.sty`. For example:

  ```
  \usepackage[automake]{glossaries-extra}
  ```

- Run the external (Lua) application:

  ```
  makeglossaries-lite.lua "thesis"
  ```

- Run the external (Perl) application:

  ```
  makeglossaries "thesis"
  ```

Then rerun LaTeX on this document.

This message will be removed once the problem has been fixed.

The list of acronyms and abbreviations should be in alphabetical order based on the spelling of the acronym or abbreviation.

Chapter 1

Introduction

svensk: Introduktion

Ofta kommer problemet och problemägaren från industrin där man önskar en specifik lösning på ett specifikt problem. Detta är ofta ”för smalt” definierat och ger ofta en ”för smal” lösning för att resultatet skall vara intressant ur ett mer allmänt ingenjörsperspektiv och med ”nya” erfarenheter som resultat. Fundera tillsammans med projektets intressenter (student, problemägare och akademi) hur man skulle kunna använda det aktuella problemet/förslaget för att undersöka någon ingenjörsaspekt och vars resultat kan ge ny eller kompletterande erfarenhet till ingenjörssamfundet och vetenskapen.
slöser man en del eller hela delen av det ursprungliga problemet.
Erfarenheten kommer ur en frågeställning som man i examensarbetet försöker besvara med tidigare och andras erfarenhet, egna eller modifierade metoder som ger ett resultat vilket kan användas för att diskutera ett svar på undersökningsfrågan.
Detta stycke skall alltså, förutom det ursprungliga ”smala” problemet, innehålla vad som skall undersökas för att skapa ny ingenjörserfarenhet och/eller vetenskap.

The first paragraph after a heading is not indented, all of the subsequent paragraphs have their first line indented.

This chapter describes the specific problem that this thesis addresses, the context of the problem, the goals of this thesis project, and outlines the structure of the thesis.

Give a general introduction to the area. (Remember to use appropriate references in this and all other sections.)

We use the *bibtex* package to handle our references. We, therefore, use the command \cite{farshin_make_2019}. For example, Farshin, *et al.*, described how to improve LLC cache performance in [1] in the context of links running at 200 Gbps.

Use the glossaries package to help yourself and your readers. Add the acronyms and abbreviations to lib/acronyms.tex. Some examples are shown below:

In this thesis, we will examine the use of Local Area Networks (LANs). In this thesis, we will assume that LANs include Wireless Local Area Networks (WLANs), such as Wireless Fidelity (Wi-Fi).

1.1 Background

svensk: Bakgrund

Present the background for the area. Set the context for your project – so that your reader can understand both your project and this thesis. (Give detailed background information in Chapter 2 - together with related work.) Sometimes it is useful to insert a system diagram here so that the reader knows what are the different elements and their relationship to each other. This also introduces the names/terms/... that you are going to use throughout your thesis (be consistent). This figure will also help you later delimit what you are going to do and what others have done or will do.

As one can find in RFC 1235 [2] 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

svensk: Problemdefinition eller Frågeställning
Lyft fram det ursprungliga problemet om det finns något och definiera därefter den ingenjörsmässiga erfarenheten eller/och vetenskapen som kan komma ur projektet.

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

1.2.1 Original problem and definition

Ursprungligt problem och definition

Some text

1.2.2 Scientific and engineering issues

Vetenskaplig och ingenjörsmässig frågeställning

some text

1.3 Purpose

Syfte

Skilj på syfte och mål! Syfte är att förändra något till det bättre. I examensarbetet finns ofta två aspekter på detta. Dels vill problemägaren (företaget) få sitt problem löst till det bättre men akademin och ingenjörssamfundet vill också få nya erfarenheter och vetskap. Beskriv ett syfte som tillfredställer båda dessa aspekter.
Det finns även ett syfte till som kan vara värt att beakta och det är att du som student skall ta examen och att du måste bevisa, i ditt examensarbete, att du uppfyller examensmålen. Dessa mål sammanfaller med kursmålen för examensarbetskursen.

State the purpose of your thesis and the purpose of your degree project. Describe who benefits and how they benefit if you achieve your goals. Include anticipated ethical, sustainability, social issues, etc. related to your project. (Return to these in your reflections in Section 7.4.)

1.4 Goals

Mål

Skilj på syfte och mål. Syftet är att åstakomma en förändring i något. Målen är vad som konkret skall göras för att om möjligt uppnå den önskade förändringen (syfte).

State the goal/goals of this degree project.

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

1. Subgoal 1

   för att tillfredsställa problemägaren – industrin?

2. Subgoal 2

   för att tillfredsställa ingenjörssamfundet och vetenskapen – akademin)

3. Subgoal 3

   eventuellt, för att uppfylla kursmålen – du som student

In addition to presenting the goal(s), you might also state what the deliverables and results of the project are.

1.5 Research Methodology

Undersökningsmetod

Här anger du vilken vilken övergripande undersökningsstrategi eller metod du skall använda för att försöka besvara den akademiska frågeställning och samtidigt lösa det e v ursprungliga problemet. Ofta kan man använda ”lösandet av ursprungsproblemet” som en fallstudie kring en akademisk frågeställning. Du undersöker någon intressant fråga i ”skarpt” läge och samlar resultat och erfarenhet ur detta.
Tänk på att företaget ibland måste stå tillbaka i sin önskan och förväntan på projektets resultat till förmån för ny eller kompletterande ingenjörserfarenhet och vetenskap (ditt examensarbete). Det är du som student som bestämmer och löser fördelningen mellan dessa två intressen men se till att alla är informerade.

Introduce your choice of methodology/methodologies and method/methods – and the reason why you chose them. Contrast them with and explain why you did not choose other methodologies or methods. (The details of the actual methodology and method you have chosen will be given in Chapter 3. Note that in Chapter 3, the focus could be research strategies, data collection, data analysis, and quality assurance.)
In this section you should present your philosophical assumption(s), research method(s), and research approach(es).

1.6 Delimitations

Avgränsningar

Describe the boundary/limits of your thesis project and what you are explicitly not going to do. This will help you bound your efforts – as you have clearly defined what is out of the scope of this thesis project. Explain the delimitations. These are all the things that could affect the study if they were examined and included in the degree project.

1.7 Structure of the thesis

Rapportens disposition

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

Chapter 2

Background

Bakgrund

When you do your literature study, you should have a nearly complete Chapters 1 and 2.
You may also find it convenient to introduce the future work section into your report early – so that you can put things that you think about but decide not to do now into this section.
Note that later you can move things between this future work section and what you have done as you may change your mind about what to do now versus what to put off to future work.

What does a reader (another x student – where x is your study line) need to know to understand your report? What have others already done? (This is the "related work".) Explain what and how prior work/prior research will be applied on or used in the degree project/work (described in this thesis). Explain why and what is not used in the degree project and give valid reasons for rejecting the work/research.

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

Vilken viktig litteratur och (forsknings-)artiklar har du studerat inom området (litteraturstudie)?

2.1 Major background area 1

Viktigt bakgrundsområde 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.

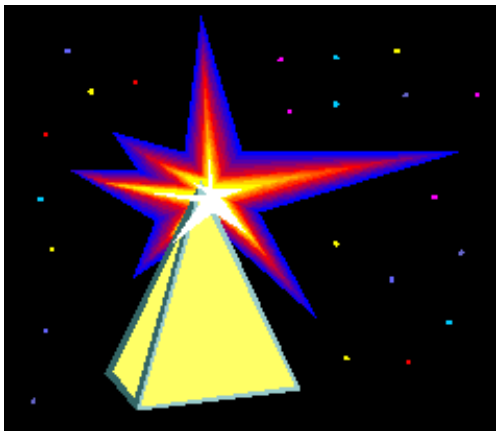


Figure 2.1: Lots of stars (Inspired by Figure x.y on page z of [xxx])

Massor av stärnor (Inspirerad av figur x.y på sidan z i [xxx])

Table 2.1: xxx characteristics

Characteristics	**Description**
α	β
1	1 110.1
2	10.1
3	23.113 231

Egenskaper

Beskrivning

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 [3].

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 [4]. ...

2.1.3 Subarea 1.1.2

Using the nearest data center may improve performance, see [5]

2.1.4 Link layer Encapsulation

See Figure 2.2 which uses the bytefield LaTeX package.

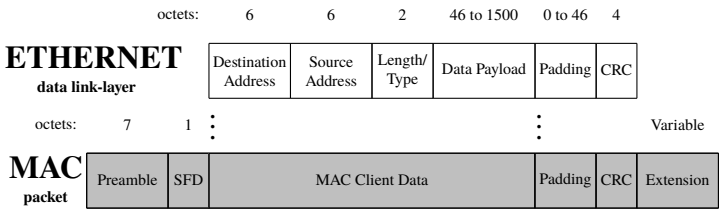


Figure 2.2: Ethernet data link layer protocol encapsulated into a IEEE 802.3 MAC packet

2.1.5 IP packet headers

The data link layer will receive a packet from the IP layer. The layout of an IPv4 packet is shown in Figure 2.3. This should be contrasted with the IPv6 header shown in Figure 2.4.

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: $(C_5O_2H_8)_n$ ...

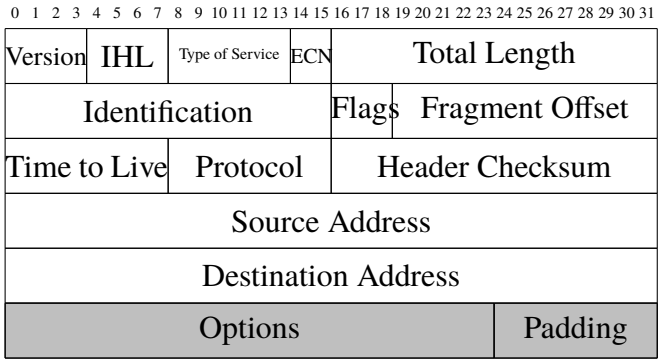


Figure 2.3: IPv4 datagram header. Light grey coloured fields are optional.

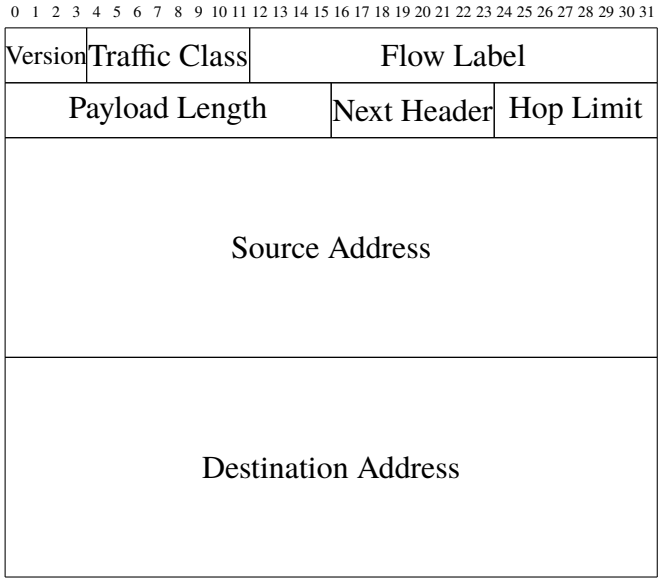


Figure 2.4: IPv6 datagram header

2.2 Major background area 2

Viktigt bakgrundsområde 2

...

2.2.1 WLAN Security

2.2.2 Network layer security

...

2.3 Related work area

Relaterade arbeten

2.3.1 Major related work 1

Relaterade arbeten 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 [6].

2.3.2 Major related work n

Relaterade arbeten

2.3.3 Minor related work 1

Mindre relaterat arbete 1

...

2.3.4 Minor related work n

Mindre relaterat arbete n

2.4 Summary

Sammanfattning

Det är trevligt om detta kapitel avslutas med en sammanfattning. Till exempel kan du inkludera en tabell som sammanfattar andras idéer och fördelar och nackdelar med varje - så som senare kan du jämföra din lösning till var och en av dessa. Detta kommer också att hjälpa dig att definiera de variabler som du kommer att använda för din utvärdering.

It is nice to have this chapter conclude with a summary. For example, you can include a table that summarizes other people's ideas and benefits and drawbacks with each - so as later you can compare your solution to each of them. This will also help you define the variables that you will use for your evaluation.

Chapter 3

Method

Chapter 4

Implementation

Choose your own chapter title to describe this

[Vad gjorde du? Hur gick det till? – Välj lämplig rubrik (“Genomförande”, “Konstruktion”, ”Utveckling” eller annat]

What have you done? How did you do it? What design decisions did you make? How did what you did help you to meet your goals?

Vad du har gjort? Hur gjorde du det? Vilka designval gjorde du? Hur kom det du hjälpte dig att uppnå dina mål?

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

Hårdvara / Mjukvarudesign ... / modell / Simuleringsmodell och parametrar / . . .

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. In 7.0 % of cases, there was an error indicating xxxxx.

Figur 4.1 visar en enkel ikon för en hemsida. Tiden för att få tillgång till den här sidan när den laddas kommer att kvantifieras i en serie experiment. De konfigurationer som har testats i provbänk listas ini tabell 4.1.
Vad du har gjort? Hur gjorde du det? Vilka designval gjorde du?

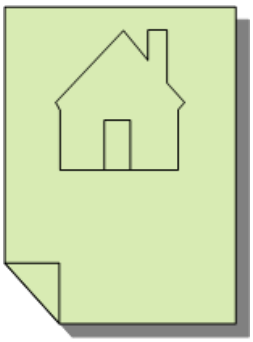


Figure 4.1: Homepage icon

Table 4.1: Configurations tested

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

Testade konfigurationer

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

Implementering . . . / modellering / simulering / . . .

Two commonly used simulators are:

Mininet This simulator uses traffic control (`tc`) to simulate network devices connected by links with specific bandwidth, packet loss rates, qdisc methods, etc.

ns-2 or ns-3 simulator These simulators are very useful for simulating wireless communication links between moving devices. You can specify the mobility patterns of the nodes.

4.2.1 Some examples of coding

This section is simply to show some example of how you can include code in your thesis - this is not a section you would have in your thesis.

Det här avsnittet är helt enkelt för att visa ett exempel på hur du kan inkludera kod i ditt examensarbete - det här är inte ett avsnitt du skulle ha i ditt examensarbete.

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
```

4.2.2 Some examples of figures in tikz

This section is simply to show some example of how you can draw your own figures for in your thesis - this is not a section you would have in your thesis.

Det här avsnittet är helt enkelt för att visa ett exempel på hur du kan rita dina egna figurer i ditt examensarbete – det här är inte ett avsnitt du skulle ha i ditt examensarbete.

These figures are just some examples to show that you can draw your own figures for in your thesis. This has two advantages: (i) you do not have to worry about copyrights – as these are your own figures and (ii) the text is now readable and not simply a picture of text – so screen readers can read the figure's contents to someone who is listening to the contents of your thesis.

4.2.2.1 Azure's Form Recognizer

Figure 4.2 shows the processing of key-value extraction from a PDF document using Azure's Form Recognizer.

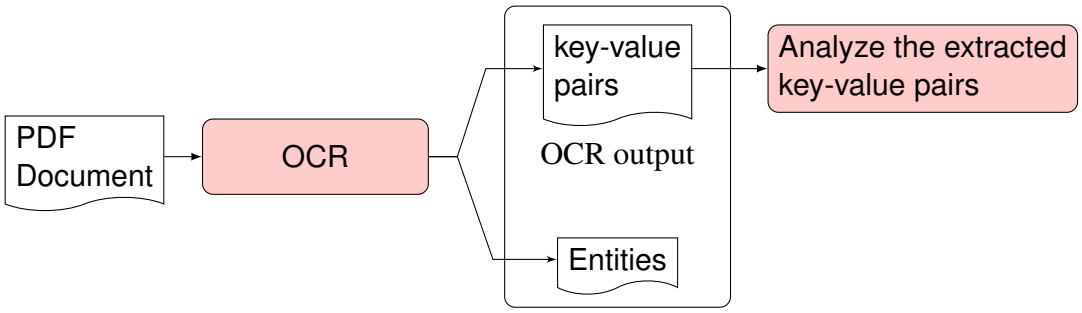


Figure 4.2: The processing of key-value extraction from a PDF document using Azure's Form Recognizer

4.2.2.2 Hyper-V with Containers

Figure 4.3 shows how Hyper-V deals with containers.

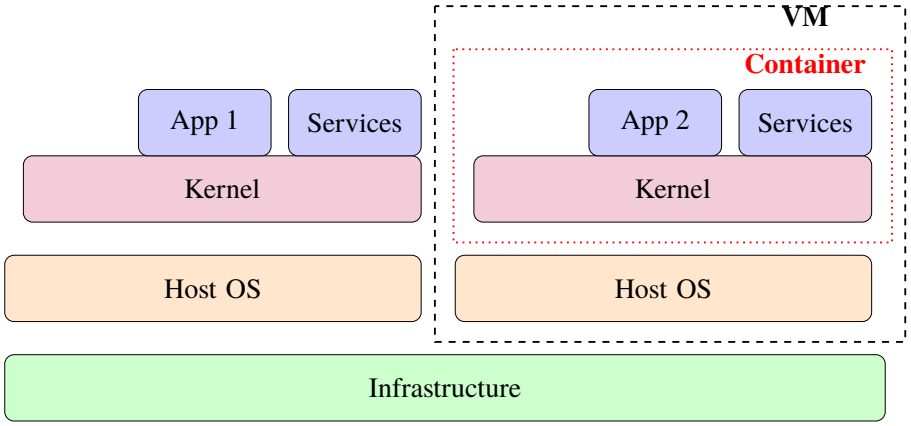
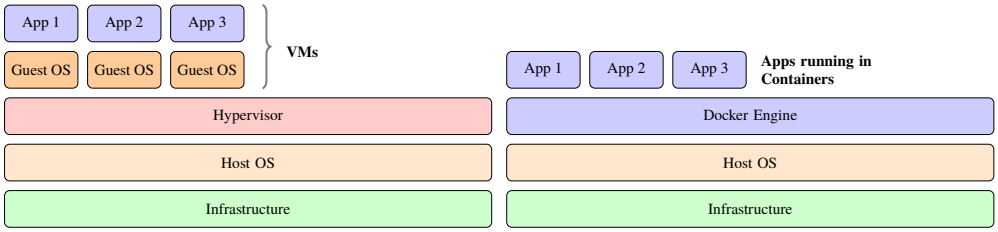


Figure 4.3: Hyper-V with containers

4.2.2.3 VM versus Containers

Figure 4.4 shows a comparison of virtual machines (VMs) versus containers.



(a) VM (b) Containers

Figure 4.4: Virtual machines (VMs) versus Containers

Chapter 5

Results and Analysis

svensk: Resultat och Analys

Sometimes this is split into two chapters.
Keep in mind: How you are going to evaluate what you have done?
What are your metrics?
Analysis of your data and proposed solution
Does this meet the goals which you had when you started?

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

I detta kapitel presenterar vi resultaten och diskutera dem.
Ibland delas detta upp i två kapitel.
Hur du ska utvärdera vad du har gjort? Vad är din statistik?
Analys av data och föreslagen lösning
Innebär detta att uppfyllelse av de mål som du hade när du började?

5.1 Major results

Huvudsakliga resultat

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.

Lite statistik av fördröjningsmätningarna visas i Tabell 5.1. Förseningen har beräknats från den tidpunkt då begäran GET tas emot fram till svaret skickas.

Table 5.1: Delay measurement statistics

Configuration	**Average delay (ns)**	**Median delay (ns)**
1	467.35	450.10
2	1 687.5	901.23

Table 5.2 shows the measurement of round trip times from four hosts to and from a server.

Table 5.2: Result for the ping measurements of RTT for 4 hosts

	host to server RTT in ms			
Host	min	avg	max	mdev
h1	5.625	5.625	5.625	0.0
h2	2.909	2.909	1.909	0.0
h3	5.007	5.007	5.007	0.0
h4	2.308	2.308	2.308	0.0

Fördröj mätstatistik

Konfiguration | Genomsnittlig fördröjning (ns) | Median fördröjning (ns)

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

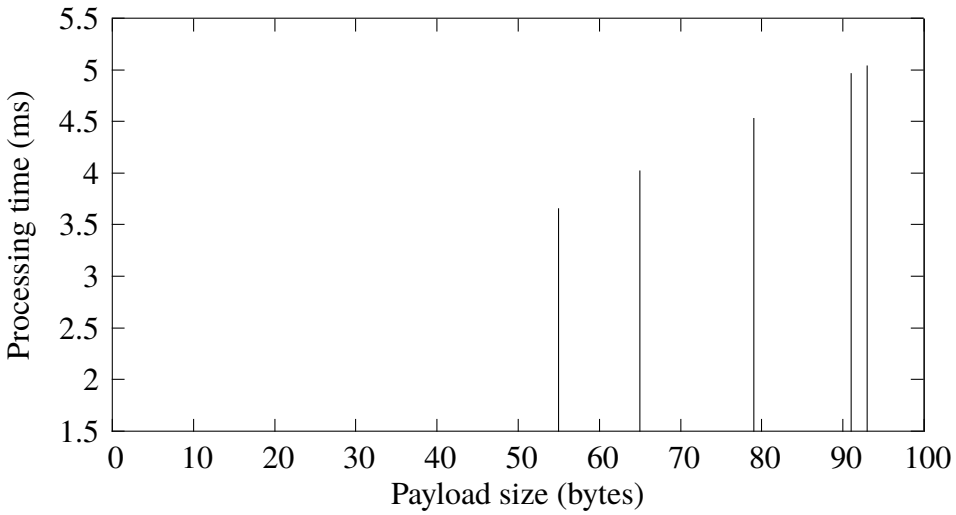


Figure 5.1: Processing time vs. payload length

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:

$$\text{bit rate} = \frac{1}{\frac{\text{time}_{\text{byte}}}{8}} = 20.03 \quad kb/s$$

Table 5.3 shows another table in which some values have been set in bold (using \B) to emphasize them. Note how the `S` formatting has been modified so that it considers the weight of the characters and this is able to decimal align even these hold-faced numbers with the numbers in the column above them.

Table 5.3: Median values of sandwich attributes

	sites	
Attribute	**A**	**B**
price (in SEK)	36.5	71.3
protean (g)	97.2	100.0
salt (mg)	9.7	9.3
Average customer rating in %	**82.2**	**89.9**

Figure 5.2 shows a stacked bar chart using pgfplots. It illustrates how easy it is to take a set of data and make a stacked bar plot. One of the features is the shifted values – this is very useful when the bar itself is too small to put the value into.

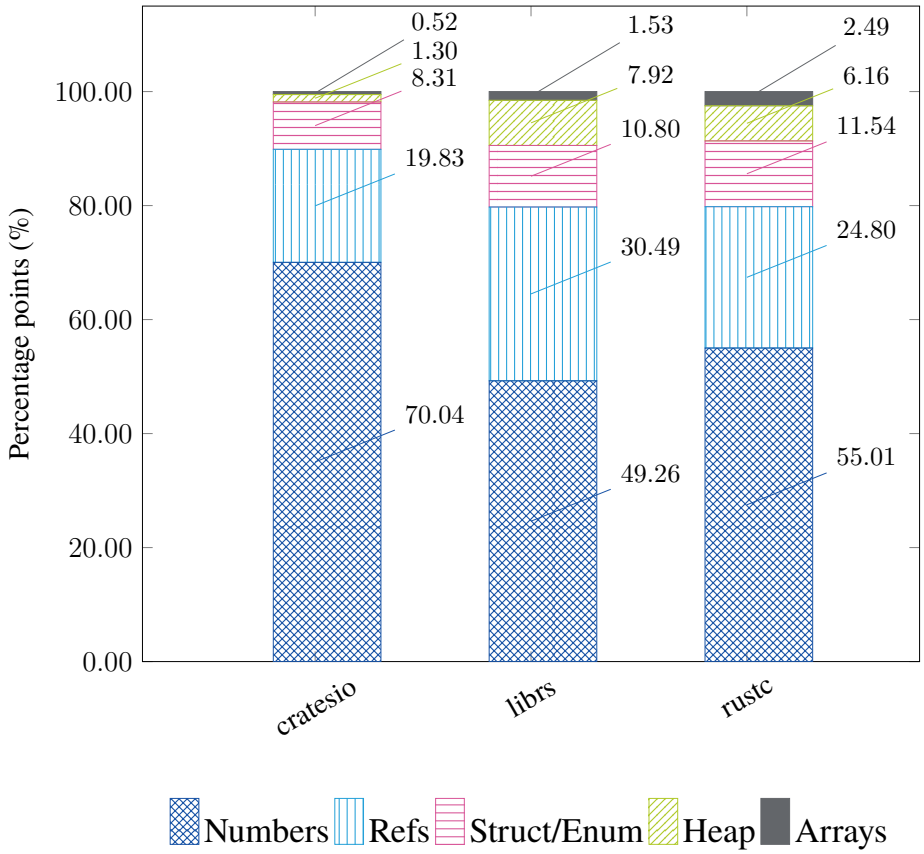


Figure 5.2: Rust types distribution for the compiler, crates.io, and lib.rs. (percentage) - appears here with the permission of the author - see the thesis at https://urn.kb.se/resolve?urn=urn%3Anbn%3Ase%3Akth%3Adiva-332124

5.2 Reliability Analysis

Analys av tillförlitlighet
Tillförlitlighet i metod och data

5.3 Validity Analysis

Analys av validitet
Validitet i metod och data

Chapter 6

Discussion

Diskussion
Förbättringsförslag?

This can be a separate chapter or a section in the previous chapter.

Chapter 7

Conclusions and Future work

Slutsats och framtida arbete

Add text to introduce the subsections of this chapter.

7.1 Conclusions

Slutsatser

Describe the conclusions (reflect on the whole introduction given in Chapter 1).

Discuss the positive effects and the drawbacks.
Describe the evaluation of the results of the degree project.
Did you meet your goals?
What insights have you gained?
What suggestions can you give to others working in this area?
If you had it to do again, what would you have done differently?

Uppfyllde du dina mål?
Vilka insikter har du fått?
Vilka förslag kan du ge till andra som arbetar inom detta område? Om du skulle göra detta igen, vad skulle du ha gjort annorlunda?

7.2 Limitations

Begränsande faktorer
Vad gjorde du som begränsade dina ansträngningar? Vilka är begränsningarna i dina resultat?

What did you find that limited your efforts? What are the limitations of your results?

7.3 Future work

Vad du har kvar ogjort?
Vad är nästa självklara saker som ska göras?
Vad tips kan du ge till nästa person som kommer att följa upp på ditt arbete?

Describe valid future work that you or someone else could or should do. Consider: What you have left undone? What are the next obvious things to be done? What hints can you give to the next person who is going to follow up on your 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

Example of a missing component

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

Example of a missing component

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

Reflektioner

Vilka är de relevanta ekonomiska, sociala, miljömässiga och etiska aspekter av ditt arbete?

What are the relevant economic, social, environmental, and ethical aspects of your work?

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 United Nations (UN) Sustainable Development Goals (SDGs) numbers 1 and 9 by xxxx.

In the references, let Zotero or other tool fill this in for you. I suggest an extended version of the IEEE style, to include URLs, DOIs, ISBNs, etc., to make it easier for your reader to find them. This will make life easier for your opponents and examiner.
IEEE Editorial Style Manual: https://www.ieee.org/content/dam/ieee-org/ieee/web/org/conferences/style_references_manual.pdf

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Appendix A

Supporting materials

Here is a place to add supporting material that can help others build upon your work. You can include files as attachments to the PDF file or indirectly via URLs. Alternatively, consider adding supporting material uploaded as separate files in DiVA.

The BibTeX references used in this thesis are attached. 

Some source code relevant to this project can be found at https://github.com/gqmaguirejr/E-learning and https://github.com/gqmaguirejr/Canvas-tools.

Your reader can access the attached (embedded) files using a PDF tool such as Adobe Acrobat Reader using the paperclip icon in the left menu, as shown in **??** or by right-clicking on the push-pin icon in the PDF file and then using the menu to save the embedded file as shown in **??**.

An argument for including supporting material in the PDF file is that it will be available to anyone who has a copy of the PDF file. As a result, they do not have to look elsewhere for this material. This comes at the cost of a larger PDF file. However, the embedded files are encoded into a compressed stream within the PDF file; thus, reducing the number of additional bytes. For example, the references.bib file that was used in this example is $10\,617\,\mathrm{B}$ in size but only occupies $4\,261\,\mathrm{B}$ in the PDF file.

DiVA is limited to $\approx 1\,\mathrm{GB}$ for each supporting file. If you have very large amounts of supporting material, you will probably want to use one of the data repositories. For additional help about this, contact KTH Library via researchdata@kth.se.

Appendix B

Something Extra

B.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

Appendix C

Main equations

This appendix gives some examples of equations that are used throughout this thesis.

C.1 A simple example

The following example is adapted from Figure 1 of the documentation for the package nomencl (https://ctan.org/pkg/nomencl).

$$a = \frac{N}{A} \tag{C.1}$$

The equation $\sigma = ma$ follows easily from Equation (C.1).

C.2 An even simpler example

The formula for the diameter of a circle is shown in Equation (C.2) area of a circle in eq. (C.3).

$$D_{circle} = 2\pi r \tag{C.2}$$

$$A_{circle} = \pi r^2 \tag{C.3}$$

Some more text that refers to (C.3).

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Enter your abstract here!

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 on your results? What can be done now that you have finished - that could not be done before your thesis project was completed?

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Canvas Learning Management System, Docker containers, Performance tuning €€€€,
"Abstract[swe]": €€€€

Enter your Swedish abstract or summary here!

Alla avhandlingar vid KTH **måste ha** ett abstrakt på både *engelska* och *svenska*.
Om du skriver din avhandling på svenska ska detta göras först (och placera det som det första abstraktet) - och du bör revidera det vid behov.

If you are writing your thesis in English, you can leave this until the draft version that goes to your opponent for the written opposition. In this way, you can provide the English and Swedish abstract/summary information that can be used in the announcement for your oral presentation.
If you are writing your thesis in English, then this section can be a summary targeted at a more general reader. However, if you are writing your thesis in Swedish, then the reverse is true – your abstract should be for your target audience, while an English summary can be written targeted at a more general audience.
This means that the English abstract and Swedish sammnfattning or Swedish abstract and English summary need not be literal translations of each other.

Do not use the \glspl{} command in an abstract that is not in English, as my programs do not know how to generate plurals in other languages. Instead, you will need to spell these terms out or give the proper plural form. In fact, it is a good idea not to use the glossary commands at all in an abstract/summary in a language other than the language used in the `acronyms.tex file` - since the glossary package does **not** support use of more than one language.

The abstract in the language used for the thesis should be the first abstract, while the Summary/Sammanfattning in the other language can follow

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Canvas Lärplattform, Dockerbehållare, Prestandajustering €€€€,
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5-6 parole chiave €€€€,
}

acronyms.tex

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%%% Local Variables:
%%% mode: latex
%%% TeX-master: t
%%% End:
% The following command is used with glossaries-extra
\setabbreviationstyle[acronym]{long-short}
% The form of the entries in this file is \newacronym{label}{acronym}{phrase}
%                                      or \newacronym[options]{label}{acronym}{phrase}
% see "User Manual for glossaries.sty" for the  details about the options, one example is shown below
% note the specification of the long form plural in the line below
\newacronym[longplural={Debugging Information Entities}]{DIE}{DIE}{Debugging Information Entity}
%
% The following example also uses options
\newacronym[shortplural={OSes}, firstplural={operating systems (OSes)}]{OS}{OS}{operating system}

% note the use of a non-breaking dash in long text for the following acronym
\newacronym{IQL}{IQL}{Independent Q^^e2^^80^^91Learning}

\newacronym{KTH}{KTH}{KTH Royal Institute of Technology}

\newacronym{LAN}{LAN}{Local Area Network}
\newacronym{VM}{VM}{virtual machine}
% note the use of a non-breaking dash in the following acronym
\newacronym{WiFi}{Wi^^e2^^80^^91Fi}{Wireless Fidelity}

\newacronym{WLAN}{WLAN}{Wireless Local Area Network}
\newacronym{UN}{UN}{United Nations}
\newacronym{SDG}{SDG}{Sustainable Development Goal}
```