



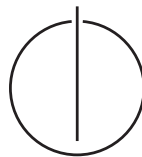
SCHOOL OF COMPUTATION,
INFORMATION AND TECHNOLOGY —
INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Bachelor's Thesis in Informatics

Effects of Linux VFIO for User Space I/O

Adrian Simon Würth





SCHOOL OF COMPUTATION,
INFORMATION AND TECHNOLOGY —
INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Bachelor's Thesis in Informatics

Effects of Linux VFIO for User Space I/O

Effekt von Linux VFIO auf User Space E/A

Author:	Adrian Simon Würth
Supervisor:	Prof. Dr. Thomas Neumann
Advisor:	Simon Ellmann, M.Sc.
Submission Date:	August 15, 2024



I confirm that this bachelor's thesis in informatics is my own work and I have documented all sources and material used.

Munich, July 1, 2024

Adrian Simon Würth

Abstract

We present a framework for students to bootstrap your final thesis. The primary goal of this template is to improve the quality of the thesis by avoiding typical mistakes. Our framework focuses on the basic thesis structure, which is mostly applicable, and helps you to immediately start writing. The first step is that the student writes down what he did so far, and performs some changes to this structure, yielding a thesis with notes and a rough plan how to write it up. The second step is to transform your notes into sentences, yielding a first draft. A template is the first step to the final thesis. In contrast to writing a thesis from scratch, our approach gives you a scaffold and helps you focusing on the important parts. We also show how to plot your data and describe your experiments. We present experimental results showing the perfect final thesis in the end.

As you might already have noticed, the abstract is the first, and sometimes only part the reader notices. Thus it's crucial to summarize your work while motivating the reader here. To help you with formulating we provide a basic structure to just fill the gaps. Afterward, you can and should reformulate it to add your personal touch to it.

[...] present [...] for [...] to [...]. The primary goal of [...] is to improve [...] by avoiding [...] . Our framework focuses on [...], which is [...] , and is [...]. The first [...] , and performs [...], yielding [...]. The second [...] where [...], and yields [...]. [...] is the first [...]. In contrast [...], our approach [...]. We also show how [...]. We present experimental results showing [...].

Contents

Abstract	iii
1 Introduction	1
1.1 Motivation	1
1.2 State of the Art	2
1.3 Structure	2
2 Background	3
2.1 vroom	3
2.2 IOMMU	3
2.3 VFIO	3
3 Related Work	4
3.1 SPDK	4
4 Implementation	5
4.1 VFIO	5
5 Evaluation	6
5.1 Setup	6
5.2 Latency	6
5.3 IOTLB	6
6 Conclusion	7
List of Figures	8
List of Tables	9
Listings	10
Bibliography	11

1 Introduction

First, a disclaimer: This document is only a template and an advice. It is not binding! You are completely free to ignore all the advice given (if you have a reason)¹.

The introduction motivates the reader and shows the importance of the topic. Thus it does not have to be as technical as the remainder of the thesis. A common method is to briefly outline the development of the topic with a time frame. One figure with some time data or other plot helps to catch the attention more easily. It is more general and motivates that a topic in this field is interesting to consider.

This chapter contains the following:

- Show importance of the topic (e.g. with time frame)
- Motivate the topic (e.g. by a knowledge gap or a controversy)
- State the focus and aim of the thesis.
- Explain some keyword and show the related work if its short
- Outline the structure of the remainder

1.1 Motivation

This section motivates why you did the thesis. For example there was a knowledge gap before or the sources cannot agree on one opinion. Afterward, it has to be clear why and what you are doing in the thesis. This gives the reader an impression of what to expect in this thesis.

In the end you may anticipate the end of the thesis and show a brief before, after comparison – maybe also using a figure. However, keep in mind that the reader may not know all technicalities yet. So it has to be as precise as possible without overusing terminologies.

¹This holds for all sections.

1.2 State of the Art

This section is optional depending on how much related work you have to cover. If it's little or very much this section may be helpful.

Little related work You can describe all your related work here and give an overview how the topic evolved. You should end in the current state of art and give the reader some insights in the field to compare your work to the work already done by others.

More related work This section gives a really brief comparing summary of the related work. It should only consist of a comparison of the most important approaches and the most important developments the reader needs to understand the topic. You should finally forward reference to your related work section.

For both cases its beneficial to introduce terminology here and introduce the reader into your subject.

1.3 Structure

Here you can give an outline over the remainder of the thesis to give a jump table for the reader to see which are the most interesting chapters to read.

[HSS08]

2 Background

2.1 vroom

2.2 IOMMU

2.3 VFIO

3 Related Work

3.1 SPDK

4 Implementation

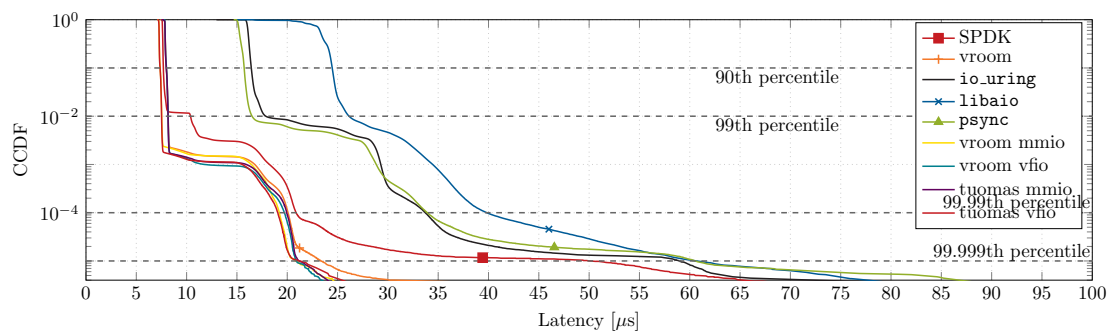
4.1 VFIO

5 Evaluation

5.1 Setup

5.2 Latency

5.3 IOTLB



(a) Random write

Figure 5.1: Tail latencies

6 Conclusion

List of Figures

5.1 Tail latencies	6
------------------------------	---

List of Tables

Listings

Bibliography

- [HSS08] A. A. Hagberg, D. A. Schult, and P. J. Swart. “Exploring Network Structure, Dynamics, and Function using NetworkX.” In: *Proceedings of the 7th Python in Science Conference*. Ed. by G. Varoquaux, T. Vaught, and J. Millman. Pasadena, CA USA, 2008, pp. 11 –15.