



UNIVERSITY OF STAVANGER

BACHELOR THESIS

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**Make the Internet Faster!**  
**Improving Alternative Backoff with ECN in Linux**

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# Abstract

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# Introduction

This chapter aims at giving an introduction and overview of the thesis. It starts with a brief explanation of why Internet today still feels slow despite major advances in technology, followed up by establishing the goals and research questions for the entire thesis. To address the research questions, a small view into the research methodology is presented, with a brief overview of the thesis structure in the final section.

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## 1.1 Background and Motivation

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## 1.2 Goals and Research Questions

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## 1.3 Research Methodology

## 1.4 Contributions

## 1.5 Thesis Structure

# Literature Review

This chapter presents the background theory for which this thesis is based upon.

## **2.1 Network Delay and Bufferbloat**

## **2.2 Transmission Control Protocol**

### **2.2.1 Congestion Control**

## **2.3 Active Queue Management**

### **2.3.1 Explicit Congestion Notification**

## **2.4 Alternative Backoff with ECN**

# Methodology

## 3.1 Network Topology

### 3.1.1 Raspberry Pi 4 Cluster

## 3.2 TCP Experimentation with TEACUP

### 3.2.1 Exposing TCP State with web10g

## 3.3 Achieving Low Latency with ABE

## 3.4 Improving ABE by Adapting Its Reduction Factor $\beta$

## Chapter 4

# Results

# Conclusion



# The PI4-Cluster Testbed

## A.1 Setting Up Dual Boot

First install Ubuntu. When asked for partitioning the disk, choose manual, select the disk and confirm creating a new empty partition with yes. Select the newly created empty partition followed by create a new partition and set a size for it. The type should be of primary, location at beginning and mounting point root. Finish off with done setting up the partition followed by finish partitioning and write changes to disk.

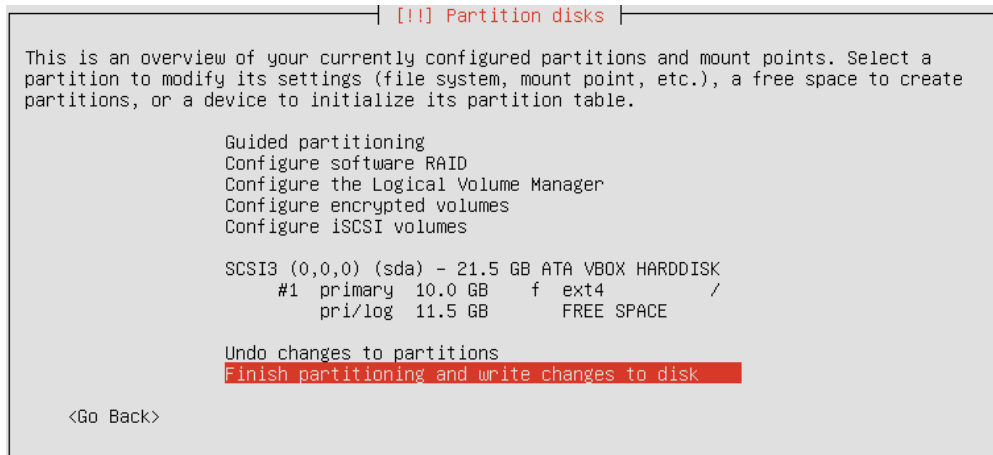


Figure A.1: The partition editor for Ubuntu.

Next, install FreeBSD. When asked for partitioning the disk, choose **auto** (UFS) followed by partition. Set a size, hit ok and finish.



Figure A.2: The partition editor for FreeBSD.

After installing both systems, only Ubuntu is presented in the **GRand Unified Bootloader (GRUB)**. To add FreeBSD as an option, run `sudo nano /etc/grub.d/40_custom` in Ubuntu, and add the following entry:

```

1 menuentry "FreeBSD" {
2     insmod ufs2
3     set root=(hd0,2)
4     kfreebsd /boot/loader
5 }
```

Then update **GRUB** with `sudo update-grub`. The FreeBSD option should now be available when rebooting. If the bootloader won't display, hold the RIGHT SHIFT key upon booting.

To enable a one-time reboot into FreeBSD from Ubuntu, run the command `grub-editenv /boot/grub/grubenv` set `next_entry="FreeBSD"` and reboot with `sudo reboot`.

## A.2 Compiling Mainline Kernel 5.5 for Raspberry Pi 4

## A.3 Patching web10g on Mainline Kernel 5.5

# Terms

**GRand Unified Bootloader (GRUB)** A Multiboot boot loader. It was derived from GRUB, the GRand Unified Bootloader, which was originally designed and implemented by Erich Stefan Boleyn.

# References

- [Kha+17] Naeem Khademi et al. “Alternative Backoff: Achieving Low Latency and High Throughput with ECN and AQM”. In: (2017), pp. 0-9.