

Small Data Center using Raspberry Pi for Video Streaming

Research Proposal

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ABSTRACT

This document describes a research proposal in the area of cloud computing services. Cloud computing is a trend IT that customers move computing and data away from desktop and portable PCs into large data centers. These data centers require a lot of power and cooling. Nowadays 30 % of the data coming from these data centers is video streaming. The Raspberry Pi is a not so costly device that can do research in Video streaming. The main research question is therefore: How well does the Raspberry Pi perform in small scale data centers with video streaming? To answer this question a micro Raspberry Pi video streaming service will be build.

Keywords

Cloud computing, Raspberry Pi, micro data server, video streaming, load balancing

1. MOTIVATION

Today most of us have some data in the cloud. But despite the attention from the community, research and development of Cloud Computing services are still in its early days [38].

Cloud computing is a trend IT that moves customers computing and data away from desktop and portable PCs into large data centers [11]. In the future most internet users will access internet services over lightweight portable devices requiring a lot of data bandwidth [11]. Video streaming for example requires a lot of bandwidth [2]. This bandwidth usage causes bottlenecks. To prevent these bottlenecks we build data centers around the globe. On these data servers a lot of improvements can be made. [bron zoeken](#)

In this research a small data server consisting of Raspberry Pi's will be investigated. A reason for this is that data centers require a lot of space and cooling. There are now new technologies such as for example the powerful ARM processor. Many companies want to explore the possibilities of for example the Raspberry Pi, this because of it's powerful processor compared to the price [29]. Some data centers already offer some cloud computing using the Raspberry Pi. Another reason for this is the small

location that the Raspberry Pi needs, and the low power usage of a Raspberry Pi [34, 29]. A Raspberry Pi has a power usage between the 3-5 Watt. A normal server has a power usage between the 75 and 250 Watt [30, 6]. However the Raspberry Pi has less computing power then a normal server. The low power consumption and its computing power could mean that it is better to use a Raspberry Pi for specific small tasks that do not demand an entire. During this research there will be a investigation on the performance of the Raspberry Pi as a small data server. A Raspberry Pi can be the small data center for the future [38]. The Raspberry is a less costly device and is sold for 40 euro. This makes it cheaper to do research in compared to a normal server. Building a cloud like this can be a cost effective scale model[38]. It's a ideal testbed for testing distributed software.

2. SPECIFIC PROBLEM

The Netherlands have one million subscribers for Netflix [10]. Netflix is a popular video streaming service that makes HD movies watching possible. For this Netflix makes use of a content distribution network (CDN). On the internet this is known as a on demand service [2]. Netflix makes use of MPEG-DASH a protocol that makes streaming over HTTP possible [23]. The problem is that Netflix is responsible for 29.7% of the peak downstream traffic in US [2]. Because of this downstream the two main providers Comcast and AT&T were limiting the downstream of Netflix. This caused a lot of criticism and a new law for net neutrality has been made [24].

In the Netherlands more and more users are making use of video streaming as Youtube and Netflix. The downstreaming problems and the more users making use of streaming make it interesting to do more research in video streaming by cloud computers. Most of the research nowadays happen on expensive large servers [38]. For this it can be very useful to see if it is possible to do research on a small computer like a Raspberry Pi. The problem is that we do not know if video streaming on a small Raspberry Pi cluster is possible.

3. RESEARCH QUESTIONS

The main research question

How well does the Raspberry Pi perform in small scale data centers with video streaming?

This research will be part literature study and a part of it will be building a small Raspberry Pi cloud to measure the availability of the video streaming. Here below there are several questions to come to a good answer for the main research question.

3.1 What are small scale data centers with video streaming and why are they used?

In this research there will be a small scale cloud data center with the Raspberry Pi. The main motivation behind this is that it is ways to expensive to do it on multiple large servers. Resources for this motivation: [8, 30, 9] Another reason is that little space is needed using a small scall data center. On the size of the data center is currently done a lot of research [29].

Small scale cloud computing is cloud computing with smaller computation amounts than normal. This can mean that it is better for different tasks. More motivation is that it does not use a lot cooling and power [38]. Resources available for small scale cloud computing: [29, 4, 35, 1, 8, 38, 7, 33, 16, 12, 13, 28, 25, 6, 9]

3.2 Is the Raspberry Pis usable for video streaming?

The Netherlands have one million subscribers for Netflix [10]. Netflix is a video streaming service that makes HD movies watching possible. This requires a lot of internet bandwidth and it could be useful to do the streaming in small scale data centers nearby. To investigate how video streaming at Netflix really works there are the following resources: [10, 2]

Netflix makes use of MPEG-DASH a protocol that makes streaming over HTTP possible. In this research there will be an investigation in the video streaming as a cloud service for a Raspberry Pi. To investigate what that is there are the following resources: [20, 37, 32, 19]

3.3 How to fit the Raspberry Pi's into a data center considering cooling, space allocation and power?

This research question will look into previous cloud cluster projects: [1, 8, 38, 7, 9]

From this a good setup for this Raspberry Pi project will be build. For this we will take power, cooling and location into account.

3.4 What setup does a Raspberry Pi cloud with video streaming require?

This research question will look into previous cloud cluster projects: [1, 8, 38, 7, 9]

There will be taken a look into the different software that has to be used. For example: [20, 37, 5, 22, 26, 3, ?, ?]

3.5 How is availability in a Raspberry pi cluster with video streaming affected by various load balancing techniques?

With this subquestion we will look into the different load balancing techniques. In a video streaming service it's very important to have high performance and availability. That's why it's interesting to do more research on this. Resources for load balancing on Raspberry Pi: [36, 17, 27, 31, 21]

Things that are interesting to look into are for example bandwidth usage, power usage, i/o throughput. For this the following resources will be used: [22, 26, 3]

4. RESEARCH METHODS

This research will investigate a cloud computer consisting of Raspberry Pi's. The research method for this would be the Design Science research method. this is a method to solve field problems. This research will make use of the design Science method proposed by Hevner [15].

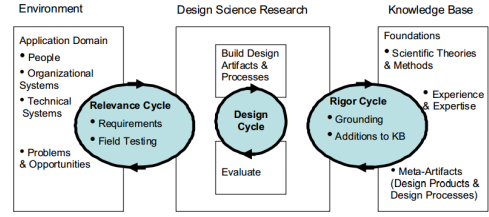


Figure 1: Design Science

For this design research the research will specify the requirements, existing solutions, new solutions and the result of this new solution. After that a conclusion will be given.

5. RESEARCH APPROACH

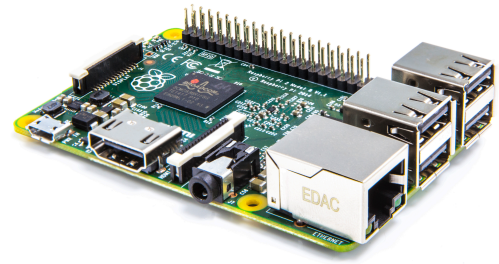


Figure 2: Raspberry Pi 2 model B

Ethernet	100 MBps
USB	4 x USB 2.0
Video out	HDMI 1.4
Audio	2 x analog
CPU	900MHz quad-core ARM Cortex-A7
card slot	Micro SD

Table 1: Specificaties

For the experiment we need a Raspberry Pi B or Raspberry Pi 2 that can make use of the Ethernet. This is because a Raspberry Pi can be used as a webserver and this is needed to have this in order to make video streaming possible. This webserver will make video streaming possible. Beside the Raspberry Pi a several other things will be needed. For this we have a cost structure:

Device	cost piece	use	amount	total cost
Raspberry Pi 2	32,60	cloud cluster	8	316
UTP cable	1,10	data cable	8	8,80
Micro usb cable	1	charging	8	8
switch	40	internet	1	40
micro SD				
				372,80

Table 2: Cost summary [18]

So first he video streaming webserver will be made. After this we will make a cluster with one Raspberry Pi as a load balancer and the other two as a video stream pi. The university of Southampton has made a cluster possible [8]. So I think it is also possible for video streaming. With this there several performance tests can be done. For example

some test in streaming in different quality with load balancing. The setup of the Raspberry Pi can be seen in the figure below 3.

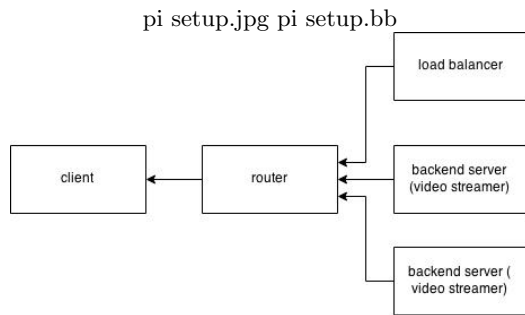


Figure 3: Setup

6. PLANNING

Week	Start Date	Activity
6-13	6 Feb	Collect literature and software
14	23-30 March	Deadline proposal
16	1 April	Accept Reject proposal
15-14	30 March	Start building test environment
17	6 April	Answer subquestion 1
18	13 April	Answer subquestion 2
19	21 April	Answer subquestion 3
16-18	6 April	working on test environment
20	1 May	Answer subquestion 4
21	4 May	conclusion and check coherency
21-22	11 May	Finalize paper
22	1 June	Deadline paper
23	8 June	Peer review
24-25	15 june	presentation preperation
26	22 June	Conference

Table 3: Planning

Here above is the table 3. The main research question is split up into several sub questions. These subquestions have each one week for answering. After that there is time to write the conclusion and answer the main question. Then there is still some time left to finalize the paper.

7. STATE OF THE ART

The amount of cloud computing services is increasing fast [4]. Despite the attention from the research community, research and development of Cloud Computing services is still in it's early days [38]. Today there is a lot of customers that use video streaming and this will become even more. Customers want to have everything has to be accessible through the network around the clock [39]. One thing that people want on demand are there film series. Currently Netflix has 30% of the downstream in the United States [19]. This downstream is huge and that means that there is optimization in this branch possible. To make the video on demand service of Netflix possible they use servers from Amazon.

The Raspberry Pi is made for research and education purposes [14]. The Raspberry Pi is a not so costly device costing around 40 euro. It has a power consumption of only three watt and has for the price a processor that is extremely well equipped to execute small tasks. For this reason it might be very useful for small scale cloud computing. The Raspberry Pi is a small device and is excellent for

a lot of small devices in a relatively small place. The Raspberry Pi doesn't use cooling and it can be used for very rapid elasticity and on-demand self-service. Because of it's cooling features and low power consumption it might be a good alternative for the nowadays high power consuming data centers. The Raspberry Pi is really small so it is a lot easier to place extra pi in a data center compared to a normal server. The Raspberry Pi has one drawback and that is that the processing power is relatively low. By using load balancing there will be taken a look at what load balancing techniques are successful for the Raspberry pi.

In this research we will make a small Raspberry Pi cloud to do research on video streaming using HTTP. This will be done using the design Science method proposed by Hevner [15]. This research will try to find out if the Raspberry Pi has enough processing power and bandwidth to be a suitable streamer to multiple web clients. The cloud performance can now be better researched, because everything is at one location and the information about what processes are running on the pi are well defined. In this way we can take a better look at algorithms used in video streaming. This is mostly because there is not a lot of overhead.

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