



University of Bamberg  
Distributed Systems Group



## Master Thesis

in the degree programme International Software Systems Science  
at the Faculty of Information Systems and Applied Computer Sciences,  
University of Bamberg

Topic:

# Model Based Pre - Warming to Mitigate the Cold Start of Serverless Function

Author:

Tasfia Sharmin

Reviewer:

Prof. Dr. Guido Wirtz

Date of submission:

04.03.2023

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Theoretical Background</b>	<b>2</b>
2.1	Cloud Computing . . . . .	2
<b>3</b>	<b>Conclusion</b>	<b>3</b>
	<b>References</b>	<b>4</b>

## List of Figures

## List of Tables

## Listings

## Abbreviations

**SaaS** Software as a Service

**PaaS** Platform as a Service

**IaaS** Infrastructure as a Service

# 1 Introduction

In today's world of cloud computing serverless computing has become quite a phenomenon as it has taken the responsibility of the underlying infrastructure where the applications will run on and the developers can solely focus on the coding aspect. The term serverless has been coined up to portray that the developers do not have to worry about anything related to servers.

As serverless has taken away all the managerial aspects from the developers but unfortunately, it comes with specific challenges. Among them, 'Cold Start' is a potential problem. Cold Start refers to the idea when a serverless function is invoked for the first time or has remained inactive for a long period and needs some time to be prepared for execution ([MSD<sup>+</sup>19], [SA20]) The size of the deployed package and the employed programming languages are a couple of the aspects that have an impact on this issue [MEHW18]

In this thesis paper, I will present an overview of the cold start problem in serverless function in particular. Further, I will analyze possible problems when running applications on serverless computing platforms by programming my own application.

## 2 Theoretical Background

### 2.1 Cloud Computing

Cloud computing has transcended its initial emergence decades ago to become a foundational pillar of modern technological advancement. It has brought revolution by ensuring flexibility, scalability, and cost-effectiveness. Through the ingenious power of virtualization, cloud computing has pioneered a model where both software and hardware resources are delivered on demand, precisely mirroring the user's requirements [Cho15]. The cloud's inherent global reach enables seamless access to applications and files from any device, anywhere in the world, fostering enhanced collaboration and productivity[MG11].

Cloud computing offers diverse service models to cater to a range of technical capabilities and project demands. **Software as a Service (SaaS)**: SaaS offers readily available, pre-configured software applications accessible through a web browser ([OAAAGW18],[HBS21]). **Platform as a Service (PaaS)**: PaaS offers a development environment with programming tools and resources to the users where they can leverage this platform to build custom applications without managing the underlying infrastructure ([OAAAGW18],[HBS21]). **Infrastructure as a Service (IaaS)**: IaaS grants users fine-grained control over computing resources such as servers, storage, and network components to build applications ([OAAAGW18],[HBS21]).



## **3 Conclusion**

This is the last chapter of this thesis.

## References

- [Cho15] David C. Chou. Cloud computing: A value creation model. *Computer Standards & Interfaces*, 38:72–77, 2015.
- [HBS21] Hassan Hassan, Saman Barakat, and Qusay Sarhan. Survey on serverless computing. *Journal of Cloud Computing*, 10, 07 2021.
- [MEHW18] Johannes Manner, Martin Endreß, Tobias Heckel, and Guido Wirtz. Cold start influencing factors in function as a service. 10 2018.
- [MG11] P. M. Mell and T. Grance. The nist definition of cloud computing, 2011.
- [MSD<sup>+</sup>19] Anup Mohan, Harshad Sane, Kshitij Doshi, Saikrishna Edupuganti, Naren Nayak, and Vadim Sukhomlinov. Agile cold starts for scalable serverless. In *Proceedings of the 11th USENIX Conference on Hot Topics in Cloud Computing*, HotCloud’19, page 21, USA, 2019. USENIX Association.
- [OAAAGW18] Isaac Odun-Ayo, M Ananya, Frank Agono, and Rowland Goddy-Worlu. Cloud computing architecture: A critical analysis. In *2018 18th international conference on computational science and applications (ICCSA)*, pages 1–7. IEEE, 2018.
- [SA20] Khondokar Solaiman and Muhammad Abdullah Adnan. Wlec: A not so cold architecture to mitigate cold start problem in serverless computing. 04 2020.

In accordance with § 9 Para. 12 APO, I hereby declare that I wrote the preceding master's thesis independently and did not use any sources or aids other than those indicated. Furthermore, I declare that the digital version corresponds without exception in content and wording to the printed copy of the master's thesis and that I am aware that this digital version may be subjected to a software-aided, anonymised plagiarism inspection.

Bamberg, 04.03.2024

Tasfia Sharmin