

LATENCY AWARE LOCATION BASED TASK OFFLOADING ALGORITHM IN EDGE AND CLOUD COMPUTING ENVIRONMENT

Basim Moulana

219370P

Degree of Master of Science in Computer Science

Department of Computer Science and Engineering

University of Moratuwa

Sri Lanka

July 2023

LATENCY AWARE LOCATION BASED TASK OFFLOADING ALGORITHM IN EDGE AND CLOUD COMPUTING ENVIRONMENT

Basim Moulana

219370P

Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree
Master of Science in Computer Science specialization in Cloud Computing.

Department of Computer Science and Engineering

University of Moratuwa

Sri Lanka

July 2023

DECLARATION OF THE CANDIDATE AND SUPERVISOR

The following declaration should be made by the candidate following the signature and the date. A candidate, after a discussion with the supervisor/s can request an embargo for a particular thesis/dissertation for a given work for a given time or indefinitely. Such an embargo may override the statement made in the thesis/dissertation itself.

“I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: _____

Date: 22/07/2023

The supervisor/s should certify the thesis/dissertation with the following declaration.

The above candidate has carried out research for the Masters/MPhil/PhD thesis/ Dissertation under my supervision.

Name of the supervisor: Prof. Indika Perera

Signature of the supervisor:

Date:

ABSTRACT

Performance-intensive applications are mainly introduced and used in the market after the evolution of 5G and IoT. Most of them still use cloud-based solutions, where only a portion of the application stays on the front end and the rest of the processing occurs in the cloud. Industries such as smart cities, smart homes, and smart grids have limitations in terms of the performance required to completely move on to cloud-based solutions for processing due to their datacenter locations, as distance gives higher latency and poor application performance. Edge computing is the technology to tackle the bottleneck raised by these performance-intensive applications. Due to the resource limitations of the devices at the edge servers, cloud computing is also required to avoid any resource constraints in the worst-case scenario where both cloud and edge computing resources could be collaboratively used. Also, end devices move very often, and their network characteristics change as their location changes. Finding the best task offloading approach based on the end-device location and finding the best possible node to offload the application task was the major objective of this thesis. Existing studies related to task offloading were reviewed and studied along with their existing algorithms used for mobile end-devices for task offloading using iFogSim2. For better performance of mobile end-device applications, a new algorithm was proposed by including a GeoHashing mechanism for faster processing and searching of locations. Then again, it was identified by the simulation that the proposed method completely utilizes the edge nodes first before offloading to the cloud, which gives better performance for the application modules. Also, it was identified that the performance of overall module placements took less time compared to other existing algorithms like random assignments and bottom-up approaches. With the results, it can be stated that the proposed latency-aware task offloading algorithm performs better than other existing algorithms and is a good fit for mobile end-devices, where it could leverage task offloading to the closest node for better performance of the application.

ACKNOWLEDGEMENT

I would like to convey my profound thanks to Prof. Indika Perera and Dr. Gayashan Amarasinghe for helping me choose an intriguing study subject and for their ongoing encouragement and support. Their direction greatly aided my participation in the research and goal setting.

I would like to say my sincere thanks to the University of Moratuwa's Department of Computer Science and Engineering for helping me succeed in this attempt. Finally, I want to express my sincere appreciation to my parents and friends for helping me with this project.

TABLE OF CONTENTS

DECLARATION OF THE CANDIDATE AND SUPERVISOR.....	i
ABSTRACT.....	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS.....	iv
LIST OF FIGURES	vi
LIST OF TABLES	vi
1. INTRODUCTION	1
1.1 Research Problem.....	2
1.2 Research Objectives	2
2. LITERATURE REVIEW.....	4
2.1 Mathematical Optimization Approach.....	5
2.2 Artificial Intelligent Approach.....	8
2.3 iFogSim Simulation	12
2.4 Geo Hashing for location	13
2.5 Summary of the past work relating to the current work.....	15
2.6 Research Motivation and Importance to this work from the Literature.....	15
3. PROPOSED METHOD	16
3.1 Application Scenario	16
3.1.1 Application Model	17
3.2 Organization of Edge and Cloud layers	17
3.3 Latency.....	20
3.3.1 Location based Algorithm.....	20
3.3.2 Geo Hashing.....	21
3.3.3 Mobility.....	22
3.4 Proposed Location based Algorithm.....	22
3.4.1 Algorithm	24
3.5 Simulation Environment	25
3.5.1 Clustering.....	25
3.5.2 End-Device and Edge Compute Configuration.....	25
3.6 Evaluation Methodology.....	26
3.6.1 Algorithm Comparison	27

3.7 Overall Conceptual Architecture.....	28
4. RESULTS AND DISCUSSION	30
4.1 Simulation Results comparison to other Algorithms	30
5. CONCLUSION.....	35
5.1 Recommendations for Future Research	35
6. REFERENCE LIST	36

LIST OF FIGURES

Figure 2.1: Task offloading - data flow	4
Figure 2.2: Task offloading algorithm - algorithm formation flow	5
Figure 2.3: Module Placement time with against number of Application (taken from [19]).....	12
Figure 3.1: Application Model.....	17
Figure 3.2: Switch Hierarchy	18
Figure 3.3: Edge nodes arrangement.....	19
Figure 3.4: Data flow	22
Figure 3.5: Cloud control selection.....	23
Figure 3.6: Location Based Node Selection Algorithm	24
Figure 3.7: End Device Mapping.....	25
Figure 3.8: Node Compute Requirement	26
Figure 3.9: Overall Conceptual Architecture	28
Figure 4.1: Latency Comparison.....	30
Figure 4.2: Algorithm run time	31
Figure 4.3: 50 End Devices Task offloading	32
Figure 4.4: 100 End Devices Task offloading	33
Figure 4.5: End devices comparison when offloaded to cloud	33

LIST OF TABLES

Table 2.1: Mathematical Optimization Approaches	6
Table 2.2: ML Approaches	9
Table 3.1: Latency Model	20
Table 3.2: Switch Locations.....	21
Table 4.1: Run time of Tasks	31