

I. IDENTIFICATION DATA

Thesis title:	Offloading the Computation for Autonomous Vehicle to the Edge of Mobile Network.
Author's name:	Bc. Anastas Nikolov
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Radioelectronics/Telecommunication Engineering
Thesis reviewer:	Ing. et Ing. Radim Kalfus, Ph.D.
Reviewer's department:	-

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	extraordinarily challenging
<i>How demanding was the assigned project?</i>	
<p>The project of developing a Multi-Access Edge Computing (MEC) system architecture and an efficient offloading decision algorithm for autonomous vehicles (AVs) was highly demanding. It required a deep understanding of various complex technologies, such as 5G communication systems, edge computing, containerization, and real-time data processing. Furthermore, the integration of different components, including a digital twin of the AV, the MEC server, and the offloading manager, added significant complexity to the project. The need to deploy and test the proposed solution on real hardware introduced additional challenges.</p>	

Fulfilment of assignment	fulfilled
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
<p>The thesis demonstrates the student's ability to communicate complex technical concepts and solutions effectively, ensuring that the work is accessible and understandable to readers with relevant background knowledge.</p> <p>The primary goals of the thesis, which were to develop a flexible and scalable MEC system architecture capable of supporting a large number of AVs with diverse computational needs, and a robust task offloading algorithm designed to prioritize and manage computational tasks effectively under varying network conditions, have been achieved. The author has successfully implemented the proposed solutions on real hardware and conducted extensive experiments to validate their effectiveness and feasibility in practical scenarios.</p> <p>The thesis comprehensively covers the assigned tasks, and there are no apparent parts that have been incompletely covered or overextended. The author has provided a thorough background on the state of the art in MEC architectures and offloading algorithms, highlighting the gaps and motivations for the proposed solutions. The implementation and testing sections are well-detailed, and the experiments cover various aspects, including data rate distribution, offloading decision time, task execution time, deadline adherence, and energy consumption.</p>	

Methodology	outstanding
<i>Comment on the correctness of the approach and/or the solution methods.</i>	

The approaches and solution methods proposed by the author are well-justified and correct. The author has rigorously followed established principles and methodologies in the fields of edge computing, communication systems, and autonomous vehicle technology.

Technical level

A - excellent.

Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?

The system model and the proposed MEC architecture adhere to industry standards and best practices, incorporating components such as Docker containers, Apache Kafka, and 5G communication setups. The decision to leverage a digital twin of the AV to host offloaded tasks is a technically sound approach, enabling efficient and accurate processing while reducing latency.

The offloading decision algorithm is well-formulated, taking into account critical factors like task priorities, deadlines, data rates, and computational resources. The mathematical formulation of the optimization problem and the heuristic approach to solve it are technically correct and appropriate for the given scenario.

How well did the student employ expertise in the field of his/her field of study?

The student has demonstrated a high level of expertise in the field of telecommunications and edge computing for autonomous vehicles. The thesis reflects a deep understanding of various relevant technologies, such as 5G communication systems, Docker containerization, ROS (Robot Operating System), and offloading algorithms.

Does the student explain clearly what he/she has done?

The system model, architecture components, and communication schemes are explained in a clear and concise manner, aided by diagrams and illustrations that enhance comprehension. The implementation details, including the digital twin integration, communication schemes, and offloading decision algorithm, are thoroughly described, leaving no ambiguity regarding the steps taken by the student.

The testing and experimentation sections are also well-explained, providing insights into the methodologies employed, the hardware and software setups used, and the metrics evaluated. The student has clearly articulated the goals, processes, and outcomes of each experiment, allowing the reader to follow the reasoning and validate the findings.

Formal and language level, scope of thesis

A - excellent.

Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?

The presentation of the thesis, including figures, diagrams, and formatting, is of good quality and aids in understanding the content. The language used is clear and understandable, with satisfactory English grammar and syntax throughout the document.

Selection of sources, citation correctness**A - excellent.**

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

The thesis makes adequate references to previous research and existing work related to multi-access edge computing, offloading algorithms, and autonomous vehicle technologies. The selection of sources cited appears to be comprehensive and covers both seminal works as well as recent publications in the relevant fields.

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

Please insert your comments here.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Overall, the thesis fulfils the assigned task of proposing a MEC system architecture and an offloading decision algorithm for AVs remarkably well. The thesis demonstrates a commendable level of research, design, and implementation efforts. The author has successfully addressed the challenges of developing a practical MEC system for AVs, contributing valuable insights and solutions to the field of edge computing and autonomous driving. The thesis is well-structured, comprehensive, and provides a solid foundation for future research and development in this domain.

Based on the content of the thesis, here are two questions for the student's defense:

1st question: The offloading decision algorithm heavily relies on the available data rates of the communication channel between the AV and the MEC server. However, the wireless channel conditions can be highly dynamic, potentially leading to fluctuations in data rates. Could you elaborate on how these channel dynamics can be steered from the 5G core network based on the 3GPP 5G specifications?

2nd question: Your thesis demonstrates the implementation and testing of the proposed solution on a model AV. Could you discuss the potential challenges and considerations involved in integrating your solution with the complex systems and software architectures of commercially available vehicles? What modifications or adaptations might be required to ensure seamless integration and compatibility?

The grade that I award for the thesis is **A - excellent**.

Date: **12.6.2024**

Signature:

