

R E V I E W

of a dissertation for obtaining the educational and scientific degree “Doctor”

Author of the dissertation: M.Sc. Dimitar Nikolov Todorov

Title of the dissertation: Methods and Tools for Load Balancing and QoS Enhancement in SDN-Based Networks

Doctoral Program: Systems Programming

Professional Field: 5.3 “Communication and Computer Engineering”

Reviewer: Prof. Dr Rozalina Dimova, Technical University of Varna

1. Relevance of the Problem Addressed in the Dissertation

The relevance of the problem addressed in the dissertation stems from the rapid adoption of Software-Defined Networks (SDN) and the need for efficient management of increasing network traffic. Modern cloud platforms, IoT, multimedia applications, and critical communications require high levels of QoS, low latency, and high reliability, which traditional network architectures struggle to provide. Limited adaptability and inefficient load distribution lead to congestion, packet loss, and degraded service quality. SDN offers new opportunities for centralized management, but existing static and dynamic routing algorithms do not sufficiently account for network parameters and dynamic traffic changes.

In this context, the dissertation is highly relevant as it develops new algorithms and sets of evaluation metrics aimed at load balancing and improving QoS. The tasks include defining metrics, developing static and dynamic routing algorithms, and creating an SDN controller for experimental evaluation, which has direct applications in modern network infrastructures.

2. Degree of familiarity with the state of the problem and creative interpretation of the literature

The doctoral candidate demonstrates a very good understanding of the current state of the research problem. In chapter one, a thorough and systematic analysis of modern approaches to routing, load balancing, and QoS assurance in SDN and NFV environments is presented. The literature review covers both classical algorithms and contemporary solutions based on dynamic traffic management, multipath routing, and SDN controllers.

A critical assessment of the advantages and disadvantages of existing methods has been made, clearly identifying gaps related to the lack of a global perspective, insufficient adaptability, controller overload, and limited QoS mechanisms. On this basis, the necessity and directions for developing new algorithms are well justified. A creative approach to the literature and the ability to draw scientifically grounded conclusions are demonstrated.

3. Compliance of the Selected Research Methodology with the Stated Goal and Objectives of the Dissertation

The chosen methodology fully corresponds to the stated goal and objectives and provides a reliable and well-founded answer to the research questions. The dissertation applies a combination of observation, comparison, experimentation, and simulation, which is an appropriate approach for studying routing algorithms and load balancing mechanisms in SDN environments.

The theoretical part is based on a literature review comprising 137 sources, including leading scientific publications, standards, and contemporary research in the fields of SDN, NFV, QoS, and routing algorithms. This provides a solid scientific foundation and enables critical comparison between different approaches and technologies.

Based on the studied impact of classical algorithms for static and dynamic traffic routing, the need for improving mechanisms for even traffic distribution in SDN networks is formulated, aiming to deliver better service quality. The experimental part relies on simulations and laboratory studies conducted in a controlled environment, ensuring reproducibility and objectivity of the results.

The use of a developed SDN controller and realistic network topologies (including Abilene) contributes to the high credibility of the empirical data. Comparative analyses between the proposed algorithms and existing solutions are carried out using clearly defined indicators, allowing accurate evaluation of effectiveness.

The simulation-based approach is particularly suitable as it enables controlled reproduction of various network topologies, loads, and scenarios that would be difficult or costly to implement in real conditions. This allows precise measurement of key indicators such as latency, throughput, packet loss, and routing stability. The methodology supports both the analysis of existing algorithms and the experimental validation of the proposed new solutions. The material is scientifically substantiated and reinforces the contributions and conclusions formulated in the dissertation.

4. Assessment of scientific results and contributions of the dissertation work

The contributions in the dissertation work as scientific-applied and applied. They consist in the development of new methods and tools for balanced traffic distribution and improving the quality of services in SDN environments. The problem of the need for routing algorithms that simultaneously provide route stability, adaptability to load and high QoS indicators, overcoming the limitations of existing static and dynamic approaches, is formulated and justified. A hypothesis is proposed according to which the combination of centralized control in SDN with multi-parameter criteria for assessing the network state leads to a more efficient and uniform distribution of traffic. It is proven through simulations and experimental studies that reveal new dependencies between the load, latency, throughput and the behavior of routing algorithms.

Classifications and systems of indicators have been created for evaluating static and dynamic routing algorithms, as well as for comparing SDN controllers. A static and dynamic algorithm have been developed, which represent routing methods that provide balanced load and improved QoS parameters. An SDN controller has also been created, which serves as a technological platform for research and implementation of routing mechanisms.

The applied contributions are the developed algorithms, indicators and controller, which can be implemented in real SDN infrastructures, data centers and research environments. Their significance is expressed in increasing the efficiency, reliability and quality of network services, which is critical for modern communication systems, cloud platforms and services with high sensitivity to delays.

The doctoral student demonstrates in-depth knowledge of the current state of the problem, the ability to critically analyze and creatively approach literary sources. The set goals and

objectives have been fully achieved, the methodology has been correctly selected, and the results obtained have been convincingly substantiated through simulations and experimental studies.

5. Assessment of the degree of personal participation of the doctoral student in the contributions

The structure and content of the dissertation demonstrate the independence of the development. The formulation of a goal, tasks, a system of indicators, as well as the development of two routing algorithms and an SDN controller are a result that implies personal contribution. These elements demonstrate skills for creative interpretation of existing problems and development of new methods for overcoming them.

Experimental studies, simulations and comparative analyses also testify to independent work. They require specific skills, selection of appropriate tools and configuration of the environment. The SDN controller developed by the doctoral student is an engineering task that can hardly be assigned or borrowed without significant personal work.

The dissertation work bears all the marks of personal creative research. The developed algorithms, systems of indicators and an SDN controller represent original scientifically applied and applied contributions with real value for the theory and practice of software-defined networks.

6. Assessment of publications on the dissertation work

The goal of the dissertation work has been achieved, and the solutions to the research tasks have been reported at national and international scientific forums. The publications contain the most significant contributions of the dissertation work, which shows that the results of the work have received publicity.

The main ideas and contributing results of the dissertation work are presented in five author's publications, four of which are published in the "Scopus" database. One of the publications is independent.

The essence and volume of the publications fully reflect what was developed in the dissertation work and meet the requirements for acquiring the educational and scientific degree "Doctor". There are twenty-seven citations of the publications in Scopus, which is evidence of the significance of the scientific results obtained in the dissertation.

The contributions and citations of the scientific works of eng. Dimitar Todorov are evidence of his recognition as a scientist among scientific circles in our country and abroad.

7. Use of the obtained results

At this stage, there is no evidence that the results of the dissertation have been implemented and that a measurable economic effect has been achieved. The abstract does not indicate documents for implementation, technology transfer and contracts with the industry. The results have potential for practical application, since the developed algorithms and controller have been tested in laboratory conditions and can be used for future research, training and experimental implementations in SDN infrastructures.

8. Opinions, remarks and recommendations

The doctoral candidate demonstrates good literary awareness, critical analysis skills and the ability to formulate original solutions. The algorithms, indicator systems and SDN controller developed in the dissertation have real potential for implementation in both scientific and practical network environments - data centers, operator networks, corporate infrastructures. It is recommended to adapt the proposed mechanisms to 5G/6G, edge computing and IoT environments, where dynamic traffic management is critical.

The abstract is structured correctly, meets the regulatory requirements and adequately

presents the main points, methodology and contributions of the dissertation. The presented dissertation is a comprehensive, independent and completed scientific study that meets the requirements for awarding the educational and scientific degree "doctor".

My recommendation is that Dimitar Todorov continue his research in the chosen field and that the results be further developed and applied in scientific and industrial projects.

9. Conclusion

Based on the above, I assess the presented dissertation work as original and complete in the sense of the set scientific goal and the tasks related to it. I give a positive assessment of the scientific-applied and applied contributions formulated therein. I believe that the dissertation work fully complies with the law in the Republic of Bulgaria and the Regulations for its implementation.

This gives me reason to propose to the esteemed scientific jury to award Eng. Dimitar Nikolov Todorov the educational and scientific degree "Doctor" in professional field 5.3. "Communication and computer technology", doctoral program "System programming".

5.01.2026

Member of the scientific jury:

/ Prof. Dr. Eng. Rozalina Dimova /