# OPINION

of the PhD student's scientific advisor, Doctor of Physical and Mathematical Sciences, Professor G.T. Balakayeva, on the dissertation work of Zhanuzakov Mukhit Baurzhanovich, proposed for the degree of Doctor of Philosophy (PhD) in the educational program «8D06103 - Computer science» on the topic «Research of fault-tolerance algorithms for reliable information processing».

I, Gulnar Balakayeva, as the scientific supervisor of Mukhit Zhanuzakov, hereby present this official review of his PhD dissertation submitted for the degree of Doctor of Philosophy (PhD).

M.B. Zhanuzakov's dissertation addresses pressing scientific issues aimed at ensuring the reliability and stability of modern information systems. The relevance of the research topic is justified by the increasing complexity of computing systems, the growing risk of failures in distributed systems, and the strengthening requirements for reliable information processing in the process of enterprise digitalization.

In the dissertation, the applicant conducted a comprehensive analysis of fault-tolerant algorithms and clearly identified their shortcomings, in particular issues of scalability, high computational costs, and limitations in adapting to various failure scenarios. To address these problems, M.B. Zhanuzakov proposed new methods for calculating the optimal interval of checkpoints for rollback-recovery mechanisms in distributed enterprise systems.

The scientific novelty of the work lies in the development of a new approach to calculating the optimal checkpoint interval for rollback-recovery algorithms based on queuing theory. In addition, the author proposed a model-based solution adapted to distributed enterprise systems and developed efficient computational algorithms that adapts to the system load and failure frequency.

All objectives set in the study have been fully accomplished. The applicant investigated fault-tolerant algorithms, designed new algorithms based on them, implemented them in an experimental environment, and conducted testing. The obtained results were compared with traditional methods, and the effectiveness of the proposed approaches was demonstrated.

The theoretical significance of the work is characterized by the expansion of scientific understanding in the field of fault tolerance and rollback-recovery mechanisms. Its practical significance lies in the applicability of the proposed algorithms in real distributed enterprise systems and their ability to improve system performance and reliability.

The results of the dissertation have been presented at international conferences and published in domestic and foreign scientific journals, which indicates recognition of the research outcomes by the scientific community.

The applicant independently conducted the scientific research and effectively applied modern programming and information technologies. The structure of the work is logically consistent, the content is complete, and it corresponds to the stated goals and objectives.

According to the classification of specialties, this dissertation corresponds to the doctoral field «8D06103 – Computer Science" within the nomenclature of scientific personnel, specifically to: «ON2 Formulating scientific goals, plan research and conducting large-scale computational experiments in specific applications», «ON6 Exploring computational complexity and stability of algorithms» and «ON7 Analyzing and evaluating the reliability and fault tolerance of computer systems».

In conclusion, the dissertation work of Zhanuzakov Mukhit Baurzhanovich on the topic «Research of fault-tolerance algorithms for reliable information processing» has been carried out at a high scientific level, meets the requirements of the «Rules for awarding scientific degrees» of the Science and Higher Education Quality Assurance Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan for the degree in the specialty "8D06103 – Computer Science," and is considered worthy of the degree of Doctor of Philosophy (PhD).

I believe that the candidate fully deserves to be awarded the degree of Doctor of Philosophy (PhD) in the relevant field.

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