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11.12.2023 № 102-07-09

To Director of the Institute for Informatics and Automation Problems of the National Academy of Sciences of the Republic of Armenia
Dr. Hracha Astsatryan

Official Opponent Review

Review of Mr. Arthur Lalayan's Ph.D. thesis entitled "Development of a cloud and high-performance platform for Earth observation data" for obtaining a Ph.D. degree in technical sciences on specialty 05.13.04 "Mathematical and software support of computers, complexes, systems and networks"

The dissertation is dedicated to developing a complex Earth observation data processing system that seamlessly integrates data repositories with any cloud-HPC infrastructures, ensuring efficient and flexible processing.

The research work involved an investigation of existing platforms and solutions, analyzing their limitations. Consequently, a scalable Earth observation data processing complex system is proposed, considering essential key performance indicators.

The dissertation includes an introduction, four chapters, and a list of used literature. The thesis is written in 109 pages and has 124 literature references.

The Introduction includes the dissertation, which establishes the research's relevance, presents the work's purpose, emphasizes scientific innovation, and highlights practical significance.

Chapter One introduces Earth observation data, emphasizing its importance on local and global scales. The chapter also addresses the computing infrastructures, standards, tools, and data formats crucial for effective Earth observation data processing. It offers an overview of various widely used EO platforms, highlighting their limitations. The chapter outlines the work's objectives and identifies the research problems that must be addressed to achieve these goals.

The author introduces a scalable Earth observation data processing system in the second chapter. The chapter provides an architectural overview, highlighting the internal modules and their interactions. The suggested system effectively fulfills the key performance indicators by processing large-scale Earth observation data. The system is infrastructure-independent, leveraging scalable resources from any cloud-

HPC infrastructure and Earth observation data repositories. This emphasizes the seamless integration of data repositories with cloud-HPC infrastructures, showcasing the system's capability to ensure efficient and adaptable Earth observation data processing.

The third chapter introduces a multi-objective method for selecting distributed computing clusters in Earth Observation data processing workflows. The method aids in choosing an efficient distributed computing cluster by considering factors such as the number of nodes in the given cluster and the computational characteristics of each node. Various criteria, including performance and cost-related objectives, are taken into account in this selection process. The effectiveness of the method is further evaluated by experimental results provided in the chapter.

In the fourth chapter, the author introduced a performance-optimized decision-making service, which suggests recommendations for efficient compression techniques to enhance the performance of big Earth observation data processing workflows. This service aids in selecting compression methods that conserve storage space and boost processing performance. The chapter also presents experimental results that substantiate the effectiveness of the proposed method.

The primary outcomes of this research can be summarized as follows:

1. Development of the scalable and computing infrastructure-independent Earth observation data processing complex system that adheres to key performance indicators, ensuring efficient processing and storage of large-scale data.

2. Development of the multi-objective method for selecting a distributed computing cluster, considering the characteristics of computing infrastructures and the intricacies of EO data processing workflows.

3. Implementation of the performance-optimized decision-making service dedicated to EO data storage, which provides recommendations for efficient data compression methods, aiming to improve the data processing performance.

The thesis is not exempt from specific limitations, and notable among them are the following:

1. The developed system is compatible with any cloud-HPC resources; however, the conducted experiments solely rely on cloud resources. It would be valuable to demonstrate the system's performance on HPC resources, such as supercomputers, and provide a comparative analysis with cloud-based executions.

2. In the third chapter, there is a discrepancy in the notation for execution time and cost budget constraints. While they are defined as 't' and 'p' in the text, there are instances, where they are listed as t and p.

3. The evaluations of the multi-objective method for efficient cluster selection focus on performance and cost objectives. It would be nice to see incorporating energy consumption as an additional objective, which is crucial for service providers involved in optimizing large-scale data processing.

Nevertheless, the mentioned limitations do not diminish the value of the dissertation.

The primary results of the dissertation have been published in 7 scientific papers, with 4 of them indexed in Web of Science or Scopus.

The developed system has been deployed in "FORESTBERG" LLC and is

used for monitoring forest environments through effective and fast EO data processing.

Building upon the aforementioned details, Mr. Arthur Lalayan proposed and successfully addressed a significant issue of both scientific and practical importance, adding substantial value to Earth observation data processing.

The dissertation stands as a comprehensive scientific achievement, and its author, Mr. Arthur Lalayan, deserves the award of a Ph.D. degree in technical sciences on specialty 05.13.04 "Mathematical and software support of computers, complexes, systems and networks".

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