RFERREE REPORT

by Prof. Dr. Aneta Nedeva Karaivanova, IICT - BAS,

on materials submitted for competition

to take the academic position "Professor" at IICT - BAS

in professional field 4.5 Mathematics, scientific specialty "Computational Mathematics (High Performance Computing)"

announced in State Gazette, issue 41/21.05.2019

Reason for the review: By the order of the Director of IICT-BAS No...... I have been appointed a member of the scientific jury of the competition for the occupation of the academic position of "Professor" in the professional field 4.5. Mathematics, scientific specialty Computational Mathematics (High Performance Computing), published in the State Gazette no. 41 / 21.05.2019, for the needs of the department "High Performance Systems, Networks and Algorithms" (old name "Grid Technologies and Applications" at IICT-BAS. At the first meeting of the scientific jury I was selected as a reviewer.

Only one candidate has submitted documents for participation in the announced competition: Assoc. Prof. Dr. Emanouil Yordanov Atanassov from IICT-BAS.

1. Brief CV and general presentation of the applicant.

Assoc. Prof. Emanouil Atanassov was born in Plovdiv in 1970. Already as a student he showed a true talent, deep interest and love for mathematics. As a member of the National Mathematics Team, in 1988 he won a special award at the International Mathematics Olympiad in Australia. In 1996 he received his Master of Science Degree in Mathematics (specialization in Mathematical Analysis) from the Faculty of Mathematics and Informatics at Sofia University "St. Cl. Ohridski ". He was a full-time PhD student at CLPI-BAS with scientific supervisor Professor Ivan Dimov, where he received his PhD degree in 2003 defending his dissertation "Monte Carlo methods and applications".

From 2002 to 2003, Dr. Atanasov was a postdoctoral fellow at Saarland University, Saarbrucken, Germany. In 2004, he won the John Atanassov Diploma for his contribution to the field of information technology. Since 2004 he has been an Assistant Professor at IICT-BAS, and since 2009 he has been appointed as Head of the department "Grid Technologies and Applications" (now under the new name "High Performance Systems, Networks and Algorithms"). In the period 2004-2019, he was coordinator of the Bulgarian participation or was participant in a number of large European and national projects. He made a significant

contribution to the development of the National Grid Initiative in Bulgaria and the HPC infrastructure in Southeast Europe.

2. General presentation of the submitted materials

The candidate Assoc. Prof. Emanouil Atanassov participates in the competition with all the necessary documents in accordance with the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for the implementation of this law, the Rules for the Acquisition of Academic Degrees and Occupation of Academic Positions at BAS, and the specific rules of IICT-BAS.

The presented 21 scientific articles published journals with SJR and / or ISI Impact Factor for this review, are not used in the doctoral dissertation and in the competition for Associated Professor, and are not submitted to NACID. All of the presented articles are published in the period 2004-2016, i.e., after the competition for associate professor. Of these, 6 publications have an impact factor and 8 have an SJR. A list of 46 citations to 10 of the papers submitted for the competition is presented. It is noteworthy that a total of 158 citations to 70 publications are visible in the SCOPUS system. The author's h-index of Assoc. Prof. Atanassov (no quotes) is 6. Assoc. Prof. Atanasov has been the leader of 5 European projects and 2 national projects, and has provided evidence for participation in 8 other EC funded projects and in 6 national projects. Below is a table with the minimum number of points for academic position "Professor" in the professional field 4.5. Mathematics at IICT-BAS and the indicators of Assoc. Prof. Atanassov.

Table. Minimal number of points of indicators for the academic position "Professor" in the professional field 4.5 Mathematics in IICT-BAS, and indicators achieved by Assoc. Prof. Atanassov.

Group of indicators	Content	Required indicators for "Professor"	Indicators of Dr. Atanassov
A	Indicator 1 (PhD dissertation)	50	50
B	Indicators 3 and 4	100	160
C	Indicators 5-10	260	302
D	Indicators 11	140	276
E	Indicators 12-18	150	510

		Total: 700	1298

3. General characteristics of Dr. Atanassov's scientific and applied activities

The scientific and applied activity of the candidate falls within the field of the announced competition and shows that Assoc. Prof. Atanassov is a scientist with high scientific achievements. The applicant's main scientific results are in the field of developing new or improved stochastic numerical methods and algorithms and their effective parallel implementation on heterogeneous high-performance computing systems. Assoc. Prof. Atanassov continues his work on the modified Holton and Sobol modified sequences done earlier, now concentrating on algorithms for their scrambling (randomization) and optimization of the code for execution on heterogeneous accelerator systems during. In parallel with these studies, in the period after his habilitation as an associate professor, Dr. Atanassov has worked on the development of a library of genetic algorithms, cryptographic research algorithms, Monte Carlo and quasi-Monte Carlo algorithms for matrix computations and for solving integrals and integral equations. Common feature of all his developments is their effective parallel implementation. The high quality of the obtained results is due to the fact that in addition to the deep knowledge and creativity in the field of computational mathematics, Assoc. Prof. Atanassov possesses exceptional expertise in the field of modern computer systems. Indeed, an important part of the work of Assoc. Prof. Atanassov is his leading role in the building, operation and maintenance of the computer systems in Bulgaria: the national grid infrastructure and the national high-performance infrastructure, as well as his significant role in the construction of these systems in the region of Southeast Europe, recognized by all partners from this region.

Assoc. Prof. Atanassov has experience in teaching as well – in addition to leading various trainings for HPC users and application developers he is a lecturer in BAS's training center and is the supervisor of two PhD students expected to defend their theses in the near future.

4. Contributions:

The contributions in the papers presented for review are related to the current computational trends and state-of-the-art high-performance computer systems. They pertain to accurate information about the communication and computational behavior of systems and tasks, low-level details that capture how applications use various hardware components, study of computational dependencies, and techniques for optimizing the design of algorithms for efficient execution.

The main contributions/achievements in the presented materials for this review are:

- **Development, software implementation and study the scalability and parallel efficiency for various classes of algorithms [2, 4, 12, 18, 19].** Algorithms that use fine-grain parallelism have been developed and studied. The necessity for such algorithms is related to the inclusion of computational accelerators (specialized graphics cards, Intel accelerators based on MIC architecture, and etc.) into modern high-performance computing systems. These developments include: a library of genetic algorithms with excellent scalability and concurrent execution performance on heterogeneous computing resources of different types (Grid [12], supercomputer [19]), with optimized organization of communication between processes; algorithms [18] using GPGPU resources for cryptographic calculations related to the security of modern communication protocols; Large-sparse matrix multiplication algorithms whose implementation on Xeon Phi accelerators shows excellent performance compared to standard library functions developed by Intel and available as part of their Math Kernel Library [2].

- **Optimization of high performance computations on heterogeneous computing systems [3, 5, 7, 8, 9, 17].** Methods and metrics have been developed to evaluate the energy efficiency of the algorithms using heterogeneous computing systems [7, 8, 9]. Optimized codes of deterministic and randomized algorithms for numerically integrating functions with different smoothness constraints are investigated, and the advantages of randomized quasi-Monte Carlo algorithms in various application problems are demonstrated [17]. A Monte Carlo algorithm for the modeling of quantum phenomena (super-fast electron transport) arising in quantum wires has been developed and implemented on high-performance systems [3]. An application used in computational chemistry has been optimized on a high-performance cluster with an Infiniband connection [5].

- **Algorithms for efficient generation of low discrepancy sequences [11, 15, 20, 21].** It is known that the naive substitution of pseudorandom sequences in Monte Carlo methods with quasirandom, as well as the direct transfer of code written to execute number generators on CPU to an systems with accelerator does not improve error and convergence speed . New algorithms have been developed for the generation of Sobol and Holton low discrepancy sequences, taking into account the characteristics of the respective accelerator and programming environment, in order to obtain adequate performance. These generators have been applied in Monte Carlo methods to solve various problems. An improvement in the speed of convergence and an the error estimation was obtained.

- **Schemes and services for efficient use of Grid resources [1, 6, 10, 11, 13, 14, 16].** Grid infrastructure consists of high performance clusters with additional servers that

control and organize the access in order to ensure the optimal use of resources. This environment works with specific software (middleware) and allows considerable flexibility, including the ability to implement and deploy new services and new execution schemes. Assoc. Prof. Atanassov participated in the development of various innovative services [6, 10, 14, 16], in studying the grid performance [1], and in study of the advantages of the developed services and implementation schemes for applications in the fields like Earth Sciences [10, 11], and Monte Carlo simulations [13].

5. Citations

The total number of citations in the List of citations presented by the candidate is 46, all of which are listed in WoS or Scopus, 2007 - 2015. The number of the cited publications is 10, all of them from the List of publications presented for this competition.

In general, the applicant's scientific output has a very good international visibility. The total number of citations (no auto-citations) visible in Scopus is 158, the number of citations (no auto-citations) for the period 2006 - 2015 is 100.

6. Assessment of the applicant's personal contribution

All of the publications submitted for the competition are co-authored, but it is natural to work in teams in this area. The applicant's personal contribution is beyond doubt.

7. Critical comments and recommendations

I have no critical remarks. My recommendation is to continue his work in the advanced topics in computational mathematics and high-performance computing.

8. Personal impressions

Emanouil Atanasov has been a colleague of mine since 1996 when he enrolled as a full-time PhD student at CLPP-BAS. I have high regard for Dr. Atanassov's personal and professional qualities – he is tolerant, scholarly, erudite, non-conflict, and possesses good leadership skills and excellent work ethic . In that sense Assoc. Prof. Atanassov is a true scientist.

9. Conclusion

The documents and materials presented by Assoc. Prof. Dr. Emanuil Atanasov meet all the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for the implementation of this law, the Regulations of BAS and the corresponding regulations of IICT-BAS. The results achieved by Assoc. Prof. Atanasov are in full compliance, and by many indicators exceed the specific requirements of IICT-BAS for the academic position of "Professor".

After acquaintance with the materials and scientific works presented in the competition and analysis of their importance and their contributions, I am convinced of my positive assessment and I strongly recommend to the Scientific Jury to submit a recommendation to the Scientific Council of IICT-BAS for the selection of Assoc. Emanuel Atanassov in the academic position of "Professor" at IICT-BAS in the professional field 4.5 Mathematics, scientific specialty "Computational Mathematics (High Performance Computing)".

16. 09.2019/Sofia

Reviewer: ....

/Prof. A. Karaivanova/