

Emanouil Atanassov: Approaches and policy for working with industry using HPC NCC Bulgaria and NCC UK twinning, 18 July 2022

Diverse HPC hardware





- Avitohol supercomputer (top500 system)
- Big Data servers with 3TB RAM each, connected with 5PB of HDD and SSD storage
- NVIDIA V100-based servers
- EuroHPC system Discoverer operational at Sofia Tech Park
- Various HPC clusters

HPC users in Bulgaria



- Public administrations: municipalities, Ministry of Environment and Waters, etc.
- Research: climatology, air quality modelling, computational chemistry, computational physics, astronomy
- SMEs and industry: startups, AI, HPDA, finance, subsidiaries of big international IT companies
 - Specifics:
 - low level of funding available for R&D in SMEs
 - bigger companies desire to keep expertise in-house

Funding for working with SMEs in HPC



- Innovation fund, EU Operational programmes
 - Funding goes mostly to the SME
 - Results of research remain with the SME
 - Limitations on pay to staff
 - IICT is a big enterprise as part of Bulgarian Academy of Sciences
- Funded by the SME:
 - Results of research remain with the SME
 - More freedom in the financial conditions
 - Bulgarian SMEs are not well capitalized and have limited funds for R&D.

HPC/HPDA for society at large



- In collaboration with NIMH meteorology forecast for Sofia in a fine mesh, using Avitohol.
- Two times per day
- Using ARW (Advanced Research WRF). WRF configured over 3 domains, 18km (100x100), 6km (153x153) and 2 km (303x255 точки), 38 levels.
- Results needed to be achieved within certain time period, that is why the supercomputer was needed.
- Main challenges optimize for speed, but avoid instabilities
- Achieve acceptable reliability of the whole system
- Impact high visibility of the results TV appearances, newspapers stories

Study of scalability



 In order to develop medical device for radio-frequency ablation of hepatic tumors, it is necessary to perform precise mathematical modeling and computer simulation of the heat transfer process in order to optimize the parameters of this low-invasive therapy technique. Main challenge – achieve efficient use of state-of-the-art mathematical methods

Scalability study (weak in this case)

Total Weak Scalability								
Ν	Р	Δt [s]	V1 [sm³]	V4.6 [cm ³]	N _{it}	T [s]		
2 183 424	128	5	12.857	9.102	642	1 723		
17 467 392	1 024	1.25	12.829	9.130	1 610	6 170		



We have 8 times more processors for 8 times larger (DOF) problem at each time step. Then we have additionally 4 times more times steps but only 3.58 times more time. This means that the related total efficiency is $E_{total} = 111$ %.

Porting of applications to accelerators

- Established contacts with many SMEs through successful projects
- More than 90% of the peak performance of our systems come from the accelerators
- Using accelerators, it is possible to achieve better price/performance and energy efficiency
- Important for startups using AI/HPDA
- Study of permeability of plates, work with startup/spin-off company

Number of processes	8	16	32
ALGORITHM 1	0.8494	0.7763	2.2047
ALGORITHM 2	0.6047	0.7149	0.9330
ALGORITHM 3	0.5619	0.3873	0.3994
MKL	0.7182	0.9029	0.9098





Generation of low-discrepancy sequences

- Quasi-Monte Carlo methods employ specially designed lowdiscrepancy sequences instead of pseudo-random number generators with the goal to speed-up the convergence of simulations
- The Sobol sequences are standard in Financial Mathematics, gaining ground in machine learning.
- Lots of theoretical and practical work has been done at IICT on fast generation of these sequences as well as optimization of their parameters.
- Some of these implementations are now available as part of a commercial product, provided by UK company.





Collaboration with the transport sector

- Bulgaria has lots of companies working in the Automobile sector.
- Connections were established as part of one EU project.
- Interest to have a larger project as a proof-ofconcept for further collaboration.
- Successful projects with one SME working on fleet management on driver risk profiling.





Policies when working with SMEs



- Rarely limited to access to infrastructure.
- The newer infrastructure has tighter limitations to access.
- Market-based pricing
- Different funding schemes have diverse requirements, sometimes requiring co-financing.
- Provision of free access/consultation in open calls, funded by some EU projects.
- Support during writing of project proposals.

Approaches to working with SMEs



- Established connections with clusters, industrial chambers
- Presentations at events, fairs, etc.
- Personal connections work best.



https://www.bcci.bg/news/13847



Synergies within the Bulgarian NCC

- Wide area of expertise is covered when aggregating teams and experts from the different partners in the centre
- Different focus of each institution, but good experience in common projects
- Further strengthening via training and mentoring, focusing on the areas that were most desired in the surveys

15	o. recument competences			Level: National/ International	Value: min 1- max 3	Persons: 1-5, 5- 20, 20+	¢
16		Cluster administration		International	3	5-20	S
17		Parallel programming		International	3	5-20	E
18		MPI/OpenMP		International	3	5-20	1
19		CUDA		International	3	1-5	E
20		OpenCL		International	3	1-5	E
		Performance					
		optimisation for in-		International	3	1-5	I
21		house software					
22		Cloud services		National	1	1-5	E
23		Software deployment		International	3	5-20	E
24		Performance optimisation for open- source software		International	3	5-20	F
25		Quantum computing		International	2	1-5	E
26		NoSQL databases		National	2	1-5	1
27		SQL databases		National	2	1-5	1
28		AI for Computer Vision		International	3	1-5	S
29		AI for Natural Language Processing		International	3	1-5	S
30		AI for Predictive analytics		International	3	1-5	E
31		Linear algebra and statistics in AI		International	3	1-5	ł
32		Neural network architectures		International	3	1-5	S
33	7. HPC/HPDI/AI Technology Assessment and Proof of concept (PoC) Assessment of the applicability of technologies Proof of concept (PoC) design and managament (from the idea to practice)			Level: National/ International	Value: min 1- max 3	Persons: 1-5, 5- 20, 20+	c
34	idea to practice)	Technology watch					
35		reemology water	HPC	International	3	1-5	F
36			HPDA	International	3	1-5	1
37			AI	International	3	1-5	0
57				international	5	1.5	12

Conclusions



- Heterogeneous hardware can be a challenge but also presents opportunities to serve different needs.
- Navigation through the requirements of the various funding schemes is a challenge.
- Working with SMEs presents opportunity to retain staff with competences in HPC, especiall young people – researchers or developers





Thanks!

http://eurocc-bulgaria.bg/bg/





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