National and European HPC infrastructures, participation of Moldova in HP-SEE project

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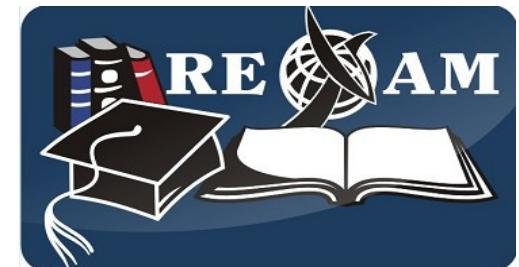
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South Eastern Europe (SEE)

Athens, Greece

www.hp-see.eu

In september 2010 new project started:
High-Performance Computing Infrastructure for South East Europe's Research

HP-SEE project brings together 14 partners from the South-East European region, more than 10 institutions involved in the project as third parties...

1. **Greece** Greek Research & Technology Network
2. **Bulgaria** Institute for Parallel Processing, Bulgarian Academy of Sciences
3. **Romania** "Horia Hulubei" National Institute of Research and Development for Physics and Nuclear Engineering
4. **Turkey**
5. **Hungary** National Information Infrastructure Development Office
6. **Serbia** Institute of Physics Belgrade
7. **Albania**
8. **Bosnia and Herzegovina**
9. **Former Yugoslav Republic of**
10. **Macedonia** SS. Cyril & Methodius University of Skopje
11. **Georgia**
12. **Moldova (Republic of)**
13. **Armenia**
14. **Montenegro**
15. **Azerbaijan**

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HP-SEE Infrastructure current status and plans of development

Country	TFlops			
	2010	2011	2012	2013
Greece	0	0	40	80
Bulgaria	25	31+8GPU	31+20GPU	40+20GPU
Romania	10	26+4GPU	30+20GPU	30+20GPU
Hungary	1	48	48+12GPU	48+12GPU
Serbia	6	6	20	20
OVERALL	42	111 + 12 GPU	169 + 52 GPU	218 + 52 GPU

	Max processes	CPU type	Nodes	TFlops	Batch system	OS	Total storage
Blue Gene, BG	8192	IBM Power PC	2048	23.42	Load leveler	Compute Node Linux (CNL)	12 TB
HPCG cluster, BG	576	Intel Xeon X5560	36	3	Torque + maui	SC Linux 5.3	30 TB
Pécs SC, HUN	1152	Intel Xeon X7542	1	10	SGE 6.2u5	SuSELinux ES 11 SP1	160 TB
Debrecen SC, HUN	3072	Intel Xeon X5680	128	18	SGE 6.2u5	SuSELinux ES 11 SP1	152 TB
Szeged SC, HUN	2112	AMD Opteron 6174	44	14	SGE 6.2u5	Red Hat ELS 5.4	230 TB
InfraGrid, RO	400	Intel Xeon E5504	50	2,15	Condor 7.4.4	CentOS 5.5	10 TB
IFIN_Bio, RO	256	Intel Xeon E5430	32	1,2	PBS Torque	CenOS 5.5	180 GB
IFIN_BC, RO	368	IBM PowerXCell 8i, AMD Opteron 2376	26	2.05 0.39	PBS Torque	Fedora 9	120 GB
NCIT cluster, RO	562	Xeon E5504, Opteron 2435, PowerXCell 8i, Xeon E5630		1,04	SGE 6.2u5, PBS Torque	SC Linux 5.5	13,1 TB
ISS_GPU, RO	4x480	Nvidia		4	PBS	Ubuntu 10.10	
PARADOX, RS	672	Intel Xeon E5345	84	5,25	Torque 2.3.6 + Maui 3.2.6	SC Linux 5.5	53.1 TB

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HPCG cluster located at IICT of Bulgarian Academy of Sciences. 576 computing cores. The storage and management nodes have 128 cores.

Number of nodes	36
CPU	Intel Xeon X5560 @2.8Ghz
RAM	24GB per node
Max number of parallel processes	576
Interconnect type	DDR Infiniband
Interconnect latency	2.5 μs
Interconnect bandwidth	20Gbps
Peak performance (Tflops, double precision)	3.23
Achieved performance (Tflops, double precision)	3
Operating system	Scientific Linux 5.3 64 bit
Batch system	torque + maui

SGI UltraViolet 1000 supercomputer at NIIFI, located in Pecs, Hungary. 1152 cores, 6057 GByte of memory

Number of nodes	1
CPU	Intel Xeon X7542 (Nehalem EX), @ 2.67GHz
RAM	6 TByte
Max number of parallel processes	1152 cores
Interconnect type	NUMAlink 5, paired node 2D torus
Interconnect latency	<1 µs
Interconnect bandwidth	15 GByte/sec
Peak performance (Tflops, double precision)	10
Achieved performance (Tflops, double precision)	10
Operating system	SUSE Linux Enterprise Server 11 SP1 (x86_64)
Batch system	Sun Grid Engine 6.2u5

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Country	Partner	Number of Nodes	Number of Cores	CPU Architecture	Interconnection	Batch System
BG	IICT	4	1920	GPU/NVIDIA	2xGigabit Ethernet	Torque
RO	UVT	50	400	x86_64	QDR 4xInfiniband	SLURM
RO	UPB	48	544	X86_64/Cell	4xGigabit Ethernet QDR 4xInfiniband	Sun Grid Engine
RO	ISS	4	2100	GPU/Fermi NVIDIA	2xGigabit Ethernet	Rocks Clusters
RS	IPB	2	16	x86_64 2.0GHz	Gigabit Ethernet Infiniband	Torque
RS	IPB	2	16	POWER6 4.0GHz	Gigabit Ethernet Infiniband	Torque
RS	IPB	2	16	PowerXCell 8i	Gigabit Ethernet Infiniband	Torque
RS	IPB	1	16	Nehalem	Gigabit Ethernet Infiniband	Torque
BA	UOBL ETF	2	16	x86_64	Gigabit Ethernet	Torque
MD	RENAM	1-6	8-20	x86_64	2xGigabit Ethernet	CCS2003
AM	IIAP NAS RA	6	48	x86_64	Gigabit Ethernet	Torque
AM	IIAP NAS RA	24	48	x86_64	Gigabit Ethernet	Torque
AM	IIAP NAS RA	1	240	Tesla 1060	GPU	

Access to High Performance Computing Infrastructure

National Resources: MS Windows Compute Cluster 2003 (8 nodes, 22 VCPU);

Name ▲	Status	Jobs Run...	CPUs	CPUs in Use	OS Vers...	Total Memory
VMWCIMI01	Ready	0	4	0	5.2.3790	2043
VMWCIMI02	Ready	1	4	4	5.2.3790	4091
VMWCIMI03	Ready	1	4	4	5.2.3790	2043
VMWCIMI04	Ready	1	4	4	5.2.3790	2043
VMWCIMI05	Ready	0	2	0	5.2.3790	507
VMWCIMI06	Ready	1	2	2	5.2.3790	507
VMWCIMI07	Ready	0	1	0	5.2.3790	507
VMWCIMI08	Ready	0	1	0	5.2.3790	507

05-10-2012 09:28:31 to 05-17-2012 09:28:31
Duration: 7d 0h 0m 0s

- 3 Grid-clusters.

Hostgroup 'Moldova' Host State Breakdowns:

Host	% Time Up	% Time Down	% Time Unreachable	% Time Undetermined
node01-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
node02-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
node05-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
node06-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
node07-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
node08-02.imi.renam.md	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%
Average	100.000% (100.000%)	0.000% (0.000%)	0.000% (0.000%)	0.000%

AMR_PAR application (Parallel algorithm and program for the solving of continuum mechanics equations using Adaptive Mesh Refinement), being developed in the Institute of Mathematics and Computer Science of the Academy of Sciences of Moldova.

AMR_PAR 64-bit application was developed in MS Visual Studio 2010.

Now AMR_PAR application is ready in OpenMP mode and was locally tested on small AMR grids (128x128x128 cells, 5 layers) on MS Windows Compute Cluster 2003.

Application was ported to Linux, compiled and tested on front-end computers *HPCG cluster located at IICT of Bulgarian Academy of Sciences* and *SGI UltraViolet 1000 supercomputer at NIIFI, located in Pecs, Hungary*.

Results of AMR_PAR application execution
on the WCC2003 cluster of IMI in OpenMP mode,cores from 1 to 8
(2 x QuadCore Intel Xeon E5310, 1600 MHz, 8 GB of RAM)
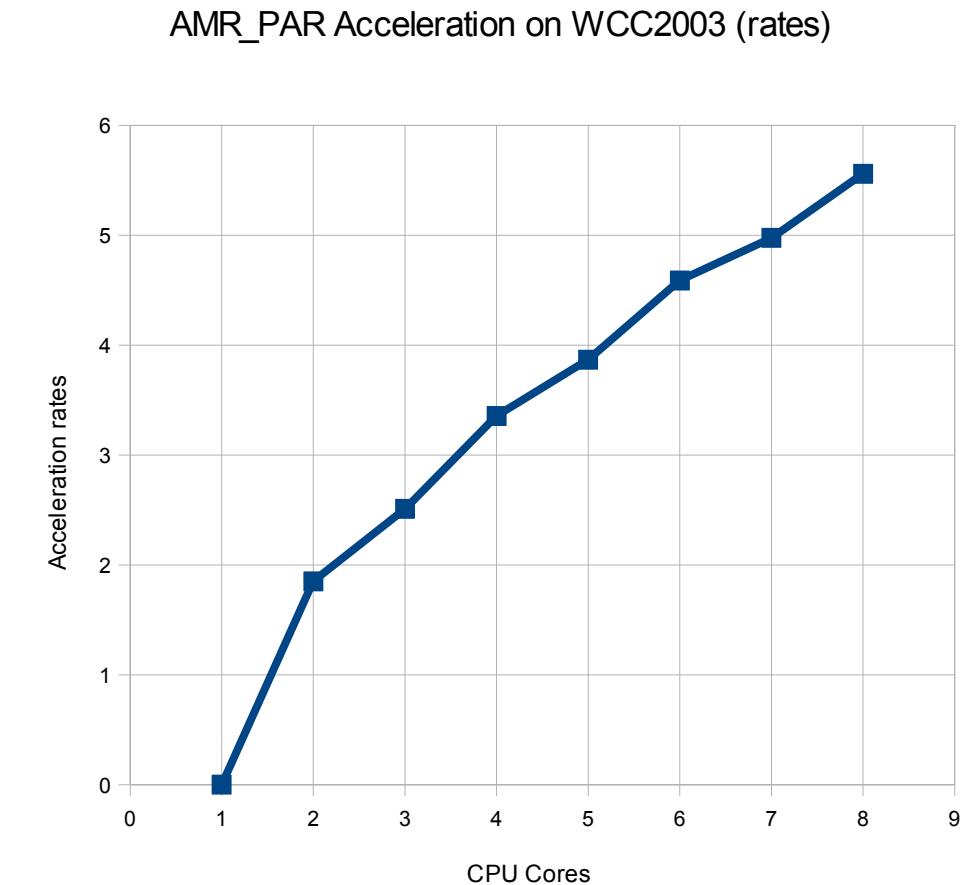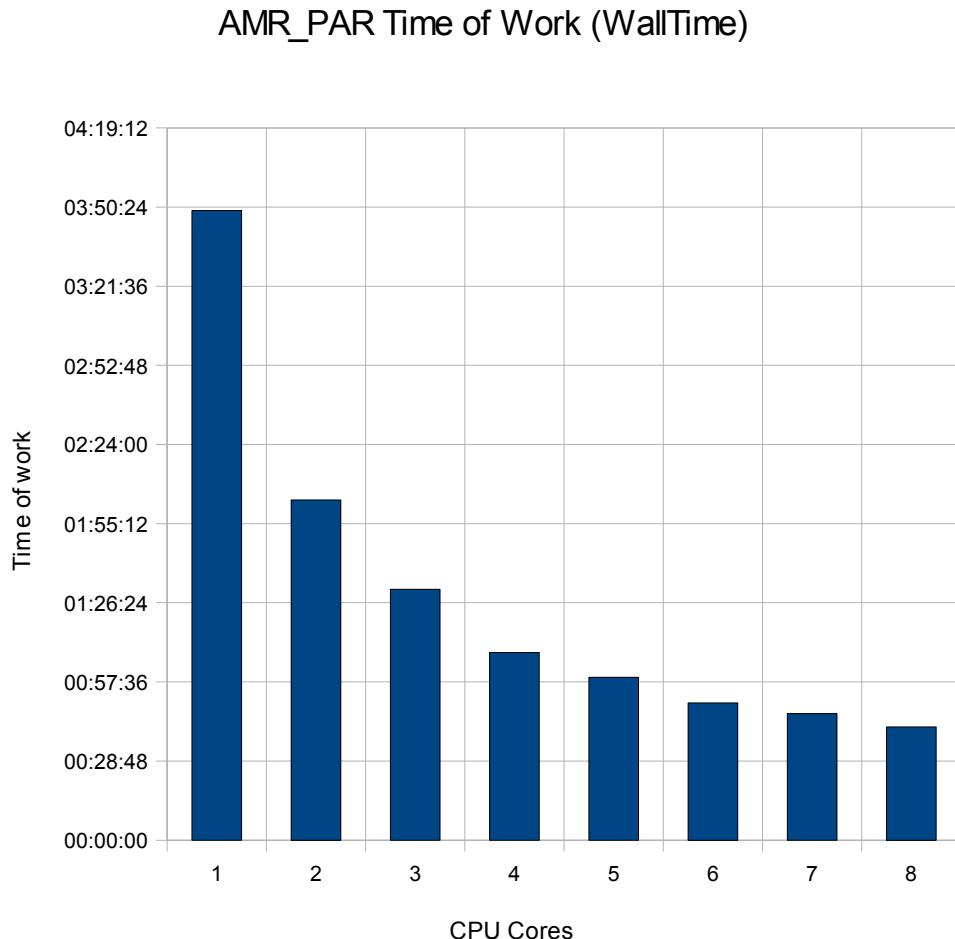
AMR_PAR Time of Work (WallTime)

AMR_PAR Acceleration on WCC2003 (rates)

<u>Porting activities</u>: Application was ported to Linux, compiled and tested on front-end computer HPCG cluster located at IICT of Bulgarian Academy of Sciences and at the front-end computer of SGI UltraViolet 1000 supercomputer at NIIFI, located in Pecs, Hungary.

<u>Scalability studies</u>: For HPCG cluster located at the Institute of Information and Communication Technologies of Bulgarian Academy of Sciences maximum grid dimension for 5 layers is 384x384x384, approximate time of calculations – 5 hours, optimal number of cores – 8.
Calculations for 5-7 levels and grid dimensions sizes more than 384x384x384 require up to 3 Tb of RAM.

Benchmarking activities:

Acceleration and Run Time dependences from CPU cores.
For 128x128x128 dimention best number of cores — 4.
4 cores - walltime - 3,3 min, CPU time -13,2 min.
16 cores - walltime - 3,7 min, CPU time - 59,1 min
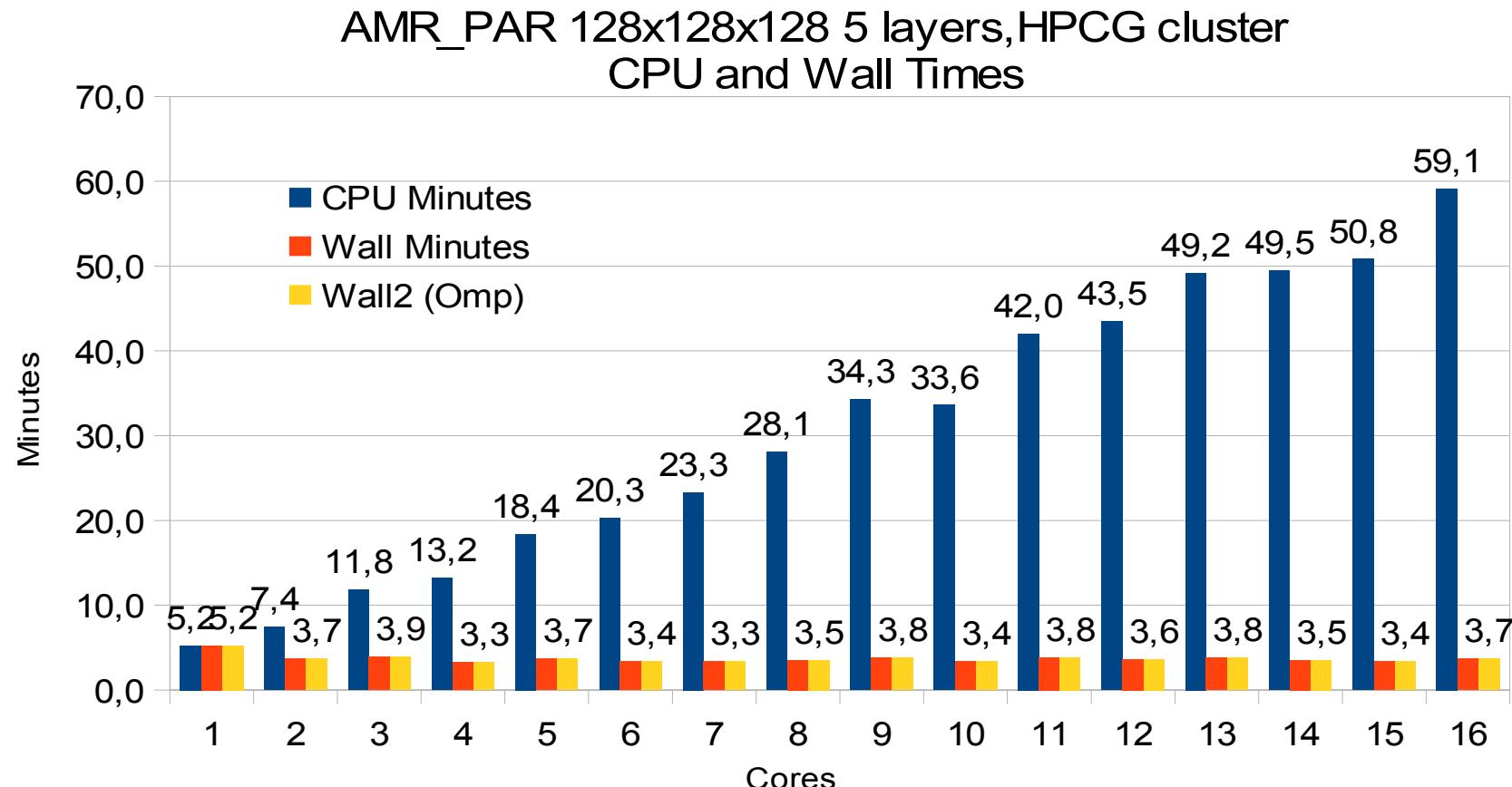
AMR_PAR 128x128x128 5 layers,HPCG cluster CPU and Wall Times

Calculated requirements of computational resources for the current OpenMP version of AMR_PAR application

Dimension	Layers	Max Iteration per level	Cores	RAM Gb	CPU minutes	WallTime minutes
128x128x128	5	200000	4	0,789	28	3,5
256x256x256	5	200000	4	5,972	273	68
256x256x256	5	200000	8	6,062	527	66
256x256x256	5	200000	12	6,068	807	68
384x384x384	5	200000	8	19,2	2110	270
448x448x448	5	200000	8 — 16	37,7	~ 4500	~ 500
512x512x512	5	200000	8 — 16	~ 55,6	~ 130 hours	~ 17 hours
1024x1024x1024	5	200000	16 — 32	~ 415	~ 2000 hours	~ 248 hours
2048x2048x2048	5	200000	32 — 64	~ 3250	~ 1200 days	~ 154 days

Questions ?