

THE EUROPEAN TECHNOLOGY PLATFORM For High Performance computing

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Achieving HPC leadership in Europe cPPP objectives

JF Lavignon ETP4HPC Chair Tuesday, May 20th, 2014





Agenda

- HPC a strategic technology
- The technological challenges
- ETP4HPC proposed approach
- The HPC contactual Public Private Partnership (cPPP)
- Working together



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HPC a strategic technology

What is HPC true measurement?

1 000 000 000 000 000 000 operations per second ?



HPC a dynamic market

• Important market with significant growth rate

Worldwide HPC Compute, Storage, Middleware, Application and Service Revenues (\$M)					
	2011	2012	2017	CAGR (12-17)	
Server	10,300	11,098	15,441	6.8%	
Storage	3,664	4,059	6,008	8.2%	
Middleware	1,147	1,254	1,568	4.6%	
Applications	3,370	3,621	4,837	6.0%	
Service	1,801	1,877	2,368	4.8%	
Total	20,282	21,909	30,223	6.6%	

• Opportunities for European providers



Yesterday's challenges are today's standards





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How to continue to innovate in HPC ? The challenges



Meeting the Application challenges with parallelism

EXAFLOP: Number of cores increases exponentially



The Current Situation:

- Only 1% of SW are capable to exploit 10 000 processors
- It takes 5 to 10 years in average to rewrite an application
- 50% of IT managers said that their applications scaled at a maximum of 120 cores (2011 survey, Addison Snell)

The two-fold Challenge:

- Keep the early adopters on path (capture the full benefits of the performance from thousands of processors to millions of cores)
- 2. Bring all the others in the game



The challenge of power consumption





1000 PF (20-40 W) Brain power consumption



Efficiency improvement beyond the 20MW target for exaflop is possible.......

HPC

Data management

- New simulation domain with data challenges
 - LHC (Large Hadron Collider) : tens of PB of compressed data peryear
 - Climate observations and simulation : EB by 2021
 - Combustion simulation : 10¹² points, 100 variable, 1,2 M time steps creation of EB raw data ; impossible to store so visualization in the loop
 - Light source experiments : hundreds of TB per day; one beam line can generate 1TB/day
- Data movement and power consumption
 - Today :
 - cache line access 50 pJ
 - DRAM access ~10 nJ (1nJ = 1,000 pJ)
 - 64 bits off chip 500 pJ
 - Tomorrow
 - Additional level in data hierarchy





Resilience

- Causes of the problem
 - Increase number of node in HPC systems
 - Increase in simulation time of applications
- Impact on system design
 - New data hierarchy
 - Duplication of access
 - System reliability
- Resilience and power consumption
 - Redundancy increase the power budget
 - New data hierarchy is a additional power budget





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ETP4HPC proposed approach

Europe achieving leadership in HPC

- Importance and impact of HPC
- 3 axes :
 - Development of HPC technology
 - Existence of world-class HPC e-infrastructure
 - Development of HPC application and use
- 3 key success factors
 - Coordination
 - Education and training
 - Focus on SMEs
- PPP could leverage all the stakeholder actions
- Budget for HPC technology R&D of 150 M€/year







IPC.



HPC



HPC.

Big data : SKA



- Data centric architecture
- On the fly correlation
- Implementation of specific workflows
- Interactive processing

- Phase 1 : 400 M€ up to 2020
- Phase 2 : 1,200 M€ 2020-2025
- Optimization € /W / EB



HPC in the loop : smart grid

- Huge optimization
 problem
- Three levels
 - Production
 - Distribution
 - Consumer
- More and more data available to optimization and control
- Big stakes
 - Electricity wasted : billion of MWh
 - Reduction of CO2
- New HPC technologies
 - Interactive HPC system,
 - Best answer at a given time algorithms





HPC.



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cPPP objectives

What is in it for European HPC?

Contractual Public-Private Partnership

Done in duplicate at Brussels on 17 December 2013.

BE VANNIER

Representative

FOR ETP4HPC ASSOCIATION

Neelie KROES Vice-President in charge of Digital Agenda

Sanzio BASSINI Board Regresentative



STATISTICS.

Brussels, 17 December 2

CONTRACTOR INC.

EU industrial leadership gets boost through eight new research partnerships

The European Common fields bunches epict contractul. Polic Protein Retroads (10%) of interacting competence for Lungean industry. The partenthops and liverings in the et & black of investments to be allocated fringing only for proposels and investments for the partent of the second three and 10 were to be expected to the page addication revented of between three and 10 were to between instructionage, product and services which will give European industry a leading packoon work in making HMD(2011)333.

European Commissioner für Sesench, Increation auf Sontre Heine Geophysau-Quin auf: "Turger and industry in movanes for outer across and glue. New technologies an protocit, such as green case, empiry efforced holdings and classer manufactures resource efforces, lies ward there contochard PPIs to have a industriated impact of the compatibilities, lies in all there are industriated and the constant one high-side glue in Stance's.

Vice Investicit Netler Kons, Commissioner responsible for the Digital Agenda, auch The or a great operation for Ergens. There PFW will resterie use glabal (and in nobotic, photonics, topia performance comparing, networks and gave us a hand start is note clice intelligient transaction, dicalation, estimationment, media and diver growship markabu. Combined with a comprehensive inductival antipage, the PFMs will ensure supress Enviropes haddparts and a before Artex.

 Factories of the Fature (FoF), to support the manufacturing industry through the development of sastainable production technologies and systems (Link to Includent)

Energy-efficient Buildings (EeB), to norisos the competitiveness and energy efficiency of the construction industry (unk to furth/set) European Green Vehicles Initiative (EGVI), to develop a competitive and

Institute and environment protecting and the process industry more environment and environment (SPIRE), to make the process industry more environment and environment (in the technolis)

 Photosics, one of the ker exclude behadopse for our future prospectry and as essential element of many sectors, from energy and fixedit, to everyday product like IVD physics and mobile phones (just in balance) and elemential to address a key down of industrie competitiveness and esential to address in postel address in an element of a decorption.

 High Performance Computing (HPC), which plays a postal ryle in straight Europic aconome growth and advanced purposes scener (Link to Extended)
 Advanced SG actuories for the Patient Internet (SSG), to straight to development of retrook insteam of manufactors to enume advanced 212 services

an second and users (<u>use to inclusive</u>) The contracts setting up the PP's were signed today by the Commission and interpersons of specially-or-ented inductival research and innovation associations, representing more than 1.000 lower and used inductival determines forces.

* ETP 4 HPC

HPC cPPP – Building a European HPC Ecosystem



cPPP governance

- Participation in the Partnership Board
 - Representative of the whole ecosystem
 - Open and accountable to the stakeholders
- Committed to advise the European Commission
 - Open working groups for preparation
 - Preparation of roadmaps to propose a vision



Animation of the ecosystem (1/2)

- Events
 - Today infoday
 - Prace days
 - ISC, Teratec,
 - September event



- Communication gateway
 - Look at our web site http://www.etp4hpc.eu
 - We can also relay your information



Animation of the ecosystem (2/2)

- Monitoring of the progress of HPC in Europe
 - KPIs
 - Exchange of information
- Participation in a support action FET HPC 2 a)

HPC related Calls



Commission				
	2014 EUR million	2015 EUR million	Call Deadline	
EINFRA-4-2014 – Pan- European HPC infrastructure and services	15		02/09/2014 - 17:00 Brussels time	
EINFRA-5-2015 - Centres of Excellence (CoE) for computing applications		40 (tbc)	2015 (14/01/2015 tbc)	
EINFRA-6-2014 - Network of HPC Competence Centres for SMEs	2		02/09/2014 - 17:00 Brussels time	
FETHPC1-2014 HPC Core Technologies, Programming Environments and Algorithms for Extreme Parallelism and Extreme Data Applications	93,4		25/11/2014 at 17.00.00 Brussels time	
FETHPC 2 - 2014: HPC Ecosystem Development	4		25/11/2014 at 17.00.00 Brussels time	



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Working together

New methods : chemistry example

- Scientific problem
 - Prediction of chemical properties
 - Drug design, electronics industry, material, biochemistry...
- Standard methods
 - Density Functional Theory, post Hartree-Fock
 - Solving the Partial Differential Equation for the unkown wave function
 - Introduction of approximation to reduce dimension problem
 - CPU intensive with communication
- New approach
 - Quantum Monte Carlo stochastic method
 - Exploration of configuration space using Markov chain to visit only the most probable states
 - Still some investigation at theoretical level
 - Able to use parallelism, non blocking communication
 - Resilient system



Optimization

1.

2



- *ab initio* Density Function Theory
- Wavefunction optimization
- A self-consistent equation $\rho(\mathbf{r}) = \sum_{i} \Psi_{i}^{*}(\mathbf{r})\Psi_{i}(\mathbf{r}), \text{ where } |\psi_{i}\rangle \text{ satisfies}$ $\left(-\frac{1}{2}\nabla^{2} + V_{H}[\boldsymbol{\rho}] + V_{xc}[\boldsymbol{\rho}] + V_{ext} + V_{pseudo}\right) |\psi_{i}\rangle = E_{i}|\psi_{i}\rangle,$
 - $|\Psi\rangle^2$ probability to find electrons at position *i*
- Convolution kernels³

V_SIM : visualization software. Can be coupled to BIGDFT for real time visualization.

- Targetting Xeon phi : high parallelism (60 cores) + vectorization (512 bits op)
- Finding the right level of off load
- Speed up : x17



Co-design



Figure 1 Notional Description of Co-design (courtesy: ASCR)

- Analysis of the interaction between application, middleware, system software and hardware
- Iterative process
- Global optimization

Co-design expect outputs

- Optimized hardware
 - Dark silicon
 - Sizing of data path and data capacities
 - Specific features
 - FPGAs ?
- Software APIs
 - Interaction between application and system software
 - Runtime, IO, performance, checkpoint...
- Exploitation optimization
 - Work flow optimization
 - Selection of results

APIs and/or directives

- Code efficiency on heterogeneous architectures
 Interface between application/runtime and runtime/OS
- Accelerate IO and optimization of data movement
 - Semantics information for file system
 - Directives for data management
- Reliability at application level
 - APIs between application and system level reliability management
- Debug and power monitoring
 - Interface between system stack, tools and applications



Power management

- Development of the needed framework
 - Event collection
 - Event analysis
 - Action
- Optimization
 - Profiling of runs
 - Exploration strategy
 - Machine learning technics



Management Node

Bullx Cluster Suite



Last message

• The scene has been set up

It is up to us to make European HPC a success !!!



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