BDEC = Convergence of Big Data & HPC

EXDCI
WP6 International Liaisons

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What is EXDCI?

- EXDCI is a 30-month project starting from September 2015 with
  - a budget of € 2.5 million
  - with 173,5 PMs
  - funded in call FET-HPC 2014.
- EXDCI’s objective is to support the coordination of the development and implementation of a common strategy for the European HPC Ecosystem.
Strategic Goals of EXDCI

Development of a common European HPC Strategy - EXDCI will support the implementation of a common European HPC strategy through the coordination of activities of stakeholders such as the European Technology Platform for HPC (ETP4HPC), PRACE, application owners and users (including emerging HPC applications), the European exascale computing research community, the open source HPC community, and other related activities in other parts of H2020.

EXDCI aims to support the road-mapping, strategy-making and performance-monitoring activities of the ecosystem, i.e.:

- **Producing and aligning** roadmaps for HPC Technology and HPC Applications;
- **Measuring** the implementation of the European HPC strategy;
- **Building and maintaining** relations with other international HPC activities and regions;
- **Supporting** the generation of young talent as a crucial element of the development of European HPC.
European HPC Ecosystem

- HPC Technology Supply Chain
- HPC Applications
- HPC Research Infrastructure

Tools for industrial simulation & prototyping
The strength of the European HPC Supply Chain (Technologies and applications)
Tools for addressing the Grand Challenges

European Economy
European Science
European Society
What is BDEC not?

The International Exascale Software Project Roadmap


Abstract
Over the last twenty years, the open source community has provided more and more software on which the world’s High Performance Computing (HPC) systems depend for performance and productivity. The community has invested millions of dollars and years of effort to build key components. But although the investments in these separate software elements have been tremendously valuable, a great deal of productivity has also been lost because of the lack of planning, coordination, and key integration of technologies necessary to make them work together smoothly and efficiently, both within individual PetaScale systems and between different systems. It seems clear that this completely uncoordinated development model will not provide the software needed to support the unprecedented parallelism required for peta/exascale computation on millions of cores, or the flexibility required to exploit new hardware models and features, such as transactional memory, speculative execution, and GPUs. This report describes the work of the community to prepare for the challenges of exascale computing, ultimately combing their efforts in a coordinated International Exascale Software Project.

Keywords
High Performance Computing, Software Stack, Exascale computing

1 The International Exascale Software Project was organized by and has received ongoing support from a variety of national agencies: In the United states, the Department of Energy Office of Advance Scientific Computing Research (DOE-ASCR) and the National Science Foundation Office of CyberInfrastructure (NSF-OCI); In France, the Commissariat à l'énergie atomique et aux énergies alternatives (CEA), Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique (CERFACS), Agence nationale de la recherche (ANR), INRIA and Teratec; In the United Kingdom, Engineering and Physical Sciences Research Council (EPSRC); In Japan, The University of Tsukuba, RIKEN, Kyoto University, Tokyo University and the Tokyo Institute of Technology. Corporations contributing to the staging of different IESP meetings have included Cray, EDF/EESI, IBM, Intel, Fujitsu Ltd., and NVIDIA.
What is BDEC?

- IESP (2009-2012)
  - IESP Roadmap
- BDEC (2013-...) = \{ EU, USA, JAPAN, CHINA \}
  - EESI – European Exascale Software Initiative
  - EESI2 – European Exascale Software Initiative
  - EXDCI

1. Create an international collaborative process focused on the co-design of software infrastructure for extreme scale science, addressing the challenges of both extreme scale computing and big data, and supporting a broad spectrum of major research domains,
2. Describe funding structures and strategies of public bodies with Exascale R&D goals Worldwide
3. Establishing and maintaining a global network of expertise and funding bodies in the area of Exascale computing
EXDCI WP6

Task 6.3: EXDCI in Europe and Worldwide (aka BDEC)

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The EXDCI project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 671558.
Achievements to date

- BoF in SC’15.
- 2-day BDEC workshop in Frankfurt, June 2016.
  - 70 invited participants from 10 countries.
  - 6 keynotes, 4 national roadmaps (EU, USA, JP, CN), 21 presentations.
  - Dynamic breakout sessions.
- ½-day BDEC workshop in ISC’16, June 2016.
  - Reporting on BDEC workshop.
  - Perspectives and roadmaps.
  - Discussion on new roadmap.
- Intensive drafting of a new international roadmap.
- BoF in SC’16
Conclusions to date

- BDEC is alive and well: Europe, through EXDCI, is an central player in international road-mapping.
- EXDCI has been an important engine.
- Europe is the only continent that has this type of CSA.
- Sharing of international perspectives is vital for future research and funding strategies in e-infrastructures.
- Convergence of Big science and Big data is going to play an increasingly important role on the global scene.
Going forward

- BoF in *SC’16* where an initial draft of the new report will be presented.
- Coordination of contributions to the final draft, entitled “Pathways to Convergence” – see next slides.
- Publication of the Pathways document in the most highly visible journals.
- Publication of white papers targeted at funding organisations and decision makers.
- Close collaboration with the EOSC initiative.
- Close collaboration with the BDVA cPPP.
- Preparation of 2017 BDEC meetings (USA, Japan).
Pathways to Convergence

- What is the problem?
  - 2 separate software stacks – 1 for HPC, 1 for Big Data.
  - Impossibility to continue investing in both.
  - Outdated paradigm for scientific process.

- What is the solution?
  - Convergence of the software stacks.
  - Coordinated investment strategies.
  - Updated scientific process paradigm…
Two ecosystems

Application Level
- Mahout, R and Applications
- Hive
- Pig
- Sqoop
- Flume
- Map-Reduce
- Storm
- Hbase BigTable (key-value store)
- HDFS (Hadoop File System)

Middleware & Management
- Cloud Services (e.g., AWS)
- Zookeeper (coordination)

System Software
- VMs, Containers and Cloud Services
- Linux OS variant

Cluster Hardware
- Ethernet Switches
- Local Node Storage
- Commodity X86 Racks

Data Analytics Ecosystem

Applications and Community Codes
- FORTRAN, C, C++ and IDEs
- Domain-specific Libraries
- MPI-OpenMP
- CUDA/OpenCL
- NA Libs
- Perf & Debug (e.g., PAPI)
- PFS (e.g., Lustre)
- Batch Scheduler
- System Monitoring

Computational Science Ecosystem
- IB + Enet Switches
- SAN + Local Storage
- x86 + GPUs or Accelerators

Credit: J. Dongarra, D. Reed

October 18th, 2016
2009:

The **Fourth Paradigm**

Data-Intensive Scientific Discovery

EDITED BY TONY HEY, STEWART TANSLEY, AND KRISTIN TOLLE
4th silo...

Thousand years ago
Description of natural phenomena

Last few hundred years
Newton’s laws, Maxwell’s equations…

Last few decades
Simulation of complex phenomena

Today and the Future
Unify theory, experiment and simulation with large multidisciplinary Data
Using data exploration and data mining (from instruments, sensors, humans…)

Crédits: Dennis Gannon
Pathways to Convergence: outline of the report (1)

- Introduction
- A Common Context for Planning Cyberinfrastructure Convergence
  - A More Analytical Model of Scientific Inquiry
  - Confronting the General Problem of Data Logistics
    - Alternative 1: Streaming
    - Alternative 2: Content Delivery Networks (Processing In-transit)
    - Alternative 3: Computing at the Edge (at the Source)
  - Other material relevant to this section:
    - Software Infrastructure for Science as Social Investment
    - Stakeholders in Software Infrastructure
  - What is to be gained from a converged cyberinfrastructure?
Pathways to Convergence: outline of the report (2)

• Pathways to Convergence: What are the Alternatives?
  • The classical paradigm of a common infrastructure: The hourglass architecture.
  • BDEC target goal onto the BD stack; use HPC technology underneath
  • Continue in the Bifurcated world, but do containerization to achieve some commonality

• An Architecture for the New Stack
  • Context for Architecture Section
    • Pragmatic meaning of convergence: Building a new hourglass
  • Containerization: The new “narrow waist”?
  • Containers with adequate HPC and security capabilities
Pathways to Convergence: outline of the report (3)

- Trends in the **Hardware Platform Substrate**
- **Applications** in the Scientific Research Process (“Applications”)
  - Taxonomy of Application/workflow patterns and templates
  - Science at the boundary of observation and simulation
  - Numerical laboratories
  - Multimodal sensing of the same reference object
- Layers and Components in the **Scientific Software Stack**
  - Math Libraries, Software Ecosystems for app development
- **Operations and Systems Management**
  - Radically improved resource management
  - QoS and Performance tools
- Conclusions and **Recommendations**
Thank you!

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https://exdci.eu