



HPC @ Inria (update)

Outlines

Update from 2009 (2nd workshop)*

- 1.** Inria Strategy in HPC
- 2.** HPC: Where within Inria?
- 3.** Inria Large-Scale initiative
 - C2S@Exa
 - Hemera

* <http://jointlab.ncsa.illinois.edu/events/09workshop/pdf/puech.pdf>

INRIA strategy in HPC

- INRIA is among the HPC leaders in Europe
 - Culture of multidisciplinary research
 - Culture of mixing methodologies within computer science (Strong collaborations between theoretical and experimental research)
 - Culture of exploration tools (owner of massively parallel machines since 1987, large scale testbed such as Grid'5000)
- National initiatives
 - 2/3 of the ANR (French NSF) projects related to HPC include INRIA researchers
 - Collaboration with Bull on Supercomputer design
 - Strategic Partnership with EDF on simulation
 - Joint laboratory with CERFACS
 - Collaboration with CEA on key system software (Kadeploy) for Supercomputers
 - French Strategic Committee on HPC: ORAP, TER@TEC
 - Collaborate in the establishment of the « House of Simulation », Grand Paris, ...
 - Participation to GENCI (shareholder)

INRIA strategy in HPC (cont'd)

- European

- Participation to PRACE-1IP/2-IP/3-IP (within GENCI)



- Participation to EESI & EESI2 (Exascale initiatives)



- International

- Joint laboratory with UIUC-NCSA



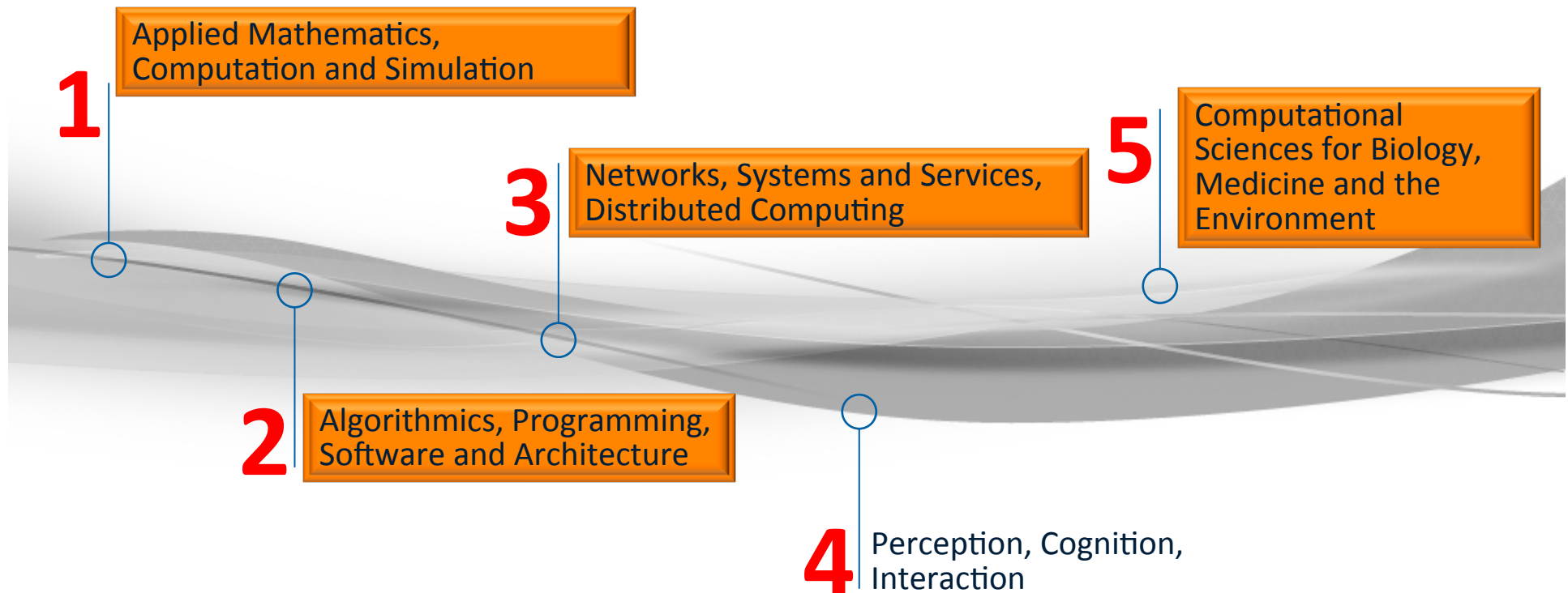
- Associated teams with key HPC players

Technology Transfer

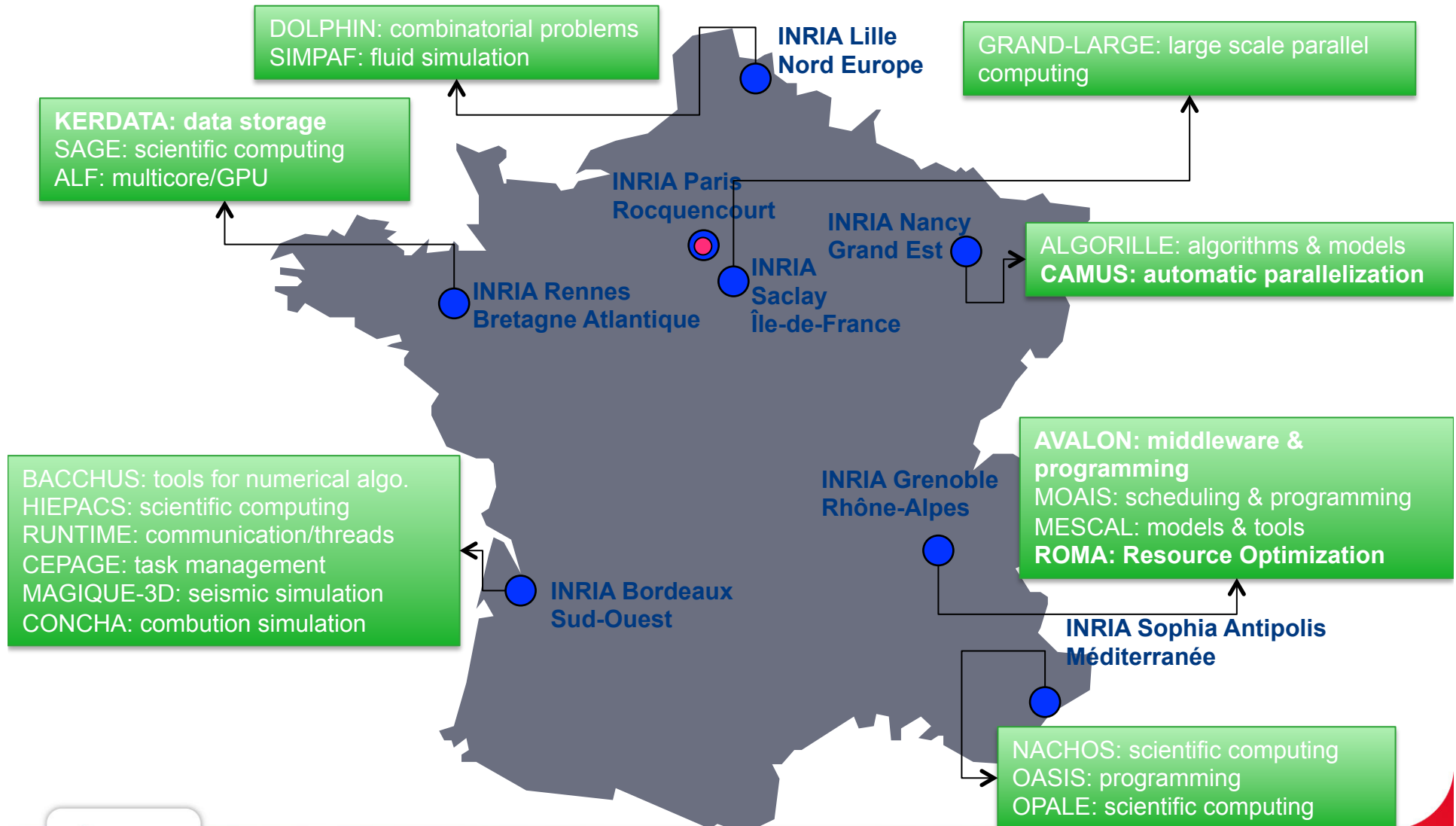
- A stream of Spin-offs
 - Caps Entreprise (HMPP compiler)
 - ActiveEon (Clusters, Grids & Clouds)
 - SysFera (SaaS tools)
- INRIA/GENCI Initiative, with French competitiveness clusters,
« national coordinated HPC program for SMEs »



1. HPC : where within Inria ?



Some project-teams involved in HPC



Recent initiatives to support HPC within Inria

- Why dedicated initiatives to support HPC ?
 - Project-teams are geographically dispersed
 - Project-teams belong to three different domains
 - Researchers from scientific computing need access to the latest research results related to tools, libraries, runtime systems, ...
 - Researchers from “computer science” need access to applications to test their ideas as well as to find new ideas !
- Concept of “Inria Large Scale Initiatives”
 - Enable the launch of ambitious projects linked with the strategic plan
 - Promote an interdisciplinary approach
 - Mobilizing expertise of Inria researchers around key challenges

C2S@Exa Large-Scale Initiative

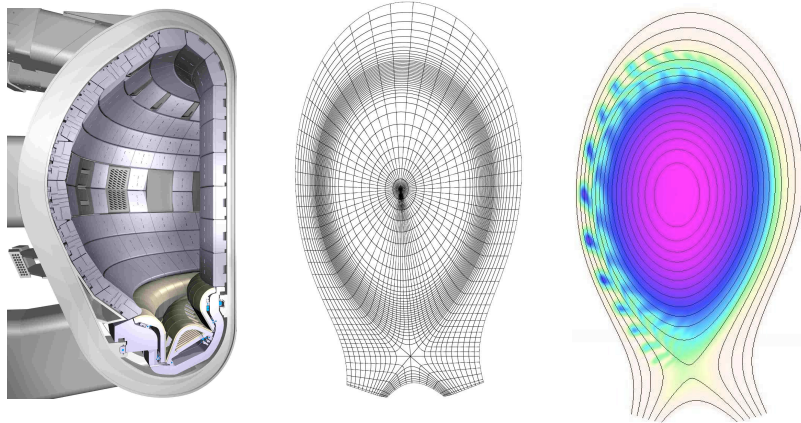
Computers and Computational Sciences at Exascale

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- Development of numerical simulation tools taking full benefits of processing capabilities of emerging high performance massively parallel architectures
- Establishment of a continuum of skills in the applied mathematics and computer science fields for a multidisciplinary approach
- Activities and contributions are organized along a three-level structure from generic building-blocks to large-scale applications:
 - Nuclear energy production (fusion) from CEA
 - Environmental applications from ANDRA

C2S@Exa Use Cases

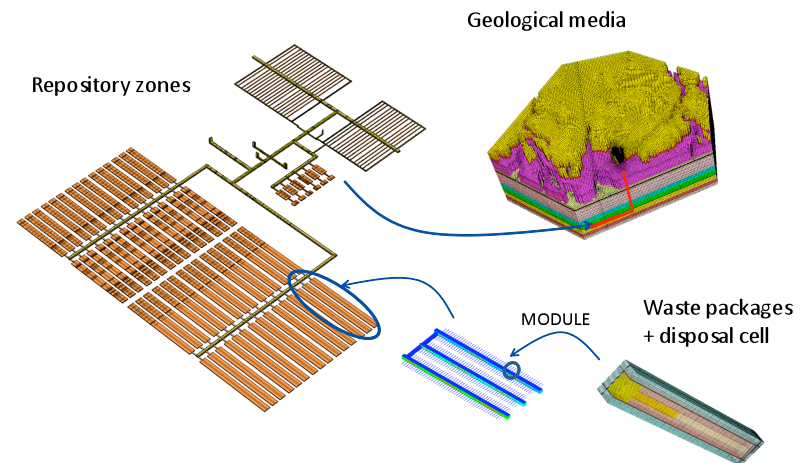
CEA use case



MHD computation with the JOREK simulation software

Simulation is especially important for ITER

ANDRA use case



Radioactive waste management scenario based on simplified physicochemical processes

Multi-processes (T, H-G, M, R, Tr)
Multi-spatial (cm to km)
Multi-temporal (up to 1 MY)

C2S@Exa thematic areas

- Numerical linear algebra
 - Core numerical kernels, sparse direct solvers, preconditioned iterative solvers, continuous solvers
- Numerical schemes for PDE models
 - Efficient numerical schemes to exploit massively parallel systems
- Optimization of performances of numerical solvers
 - Resource management and scheduling strategies, runtime systems, static and dynamic processing of numerical data sets
- Programming models
 - Component models for code coupling
 - High level parallel programming models to abstract the architecture
- Resilience for exascale computing
 - Energy effective fault tolerant protocols, algorithm-based fault tolerance, performance execution models for fault-tolerant applications, resilience for sparse linear algebra.

C2S@Exa membership

5 Core project-teams: numerical mathematicians

BACCHUS [INRIA Bordeaux - Sud-Ouest] **Parallel tools for numerical algorithms, resolution of hyperbolic problems**
CALVI [INRIA Nancy - Grand-Est] **Scientific computing and visualization**
HIEPACS [INRIA Bordeaux - Sud-Ouest] **High-end parallel algorithms for challenging numerical simulations**
NACHOS [INRIA Sophia Antipolis - Méditerranée] **Numerical modeling and HPC for evolution problems in complex domains and heterogeneous media**
SAGE [INRIA Rennes - Bretagne Atlantique] **Simulations and algorithms on Grids for environment**

5 Core project-teams: computer scientists

AVALON [INRIA Grenoble - Rhône-Alpes] **Large algorithms and software architectures for service oriented platforms**
GRAND-LARGE [INRIA Saclay - Ile-de-France] **Global parallel and distributed computing**
MOAIS [INRIA Grenoble - Rhône-Alpes] **Programming and scheduling design for applications in interactive simulation**
ROMA [INRIA Grenoble - Rhône-Alpes] **Resource Optimization: Models, Algorithms, and scheduling**
RUNTIME [INRIA Bordeaux - Sud-Ouest] **Efficient runtime systems for parallel architectures**

Hemera Large-Scale initiative

Scientific Challenges using Grid' 5000

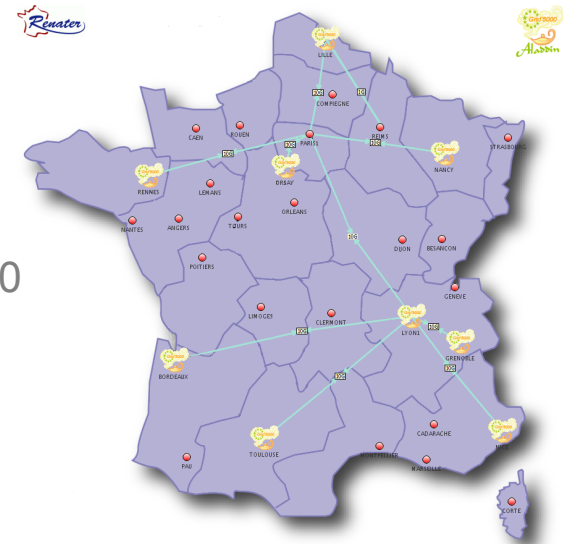
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Grid'5000 is a scientific instrument designed to support experiment-driven research in all areas of computer science related to parallel, large-scale or distributed computing and networking.

- 9 main sites connected through 10G Ethernet
- 20 clusters, 1500 nodes totalling 7244 cores

Hemera goals:

- Animate the scientific community around Grid'5000
- Demonstrate ambitious up-scaling techniques for large scale distributed computing by carrying out several dimensioning experiments on Grid'5000



Hemera challenges

- Network
 - Traffic Awareness
- System
 - Energy Profiling of Large Scale Applications
 - Robustness of Large Systems in Presence of High Churn
 - Orchestrating Experiments on the gLite Production Grid Middleware
 - Large Scale Virtual Machine Deployment & Management
- Programming Paradigm
 - Large Scale Computing for Combinatorial Optimization Problems
 - Scalable Distributed Processing Using the MapReduce Paradigm
- Application Domain Specific
 - Multi-parametric Intensive Stochastic Simulations for Hydrogeology
 - Thinking GRID for Electromagnetic Simulation of Oversized Structures

Hemera membership

- 1.ACADIE - Assistance à la Certification d' Applications Distribuées et Embarquées
- 2.ALGORILLE - Algorithms for the Grid
- 3.APO - Algorithmes Parallèles et Optimisation
- 4.ASAP - As Scalable As Possible: foundations of large scale dynamic distributed systems
- 5.ASCOLA - Aspect and composition languages
- 6.ASTRE - Architecture, Systèmes, Temps-Réel, Embarqués
- 7.CC-IN2P3 - Equipe de recherche du Centre de Calcul de l'IN2P3
- 8.CEPAGE - Chercher et Essaimer dans les Plates-formes A Grande Echelle
- 9.DOLPHIN - Parallel Cooperative Multi-criteria Optimization
- 10.GRAAL - Algorithms and Scheduling for Distributed Heterogeneous Platforms.
- 11.GRAND-LARGE - Global parallel and distributed computing
- 12.ICPS - Scientific Parallel Computing and Imaging
- 13.KERDATA - Cloud and Grid Storage for Very Large Distributed Data
- 14.OASIS - Active objects, semantics, Internet and security
- 15.MAESTRO - Models for the performance analysis and the control of networks
- 16.MESCAL - Middleware efficiently scalable
- 17.MINC - Micro et Nanosystèmes pour les Communications sans fils
- 18.MRS – Modélisation et contrôle des Réseaux et Signaux
- 19.MYRIADS - Design and Implementation of Autonomous Distributed Systems
- 20.REGAL - Large-Scale Distributed Systems and Applications
- 21.RESO - Protocols and Software for Very High-Performance Network
- 22.RUNTIME - Efficient runtime systems for parallel architectures
- 23.SAGE - Simulations and Algorithms on Grids for Environment

To get more information

- Leaders of the large-scale initiatives and project-teams
- Deputy Scientific Directors
 - Gilles Dowek (Algorithmics, Programming, Software and Architecture)
 - Thierry Priol (Networks, Systems and Services, Distributed Computing)
 - Jean Roman (Applied Mathematics, Computation and Simulation)
 - Alain Viari (Computational Sciences for Biology, Medicine and the Environment)