HPC and Clouds @ Inria

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INRIA strategy in HPC/Clouds

INRIA is among the HPC leaders in Europe

- Long history of researches around distributed systems, HPC, Grids, and now Clouds
- Several activities virtualized environments
- Culture of multidisciplinary research
- Culture of exploration tools (owner of massively parallel machines since 1987, large scale testbeds such as Grid'5000)

- **National initiatives**
  - 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
  - *HPC-PME* (with GENCI and OSEO)
  - …

INRIA strategy in HPC/Clouds

European

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

EESI & EESI2 (Exascale initiatives)

ETP4HPC

FP7 ICT, Challenge 1: Pervasive and Trusted Network and Service Infrastructures

XtreemOS , Contrail

BonFire, Fed4Fire

International

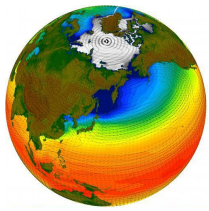
INRIA-Illinois joint laboratory

G8 ECS (Towards Exascale Climate simulation)

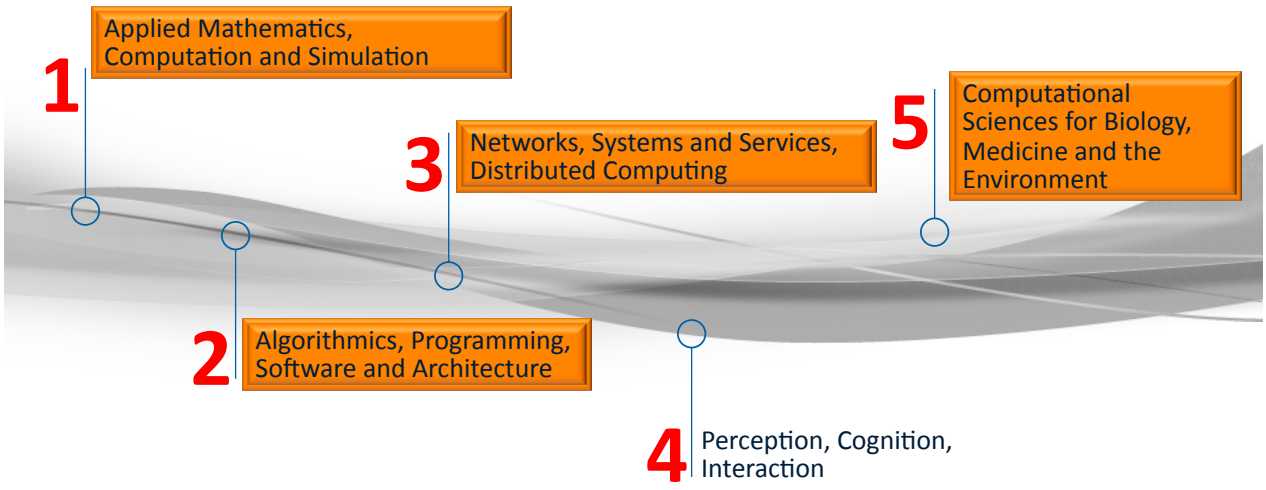
USA with Inria@SiliconValley: Stanford and Berkeley Universities

Associated teams with key HPC players

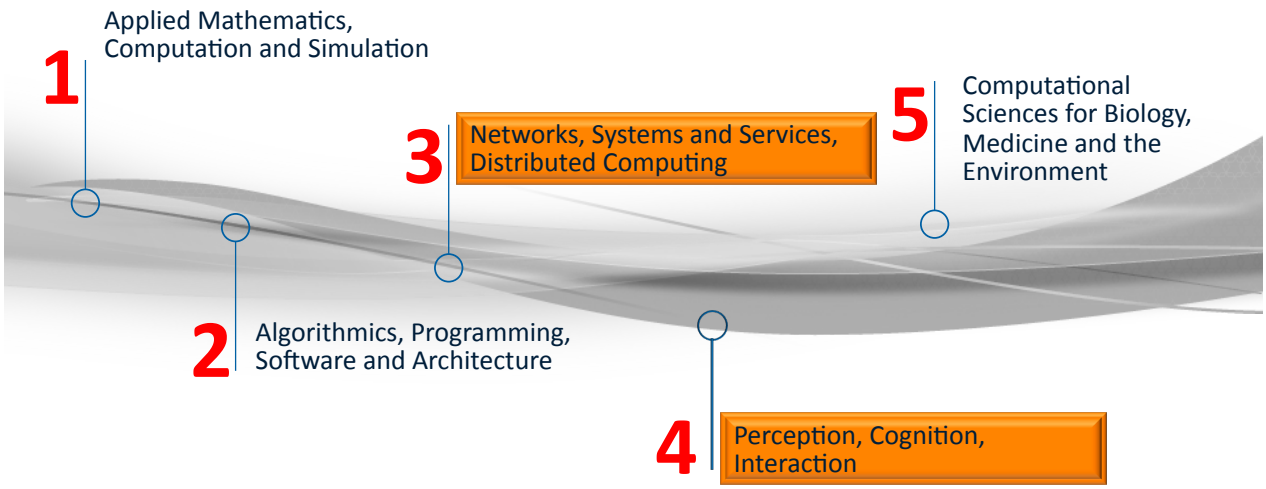
Standardization (DTMF, OGF/OCCI)



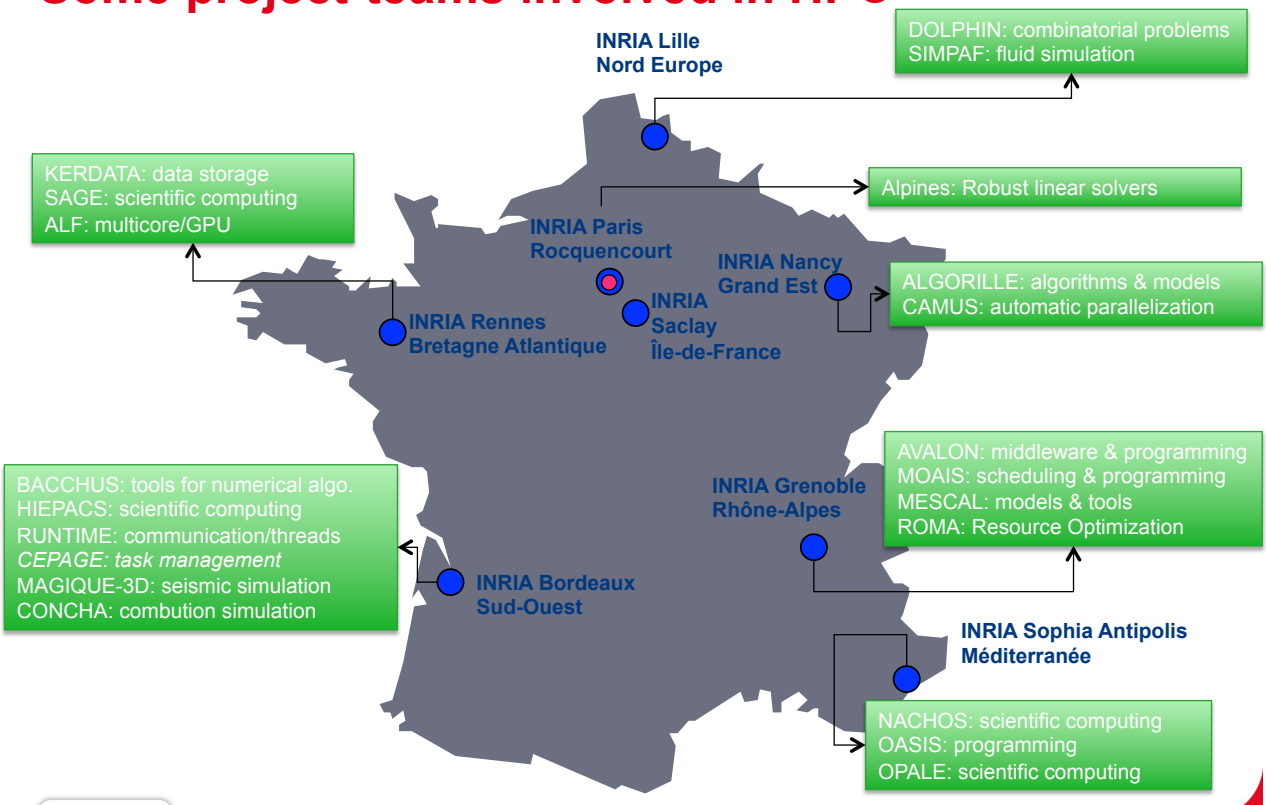
1. HPC : where within Inria ?



2. Clouds: where within Inria ?



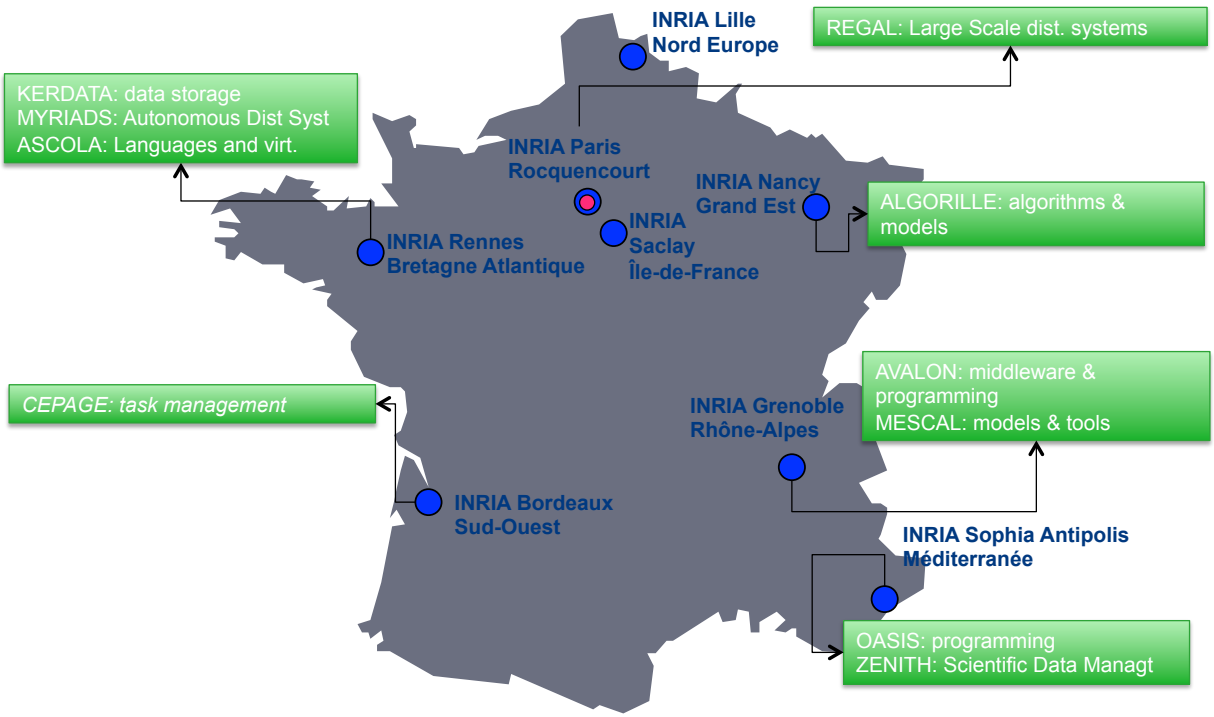
Some project-teams involved in HPC



Current activities around HPC@ INRIA

- **Resource allocation and management**
  Avalon, *Cepage*, Roma
- **GPU/Manycore**
  Algorille, Runtime, Mescal
- **Parallel Solvers**
  Alpines, Hipeacs, Roma
- **Simulation**
  Algorille, Avalon, Mescal
- **Fault-tolerance/Resilience**
  Cepage, Hiepacs, Roma, Mescal, Algorille
- **Programming models**
  Avalon, Moais, Runtime
- **Visualization**
  Hiepacs, Moais
- **Data Management**
  Avalon, Mescal, Algorille Kerdata
- **Desktop Grid**
  Avalon, Mescal

Some project-teams involved in Clouds/Big Data



Current activities around Clouds@ INRIA

- **Resource allocation and management**
  Avalon, Cepage, Regal
- **Energy management**
  Avalon, Myriads, Ascola
- **VM management**
  Ascola, Myriads
- **Security**
  Avalon
- **Adaptative Dist. Applications**
  ADAM
- **OS**
  Ascola, Myriads
- **Simulation**
  Algorille, Ascola, Avalon, Mescal
- **Programming models**
  Avalon, OASIS
- **Unconventional paradigms**
  Myriads
- **Model Driven Engineering**
  Triskell
- **MapReduce paradigm**
  Avalon, Kerdata
- **PaaS**
  Avalon, Myriads, ADAM
- **IaaS**
  Ascola, Myriads
- **Scalable data analysis**
  Zenith
- **Big Data management**
  KerData, Zenith

Initiatives to support HPC/Clouds within Inria

Why dedicated initiatives to support HPC/Clouds ?

- Project-teams are geographically dispersed
- Project-teams belong to 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” (now Inria Project Labs)

- 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

Contact: Stephane.Lanteri@inria.fr

- 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 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 performance 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.

Hemera Large-Scale initiative

Scientific Challenges using Grid'5000

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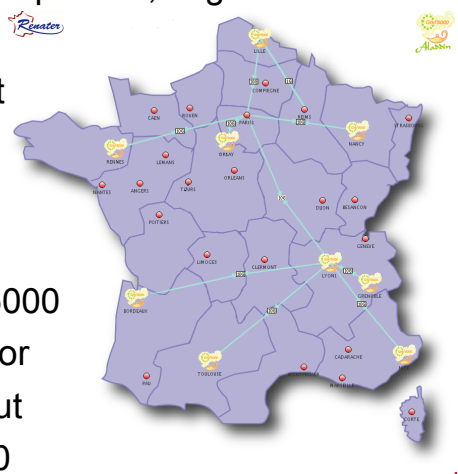
Grid'5000 is a scientific instrument designed to support experiment-driven research in all areas of computer science related to parallel, large-scale or distributed computing and networking.

- 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

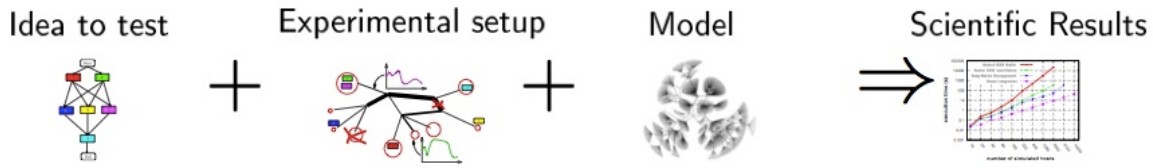
- Large Scale Computing for Combinatorial Optimization Problems
- Scalable Distributed Processing Using the MapReduce Paradigm

Application Domain Specific

- Multi-parametric Intensive Stochastic Simulations for Hydrogeology
- Thinking GRID for Electromagnetic Simulation of Oversized Structures

ADT SimGrid: Simulator of Distributed Applications

Scientific instrument for the study of large scale distributed computing



Main Features

- Versatile: Grid, P2P, HPC, Volunteer Computing, Clouds, . . .
- Valid: Accuracy limits studied and pushed further for years
- Scalable: 3M chord nodes; 1000× faster than other (despite precise models), thousands of VMs (and Amazon Cloud)
- Usable: Tooling (generators, runner, vizu); Open-source, Portable, . . .