The HPC-BigData Project Lab at INRIA

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*Many slides from Bruno Raffin (Inria Grenoble)

Bordeaux, January 2019
HPC versus Big Data

**Traditional HPC:**
- Applications: large scale scientific computing
- Machines: supercomputers
- Programming: MPI+ OpenMP

**Traditional Big Data:**
- Applications: web and business analytics - descriptive and predictive (include machine learning and deep learning)
- Machines: cloud infrastructures
- Programming: Map/Reduce, ML and DL dedicated libraries
HPC and Big Data: a Closer Look at the Differences

Divergent ecosystems

Application Level
- Mahout, R and Applications
- Applications and Community Codes
- FORTRAN, C, C++ and IDEs
- Domain-specific Libraries
- Perf & Debug (e.g., PAPI)

Middleware & Management
- Hive, Pig, Sqoop, Flume
- Map-Reduce, Storm
- Hbase BigTable (key-value store)
- MPI-OpenMP CUDA/OpenCL
- NA Libs
- PFS (e.g., Lustre)
- Batch Scheduler
- System Monitoring

System Software
- HDFS (Hadoop File System)
- VMs, Containers and Cloud Services
- Linux OS variant
- Linux OS variant

Cluster Hardware
- Ethernet Switches, Local Node Storage, Commodity X86 Racks
- Data Analytics Ecosystem
- Computational Science Ecosystem
- IB+ InfiniBand Switches, SAN+Local Storage, x86+GPUs or Accelerators
The HPC-BigData Integrated Project Lab
(IPL HPC-BigData)

An INRIA funded project (2018-2022)

Gather teams from HPC, Big Data and Machine Learning to work on the convergence between these domains

Eventually more HPC-IA than HPC-BIGDATA
## Teams/People Involved

### INRIA Teams

**HPC:**
- DataMove: Bruno Raffin, Olivier Richard
- KerData: Gabriel Antoniu, Alexandru Costan
- Tadaam: Emmanuel Jeannot, Guillaume Aupy
- RealOpt: Olivier Beaumont
- Hiepacs: Olivier Coulaud
- Storm: Samuel Thibault
- Grid’5000: Pierre Neyron

**BigData/ML:**
- Zenith: Patrick Valduriez et Alexis Joly
- Parietal: Gael Varoquaux
- Tao: Guillaume Charpiat
- SequeL: Philippe Preux
- Sierra: Francis Bach

### Non INRIA Partners

**External Research Teams:**
- **ANL (USA):** Rob Ross, Tom Peterka
- **LBT (CNRS Paris):** Marc Baaden, Jérome Hénin -> Molecular Dynamics

**Companies:**
- **ATOS/Bull** -> HPC Vendor
- **ESI-group** -> Computational Mechanics
High Performance Analytics for Scientific Computing Apps

- In Situ/Transit analytics combining HPC (FlowVR, Damaris, Decaf) and Big Data solutions (Spark, Flink)
- On-line data streams assimilation combining ML and numerical simulation.
Toward a parallelization based on task programming with Dask (Python framework).

Use StarPU as a runtime
Infrastructure and Resource Management

Two different machine models: supercomputer versus cloud
- Centralized file system / distributed on-node storage
- Exclusive resources / virtual machines and multitenant apps
- High performance architectures / cost efficient architectures

Toward a converged Architectures?
- How to handle on-node storage (elastic/ephemeral store)?
- How to perform locality-aware scheduling (dynamics and static)?
- What abstractions for convergent storage (key-value store, blob store)?
- How to leverage ML/DL approaches for scheduling?
How application can make the best possible use of the available resources

Problematic:
- Allocate data
- Partition data
- Reserve resources
- Control affinity
- Map computation
- Manage contention
- Optimize communication
- Access storage
- Perform visualization

![Diagram illustrating topology, locality, and data relationships](image)
Conclusion

Follow-up of the challenge *When extreme-scale computing meets data-intensive science* for the next Inria strategic roadmap

Sparked off more interest than expected. Very motivating discussions between partners

Expect to gain momentum as we understand each other domain better:

- Start with modest direct knowledge/technology transfers
- Go up to the co-design of innovative solutions

Very important and timely topic: we will be happy to collaborate with other teams.