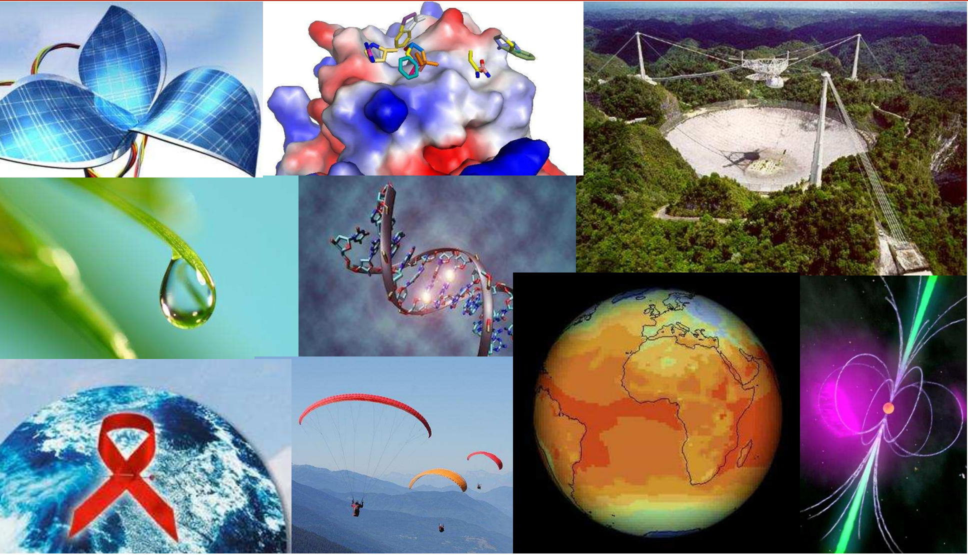
MOSIG, PDES Option
Parallel, Distributed, Embedded Systems

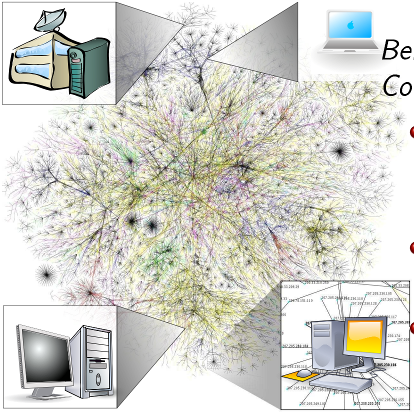
Arnaud Legrand

What do ... have in common?



Clean water, solar cells, new drugs against Ebola/AIDS/Cancer, climate evolution, weather forecast for paragliding, searching for Extra-Terrestrial Intelligence, pulsars,

Volunteer Computing



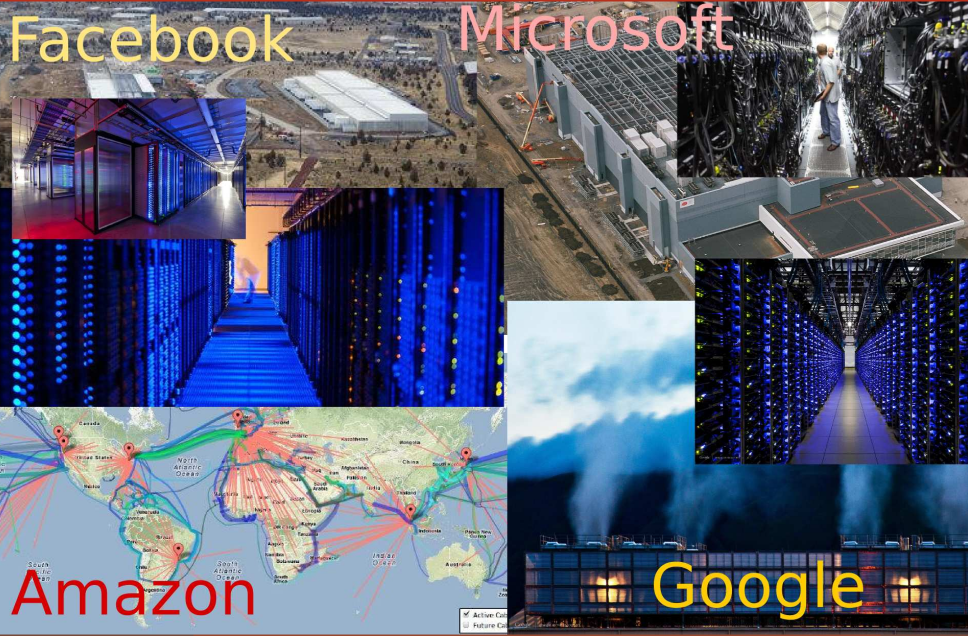
Berkeley Open Infrastructure for Network Computing (BOINC):

- About 238 000 volontaires actifs providing more than 420 800 computers

  (but also smartphones and tablets …)
- The average computation power over 24 hours is around 6 722 PetaFlops
- Heterogeneous, dynamic, volatile, unreliable, . . .

> *Today the computer is just as important a tool for chemists as the test tube. Simulations are so realistic that they predict the outcome of traditional experiments*
>
> – *Comité Nobel (Chimie), 2013*

The Cloud


Facebook
Microsoft
Amazon
Google
Canada
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Mongolia
China
Australia

Supercomputers

- 100,000 to 1,000,000 cores with accelerators (GPU, Xeon Phi) and a high throughput/low latency interconnection network
- An international race (Top500)

A Breathtaking Evolution

Hybrid and very large scale parallel architectures to answer computation needs in restricted power envelopes.

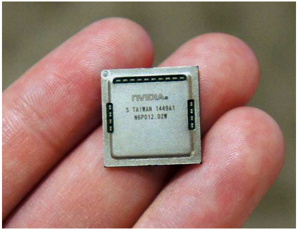
1996

ASCI Red
1 Teraflop
9298 Pentium II
1 000 Flops/W

2009

ATI Radeon
2.4 Teraflop
1600 Stream Processors
1 600 000 Flops/W

2015



Nvidia Tegra X1
1 Teraflop
8-core ARM CPU
667 000 000 Flops/W

My smartphone is as powerful as a 20 years old supercomputer

Embedded Systems, Sensor Networks, Internet of Things . . .

As a Conclusion

Our society (citizens, companies, science, ...) relies (often obliviously) on gigantic computation infrastructures

How to design/use/optimize/understand such infrastructures?

- Energy consumption
- Fair sharing
- Fault tolerance
- Modeling/analysis/evaluation/experimentation

Similar issues in:

- Bike sharing, carpooling, transportation, smart grids, ...

LIG Teams

- MESCAL ($\rightsquigarrow$ POLARIS): Middleware Efficiently SCALable
  - HPC middlewares, Performance Evaluation, Game Theory
- MOAIS ($\rightsquigarrow$ DATA-MOVE): PrograMming and scheduling design fOr Applications in Interactive Simulation
  - Parallel Algorithms, Programming Models, Scheduling and Interactive Computing
- NANOSIM ($\rightsquigarrow$ CORSE): Compiler Optimization and Runtime SysEms
  - Architecture, Compiling, Runtime, Efficiency/Energy
- SARDES ($\rightsquigarrow$ ERODS, CTRL-A): Efficient and RObust Distributed Systems
  - Cloud computing, OS, Autonomous systems, ...
- DRAKKAR: Networking and Multimedia
  - Wireless networks/protocols, Sensor networks/Internet of Things

Plus other teams (e.g., VERIMAG for verification/embedded systems, TIMA for architecture)

Collaborations

Academia

- US (Berkeley, Illinois, Idaho, ...)
- Brazil, Columbia, Cameroon, ...
- Europe (EPFL, Juelich, BSC, ...)

Companies

- CEA, BRGM
- Google, HP, Bull, Orange, Alcatel, ST Microelectronics, ...

No problem getting a very well paid job after a PhD... ☺

Lectures

- Parallel Systems (A. Legrand, V. Danjean): parallel algorithms, architectures, programming, trends in HPC/cloud
- Distributed Systems (V. Quéma, O. Gruber): distributed algorithms, consensus, fault tolerance, the fundamentals of peer-to-peer and distributed systems, ...
- Embedded Systems (F. Maraninchi, P. Raymond): critical and embedded systems, correctness and verification
- Advanced Aspects of Operating Systems (O. Gruber, R. Lachaize): OS structure, virtualization, ...
- Wireless and Sensor Networks (M. Heusse, C. Castelluccia): protocols, security

Plus:

- Performance Evaluation Workshop (A. Legrand, J.M. Vincent, 15 hours): scientific methodology, design of experiments, statistics, visualization, ...