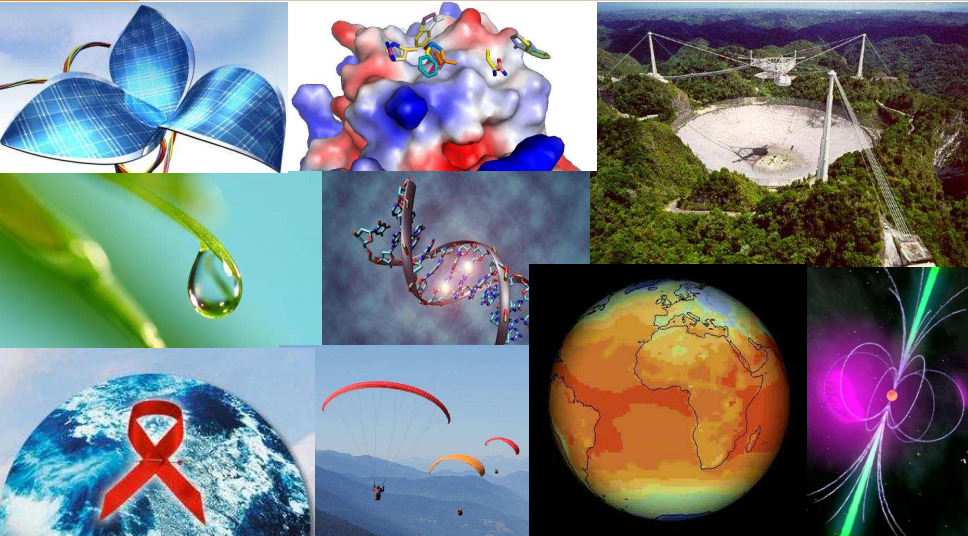


DIGITAL INFRAStructure CHALLENGES

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-

VOLUNTEER COMPUTING



Work Units Sent
2/sec

Work Units Received
2/sec

Application Downloads
0/sec

SETI Data Sources
0 sources

BOINC

This map shows SETI@home transmissions during a period of five minutes collected within the past 24 hours, and includes IP2Location LITE data available from www.ip2location.com. Current data is entirely collected from the BOINC client.

Berkeley Open Infrastructure
for Network Computing



Berkeley
GBT (Green Bank Telescope)
Arecibo

• About 238 000 active volunteers 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

Thousands of students are running SETI@home as part of their science curriculum. The question "Are we alone?" touches on many disciplines, including physics, astronomy, chemistry, biology, engineering, and computer science.

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

– Nobel committee (chemistry), 2013

SUPERCOMPUTERS

World's #1 Open Science Supercomputer

Flagship accelerated computing system | 200-cabinet Cray XK7 supercomputer |
18,688 nodes (AMD 16-core Opteron + NVIDIA Tesla K20 GPU) |
CPUs/GPUs working together – GPU accelerates | 20+ Petaflops


TITAN



K-computer

Performance of over 10 Peta
floating point number operations per second

(10 Peta=10,000,000,000,000,000)

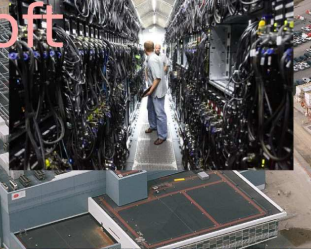


- 100,000 to 10,000,000 of cores, accelerators (GPU, KNL), a high throughput/low latency interconnection network
- A race between countries (Top500)

CLOUD COMPUTING

Facebook

Microsoft



Amazon



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



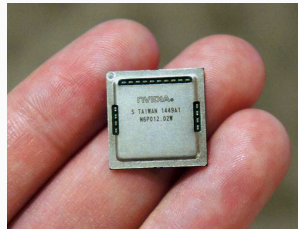
ATI Radeon

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

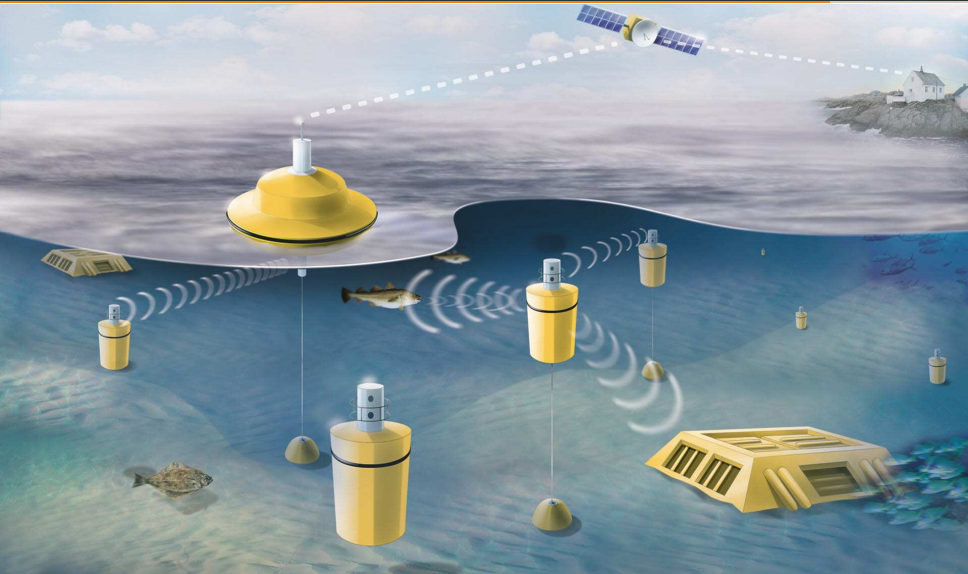
My **smartphone** is as powerful as a **20 years old supercomputer**

Wait! **Millions of threads** exchanging data!?!

EMBEDDED SYSTEMS, SENSOR NETWORKS, INTERNET OF THINGS...



EMBEDDED SYSTEMS, SENSOR NETWORKS, INTERNET OF THINGS...



DIGITAL INFRASTRUCTURES

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

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

- Scalability
- Fair sharing
- Fault tolerance
- Capacity planning
- Energy consumption
- Modeling/performance evaluation

Similar issues with any **large distributed infrastructure**

- HPC/cloud/...
- Smart grids
- Wireless networks
- Transportation systems

