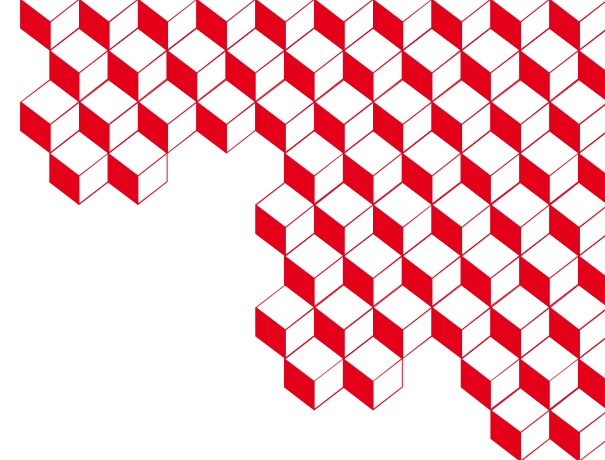# France within the international Exascale ecosystem

France.boillod-cerneux@cea.fr

From petascale to the exascale

TGCC/CEA - Ile de France
- Future hosting site for one of the EuroHPC European Exascale machines
- Site hosting the 1st brick of a federated and integrated quantum infrastructure with an HPC infrastructure (HPCQS)

IDRIS/CNRS - Ile de France
- 1st AI machine in France in response to the #AIForHumanity plan
- Bringing sovereign power to French research in AI
- 350 annual AI projects
- > 3100 GPUs at the start of 2022

CINES/CPU - Montpellier
- > 70 PF with next-gen AMD CPUs and GPUs
- Available early 2023
- Last big step before the exascale for France

EuroHPC exascale machines: next step for France

- Organization of the french application
    - GENCI is the Hosting Entity
    - CEA is the Hosting Site
    - SURF (NL) is member of the consortium

- Full TCO over 5 years : 500 to 600M€ (50% EuroHPC, 50% consortium)
    - French public contribution
    - NL contribution

Global performance targets for the supercomputer: Sustained HPL performance > 1 EFlops

Target composition :

- 60% accelerated nodes and 40% scalar nodes but accelerated nodes will bring > 90% peak performance

- >100 PB Flash/HDD and > 200 PB archive

- Power consumption < 20 MW

- European technology!

#EuroHPC (high performance computing)
Joint Undertaking

The European High Performance Computing Joint Undertaking (EuroHPC JU) will pool European resources to develop top-of-the range exascale supercomputers for processing big data, based on competitive European technology.

Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Montenegro, the Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and Turkey.

EuroHPC
Joint Undertaking

Our vision for an European Exascale machine

Addressing societal and scientific challenges (such as universe sciences, climate change, health, new energy, innovative materials, transport or smart cities/systems) via large scale numerical simulations and massive data analysis using artificial intelligence

- An accelerator of European Science and Innovation
  - open to all scientific and industrial collaborations, supporting new services including Cloud based interactive supercomputing / visualisation, containerisation and urgent computing for fast decision making
- A converged HPC/HPDA/AI system with a modular and balanced architecture
  - based on accelerated, scalar and HPDA partitions within a tiered data centric infrastructure
  - integrating state-of-the-art post-exsacale quantum accelerators and related services for specific workloads
- A system fully embedded inside the digital continuum
  - ready for secured end-to-end workflows from instruments / edge devices to long term sovereign storage
- A system with European Technology
  - integrating European hardware and software technologies in terms of computing, storage, network, cooling and infrastructure monitoring

<u>A system ready to harness European technologies and the best breed
of opensource software in a highly secure environment</u>

TIMELINE FOR THE Exascale PROJECT

Stage 1:
Developping the consortium & joint response to call

Stage 2:
Preparing the specifications for the Exascale computer/ Final Governance

Stage 3:
Launch and implementation

Joint response GENCI & Associates, Industry and international partners
Q4 2022 to Q1 2023

Hearing session & negotiations
Q2 2023

Machine specifications/ Competitive dialogue
Q4 2023 – Q4 2024

Exascale machine launched at TGCC site
H2 2025

Call for EoI issued by EuroHPC
13 December 2022

Closure of Call,
15 February 2023

Notification of outcome by EuroHPC expected in Spring 2023

EuroHPC tendering for the constructor of the machine/ supported by the consortium

Delivery / installation from H2/2025 then operation during 5 years

Finalisation of the French-led consortium : May 2023

EuroHPC exascale machines: next step for France

- Organization of the French application
  - 3 "sub-projects"
    - Sub project 1: in charge of legal aspects
    - Sub project 2: in charge of design and integration of the exascale supercomputer
    - **Sub project 3: in charge of the applications**

Focus on applications

Team dedicated to the applications

France
Boillod-Cerneux

Michel
Daydé

Anne
Laurent

Bruno
Raffin

A team, representing the application community within the exascale project and which
brings together GENCI partners

Our missions

- Study and represent the needs of the users concerned by the exascale

- Propose and implement actions to help the application community to
    - Taking ownership of the exascale
    - Proposing areas for improvement
    - Formulate the needs and blocking points for the applications

- Support the research community with
    - Training support
    - Support in terms of resources (human, material, etc.)

- Identify the applications that will be present in the call for expressions of interest

Scientific domains

Benchmarking

Codesign

Training and education
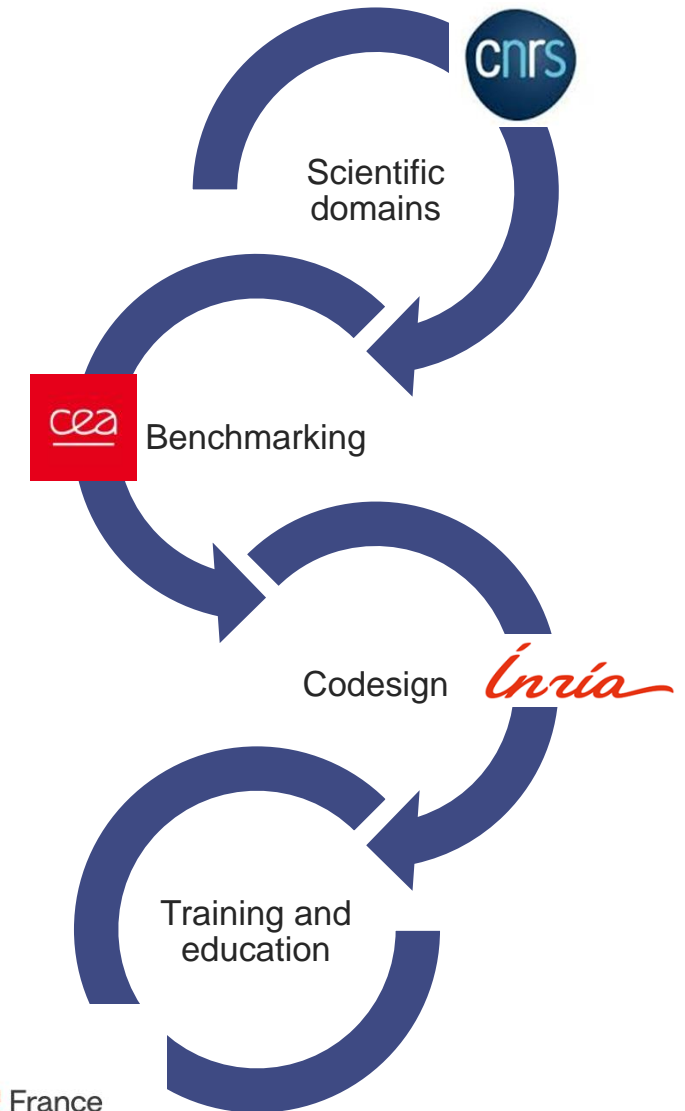
Lifetime of supercomputers vs the Science

- At the intersection of various projects and collaborations around the Exascale

- Dedicated to scientific applications (High Performance Computing, Artificial Intelligence, Data Analysis, High Performance Computing Processing, etc.)
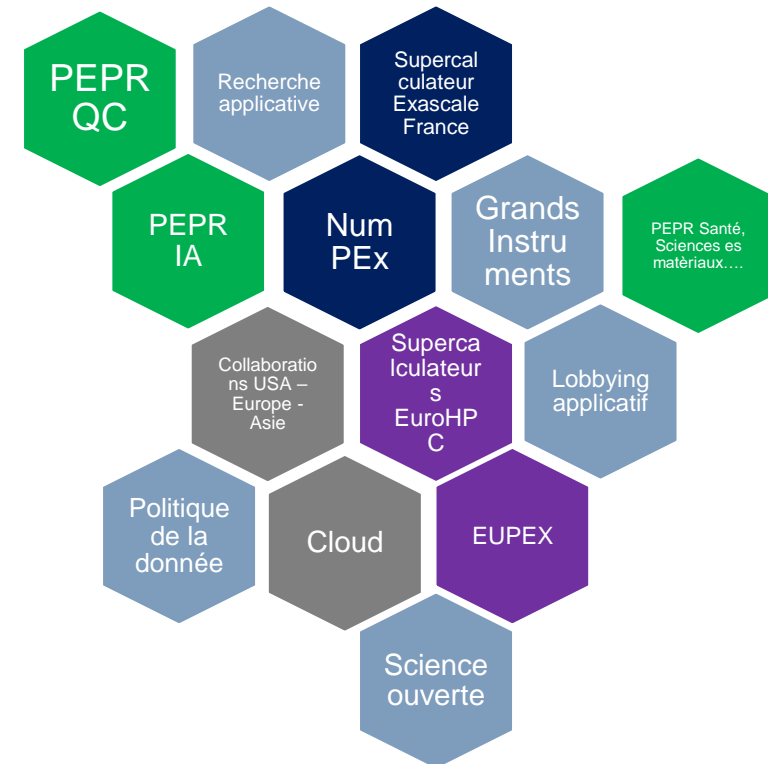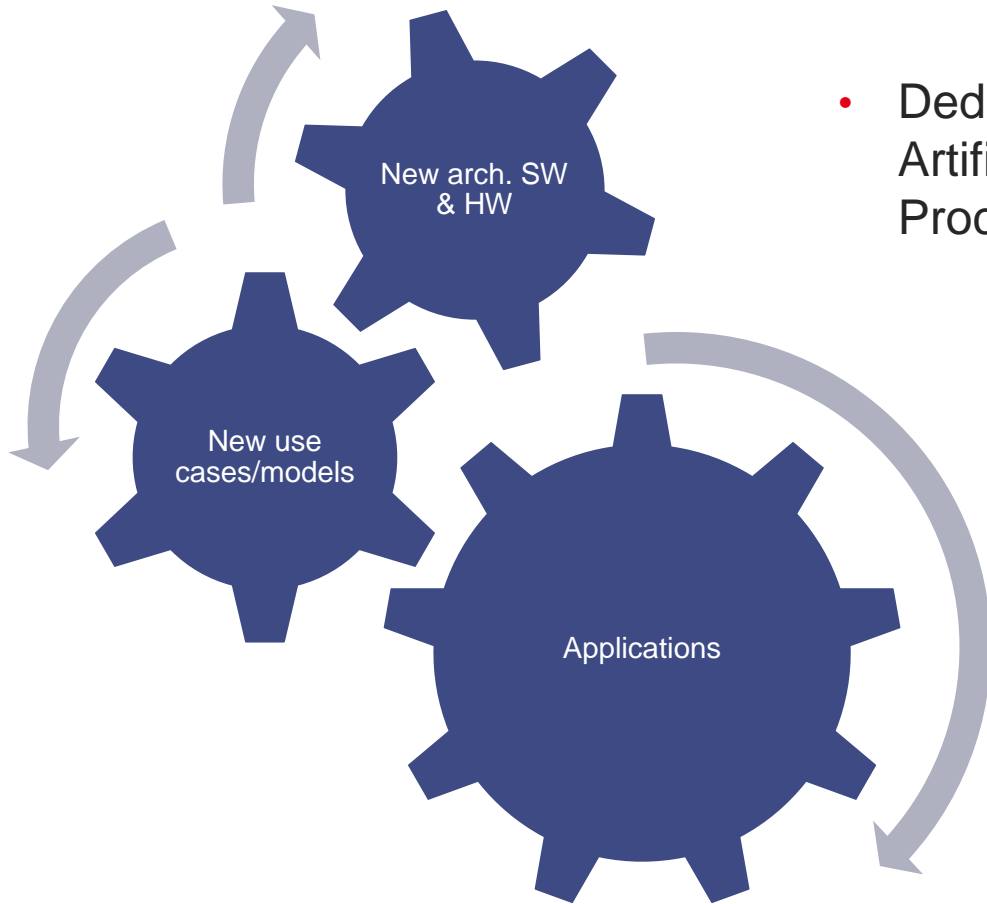
HPC, AI and HPDA community in France

- The French research community is very rich in scientific themes with an important place in the digital sector

- Applications are a key point to maintain France at a world rank in various strategic fields of scientific research: climate, energy, health, new materials…

- This involves considering the entire research chain in France, including:
  - Upstream research: applications in the "prototype" state, allowing applications to be maintained on innovative and futuristic architectures
  - Scientific production: maintaining the production of scientific results, essential for research and innovation
  - The notion of sovereignty: it is about being able to act and master the application chain, ensuring that our researchers can and are able to exploit scientific applications (and their ecosystem as a whole)

- Thus, maintaining scientific production within the framework of the exascale requires a "general" mobilization of the community

Our work

- The SP3 organized the writing of a deliverable to identify applications from the French research community:

  https://hal.archives-ouvertes.fr/hal-03736805/document

- The document is intended to provide a clear vision of the applications of the French research community
  - Current state/status of the applications
    - Who's using/developing the application?
    - Is it open source?
    - Is it portable? Scalable?
  - Prospects and projections for the exascale: The projection and ambitions of the teams with regard to exascale (and beyond)
  - Cost induced by the evolution of codes (material, human, …)
    - Requirements for switching to exascale, meaning:
      - accelerated architecture and/or improved scalability via algorithmic developments and/or integration of new digital models, human resources, etc.
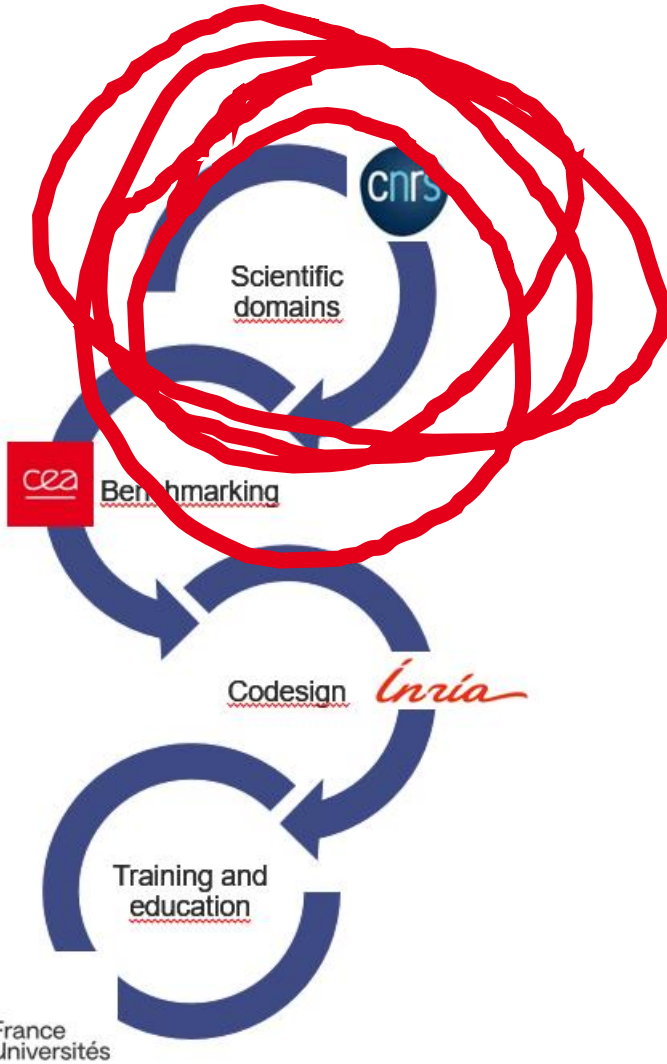
Exascale as a key application enabler
for European scientific and societal challenges

Overview of codes

NOMBRE DE CODES RECENSÉS POUR CHAQUE GROUPE DE TRAVAIL

- 10 — RF
- 38 — SDU
- 17 — SDV
- 13 — ITN
- 22 — E
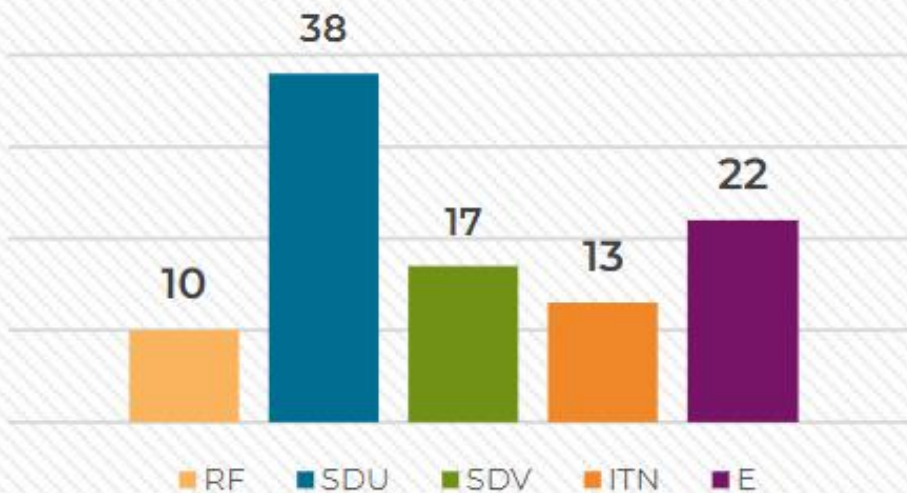
COMMUNAUTÉ DES CODES RECENSÉS DANS LES GROUPES DE TRAVAIL

- 2 - Équipe
- 2 - Organisme
- 16 - Nationale
- 8 - Européenne
- Internationale - 35
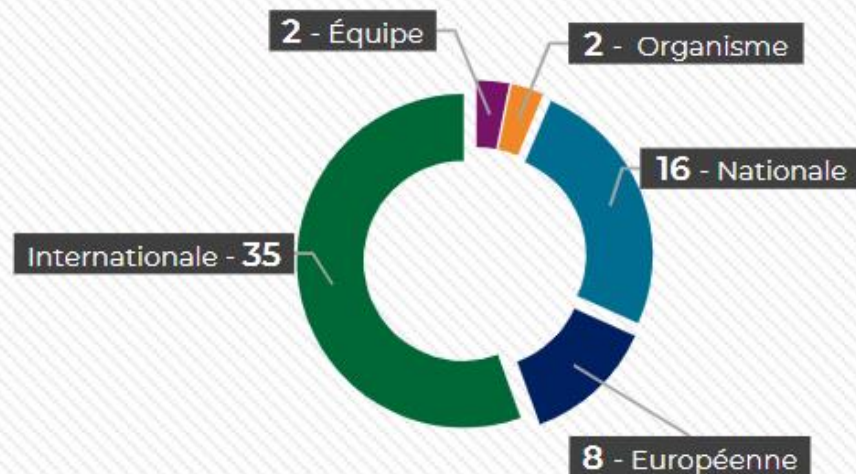
STATUT DES CODES RECENSÉS DANS LES GROUPES DE TRAVAIL

- 2 — Grands Instruments
- 54 — Production
- 14 — Développement ou re-développement
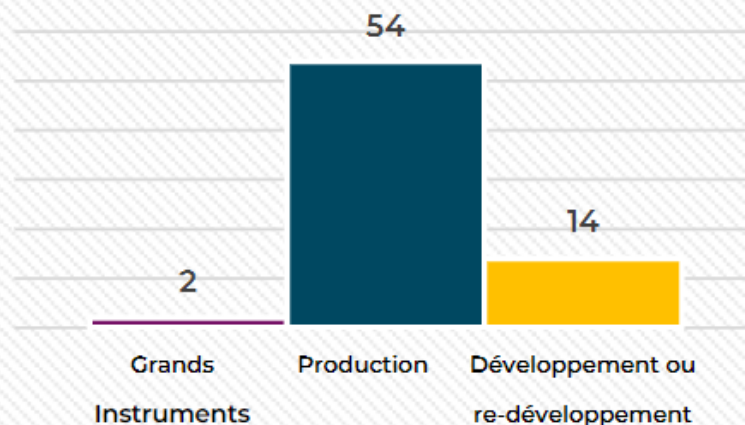
Scalability

SCALABILITÉ À L'HORIZON 2025 DES CODES RECENSÉS PAR LE GROUPE DE TRAVAIL ENERGIE

GPU   CPU

ABINIT
AVBP
BigDFT
Coupleurs (MEDCoupling/C3PO)
DIOGENes
GIBBS
GYSELA
KINECLUE
LAMMPS
MANTA
PASSMO
TinkerHP
Trust/TrioCFD
Xhells/Parody

■ 10000-99999 ■ 100000-999999 ■ 1000000- + ■ 100-999 ■ 1000-9999 ■ 10000- +
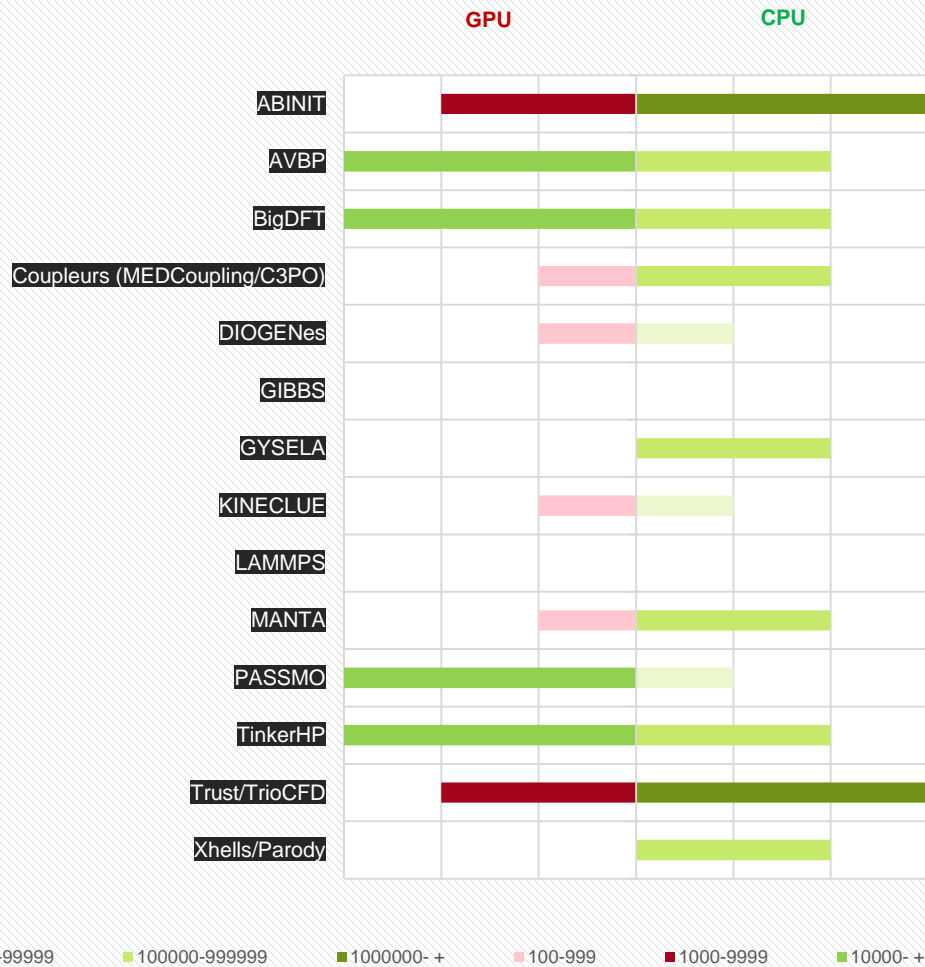
SCALABILITÉ À HORIZON 2025 DES CODES RECENSÉS PAR LE GROUPE DE TRAVAIL SCIENCES DU VIVANT

GPU   CPU

ABINIT
Aevol
Amber
Assemble-All-DNA
AVBP
BigDFT
CP2K
Gromacs
ICY
Muphy
TinkerHP
VASP
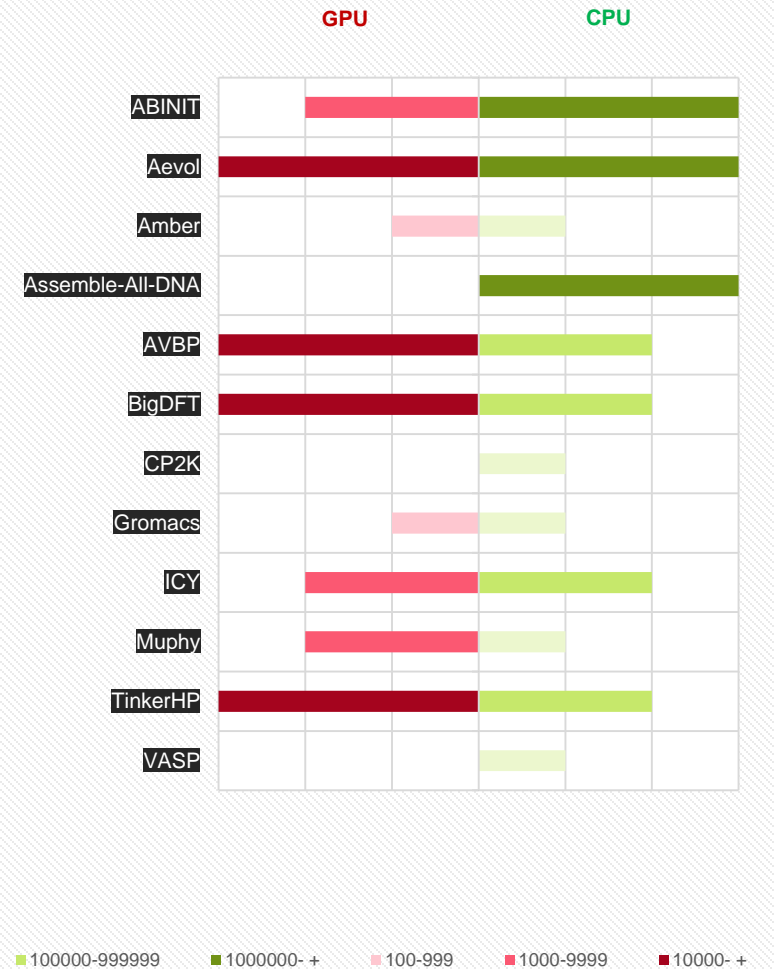
■ 10000-99999 ■ 100000-999999 ■ 1000000- + ■ 100-999 ■ 1000-9999 ■ 10000- +

A united community

About 230 researchers involved

Jean-Paul AMPUERO
Gabriel ANTONIU
Dominique AUBERT
Ludovic AUBRY
Édouard AUDIT
Nicolas AUNAI

Marc BAADEN
Mohd-Afeef BADRI
Rémi BARON
Corinne BEAL
Olivier BEAUMONT
Arnaud BECK
Marina BECOULET
Rachid BENSHILA
Marjorie BERTOLUS
Édouard BERTRAND
Guillaume BESLON
Gérard BIAU
Julien BIGOT
Quentin BLETERY
Benoît BLOSSIER
François BODIN
France BOILLOD-CERNEUX
Olivier BOUCHER
Fréderic BOURNAUD
Éric BOYER
Olivier BRESSAND
Patrick BROCKMANN
Romain BROSSIER
Allan-Sacha BRUN
Hugo BUFFERAND
Gaël BURGOS
ALFREDO BUTTARI

Ansar CALLOO
Yann CAPDEVILLE

Alessandra CARBONE
Fabien CASSE
Fréderic CAZALS
Jean-Pierre CHABOUREAU
Emmanuel CHALJUB
Jérôme CHAPELLE
Damien CHAPON
Fréderic CHEVALLIER
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Laurent COLOMBET
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Julien DEROUILLAT
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Thierry GAUTIER
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Virginie GRANDGIRARD
Mickael GRECH
Sergei GRUDININ
Abdou GUERMOUCHE
Fabien GILLET-CHAULET
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Yann HÉRAULT
Guido HUIJSMANS
Guillaume HUPIN

Olivier JAMOND
Sebastien JAN

Emmanuel JEANNOT
Pierre JOLIVET
Laetitia JOURDAN
Sylvie JOUSSAUME
Laurène JOUVE

Masa KAGEYAMA
Charles KERVRANN
Bruno KLAHOLZ
Samuel KOKH
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Gerhard KRINNER

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Elodie LAINE
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Philipe LAVOCAT
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Arnaud LEGRAND
Geoffroy LESUR
François LEVRIER
Mathieu LOBET
David LOFFREDA
Celine LOSCOS

Pierre-Etienne MACCHI
Fabienne MAIGNAN
Jean-François MANCIP
Marinica MIHAI-COSMIN
Olivier MARTI
Michel MASELLA
Sébastien MASSON
Benoit MATHIEU
Yves MECHULAM
Claudine MEDIGUE
Luca MESSINA
Yann MEURDESOIF
Raphaël MITTEAU
Vadim MONTEILLER
Luca MONTICELLI
Richard MORENO
Raymond NAMYST
Cyril NGUYEN
Florence NIEDERGANG
Michael NILGES
Gregory NUEL
Lucas NUSSBAUM

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Anne-Cécile ORGERIE

Jean-Noël PATILLON
Perrine PAUL-GILLOTEAUX
Christian PEREZ
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Mathieu SALANNE
Samuel SALVADOR
Emilia SANCHEZ-GOMEZ
Yanick SARAZIN
Claude SCARPELLI
Nathanaël SCHAEFFER
Roch SMETS
Vittorio SOMA
Aymeric SPIGA
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Antoine STRUGAREK

Patrick TAMAIN
Éric TANNIER
François TESSIER
Maxence THEVENET
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Marc TORRENT
El-Ghazali TALBI
Helene TOUZET
Pascal TREMBLIN

Sophie VALCKE
Patrice VERDIER
Thibaut VERY
Denis VEYNANTE
Jean-Pierre VILOTTE
Henri VINCENTI
Dorothee VOM BRUCH
Mathieu VRAC
Rodolphe VUILLEUMIER

Philippe WAUTELET

Savvas ZAFEIROPOULOS
Neil ZAIM
Christophe ZIMMER

Ainsi que nos partenaires industriels qui ont contribué à ce document, et bien d'autres encore que nous remercions chaleureusement.

What I was supposed to present

- All the collaborations (within EU and worldwide) around exascale. We can discuss it at the coffee break
    - Strong work within all EU: EuroHPC and bilateral collaboration with FZJ *(but if you want to join we are happy to work with you)*

    - Strong collaboration with Japan (HPC, AI and HPC-QC coupling): CEA/RIKEN collaboration *(but if you want to join we are happy to work with you)*

    - Strong collaboration with USAs (HPC and AI)

What I will talk about

- How the hell do we do benchmark and codesign for an exascale machine? What does even this mean?

What's next?

- Reminder: the exascale project is funding the supercomputer (TCO), NOT the users.

- In this context, a benchmark is « just » a use case within an RFP
  - Which will be confidential. Therefore, the outcome of a benchmark in this context is 0 for the scientific team.

  - Plus, the supercomputers must achieve an exaflop: meaning, the HPL must go beyond 1 Eflops.
    - In consequence, the codesign is GPU constrained

- Then, why shall we consider the benchmark and codesgin in this project?
  - Opportunity to execute mixed/complex workflows is open
  - Data issue is considered
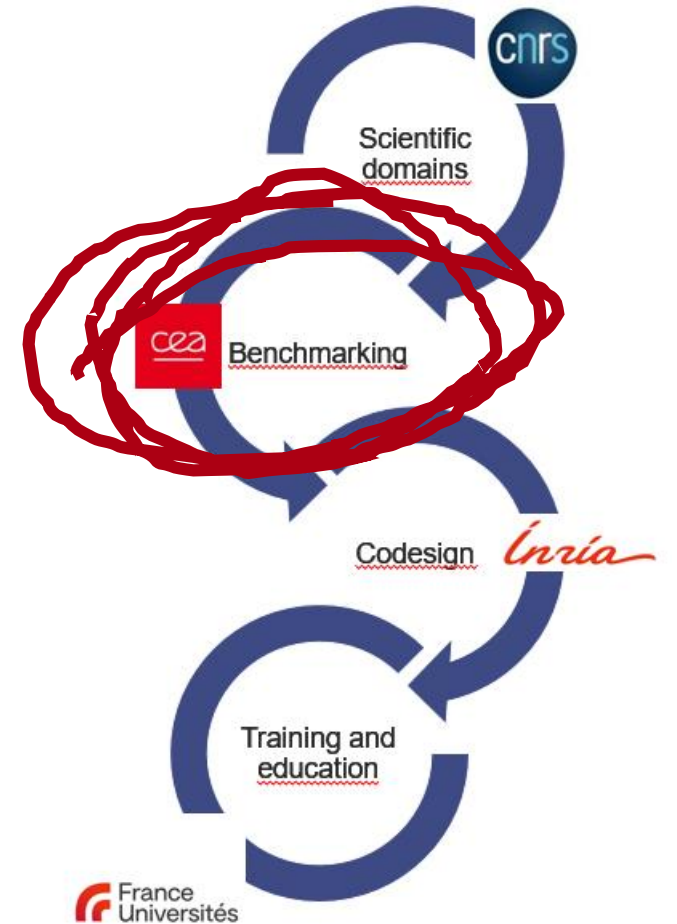
What's a benchmark?

- User: a benchmark is a use case I execute as a daily routine on the supercomputer.

- Vendor: a benchmarck is an execution from which I will reduce as much as I can the TTS and make sure this is compliant with my products (among which, the compiler I sell)

- Sys-admin: a benchmark is a mini-app extracted from a representative application that is stressing a specific caracteristic of the supercomputer.
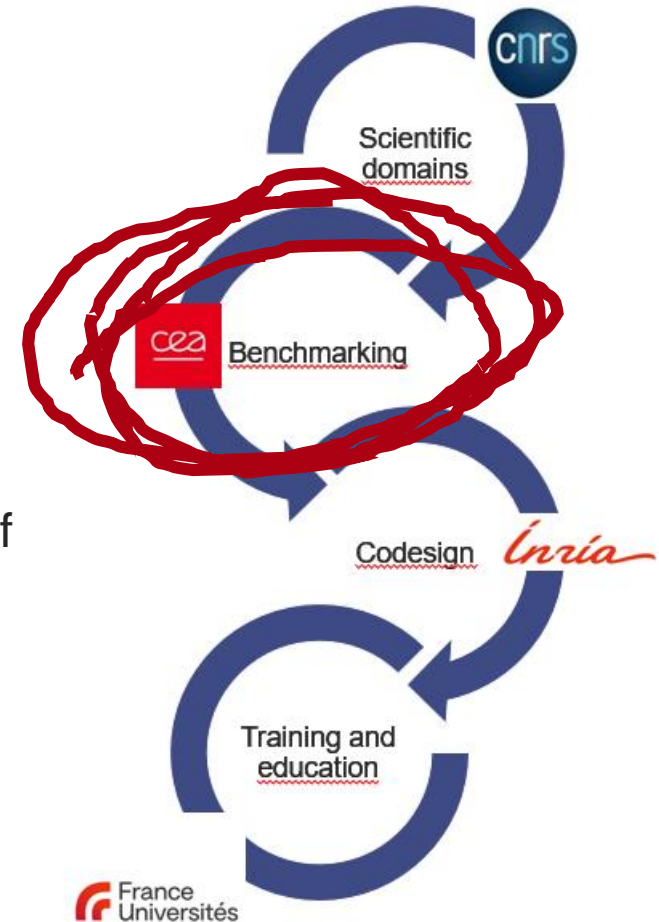
What's a benchmark?

- 3 different priorities therefore 3 different definitions.

- 1 common point though: the science
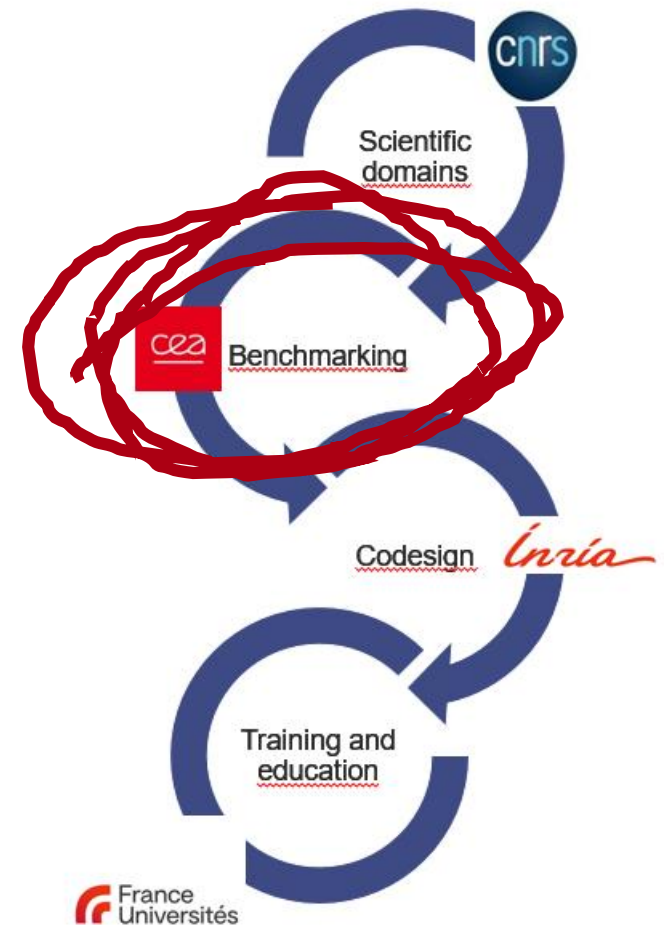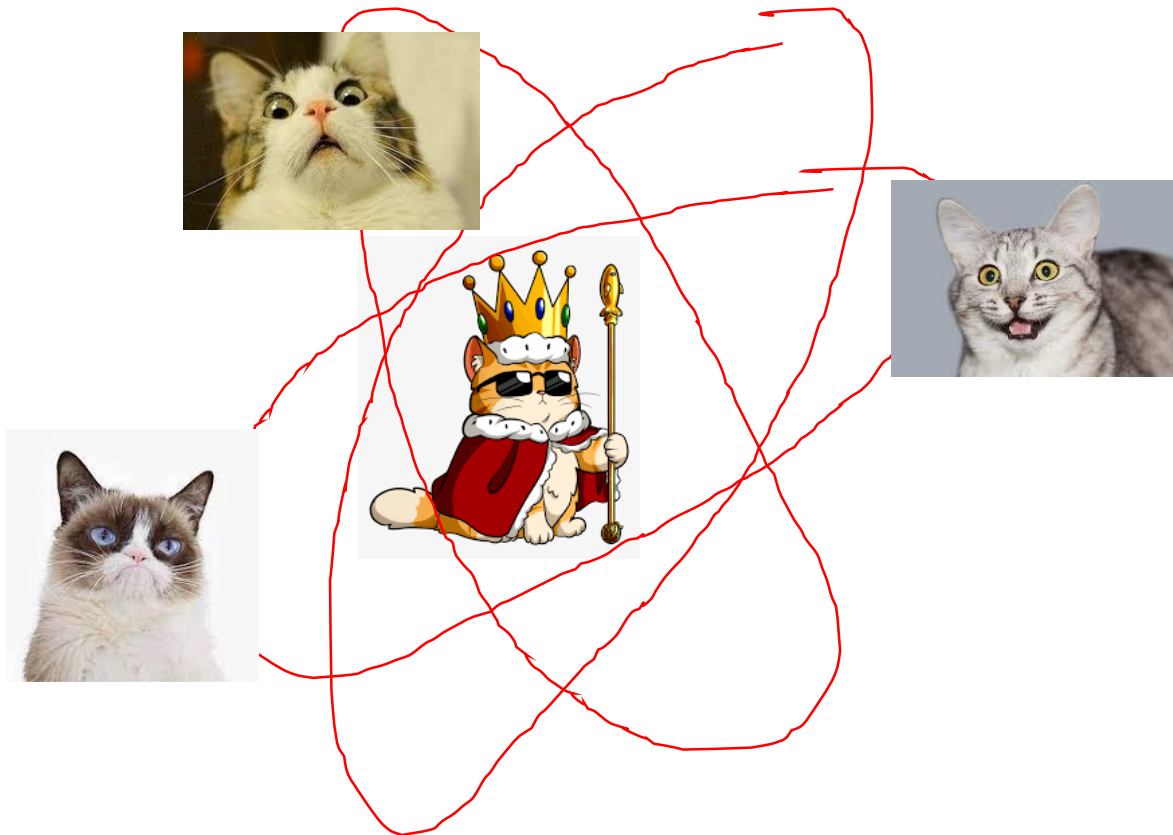
One use case to rule them all

- How do you go from this


work on app1

work on app1'

work on app1''

- To this

1 ring to rule them all
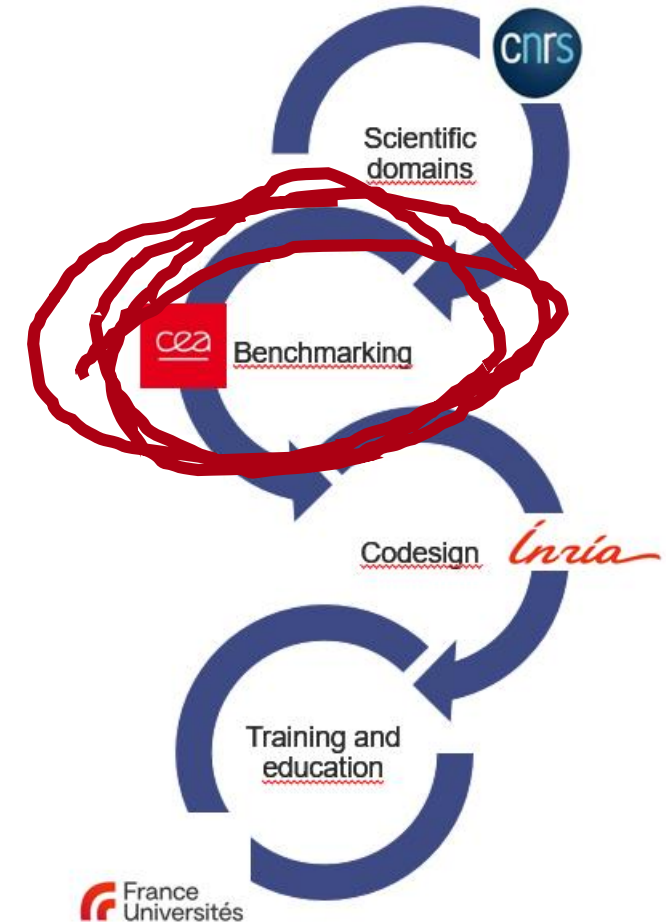
Thinking…

- Start from the start
  - What's the community? The three groups we mentioned. And they MUST work together.
  - What's a benchmark? Gather the community to build the definition
  - When you get the definition, you can collect the needs.
  - When you get the needs, you can start thinking of a solution.

 - Make sure the community is maintaining the 4 steps above during all the process
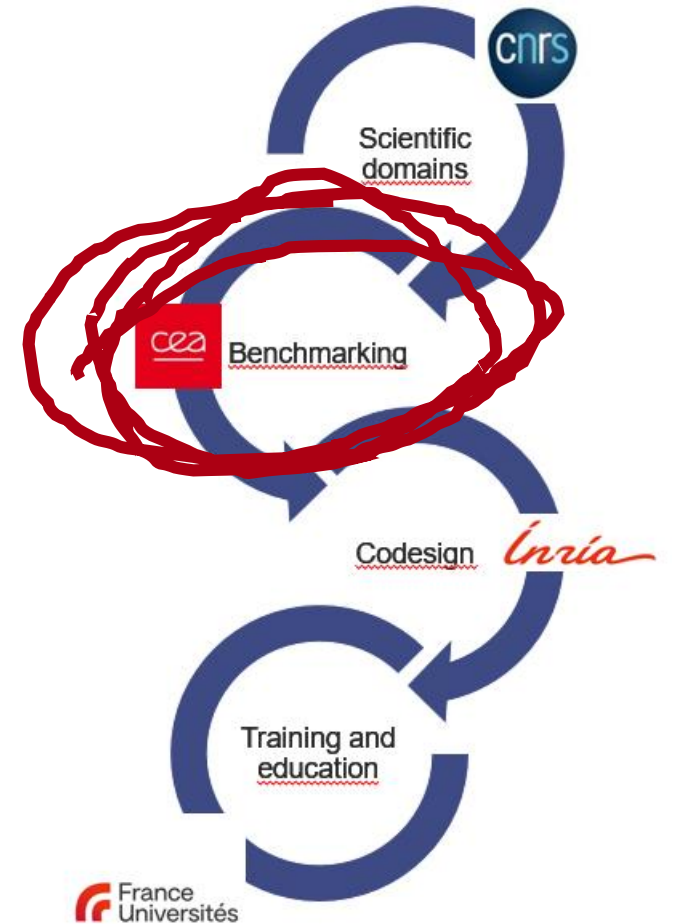
Still thinking...

- What's a benchmark? Gather the community to build the definition
  - The community shall provide a list of metrics to caracterize a benchmark
    - Ex: portability, possible caracteristics of the bench (io bound?), other…
    - This can be viewed as « metadata » of a benchmark

  - Depending on « who's using » the benchmark (and therefore what the computing cat has to do with is)
    - The priority on the listed metrics are different
      - Sys admin cat highest priority is « possible caracteristics of the bench «
      - Vendor car highest priority is « TTS » and « runability » of the code
   - Scientific cat highest priority is « scientific truthworthy »
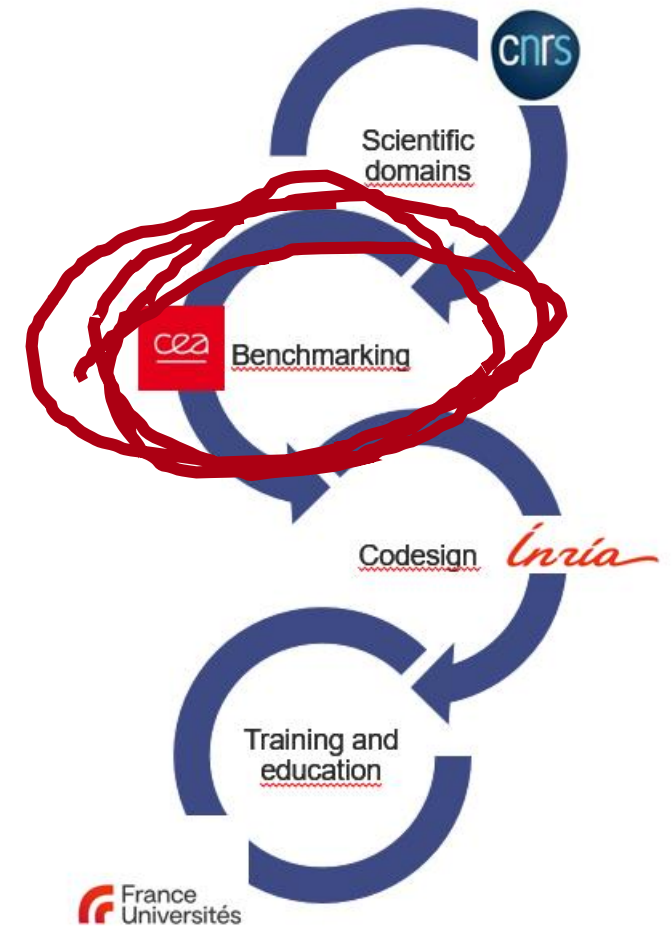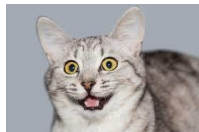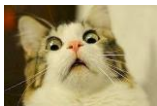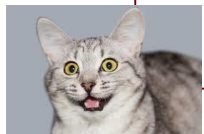
Where does it go wrong?

- A benchmark is **WRONG** when you miss one of the metric…
- … The priority on each of the metric can be different …
- … **But even for the lowest priority metric, you must make SURE this one is still true**
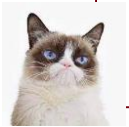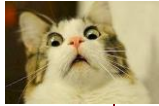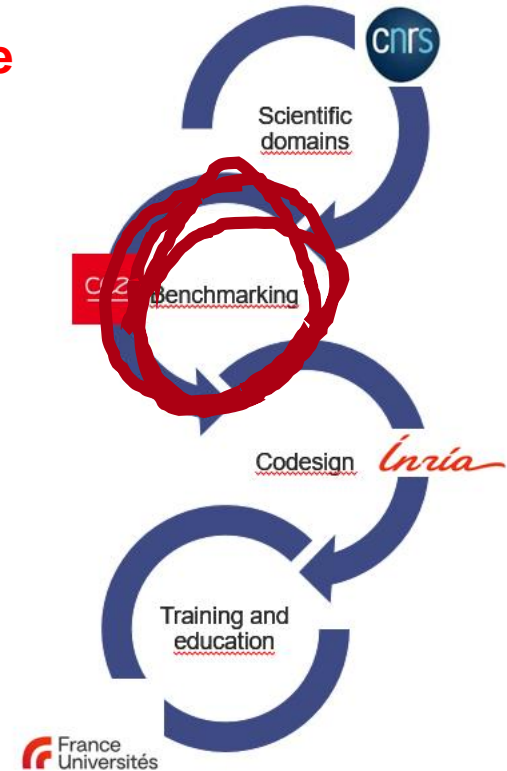
The sys-admin cat and vendor cat methodologies are wrong when they forgot to consider the « scientific truthworthy » of the benchmark.
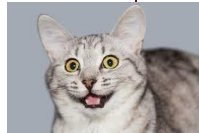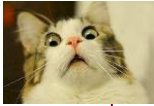
The scientific cat methodology is wrong when it forgot to consider the portability metric

The sys-admin and scientific cats methodology is wrong when it forgot to consider the metrics relevants to the vendor cat
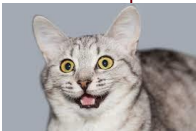
Where does it go wrong?

The sys-admin cat and vendor cat methodologies are wrong when they forgot to consider the « scientific truthworthy » of the benchmark.

**Expertise developped on irrelevant use case**

The scientific cat methodology is wrong when it forgot to consider the portability metric

Possible decrease (or stop) of the scientific production

The sys-admin and scientific cats methodology is wrong when it forgot to consider the metrics relevants to the vendor cat

Expertise developped on a use case that will be irrelevant on future HW & SW
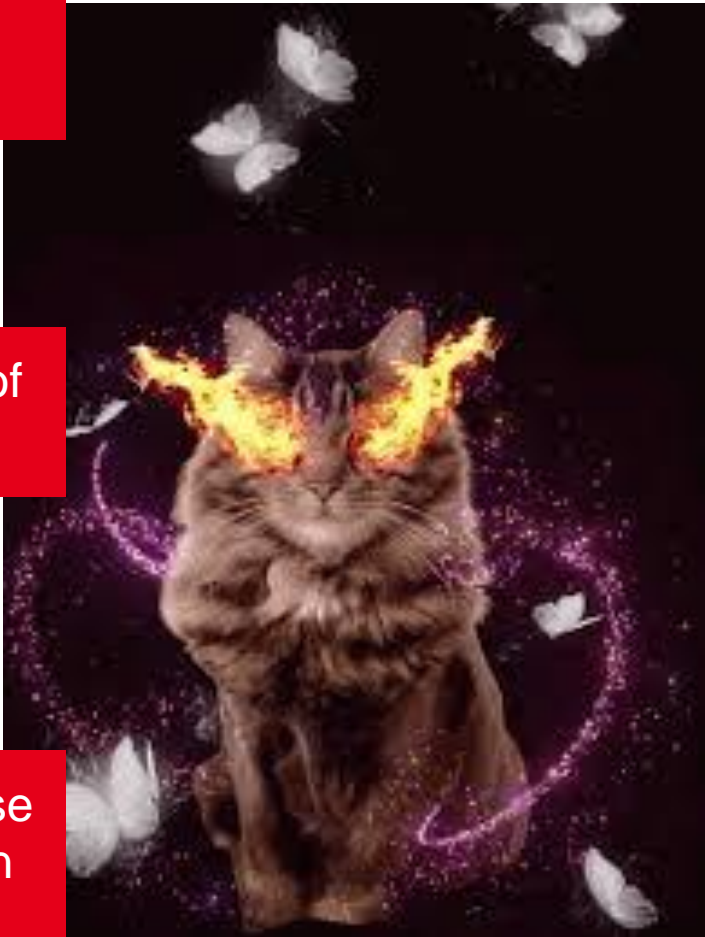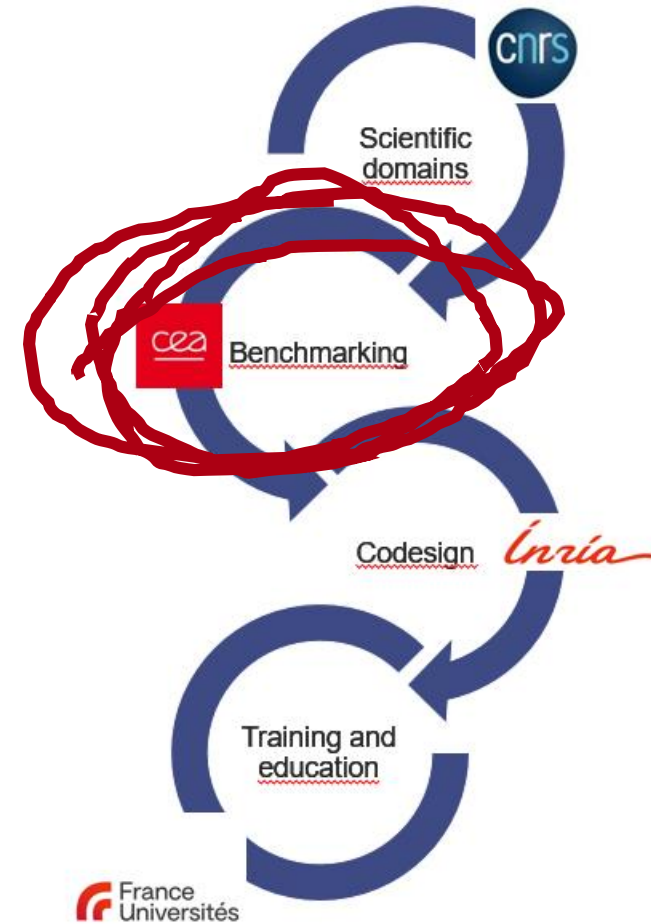
Can we fix it?

- Bring the community around the table

- Let's discuss the metrics
  - Based on the ongoing work developped within DOE-MEXT collaboration
  - Gather the internationnal community around this very important work

- **Please join in Paris (or online) in September 2023: 25-27 very likely.**

One community

The scientific cat needs to maintain its scientific production and anticipate its future scientific production

The vendor cat wants to make sure the Supercomputers that will be on the market in 5 to 10y from now will be able to execute scientific applications

Regression tests

Design new models

Optimize the application

Optimize the SC usage

Caracterize the execution

The sys-admin cat wants to make sure the Supercomputer is at its best level to execute scientific production

Thank you for your attention
French community is waiting for you !