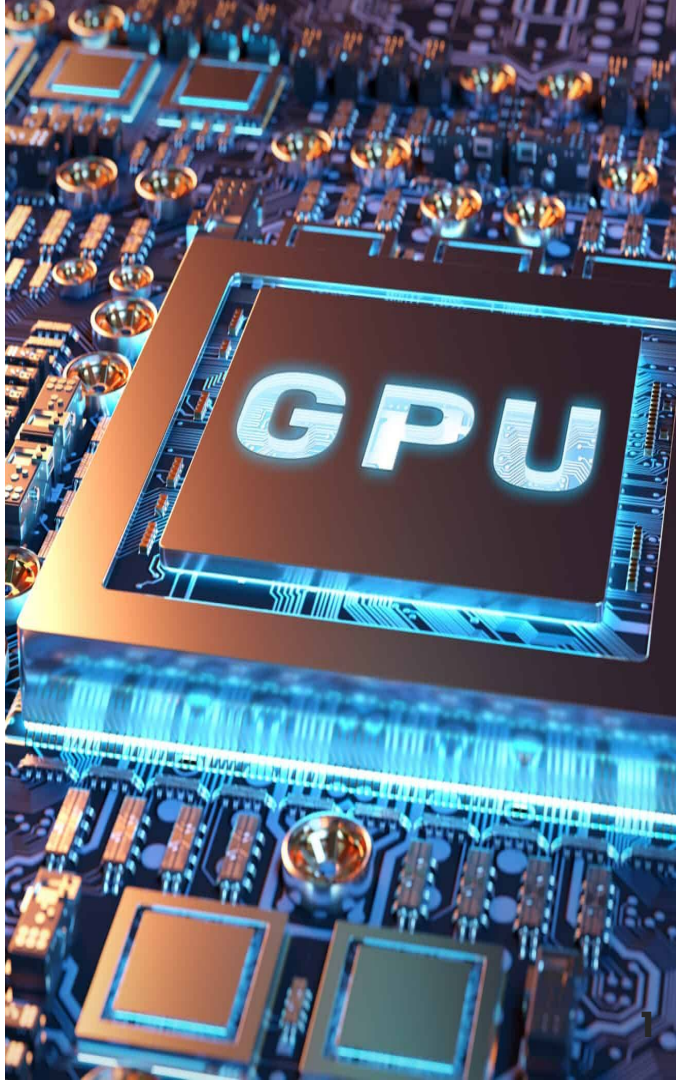


CEA Sustainability Strategy through the High-Performance Software Foundation

With a focus on Kokkos development by the CExA project

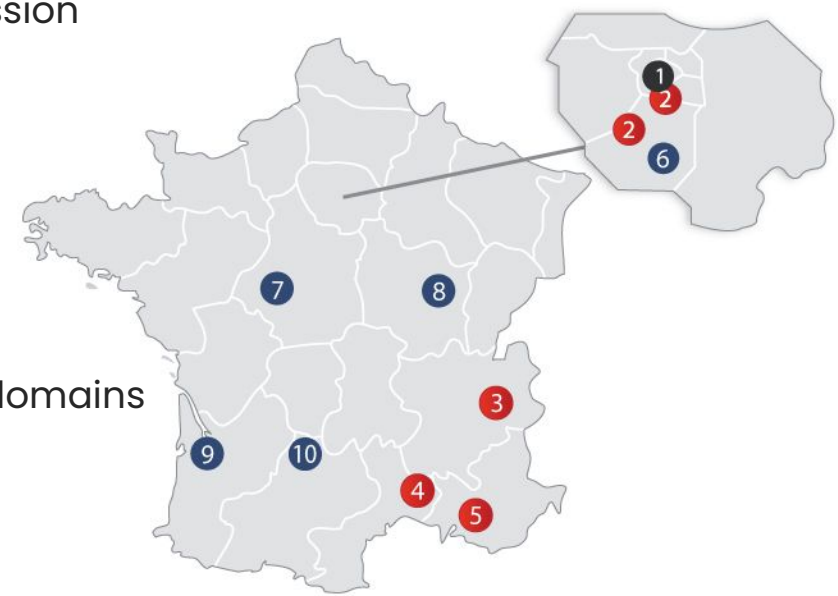
PASC, Pathways for Sustaining Long-Term Open Source Projects in Societal Interest

June 17th 2025 – Julien Bigot, the CExA, Kokkos & HPSF teams

What's CEA?

French **A**tomic **E**nergy & **A**lternative **E**nergy **C**ommission

- A governmental research institute
- 4 divisions
  - Military applications (DAM)
  - Energies (DES)
  - Technological research (DRT)
  - Fundamental research (DRF)
- Around 20k engineers & researchers in many domains
  - Physics
  - Life-sciences
  - Mathematics
  - Computer-science
  - etc.



CEA & HPC

CEA hosts **4 computing centers**

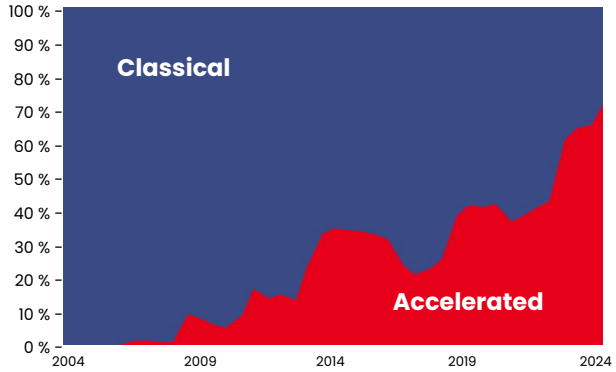
- Internal center for military applications
- Industrial compute center (CCRT)
- Industrial classified compute center
- **Public research** compute center (TGCC)
  - Will host one of the 2 European **Exascale supercomputers**: Alice Recoque

For HPC, CEA relies mostly on **open-source software** and develops its own

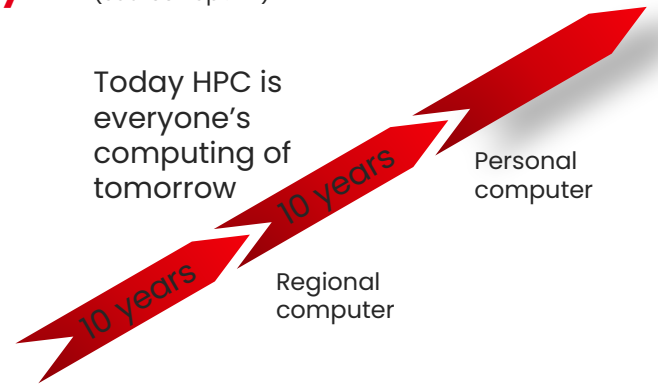
- Many **system & administration** tools
  - E.g. OCEAN, env. modules, PCOCC, Wi4MPI, etc. (60+ @ https://github.com/cea-hpc/)
- Many **HPC application libraries and tools** (IO, parallelism, mesh management, etc.)
  - E.g. PDI, DDC, Arcane, MPC, Hercule, etc.
- Many **HPC simulation applications**

GPU Computing @ CEA back in 2023

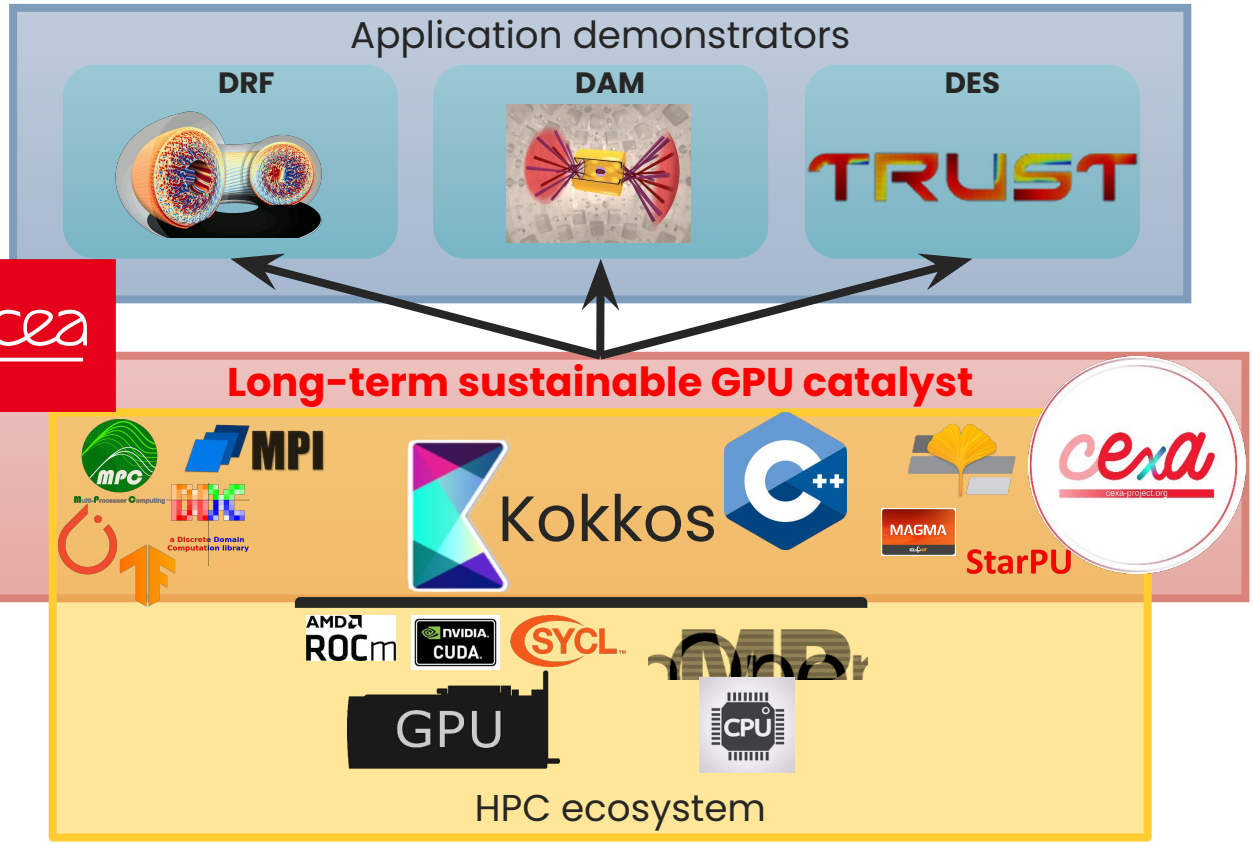
- We're entering the **Exascale** era, that means **GPU (~86% Top500)**
  - European pre-Exascale systems: Mix of AMD & Nvidia
  - US Exascale systems: AMD & Intel
  - First European Exascale machines are coming
    - *Jupiter* at Jülich (Germany) => Nvidia & Rhea
    - *Alice Recoque* at **CEA/TGCC** (call still open)
  - Need to re-develop applications with **Performance portability**
- GPU programming models: **software catalysts**
  - France and Europe: great research but no production tool
- A **need** for a long-term sustainable solution
  - **Adapted** to our hardware and software specificities
  - Where we can have **trust** in the roadmap



Computing power of the 500 top supercomputers from june 2004 to june 2024 (source Top500)



CExA project: goals



Disseminate and offer training

Adapt application demonstrators

Provide a long-term sustainable software catalyst for GPU computing

Available solutions

- Cuda
- HIP
- Kokkos
- OpenACC
- OpenMP (target)
- Raja
- SYCL
  - OneAPI/DPC++
  - AdaptiveC++/OpenSYCL/hipSYCL

Available solutions

- Cuda
- HIP
- Kokkos
- OpenACC
- OpenMP (target)
- **Raja**
- SYCL
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- **Production grade, with public support**

Available solutions

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- Production grade, with public support
- **Vendor neutral**

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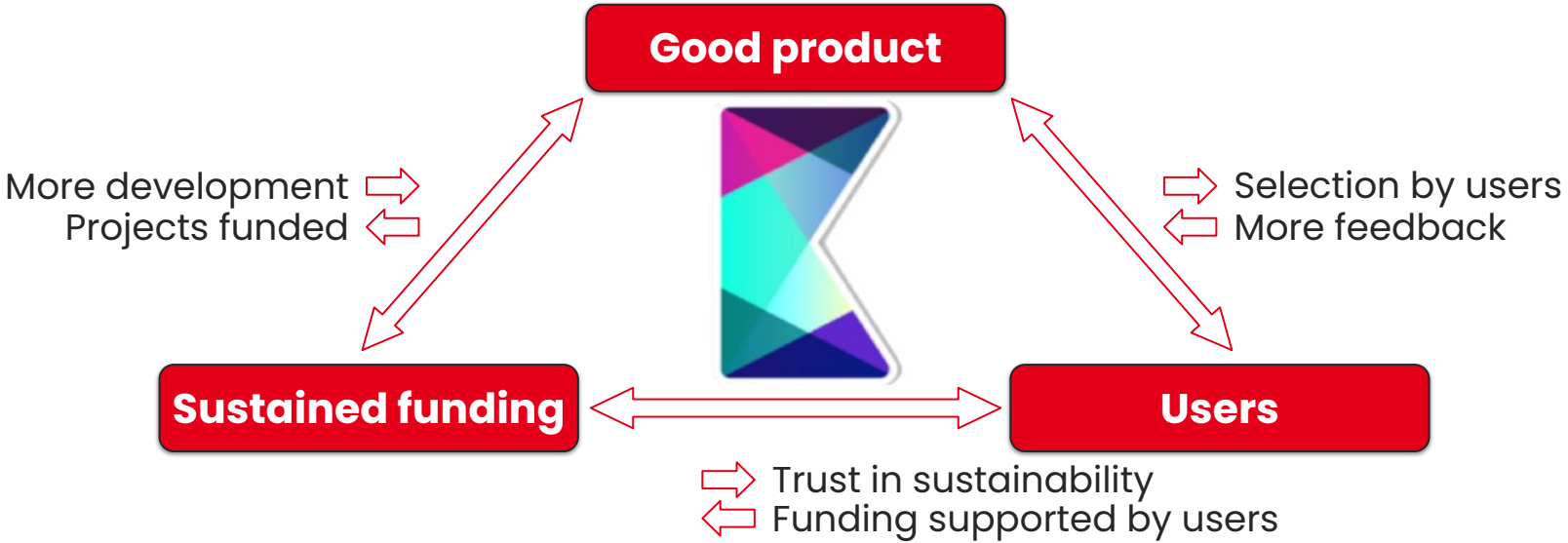
- Production grade, with public support
- Vendor neutral
- Annotations
  - Works best with imperative languages: C, Fortran, …
  - Compiler integration: potential for additional optimizations
  - Seq. first, requires to re-design applications for GPU
- Library
  - Suited to language with deep encapsulation: C++, …
  - On top of vendor toolchains: easier to port to new hardware
  - GPU first, requires to re-write applications for GPU

Kokkos at the center of a virtuous cycle



There is strength in numbers:
collaboration on core products is good for everyone

The CExA project

“adopt and adapt” strategy based on Kokkos

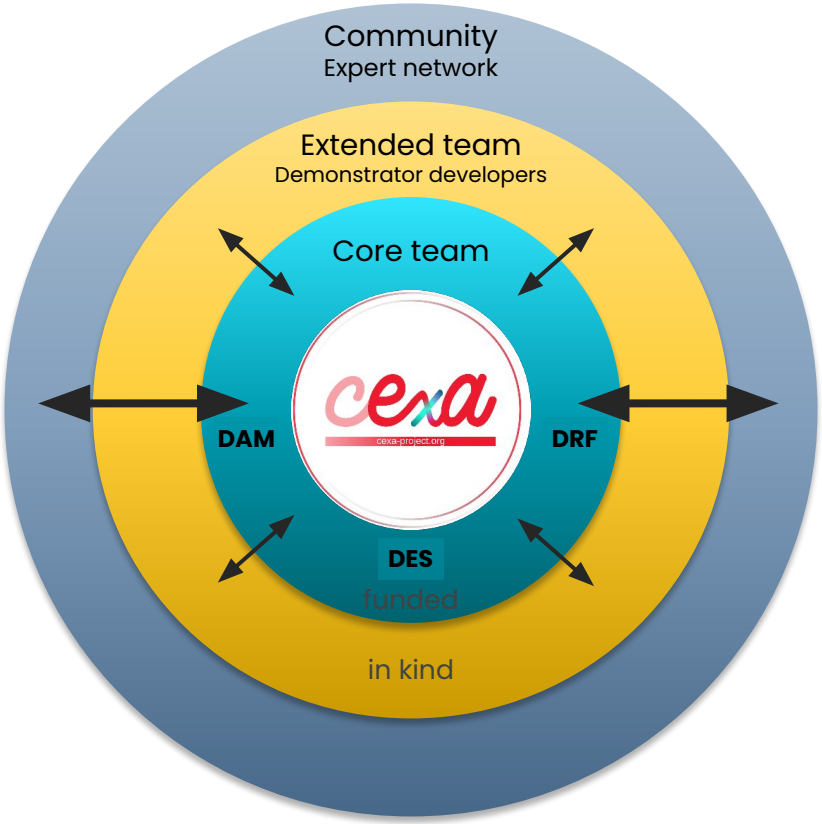
Kokkos : **a strong technical basis**

- A software architecture ready for the future
- Mature, free, libre, and open-source
- An open-development project with a wide user community
  - An objective to move to an open community-based development model
- A standardisation effort in ISO C++
  - A **stepping stone** one step ahead toward **parallel C++**

Some **adaptations required**

- For European **hardware**
  - There is no real hardware sovereignty without software sovereignty
- For **applications** from CEA, France and Europe
  - Take our specificities into account

CExA project in practice



- **Core team**
  - Management, implementation and dissemination
  - 12 researchers from all over CEA
  - 6 dedicated recrutements
    - 1 as a permanent researcher !
  - Funding for 2 or 3 hires expected every year
- **Extended team**
  - Demonstrator developers
    - Not funded
    - Find their own interest in the participation
  - 2-3 new demonstrators every year
- **Community**
  - Federation of an expert network
  - Co-design of C**ExA**:
    - Identification of needs
    - Usage of C**ExA** in applications
  - Priority target for dissemination
  - Sustainability of the work

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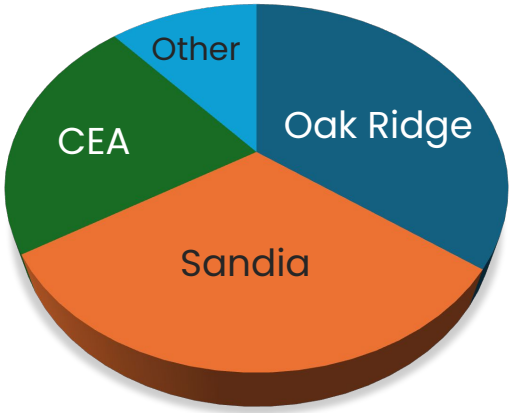
Kokkos development today

Primary teams



Contributions & support

- Number of commits by institution
- In the last 6 month

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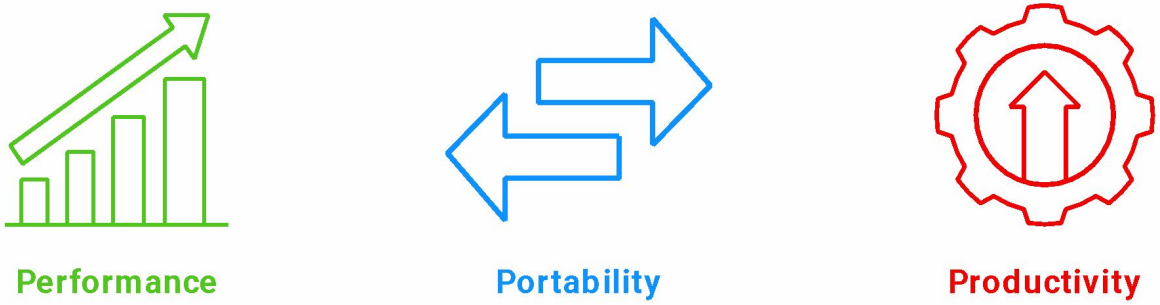
One year ago, HPSF was launched at ISC 2024

HPSF
HIGH PERFORMANCE
SOFTWARE FOUNDATION

High Performance Software Foundation?



1. A neutral hub for open source, vendor-neutral, high performance software
2. Supports projects that advance portable software for diverse hardware by:
   - Increasing adoption
   - Aiding community growth
   - Enabling development efforts
3. Lower barriers to productive use of today's and future high performance computing systems

HPSF
HIGH PERFORMANCE SOFTWARE FOUNDATION

HPSF

HIGH PERFORMANCE SOFTWARE FOUNDATION

Fund & vote

Members

Premier $175k/y

Hewlett Packard Enterprise

Sandia National Laboratories

aws

Lawrence Livermore National Laboratory

General $5k-50k/y

AMD

Argonne NATIONAL LABORATORY

arm

cea

intel

kitware Delivering Innovation

NVIDIA

Los Alamos NATIONAL LABORATORY EST.1943

OAK RIDGE National Laboratory

RIKEN

R-CCS

INES

Associate for Academia

BERKELEY LAB

CDAC

JÜLICH Forschungszentrum

Tennessee TECH

UCL

UNIVERSITY OF MARYLAND

UNIVERSITY OF OREGON

UTokyo

Universität der Bundeswehr München

CSCS

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aws Hewlett Packard Enterprise | Sandia National Laboratories | Lawrence Livermore National Laboratory | cea | kokkos

Governing board

Participate & vote

Technical Advisory Council

Join & vote

WGs & committees

- Outreach
- Diversity
- CI & Testing
- Events
- Tools
- ...

Projects

Spack | Charliecloud | AMReX | HPCToolkit | APPTAINER | E4S | TRILINOS | kokkos | OpenCHAMI | VISKORES | HPX | Warpx | ENVIRONMENT MODULES | CHAPEL

What's in it for members?

HPC Providers (HW/SW/Services)

Leverage HPSF projects to enhance your services and products

Ensure your products are **well supported** by HPSF software

Secure mindshare and collaborate with some of the leading software teams in the HPC space

HPC Users (Scientists, Analysts)

Leverage HPSF projects to develop, build, deploy and profile your projects

Connect with a community that can help you use the latest high performance computing software and hardware

- CPUs, GPUs, AI/ML architectures

Voice concerns and requirements to the HPSF community

De-risk software decisions knowing there's a community to rely on

HPSF
HIGH PERFORMANCE SOFTWARE FOUNDATION

The TAC has established a project lifecycle as a path to sustainability

Emerging

- Committed to open governance
- Working towards best practices
- Libre & open source vendor-neutral HPC project

Established

- Wide usage by at least 3 orgs of sufficient size and scope
- Steady commits from at least one organization
- Robust development practices

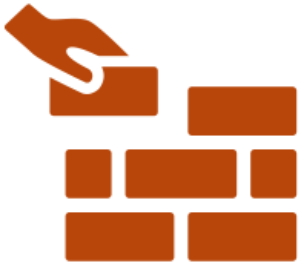
Core

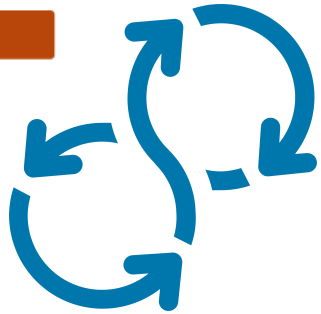
- Used commonly in production environments
- Steady commits from *more* than one organization
- Large, well-established project communities
- Sustainable cycle of development and maintenance

HPSF
HIGH PERFORMANCE SOFTWARE FOUNDATION

Projects Neutrality thanks to HPSF

Solving the “chicken & egg” problem





1. **Sustaining** OSS projects requires a **community**
2. Building a **community** requires **trust**
   - Projects will continue to be available
   - Projects are usable by anyone
   - No one organization can control the direction of the project
   - Projects are open to new contributors and new ideas
3. **Trust** gets us users; some users become **contributors**
4. **Neutral**, **open governance** ensures that we can build the **broadest** possible **communities**

HPSF
HIGH PERFORMANCE SOFTWARE FOUNDATION

Joining HPSF as a Project

- **Proposal submission (via GitHub)**
  - Template provided https://github.com/hpsfoundation/tac
  - Find two sponsors on the TAC which help you along!
- **Project presentation to the TAC**
  - How does the project fit into HPSF?
  - What level should it join at?
  - How does it meet the criteria for acceptance (lifecycle model)?
- **TAC review and feedback**
  - More evidence needed?
- **TAC (provisional) approval (2/3 majority)**
  - You still need to join the Linux Foundation (but wait for provisional HPSF approval)!
  - Linux Foundation requires transfers of trademark, website etc.
  - Copyright stays with developer institutions

HPSF
HIGH PERFORMANCE
SOFTWARE FOUNDATION

HPSF Conference 2025

HPSF
CONFERENCE 2025

204 Attendees

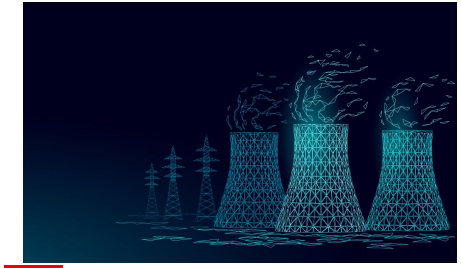
79% North America

14% Europe

Monday	Tuesday	Wednesday	Thursday
HPSF Status Update Project Updates Panel: Platform Trends	Usability & Performance Panel: Processor Trends WG Breakouts Panel: HPSF Community	Project Days Spack, Kokkos, Charliecloud, Apptainer, Trilinos, AMReX	Project Days Spack Kokkos, Charliecloud, HPX

Recordings: https://www.youtube.com/@HPSF-community/videos

So, about CEA open-source strategy?



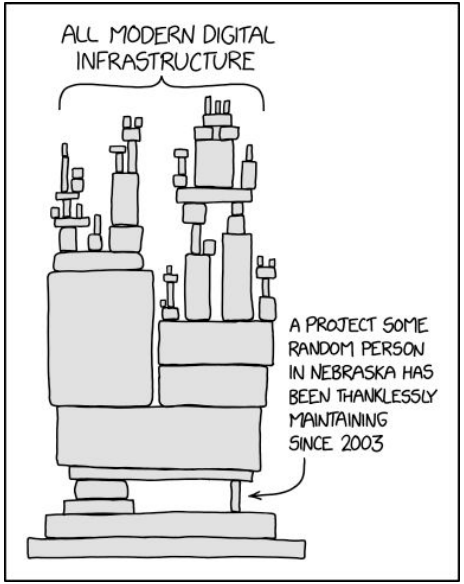
- Not one single global strategy for all 20k researches
  - But some shared guidelines and directions

In the case of **HPC**, **CExA** & **HPSF**

- Identify critical software building blocks
- Contribute code & time to put our money where our mouth is
- Join and animate community projects
  - **Share the maintenance burden**
  - The more, the merrier
- Join **HPSF**
  - Kokkos, env. Modules, Wi4MPI, PDI, …

A success with Kokkos

- A real knock-on effect
  - New potential partners identified every months



https://xkcd.com/2347/