

# EuroHPC quantum technologies and which applications can use them and why

Paving the way to a federated European HPC-QCS ecosystem



# THE STATE OF QUANTUM COMPUTING AND SIMULATION \_\_\_\_\_

A technology in its emerging phase



Quantum computing is based on **the manipulation of natural properties of particles** et and exploits some **quantum effects**



These systems **cannot be used like classical computers** (access, programmability, data, resource management, etc.)



Applications and algorithms must be **rewritten from scratch**



Quantum computing only allows the efficient resolution of **very specific problems** thanks to **new algorithms**

# THE CONCEPT OF HPC-QCS HYBRIDIZATION

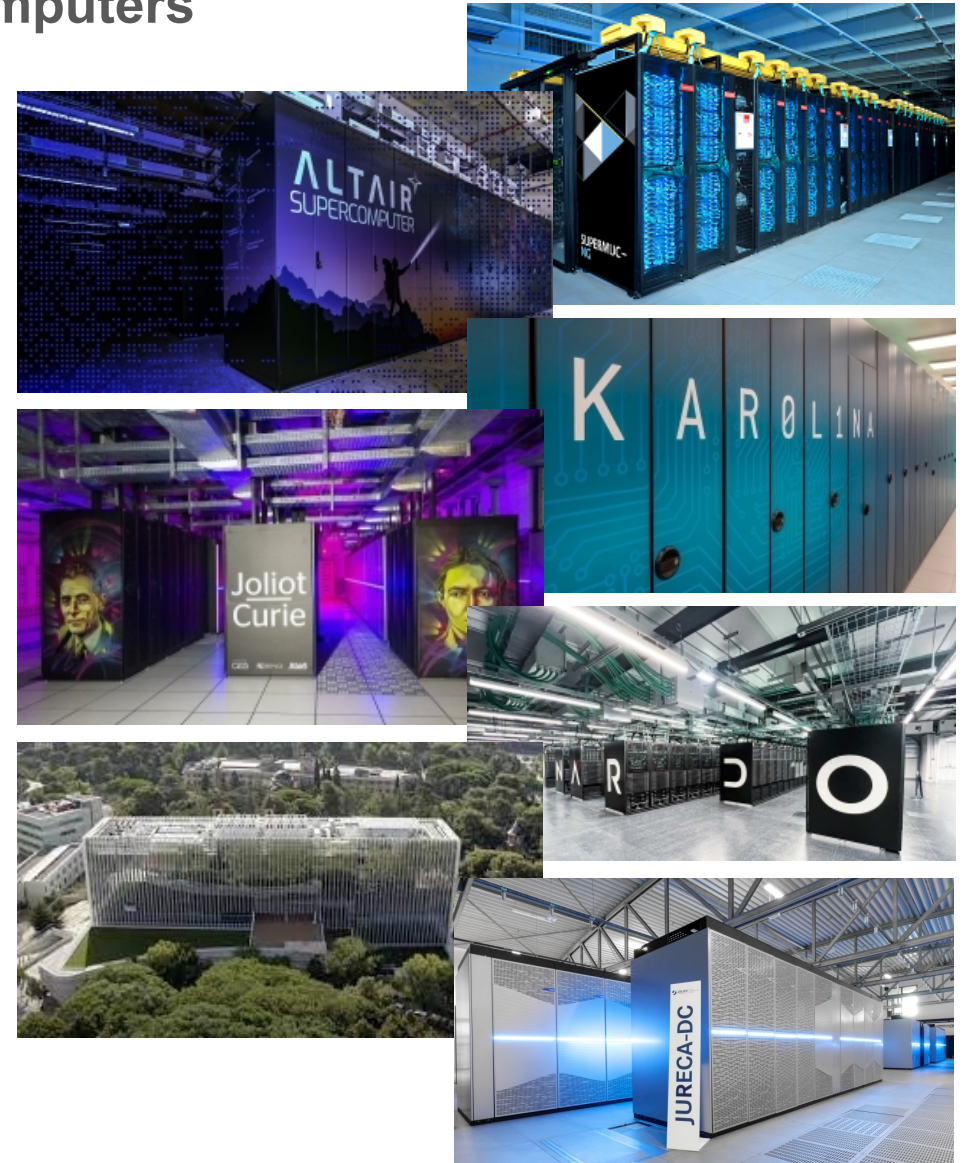
... that will be coupled with classical supercomputers

Quantum computing is **an accelerator** for targeted **HPC/AI** applications and algorithms that will be **offloaded to the QPU**

**Workload evaluation** must be adapted on existing middleware environments

**Well-known access procedures**


**A federated HPC-QCS infrastructure** to build programming environments, develop and provide access to scalable and interconnected quantum computers as well as applications.





# THE EUROHPC QUANTUM COMPUTING INITIATIVE

## Two pilot systems acquired for the HPCQS project

 **2** 100+-qubit quantum simulators acquired in the context of

**<HPC|QS>**

  GENCI/CEA

 FZJ

**15** partners in total  
**6** countries involved





# THE EUROHPC QUANTUM COMPUTING INITIATIVE

## Six additional quantum computers acquired

**6** 10+-qubit  
quantum  
computers  
acquired through a  
call for expression  
of interest (CEI)

**30** partners in  
total

**17** countries involved




 **EuroQCS-France**  
GENCI/CEA

 **Euro-Q-Exa**  
LRZ

 **EuroQCS-Italy**  
CINECA

 **Lumi-Q**  
IT4I @ VSB

 **EuroQCS-Poland**  
PSNC

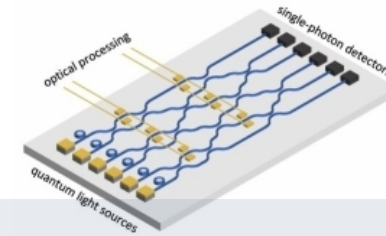
 **EuroQCS-Spain**  
BSC-CNS

# THE EUROHPC QUANTUM COMPUTING INITIATIVE

Six different flavors of new quantum computers acquired

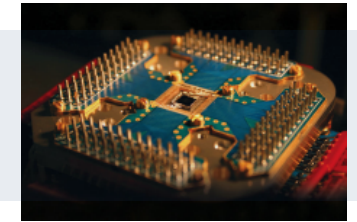
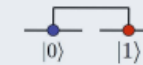
 **EuroQCS-France**  
GENCI/CEA

Photonic quantum computer



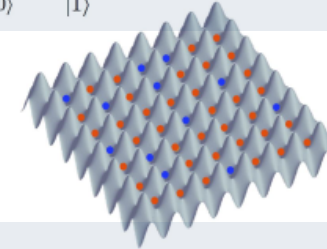
 **Euro-Q-Exa**  
LRZ


Superconducting qubits



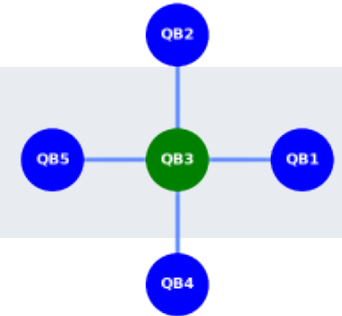
 **EuroQCS-Italy**  
CINECA

Neutral atoms



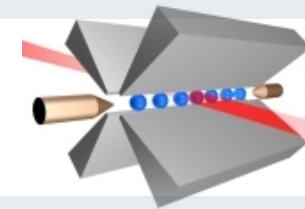
 **Lumi-Q**  
IT4I @ VSB

Superconducting qubits with a star-shaped topology



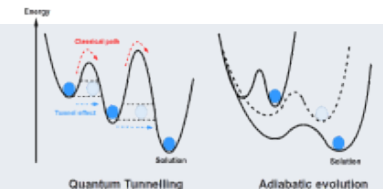
 **EuroQCS-Poland**  
PSNC

Trapped ions



 **EuroQCS-Spain**  
BSC-CNS

Quantum annealer

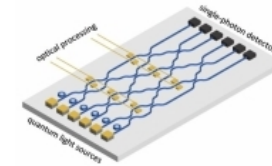


# THE EUROHPC QUANTUM COMPUTING INITIATIVE

Seven different flavors of HPC-QC infrastructures

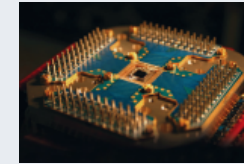
 **EuroQCS-France**  
GENCI/CEA

Photonic quantum computer



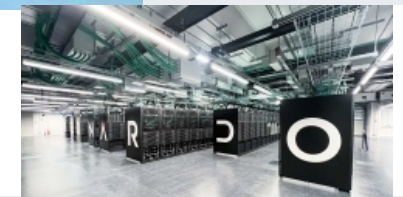
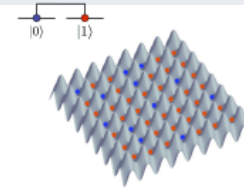
 **Euro-Q-Exa**  
LRZ


Superconducting qubits



 **EuroQCS-Italy**  
CINECA

Neutral atoms



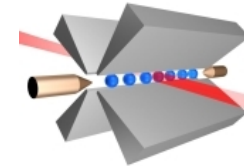
 **Lumi-Q**  
IT4I @ VSB

Superconducting qubits with a star-shaped topology



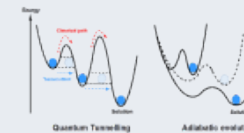
 **EuroQCS-Poland**  
PSNC

Trapped ions



 **EuroQCS-Spain**  
BSC-CNS

Quantum annealer





# THE EUROHPC QUANTUM COMPUTING INITIATIVE

Joint HPC-QCS integration efforts from the 7 Hosting Entities and their partners

Harmonization of the user experience for the EuroHPC quantum systems across the six Hosting Entities and HPCQS



Creation of a repository of **shared collection of proof-of-concept applications and benchmarks** running on various hybrid systems

Collaboration with **standardization bodies** and participation in relevant working groups and committees



Implementation of an HPC-QC **Technical Support Team**

# EUROQCS-POLAND

## Consortium

Poznań Supercomputing and Networking Center (PSNC), EuroQCS-Poland Coordinator, EuroHPC Hosting Entity, full hardware & software development integration, app and users support

University of Latvia - the first to use quantum walks for designing quantum algorithms (methods for quantum lower bounds), design and test new quantum algorithms

Center for Theoretical Physics PAS - incorporate and develop techniques for efficient characterization & error mitigation tailored to the trapped ions quantum system

Creotech Instruments - development of a subsystem to mitigate errors and enhance the performance of quantum computers, low-latency classical/quantum hardware integration



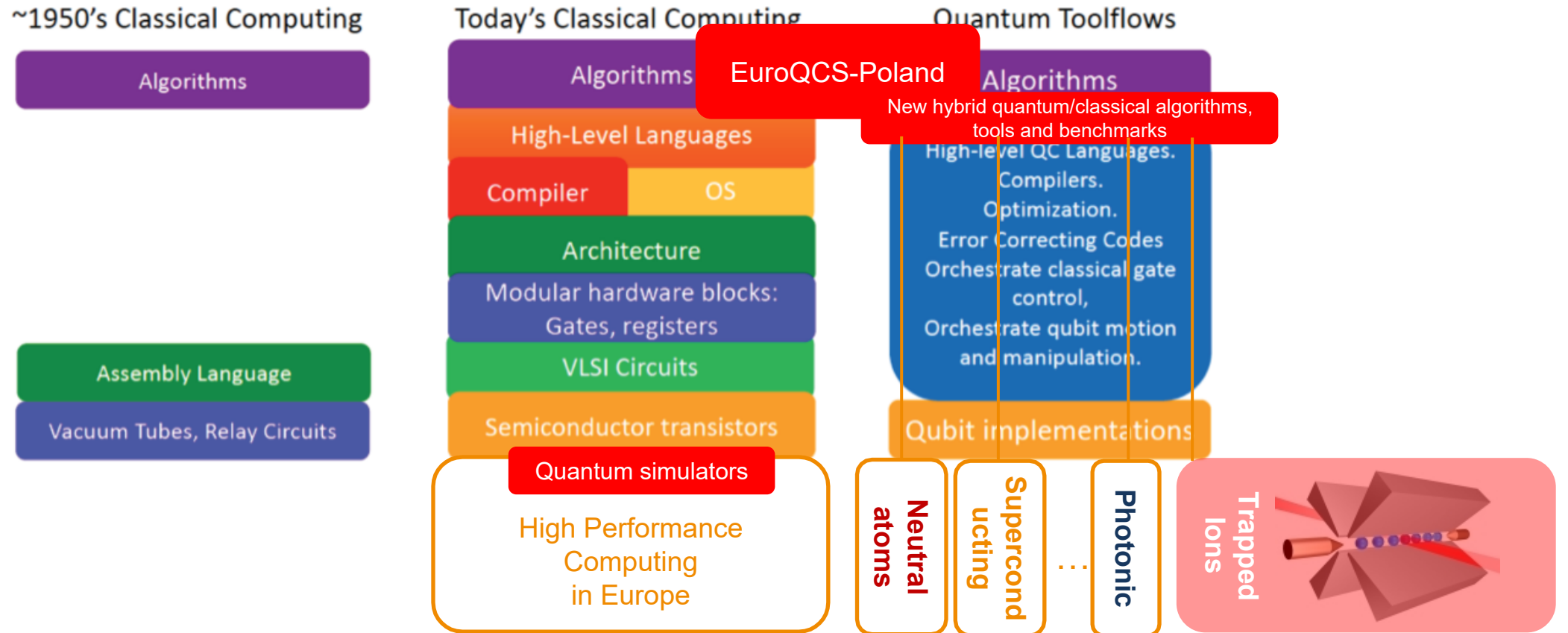
Center for Theoretical  
Physics PAS



  
**EuroQCS-Poland**  
PSNC

# EUROQCS-POLAND

## How to use a new trapped ions quantum system?



6 selected and different on-premises HPC+Q Hosting Entities in Europe



### Challenges:

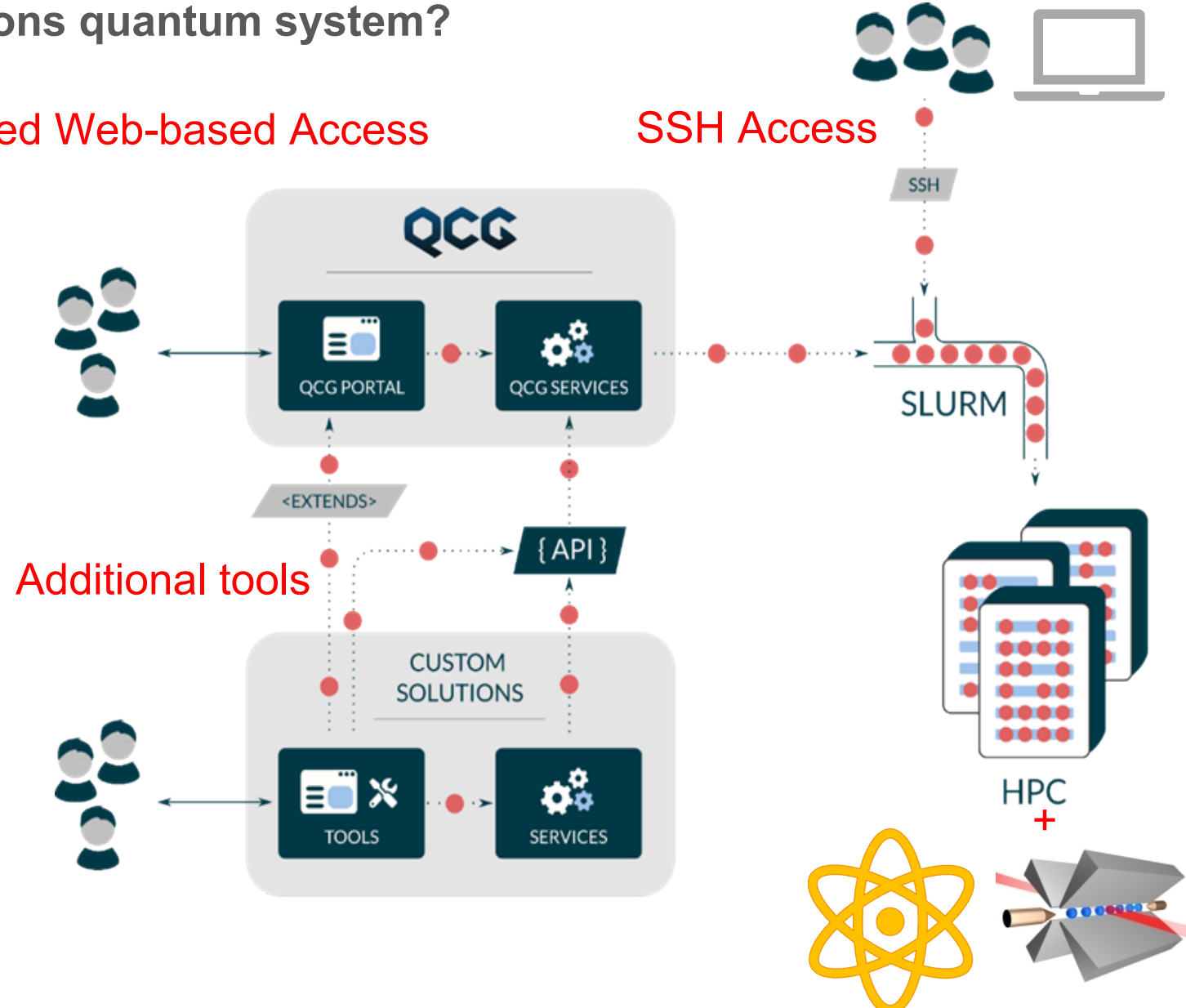
Management of both quantum algorithms executed on a trapped ions QPU together with classical jobs submitted by regular HPC users.

Static (offloading the problem to the QPU) vs dynamic scenarios (resource scheduling and hybrid classical-quantum algorithms).

Use of QPUs as HPC accelerators requires a deep integration with the existing and widely deployed HPC software stacks.

### Federated Web-based Access

### SSH Access





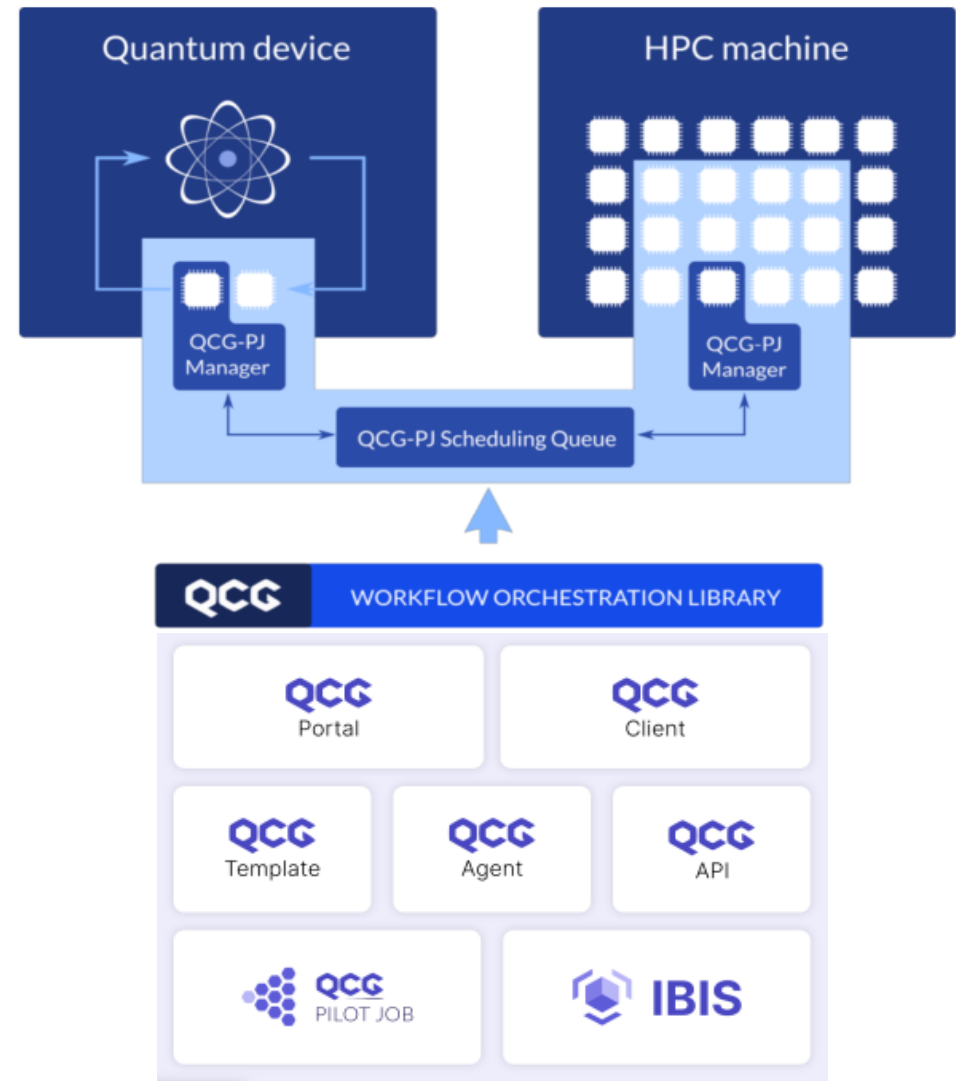
### Challenges:

Develop an open hybrid HPC-QC software.

Develop benchmarking and validation methods for the algorithms/application scenarios.

Develop open quantum architecture, conduct R&D, support open standards, and interoperability.

Implement reference hybrid quantum algorithms/use cases to test on EuroHPC HPC-QC infrastructures with end-user communities.



We plan to deliver the full open middleware software stack for resource management and scheduling of large-scale and extremely demanding computational scenarios, including hybrid classical-quantum apps.

QCG is a fully-featured solution developed by PSNC in many EU-funded projects. It offers well-defined remote interface enabling access to a local queuing system, in particular SLURM.

QCG-PilotJob is a Flexible Application Manager service for execution of many computing tasks (including coupled CPU-QPU) inside one allocation in a queuing system.

Easy to install with pip in a user space:  
*pip install qcg-pilotjob*

Simple launch and control commands:

```
from qcg.pilotjob.api.job import Jobs

qcg_jobs = Jobs()
qcg_jobs.add({'name': 'job_name',
              'exec': './src/job.py',
              'args': ['arg1', 'arg2'],
              'model': 'openmpi',
              'numCores': 64})

qcg_job_ids = manager.submit(qcg_jobs)

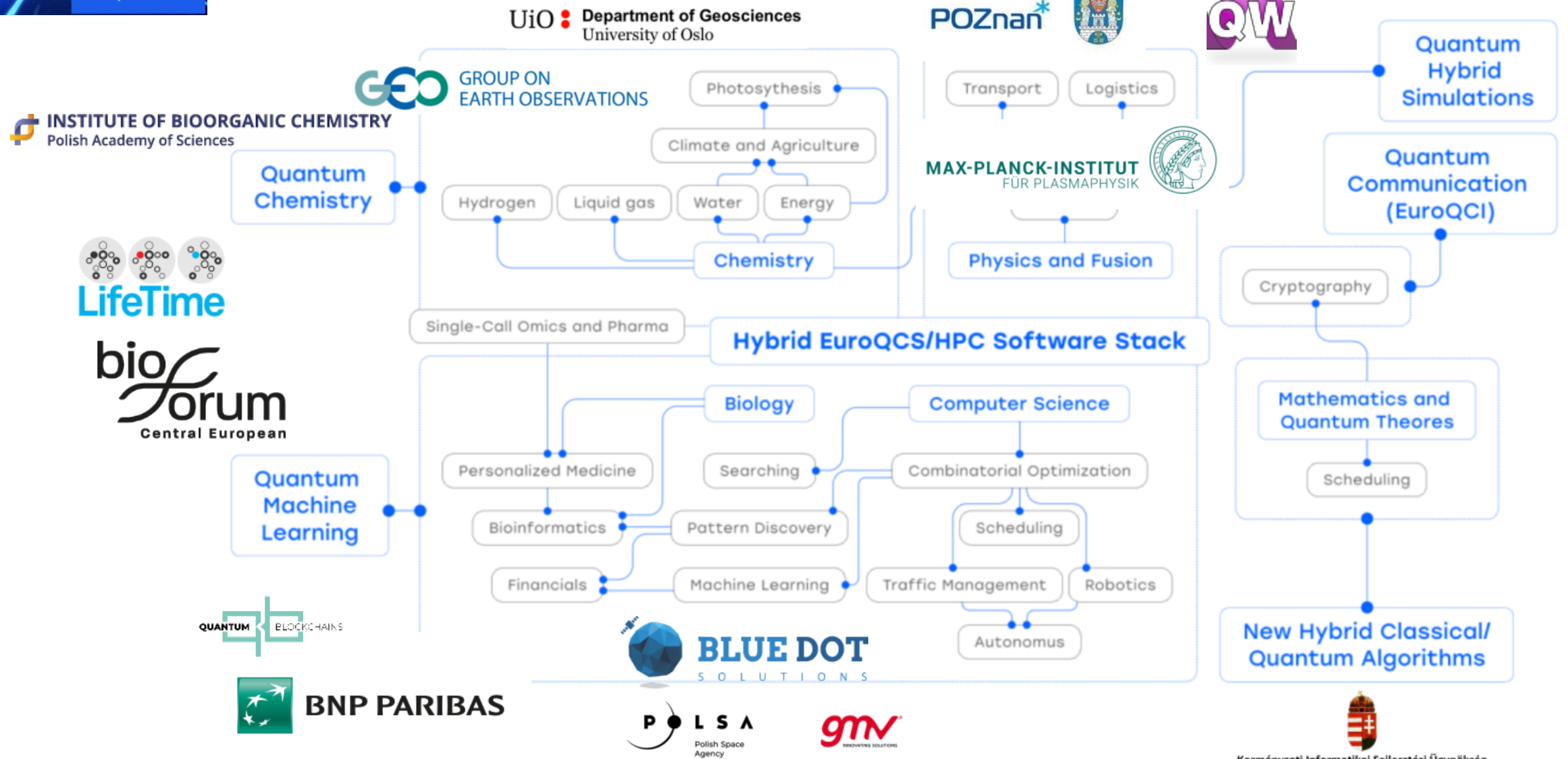
print(f'available resources: {manager.resources()}')

jobid, state = manager.wait4_any_job_finish(timeout=10)
```



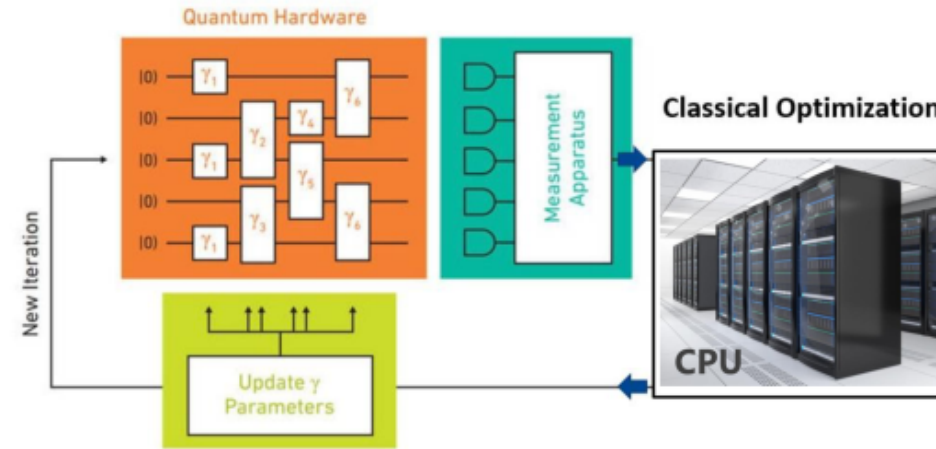
# EUROQCS-POLAND

## User communities and application areas

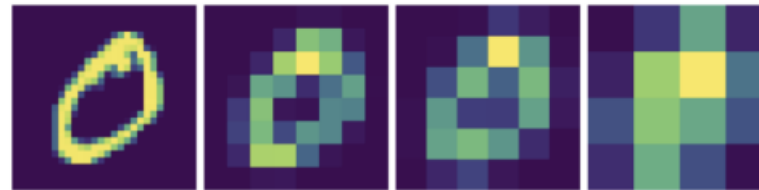


## What are the first applications?

### Quantum Optimization & OR



### Quantum SVM & ML

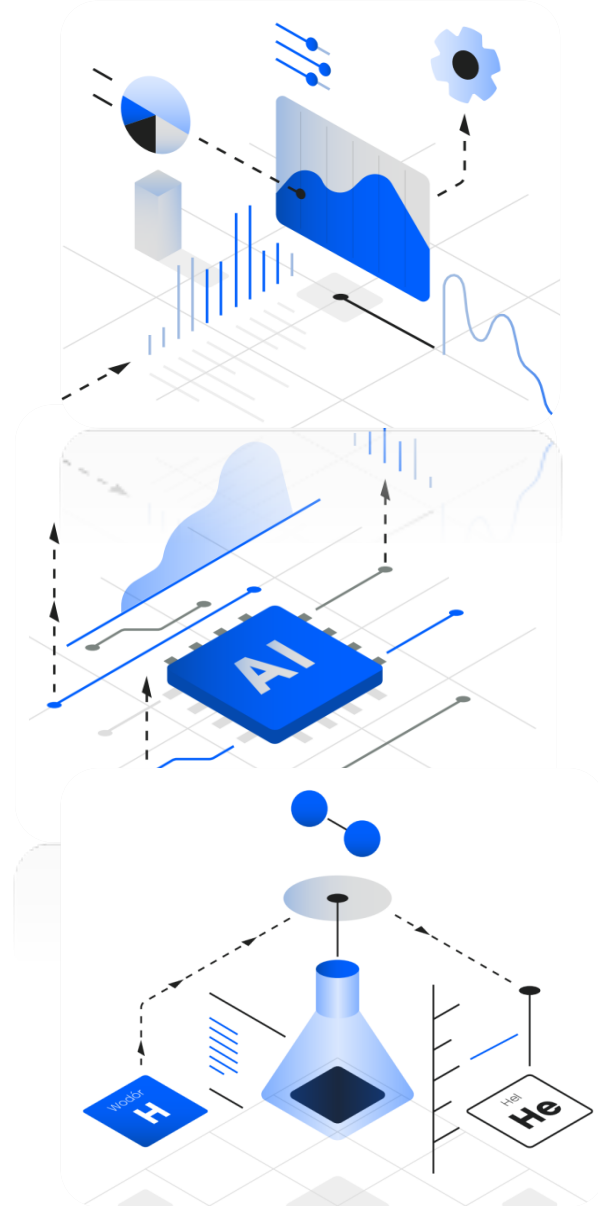
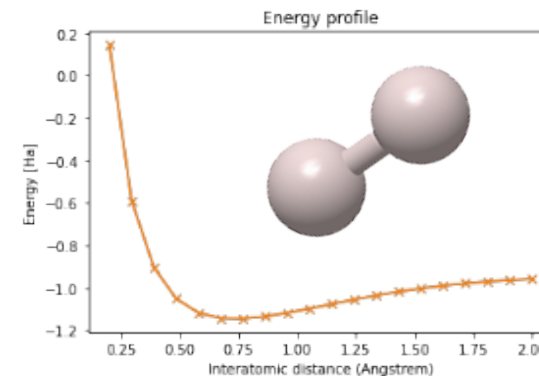


### Quantum Chemistry, Biology & Material Sciences

Kurowski, K., Pecyna, T., Slysz, M., Różycki, R., Waligóra, G., & Węglarz, J. (2023). Application of quantum approximate optimization algorithm to job shop scheduling problem. *European Journal of Operational Research*, 310(2), 518-528.

Slysz, M., Kurowski, K., Waligóra, G., & Węglarz, J. (2023). Exploring the Capabilities of Quantum Support Vector Machines for Image Classification on the MNIST Benchmark. In *International Conference on Computational Science* (pp. 193-200). Cham: Springer Nature Switzerland.

Quantum chemistry calculations (H2 and LiH) *Phys. Rev. X* 8, 031022 (2018)



### Application Performance Benchmarks

Entanglement in GHZ state

Toffoli gate

Grover's Algorithm

Quantum Fourier Transform

VQE for quantum chemistry calculations

QAOA for combinatorial problems optimization

Quantum Support Vector Machine for image classification

Qiskit, PennyLane, ... & Python

OpenQASM 2.0/3.0

Quantum Algorithm

Programming language & SDKs

Runtime & Compiler

Quantum Instruction Set Architecture

Quantum Simulator  
for Trapped Ions  
(HPC resources)

Trapped Ions QPU



# THE EUROHPC QUANTUM INITIATIVE

## When will the EuroHPC quantum devices be available?

23/05/2023

### With Software From EVIDEN and PASQAL, FZJ, GENCI and CEA Prepare European Research Communities for the Quantum Era

Forschungszentrum Jülich (FZJ), GENCI and CEA announce today that they will provide access to hardware-agnostic (EVIDEN Qaptiva™) and hardware-specific (PASQAL Pulser) programming and emulation environments as part of the pan-European hybrid HPC/quantum pilot project HPCQS. These first services will allow European research communities to prepare for the arrival of two twin 100+-qubit PASQAL quantum simulators, one at the Jülich Supercomputing Centre (FZJ/JSC) and one at CEA/TGCC, by the end of this year. In between, FZJ, GENCI and CEA will gradually deploy additional noisy emulators of such type of Fresnel analog quantum computers based on the technology of neutral atoms and will provide remote access to an identical Fresnel system hosted by PASQAL.



- Emulation capabilities already available
- 2 100+-qubit simulators available in H1 2024 !

PRESS RELEASE | 16 October 2023 | European High-Performance Computing Joint Undertaking

### EuroHPC JU Launches Procurement for EuroQCS-Poland

The European High Performance Computing Joint Undertaking (EuroHPC JU) has launched a call for tender for the installation of EuroQCS-Poland, the EuroHPC quantum computer to be located in Poland.



### Acquisition, delivery, installation and hardware and software maintenance of Euro-Q-Exa quantum computer for EuroHPC Joint Undertaking

The purpose of this call for tenders is to select one vendor for the acquisition, delivery, installation and hardware and software maintenance of Euro-Q-Exa quantum computer for the European High Performance Computing Joint Undertaking.

2 additional procurements were launched



Stay tuned for more information !



Thank you





# EuroHPC JU Calls for Access & Peer-Review

**EUROHPC  
USER DAY  
2023** Brussels  
11.12.23



**EuroHPC**  
Joint Undertaking

**Speaker:** *Krishnakshi BHUYAN (EuroHPC JU)*

# EuroHPC JU Calls for Access

## ACCESS MODES



**BENCHMARK  
ACCESS MODE**

**DEVELOPMENT  
ACCESS MODE**

**REGULAR ACCESS MODE**

**EXTREME SCALE ACCESS  
MODE**



# Calls for Access - Eligibility

- Principal Investigators and Team Members affiliated in organizations from countries associated to Horizon 2020
- Principal Investigator's employment contract should be valid for more than 3 months after the end allocation date
- Specific terms and conditions stated in the Terms of Reference per Access mode

# Benchmark and Development Access

## Benchmark Access

Scaling tests & benchmarks  
Allocation duration – 2 or 3 months

## Development Access

Code and algorithm development  
Allocation duration – 6 or 12 months



Continuously open calls with  
monthly cut-offs



Predefined resources available  
per partition

Proposal  
submission



Technical  
Assessment



Administrative  
Check

Access to the  
systems

# Calls for Access – Regular Access



Continuously open call with 3 cut-off dates per year: **March, July,**

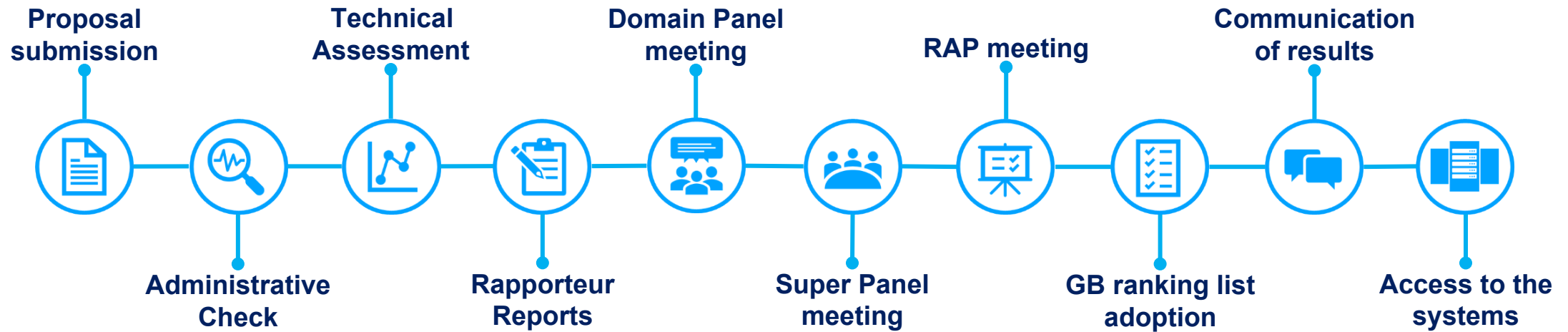
**November**



Available resources on petascale and pre-exascale systems

Intended for projects that require large-scale HPC resources

Peer-Review process duration: **4 months**



# Calls for Access – Extreme Scale Access



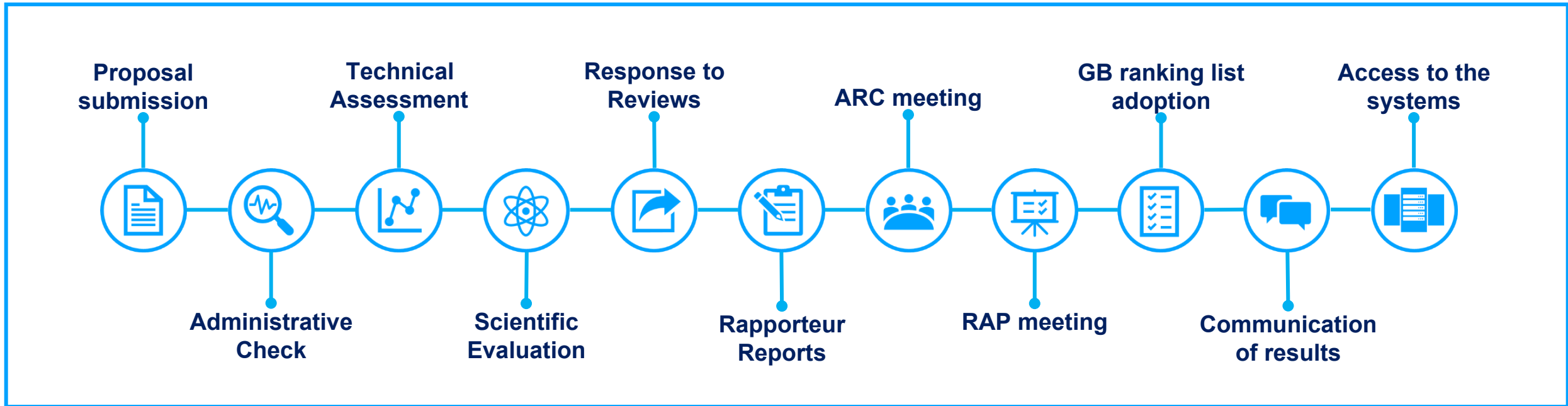
Continuously open call with 2 cut-off dates per year: **April, October**

Intended for high-impact, high-gain projects that require extremely large-scale HPC resources



Available resources on pre-exascale systems

Peer-Review process duration: **6 months**





# Extreme Scale and Regular Access- evaluations



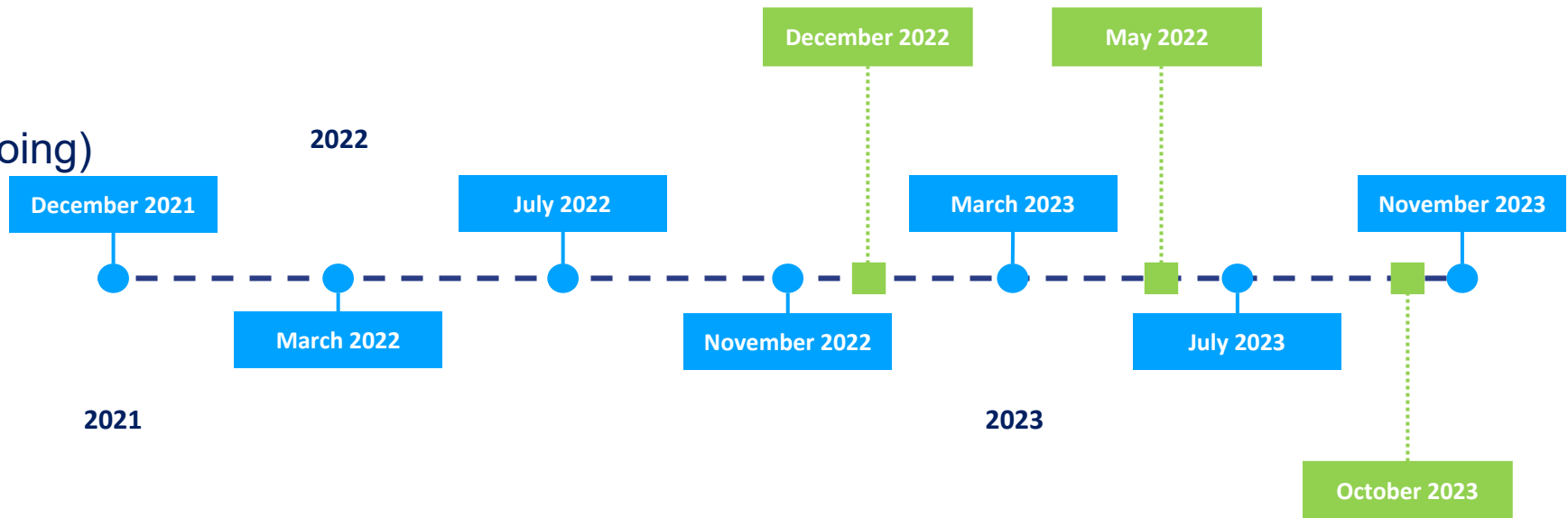
# Regular Access and Extreme Scale- **timeline**

## REGULAR ACCESS:

- December 2021
- March 2022
- July 2022
- November 2022
- March 2023
- July 2023
- November 2023 (ongoing)

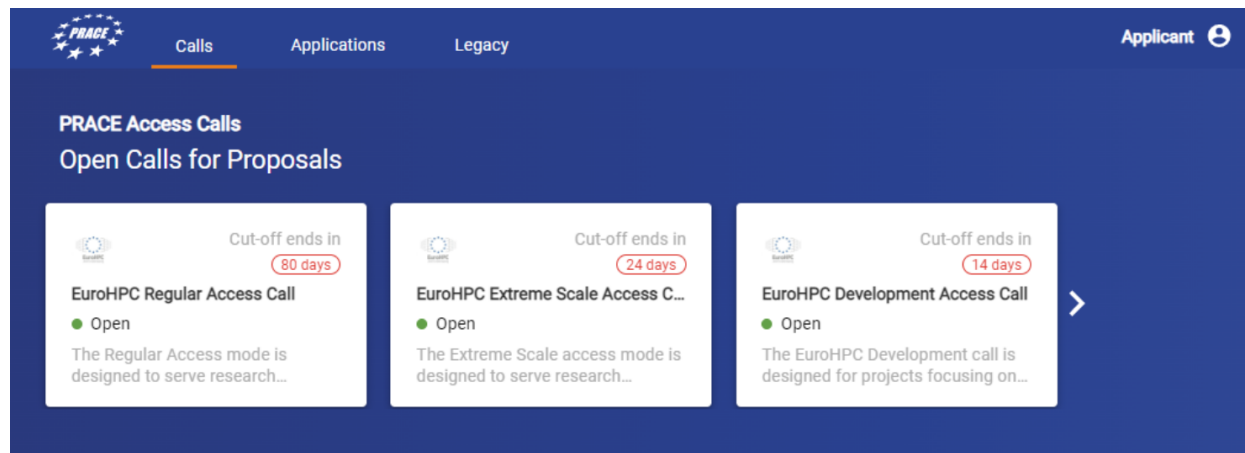
## EXTREME SCALE ACCESS:

- December 2022
- May 2023
- October 2023 (ongoing)



# How to apply?

Proposal submission via the **Peer-Review Platform** available at <https://pracecalls.eu>



The screenshot shows the PRACE Access Calls website interface. At the top, there are navigation tabs for 'Calls', 'Applications', and 'Legacy', along with an 'Applicant' profile icon. The main heading is 'PRACE Access Calls' and 'Open Calls for Proposals'. Three call cards are displayed:

- EuroHPC Regular Access Call**: Cut-off ends in 80 days. Status: Open. Description: 'The Regular Access mode is designed to serve research...'
- EuroHPC Extreme Scale Access C...**: Cut-off ends in 24 days. Status: Open. Description: 'The Extreme Scale access mode is designed to serve research...'
- EuroHPC Development Access Call**: Cut-off ends in 14 days. Status: Open. Description: 'The EuroHPC Development call is designed for projects focusing on...'



Login at: <https://pracecalls.eu/auth/login>

Register at: <https://pracecalls.eu/auth/register>



**EUROHPC  
USER DAY  
2023**  
Brussels  
11.12.23



**EuroHPC**  
Joint Undertaking

# Advice to the applicants



Study the call documentation – available on EuroHPC JU website:

- Terms of Reference
- Technical Guidelines



Project Scope and Plan document-

- Use the correct, up-to-date Project Scope and Plan template
- Fill in all sections and sub-sections of the template and include mandatory plots, tables



Perform scalability tests on desired system(s) before applying to production run calls



Justify well for the requested resources



Pay kind attention to cut-off deadlines



Communicate with the Hosting Entities and the EuroHPC JU staff



Submit the Final Reports within 3 months after the project completion



Take into consideration the qualitative feedbacks given by the Access Resource Committee





# The Peer-Review Team



**Klara  
Meštrović**

[Klara.MESTROVIC@eurohpc-ju.europa.eu](mailto:Klara.MESTROVIC@eurohpc-ju.europa.eu)



**Krishnakshi  
Bhuyan**

[Krishnakshi.bhuyan@eurohpc-ju.europa.eu](mailto:Krishnakshi.bhuyan@eurohpc-ju.europa.eu)



**Dora Marton**

[dora.marton@eurohpc-ju.europa.eu](mailto:dora.marton@eurohpc-ju.europa.eu)



**Catarina Guerreiro**

[catarina.guerreiro@eurohpc-ju.europa.eu](mailto:catarina.guerreiro@eurohpc-ju.europa.eu)

**EUROHPC  
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2023** Brussels  
11.12.23



Office email: [access@eurohpc-ju.europa.eu](mailto:access@eurohpc-ju.europa.eu)



# THANK YOU!

For more information, feel free to visit our website and social media:



**EUROHPC  
USER DAY  
2023** Brussels  
11.12.23



[/eurohpc-ju.europa.eu](https://eurohpc-ju.europa.eu)



[/EuroHPC\\_JU](https://twitter.com/EuroHPC_JU)



[/eurohpc-ju](https://www.linkedin.com/company/eurohpc-ju)



[/eurohpc-ju](https://www.youtube.com/channel/UC...)



BY

# DESTINATION EARTH

## A JOINT UNDERTAKING STRATEGIC ALLOCATION USE CASE

Nils Wedi



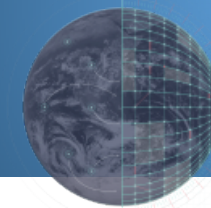
Funded by  
the European Union

**Destination Earth**

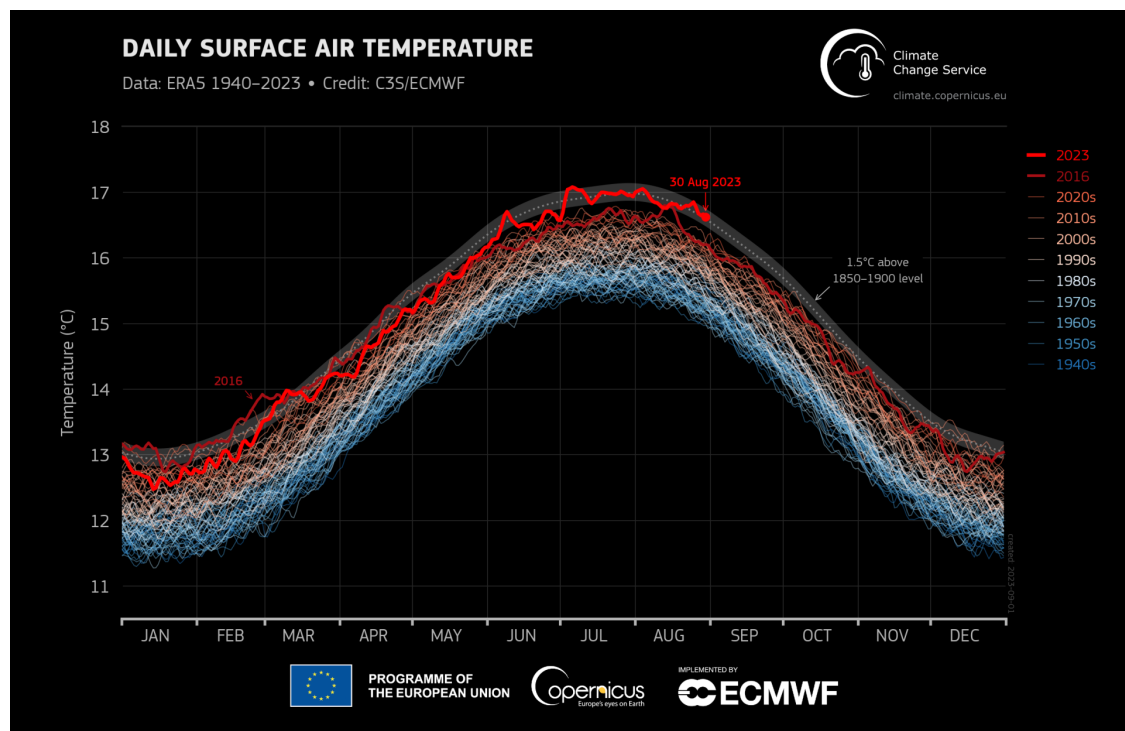
implemented by







# CLIMATE CHANGE AND INCREASE OF EXTREME EVENTS



## The landscape ...

<https://community.wmo.int/en/news/exploring-possibilities-artificial-intelligence-areas-water-weather-and-climate>

**DeepMind & Google's ML-Based GraphCast  
Outperforms the World's Best Medium-Range  
Weather Forecasting System**



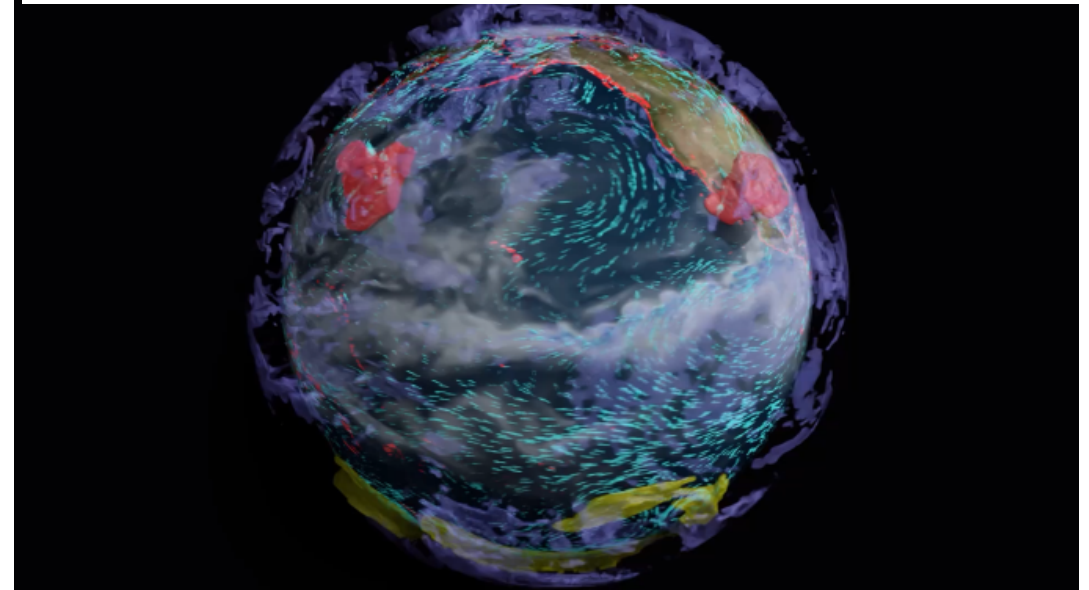
<https://arxiv.org/abs/2212.12794>



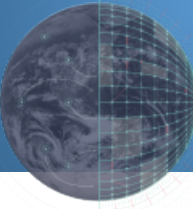
*Natural language translation*

## NVIDIA to Build Earth-2 Supercomputer to See Our Future

November 12, 2021 by JENSEN HUANG

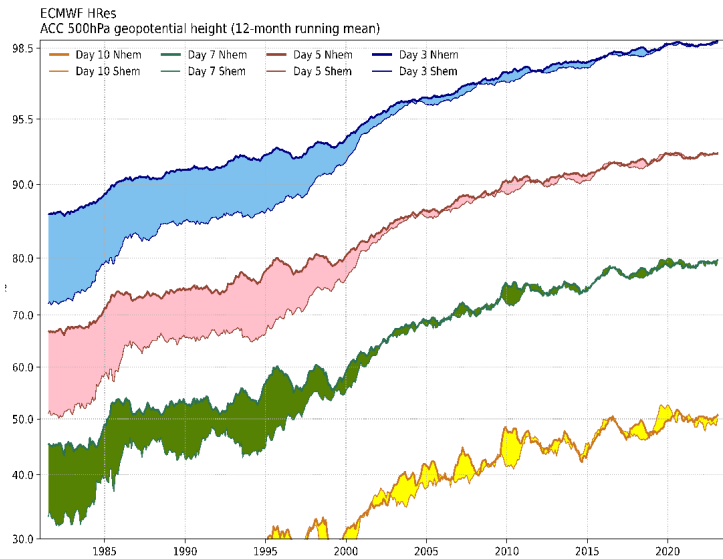




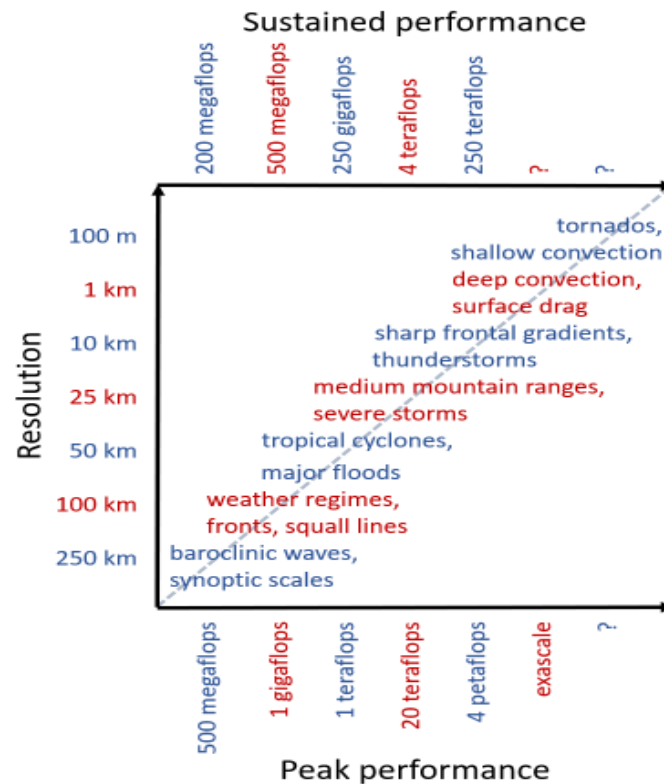


# EXPLOITING INVESTMENTS IN SCIENCE, TECHNOLOGY,

## The quiet NWP revolution (1980 - today)



## The digital revolution (2020 – today)



## The machine learning revolution (2022 – today)

arXiv > physics > arXiv:2307.10128

Physics > Atmospheric and Oceanic Physics

[Submitted on 19 Jul 2023]

### The rise of data-driven weather forecasting

ECMWF unveils alpha version of new ML model

13 October 2023  
The AIFS team

ECMWF is today launching a newborn companion to the IFS (Integrated Forecasting System), the AIFS, our Artificial Intelligence/Integrated Forecasting System (one "I" covering both Intelligence and Integrated).

The AIFS is barely a few months old and proudly entering its alpha version. Its arrival signals the strengthening of ECMWF's efforts in the field of machine learning (ML), which we have been navigating for a few years now. The AIFS forms one of three components of our new ML project, which began in summer 2023 and aims to expand our applications of machine learning to Earth system modelling.

Recent posts

ECMWF unveils alpha version of new ML model

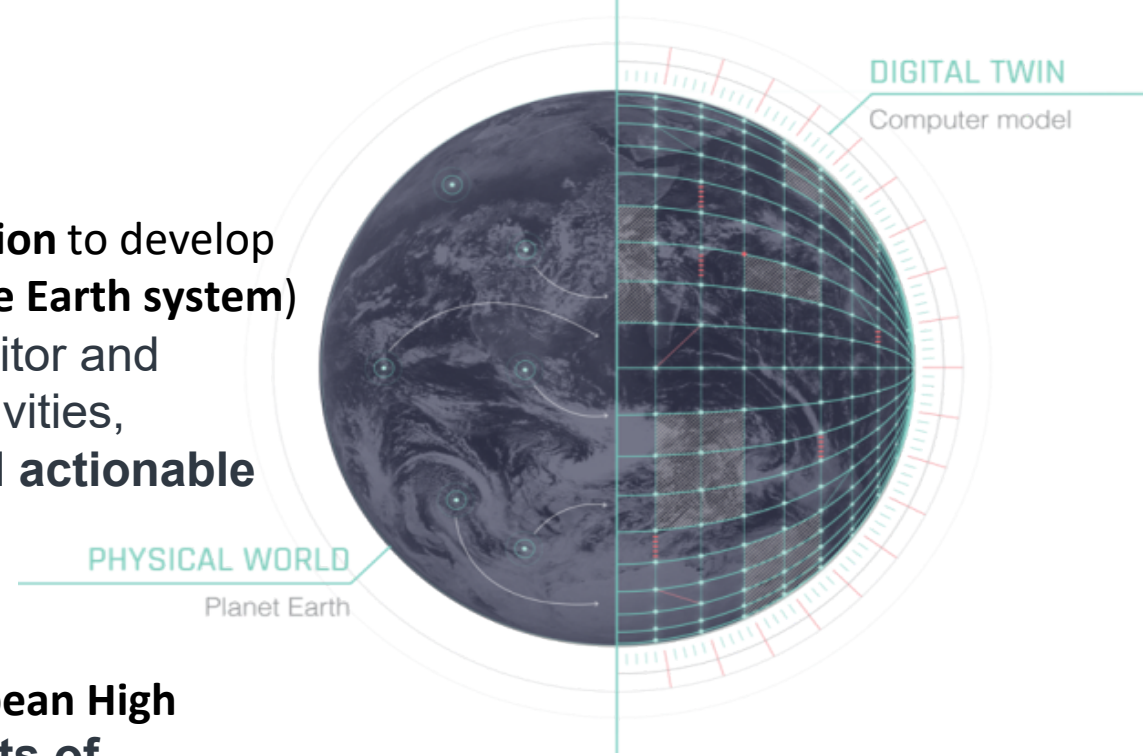
## DESTINATION EARTH

**Destination Earth** is a **flagship initiative of the European Commission** to develop highly accurate digital models of the Earth (i.e., **Digital Twins of the Earth system**) to **deliver bespoke simulation capabilities** that model, monitor and simulate natural phenomena, hazards and related human activities, assisting users in designing and communicating accurate and **actionable adaptation strategies and mitigation measures**.

Harnessing **world-leading supercomputing capacities of the European High Performance Computing Joint Undertaking**, by **pushing the limits of computing, ML/AI and climate sciences**, and leveraging the “*path to the digital decade*” with **hundreds of European research and computational scientists** from industry, academia, many national as well as European international institutions,

DestinE represents an essential pillar of the European Commission’s effort towards both the **Green Deal** and the **Digital Strategy**.

Three entities **ECMWF, ESA, EUMETSAT** are working together with the European Commission **DG-CNECT** and the **JU**



<https://destination-earth.eu/>



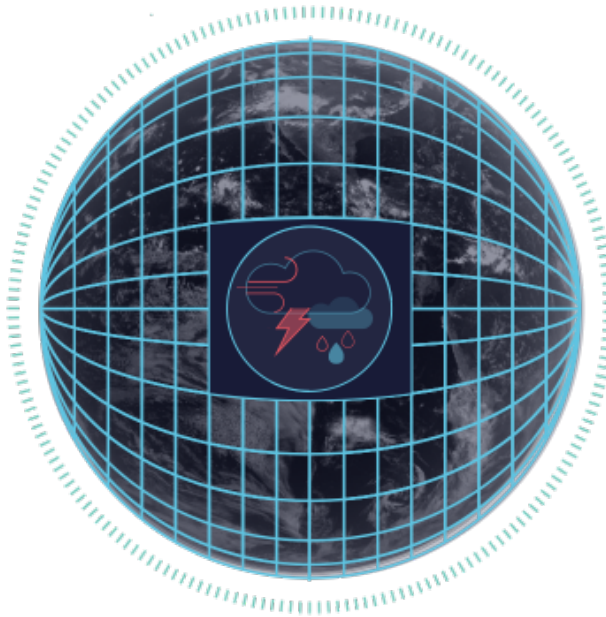
# Two high-priority Digital Twins

To support decision making for real-time response to extreme events

To support the efforts of defining and planning activities linked to climate change adaptation

Timescale of 2-5 days ahead  
(1h to sub-hourly output)

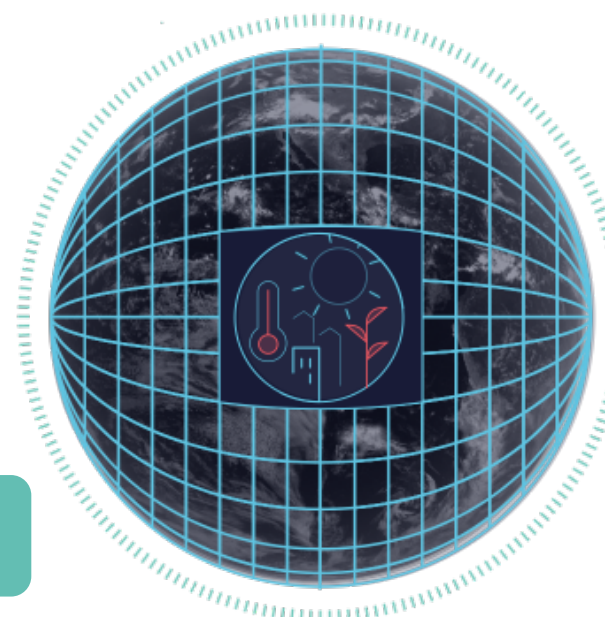
Km-scale resolution  
1-4 km globally,  
500-750m regionally



**Weather-induced extremes**

Run regularly & on demand & configurable

Decision-driven data analytics



**Climate change adaptation**

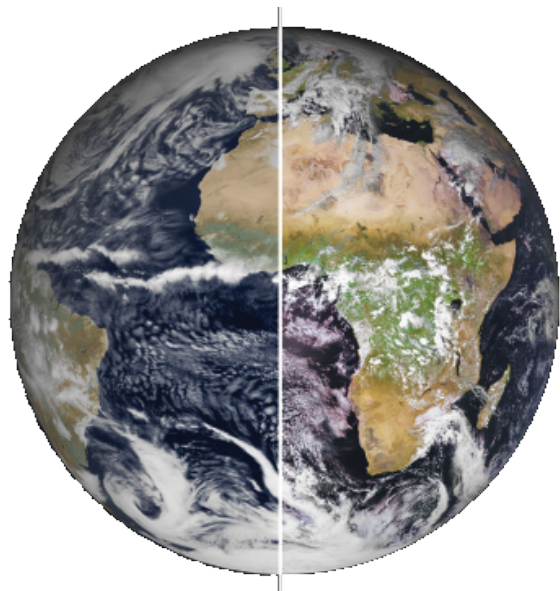
Multi-decadal timescales  
(2020 to ~2050)  
(1h to 6 hours output)

Global multi-decadal projections operationalised

Km-scale resolution globally (5km)

# ECMWF's role in EU's DestinE initiative

## Towards a Digital Twin Earth



Weather-induced and Geophysical\* **Extremes Digital Twin:**

- capabilities and services for the assessment and prediction of **environmental extremes**

*ECMWF will develop the global component of the Extremes DT*

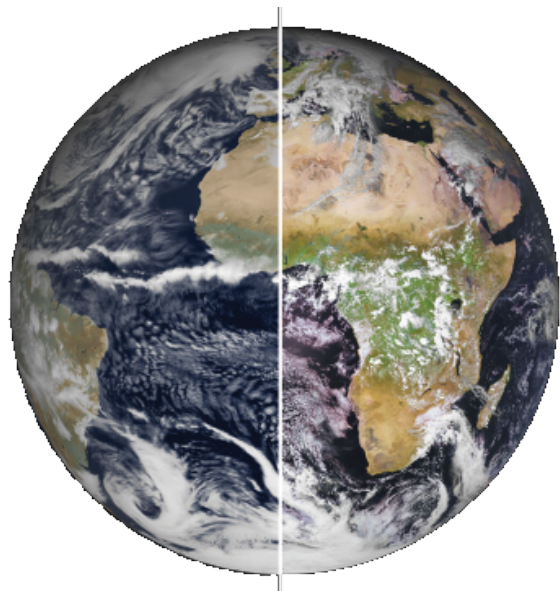
*“The French Meteorological Service **Météo-France** and partners from **22 European countries** will develop a **configurable capability for an interactive European monitoring and prediction framework.**”*

\*not in phase 1



# ECMWF's role in EU's DestinE initiative

## Towards a Digital Twin Earth



### Climate Change Adaptation Digital Twin

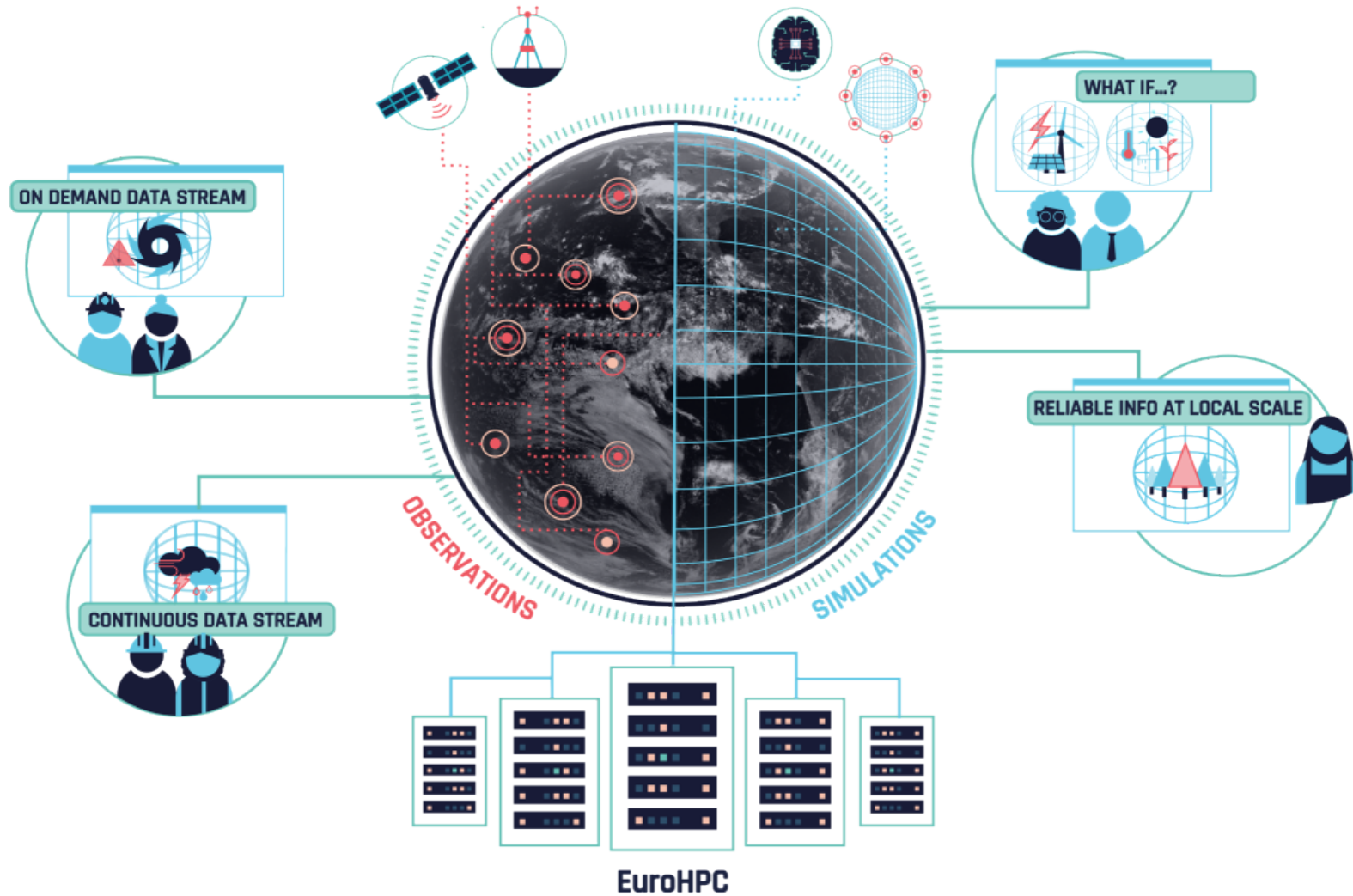
- capabilities and services in support of climate change **adaptation policies and mitigation scenario testing**

*“CSC – IT Center for Science leads a European partnership to deliver the Climate Change Adaptation Digital Twin – with a global multi-decadal storm & eddy resolving simulation capability”*



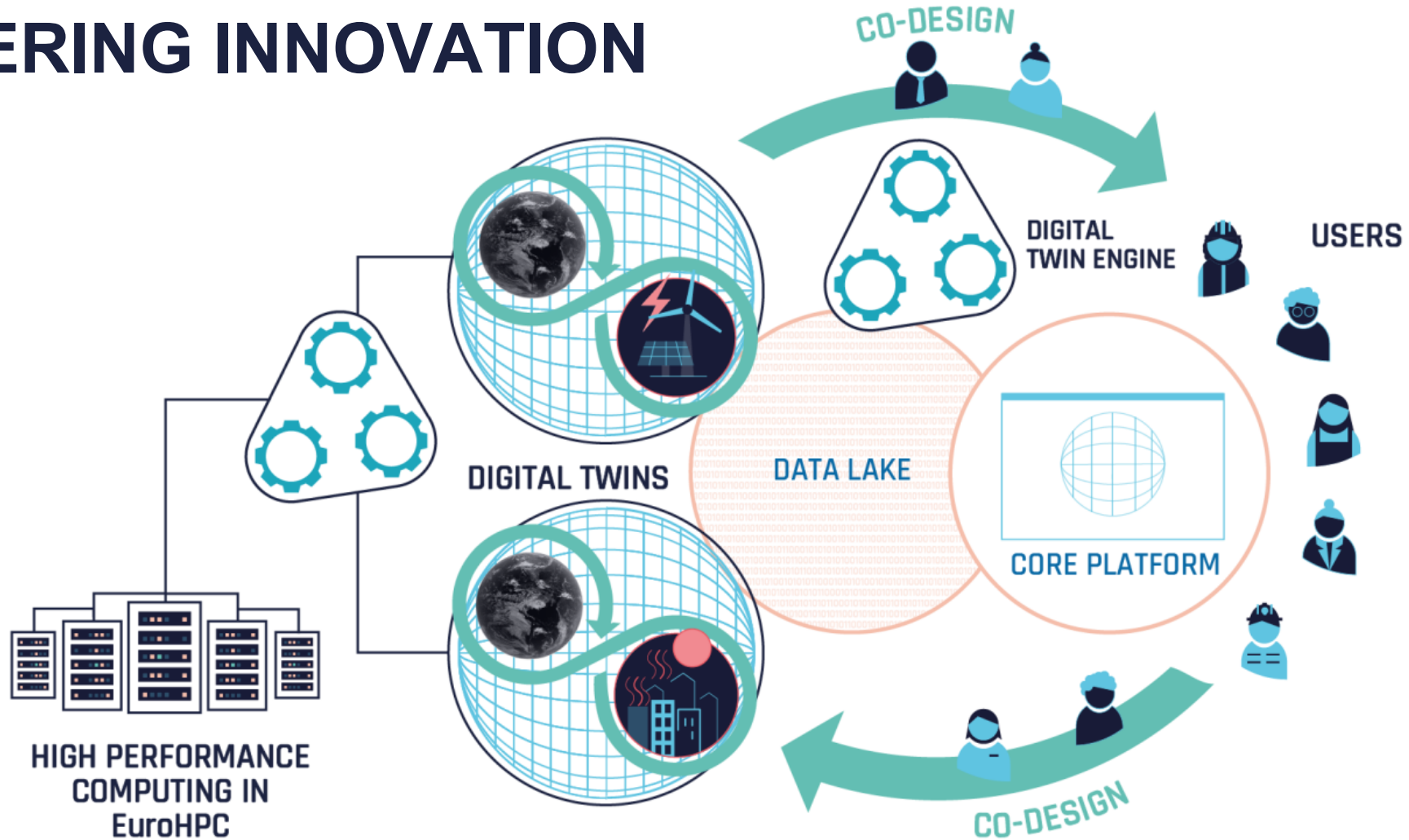


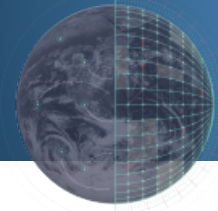
# A NOVEL INFORMATION SYSTEM



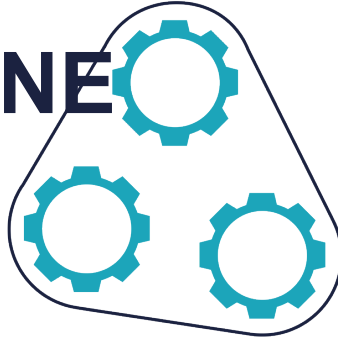


# FOSTERING INNOVATION





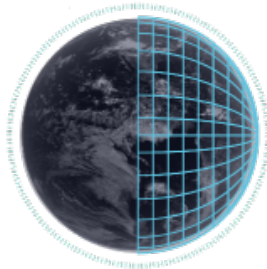
# THE DIGITAL TWIN ENGINE



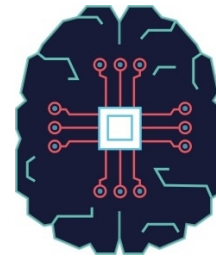
## Software environment



Ensuring complex simulations are run efficiently on EuroHPC



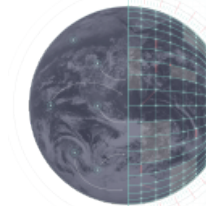
Running the digital twins and managing distributed big data



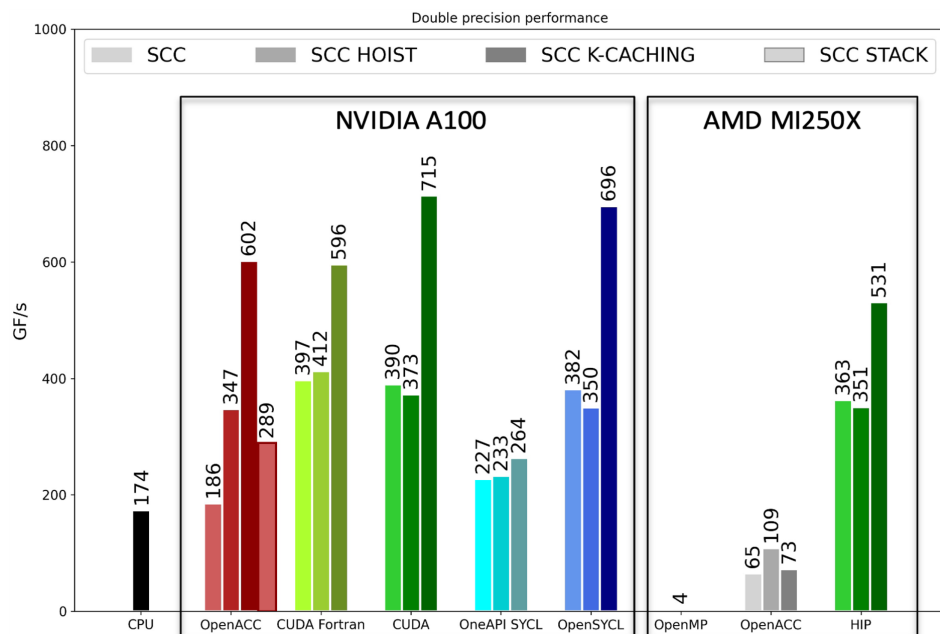
Using ML/AI to increase the efficiency of the digital twins and estimate uncertainty



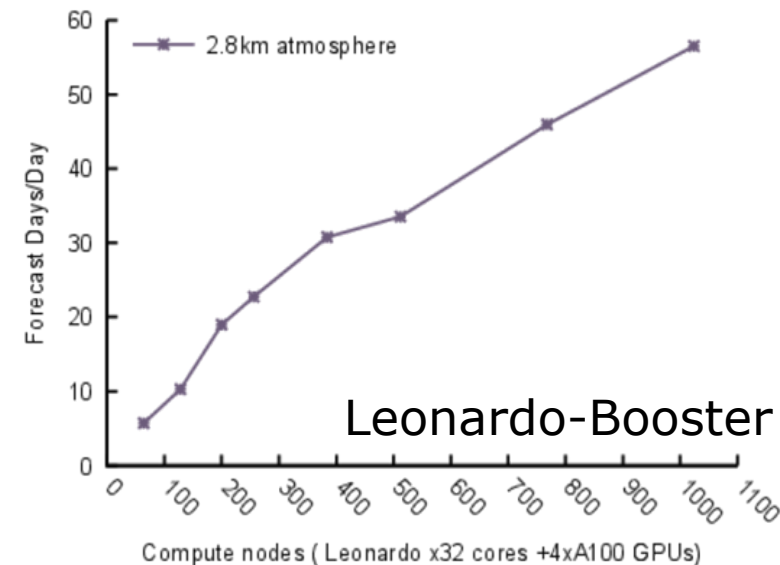
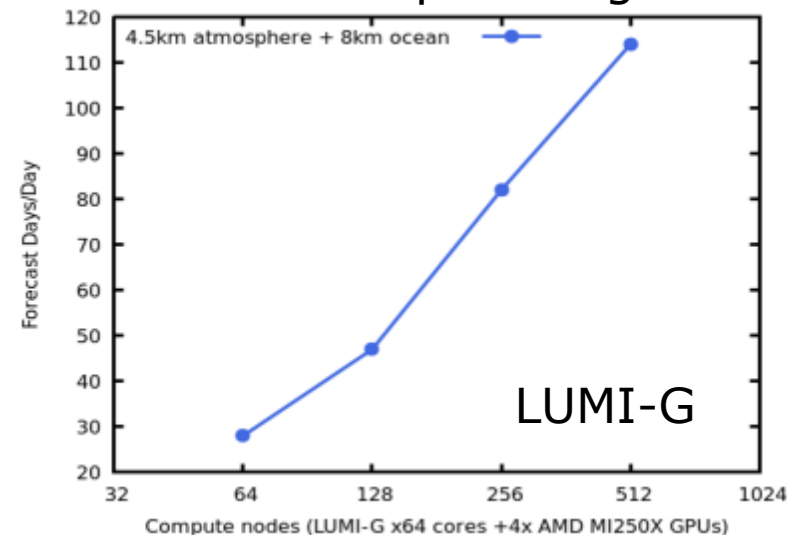
Tailoring information to user's needs and interactivity



# HIGH PERFORMANCE COMPUTING



## Optimising DTs





# Partnering with use cases



Energy systems

- Resource adequacy
- Grid planning
- Validation



Air quality

- High-res regional AQ
- Coupled to DT Extremes
- Interactive emissions



Compound flood risk

- Five regional/local hydro models
- Disaster risk and climate scales

Deltares



Urban heat

- Coupled urban climate model
- Simulate heat stress/health impact



Forestry

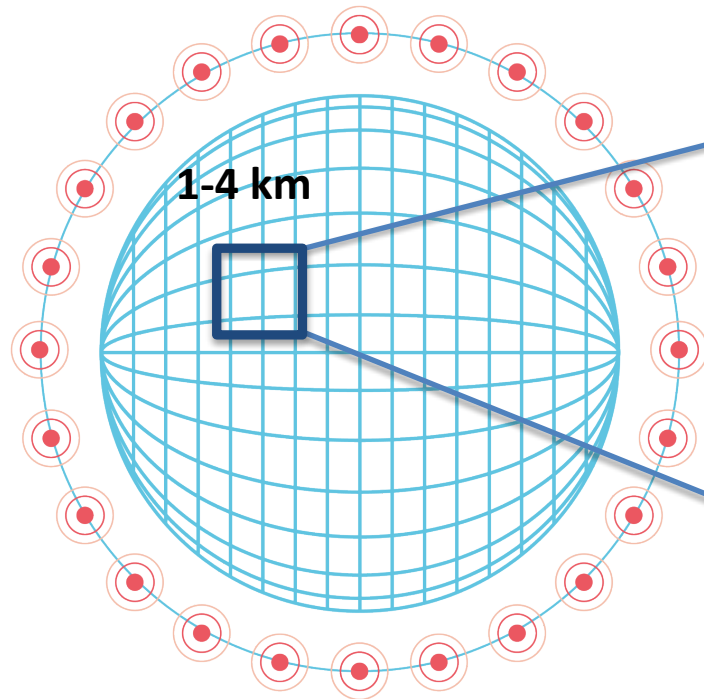
- Wind damage risk predictions
- Harvesting conditions under climate scenarios



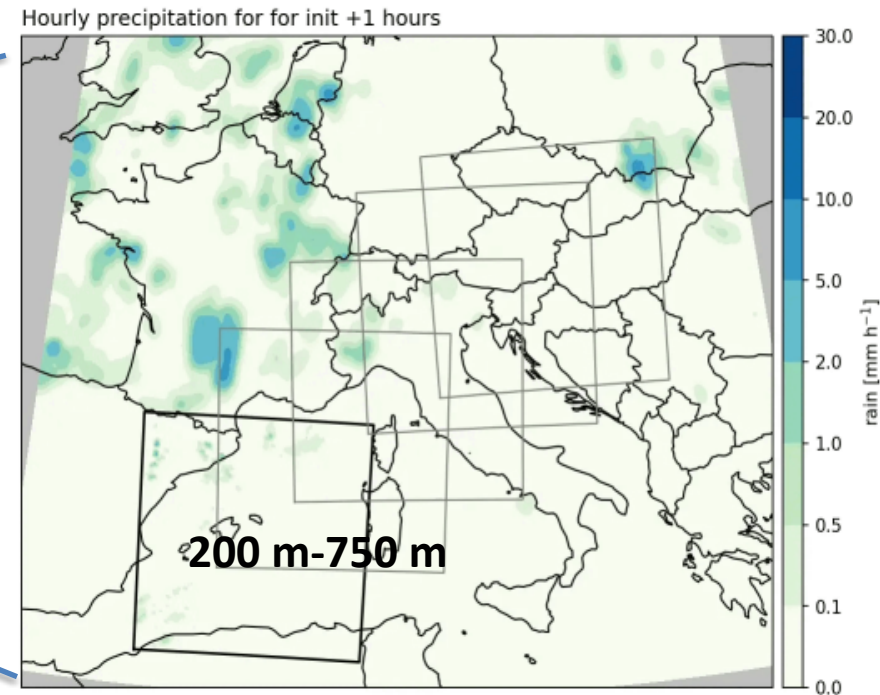


# EXTREMES DT: ON-DEMAND SIMULATION CAPABILITIES

Continuous global component



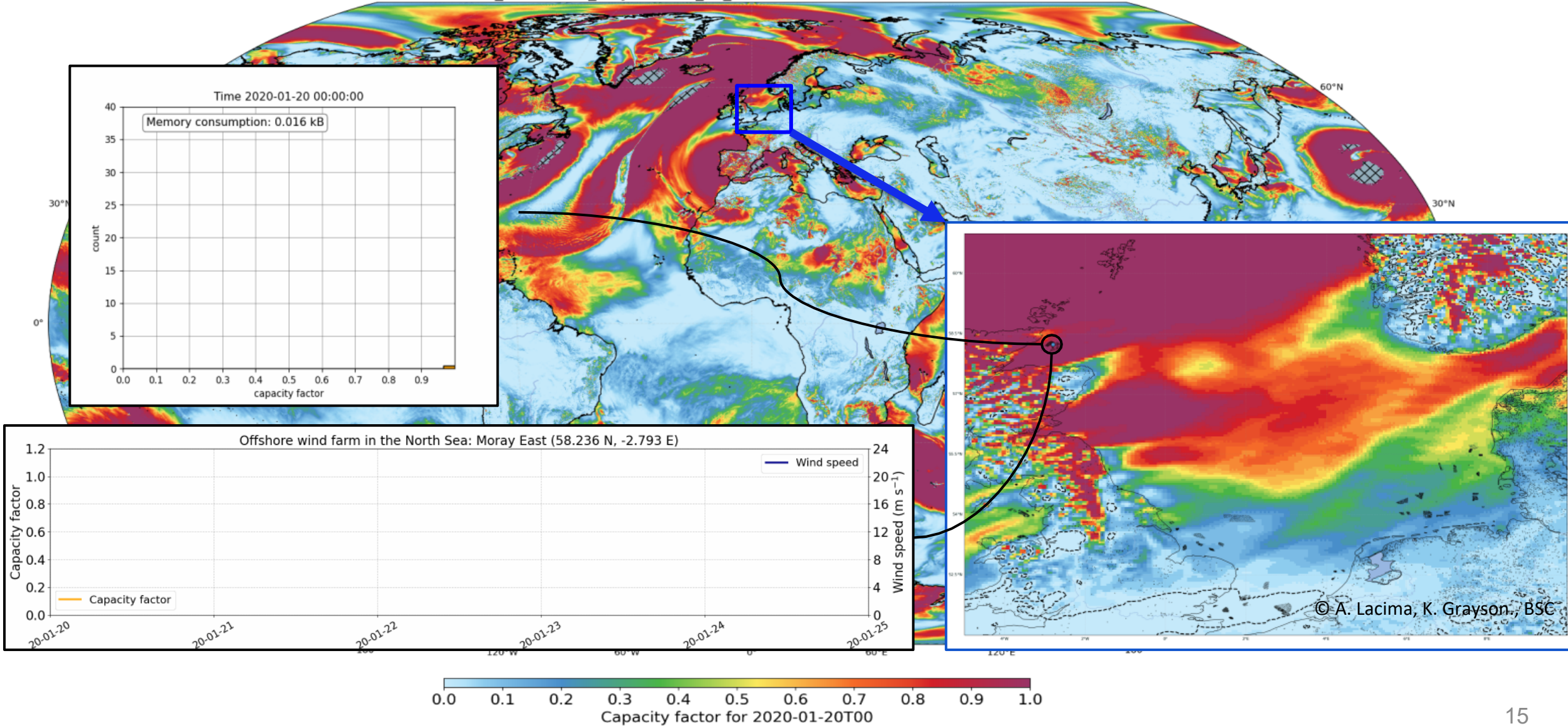
On-demand regional component



Crisis management in Extreme situations and urgent computing is manifested in the regulation but requires refining the access policies and system availability to make this a reality.

# Tailoring the information to user needs

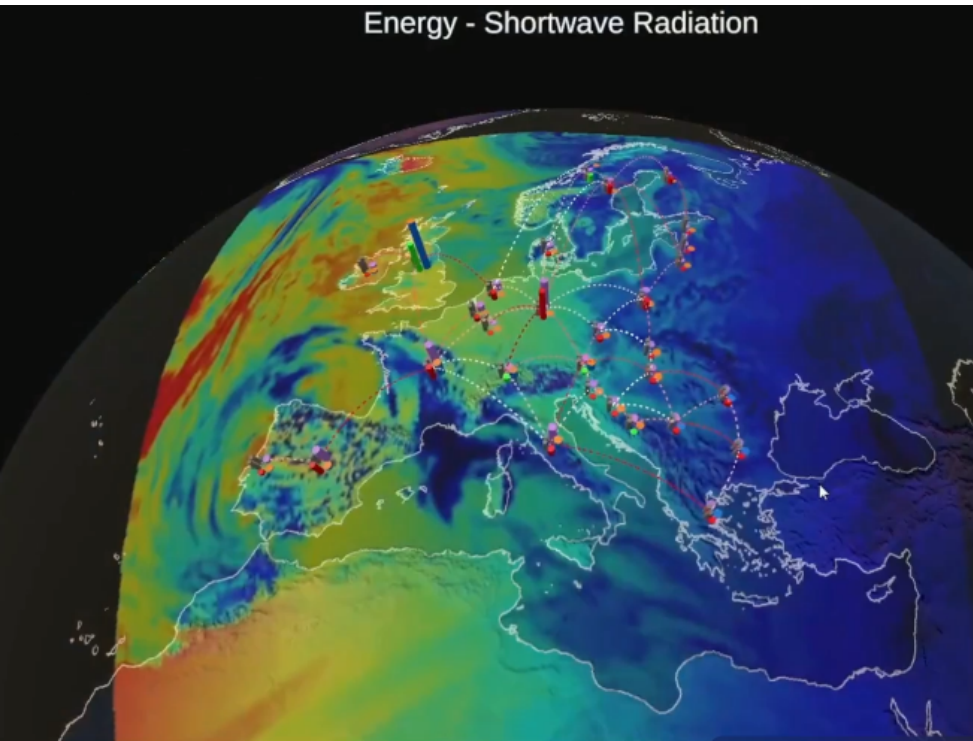
IFS\_4.4-FESOM\_5-cycle3 (2D\_1h\_native) - Class S (Vestas V164/9.5MW)





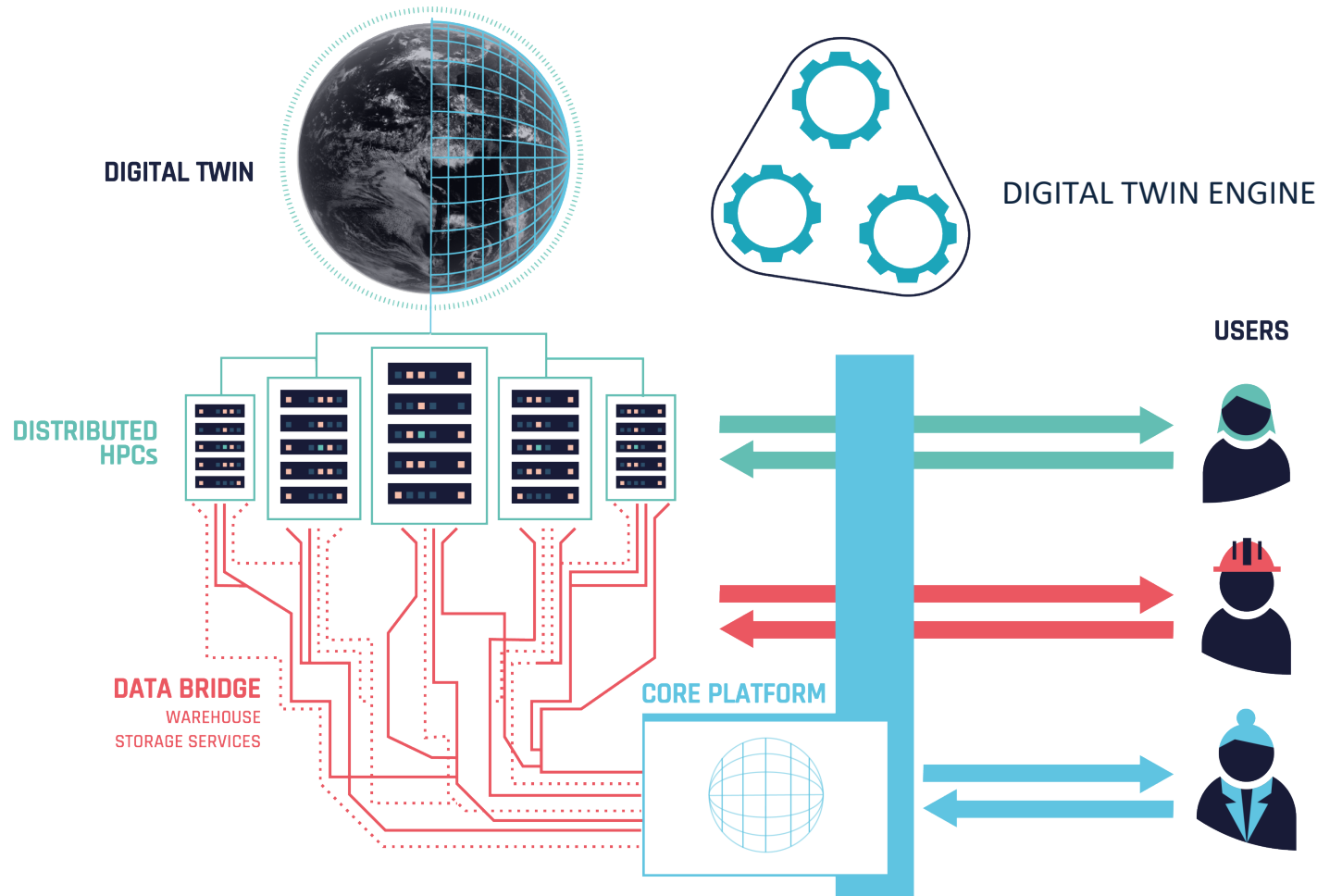


# DTE: INTERACTIVITY



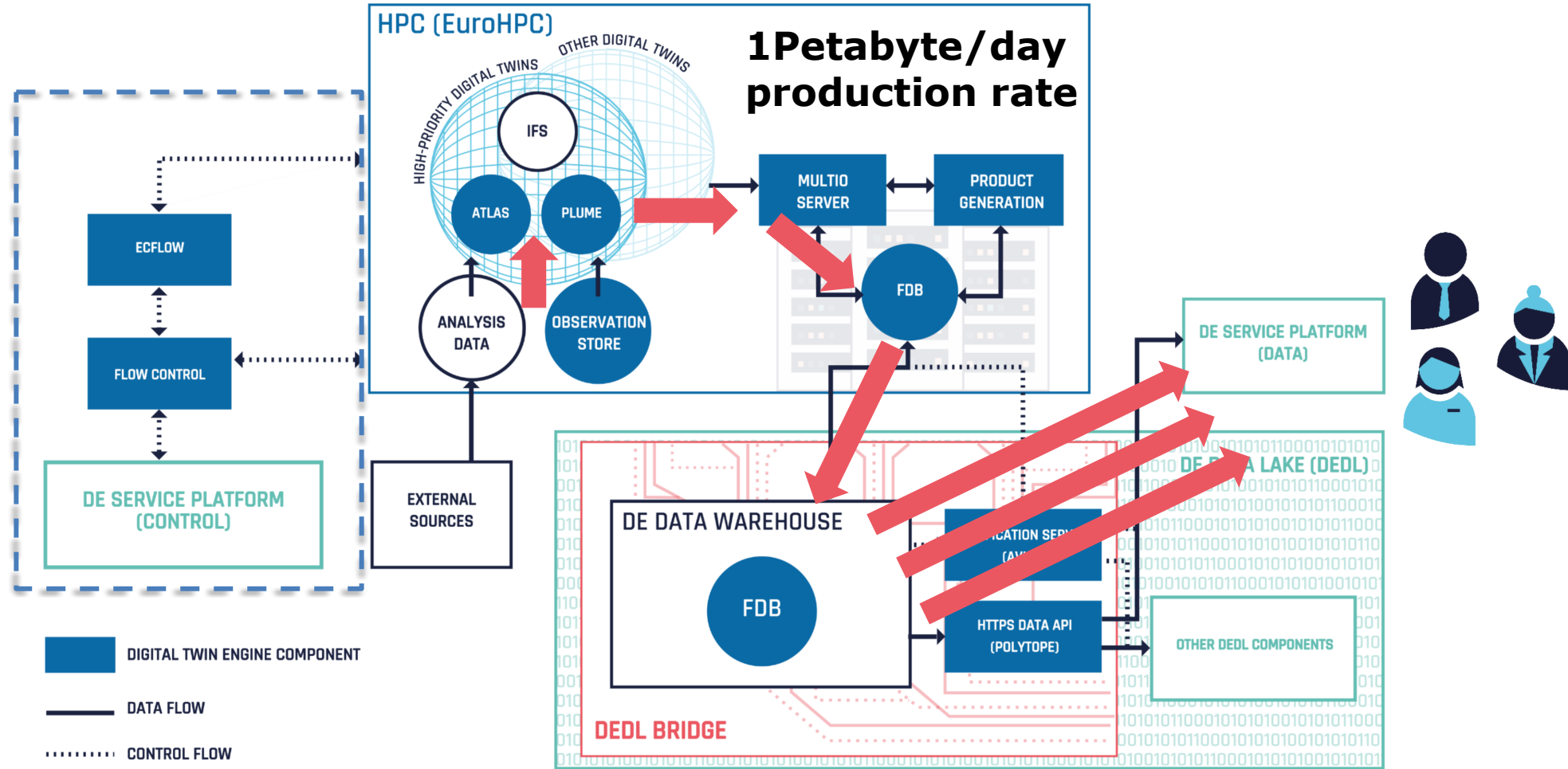
Exprivia/CMCC/DLR

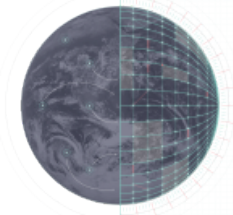
Renewable energy online  
supply/demand/redistribution  
in a changing climate





# Running DTs & Managing Big Data

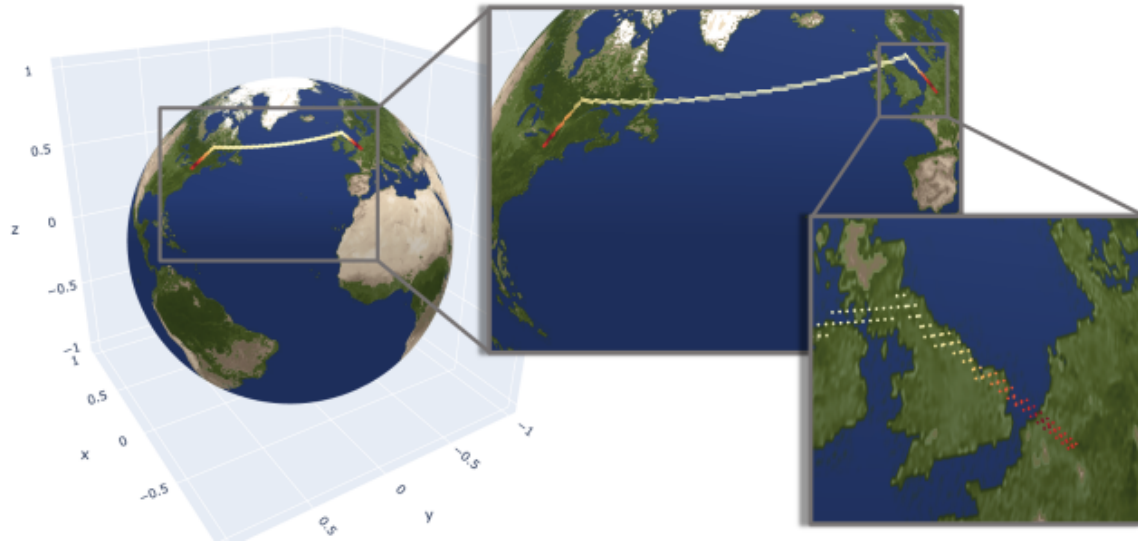




# REST-API POLYTOPE FEATURE EXTRACTION

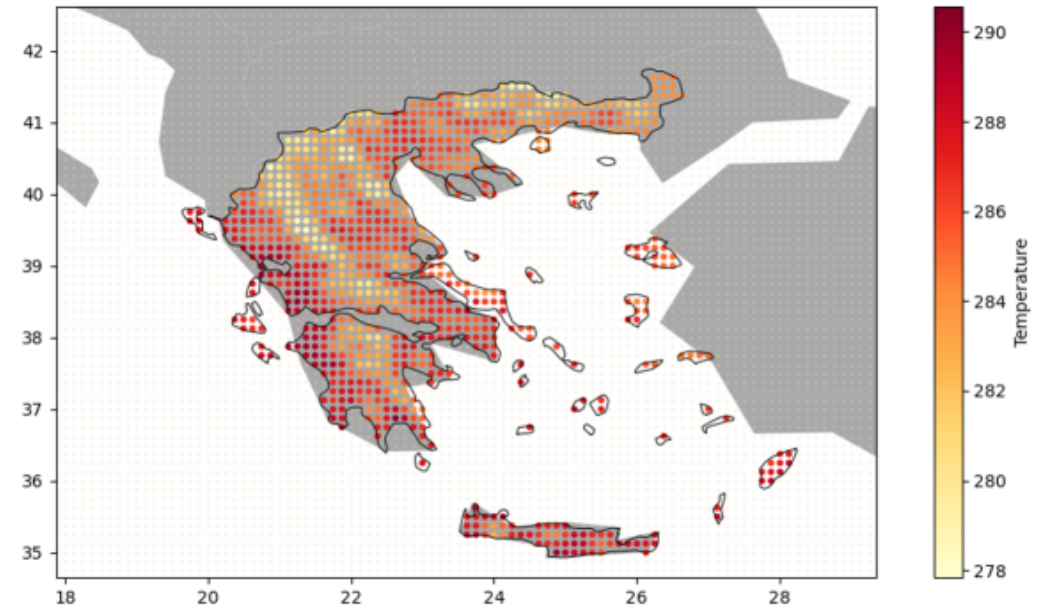
OGC compliant, supporting new WMO data governance and data distribution standards

FLIGHT PATH



99.99% I/O reduction vs 4D (x, y, z, t) bounding-box

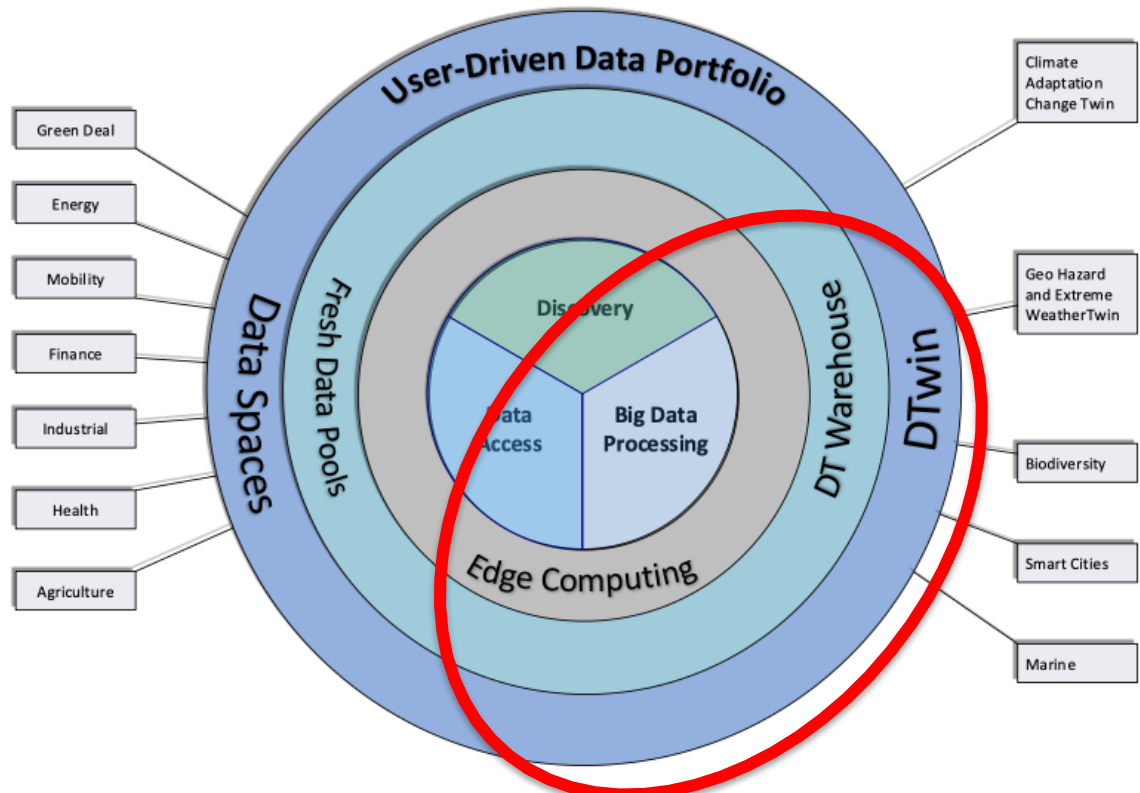
SHAPE  
EXTRACTION



Coloured points are directly addressed and extracted from within the DestinE data warehouse(s).

# Digital Twin data governance, provenance & federation

## Destination Earth Data Lake – physical & digital twin data



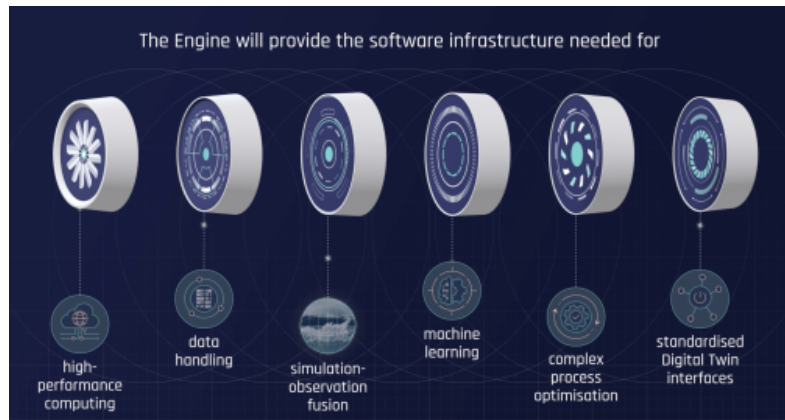
- Destination Earth**
- To create and test "what if" scenarios and to integrate impact sector applications for more sustainable development
  - To support near real-time decision-making at various levels (e.g. EU, national, regional, local)
  - To go beyond the current complex systems designed mainly for expert use
  - To scale up existing models and fuse simulation with observation
  - To monitor, simulate and predict natural phenomena and the impact of human activity on Earth
  - To assist in designing accurate adaptation strategies and climate change related mitigation measures
  - To accelerate the EU's green and digital transition
  - To leverage existing and new data sources and EU's advanced digital and computing infrastructure

Key Points: fusion of data, on-Demand, distributed processing near data, extendable reference Architecture, suitable for AI/ML, workflows

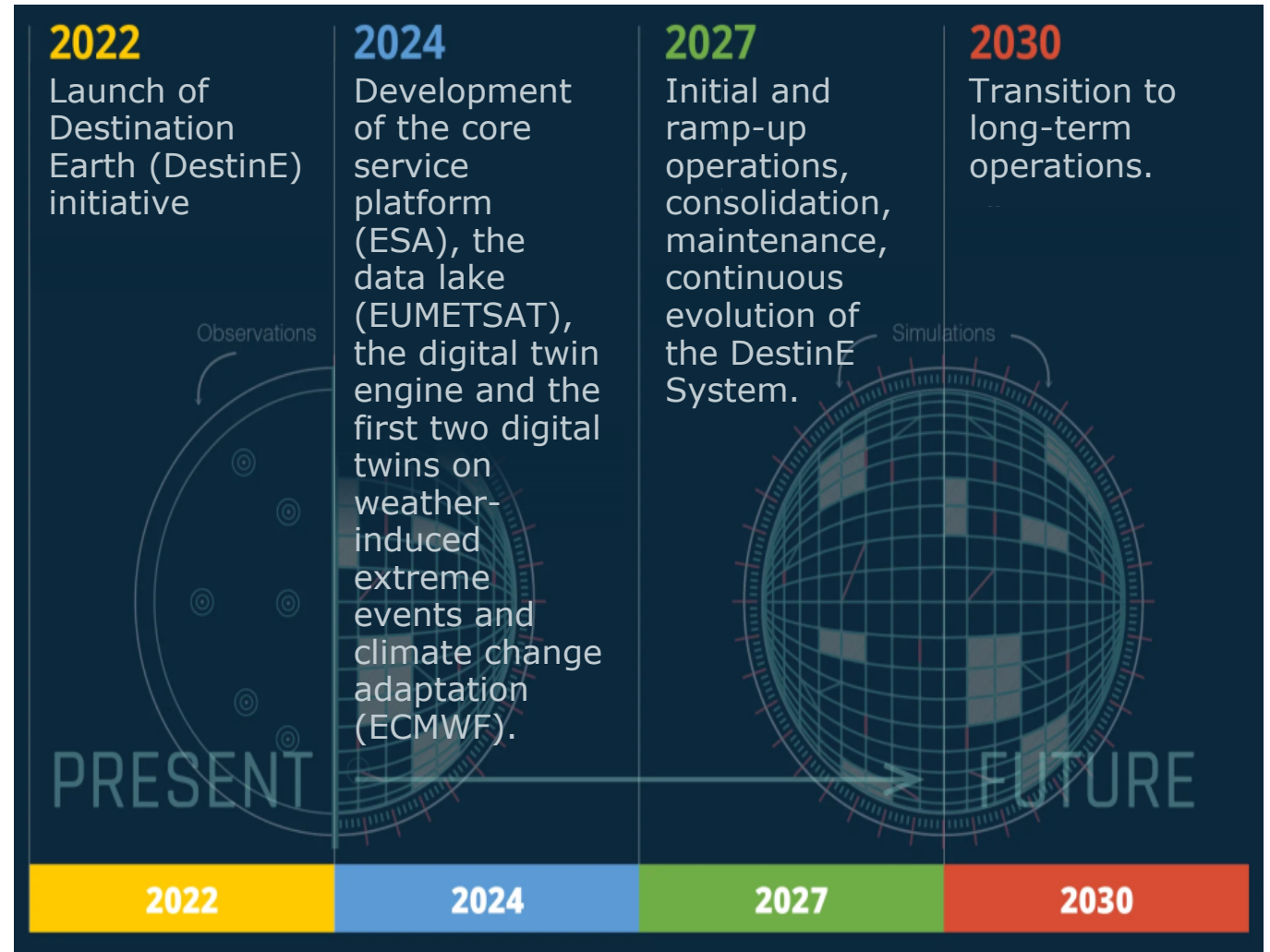


# Implementation: Phasing

- Novel investment in infrastructure & technology
- Embed Earth-system information into the wider digital environment to enable creation of new information



**EuroHPC**  
Joint Undertaking



Funded by the  
European Union







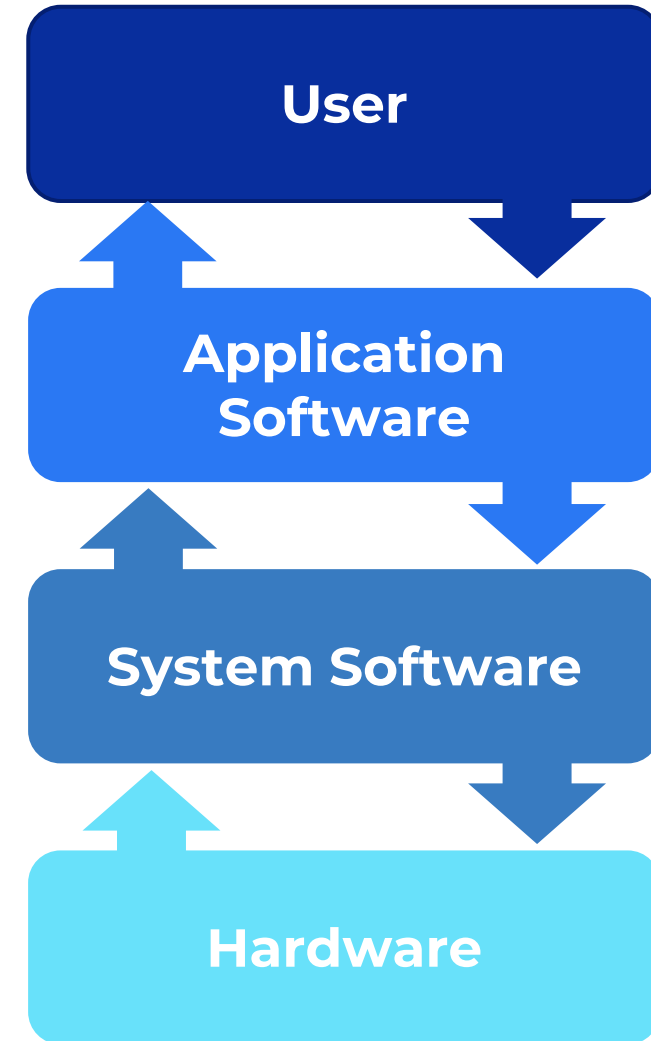
## RESEARCH & INNOVATION

- EuroHPC JU funds an R&I programme to develop a full European supercomputing ecosystem
- Aiming to support European digital autonomy and reduce Europe's dependency on foreign manufacturers
- Currently around **40** projects focusing on a number of areas including **technologies, applications and skills**

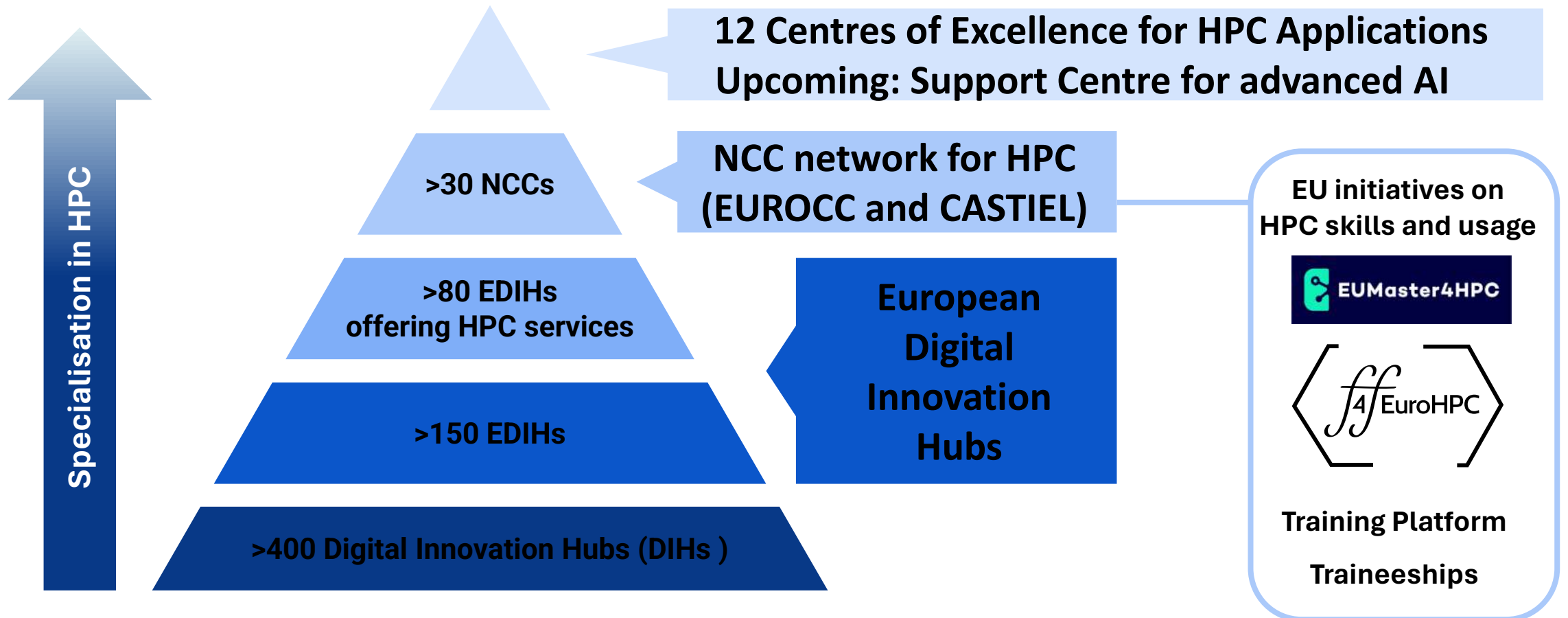


# STRATEGIC R&I – INTERVENTION AREAS

- » **Leadership in Use & Skills**  
Competence Centres and training programmes in HPC commensurate with the labour market.
- » **Applications and Algorithms**  
Centres of Excellence for HPC Applications and new algorithms for European exascale technology.
- » **European Software Stack**  
Software and algorithms, programming models and tools for exascale and post exascale systems.
- » **European Open Hardware**  
Ecosystem for the low power high-end general purpose processor and accelerator.



# EuroHPC support services for user communities



# National Competence Centres for HPC



- **EUROCC / EUROCC 2**  
A European network of more than 30 national HPC Competence Centres to widen the use of HPC in Europe
- **CASTIEL / CASTIEL 2**  
Coordinate and support the NCC network (and the European Centres of Excellence for HPC Applications in phase 2), e. g. with twinning and mentoring initiatives



<https://www.eurocc-access.eu/>

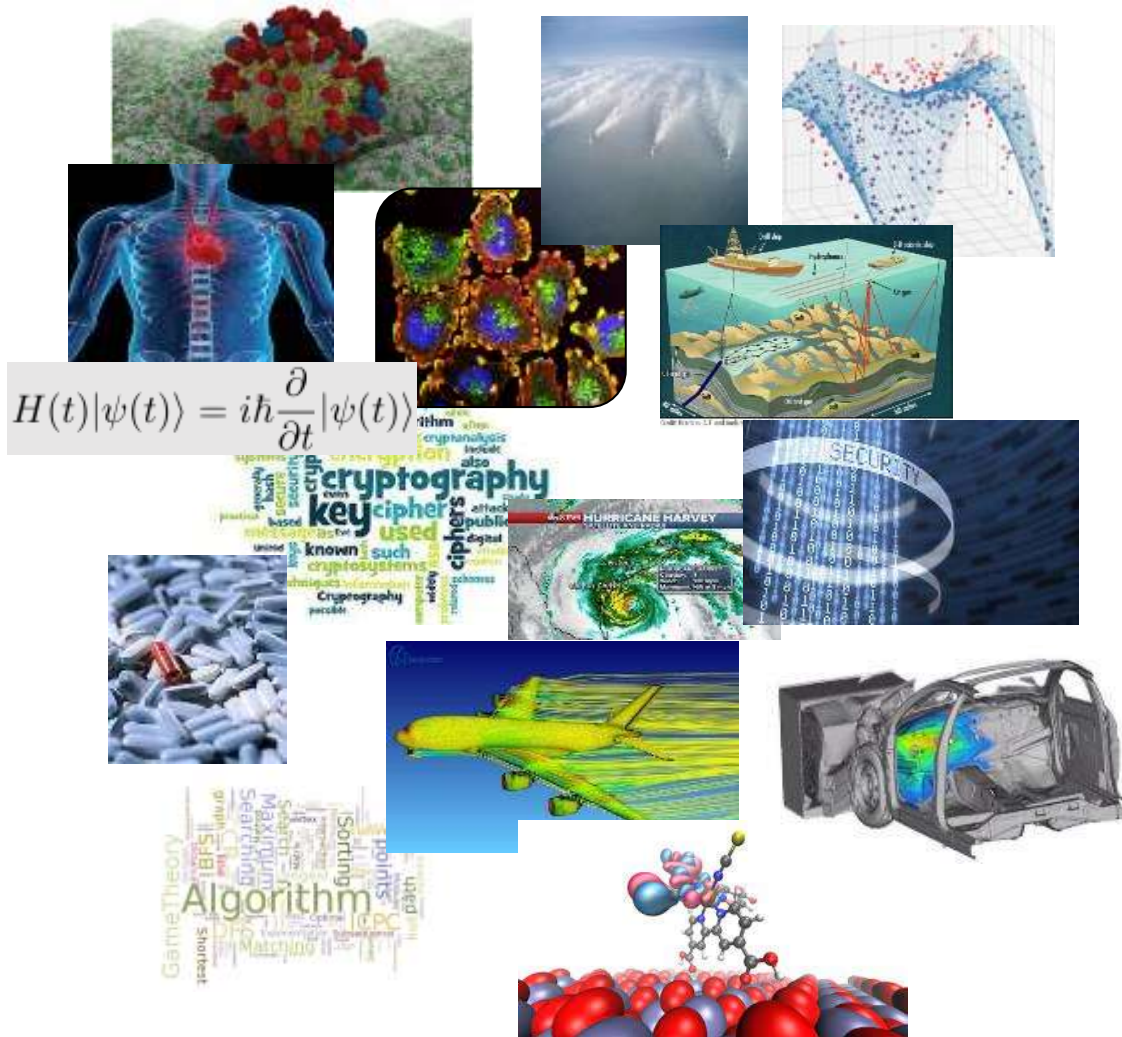
EUROCC / CASTIEL  
09/2020 – 12/2022

EUROCC 2 / CASTIEL 2  
01/2023 – 12/2025



# APPLICATIONS

## Centres of Excellence for Exascale HPC Applications



## Centres of Excellence for HPC Applications

Project launch: 01/01/2023

**MaX**

Materials / Quantum Chemistry

**SPACE**

Astrophysics & Cosmology

**Plasma-PEPSC**

Plasma science

**CEEC**

Engineering, Aeronautics

**ChEESA-2p**

Earth Sciences

**BioExcel-3**

Bioinformatics, biomolecular

**EXCELLERAT P2**

Multidomain engineering

**ESiWACE3**

Meteorology and Climate change

**HiDALGO2**

Multidomain environmental challenges

**MultiXscale**

Tools for performance, productivity

Project launch 01/01/2024

- Energy
- Performance optimisation

**Codes will be deployed on EuroHPC machines.**

# AI Support Centres

## Support Centre for HPC-powered Artificial Intelligence (AI) Applications

- Transfer of advanced HPC-AI knowledge to the European AI user and developer communities
  - Train and enable European AI communities to benefit from the use of advanced HPC capabilities for large-scale AI models
  - Single access point to the most advanced European competences for large scale AI model development and training
- 
- Budget: up to 10M€ (50% EU) funding
  - Deadline: 27 February 2024

Open Call

# Support for SME for HPC and AI

## Financial support for HPC uptake



- Boost **innovation and business opportunities for SMEs**
- **Solve business problems with HPC**, financial support and expertise from European HPC leaders

## Follow up project: Supporting competitiveness and innovation potential of SMEs

- Open calls to stimulate innovation potential of SMEs
- **Empower SMEs** with advanced computational capabilities on the basis of HPC
- Enable **large-scale simulations, data analysis, large language models or machine learning** utilising HPC resources



- „ It is our proposed level of ambition that by 2030:*
- *75% of European enterprises have taken up cloud computing services, big data and Artificial Intelligence*
  - *More than 90% of European SMEs reach at least a basic level of digital intensity“*

# EuroHPC Training Initiatives

## EuroHPC Training Platform

- Accessible archive of courses, learning materials and events
- Pave the way to a pan-European HPC training and certification scheme

## International HPC Summer School

- Support to the International HPC Summer School
- 40 students from EuroHPC JU Participating States will receive funding to participate

## EuroHPC Traineeships

- Traineeships in either an HPC competence centre, companies or SMEs using HPC systems or EuroHPC Hosting Entities
- Acquire work experience and put in practice advanced HPC skills.

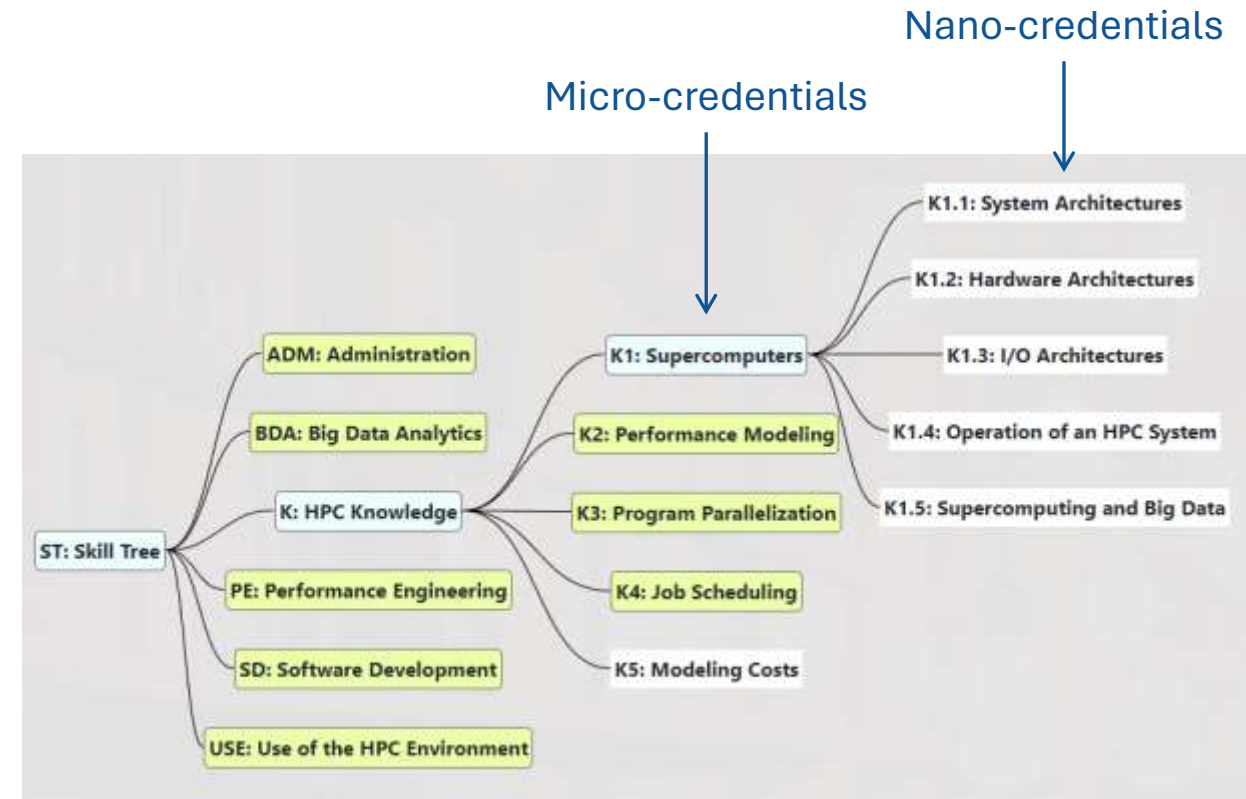
## Talent development

- Train the **next generation of HPC experts** in Europe
- 1<sup>st</sup> **pan-European MSc Programme** in HPC including 19 countries
- **Connect academic education with HPC industry**



# EuroHPC Virtual Training Academy

- The EuroHPC Academy will support training providers with the implementation of HPC education, training, qualifications and assessments.
  1. Competence and qualification framework (CQF)
  2. Reference course material for the modular CQF
  3. Assessment and certification scheme
  4. Technical infrastructure



Expected launch of the Academy in 2025

- Example of a “Skill Tree“ – a hierarchical representation of HPC skills
- Each node defines specific learning outcomes and provides curated reusable content for learning and teaching, exercises, exam questions and solutions
- Nano-credentials can be combined to varying modules, courses, curricula etc. which should fit into existing programmes

# THANK YOU



**EuroHPC**  
Joint Undertaking

**For more information, feel free to visit our website and social media:**



[eurohpc-ju.europa.eu](https://eurohpc-ju.europa.eu)



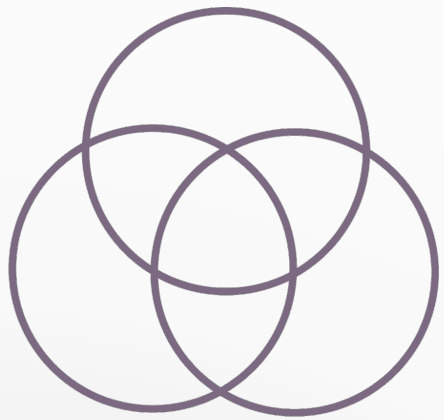
[@euroHPC\\_JU](https://twitter.com/euroHPC_JU)



[eurohpc-ju](https://www.linkedin.com/company/eurohpc-ju)



[@eurohpc-ju](https://www.youtube.com/@eurohpc-ju)



CASTIEL 2



# NCCs and CoEs – Services for Users

Dr. Natalie Lewandowski, High-Performance Computing Center Stuttgart (HLRS)

HPC User Day

Brussels, 11.12.2023

# NCCs

Natalie Lewandowski, HLRS



## What are the NCCs?

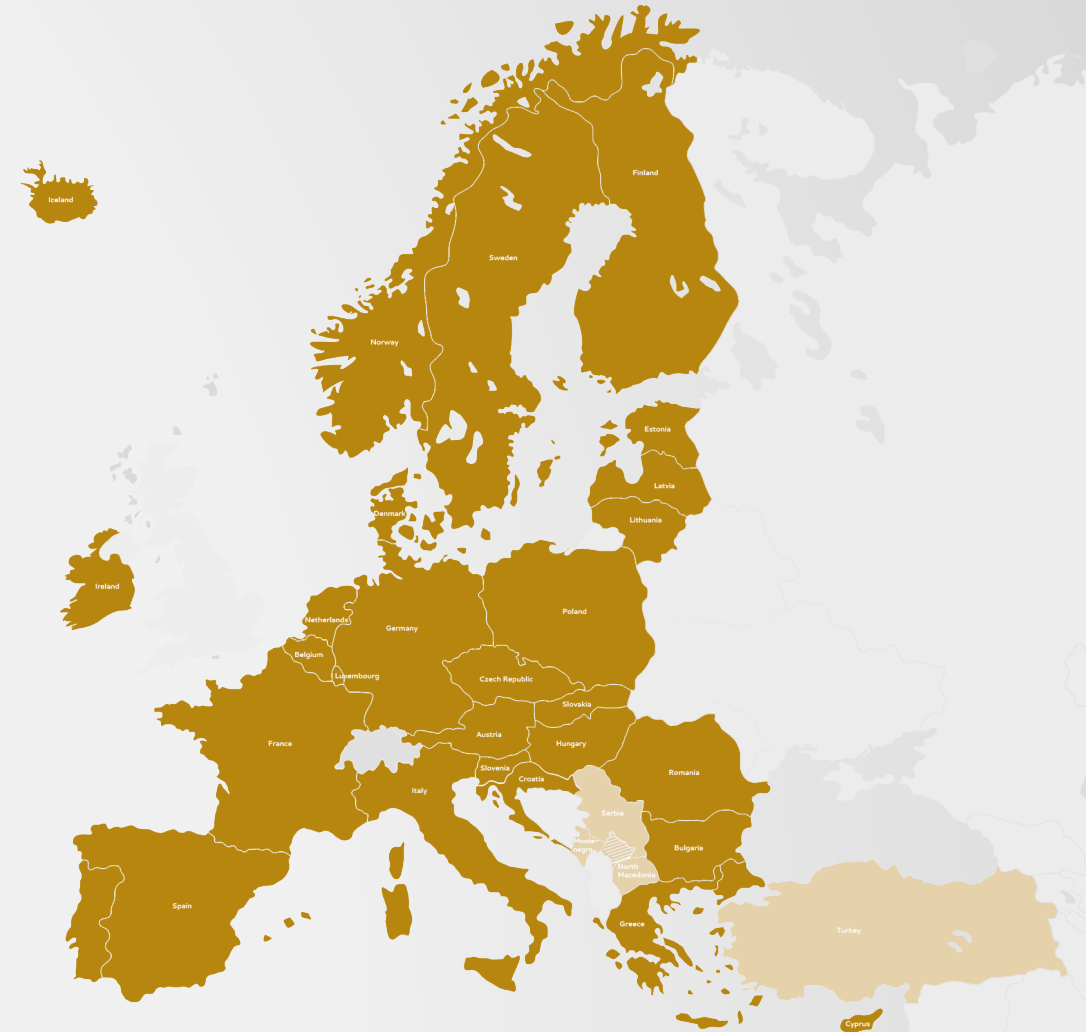
**National Competence Centres (NCCs): currently 32 across Europe**

In the areas:

- High-Performance-Computing (**HPC**)
- High-Performance Data Analytics (**HPDA**)
- Artificial Intelligence (**AI**)

Support Project:

**CASTIEL 2** (Coordination and Support Action), which supports the NCCs and also the CoEs





# CoEs

Natalie Lewandowski, HLRS



## What are the CoEs?

Centres of Excellence in HPC Applications

→ Other than the NCCs, they operate domain-focussed



Astrophysics and cosmology



multiscale modelling



Materials design  
at the Exascale



Center of Excellence for  
Computational Biomolecular  
Research



Exascale CFD



Global systems



Engineering Applications



ChEESE



The EuroHPC Center of Excellence  
for Plasma Simulations



esiwace  
CENTRE OF EXCELLENCE IN SIMULATION OF WEATHER  
AND CLIMATE IN EUROPE

Applications Exascale:

**MAX, SPACE, Plasma-PEPSC, CEEC**

Applications Science & Innovation:

**ChEESE-2P, BioExcel-3, EXCELLERAT P2, ESiWACE3, HiDALGO2, MultiXscale**

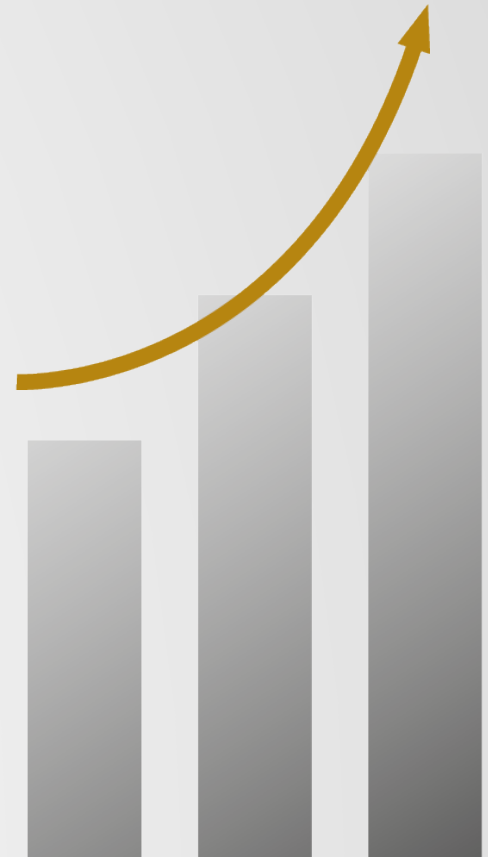
Two new CoEs coming soon!

(~ 01.01.2024)

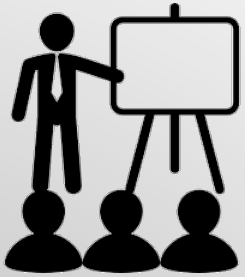
- **POP3** (Performance Optimisation and Productivity)
- **EoCOE-III** (Energy)

## Goals

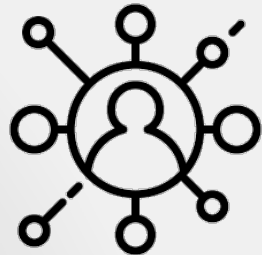
- Provision of a **broad service portfolio** tailored to the needs of **our user groups: industry, academia and public administration**
- Catalogue and increase national HPC competences, High-Performance Data Analytics (HPDA) and Artificial Intelligence (AI) capabilities
- Foster **each NCC as a single point of contact towards the world of HPC** in the respective states and the EU



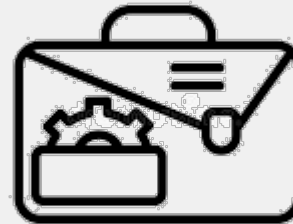
## What do the NCCs offer?



Training



Access to Skills &  
Competences (National &  
European level)



HPC+ services throughout  
the whole user journey

### Our advantages:

- One-stop-shop
- Local, accessible service
- European network available

- Consulting
- Proofs of concept
- Support

## How to find the NCCs?



The screenshot shows the top navigation bar of the EUROCC ACCESS website. It features the EUROCC logo on the left and four menu items: ABOUT US, SERVICES, NEWS, and LOGIN. Below the navigation bar is a large heading 'WELCOME TO EUROCC ACCESS' and a map of Europe. To the right of the map is a paragraph of text and a list of missions.

ABOUT US ▾ SERVICES ▾ NEWS ▾ LOGIN

### WELCOME TO EUROCC ACCESS

The National Competence Centres (NCCs) are the **central points of contact** for HPC and related technologies in their country.

Their missions are to:

- Develop and display a comprehensive and transparent map of **HPC competences and institutions** in their country
- Act as a **gateway for industry and academia** to providers with suitable expertise or relevant projects, may that be national or international
- Collect **HPC training offers** in their country and display them on a central place together with international training offers collected by other NCCs
- Foster the **industrial uptake of HPC**

<https://www.eurocc-access.eu/>

- Overview of all NCCs
- Map of competences
- Training offer



# The CoEs

Natalie Lewandowski, HLRS



## How do the CoEs support? Example of Hidalgo (2):

### HPC AND BIG DATA TECHNOLOGIES FOR GLOBAL CHALLENGES

- The project focuses on five use cases from the **environmental area**: improving air quality in urban agglomerations, energy efficiency of buildings, renewable energy sources, wildfires and meteorological forecasting (<https://www.hidalgo2.eu/about/#usecases>).
- common feature of the modelling of the above simulations is the use of numerical analysis of fluid flows by Computational Fluid Dynamics (CFD) method
- Mailing list for support requests with an internal ticket system <https://hidalgo-project.eu/support>
- **Consulting** offer:
- **Training at HiDALGO2** collects and shares knowledge, best practices, available resources and mechanisms for appliances, applications and software frameworks for tackling Global Challenges with HPC and AI.
- HPC experts are made aware of Global Challenges themes and support Global Challenges scientists concerning scaling and optimization codes.

# The CoEs

Natalie Lewandowski, HLRS



## Support offer of Hidalgo (2):

**Whether you are from industry, research, policy, an NGO or the general public...**

... facilitate contacts within the global challenges community

- Use our support service
- Discuss in our forum
- Use our match-making service to connect to other experts
- Visit our workshops and presentations at conferences
- Learn more at our training events
- Co-organise a workshop with us
- Become an associated partner

...Provide solutions to your questions:

- Consultancy
- Tailored solutions
- Including Co-design

...help you to solve your problem

- Easy access to compute resources on Tier-0 HPC systems for data-centric applications
- Support for running your own codes on HPC machines
- Support on the use of Artificial Intelligence
- Training

# The CoEs

Natalie Lewandowski, HLRS



## Example of MultiXScale

- MultiXscale is a EuroHPC JU Centre of Excellence in **multiscale modelling**. It is a collaborative project between the CECAM network and EESSI that will allow domain scientists to take advantage of the computational resources that will be offered by EuroHPC.
- EESSI is an HPC community effort to build a common stack of scientific software installations for HPC systems.
- It provides the **technical backbone** to the project, including CI/CD capabilities and hardware support across EuroHPC resources.
- EESSI aims to reduce the technical burden on developers and end-users of **scientific applications**.
- MultiXScale supports EESSI with HPC Codes, libraries & tools

# The CoEs

Natalie Lewandowski, HLRS



## Example of MultiXScale:

- Training Offer

<https://www.multixscale.eu/training-events/>

A screenshot of the MultiXScale Training Events page. The page has a white background with a grey header. The main content area is divided into three columns, each representing a training event. Each event card includes a title, a date, a description, and a "Click here for more details" link. At the bottom of each card are buttons for "Event website", "Google", and "Outlook".

**Training Events**

Event feed: [Download](#) [Copy URL](#) Search events:  Past events: [↗](#)

Event Title	Date	Location
CernVM File system	Mon Dec 04 2023	Online
Streaming optimised scientific software: an introduction to EESSI	Tue Dec 05 2023	Online
An introduction to High Performance Computing	Feb 06 - Feb 08 2024	Online



# The CoEs

Natalie Lewandowski, HLRS

## Example of EXCELLERAT P2 (Engineering):

Offers a variety of tailored services for different users:

- **End-users:** For engineers, we develop solutions for challenges along the entire exascale engineering cycle, e.g. with simulations.
- **Code developers:** We provide expertise to code developers that helps them to evolve engineering software packages (codes/applications) towards extreme-scale applicability.

Are you facing any specific challenge and need support by an expert? For service or consultancy requests, please contact [support@excellerat.eu](mailto:support@excellerat.eu).



Visit [www.excellerat.eu](http://www.excellerat.eu)

Follow us on social media



# The CoEs

Natalie Lewandowski, HLRS



## EXCELLERAT P2: The European Centre of Excellence for Engineering Applications:

<https://services.excellerat.eu/>

EXCELLERAT P2 offers cross-cutting support for various engineering sectors, like manufacturing, automotive, energy, aerospace, chemistry, biology and climate.

→ Service Portal

### EXCELLERAT Centre of Excellence - Service Portal

EXCELLERAT offers cross-cutting support for various engineering sectors, like manufacturing, automotive, energy, aerospace, chemistry, biology and climate.

Tackling the next generation engineering challenges, those requiring an unprecedented amount of computational power, requires a new frame of skills and resources. EXCELLERAT mission is to provide support and consulting services at different levels to cover all the engineering lifecycle. To facilitate the access to the services that really matter to you, we divided their presentation into three dashboards aimed to different roles.



The European Centre of Excellence for Engineering Applications



#### Community dashboard

Start here if you are interested in the future of engineering or want to know more about the project activities and success stories. You will know about the next events and training and consult our public material.

[— Read more](#)



#### Engineer dashboard

Start here if you are an end-user fighting with exciting engineering challenges. You will know how we dealt with similar challenging use-cases, how we developed new tools and how we might support you to solve your problem.

[— Read more](#)

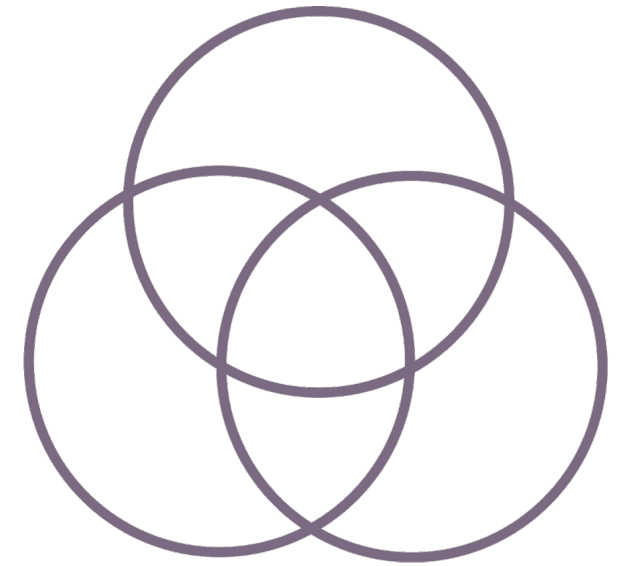
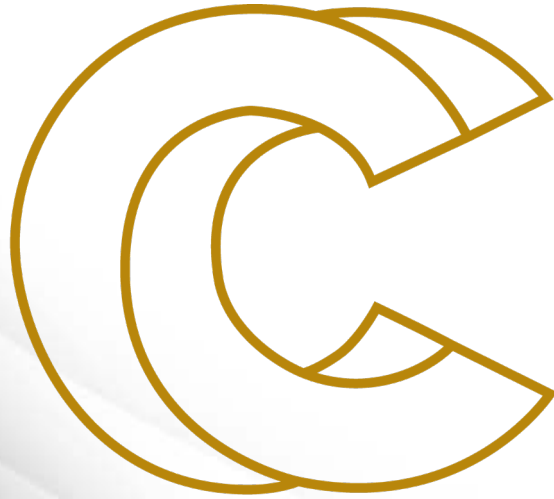


#### Developer dashboard

Start here if you are developing or updating engineering software. You will know how we optimized popular software codes to make them exascale-ready and how we might support your development effort.

[— Read more](#)

# Thank you!



CASTIEL 2

# EURO<sup>2</sup>

[Eurocc2-pmt@lists.projects.hlrs.de](mailto:Eurocc2-pmt@lists.projects.hlrs.de)



Co-funded by  
the European Union



**EuroHPC**  
Joint Undertaking

Funded by the European Union. This work has received funding from the European High Performance Computing Joint Undertaking (JU) and Germany, Bulgaria, Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland, Portugal, Romania, Slovenia, Spain, Sweden, France, Netherlands, Belgium, Luxembourg, Slovakia, Norway, Türkiye, Republic of North Macedonia, Iceland, Montenegro, Serbia under grant agreement No 101101903.