

# HPC for Extreme Events: Use Cases and Opportunities at CINECA



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# HPC For Extreme Events

Use cases and opportunities at CINECA

- CINECA: the Italian supercomputer center
- Destination Earth: digital twin and extreme events
- RUSH: Rapid Update Short-term High-resolution forecast
- IT4LIA: the Italian AI Factory



The background is a city skyline at dusk or dawn, with a large blue diagonal overlay. Glowing light trails in red, blue, and purple swirl across the scene, suggesting high-speed data or computation. The text is centered in white.

# CINECA

## The Italian Supercomputer Center



# NOT-FOR-PROFIT CONSORTIUM

Since 1969 Cineca supports the  
Italian Academic System



## 122 MEMBERS

2 Ministries, 71 Universities,  
49 Academic and Research Institutions



## 6 OFFICES

Bologna, Milan, Rome, Naples, Chieti, Palermo



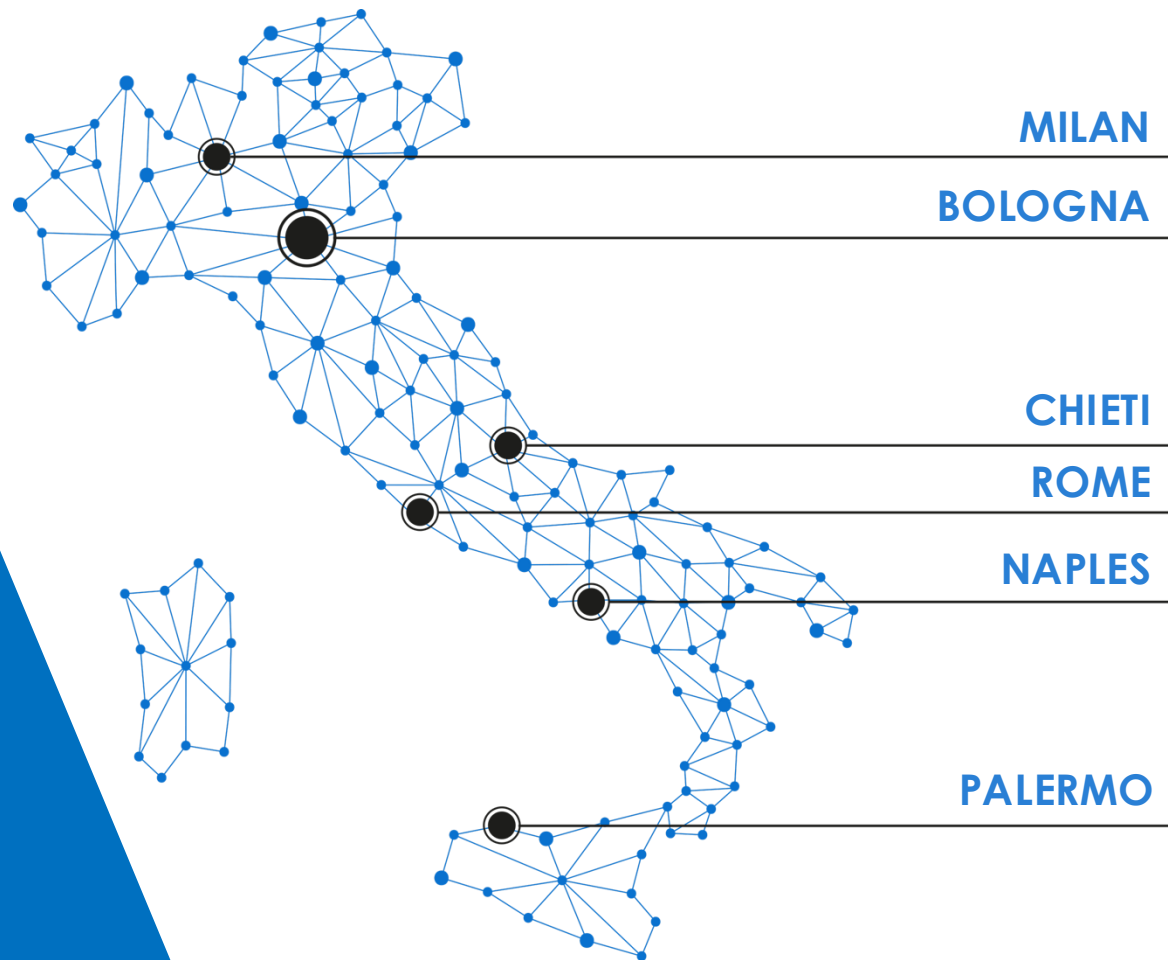
## ≈ 1100

Employees

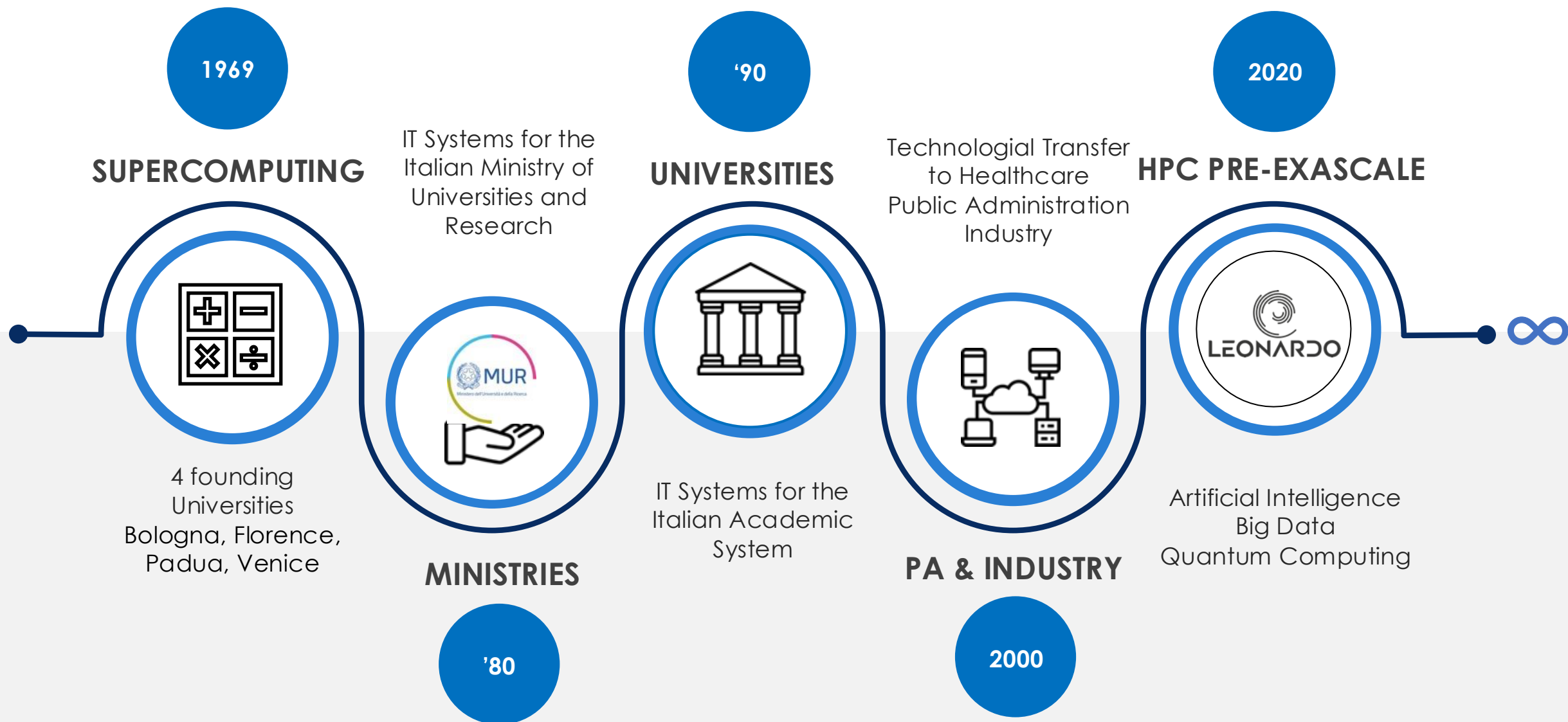


## ≈ 130 MLN €

Yearly Revenue in 2024



# 50+ YEARS OF IT SERVICES



# ONE OF THE MOST POWERFUL HPC FACILITIES IN THE WORLD

Cineca is the most important research supercomputer facility in Italy.

- The Italian Ministry of Universities and Research delegated Cineca to develop and manage **a world-class supercomputer facility** and to represent Italy in the European context of HPC.
- High Performance Computing is a crucial asset for the European Community, to support research and innovation, to **enhance the digital economy.**

# EURO HPC SYSTEM



Exascale



Pre-exascale



Petascale / mid-range



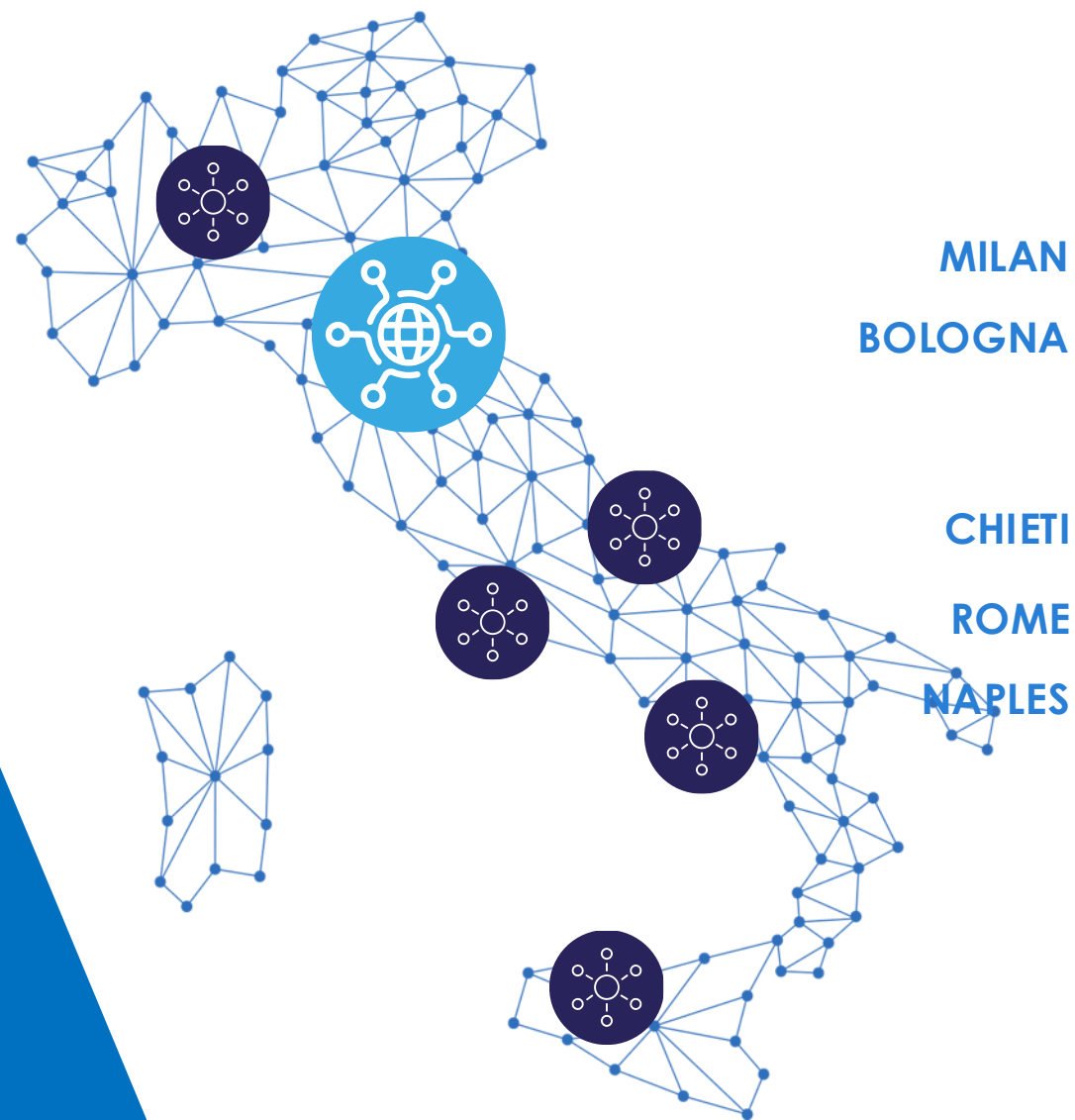
Quantum system / simulator



# BUILDING THE ITALIAN HPC NETWORK

We are currently working on the creation of a **supercomputers network**, connected with the HPC Leonardo.

We therefore opened two new centres in **Naples** and **Palermo**, and we are due to open two more in **Milan** and **Rome**.





The background is a city skyline at dusk or dawn, with a large blue diagonal overlay. Glowing digital lines in red, blue, and purple swirl across the scene, suggesting a digital or data theme. The text is centered in white, bold font.

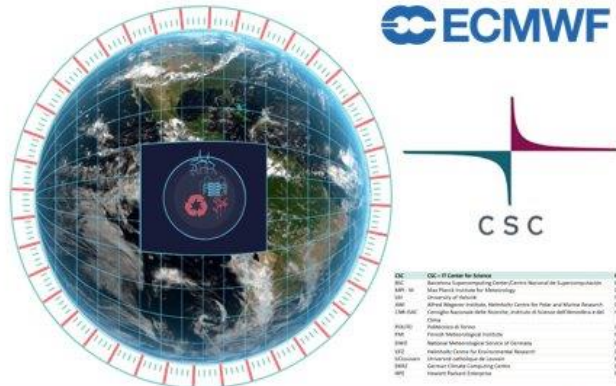
# Destination Earth

## Digital twin and extreme events

# Destination Earth

Destination Earth, in strategic partnership with the EuroHPC Joint Undertaking, develops bespoke and cutting-edge simulation capabilities, **delivering Earth system information at the scales where the impacts of extreme events and climate change are directly experienced**. At the same time, it promotes the growth of an innovative and dynamic digital ecosystem, powered by artificial intelligence.

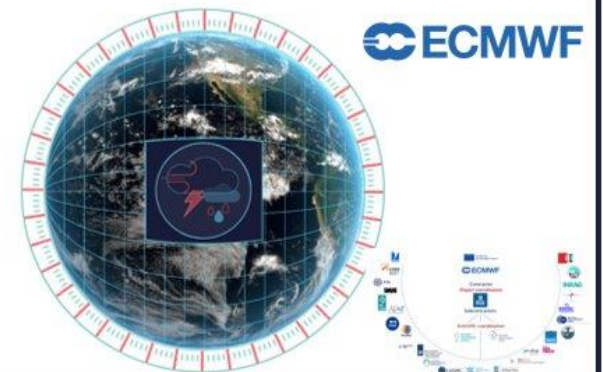
## Climate change adaptation



To support policymaking for adaption

Multi-decadal timescales

## Weather-induced extremes



For rapid response to extreme events

For a few days ahead



# Destination Earth

MN5



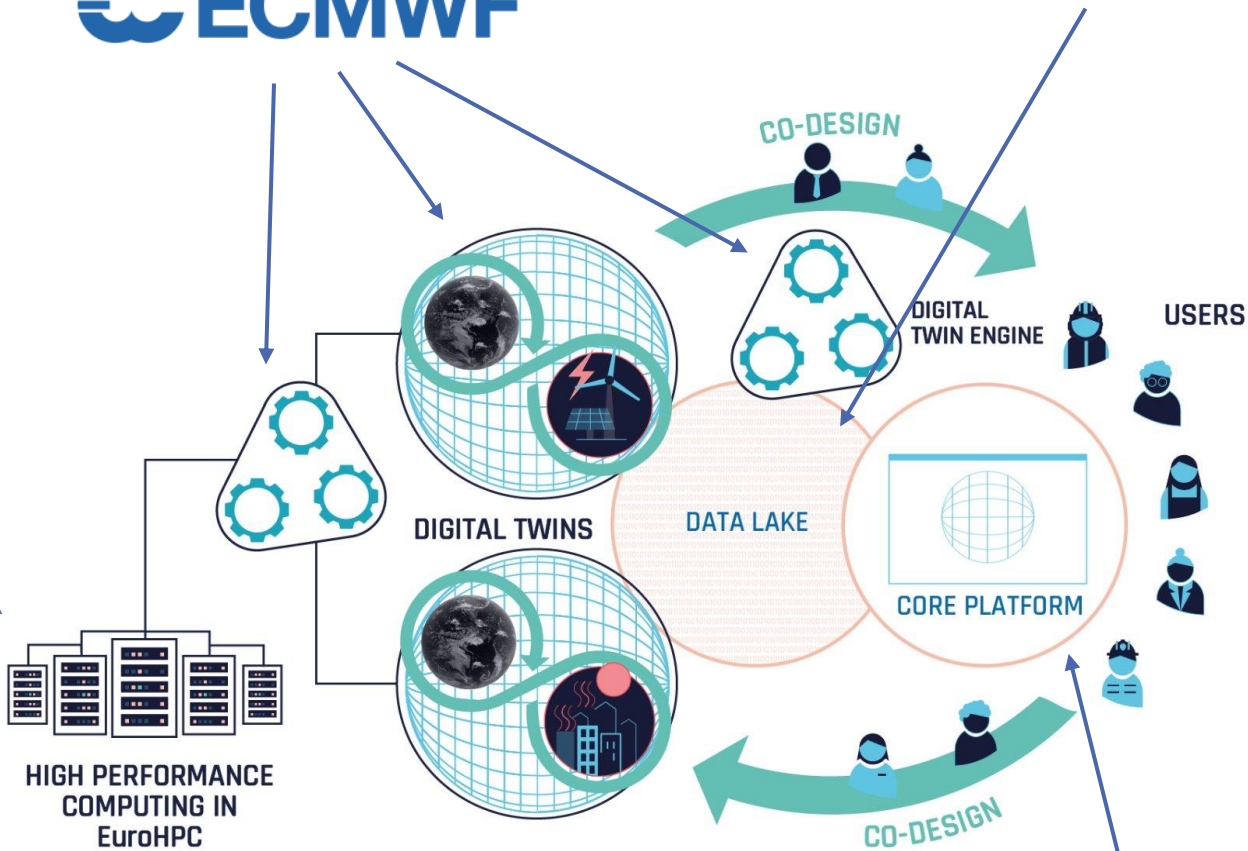
MeluXina



LUMI



Leonardo





## Idea

## Results



**Advanced regional model forecasting** based on initial and boundary conditions provided by DestinE (IFS) or GLORI (ICON) to drive regional simulations



Integration of key Destination Earth services including **Data Lake, FDB, ecFlow, Polytope, and Aviso**



**Coordination with GLORI** partners involving testing and assessment of the ICON workflow and the development of a shared S3-based data transfer framework across COSMO consortium sites



Validation of the GLORI4DE workflow through a focused analysis on the May 2023 Emilia-Romagna flood event



# GLORI4DE

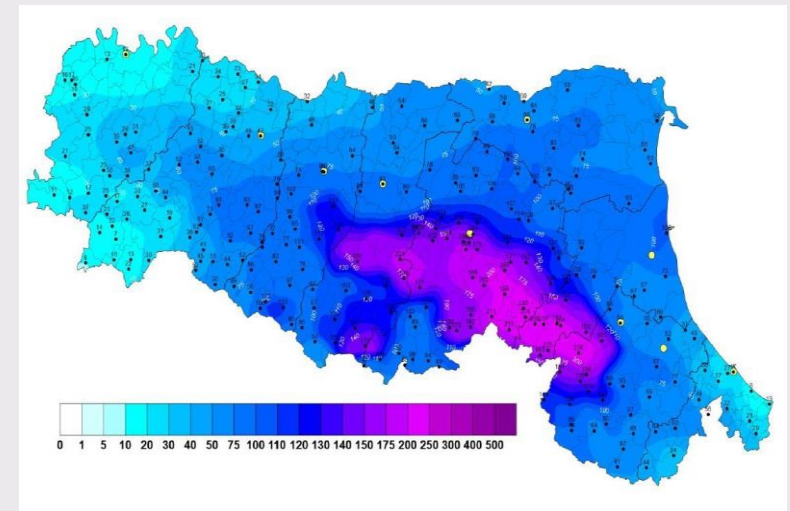
## Idea

During May 2023, **Emilia-Romagna was hit by severe flood events**. COSMO, the production model at the time, failed to predict accurately the intensity and location of the precipitation.

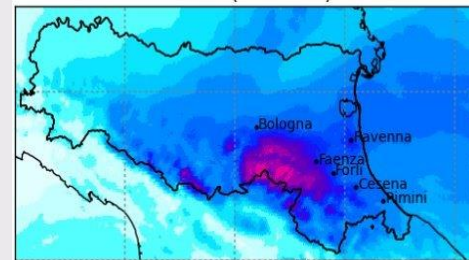
**We reran the simulations via Scenario3 of GLORI4DE** (IFS + ICON-LAM). The IFS data were retrieved via a MARS request and the initial/boundary conditions adapted for an ICON-LAM run via the ICON Tools software.

The output showed **a clear improvement** with respect to the COSMO forecasts.

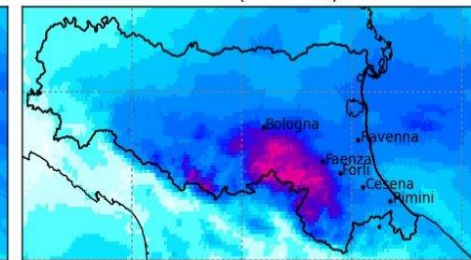
## Results



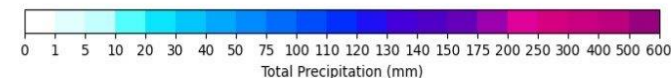
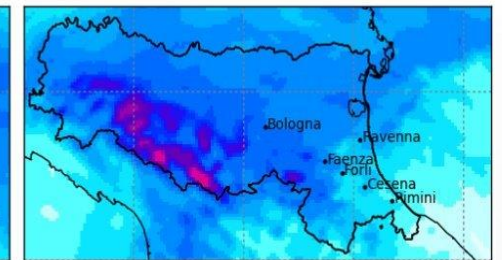
ICON 1km IFS driven (hindcast)



ICON 2km IFS driven (hindcast)



COSMO 2km ERA5 driven



# High-Resolution Early Precipitation-to-Flood Signals

## Idea

## Methods

## Results



Development of **early warning indicators** based on high-resolution precipitation data from Extremes Digital Twin.



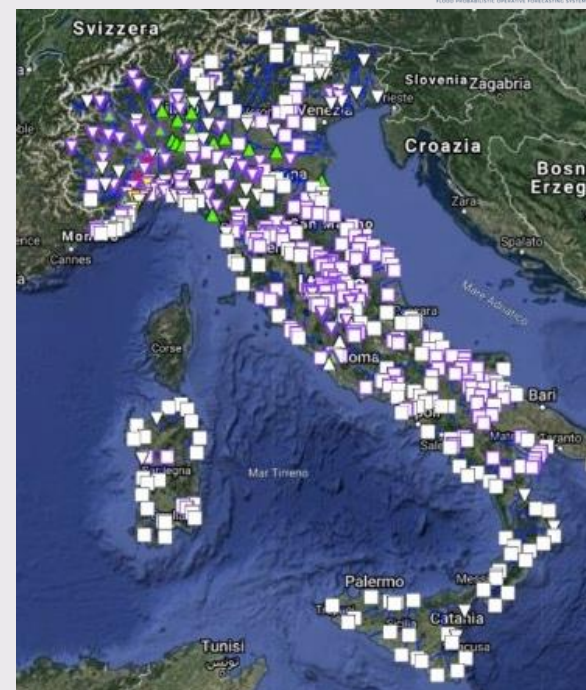
Integration with the national **hydrological forecasting system (FloodPROOFS)** for the simulation of river behaviour and flood impact scenarios.



On-demand high-resolution forecasting using the **ICON model coupled with hydrological modelling** for selected critical areas.



**Stakeholder engagement and user validation** through the collection of user needs, co-design workshops, and final-phase evaluation.





# High-Resolution Early Precipitation-to-Flood Signals

Idea

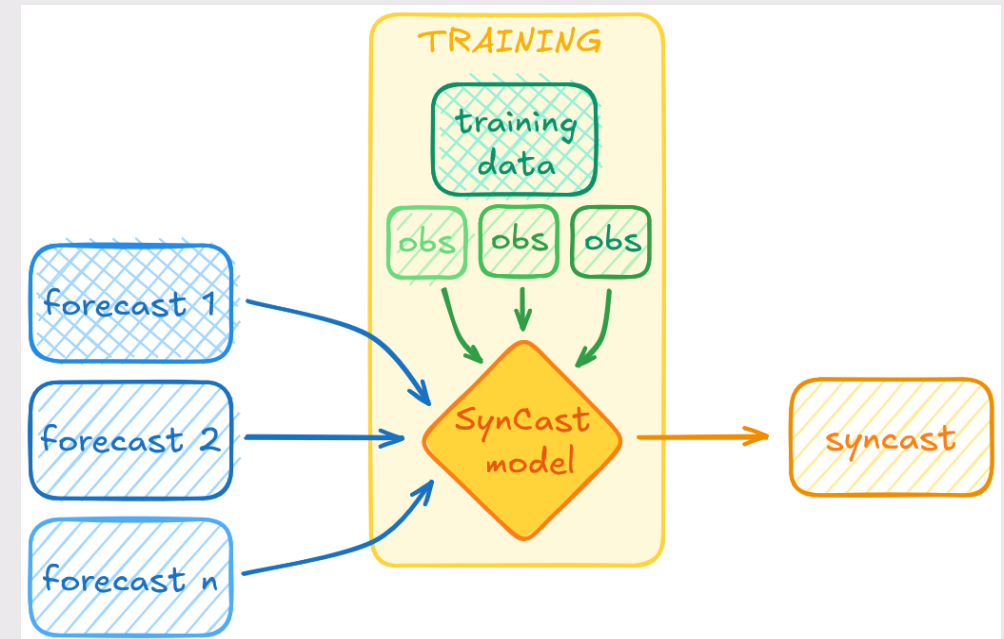
Methods

Results

FRAIM (FRamework for AI in Meteorology) developed at DWD provides **a flexible framework for advanced forecasting**, within which the SynCast system merges multiple forecasts into a single optimal prediction (the syncast).

SynCast is based on the AI-VAR data assimilation system and can flexibly **integrate different input forecasting systems, using observations, model fields, and analyses** as training data.

Its optimal forecast is obtained by minimizing a loss function, defined as a **cost functional inspired by variational data assimilation**, enabling consistent and optimized multi-source predictions.

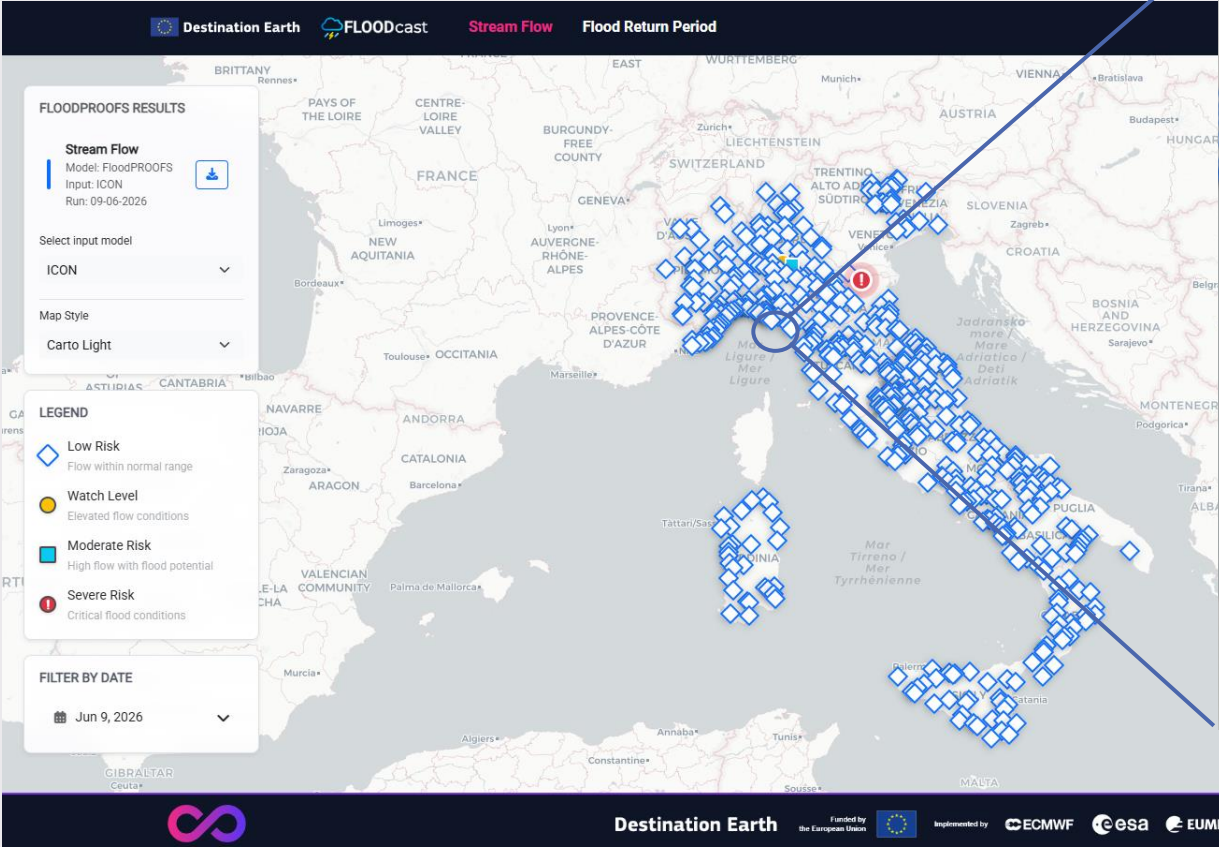


# High-Resolution Early Precipitation-to-Flood Signals

Idea

Methods

Results



The background is a city skyline at dusk or dawn, with a large blue diagonal overlay. The overlay contains the text 'RUSH' and 'Rapid Update Short-term High-resolution forecast'. There are also colorful light trails (red, blue, green, yellow) swirling around the city buildings.

# RUSH

Rapid Update Short-term High-resolution forecast



# RUSH

## Idea

## Methods

## Results



**Improve the accuracy** of immediate forecasts by integrating the most recent observations with numerical weather predictions.



**Combine observation-based nowcasting and Numerical Weather Prediction** methods to create a coherent forecasting workflow that bridges the gap between the two.



Develop an AI-driven weather forecasting system characterized by **high spatial resolution** of 1 km, **probabilistic forecasts, rapid and frequent updates**, with forecasts refreshed every 5 minutes in sync with radar and satellite data, **national-scale coverage**



Forecasts extend **up to 24 hours ahead**, continuously updated with the latest available data.



# RUSH

Idea

Methods

Results

Radar

Satellite

AIFS

Extrapolation  
Observations weighted higher near  $t=0$

6h

Conditioning & Downscaling  
Forecast weight increases  
with lead time

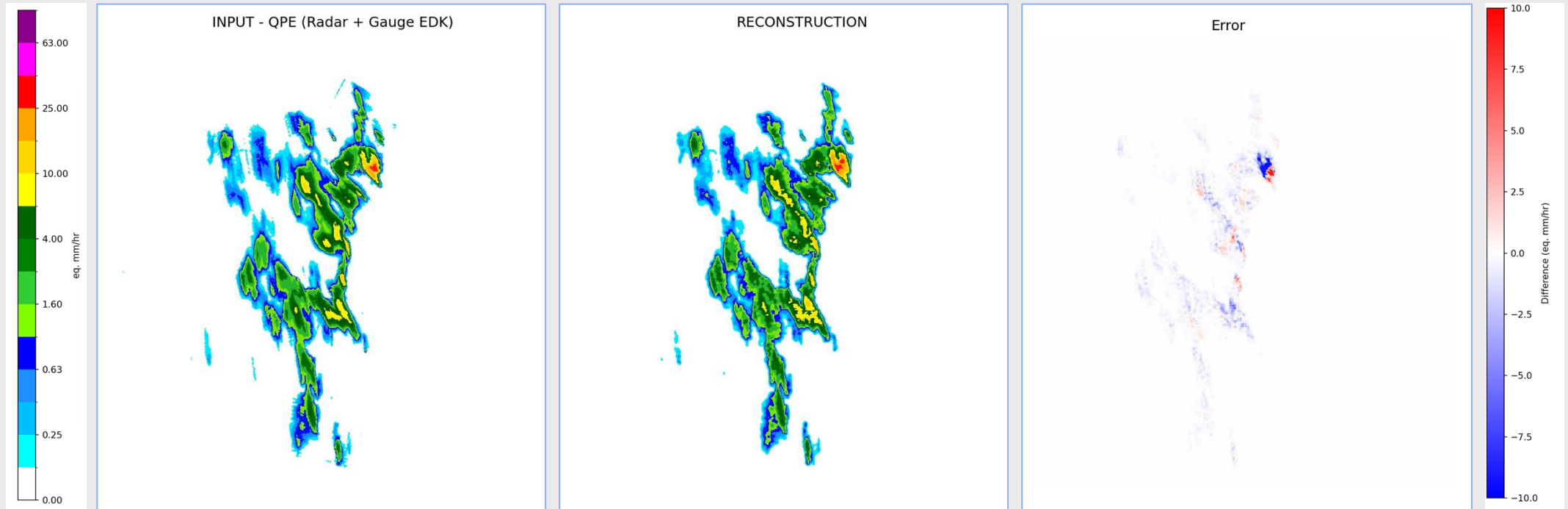
Precipitations

# RUSH

Idea

Methods

Results



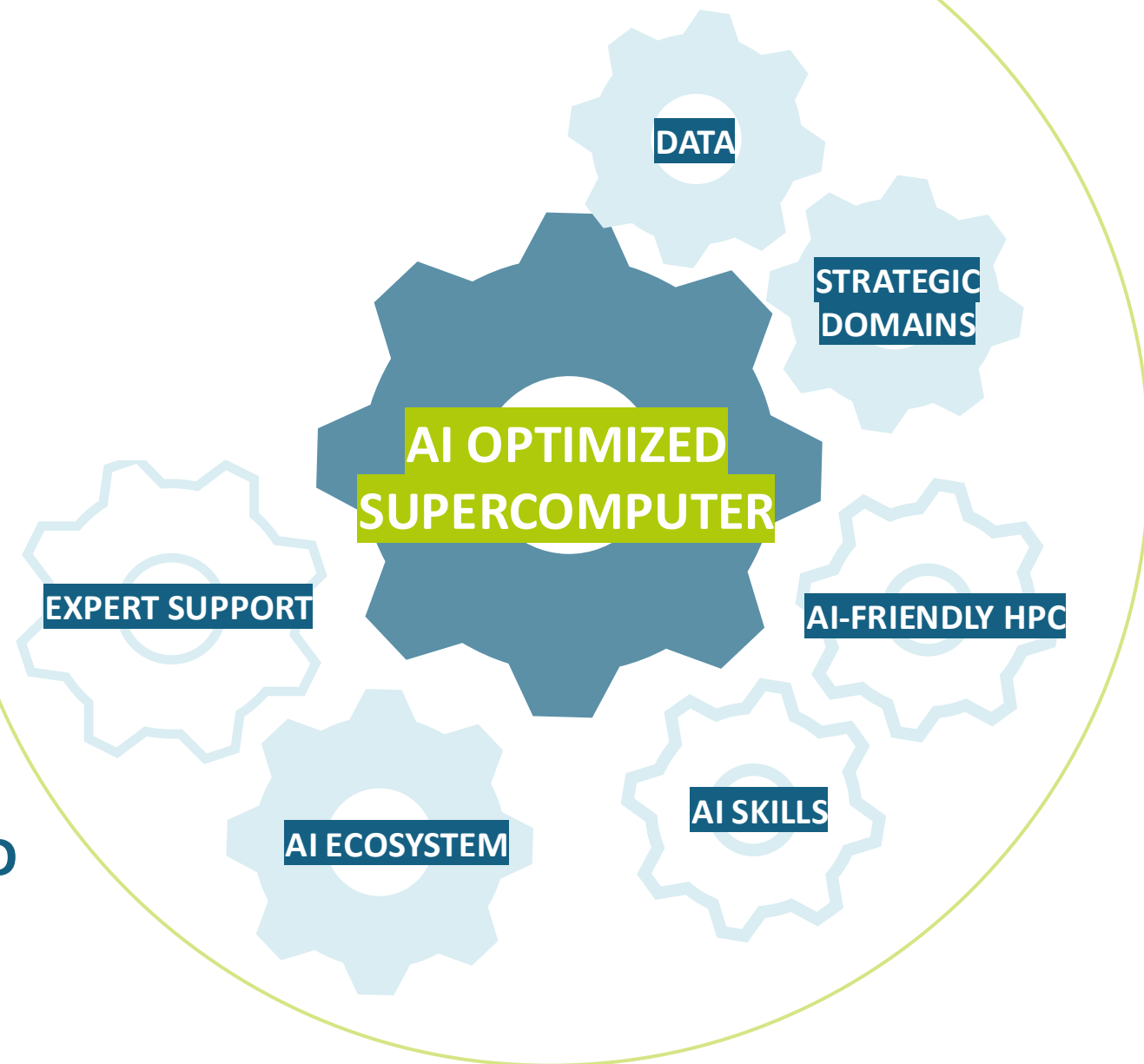
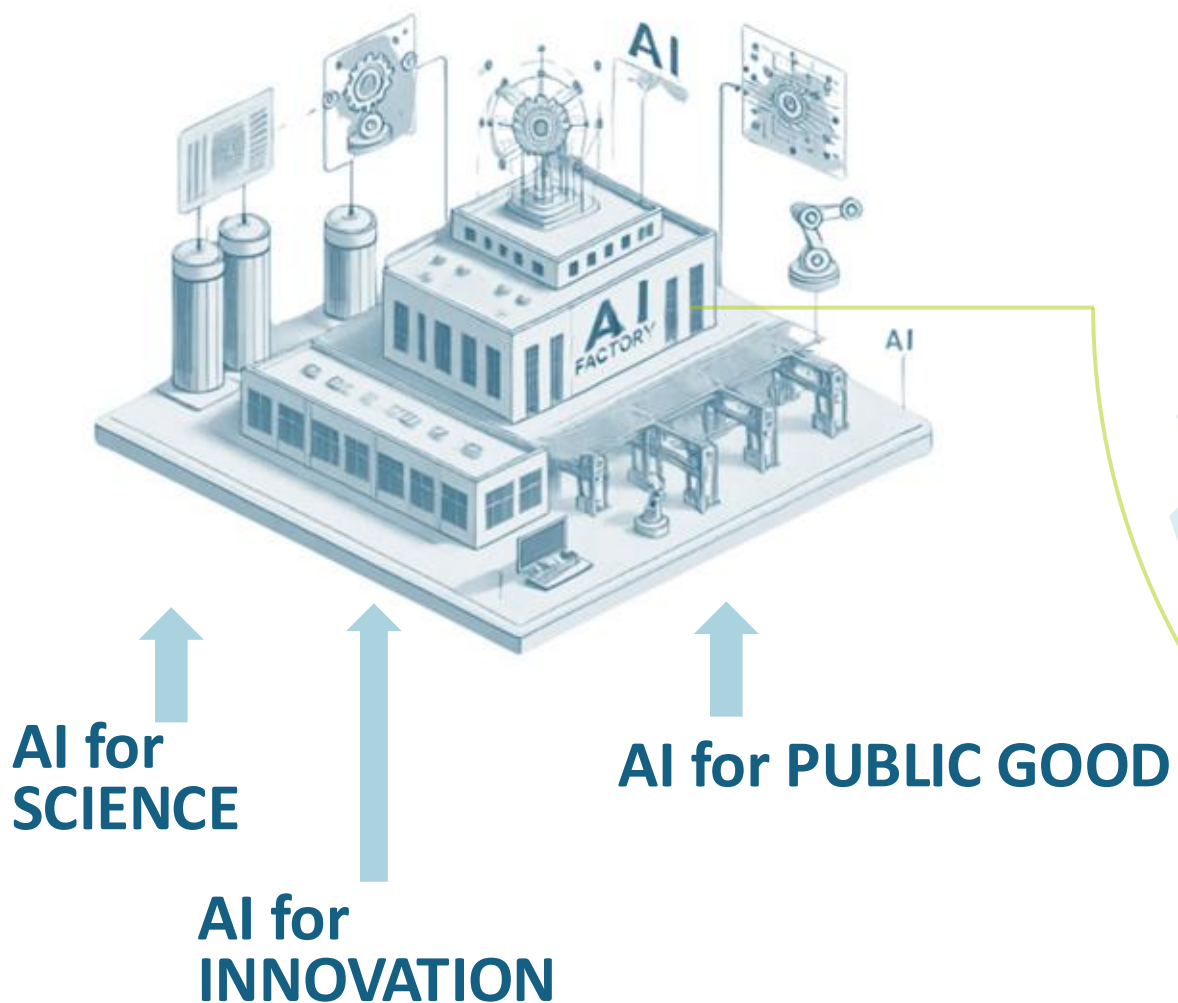


The background is a city skyline at dusk or dawn, with a large blue diagonal overlay. Glowing neon lines in red, blue, and purple swirl across the scene, suggesting a digital or AI theme. The text is centered on the blue overlay.

# IT4LIA

## The Italian AI Factory

# What is an AI Factory?



## Promotori



Ente ospitante

**CINECA**

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## Altri Stati membri partecipanti

 Federal Ministry  
European and  
International Affairs  
Republic of Austria

 REPUBLIC OF SLOVENIA  
MINISTRY OF HIGHER EDUCATION,  
SCIENCE AND INNOVATION

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## Partner

 Regione Emilia-Romagna

 INFN  
Istituto Nazionale di Fisica Nucleare

 ANI

 F&K  
FONDAZIONE  
BRUNO KESSLER

 ItaliaMeteo

 ICSC  
CENTRO ITALIANO DI RICERCA  
SUL CALCOLO SCIENTIFICO

 iFAB  
INSTITUTO ITALIANO DI FISICA  
ALTERNATIVA E INNOVATIVA  
PER LA RICERCA E L'INDUSTRIA

 SAPIENZA  
UNIVERSITÀ DI ROMA

 INFN  
Istituto Nazionale di Fisica Nucleare

 UNIMORE  
UNIVERSITÀ DI MODENA E  
REGGIO EMILIA

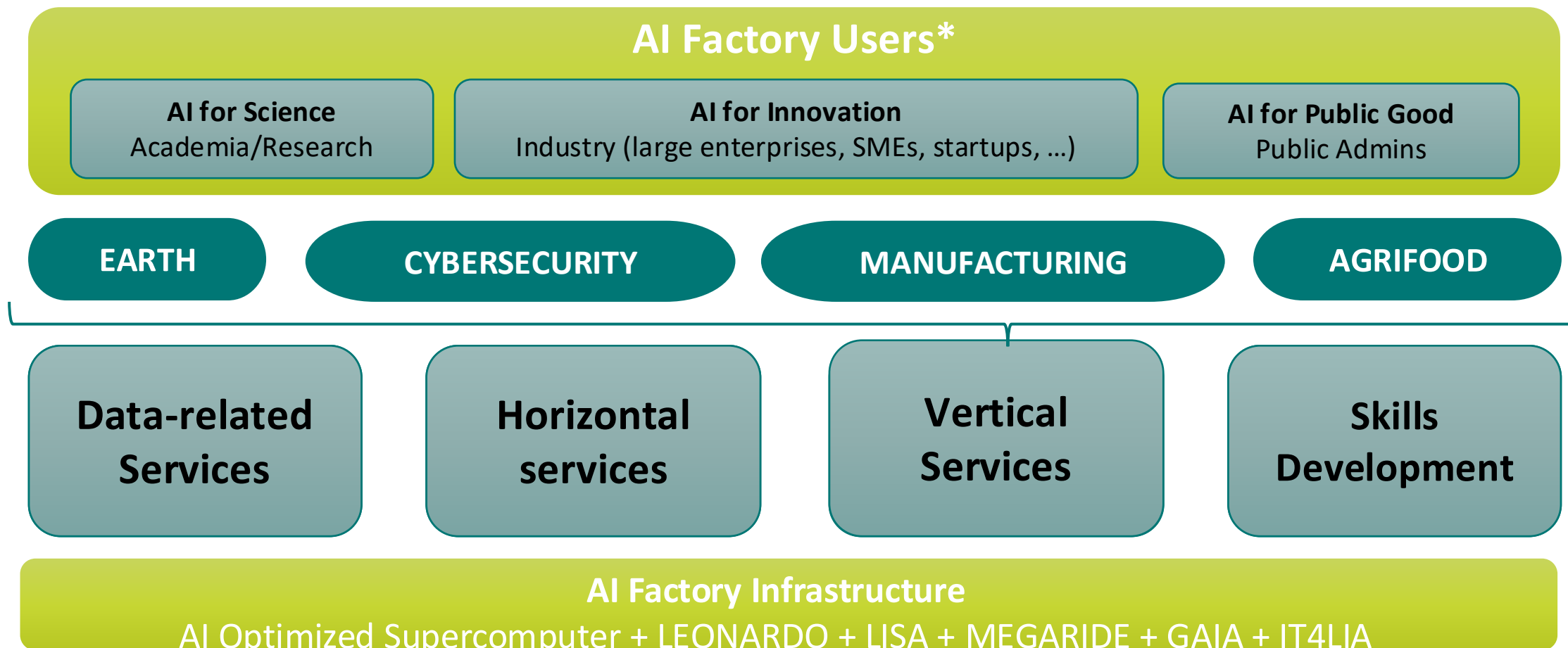
 UNIVERSITÀ  
DI TORINO

 ART-ER  
ALTERNATIVE RESEARCH  
TECHNOLOGICAL ENVIRONMENT

 CONFINDUSTRIA



# IT4LIA AI Factory



*\*In addition to a strategic focus on four key sectors, IT4LIA offers a wide range of services tailored to organisations across all industries*

# IT4LIA AI Factory — European and national calls for proposals

## 1. European calls for proposals – EuroHPC JU

### For SME e startup

#### BASIC

Fino a 5.000 ore GPU  
1-3 months

#### INTERMEDIATE

10.000–50.000 GPU/h  
1-3 months

#### ADVANCED

More than 50.000 GPU/h  
6-12 months

- A clear focus on industrial innovation
- Data and models remain the property of the beneficiary

For universities, research organisations  
and companies involved in EU projects:

80.000–360.000 GPU/h  
6 months

- The project must relate to scientific AI applications
- The need for supercomputing resources must be justified
- It must be demonstrated that the work cannot be carried out on standard computing infrastructure

## 2. Italian calls for proposals — ISCRA

For Italian SME and startup  
(Coming Soon – June '26)

#### BASIC

Up to 1.500 GPU/h

#### INTERMEDIATE

Up to 10.000 GPU/h

#### ADVANCED

Max 500.000 GPU/h

**Consultancy Package 1**  
**Services only**  
6 months

**Consultancy Package 2**  
**Services only**  
12 months

For Italian researchers and  
universities:

#### BASIC

Up to 1.000 GPU/h

#### INTERMEDIATE

1.000-10.000 GPU/h

#### ADVANCED

10.000-250.000 GPU/h

- Programme open to researchers and scientists affiliated with Italian research institutions
- The project must be realistic, have clear objectives, and demonstrate that HPC resources are necessary

# How to contact us



## Website

[www.it4lia-aifactory.eu](http://www.it4lia-aifactory.eu)

## Social

[!\[\]\(a03a7eb2f4046e1d3c76772003e549ea\_img.jpg\) IT4LIA AI Factory](#)  
[!\[\]\(844169987a590ed8c7e31d5d18950e8d\_img.jpg\) IT4LIA AI Factory](#)



Scan the QR Code

Fill in the form

Get the brochure and stay up to date with IT4LIA



The logo features a large, light blue stylized letter 'C' on a solid blue background. The word 'CINECA' is written in white, bold, uppercase letters across the center of the 'C'.

**CINECA**

**Grazie**

A decorative graphic consisting of two parallel diagonal bars. The top bar is a medium grey color, and the bottom bar is a darker blue-grey color. They are positioned on the right side of the image, overlapping the blue background and extending towards the white background.