EU-WB Policy Dialogue Stakeholder Platform

The Role of HPC and e-Infrastructures in Montenegrin development

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Outline

- What are HPC and eInfrastructures?

- Past projects in Montenegro

- Current capabilities and initiatives

- NCC Montenegro / EuroCC

- How research infrastructures can support our companies/SMEs/citizens?

HPC and eInfrastructures

- Scientific problems today are data- and compute-intensive.

- What are remote infrastructures?
  - distributed computing systems, cloud platforms, and scientific data services accessible over the internet;
  - supercomputers/HPC clusters, cloud services, storage systems, high-speed academic networks, telescopes, sensors …

- Researchers and organizations (industry, SMEs, startups) can access and use computing power, storage, and tools without owning physical machines and local supercomputers.

- Enable access to powerful tools, foster international collaboration, improve reproducibility, and reduce costs.

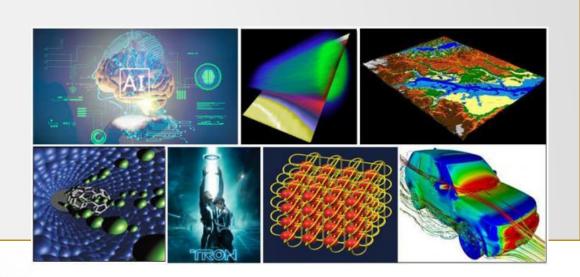# HPC and eInfrastructures

- High Performance Computing (HPC) refers to the technologies and use of supercomputers for <u>complex computational problems</u> that are <u>so demanding</u> that they <u>cannot be performed using a general-purpose computer</u>.
- Enables simulations, modeling, and data analysis that would be impossible or too slow on regular computers.
- Core Technologies:
    - Parallel Programming
    - Machine Learning, Deep Learning, NLP, LLMs...
- Key Applications:
    - Modeling & Simulations of real-world phenomena in various industries
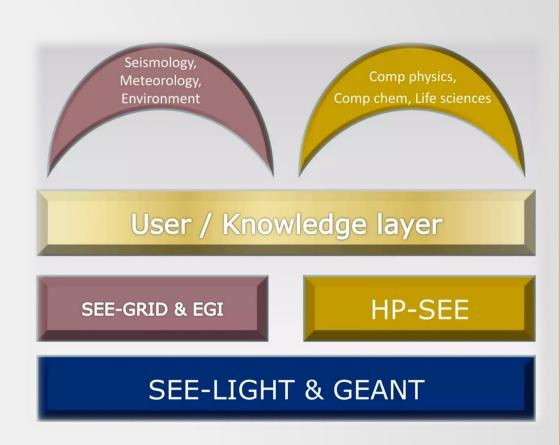   - Data Science

Applications in industry and science

- **Simulations in science:** physics and chemistry, molecular dynamics, bioinformatics, simulations of fluid dynamics, climate modeling …

- **Engineering and Manufacturing:** Aerospace Engineering, Automotive Design, Construction

- **Healthcare and Life Sciences:** Genomics, Discovery, Medical Imaging

- **Financial analysis:** Market modeling, predictions and risk management.

- **Media and Entertainment:** Rendering, Game Development, Virtual Reality,

- **Defense and Security:** Cryptography, Surveillance and Monitoring, Weapon Systems Design

- **Earth Sciences and Space Exploration**

- **AI and machine learning:** empowers analysis and training of deep learning models on large datasets.

Montenegro : past projects

- Network
  - SEEREN i SEEREN2 (FP6/7, 2002-2008)
    - MREN - Montenegrin research & education network
  - GEANT and PRACE

- eInfrastructures/Grid/HPC
  - SEE-GRID (FP6), SEE-GRID-2 i SEE-GRID-SCI (FP7) (2004–2010)
  - HP-SEE (FP7, 2010-2012)
  - SEEERA-EI (FP7)
  - VI-SEEM (H2020)
  - EGI-InSPIRE (FP7, EGI (European Grid Infrastructure))
  - NI4OS-Europe (National Initiatives for Open Science in Europe, H2020, 2019-2023)

- Areas : physics, meteorology, bioinformatics...

Montenegro : current projects

- **EuroCC/NCC Montenegro**
  - EuroCC1 (2020-2022), EuroCC2(2023-2025)
  - Academy, industry, public administration
  - UDG, UoM.
  - HPC, AI, HPDA

- **MonteDiH** :
  - Digital innovation hub for supporting the digital transformation of Montenegrin companies and the public sector, 2025-2028
  - UoM, UDG, PKCG, NTP, ICT Cortex, Tehnopolis, IMTM, CF
  - AI, BI, Cloud, Blockchain, Cybersecurity, HPC, IoT …

- **GenAI-HPC4WB, AI-AGE, HPC4S3ME, AI Fusion, AI4S3, AIMIGH, FoodDecide** …

- Some projects funded by Ministry of science , Inovaiotn fund …

EuroCC - Access to Supercomputing

- Development of **EU world class supercomputing & data infrastructure**
- **Widen the use of supercomputing** to a large number of public & private users
- Support the development of **key HPC skills** for European science and industry

- Establish/Running a network of **HPC National Competences Centers (NCCs)** in 34 European countries
- Increasing awareness and competences on HPC/HPDA/AI
- Providing supercomputing and data infrastructure to **industry, academia and public administration**

- **Development of the national HPC ecosystem**
- HPC/HPDA/AI **competence mapping & skills development**
- HPC/HPDA/AI **training courses & service portfolio**
- **HPC uptake & industry onboarding** (especially SMEs)
- **Access to EuroHPC supercomputers and expertize**

EuroCC4SEE

8

NCC Montenegro

NCC governance

- **UDG as a Leading partner** and **UoM as an Associated partner** in EuroCC2/EuroCC4SEE
- **National reference point** for HPC/HPDA/AI-related activities/ infrastructure/services
- **20+ members** focused on **HPC/HPDA/AI** awareness**,** capacity building, research excellence, technical expertize and user support.

NCC infrastructure

- **Local resources**
- **Yotta** Advanced Computing
- **EuroHPC supercomputing access** (10 supercomputers)
- **Member of GRNET consortium -** new EuroCC HPC supercomputer **DEDALUS in Greece**

NCC MNE

NCC service portfolio

- HPC/AI **academic programs, professional courses,** industry-specific/user-customized **training events**
- Developing service portfolio for **academic community** (R&D&I) and **public administration** (Digital Agenda, S3)
- Focusing on **industry uptake/SMEs, technology transfer and new business development** (Ag-Tech, Fin-Tech...)

NCC collaboration model

- **Projects cross-collaboration (>10)** for synergy effects, enhanced visibility and sustainable funding
- **NCCs cross-collaboration (>15)** for joint training and industry events, capacity building and shared expertise
- **Key MNE stakeholders productive collaboration (>20)** for private and public sector outreach and onboarding

UDG - University of Donja Gorica
UoM - University of Montenegro

S3 – Smart Specialization Strategy

HPC/HPDA/AI skills development @NCC MNE

EURO²

Academic/study programs

Professional training courses

Invited Lectures

HPC/AI @ IT IEEE conference

*Professional courses for **industry, academia and public sector** providing in-demand HPC/AI knowledge, **technical upskilling** and **supercomputing hands-on sessions**.*

- *The **first nationally accredited AI Master program***
- *Technology-centric (HPC, Python, PP, DL, Edge IoT, NLP…) training portfolio*
- *Industry-oriented (S3: energy, health, agriculture) workshops & courses*

Collaboration

FIST UDG · ETF UCG · FON UB · MAIA · ANSO · ICT Cortex · CANU · CIGRE

NCC MNE · NCC DE · NCC ESP · NCC AT · NCC SWE · NCC CY · NCC SLO · NCC TR · NCC RO · NCC NMK · NCC SRB

NCC Montengro - Industry/SME outreach and onboarding

Industry interaction

- Organizing dedicated SME events – **HPC Info Day**
- SME outreach through **AI Master program / training courses / R&D activities**
- Organizing **industry-centric workshops**, **conferences** and **networking events**
- Promoting HPC/AI benefits with **PoC, Use Cases and Success Stories**

Services & Support

- **HPC4SME assessment tool:** HPC/AI competences and maturity assessment
- **Initial & Expert consultations:** Needs assessment & Technical feasibility
- **Tailored Training Programs:** user- and domain-specific training
- **HPC Access/Deployment:** testing, parallelization, code optimization, HPDA/AI workload
- **Proof of Concept:** validation and risk minimization

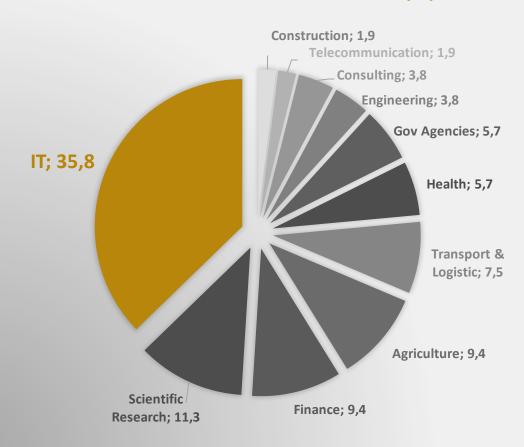**Open calls & collaborative projects**

- Collaborations on **knowledge & technology transfer** and **new business development BD**
- Inter(national) collaborative **grants, experiments, projects** and **partnerships**

HPC market research in MNE –
Industry-diversified sample

STRUCTURE OF MARKET SAMPLE (%)

Construction; 1,9
Telecommunication; 1,9
Consulting; 3,8
Engineering; 3,8
Gov Agencies; 5,7
Health; 5,7
Transport & Logistic; 7,5
Agriculture; 9,4
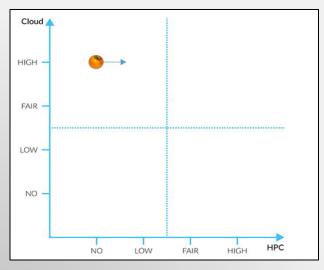Finance; 9,4
Scientific Research; 11,3
IT; 35,8

HPC4SME Automated Assessment Tool, developed by Arctur SLO, was provided to MNE NCC to be used for:

- Conducting **market research in MNE** on an **industry-diversified sample** (53 companies: 75% SME 36% IT cluster)

- **Generating self-evaluation reports for companies** to assess "if" and "how" they can benefit from HPC use

EURO²
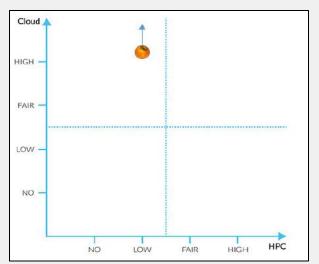
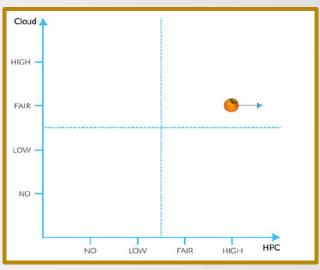# HPC market research in MNE –
SME/IT drivers of smart growth

EURO²

**53 surveyed companies
(100% market sample)**

**IT sector
(36% of market sample)**

**Active or potential HPC users
(21% of market sample)**

MAIN RESULTS:

- **High potential** to integrate **Cloud services**
- **No critical need** for **HPC computational power** for the majority of MNE companies

POTENTIAL OR ACTIVE HPC USERS

- already **use at least 16-128 cores** for simulations,
- require **time-critical simulations (<1h)**
- perform **simulations on a daily or weekly basis**
- require **>10 design reiterations** during the simulation
- measure simulations at a level of **+10,000 core hours**

NCC Montengro - HPC/AI scientific research

EURO²

HPC+ technologies

Research efforts in:
HPC, HPDA, Big Data, IoT,
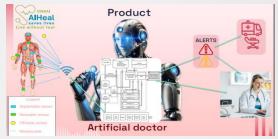AI, ML, DL, NLP, Computer Vision,

Applied domains

- ✓ Smart Agriculture,
- ✓ Smart Cities
- ✓ Energy & Sustainability,
- ✓ Healthcare & Assisted Living
- ✓ Advanced Consumer Analytics
- ✓ Precise Weather Forecasting
- ✓ Advanced Statistical Modelling
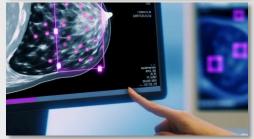- ✓ Cultural Heritage Protection

MAIN ACHIEVEMENTS : SUCCESS STORIES

NCC Montenegro success stories highlight the effective use of HPC, AI, and advanced digital technologies across various sector (*agriculture, medicine, fintech, meteorology …*) to address real-world challenges and drive innovation.
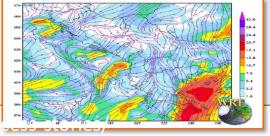
https://eurocc.udg.edu.me/success-stories/

MAIN ACHIEVEMENTS : SUCCESS STORIES

AI/ML and COMPUTER VISION POWERED BY HPC FOR SMART POULTRY FARMS

- **Monitoring chickens on large poultry farms** is labor-intensive, requiring constant attention to environmental conditions and animal well-being.
- The **HPC and AI/Deep Learning** were used to create **prediction models** that can be deployed on **Edge devices** equipped with **camera sensors** for the use in **IoT/AI solutions**
- **Reduced both manual labour costs and chicken mortality rate by 10%,** saving hundreds of thousands of Euros annually.
- **Smart agriculture solution** -enhancing the competitiveness and innovation in the commercial poultry sector.

PRECISE WEATHER FORECASTING

- **Institute for Hydrometeorology and Seismology (IHMS)** and NCC Montenegro
- **Complex terrain in Montenegro** with, the Adriatic Sea, rapid altitude change, high mountain systems, large natural and artificial lakes, and high biodiversity on a relatively small terrain.
- Dataset: 5 years (2017 to 2021), 6 stations (BR, TV, NK, PG, PV, ŽB)
- Simulations used the Weather Research and Forecasting Non-Hydrostatic Mesoscale Model (WRF-NMM), combining **advanced numerical techniques with HPC,** for studying atmospheric phenomena **with high spatial and temporal resolution**.
- precise weather forecasting/ intelligence on the localised level and through applications related to **smart agriculture, tourism activities, green energy, maritime, optimised/safe transportation, etc.**

MAIN ACHIEVEMENTS : SUCCESS STORIES

EURO²

Uhura Solutions is developing an AI platform for document-driven process automation in financial services. **The "Generative AI Intelligent Process Automation Platform - GAIPAP" project** aims at revolutionizing the financial industry through the integration of advanced AI-driven automation solutions that combine LLM, low-code development, and process automation workflows.

PAID MNE company provides **PAID-T (Price Action Intelligent Detection Trading)** - a scalable software solution for investment funds, banks, and brokers. PAID-T leverages mathematical models for statistical data processing, **price action detection algorithms**, **AI/ML and blockchain technology** to **optimize the trading experience**. **The goal is to recognize trends and determine the best time to invest**.
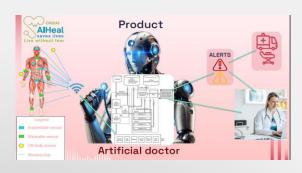
FLEKA and FIST UDG, partly funded by the Innovation Fund of Montenegro.
The development of a set **of SaaS solutions**, based on ML and data collection, enable financial institutions and other companies to significantly improve personalized banking and payment services for their clients.
ML classification algorithm based on NLP. Analyses collected data and classifies them into predefined categories (food, drinks, services …)

MAIN ACHIEVEMENTS : SUCCESS STORIES

AI HEAL

- Developed by **ONE AI** startup and supported by the Innovation Fund of Montenegro, AIHeal project **integrates sensor technologies and smart mobile devices to monitor patient health in real-time**.
- The system **enables precise diagnostics, reduces costs, and optimizes health conditions** monitoring.
- The goal is to develop a smart-phone application for monitoring different health parameters and obtaining AI advices based on the experiences of doctors across the world.

MEDICAL IMAGING: BREAST CANCER DETECTION through Image Processing and Computer Vision

- The **diagnostic landscape in mammography** calls for an innovative solution that could augment human expertise with advanced digital diagnostics.

- **Image processing techniques like CLAHE** not only elevated the visualization quality by 40% but also laid the groundwork **for sophisticated ML object detection** models to analyze mammographic images.

- This project harnessed advanced computational power, **improving the efficiency of image analysis** by 25% and significantly **reducing manual examination** time by 35%.

MAIN ACHIEVEMENTS : SUCCESS STORIES

FORECASTING DAY-AHEAD ELECTRICITY METRICS WITH ARTIFICIAL NEURAL NETWORKS

- **The day-ahead energy market** lets participants commit to buy or sell wholesale electricity one day before the operating day, to help avoid price inconsistency.
- Consumption (load) prediction models using ML are widely used in electricity production and distribution systems, power plants, markets, energy usage estimation, and other fields.
- The experiment examines the efficiency of **time-series prediction models**, based on **artificial neural network (ANN)** architectures, when given the dataset of hourly values, connected to day-ahead market of electrical energy.
- **Datasets** : the Hungarian HUPX market day-ahead price dataset and the Montenegrin dataset for load prediction.

WASCO AI

- **Advanced custom-built AI assistant** designed for enterprise applications in order to enhance and simplify everyday business operations.
- Developed by **FiveG** is an IT company specialized in 3D design, gaming, and AI-based solutions.
- Wasco AI is designed for micro, small, and medium-sized businesses aiming to improve their operational efficiency and customer experience without increasing overhead.

HPC/AI cases in Europe

- EuroCC success stories
  - https://www.eurocc-access.eu/success-stories/
- Sections :
  - IT and Software
  - Environment, Energy and Agriculture
  - Natural Sciences and Aeronautics
  - Manufacturing and Engineering
  - Finance
  - Pharmacy and Medicine
  - Traffic and Logistics
  - Public and Communication

Thanks!

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