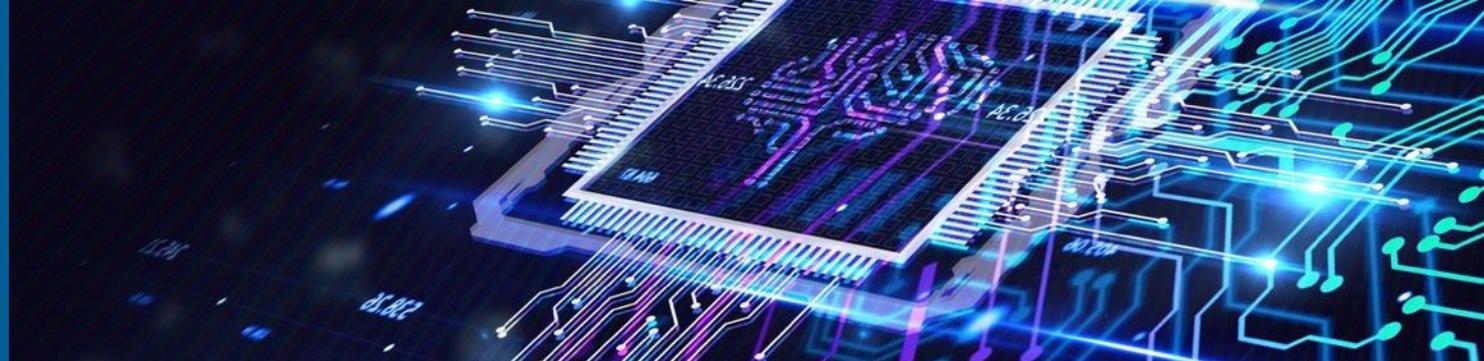




CSC

ICT Solutions for
Brilliant Minds



e-Infrastructure in Finland and collaboration in Nordic Countries

Per Öster (per.oster@csc.fi)



CSC – IT Center for Science



Non-profit special purpose company owned by the Finnish state (70%) and HEI (30%)

Volume 2023: ~89M€
Employees: 675 (28 Apr 2024)

CSC's solutions



Computing and software



Data management and analytics for research



Support and training for research



Research administration



Solutions for managing and organizing education



Solutions for learners and teachers



Solutions for educational and teaching cooperation



Hosting services tailored to customers' needs



Identity and authorisation



Management and use of data



ICT platforms, FUNET network and data center functions

- Countries which have signed the EuroHPC Declaration
- LUMI Consortium countries

LUMI

CSC Datacenter in Kajaani

- **World's #3 supercomputer**
- Hosted by CSC
- Consortium of EC (EuroHPC JU) and 11 EU countries
- Resource for whole ERA including industry

National Computing Services



- **High-performance computing: Puhti and Mahti**

- **Puhti** – BullSequana X4,00 Cluster with
 - 682 Intel Cascade Lake CPU nodes, 1.8 Pflop/s
 - 80 Nvidia Volta V100 GPU nodes, 2.7 Pflop/s
- **Mahti** – Bull Sequana XH2000 with
 - 1404 AMD AMD Rome CPUs nodes, 7.5 Pflop/s
 - 24 Nvidia Ampere A100 GPU nodes, 2.0 Pflop/s
- SSH and www-interfaces

- **Cloud services**

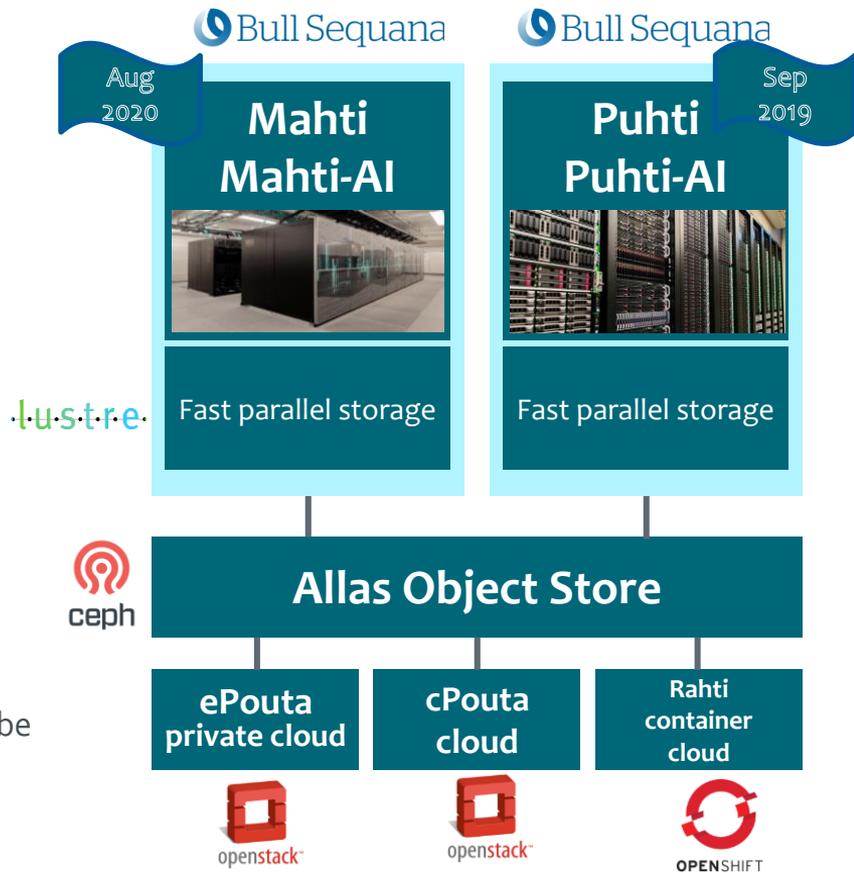
- cPouta, ePouta and Rahti

- **Object store: Allas**

- Service for all of computing and cloud services, data can be shared to Internet – 12 PiB

- **Kvasi – Quantum Learning Machine**

- Quantum computing simulator



The web interface has been updated to release 19. Visit <https://docs.csc.fi/support/wn/comp-new/> to see what's new.

The desktop icons in the Desktop app have been changed. To ensure that the Desktop apps work properly, please use the *Reset desktop icons* checkbox in the app launch form as they are not automatically overwritten.

Pinned Apps

 Home Directory	 Disk quotas	 Cloud storage configuration	 Compute node shell	 Login node shell
 Accelerated Visualization	 Desktop	 Jupyter	 Jupyter for courses	 Julia-Jupyter
 MATLAB	 RStudio	 TensorBoard	 MLflow	 Visual Studio Code

Notifications

QUOTA WARNING FOR /PROJAPPL/PROJECT_2001659 Hide

▲ Using 96.9 GB of quota 100 GB 96%

QUOTA WARNING FOR /SCRATCH/PROJECT_2001659 Hide

▲ Using 7.65 TB of quota 8 TB 95%

Services for Research Service Catalogue



Compute and analyze

Chipster

Chipster is a user-friendly bioinformatics software that offers access to hundreds of analysis tools for data.

[Read more](#)

ePouta

ePouta is a virtual private cloud service that is specifically meant for processing sensitive data.

[Read more](#)

LUMI

LUMI is one of the most competitive supercomputers in the world.

[Read more](#)

Puhti

Puhti is a supercomputer meant for a wide range of use cases from data analysis to medium scale simulations.

[Read more](#)

cPouta

cPouta is a community cloud service which allows you to quickly deploy self-administrated infrastructure.

[Read more](#)

Kaivos

Kaivos is a relational database service. It allows you to use your own MariaDB databases in CSC's computing environment.

[Read more](#)

Mahti

Mahti is a supercomputer which is particularly geared towards medium to large scale simulations.

[Read more](#)

Rahti

Rahti is a container cloud service that provides a platform for you to host your own applications.

[Read more](#)

Elmer

Elmer offers a wide range of methods and techniques for the computational modeling of physical phenomena.

[Read more](#)

Kvasi

Kvasi is a quantum computing simulator with which you can learn to use and develop new quantum algorithms.

[Read more](#)

Notebooks

Notebooks is a cloud platform that provides easy-to-use environments for programming and working with data.

[Read more](#)

Sensitive Data Desktop

Sensitive Data Desktop (SD Desktop) provides secure access to the CSC ePouta service through a web browser, running locally on a user's own computer.

[Read more](#)

Discover and reuse data

EUDAT Services

EUDAT provides a set of integrated services for different stages of the data management lifecycle.

[Read more](#)

The Language Bank of Finland

The Language Bank is a service for using language resources. It contains text and speech corpora and tools for studying them.

[Read more](#)

Sensitive Data Apply

Sensitive Data Apply (SD Apply) is a service for data controllers to manage data access permissions on their datasets stored as part of the Federated European Genome-phenome Archive (FEGA) or SD Submit.

[Read more](#)

Store and share data during a project

Allas

Allas is a general purpose data storage server that provides an environment for storing and sharing data.

[Read more](#)

Pukki

Pukki is a database cloud service that allows you to quickly deploy dedicated databases.

[Read more](#)

EUDAT Services

EUDAT provides a set of integrated services for different stages of the data management lifecycle.

[Read more](#)

Sensitive Data Connect

Sensitive Data Connect (SD Connect) provides a simple user interface for storing and sharing encrypted sensitive data.

[Read more](#)

Fairdata Services

With Fairdata services you can store, share, describe, and publish your research data with easy-to-use web tools.

[Read more](#)

Paituli

Paituli is a spatial data download service. It provides datasets and their historical versions.

[Read more](#)

Federated European Genome-phenome Archive

FEGA is a service for storing and sharing biomedical data.

[Read more](#)

Research Information Hub

Research Information Hub service portal gathers and shares information on scientific research carried out in Finland.

[Read more](#)

Funet FileSender

Funet FileSender is a file sharing service for sending large attachment files.

[Read more](#)

Publish and preserve data

Digital Preservation Service

DPS guarantees the digital preservation of research data from several decades to centuries.

[Read more](#)

EUDAT Services

EUDAT provides a set of integrated services for different stages of the data management lifecycle.

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Fairdata Services

With Fairdata services you can store, share, describe, and publish your research data with easy-to-use web tools.

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Federated European Genome-phenome Archive

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[Read more](#)

Paituli

Paituli is a spatial data download service. It provides datasets and their historical versions.

[Read more](#)

Fairdata IDA

Fairdata IDA allows you to store research data, which can then be published with other Fairdata services.

[Read more](#)

The Language Bank of Finland

The Language Bank is a service for using language resources. It contains text and speech corpora and tools for studying them.

[Read more](#)

<https://research.csc.fi/service-catalog>

- Landing page
- Overview
- Organization
- Projects
- LUMI
- Fairdata IDA
- Sensitive Data
- Software usage
- Storage usage
- Custom Report
- Reporting Page
- KTPO Reporting
- Documentation
- Contact us

Cloud computing

Rahti
8.57 M

Rahti2
446.1 K

ePouta
91.86 M

cPouta
68.33 M

SD Desktop
3.24 M

HPC computing

Mahti
323.29 M

Puhti
166.34 M

LUMI
50.49 GPU
1.16 CPU
759686 QPU

Storage

Allas
20.29 M

Mahti Lustre
17.02 M

Puhti Lustre
24.35 M

Shared Fileservice
13.56 M

Fairdata IDA
1355.2 TiB

11714 users

3643 open projects

3956 total

Annual usage statistics by service

Variable

billing units

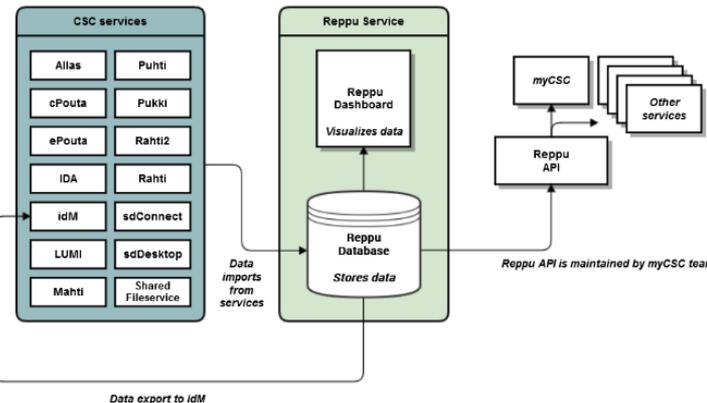
Service

Puhti, Mahti, Allas, cPouta, ePouta, Rahti, SD desktp

Snapshot April 2024
National resources: Billing Units
Lumi: Million hours

Reppu Service

Resource Usage Follow-up and Statistics Service



Roadmap for Finnish Research Infrastructures 2021–2024



Update of RI roadmap ongoing

Finland's national roadmap research infrastructures		Finland's memberships in international research infrastructures
Research infrastructure	Abbreviation	
Biosciences and health		
Biobanking and Biomolecular Resources Research Infrastructure of Finland	BBMRI.fi	BBMRI-ERIC
Biocenter Finland	BF	EATRIS
European Life-Science Infrastructure for Biological Information	ELIXIR Finland	ELIXIR
Euro-BiImaging: Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	EuBI-Fi	EMBL sis. EMBC
European Infrastructure of Screening Platforms for Chemical Biology	EU-OS FI	EU-OPENSREEN
Integrated Structural Biology Infrastructure	FinStruct	Euro-BiImaging
		INFRAFRONTIER
		Instruct-ERIC
Data and computational sciences		
CSC's Research Infrastructure Services	CSC	EuroHPC JU
Partnership for Advanced Computing in Europe	EuroHPC/PRACE Finland	IML
Finnish Computing Competence Infrastructure	FCCI	NeIC
Finnish Quantum Computing Infrastructure	FIQCI	PRACE
Research Infrastructure for Future Wireless Communication Networks	FUWIRI	
Physical sciences, engineering and energy		
ALD center Finland	ALD center Finland	CERN
Bioeconomy Infrastructure	BIOECONOMY RI	EFDA-JET
Finnish National Infrastructure for Light-Based Technologies	FinnLight	ESA
Accelerator Laboratory of the University of Jyväskylä	JYFL-ACCLAB	ESO
Otaniemi Micro- and Nanotechnology Research Infrastructure	OtaNano	ESRF
Printed Intelligence Infrastructure	PII	FAIR
RawMATTERS Finland Infrastructure	RAMI	ITER
		JHR MTR
		MAX IV
Social sciences and humanities		
European Social Survey (ESS)	ESS Finland	CESSDA
Common Language Resources and Technology Infrastructure	FIN-CLARIAH	CLARIN
Finnish Research Infrastructure for Population Based Surveys	FIRI-PBS	ESS
Finnish Infrastructure for Public Opinion	FIRIPO	
Finnish Social Science Data Archive & CESSDA ERIC's Finnish Service Provider	FSD	
Environmental sciences		
Earth-space research ecosystem	E2S	EISCAT (+3D)
Finnish Biodiversity Information Facility	FinBIF	EURO-ARGO ERIC
European Plate Observing System	FIN-EPOS	GBIF
Finnish Marine Research Infrastructure	FINMARI	ICDP
Integrated Atmospheric and Earth System Science Research Infrastructure	INAR RI	ICOS
Measuring Spatiotemporal Changes in Forest Ecosystem	Scan4est	IODP



NORDIC E-INFRASTRUCTURE COLLABORATION

European flagship
supercomputer

LUMI

Unique HPC
Ecosystem



www.lumi-supercomputer.eu #lumisupercomputer #lumieurohpc

LUMI is an HPE Cray EX Supercomputer

LUMI



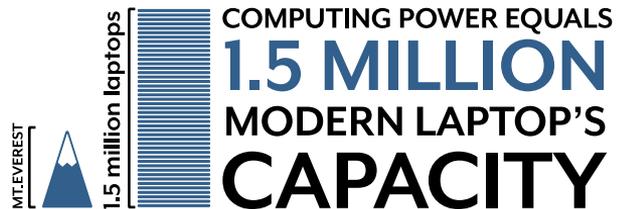

**Hewlett Packard
Enterprise**

LUMI is one of the fastest supercomputers in the world **LUMI**

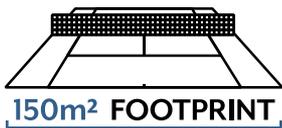
SUSTAINED PERFORMANCE

380 PETAFLP/S

= performs 380×10^{15} calculations per second



2 x



High-
performance
computing

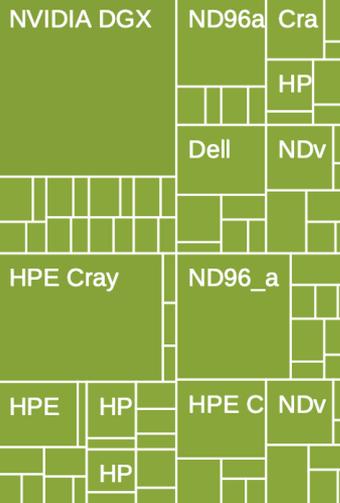
AI

Data
analytics

[+] NA

HPE Cray EX235a, AMD Optimized 3rd G

#1 Frontier

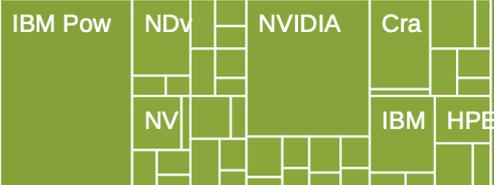


HPE Cray EX - Intel Exascale

#2 Aurora

Microsoft NDv5, Xeon Platinu

#3 Eagle



#7 Summit



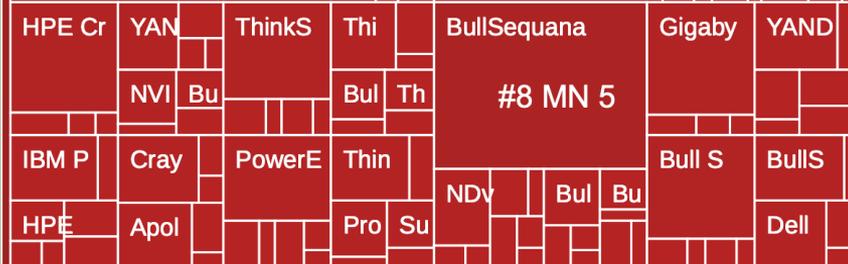
[+] EU

HPE Cray EX235a, AMD

#5 Lumi

BullSequana X

#6 Leonardo

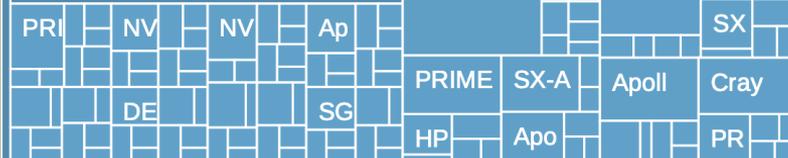


[+] AS

Supercomputer Fugaku,

#4 Fugako

Sunway MPP,



[+]

[+]

Modern architecture

LUMI-C:
x86 Partition
Supplementary CPU partition:
over **262,000**
AMD EPYC CPU cores.



LUMI-K:
Container Cloud Service



LUMI-O:
Object Storage Service
30 PB
encrypted object storage
(Ceph) for storing, sharing
and staging data.



LUMI-Q:
Quantum Computing



High-speed interconnect

Possibility for combining
different resources within
a single run. HPE
Slingshot technology.



LUMI-G:
GPU Partition

Sustained performance
380
Pflop/s powered by AMD
Radeon Instinct™ MI250X GPUs.



LUMI-D:
Data Analytics Partition
Interactive partition with
32 TB

of memory and graphics GPUs for
data analytics and visualization.



LUMI-F:
Accelerated Storage

10 PB
Flash-based storage layer with
extreme I/O bandwidth of
2 TB/s and IOPS capability.



LUMI-P:
Lustre Storage

80 PB
parallel file system.



LUMI

Accelerated Computing with Quantum HPC + Quantum Computing

LUMI-Q

Finland's prime minister Sanna Marin and European Commission president Ursula von der Leyen inspect the inside of Helmi in October 2021. Photo: © Laura Kotila/Prime Minister's Office

LUMI-Q

-  LUMI-Q consortium
-  LUMI consortium
-  LUMI-Q quantum computer
-  quantum computer
-  supercomputer

Inclusive

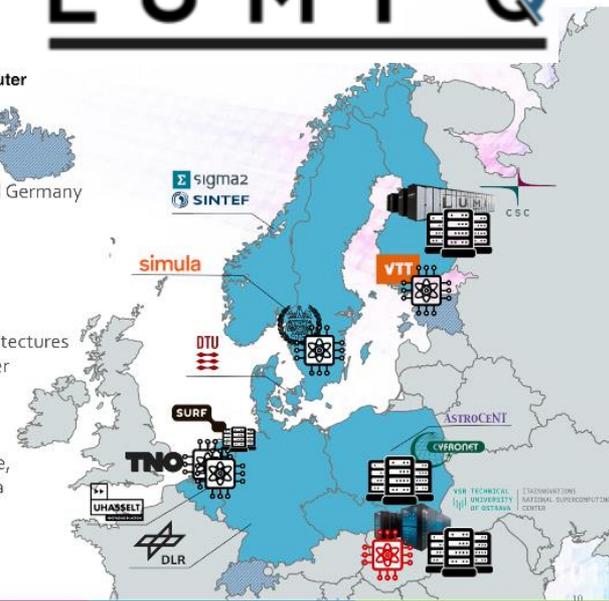
- Builds on the 10-country pan-European LUMI consortium + The Netherlands and Germany

Diverse

- Getting several QCs to the fingertips of researchers and developers is crucial for catalysing software development.
- Different problems will fit different architectures and software stack infrastructure better

Accessible

- By being available through several platforms distributed throughout Europe, LUMI-Q provides a familiar interface to a uniquely large user base

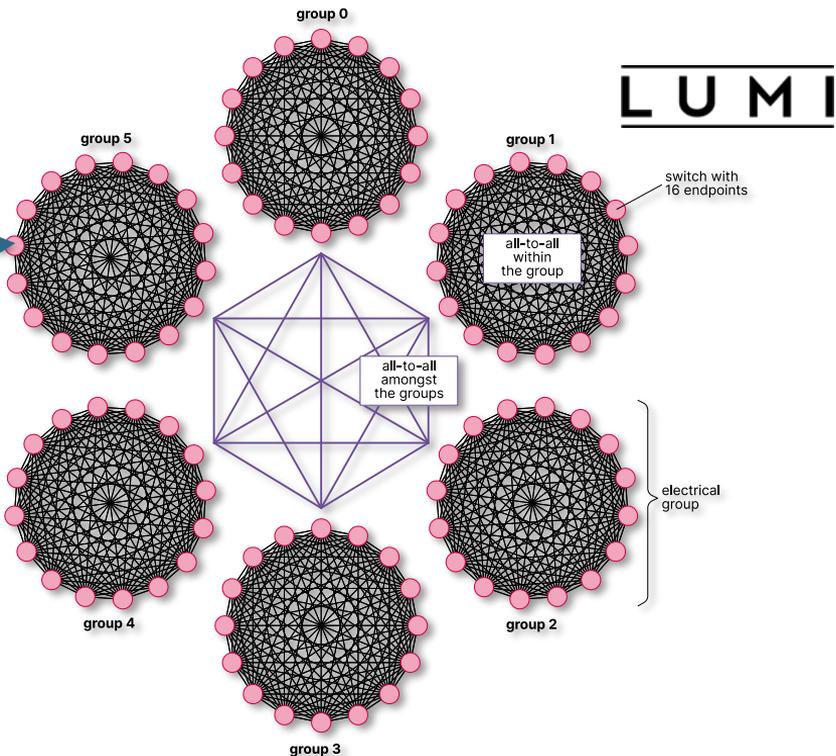
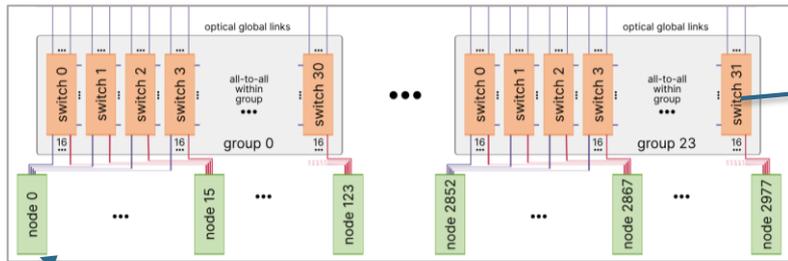


LUMI



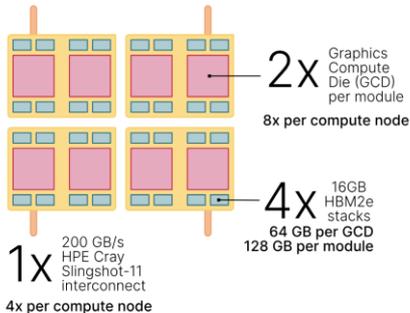
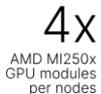
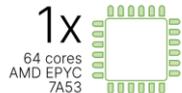
A Supercomputer is many layers of complexity

LUMI-G (the GPU Partition of 380 PFlop/s)



LUMI

2978x compute nodes



But it is "worse", LUMI has 24 groups each of 124 nodes*

*except one group with 126 nodes ($23 \times 124 + 126 = 2978$)

LUMI-G:
GPU Partition
Sustained performance
380
PFlop/s powered by AMD
Radeon Instinct™ MI250X GPUs.

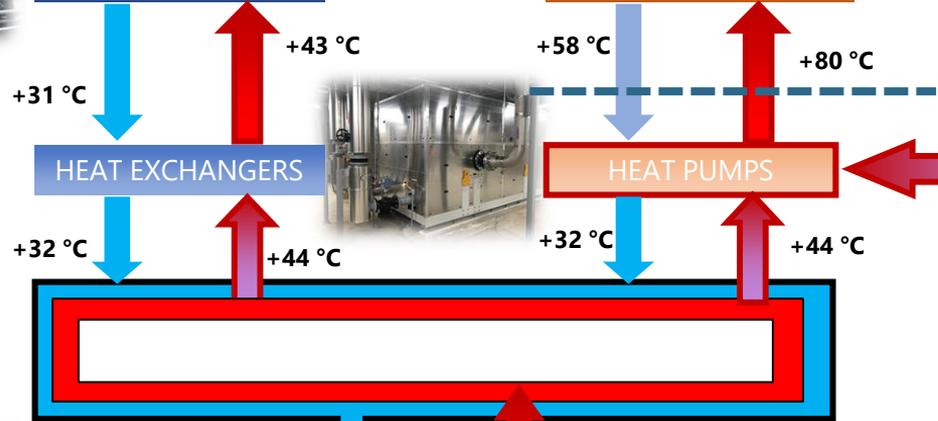
LUMI: Excess Heat Utilization Process Overview



DRY AIR COOLING FOR BACK UP
~ 10 MW

57% of energy is reused

DISTRICT HEATING NETWORKS ~ 10 MW
-Renforsin Ranta Business Park
-CITY of Kajaani



Metric	LUMI (values from 2023)
Free cooling PUE	<1.05
PUE with heat re-use	1.31
Heat re-use COP	4
ERE	0.52
ERF	0.57 = 57%
Annual heat production	26,7 GWh
Reduced CO2 emission	~ 2895 CO2 tonnes *
Source of electricity	100% hydroelectric power



HPC load

In addition of Direct Liquid Cooling there is approximately 1 MW of capacity for the air-cooled servers (e.g. storage and management servers).

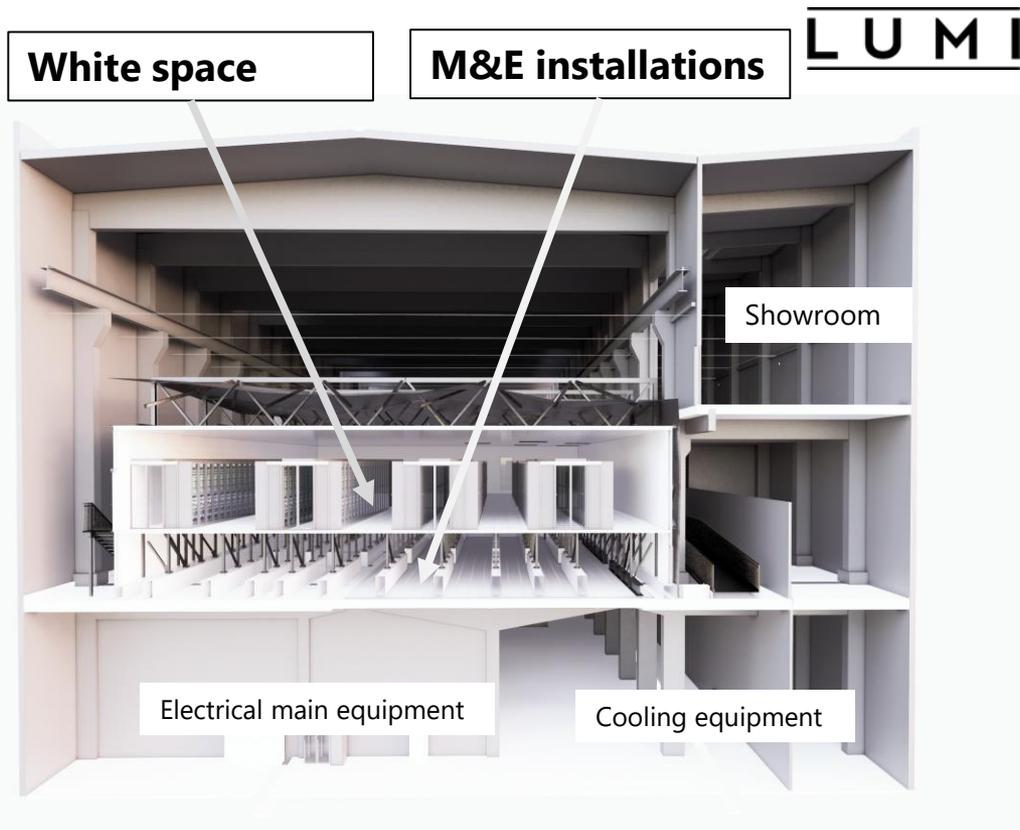
LUMI data center

LUMI facility overview

- 5800m² in three floors
- 800m² whitespace for IT devices
- Power capacity 15MW at full buildout
- 14 000m² free space for future expansions

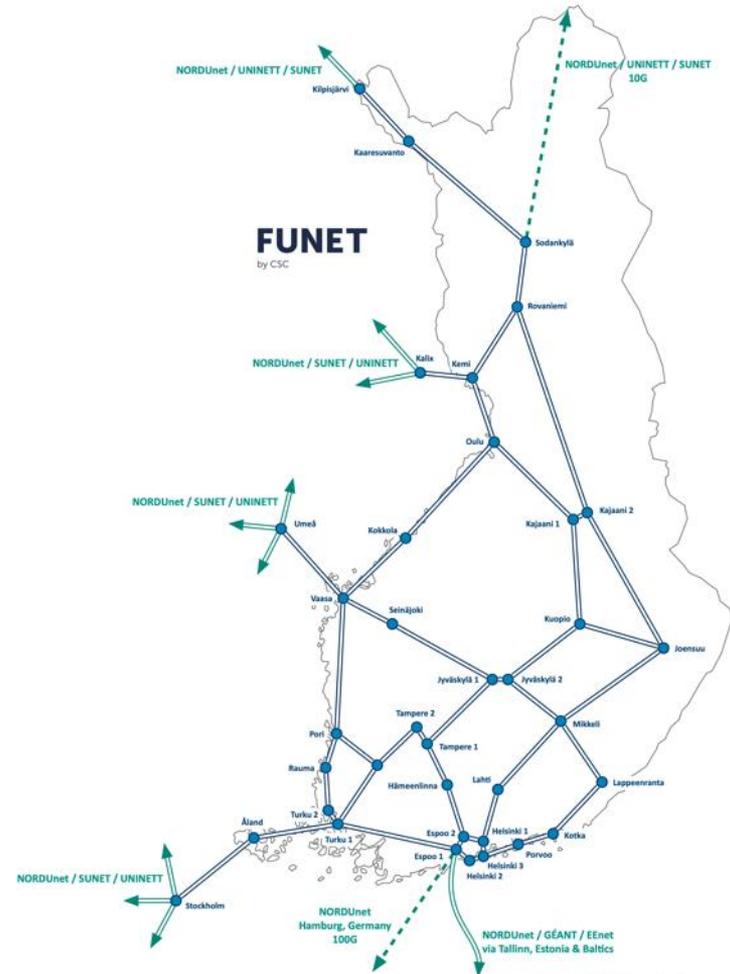
Data center cooling

- Mechanical cooling with 3 heat pumps with 7.2MW total cooling capacity and 9MW of total heating capacity
- Free cooling, total capacity 10MW
- Air cooling installed capacity 1MW with N+1 redundancy
- 17°C inlet to CRAH units in whitespace
- Free cooling on chillers >15°C outside temperature

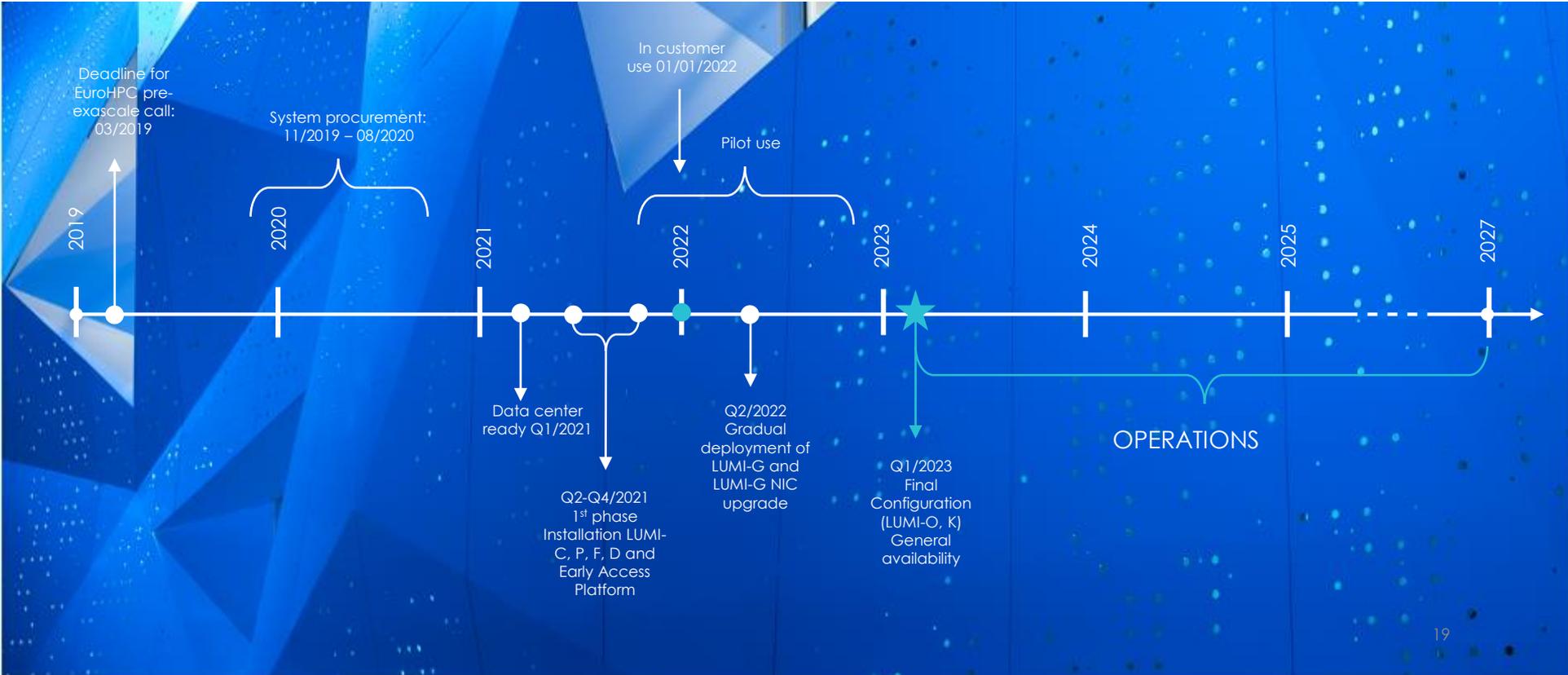


The reliable high-speed data communications networks of the data center are designed specifically for HPC

- LUMI research infrastructure is a **direct part of the Nordic backbone**
- Scalability for multi-terabit transmission needs already today, and readiness for future transmission technologies
- The Funet 2020 network supports the EuroHPC installation perfectly **without a need for additional investments**
- The next-generation NORDUnet connects the Kajaani LUMI site to GÉANT, ensuring European-wide availability of any HPC resources installed in Kajaani



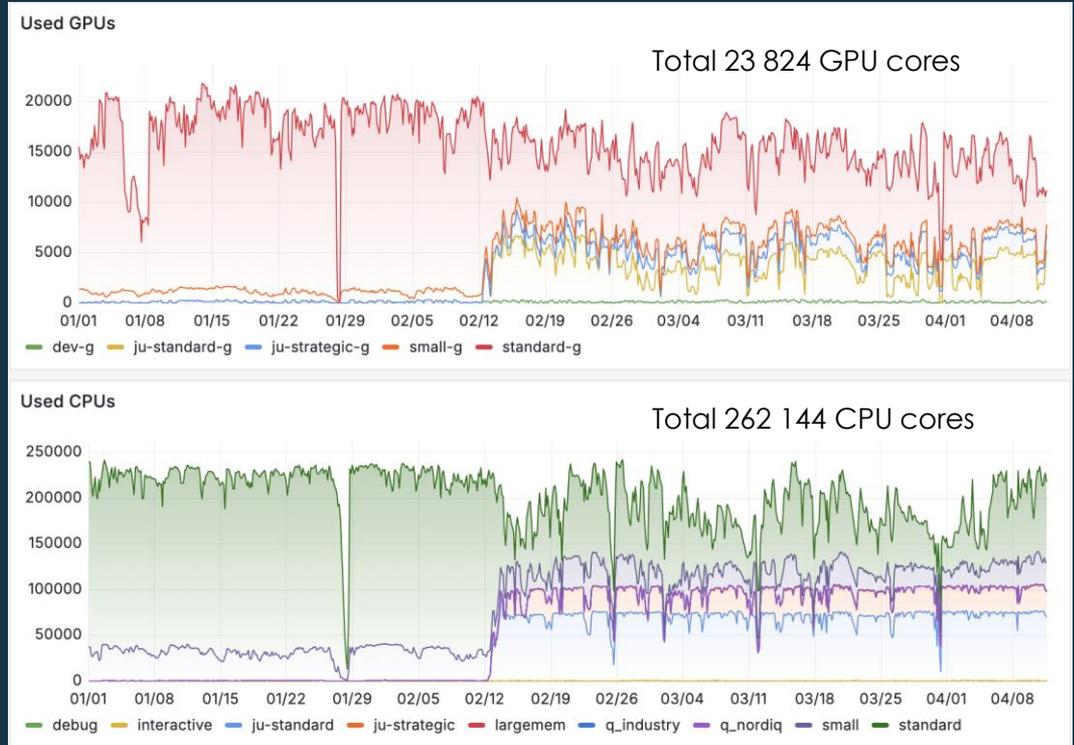
LUMI timeline



Key Numbers for LUMI as of “Today” April 11 Production during 2024

3462 Users consumed:

- 45.33 M GPUh
- 1.05 M CPUh
- 747207 QPU seconds

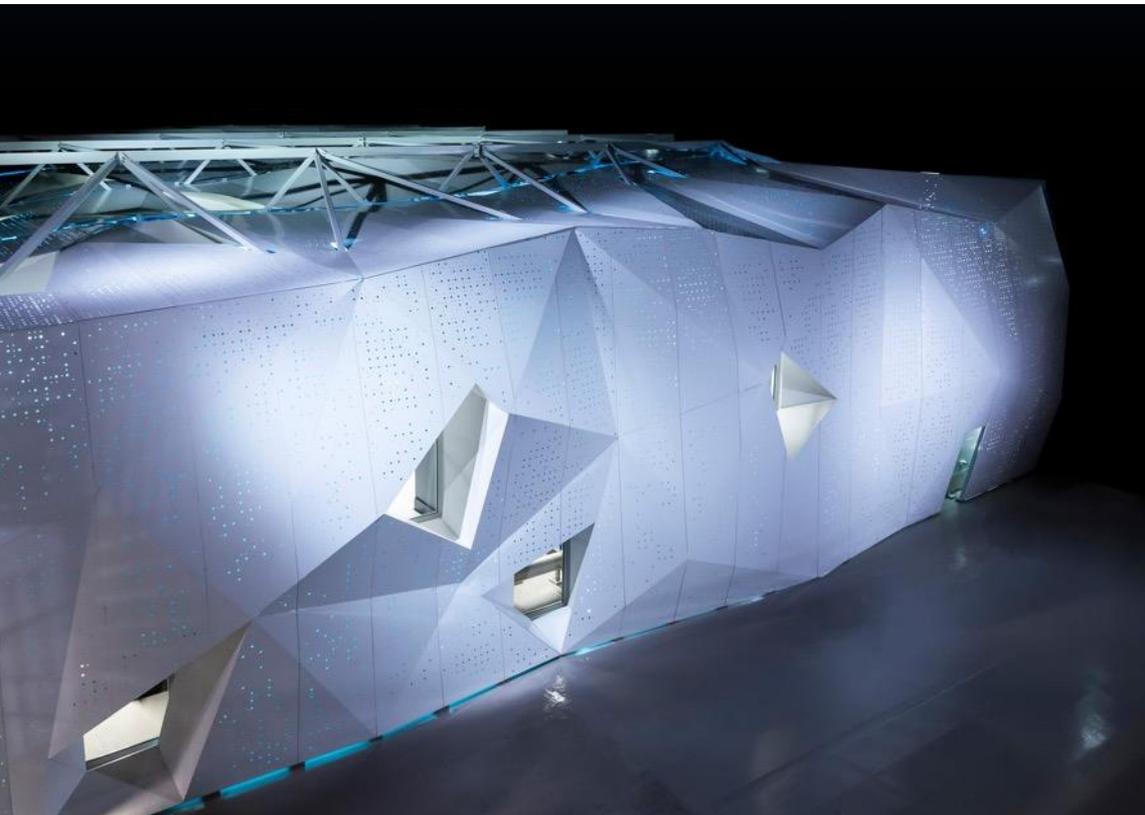


Enabling top research and scientific breakthroughs



EuroHPC
Joint Undertaking

LUMI



LUMI supercomputer is the first co-investment ever of this scale in scientific computing.

The total budget of the EuroHPC pre-exascale system in CSC's data center in Kajaani is over 202 million Euros. Half of this funding comes from the EU and the other half from the consortium countries.

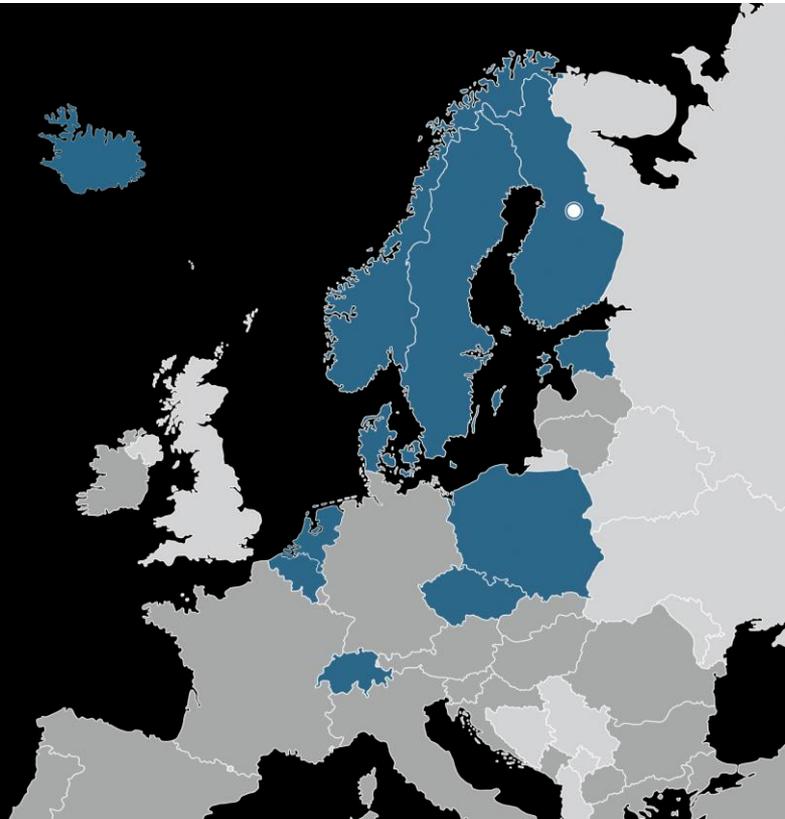


EuroHPC
Joint Undertaking

LUMI

A unique collaboration between eleven LUMI consortium countries and the EU to build and operate a world-class supercomputer.

LUMI research infrastructure provides a high-quality, cost-efficient and environmentally sustainable HPC ecosystem based on true European collaboration.





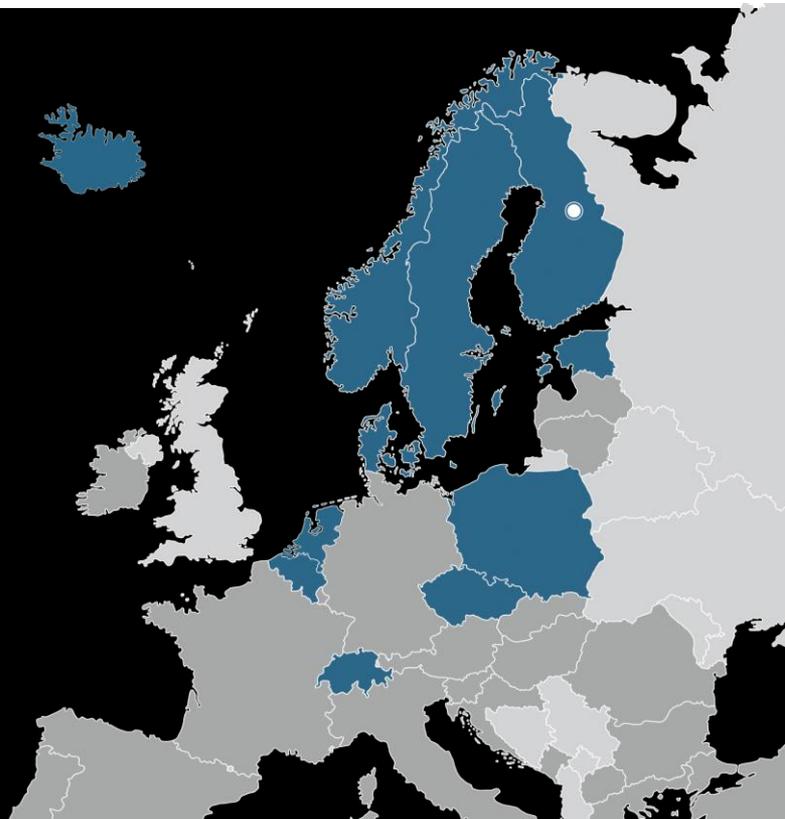
EuroHPC
Joint Undertaking

LUMI

The consortium continues a solid tradition of collaboration in HPC training and education, user support and data management services.

The resources of LUMI will be allocated per the investments. The share of the EuroHPC JU (50%) will be allocated by a peer-review process and available for all European researchers.

www.lumi-supercomputer.eu/get-started/





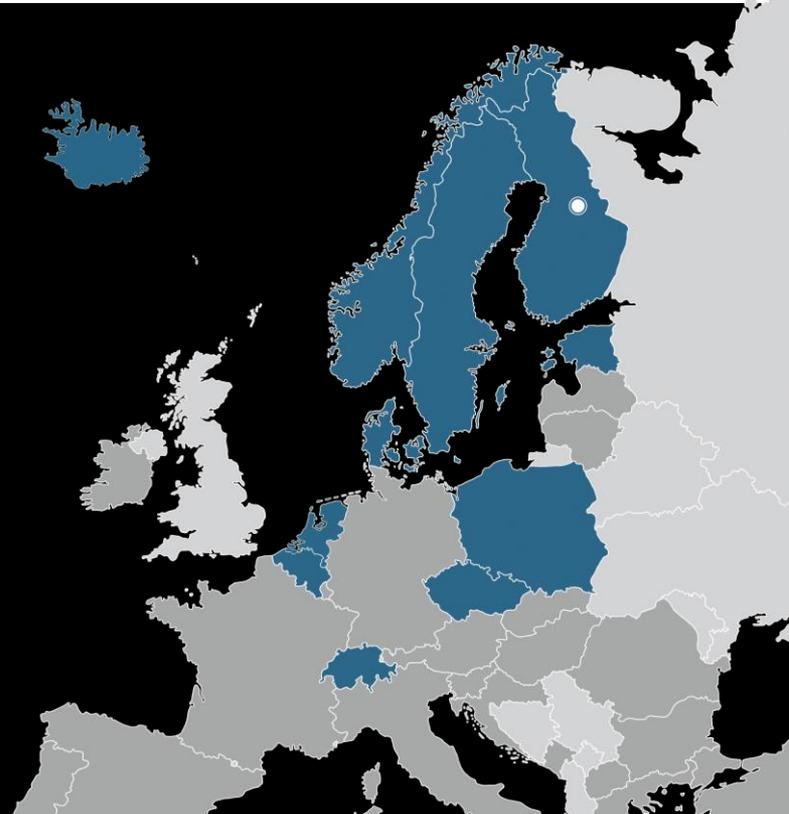
EuroHPC
Joint Undertaking

LUMI

LUMI supercomputer is hosted by the LUMI consortium. LUMI is located in CSC's data center in Kajaani, Finland.

CSC – IT Center for Science is a Finnish center of expertise in information technology owned by the Finnish state and higher education institutions.

CSC provides internationally high-quality ICT expert services for higher education institutions, research institutes, culture, public administration and enterprises.

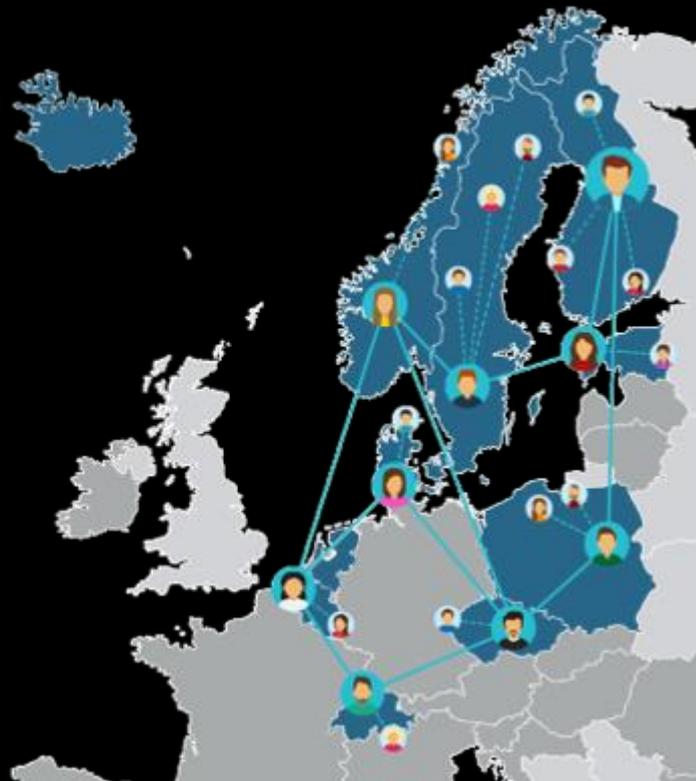


LUMI User Support



LUMI User Support and a centralized help-desk by the distributed LUMI User Support Team

- The model is based on a network of dedicated LUMI experts: each partner provides one full-time person for the task
- User Support Team also provides end-user training, maintain the software portfolio and user documentation of the system



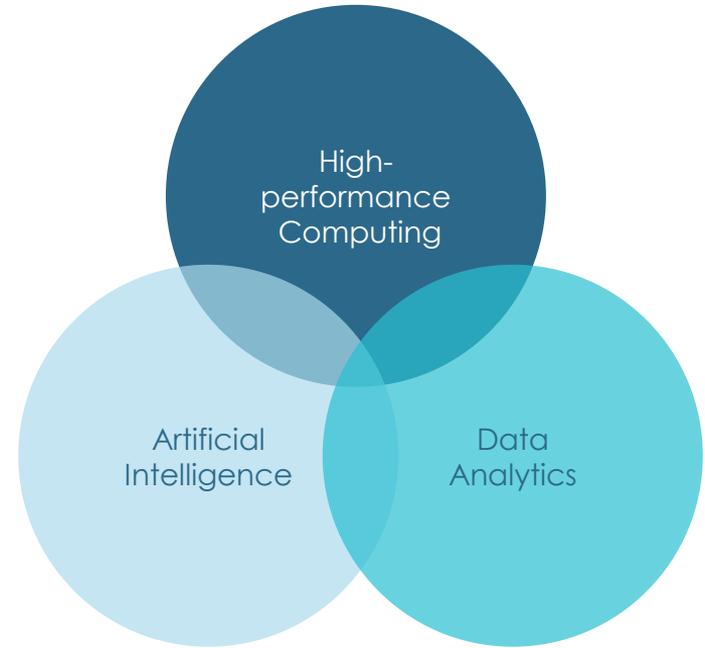


LUMI

Boosts European competence and
business to the next level



The convergence of High-performance Computing, Artificial Intelligence and Data Analytics will be key for solving the great scientific and societal challenges.





Up to 20%

of LUMI's capacity
is reserved for
European industry
and SMEs

LUMI

- **To boost innovation and new data-driven business** in areas such as platform economy and AI.
- LUMI world-class computing resources **brings European RDI to the next level**
- Unparalleled computing and data management capacities for researchers in academia both and industry **opens up possibilities to address novel research questions**
- LUMI research infrastructure **positions Europe as one of the global leaders in supercomputing**



Destination Earth key dates

2022

Launch of Destination Earth (DestinE) initiative.

2024

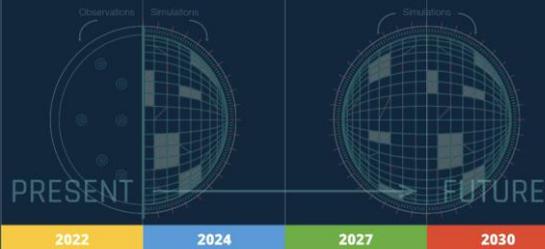
Demonstration of open core digital platform and the first two digital twins: weather-induced extremes and climate change adaptation.

2027

Completion of the core platform, the first two digital twins and integration of additional digital twins.

2030

A full digital replica of the Earth through the convergence of the digital twins available.



CLIMATE CHANGE

How will living conditions change when the climate is warming?



Life Sciences

Advanced computing plays a key role in all levels of modern medicine and health, and will have tremendous impact for personalised medicine.

Researchers are already able to rapidly identify genetic disease variants, and it will become possible to identify diseases that are caused by combinations of variants, with treatments and drugs tailored both to the individual patient and the exact state of the disease.



TIME CRITICAL MODELLING

Fast-track for urgent computing needs in time- and mission-critical simulations, e.g., related to national or EU threat or other major crisis, e.g., pandemics.



ARTIFICIAL INTELLIGENCE

LUMI is a one of the worlds leading research platforms for AI.

LUMI enables the convergence of high-performance computing, artificial intelligence, and high-performance data analytics.



LUMI



Poro 34B Model Card

Poro is a 34B parameter decoder-only transformer pretrained on Finnish, English and code. It is being trained on 1 trillion tokens. Poro is a fully open source model and is made available under the Apache 2.0 License.

Poro was created in a collaboration between [SiloGen](#) from [Silo AI](#), the [TurkuNLP group](#) of the University of Turku, and [High Performance Language Technologies \(HPLT\)](#). Training was conducted on the [LUMI supercomputer](#), using compute resources generously provided by [CSC](#) - IT Center for Science, Finland.

Promoting the European Green Deal

A vibrant data center ecosystem in Kajaani



Award-winning LUMI data center



What makes LUMI a success story?

LUMI



Collaboration



Sustainable future



Societal impact

LUMI



Per Öster

Director, Advanced Computing Facility

CSC – IT Center for Science

Per.Oster@csc.fi

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www.lumi-supercomputer.eu

contact@lumi-supercomputer.eu



EuroHPC
Joint Undertaking



The acquisition and operation of the EuroHPC supercomputer is funded jointly by the EuroHPC Joint Undertaking, through the European Union's Connecting Europe Facility and the Horizon 2020 research and innovation programme, as well as the Participating States FI, BE, CH, CZ, DK, EE, IS, NL, NO, PL, SE.

Leverage from
the EU
2014–2020

