LUMI

LUMI – the pre-exascale supercomputer in the North

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Outline

- LUMI - story so far
- LUMI capabilities

The EuroHPC Initiative

- The **EuroHPC Joint Undertaking** pools EU and national resources in high-performance computing (HPC) to
  - acquire and provide **world-class supercomputing and data infrastuctures**
  - support ambitious **research and innovation agenda**
- The EuroHPC declaration has been signed by **32 European countries**
- The first generation of EuroHPC systems announced in June 2019
  - 3 pre-exascale systems to Finland, Italy and Spain
  - 5 petascale systems to Czech Republic, Bulgaria, Luxembourg, Portugal and Slovenia

LUMI Consortium

- LUMI supercomputer has been funded jointly by EuroHPC JU and LUMI consortium
- LUMI consortium includes 10 countries with strong national HPC centers
- The resources of LUMI will be allocated per the investments
- The share of the EuroHPC JU (50%) will be available for all European researchers
- The shares of the LUMI partner countries will be allocated by local considerations and policies

Countries which have signed the EuroHPC Declaration

LUMI Consortium countries

CSC Datacenter in Kajaani

LUMI: one of the fastest supercomputers in the world

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- LUMI is an **HPE Cray EX** supercomputer manufactured by **Hewlett Packard Enterprise**

- HPL performance over **375 petaflop/s** makes the system one of the world's fastest
  - Partial system listed 05/22 with 152 Pflop/s, #3 Top500
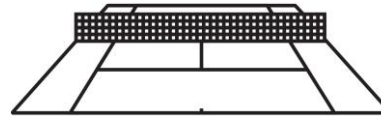
    #3 also in Green500 and HPCG

1 system

375 Pflop/s

Sustained performance

Computing power equivalent to

1 500 000

Modern laptop computers

Size of two tennis courts

Modern platform for

High-performance computing, Artificial intelligence, Data analytics

Based on GPU technology

Enabler of world-class scientific breakthroughs

LUMI is designed as a 'Swiss army knife' targeted for **a wide spectrum of use cases and user communities**.

- **Climate research:** More precise climate models and the interconnection of different climate models – Digital Twins of Earth

- **Data science**: analyzing and re-analyzing large data sets (simulated and measured) e.g. in atmospheric science, environmental science, climate modelling, material science and linguistics.

- **Plasma physics**: Predicting and preparing for the societal effects of extreme space weather events. Multi-scale modeling of fusion reactors.

- **Life sciences:** enabling calculation of protein function, structural protein-protein interactions.

- **Materials science:** quantum-mechanical simulations with global impact are development of better energy storage materials, more efficient solar cells, and better catalyst materials.

- **Humanities and social sciences:** Natural language processing. Large-scale data analytics from social networks and the modelling of complex societal phenomena.

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

LUMI Datacenter in Kajaani

100% hydroelectric energy up to 200 MW

Very reliable power grid: Only one 2 min outage in 38 years

100% free cooling available, PUE 1.03

Waste heat reuse: effective energy price 35 €/MWh,
negative CO_2 footprint: 13500 tons reduced every year

Extreme connectivity: Kajaani DC is a direct part of the Nordic backbone.
4x100 Gbit/s to GÉANT in place, can be easily scaled up to multi-terabit level

Elevated security standards guaranteed by ISO27001 compliancy
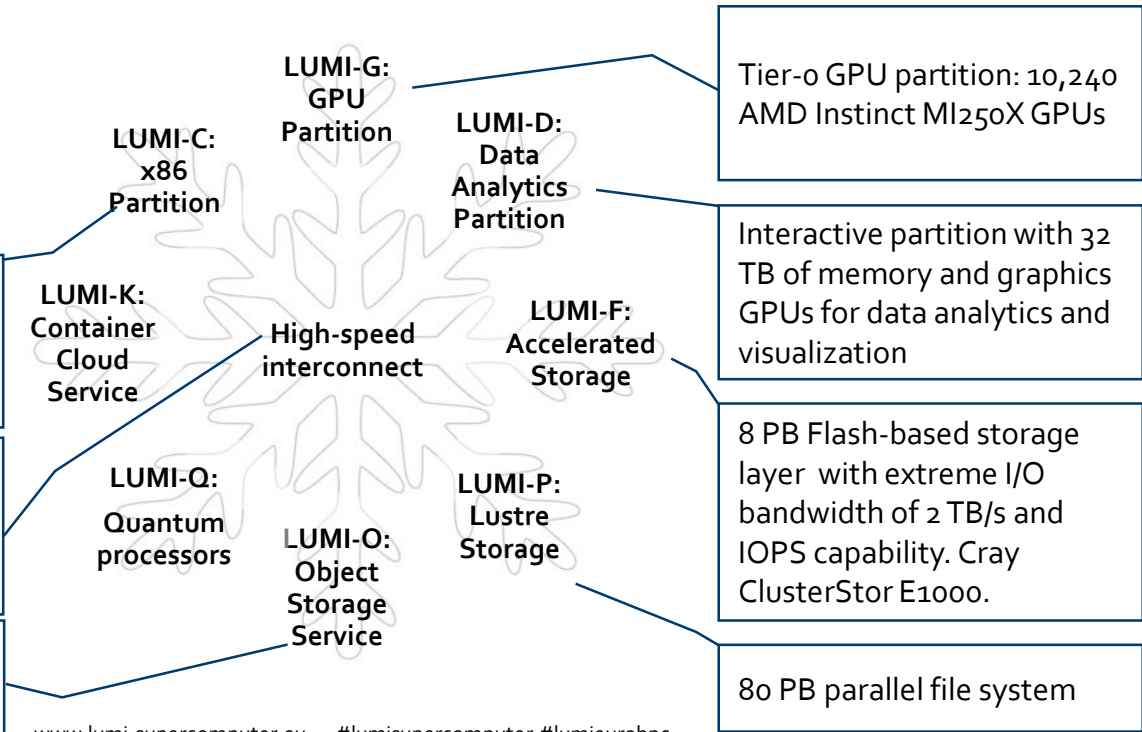
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LUMI capabilities

LUMI, the Queen of the North

*LUMI is a Tier-0 **GPU-accelerated supercomputer** that enables the convergence of **high-performance computing**, **artificial intelligence**, and **high-performance data analytics.***
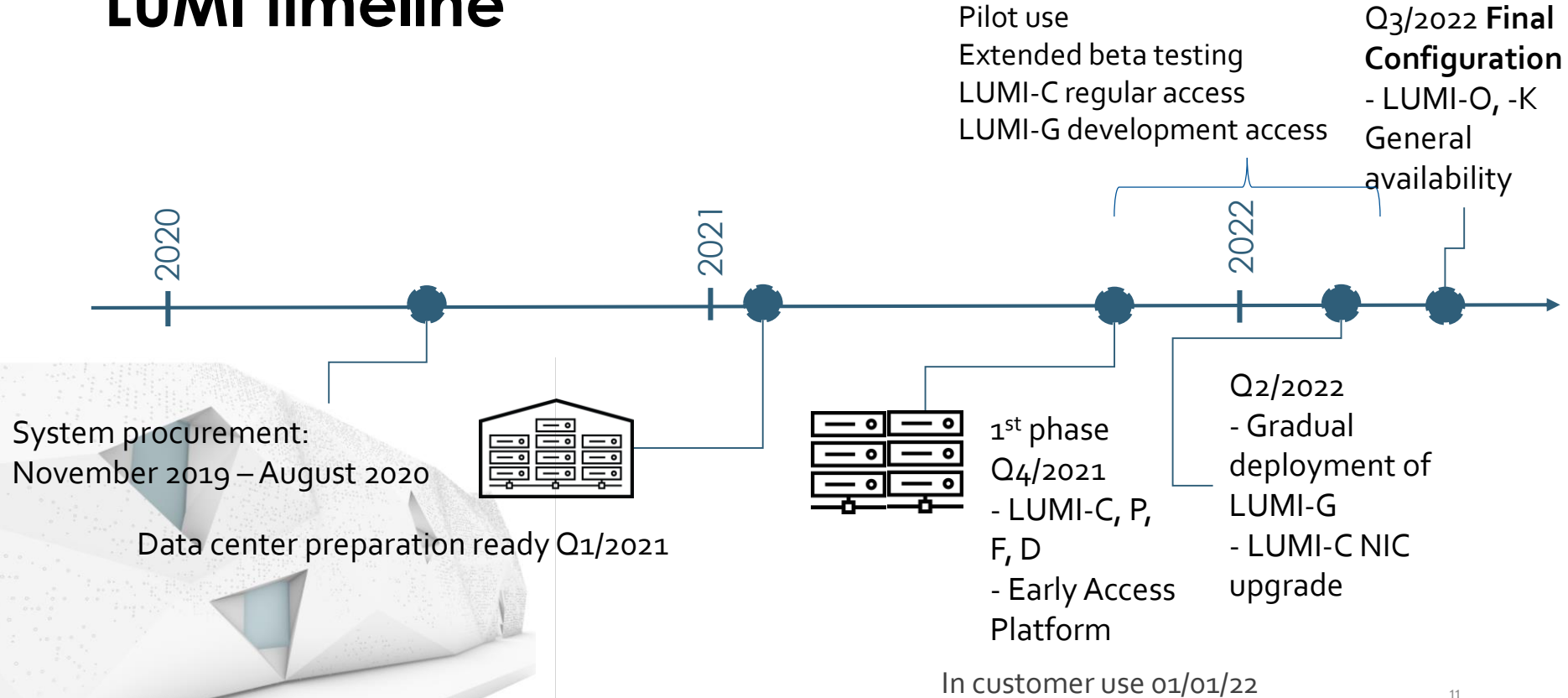
- Supplementary CPU partition
- ~200,000 AMD EPYC CPU cores

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

30 PB encrypted object storage (Ceph) for storing, sharing and staging data

LUMI-C: x86 Partition

LUMI-K: Container Cloud Service

LUMI-Q: Quantum processors

LUMI-G: GPU Partition

LUMI-D: Data Analytics Partition

High-speed interconnect

LUMI-F: Accelerated Storage

LUMI-O: Object Storage Service

LUMI-P: Lustre Storage

Tier-0 GPU partition: 10,240 AMD Instinct MI250X GPUs

Interactive partition with 32 TB of memory and graphics GPUs for data analytics and visualization

8 PB Flash-based storage layer with extreme I/O bandwidth of 2 TB/s and IOPS capability. Cray ClusterStor E1000.

80 PB parallel file system

LUMI timeline

LUMI

Pilot use
Extended beta testing
LUMI-C regular access
LUMI-G development access

Q3/2022 **Final Configuration**
- LUMI-O, -K General availability

2020

2021

2022

System procurement:
November 2019 – August 2020

Data center preparation ready Q1/2021

1st phase
Q4/2021
- LUMI-C, P, F, D
- Early Access Platform

Q2/2022
- Gradual deployment of LUMI-G
- LUMI-C NIC upgrade

In customer use 01/01/22

Enhanced user experience

- In addition to traditional CLI, we support high-level interfaces on LUMI, i.e. seamlessly integrate Jupyter Notebooks, Rstudio and such to back-end to LUMI (Q3/22)

- A rich stack of pre-installed software (Q2/22)

- Datasets as a Service: curated large reference datasets available and maintained (Q4/22)

- Support for handling sensitive (GDPR subjected, IP-closed, etc) data (Q2/23)

LUMI capacities, a brief summary

- Extreme computing capacity based on LUMI-G and LUMI-C partitions
- Interactive use (visualization, data analysis, pre/post processing,..) on LUMI-D
- Broad stack of pre-installed scientific software, databases and datasets, both commercial and community
- Sharing datasets over LUMI-O service
- Running microservices on LUMI-K
- Exploring the quantum computing world with LUMI-Q

Getting LUMI resources

- European researchers can apply for LUMI resources via EuroHPC calls
- Researchers in the LUMI consortium countries can additionally apply from local resource providers
  - See **www.lumi-supercomputer.eu/get-started**
- LUMI resources are allocated in terms of GPU-hours, CPU-core-hours, and storage hours
  - No dedicated hardware - all users can access the whole system within the batch job policies
- Resources brokered in terms of
  - Preparatory access projects
  - Development access projects
  - General access (Tier-1) projects
  - Extreme scale (Tier-0) projects (should be mostly GPU hours)

LUMI features for enchancing weather & climate research workflows

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- CI/CD pipelines for model and dataset versioning
- Interactive LUMI-D partition for visualization and analysis of massive datasets
- Microservices platform with an access to the parallel filesystems
  - Interactive + batch job orchestration
  - Workflow management
  - Running data mover utilities
- Possibility for running Notebooks and Julia on compute partitions
- Dataset repositories

Concluding remarks

- Unprecendent amount of computational resources and capabilities are currently available for European research & innovation

- LUMI is a leadership-class resource designed for a broad range of user communities and workloads, with an enhanced user experience
  - Weather and climate modellers among key user communities
  - LUMI will be one of the main platforms for European Comission's Destination Earth program

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EuroHPC Joint Undertaking

Leverage from the EU 2014–2020

European Union European Regional Development Fund

Kainuun liitto