The pan-European supercomputer of the North

Outline

- The long story of LUMI and EuroHPC (made short)
- The opportunities and benefits for research, development and innovation offered by LUMI
- How to prepare for LUMI?
- Q&A

The EuroHPC Initiative

- The **EuroHPC Joint Undertaking** will pool EU and national resources in high-performance computing (HPC)
  - **acquiring and providing a world-class supercomputing and data infrastructure** for Europe's scientific, industrial and public users
  - supporting an 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
- Next generations of systems planned for 2023-2024 and 2026-2027

LUMI Consortium

- Unique consortium of 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 allocated by a peer-review process (cf. PRACE Tier-0 access) and available for all European researchers
- The shares of the LUMI partner countries will be allocated by local considerations and policies – seen and handled as extensions to national resources

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

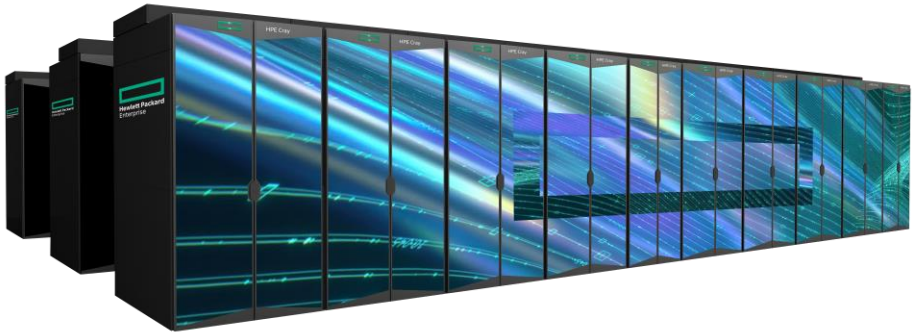
Extreme connectivity: Kajaani DC is a direct part of the Nordic backbone.
4x100 Gbit/s to GÉANT in place, can be easily scaled up to multi-terabit level

Elevated security standards guaranteed by ISO27001 compliancy

Benefits and opportunities for R&I by LUMI

LUMI: one of the fastest supercomputers in the world

LUMI



- LUMI will be an **HPE Cray EX** supercomputer manufactured by **Hewlett Packard Enterprise**
- Peak performance over **550 petaflop/s** makes the system one of the world's fastest
  - Fastest today is Fugaku supercomputer in Japan with 513 petaflop/s, second fastest Summit in USA with 200 petaflop/s)

1 system

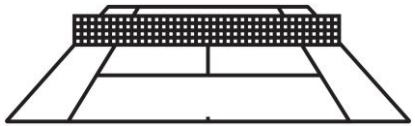
550 Pflop/s

Peak Performance

Computing power equivalent to

1 500 000

Modern laptop computers



Size of a tennis court

Modern platform for

High-performance computing, Artificial intelligence, Data analytics

Based on GPU technology

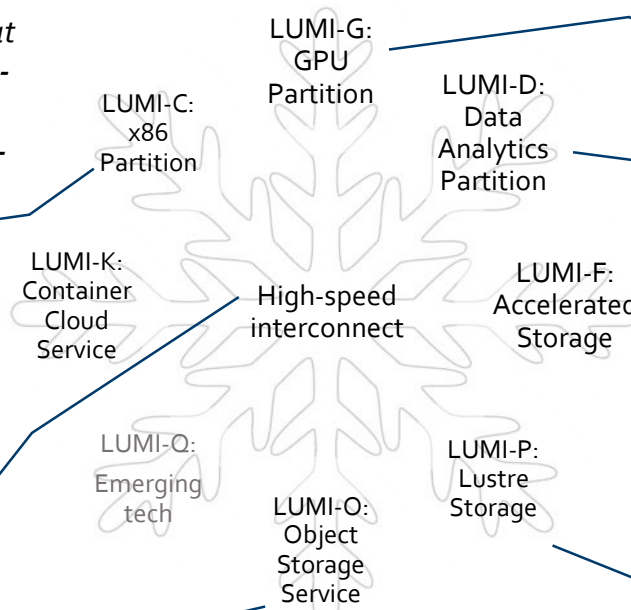
LUMI, the Queen of the North

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



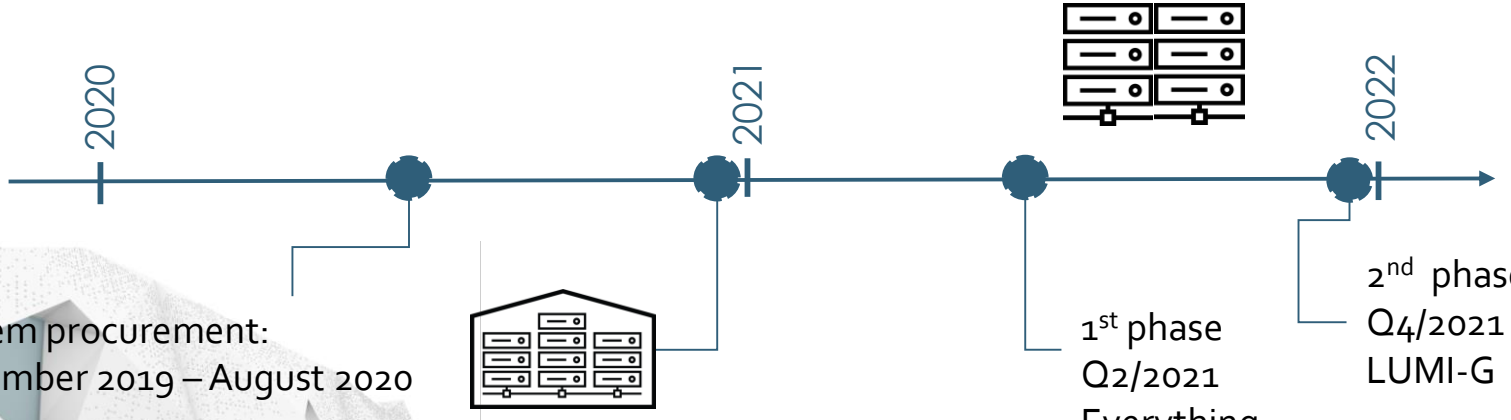
Tier-0 GPU partition: over 550 Pflop/s powered by AMD Instinct GPUs

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

7 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

Enhanced user experience

- In addition to traditional CLI, we wish to support high-level interfaces on LUMI, i.e. seamlessly integrate Jupyter Notebooks, Rstudio and such to back-end to LUMI
  - Ultimately the LUMI resources being an extension to your laptop
- Large software budget will enable a rich stack of pre-installed software
- Datasets as a Service: curated large reference datasets available and maintained
- Interactive resources for steering batch job simulations
- Exhaustive user support by the LUMI User Support Team

Enterprise use of LUMI resources

- Up to 20% of LUMI's capacity is reserved for industry and SMEs
- New RDI opportunities are available utilizing world class HPC resources combined with data-analytics and AI
- Novel co-operation possibilities for enterprises with universities and research centers
- Business Finland's Business AI program provides free-of-charge computing resources for startups and SMEs for significant research projects
- Computing resources can also be used in co-innovation projects of companies and academia
  - Resources arranged through academic PIs in these cases

How to prepare for LUMI?

LUMI capacities, a brief summary

- Extreme computing capacity based on LUMI-G and LUMI-C partitions
  - LUMI queue policies will support jobs from single CPU core or a GPU to 50% of the nodes, even 100% with special arrangements
  - Jobs can combine resources from both sides within a workflow, even within the same executable
- 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

- LUMI resources are allocated in terms of GPU-hours, CPU-core-hours, and storage hours
  - Each project applies and gets a combination of this
  - No dedicated hardware - all users can access the whole system within the batch job policies
  - All countries receive shares of these pools per their share of the TCO
- Researchers affiliated to Finland can apply from the EuroHPC allocation or from Finland's allocation
  - CSC will be your first point of contact
  - Similar schemes in other consortium member countries
- Resources brokered in terms of
  - Preparatory access projects (XS) – single-PI
  - Development access projects (S) – single-PI
  - General access (Tier-1) projects (M) – single-PI
  - Extreme scale (Tier-0) projects (L) – single-PI, should be mostly GPU hours
  - Community access projects (XL) – multi-PI, multi-year

How to prepare for LUMI?

- Thinking projects and use cases for Lumi
  - Cases for Tier-0 grand challenges
  - Combining simulation and AI methods within the same workflow
- There is a vast pool of GPU-enabled community codes
  - See if your favorite software suite already has been enabled- if not, consider moving to a competing package that is
  - Perhaps only part of the application needs to be GPU-enabled, rest running on the CPU nodes
- Modernizing applications and GPU-enabling them
  - "even if it works, fix it"

LUMI programming environment

- ROCm (Radeon Open Compute)
  - Usual set of accelerated scientific libraries (BLAS, FFT etc)
  - Usual machine leaning frameworks and libraries (Tensorflow, PyTorch etc)
  - Compilers for the GPUs
- Cray Programming Environment (CPE) stack
  - Cray Compiling Environment, LibSci libraries, CrayPAT, debuggers,…
  - CPE Deep Learning Plugin

Preparing applications and workflows for LUMI

LUMI

- Remember the possibility of combining CPU and GPU nodes within one job – perhaps only part of the application needs to be GPU-enabled
- Refactorize and modernize your code
- Employ modern frameworks and libraries
- Write a well-scaling MPI code first and accelerate it with GPUs, not vice versa
- Convert CUDA codes to HIP, OpenACC codes to OpenMP
  - LUMI 1st phase will come with a porting platform
  - HIP porting can be done already now on Puhti-AI

Concluding remarks

- **EuroHPC era: Unprecendent amount of computational resources and capabilities** available for European research & innovation
  - Complemented by competence building and user support activities
  - Synergestic with the up-to-date national data infrastructure
- **LUMI, the Queen of the North**: leadership-class resource designed for a broad range of user communities and workloads, with an enhanced user experience
  - **LUMI will be a GPU system**, which needs some preparatory work – but it will be a robust production system, and not experimental or esoteric in any manner
- **Modernizing HPC applications** for harnessing the largest systems is not trivial, and needs a lot of focused effort – but it will pay off
  - It is time already to start preparing for the LUMI era

LUMI

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EuroHPC Joint Undertaking

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Kainuun liitto