LUMI: one of the fastest supercomputers in the world

- LUMI is an HPE Cray EX supercomputer manufactured by Hewlett Packard Enterprise
- HPL performance over 309 petaflop/s makes the system #3 in the world (Top500)
  - #3 on HPCG, #2 on HPL-MxP

1 system
309 Pflop/s
Sustained performance

Modern platform for
High-performance computing, Artificial intelligence, Data analytics
Based on GPU technology

Size of two tennis courts
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: 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-C: x86 Partition
LUMI-G: GPU Partition
LUMI-D: Data Analytics Partition
LUMI-F: Accelerated Storage
LUMI-O: Lustre Storage
LUMI-Q: Quantum processors
LUMI-K: Container Cloud Service
LUMI compute node configurations

**LUMI-G**

- 2560 nodes with 4 x MI250X + 1 x AMD Trento processor, 512 GB host memory and 512 GB device memory (HBM2)
- 4 x 200 Gbit/s NIC
- Infinity Fabric

**LUMI-C**

- 2x 64-core AMD Milan processors per node
- 1376 nodes with 256 GB, 128 with 512 GB and 32 with 1 TB
- 1 x 200 Gbit/s NIC
LUMI timeline

System procurement: November 2019 – August 2020
Data center preparation ready Q1/2021

Q4/2021 - LUMI-C
- storage
- Early Access Platform

Q4/2021 Final Configuration
- LUMI-O
General availability

1st phase Q4/2021
- LUMI-C
- storage
- Early Access Platform

Q2-3/2022
- Gradual deployment of LUMI-G
- LUMI-C NIC upgrade

In customer use 01/01/22
LUMI programming environment

• ROCm (Radeon Open Compute)
  • Usual set of accelerated scientific libraries (BLAS, FFT etc)
  • Usual machine learning frameworks and libraries (Tensorflow, PyTorch etc)
  • Compilers for the GPUs (AOCC)
  • Performance analysis tools

• Cray Programming Environment (CPE) stack
  • Cray Compiling Environment
  • GNU compilers
  • LibSci libraries, performance analysis tools, debuggers,...

• LUMI stack
  • Allows software installed in the user's space through EasyBuild in a way that is 100% compatible with the system stack

• More information: https://www.lumi-supercomputer.eu/may-we-introduce-lumi/
LUMI programming environment

• Traditional HPC programming models & languages supported
  • C, C++, Fortran, Python

• Parallel programming
  • MPI, OpenMP
  • PGAS (Fortran Coarrays, UPC, OpenSHMEM)

• GPU programming
  • OpenMP 5.1 offload
  • OpenACC: 3.0 for Fortran, no proper support in C/C++
  • HIP (Heterogeneous Interface for Portability)
  • hipSYCL

• Performance analysis tools
  • CrayPAT, Reveal
  • Tau
  • ROCprof
  • OmniPerf/OmniTrace
  • SCORE-P/Vampir

• Debuggers
  • ARM Forge
  • CPE debuggers (CCDB, gdb4hpc,...)

• Software installation and management
  • EasyBuild, Spack
Preparing applications and workflows for LUMI

• Possibility of combining CPU and GPU nodes within one job – perhaps only part of the application needs to be GPU-enabled

• CUDA codes needs to be converted to HIP
  • HIPify tools can automatize the effort (~25% code needs manual work)

• Recommended to port C/C++ OpenACC codes to OpenMP offload

• In case of major rewrites: Consider writing your application on top of modern frameworks and libraries
  • Kokkos, Alpaka etc, or domain-specific frameworks e.g. GridTools