LUMI

Welcome

Moving your AI training jobs to LUMI workshop

26.11.2024

VSB TECHNICAL UNIVERSITY OF OSTRAVA | IT4INNOVATIONS NATIONAL SUPERCOMPUTING CENTER

EURO CZECHIA

Introduction to LUMI

Moving your AI training jobs to LUMI workshop

26.11.2024

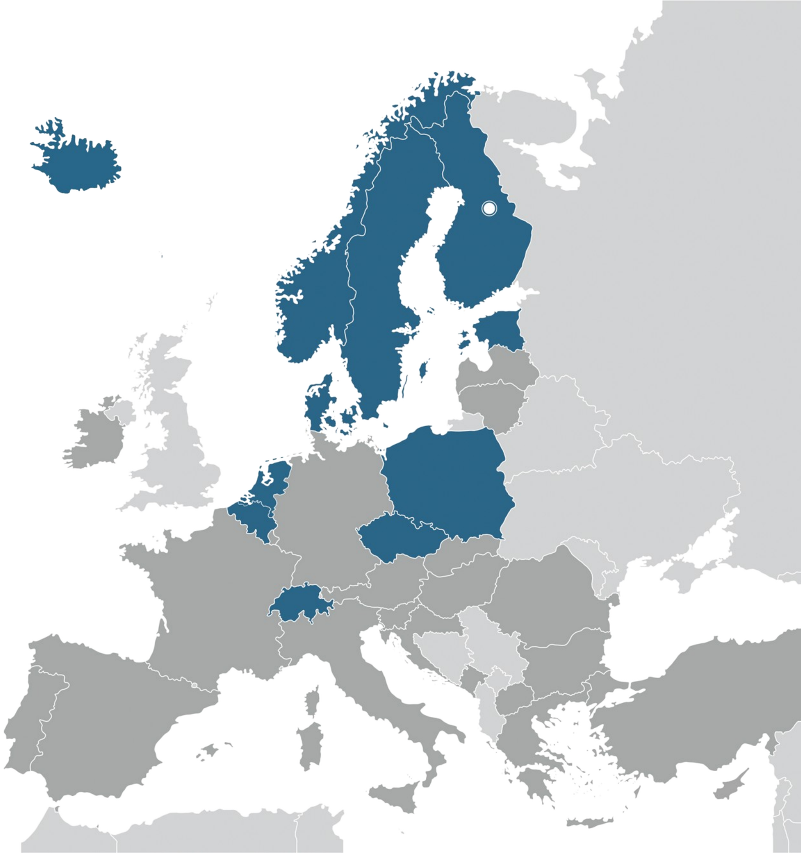
LUMI is not one supercomputer

But it is a very powerful machine

LUMI is fastest computer in Europe

LUMI

- 5th fastest computer in world (TOP500)
- Operated by LUMI consortium
  - 11 countries collaborating
  - 50 % financed by EuroHPC JU
- Located in Kajaani, Finland
- Distributed LUMI user support team (LUST)
  - One full time employee equvalent from each country
  - Offer email support, courses, workshops, ...
  - Responsible of software stack

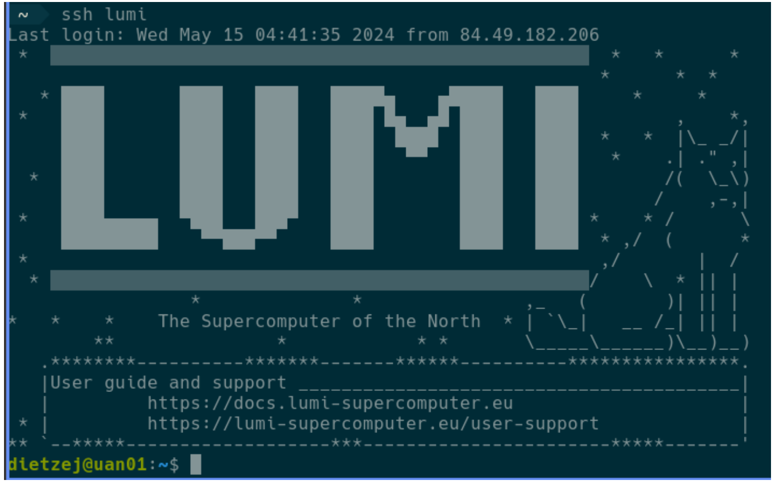


LUMI is a cluster of individual computers

- LUMI is not one superfast PC
- Instead it consists of a few thousand individual computers (“nodes”)
- All of them are connected by a fast interconnect
- Speed comes from parallelization

Two ways of connecting

Command line interface

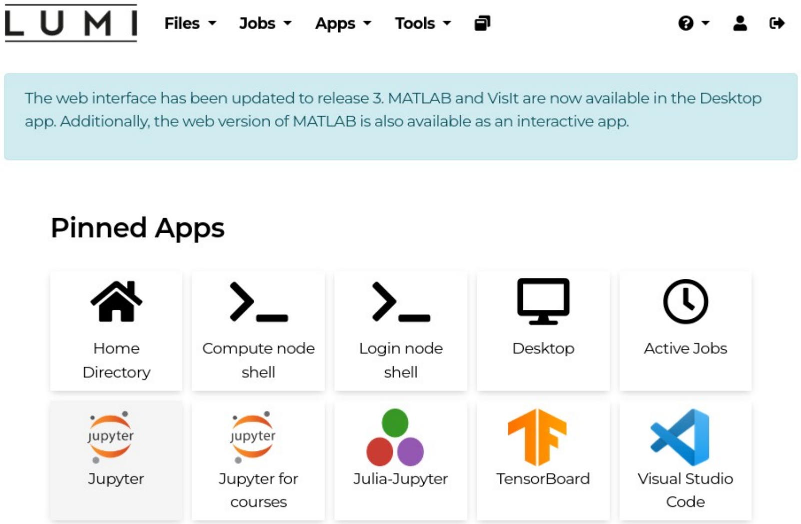


```
~  ssh lumi
Last login: Wed May 15 04:41:35 2024 from 84.49.182.206

         The Supercomputer of the North

 .********----------*******------******----------****************.
 |User guide and support _________________________________________|
 |         https://docs.lumi-supercomputer.eu                      |
 |         https://lumi-supercomputer.eu/user-support              |
 `--*****--------------------***-----------------------*****------'
dietzej@uan01:~$ 
```

Browser based interface (OpenOnDemand)

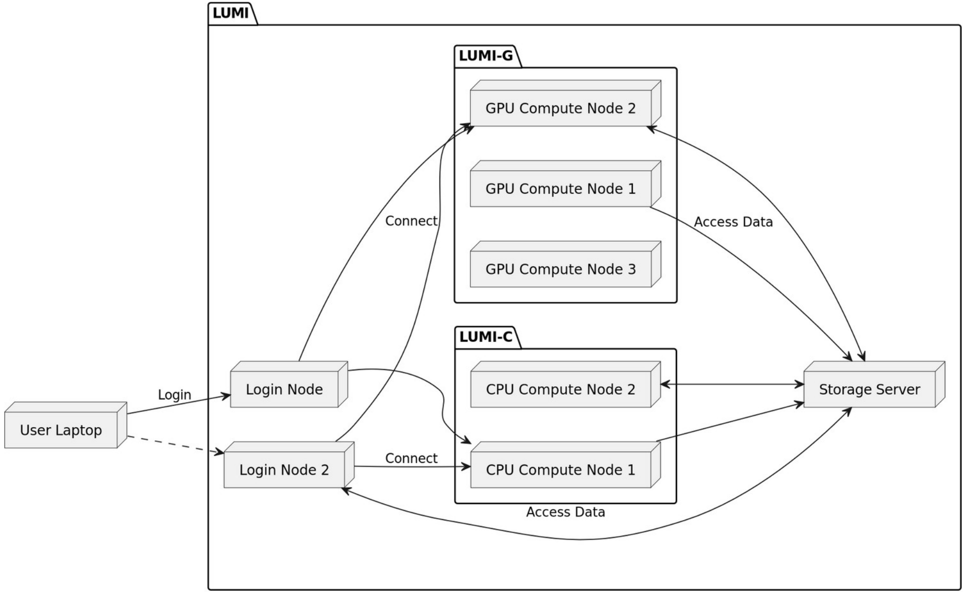


The web interface has been updated to release 3. MATLAB and VisIt are now available in the Desktop app. Additionally, the web version of MATLAB is also available as an interactive app.

Pinned Apps

LUMI consists of different parts

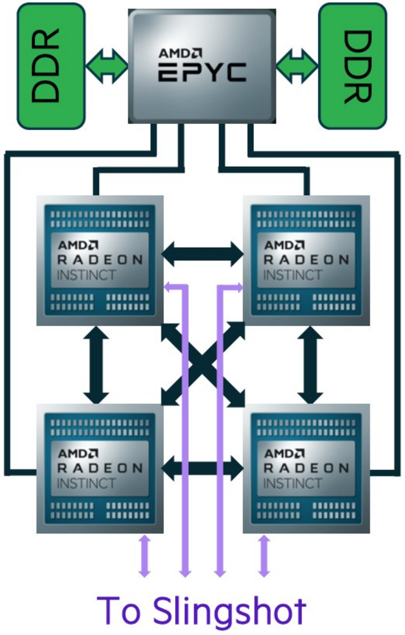
- Computers
  - Login nodes – UAN (user access nodes)
  - CPU compute nodes – LUMI-C
  - GPU compute nodes – LUMI-G
  - Visualisation nodes – LUMI-D
- Storage
  - 80 PB main parallel storage – LUMI-P
  - 8.5 PB accelerated storage – LUMI-F
  - 30 PB object-based storage – LUMI-O
- Interconnect
  - HPE Slingshot 13
  - Connects everything



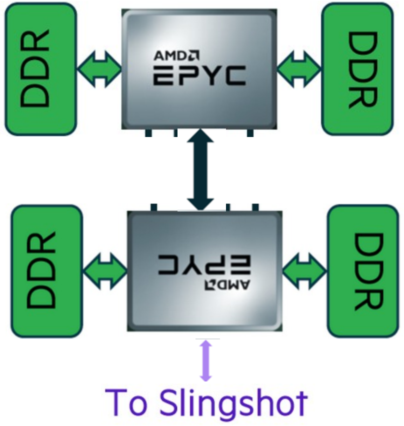
LUMI-C and -G are quite different

LUMI

LUMI-G



2978 nodes with
4x MI250X (2 x 64GB)
1x AMD Trento CPU
512 GB RAM
4x 200 Gbit/s NIC



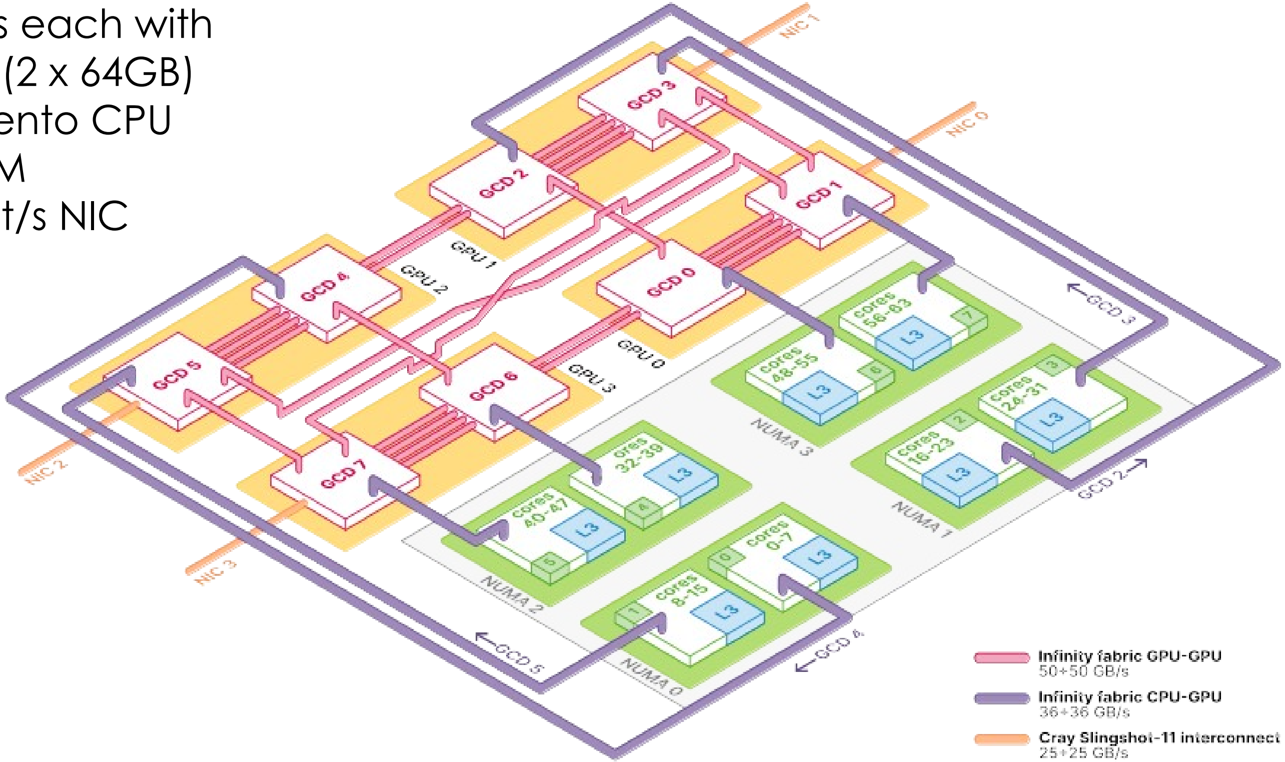
2x 64-core AMD Milan CPUs
1888 nodes with 256 GB,
128 with 512 GB and 32 with 1 TB RAM
1 x 200 Gbit/s NIC

LUMI-C

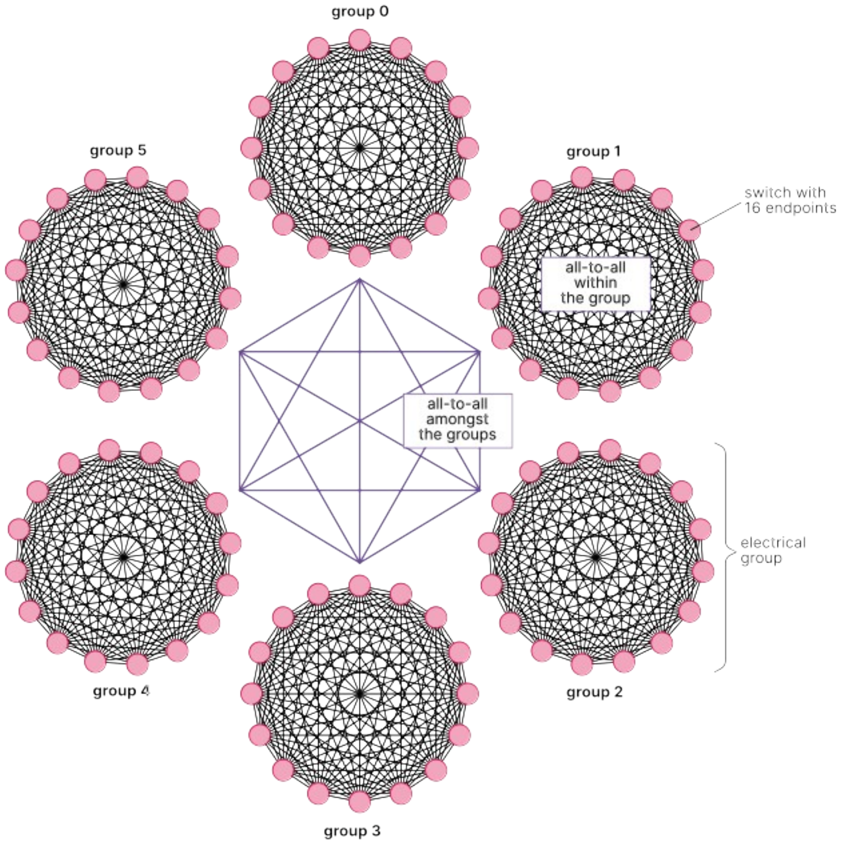
GPU nodes are the center of LUMI

LUMI

2978 nodes each with
4 x MI250X (2 x 64GB)
1 x AMD Trento CPU
512 GB RAM
4 x 200 Gbit/s NIC

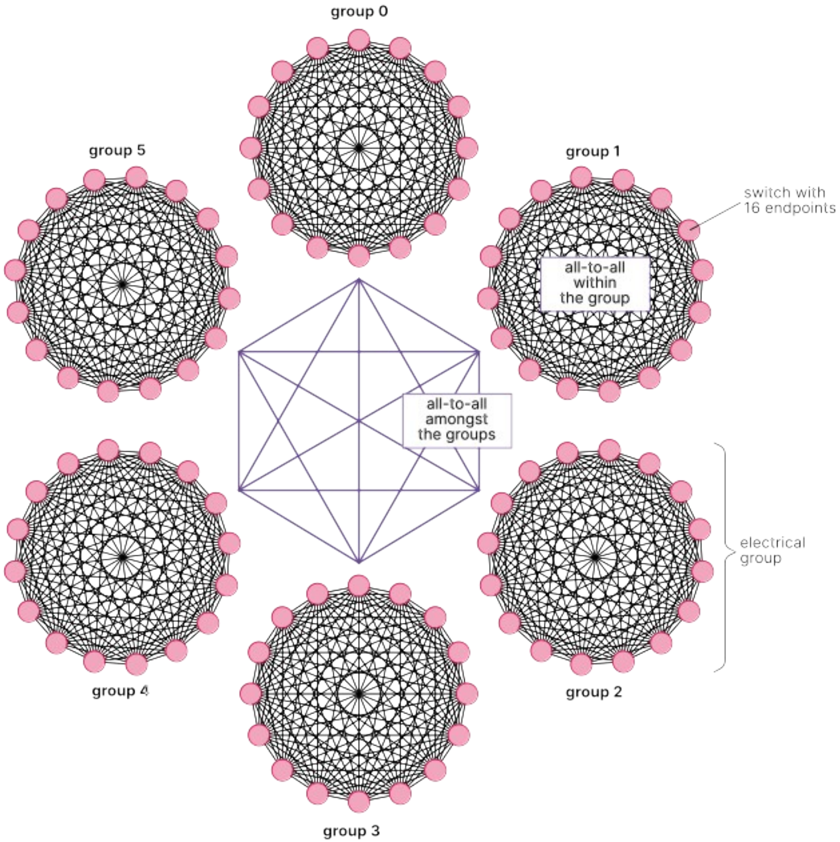


Interconnect is the fast backbone of LUMI



- Slingshot in Dragonfly topology
  - Each G node is connected to 4 switches
  - All-to-all amongst switches in a group
  - All-to-all between groups
  - Max of 3 switch hops
- Make sure to use it

Make sure that Pytorch takes advantage

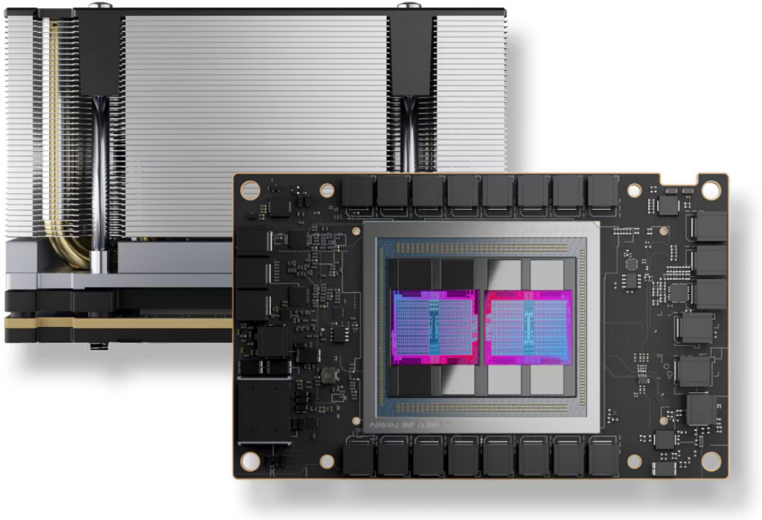


- RCCL based communication between GPUs
- Requires plugin to use Slingshot
- Load `aws-ofi-rccl` module

AMD is not Nvidia

But the differences are quite small

Our GPUs are confusing



Each AMD Instinct MI250X

- 2 Graphics Compute Die (GCD)
- 110 compute units per GCD with each 64 stream processors
- 64 GB HBM GPU memory per GCD
- Each process can only use 64GB max – not 128GB

Different names but usually same concept

LUMI

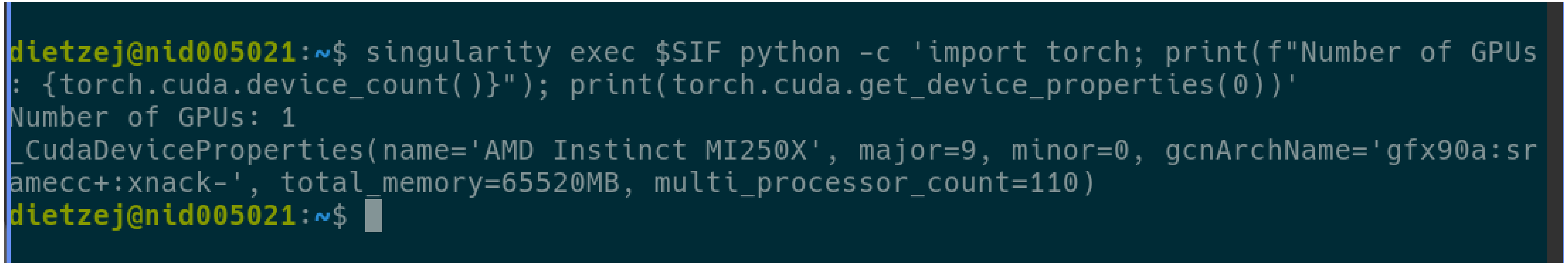
NVIDIA		AMD
PyTorch	ML Training	PyTorch
Infiniband / RoCE	Networking Between Nodes	HPE Slingshot
NCCL	Cross-GPU Communication	RCCL
CUDA / CuDNN	Software Stack	ROCm
A100, H100	GPU	MI250X, MI300X

ROCm is not CUDA

- ROCm is the equivalent software stack to Nividia’s CUDA
- Basically drop-in replacement
- Very similar concept
- Some small differences
- Consists of
  - GPU drivers
  - Compilers and profilers
  - Math and communication libraries

PyTorch makes it simple

- Both CUDA and ROCm are loaded with `cuda` submodule
- Check whether you can see any GPUs with `torch.cuda.device_count()`

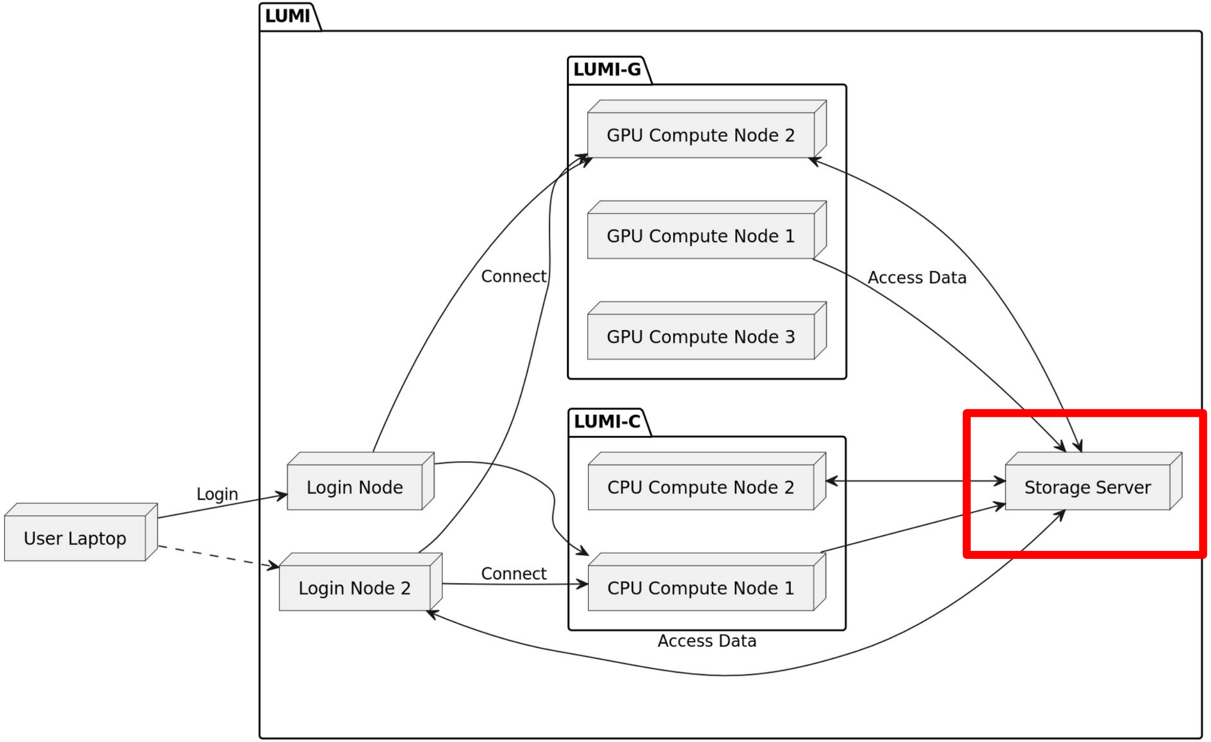


```
dietzej@nid005021:~$ singularity exec $SIF python -c 'import torch; print(f"Number of GPUs
: {torch.cuda.device_count()}"); print(torch.cuda.get_device_properties(0))'
Number of GPUs: 1
_CudaDeviceProperties(name='AMD Instinct MI250X', major=9, minor=0, gcnArchName='gfx90a:sr
amecc+:xnack-', total_memory=65520MB, multi_processor_count=110)
dietzej@nid005021:~$
```

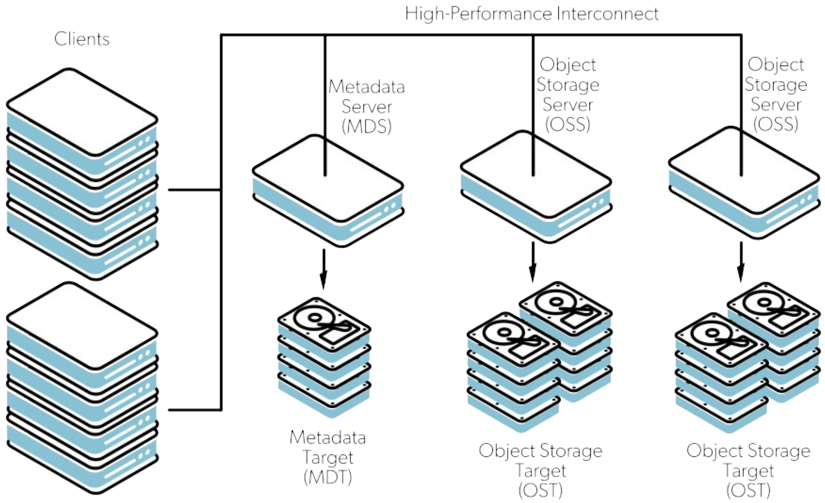
Storage is not as easy as on your laptop

But if you follow some rules you will be fine

There is more than one storage server



LUMI has three storage systems


High-Performance Interconnect
Clients
Metadata Server (MDS)
Object Storage Server (OSS)
Object Storage Server (OSS)
Metadata Target (MDT)
Object Storage Target (OST)
Object Storage Target (OST)

- LUMI-P
  - Lustre file system
  - Disk based
  - 4 independent systems with each 20 PB
- LUMI-F
  - Lustre file system
  - Solid-state (flash) based
  - 8.5 PB
- LUMI-O
  - Object storage based
  - Disk based
  - 30 PB

There are no local disks

- Compute nodes have no local disks
- Instead network storage (LUMI-P & -F) has to be used
- 4 storage areas

Area	Path	Usage
User home	`/users/<username>`	Configuration files
Project persistent	`/project/<project>`	Installations + final results
Project scratch	`/scratch/<project>`	Input + Intermediate results
Project flash	`/flash/<project>`	Input if high bandwidth is needed

What about /tmp?

- Compute nodes don’t have local disks/flash
- /tmp resides in memory
- Consumes space of your memory allocation
- Remember to allocate enough memory if you want to use /tmp

Questions?