



# Uni.lu HPC Facility

## Overview & Challenges at the EuroHPC Horizon

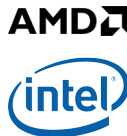
High Performance  
Computing &  
Big Data Services



Uni.lu High Performance Computing Team

University of Luxembourg (UL), Luxembourg

<https://hpc.uni.lu>





# Summary

- 1 **Research Excellence in Luxembourg**
- 2 High Performance Computing (HPC) @ UL
  - Overview
  - Governance
  - ULHPC Supercomputing Facilities Details
- 3 HPC Strategy in Luxembourg and in Europe



- **Created in 2003**, moved to Belval (South of the country) in 2015
- Among the top 250 universities in the Times Higher Education (THE) Rankings 2020
  - ↳ N°1 worldwide in the THE “international outlook” Rankings
  - ↳ N°17 worldwide in the THE Young University Rankings 2019.
    - ✓ N°4 (out of 64) in the THE Millennials Rankings 2019.

# Uni.lu: Heart of Science in Luxembourg

- Establishment of **3 faculties**

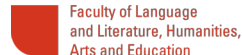


- ... and **3 Interdisciplinary Centres (ICs)**



# Uni.lu: Heart of Science in Luxembourg

- Establishment of **3 faculties**



- ... and **3 Interdisciplinary Centres (ICs)**



## ULHPC: 2<sup>nd</sup> Largest High Performance Computing (HPC) Facility

- support research excellence in national & international projects
  - ↪ edge access to **National HPC Facility MeluXina** (operated by LuxProvide)



# Summary

- 1 Research Excellence in Luxembourg
- 2 High Performance Computing (HPC) @ UL**
  - Overview
  - Governance
  - ULHPC Supercomputing Facilities Details
- 3 HPC Strategy in Luxembourg and in Europe



High Performance Computing (HPC) @ UL

## University of Luxembourg & HPC

- *With regards to HPC*, University of Luxembourg offers:

↪ **People**

- ✓ **Domain experts**, Computational and Data scientists
- ✓ Specialists in parallel algorithmics



High Performance  
Computing &  
Big Data Services

 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

 @ULHPC



## University of Luxembourg & HPC

- *With regards to HPC*, University of Luxembourg offers:

- ↳ **People**

- ✓ **Domain experts**, Computational and Data scientists
- ✓ Specialists in parallel algorithmics


- ↳ **Services**

- ✓ **HPC Compute & Data services** (HPC for research)
- ✓ IT services (SIU)



High Performance  
Computing &  
Big Data Services

 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

 @ULHPC





# University of Luxembourg & HPC

- *With regards to HPC*, University of Luxembourg offers:

- ↪ **People**

- ✓ **Domain experts**, Computational and Data scientists
- ✓ Specialists in parallel algorithmics

- ↪ **Services**

- ✓ **HPC Compute & Data services** (HPC for research)
- ✓ IT services (SIU)

- ↪ **Infrastructure**

- ✓ **State-of-the-art HPC systems**, **2.7 PFlops** compute capacity
- ✓ Highly capable Data Center (*Centre De Calcul CDC*)
- ✓ Cutting-edge energy-efficient Direct Liquid Cooling capability



High Performance  
Computing &  
Big Data Services

 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

 @ULHPC



## University of Luxembourg & HPC

- *With regards to HPC*, University of Luxembourg offers:

- ↳ **People**

- ✓ **Domain experts**, Computational and Data scientists
- ✓ Specialists in parallel algorithmics

- ↳ **Services**

- ✓ **HPC Compute & Data services** (HPC for research)
- ✓ IT services (SIU)

- ↳ **Infrastructure**

- ✓ **State-of-the-art HPC systems**, **2.7 PFlops** compute capacity
- ✓ Highly capable Data Center (*Centre De Calcul CDC*)
- ✓ Cutting-edge energy-efficient Direct Liquid Cooling capability

- ↳ **Education & Training**

- ✓ MICS Parallel and Grid Computing lecture, Bi-annual **HPC School**
- ✓ **Technology Transfer HPC workshops & seminars**  
... in collaboration with **UL** / National HPC Competence Center)



High Performance  
Computing &  
Big Data Services

 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

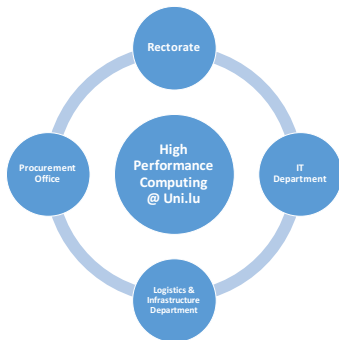
 [@ULHPC](https://twitter.com/ULHPC)



High Performance Computing (HPC) @ UL

# High Performance Computing @ UL

- **Started in 2007** under resp. of Prof P. Bouvry & Dr. S. Varrette
  - ↪ 2nd Largest HPC facility in Luxembourg...
  - ✓ after EuroHPC MeluXina ( $\geq 10$  PFlops) system



<https://hpc.uni.lu/>

## HPC/Computing Capacity

2794.23 TFlops

(incl. 748.8 GPU TFlops)

## Shared Storage Capacity

10713.4 TB storage

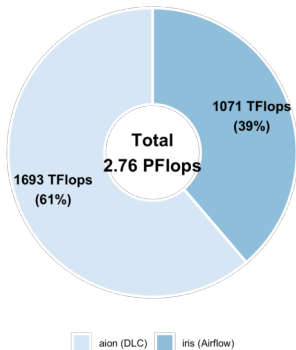


High Performance  
Computing &  
Big Data Services

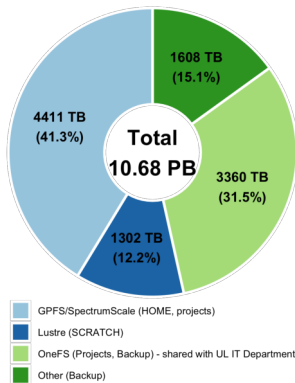


## High Performance Computing @ UL

UL HPC Cluster (2020)



UL HPC Storage FileSystems (2020)

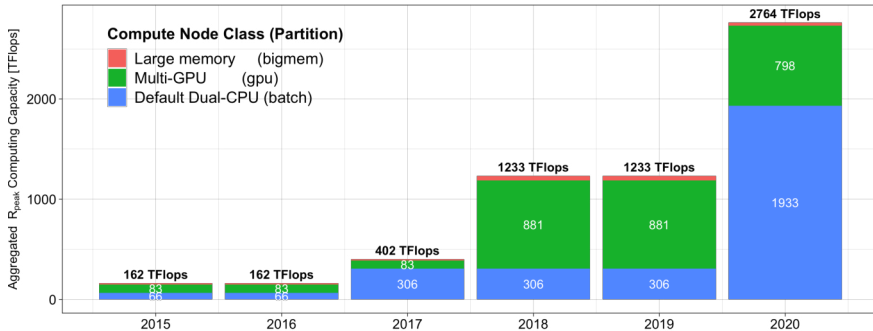


High Performance  
Computing &  
Big Data Services



## High Performance Computing @ UL

Evolution of the UL HPC Compute Capacity



- 3 types of computing resources across 2 clusters (aion, iris)



High Performance  
Computing &  
Big Data Services

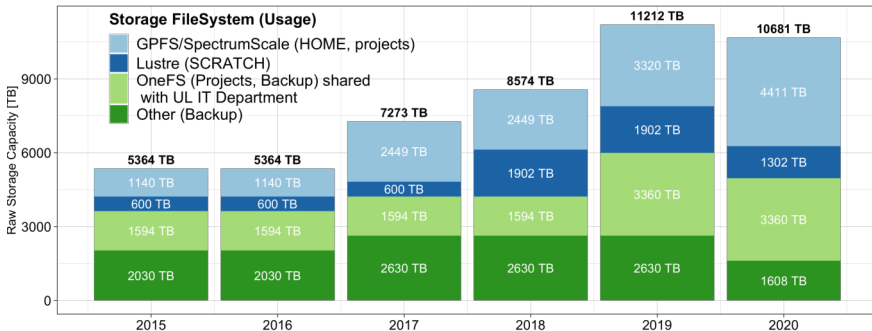
 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

 @ULHPC

# High Performance Computing @ UL

Evolution of the UL HPC Storage Capacity



- 4 File Systems commons across the 2 clusters (aion, iris)



High Performance  
Computing &  
Big Data Services

 [hpc.uni.lu](http://hpc.uni.lu)

 [hpc@uni.lu](mailto:hpc@uni.lu)

 @ULHPC

## HPC in Luxembourg and Around in EU

(CPU)

Country	System(s)	Type	Institute	#Nodes	#Cores	#[GPU]Accelerators	R <sub>peak</sub>	Shared Storage
Luxembourg	MeluXina	Tier 0/1 (EU,Nat.)	LuxProvide	824	≈ 88 000	764 NVidia A100	17,57 PF	≈ 20 PB
	aion,iris	Tier 2 (Univ.)	Uni.lu HPC	552	46896	96 NVidia V100	2.79 PF	10.71 PB
		Tier 2 (local)	LIST	40	1280	8 Nvidia V100	0.126 PF	0.58 PB
France	TGCC <sup>(Joliot-Curie)</sup>	Tier 0 (EU)	GENCI/CEA	4808	430 448	828 Xeon Phi, 128 NVidia V100	22.26 PF	35PB
	JeanZay	Tier 1 (Nat.)	GENCI/Idris	1 528	61 120	1292 NVidia V100	14.97 PF	31.2 PB
	ROMEO	Tier 2 (Reg.)	Univ. Reims	115	3 220	280 NVidia P100	1.75 PF	0.634
Belgium	Vlaams	Tier 1 (Nat.)	VSC	988	27 664	n/a	1.63 PF	1.3PB
	zenobe	Tier 1 (Nat.)	Cenaero	584	14 016	4 NVidia K40	0.41 PF	0.356PB
	Stevin	Tier 2 (Reg.)	Gent Univ.	522	14 112	40 NVidia V100	1.10 PF	3.79PB
	(7 clusters/5 univ.)	Tier 2 (Reg.)	CECI	372	9 616	4 Nvidia V100, 4 Nvidia C2075	0.36 PF	0.25PB
Germany	JUWELS	Tier 0 (EU)	JSC	2571	122 768	224 Nvidia V100	12.3 PF	130.3PB
	JURECA	Tier 0 (EU)	JSC	3524	156 736	1640 Xeon Phi	7.24 PF	(as above)
	Hawk	Tier 0 (EU)	HLRS, Univ. Stuttgart	5632	720 896	n/a	26 PF	≈25PB
	SuperMUC-NG	Tier 0 (EU)	LRZ, Munich	6480	311 040	n/a	26.9 PF	70.16PB
	CLAIX-2018	Tier 2 (Univ.)	Univ. Aachen	1307	61 200	108 Nvidia V100	4.11 PF	3PB
	Goether-HLR	Tier 2 (Univ.)	Univ. Frankfurt	623	22 140	n/a	1.59 PF	2.4PB
Switzerland	Piz-Daint	Tier 0 (EU)	CSCS, ETH Zürich	7517	387 872	5704 NVidia P100	29.34 PF	8.8PB
Czech Republic	Barbora	Tier 1 (Nat.)	IT4Innovation	201	7232	32 NVidia V100	0.85 PF	≈ 1PB
Italy	Marconi-A3	Tier 0 (EU)	Cineca	3216	154 368	n/a	10.37 PF	10PB
	Galileo	Tier 1 (Nat.)	Cineca	1022	36792	n/a	1.35 PF	1.92PB
	Leonardo	Pre-exa Tier 0 (EU)	Cineca	?	?	?	≈ 200 PF	?
Spain	MareNostrum 4	Tier 0 (EU)	BSC	3456	165 888	n/a	11.15 PF	14PB
	MareNostrum 5	Pre-exa Tier 0 (EU)	BSC	?	?	?	≈ 200 PF	?
Finland	LUMI	Pre-exa Tier 0 (EU)	CSC	?	?	?	≈ 200 PF	60PB

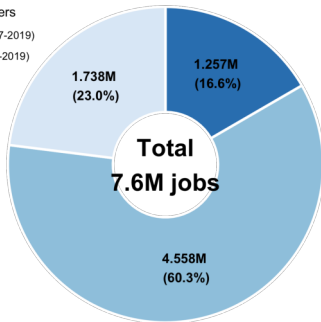
## Uni.lu HPC Users

- **1518** registered HPC Users
- 23 computational domains accelerated on UL HPC

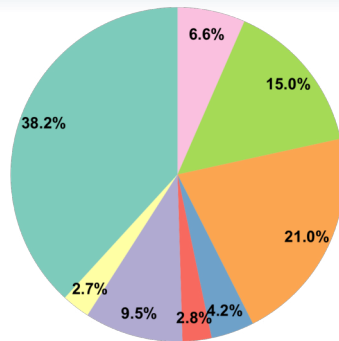
### Total Number of Submitted Jobs on the UL HPC Facilities (2008-2019)

#### UL HPC clusters

- chaos (2007-2019)
- gaia (2011-2019)
- iris (2017-)



### Repartition of UL HPC users

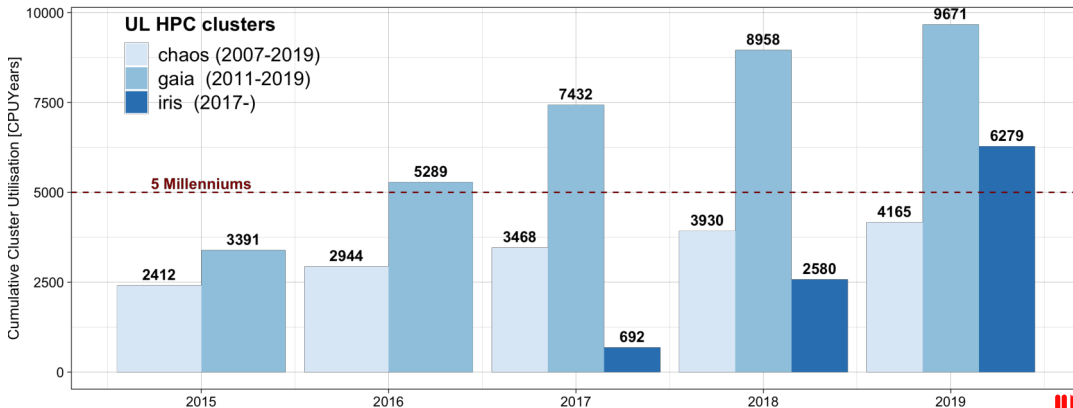


- Computer Sciences
- Digital History, Social Sciences
- Engineering
- Industry and External Partners
- Law, Economics and Finance
- Life Sciences
- Other
- Physics and Materials Science



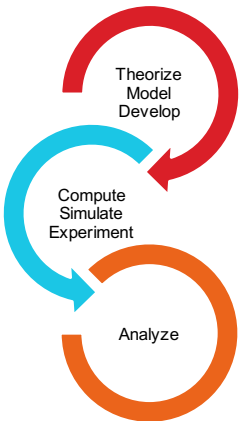
## Uni.lu HPC Cumulative Usage

UL HPC Facility Usage (in CPU Years)



## Accelerating UL Research - User Software Sets

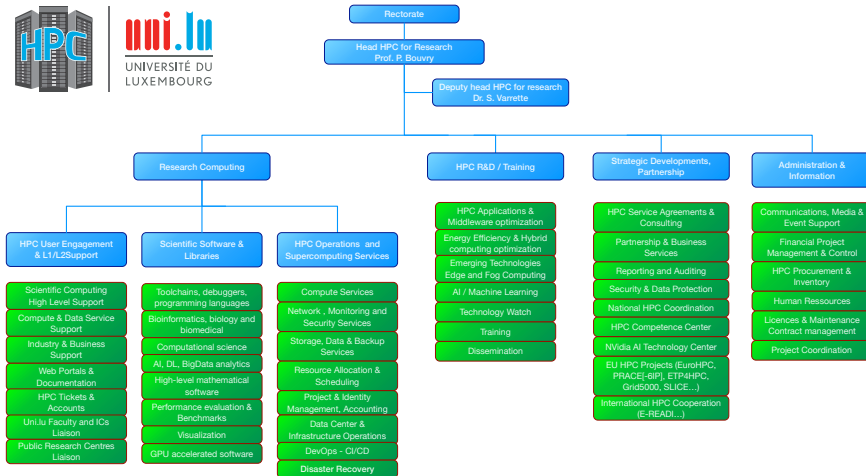
- **Over 230 software packages** available for researchers
  - software environment generated using **Easybuild / LMod**
  - containerized applications delivered with **Singularity** system



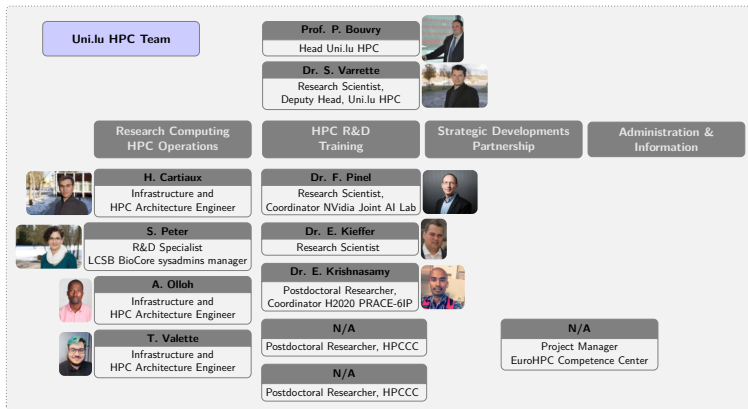
Domain	2019 Software environment
Compiler Toolchains	FOSS (GCC), Intel, PGI
MPI suites	OpenMPI, Intel MPI
<b>Machine Learning</b>	PyTorch, TensorFlow, Keras, Horovod, Apache Spark...
<b>Math &amp; Optimization</b>	Matlab, Mathematica, R, CPLEX, Gurobi...
<b>Physics &amp; Chemistry</b>	GROMACS, QuantumESPRESSO, ABINIT, NAMD, VASP...
<b>Bioinformatics</b>	SAMtools, BLAST+, ABySS, mpiBLAST, TopHat, Bowtie2...
<b>Computer aided engineering</b>	ANSYS, ABAQUS, OpenFOAM...
<b>General purpose</b>	ARM Forge & Perf Reports, Python, Go, Rust, Julia...
<b>Container systems</b>	Singularity
<b>Visualisation</b>	ParaView, OpenCV, VMD, VisIT
Supporting libraries	numerical (arpack-ng, cuDNN), data (HDF5, netCDF)...
...	

<https://hpc.uni.lu/users/software/>

## UL HPC Governance & Pillars

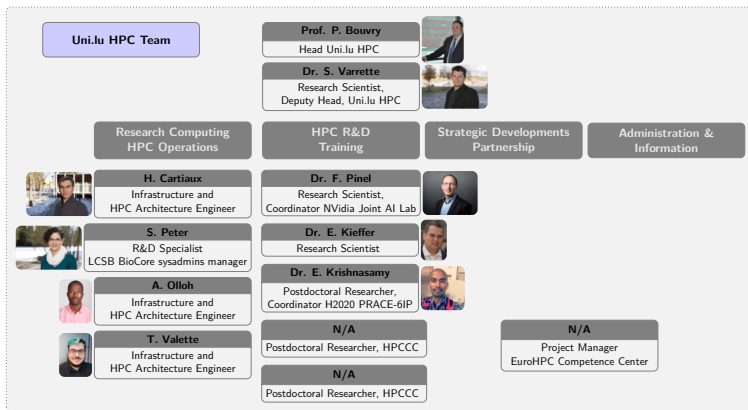


## UL HPC Core Team

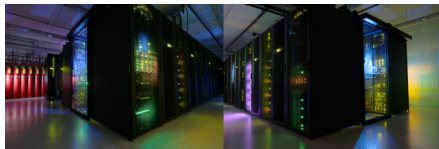


## UL HPC Core Team

... and domain experts across ALL the University



## Data center



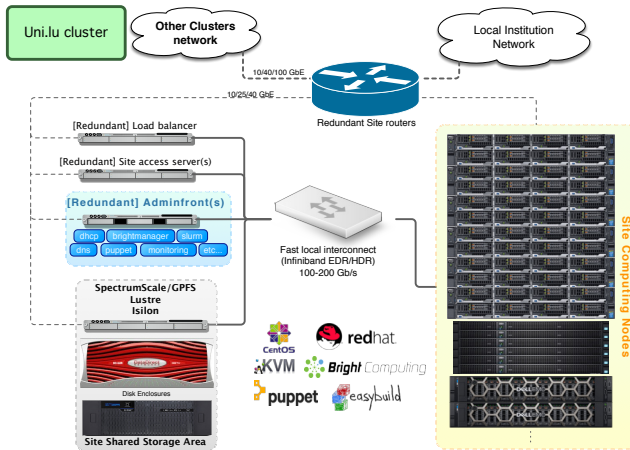
Belval Campus

Centre De Calcul  
(CDC)

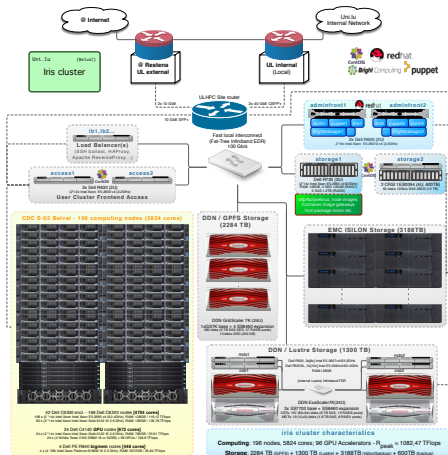
- Power generation station for HPC floor:
  - up to **3 MW of electrical power**
  - **2.4 MW of cold water** at a 12-18°C regime
    - ✓ used for traditional Airflow with In-Row cooling.
  - Separate hot water circuit (between 30 and 40°C)
    - ✓ used for Direct Liquid Cooling (DLC): aion
- Reminder: Avg. Annual Power consumption of residential household:  $\simeq 4,9\text{MWh}$

Location	Cooling	Usage
CDC S-02-001	Airflow	Future extension
CDC S-02-002	Airflow	Future extension
CDC S-02-003	DLC	Future extension - High Density/Energy efficient HPC
CDC S-02-004	DLC	High Density/Energy efficient HPC: aion
CDC S-02-005	Airflow	Storage / Traditional HPC: iris and common equipment

# UL HPC Supercomputers: General Architecture



## UL HPC Supercomputers: iris cluster



- **Dell/Intel** supercomputer, Air-flow cooling

- 196 compute nodes

- ✓ 5824 compute cores

- ✓ Total 52224 GB RAM

- $R_{peak}$ : **1,072 PetaFLOP/s**

- **Fast InfiniBand (IB) EDR network**

- **Fat-Tree Topology**

blocking factor 1:1.5

Rack ID	Purpose	Description
D02	Network	Interconnect equipment
D04	Management	Management servers, Interconnect
D05	Compute	iris-[001-056], interconnect
D07	Compute	iris-[057-112], interconnect
D09	Compute	iris-[113-168], interconnect
D11	Compute	iris-[169-177, 191-193] (gpu), iris-[187-188] (bigmem)
D12	Compute	iris-[178-186, 194-196] (gpu), iris-[189-190] (bigmem)

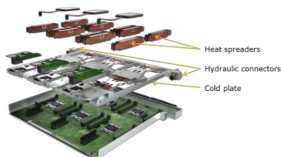
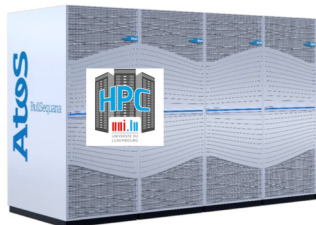
### iris cluster characteristics

Computing: 196 nodes, 5824 cores; 96 GPU Accelerators -  $R_{peak}$  ≈ 1082.47 TFlops

Storage: 2284 TB (GPFS) + 1300 TB (iSeries) + 3185TB (non-backup) + 600TB (backup)



## UL HPC Supercomputers: aion cluster

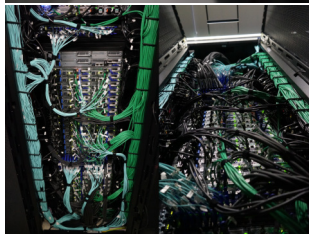


- **Atos/AMD** supercomputer, DLC cooling
  - ↪ 4 BullSequana XH2000 adjacent racks
  - ↪ 318 compute nodes
    - ✓ 40704 compute cores
    - ✓ Total 81408 GB RAM
  - ↪  $R_{\text{peak}}$ : **1,693 PetaFLOP/s**
- Fast InfiniBand (IB) HDR network
  - ↪ **Fat-Tree** Topology

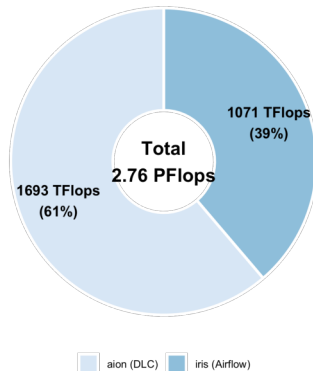
blocking factor 1:2

	Rack 1	Rack 2	Rack 3	Rack 4	TOTAL
Weight [kg]	1872,4	1830,2	1830,2	1824,2	<b>7357 kg</b>
#X2410 Rome Blade	28	26	26	26	<b>106</b>
#Compute Nodes	84	78	78	78	<b>318</b>
#Compute Cores	10752	9984	9984	9984	<b>40704</b>
$R_{\text{peak}}$ [TFlops]	447,28 TF	415,33 TF	415,33 TF	415,33 TF	<b>1693.29 TF</b>

## UL HPC Computing capacity



UL HPC Cluster (2020)



# UL HPC - Detailed Computing Nodes

	#N	#C	R <sub>peak</sub>
<b>Uni.lu HPC TOTAL:</b>	<b>552</b>	<b>46896</b>	<b>2794.23 TFlops</b>
(incl. 748.8 GPU TFlops)			

Cluster	Date	Vendor	Proc. Description	#N	#C	R <sub>peak</sub>
aion	2020	Atos	AMD EPYC 7H12 @2.6 GHz 2 × 64c, 256GB	318	40704	1693,29 TFlops
			<b>aion TOTAL:</b>	<b>318</b>	<b>40704</b>	<b>1693.3 TFlops</b>

iris	2017	Dell	Intel Xeon E5-2680 v4@2.4GHz 2 × 14C,128GB	108	3024	116,12 TFlops
	2018	Dell	Intel Xeon Gold 6132 @ 2.6 GHz 2 × 14C,128GB	60	1680	139,78 TFlops
	2018	Dell	Intel Xeon Gold 6132 @ 2.6 GHz 2 × 14C,768GB	24	672	55,91 TFlops
	2019		Per node: 4x NVIDIA Tesla V100 SXM2 16/32GB 96 GPUs	491520		748,8 GPU TFlops
	2018	Dell	Intel Xeon Platinum 8180M @ 2.5 GHz 4 × 28C,3072GB	4	448	35,84 TFlops
<b>iris TOTAL:</b>				<b>196</b>	<b>5824</b>	<b>347.65 TFlops</b>
				<b>96 GPUs</b>	<b>491520</b>	<b>+748.8 GPU Tflops</b>

g5k	2008	Dell	Intel Xeon L5335@2GHz 2 × 4C,16GB	22	176	1.408 TFlops
	2012	Dell	Intel Xeon E5-2630L@2GHz 2 × 6C,24GB	16	192	3.072 TFlops
<b>granduc/petitprince TOTAL:</b>				<b>38</b>	<b>368</b>	<b>4.48 TFlops</b>

## Fast Local Interconnect Network

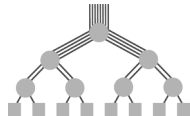
- HPC interconnect technologies nowadays divided into three categories
  - ① Ethernet: dominant interconnect standard yet underlying protocol has inherent limitations
    - ✓ preventing low-latency deployments expected in real HPC environment
  - ② InfiniBand: predominant interconnect technology in the HPC market
  - ③ Vendor specific interconnects: Cray/HPC Slingshot, Intel Omni-Path, Bull BXI...

- **On ULHPC: InfiniBand (IB) solution**

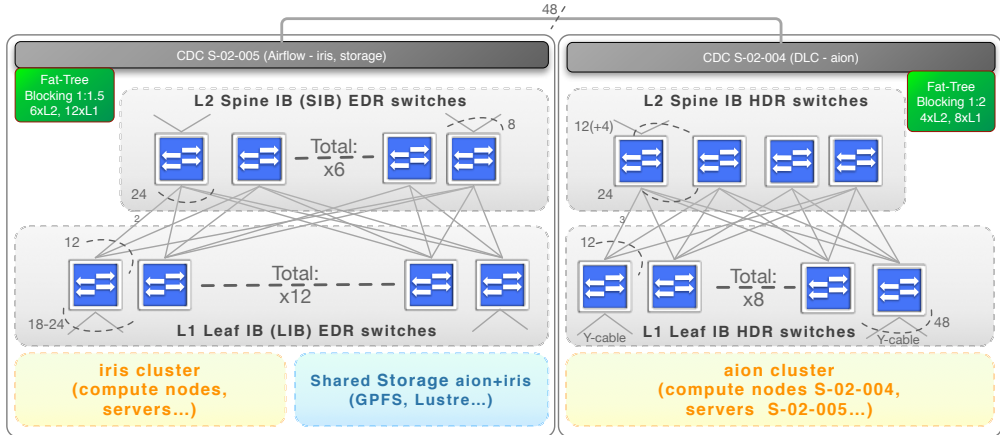
- ↪ iris: Infiniband (IB) **EDR** Fabric in a **Fat-Tree** Topology
  - ↪ aion: Infiniband (IB) **HDR100** Fabric in a **Fat-Tree** Topology

- **Up/Down InfiniBand Routing Algorithm**

- ↪ super-set of Fat-Tree with a tracker mode (allow each node to have dedicated route)
  - ↪ well adapted to IO traffic patterns



# Fast Local Infiniband Interconnect Network



## Ethernet Network

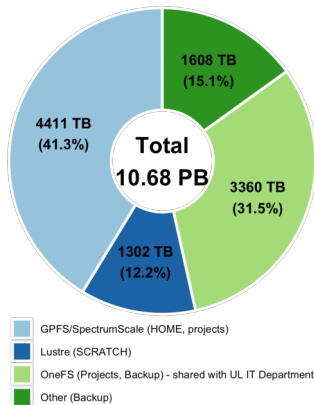
- High-bandwidth and low-latency network: local Fast IB interconnect network
  - ↳ support efficient HPC and Big data workloads
- Flexibility of Ethernet-based networks still required

### UL HPC Ethernet network

- **2-layers** topology
  - ↳ Upper level: **Gateway Layer**
    - ✓ routing, switching features, network isolation and filtering (ACL) rules
    - ✓ meant to interconnect only switches.
    - ✓ allows to interface the University network (LAN/WAN)
  - ↳ bottom level: **Switching Layer**
    - ✓ composed by [stacked] core switches as well as the TOR (Top-the-rack) switches,
    - ✓ meant to interface HPC servers and compute nodes

## UL HPC Storage Systems

UL HPC Storage FileSystems (2020)



## UL HPC Software Stack

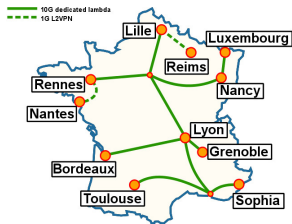
### Operating System: **Linux CentOS/Redhat**

- **User Single Sign-on:** Redhat IdM/IPA
- **Remote connection & data transfer:** SSH/SFTP
  - ↳ **User Portal:** Open OnDemand
- **Scheduler/Resource management:** Slurm
- **(Automatic) Server / Compute Node Deployment:**
  - ↳ BlueBanquise, Bright Cluster Manager, Ansible, Puppet and Kadeploy
- **Virtualization and Container Framework:** KVM, Singularity
- **Platform Monitoring** (User level): Ganglia, SlurmWeb, OpenOnDemand...
- **ISV software:**
  - ↳ ABAQUS, ANSYS, MATLAB, Mathematica, Gurobi Optimizer, Intel Cluster Studio XE, ARM Forge & Perf. Report, Stata, ...



## The case of Grid'5000

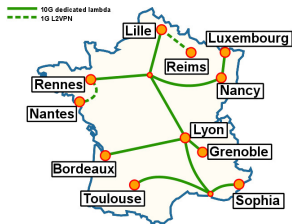
- Large scale nation wide infrastructure  
 ↳ for large scale parallel and distributed computing research.



- 8 sites, 7 in France (1 site **Abroad**: Luxembourg)  
 ↳ Total: **12326** cores over **31** clusters
- 1-10GbE / Infiniband  
 ↳ **10Gb/s dedicated** between all sites
- Unique software stack  
 ↳ **kadeploy, kavlan, kwapi**

## The case of Grid'5000

- Large scale nation wide infrastructure  
 ↳ for large scale parallel and distributed computing research.



- 8 sites, 7 in France (1 site **Abroad**: Luxembourg)  
 ↳ Total: **12326** cores over **31** clusters
- 1-10GbE / Infiniband  
 ↳ **10Gb/s dedicated** between all sites
- Unique software stack  
 ↳ **kadeploy, kavlan, kwapi**

### • Out of scope for this talk

- ↳ General information:
- ↳ Grid'5000 website and documentation:

<https://hpc.uni.lu/g5k>

<https://www.grid5000.fr>



# Summary

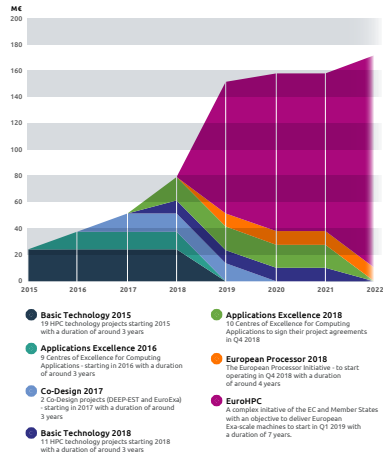
- 1 Research Excellence in Luxembourg
- 2 High Performance Computing (HPC) @ UL
  - Overview
  - Governance
  - ULHPC Supercomputing Facilities Details
- 3 HPC Strategy in Luxembourg and in Europe

## European HPC strategy

- EU HPC strategy initiated in 2012  
→ implementation within H2020 program
- Based on three pillars:
  - ① **HPC Infrastructure:** PRACE, GEANT
  - ② **HPC Technology:**
    - ✓ ETP4HPC, European Processor Initiative (EPI)
  - ③ **Application expertise:**
    - ✓ Centres of Excellence of Computing Applications (CoEs)
- Significant upgrade in 2018 of the EC Strategy on HPC  
→ **EuroHPC Joint Undertaking (JU)**

EU Tier-0 HPC systems	Total Capacity
PRACE	111.24 PFlops
EuroHPC {Peta,Pre-Exa}scale	717 PFlops

Summary of the EU HPC funding efforts  
[Source : ETP4HPC Handbook 2018]





## EU HPC Strategy Implementation

- **European Technology Platform (ETP) for HPC**

- ↪ Industry-led forum feat. HPC stakeholders
- ↪ Providing EU framework to define HPC research priorities/actions: SRA, HPC Handbook
  - ✓ UL part of ETP4HPC (2016-)



EUROPEAN  
TECHNOLOGY  
PLATFORM  
FOR HIGH  
PERFORMANCE  
COMPUTING

# EU HPC Strategy Implementation



EUROPEAN  
TECHNOLOGY  
PLATFORM  
FOR HIGH  
PERFORMANCE  
COMPUTING

- **European Technology Platform (ETP) for HPC**

- ↪ Industry-led forum feat. HPC stakeholders
- ↪ Providing EU framework to define HPC research priorities/actions: SRA, HPC Handbook
  - ✓ UL part of **ETP4HPC** (2016-)

- **PRACE** - Partnership for Advanced Computing in Europe

- ↪ Non-profit association, 25 member countries, now entering PRACE2/PRACE3
- ↪ (Oct. 2017) **Luxembourg 25th country to join PRACE**
  - ✓ Official Delegate/Advisor (P. Bouvry/S. Varrette) from UL



## EU HPC Strategy Implementation

### • European High-Performance Computing Joint Undertaking

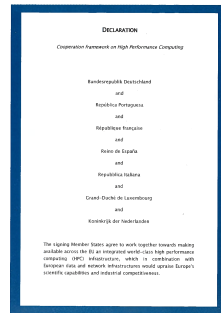
- EuroHPC JU effectively operational starting **Jan 1st, 2019**
  - ✓ administrative management from **Luxembourg**
- **Budget:  $\simeq$  1.5 B€** (536M€ from EU)
- Public and private members
  - ✓ EC, 32 MS, representatives from supercomputing/BD stakeholders
  - ✓ Governing Board (public members)
  - ✓ Industrial & Scientific Advisory Board (private members)
- EU Objective with EuroHPC:
  - ✓ 5 **Petascale** systems (2020) (incl. MeluXina in Luxembourg)
  - ✓ 3 **Pre-exascale** systems (2020)
  - ✓ 2 **exascale** systems (2022-2023)
  - ✓ Post-exascale system (2027)

### • European Processor Initiative (EPI)

- **120 M€** via Framework Partnership Agreement (FPA)



**EuroHPC**  
Joint Undertaking



## EuroHPC JU Ongoing Activities (Q3 2020)

- HPC in the lead for finding solutions for COVID-19 pandemics
  - ↳ PRACE specific fast track call for COVID-19 research
  - ↳ Exascale4Cov project
- Election of the EuroHPC JU Executive Director (postponed early Autumn)
- EU-US cooperation (PRACE-XSEDE)
- Procurement for 8 supercomputers (3 pre-exa, 5 Peta) continued
  - ↳ EuroHPC 2020 Budget for MeluXina: 10,5 M€
- **EuroHPC Competence Center**, CASTIEL



**EuroHPC**  
Joint Undertaking

- **Sept 2020:** EuroHPC Phase 2 (revised Regulation 2021-2027) announcement (EC)
  - ↳ State of the Union speech, by Ursula von der Leyen
  - ↳ **8 B€ investment in EU HPC / Digital sovereignty**
    - ✓ Next-generation exascale supercomputers
    - ✓ Quantum computers and hybrid computers
    - ✓ EU Cloud **Gaia-X**, a Federated Data Infrastructure for Europe. . .





Thank you for your attention...

## Questions?

<http://hpc.uni.lu>

### High Performance Computing @ uni.lu

Prof. Pascal Bouvry  
Dr. Sebastien Varrette  
Sarah Peter  
Hyacinthe Cartiaux  
Dr. Frederic Pinel  
Dr. Emmanuel Kieffer  
Dr. Ezhilmathi Krishnasamy  
Teddy Valette  
Abatcha Olloh

University of Luxembourg, Belval Campus:  
Maison du Nombre, 4th floor  
2, avenue de l'Université  
L-4365 Esch-sur-Alzette  
*mail:* [hpc@uni.lu](mailto:hpc@uni.lu)



- 1 Research Excellence in Luxembourg
- 2 High Performance Computing (HPC) @ UL  
Overview

Governance  
ULHPC Supercomputing Facilities Details

- 3 HPC Strategy in Luxembourg and in Europe

