



Atos



# The New Aion Supercomputer

## Overview, Technical Specifications and Capabilities

High Performance  
Computing &  
Big Data Services



hpc.uni.lu



hpc@uni.lu



@ULHPC



Dr. S. Varrette & UL HPC Team

<https://hpc.uni.lu>

Official Inauguration of the Aion Supercomputer

Nov 10<sup>th</sup>, 2021





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# Summary

- 1 Introduction
- 2 RFP 190027 Technical Characteristics
- 3 Performance Evaluation
- 4 Conclusion

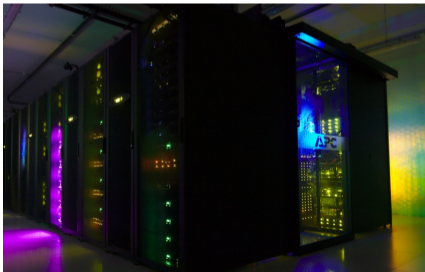
## Context & Motivations

- **2019: gaia and chaos clusters decommissioned**

Total: 354 nodes

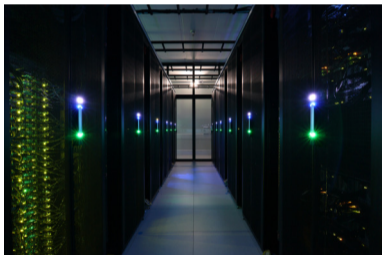
↳ After 8 (resp. 12) years of good & faithful service

✓ 6.2 million jobs were processed, cumulating **13,8 MILLENIUM** of CPU Time usage



## Context & Motivations

- Leaves **only iris supercomputer** to serve the University & its partners (in production since 2017)

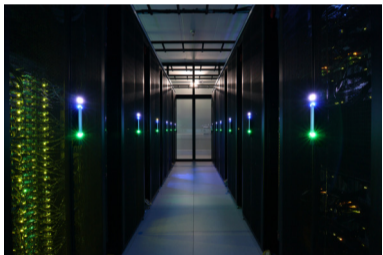


[hpc-docs.uni.lu/systems/iris/](https://hpc-docs.uni.lu/systems/iris/)

- **Dell/Intel** supercomputer *Air-flow cooling*
  - ↪ 196 compute nodes, **5824 cores**, 52.2 TB RAM
  - ↪  $R_{\text{peak}}$ : **1,07 PetaFlop/s**

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- ⇒ **European Tender for acquisition of a new HPC supercomputer aion** (RFP 190027)
  - ↪ to compensate for the 354 decommissioned nodes

# RFP 190027 Chronology

## RFP 190027 Release

2019

- **Sept, 2019:** Official Public release of Aion cluster tenders on TED European tender and PMP Portal (Portail des Marchés Publics)
  - TED European tender: TED72/2019-608787
  - PMP Reference: 1901442

- **July-August 2019:** RFP 190027 Preparation
  - Tender description (**116 pages**)
  - Criteria Weighting: **~550 evaluated criterias**
  - Budget: **3.5 M€**



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## 2020 Attribution & Kickoff

- Dec, 2019: RFP awarded to Atos (MOM)
  - Lot 1: DLC supercomputer aion
  - Lot 2: Iris storage extension and consolidation
  - Lot 3: Infiniband/Ethernet interconnect consolidation
- Jan, 2020: Project Kickoff
  - Planned completion: Q3 2020

- July-August 2019: RFP 190027 Preparation
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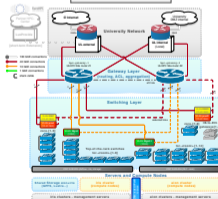
Lot 1: Aion Supercomputer



Lot 2 / Storage extension



Lot 3 / Ethernet



Lot 3 / Infiniband



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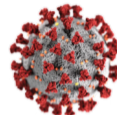
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COVID-19 Pandemic and worldwide crisis

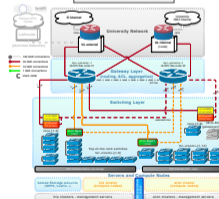
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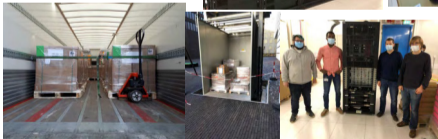
# RFP 190027 Chronology

## Delivery & Install

2021

- **Jan-Feb, 2021:** Start of installation Lot 1
- **Mar, 2021:** Installation Lot 2 GPFS/SpectrumScale: GS7990 expansion installation, setup, and integration ; Lustre upgrade  
Slurm upgrade

- **Oct, 2020:** CDC S02-004 (Power & Hydraulic Work) completed
- **Dec, 2020:** Partial Delivery of intermediate equipment (Servers, DDN part)



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## Setup & Evaluation

- **Apr, 2021:** Start of installation Lot 3
- **May, 2021:** Merge Iris/Aion Infiniband Island
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## Beta Opening

- **July 30, 2021:** Aion supercomputer opened for beta testers  
Aion Pre-acceptance  
Benchmark results submissions (HPL, HPCG, Green500, Graph500, IOR, IO500...)

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## Production Release

- **Oct 3, 2021:** Aion supercomputer opened
- **Nov 10, 2021:** Official inauguration
- **Nov 12-19, 2021:** 11<sup>th</sup> UL HPC School 2021  
Practical sessions on Aion  
3 keynotes, 12 practical sessions

- **Oct, 2020:** CDC S02-004 (Power & Hydraulic Work) completed
- **Dec, 2020:** Partial Delivery of intermediate equipment (Servers, DDN part)



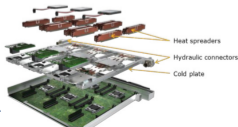
# Lot 1: aion supercomputer

[hpc-docs.uni.lu/systems/aion/](http://hpc-docs.uni.lu/systems/aion/)

## • Atos/AMD supercomputer

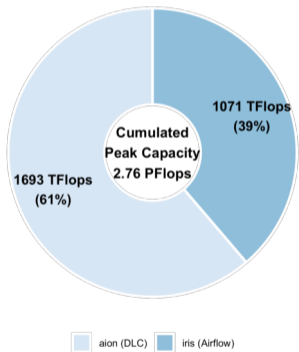
- ↪ Bull Sequana XH2000 adjacent racks
  - ✓ Direct-Liquid-Cooling (DLC)
- ↪ 318 compute nodes, **40704 cores**, 81.4 TB RAM
- ↪  **$R_{peak}$ : 1.7 PetaFlop/s**

#Nodes	#cores	Processors Type per node	RAM/node
318	40704	2× AMD Epyc ROME 7H12 @ 2.6 GHz [64c/280W]	256 GB



# Increased UL HPC Computing Capacity

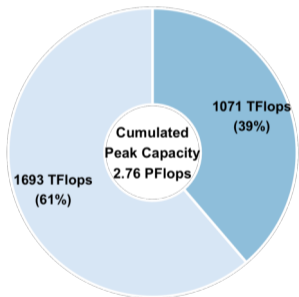
UL HPC Supercomputers (2021)



[hpc-docs.uni.lu/systems/](http://hpc-docs.uni.lu/systems/)

# Increased UL HPC Computing Capacity

UL HPC Supercomputers (2021)



■ aion (DLC)
 ■ iris (Airflow)

[hpc-docs.uni.lu/systems/](http://hpc-docs.uni.lu/systems/)

	#N	#C	R <sub>peak</sub>
<b>Uni.lu HPC TOTAL:</b>	<b>514</b>	<b>46528</b>	<b>2764 TFlops</b>
	(incl. 748.8 GPU TFlops)		

Cluster	Date	Vendor	Processors Type and Model	#N	#C	R <sub>peak</sub>	
aion	2021	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>

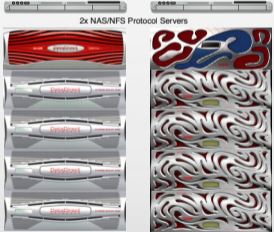
iris	2017	Dell	Intel Xeon E5-2680 v4@2.4GHz	2 × 14C,128GB	108	3024	116,12 TFlops
	2018	Dell	Intel Xeon Gold 6132 @ 2.6 GHz	2 × 14C,128GB	60	1680	123,65 TFlops
	2018	Dell	Intel Xeon Gold 6132 @ 2.6 GHz	2 × 14C,768GB	24	672	49,45 TFlops
	2019		<i>Per node: 4x NVIDIA Tesla V100 SXM2 16/32GB</i>		96 GPUs	491520	748,8 GPU TFlops
	2018	Dell	Intel Xeon Platinum 8180M @ 2.5 GHz	4 × 28C,3072GB	4	448	32,97 TFlops
<b>iris TOTAL:</b>				<b>196</b>	<b>5824</b>	<b>1071 TFlops</b>	
				<b>96 GPUs</b>	491520		

## Lot 2: GPFS/SpectrumScale Storage Extension

- Global high-performance clustered file system  
↳ capacity & performance increased

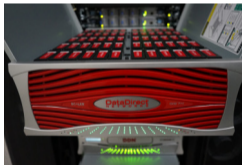
**GPFS/SpectrumScale Storage**  
(\$HOME, projects data)  
4260 TB (raw), 3408 TB (effective)

2x NAS/NFS Protocol Servers



**DDN GridScaler 7K (24U)**  
1xGS7K base + 4 SS8480 expansion  
350 disks (8 TB SAS SED, 35 RAID6 pools)  
28 disks SSD (400 GB, 14 RAID1 pools)

**DDN GridScaler 7990 (24U)**  
1xGS7990 base + 4 SS9012 expansion  
360 disks (6 TB SED NL-SAS, 36 RAID6 pools)  
10 disks SAS-SSD (3.2 TB, 1 RAID6 pool)



[hpc-docs.uni.lu/filesystems/](http://hpc-docs.uni.lu/filesystems/)



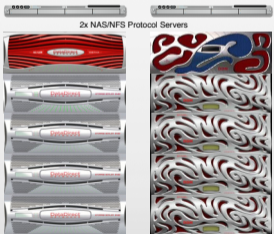
# Lot 2: GPFS/SpectrumScale Storage Extension

- **Global high-performance clustered file system**

- ↳ capacity & performance increased
- ↳ other shared storage solutions available

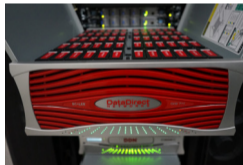
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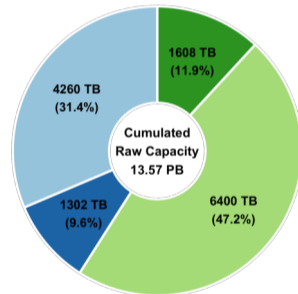
**DDN GridScaler 7K (24U)**  
1xGS7K base + 4 SSB460 expansion  
350 disks (8 TB SAS SED, 35 RAID6 pools)  
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## UL HPC Storage FileSystems (2021)



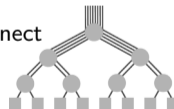
- GPFS/SpectrumScale (HOME, projects)
- Lustre (SCRATCH)
- OneFS (Projects, Backup) shared with UL IT Department
- Other (Backup)

## Interconnect Networks (Infiniband and Ethernet)

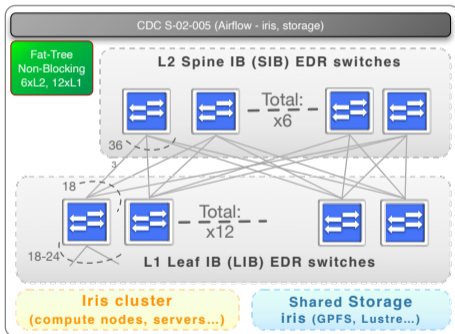
- HPC interconnect technologies nowadays divided into three categories
  - ① **Ethernet**: dominant interconnect standard yet underlying protocol has inherent limitations
    - ✓ preventing low-latency deployments expected in real HPC environment
  - ② **InfiniBand**: predominant interconnect technology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

- **On ULHPC Supercomputers:**

- ↳ **InfiniBand (IB)** in a **Fat-Tree** Topology as *Ultra-Fast* local interconnect
- ↳ Complementary Ethernet network
  - ✓ Consolidated as a 2-layers topology (Gateway / Switching Layers)

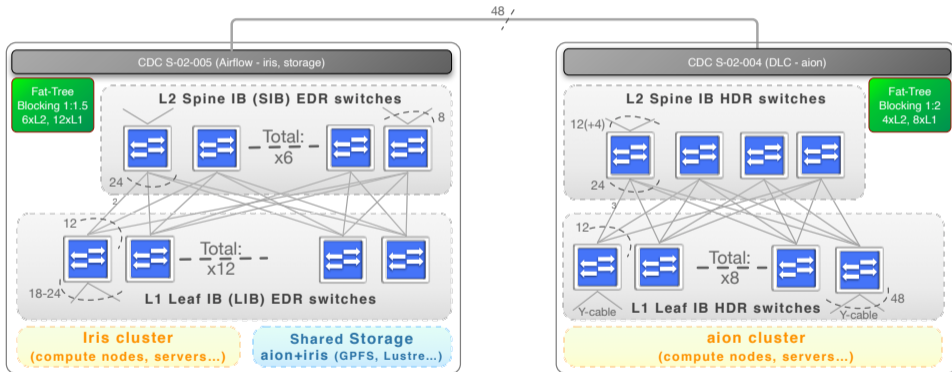


# Lot 1/3: Fast Infiniband (IB) Network (before)



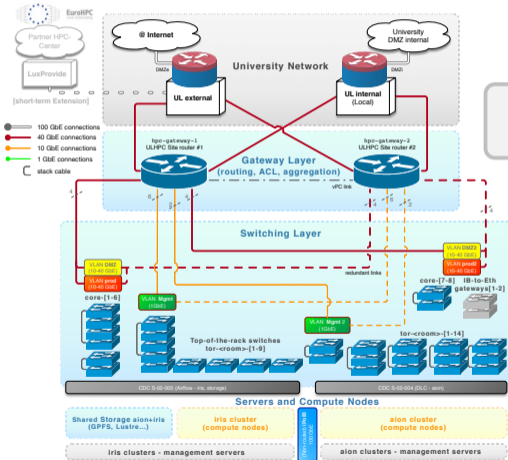
[hpc-docs.uni.lu/interconnect/ib/](http://hpc-docs.uni.lu/interconnect/ib/)

# Lot 1/3: Fast Infiniband (IB) Network (now)



[hpc-docs.uni.lu/interconnect/ib/](http://hpc-docs.uni.lu/interconnect/ib/)

# Lot 3: Ethernet Network Adaptation

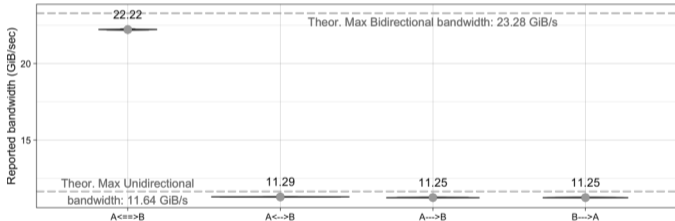


[hpc-docs.uni.lu/interconnect/ethernet/](http://hpc-docs.uni.lu/interconnect/ethernet/)

# Aion Supercomputer *[selected]* Performance Evaluations

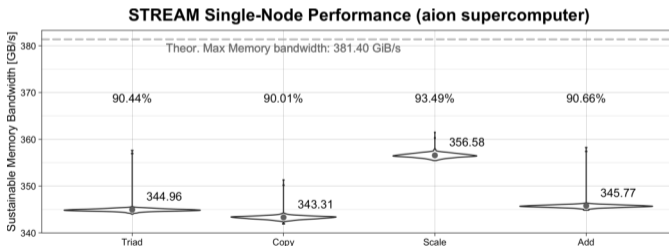
- Bisection Bandwidth (**BB**) benchmarks: **96,99% efficiency**

MPI Parallel Bisection Bandwidth (BB) benchmark of ULHPC IB Network



# Aion Supercomputer *[selected]* Performance Evaluations

- Bisection Bandwidth (**BB**) benchmarks: **96,99% efficiency**
- **STREAM** sustainable **Memory Bandwidth** performance  
 ↳ **above 90,01% efficiency** for 4 highly-intensive memory access pattern





# Aion Supercomputer *[selected]* Performance Evaluations

- Large-scale optimized [full] runs

- Reference HPC benchmarks: HPL, HPCG, Graph500...
- Energy-efficiency evaluation: Green500, GreenGraph500...

Benchmark	#Node	Best Performance	Improvement*	Equivalent Worldwide Rank
HPL (Top500)	318	$R_{max} = 1255.36$ TFlops (74,20% efficiency)	+ 1.9%	> 500 (Nov 2021), #490 (Jun 2020)
Green500	318	5.19 GFlops/W	+ 12,83%	#56 (Jun 2021)
HPCG	318	16.842 TFlops	+ 15,35%	#135 (Jun 2021)
Graph500 BFS	256	975 GTEPS	+ 64%	#23 (Jun 2021)
GreenGraph500	256	6.14 MTEPS/W	+ 180%	#36 (Jun 2021)

\*: performance improvement with the minimal acceptance threshold set in the tender





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- In complement: UL HPC Software Set Validation

# UL HPC Shared Storage Performance Evaluation

- **IOR I/O benchmarks: 2x performance increase with Lot 2 extension**

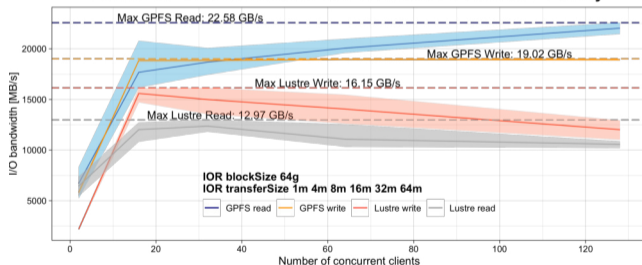
↳ Max Read: 22.58 GB/s

(was 11.33 GB/s on the previous configuration)

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IOR v3.1.0 - MPI Coordinated Test of Parallel I/O on ULHPC Facility



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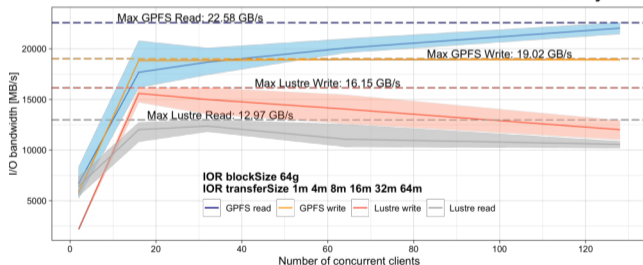
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IOR v3.1.0 - MPI Coordinated Test of Parallel I/O on ULHPC Facility



- **IO500 best score 11.345219**

Would rank ULHPC #42 in the latest IO500 list (Nov 2020)

# Aion would NOT be here Today without...



Prof. S. Pallage



Prof. J. Kreisel



Prof. P. Bouvry



Prof. J.M. Schlenker



Prof. R. Balling



Prof. B. Ottersten



Prof. A. Tkatchenko

Uni.lu HPC for research (86.66%)

FSTM (3.33%)

LCSB (3.33%)

SnT (3.33%)

ERC-CoG (3.33%)



## Conclusion

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Procurement



M. Bourcy



Q. Bracaval

Rectorate & Financial Support



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Q. Bracaval

Legal affairs



C. Isolano



A. Lashram



S. Munoz

DPO

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**SIU**










D. Constant    S. Lassere    M. De Souza    M. Christophe    J. Lorang    M. Reiter




**Datcenter Engineers**                      **Uni.lu Network and IT specialists**

**Procurement**

M. Bourcy    Q. Bracaval

**Legal affairs**

C. Isolano    A. Lashram    S. Munoz

**DPO**

**Rectorate & Financial Support**









Prof. S. Pallage    Prof. J. Kreisel    Prof. P. Bouvry    Prof. J.M. Schlenker    Prof. R. Balling    Prof. B. Ottersten    Prof. A. Tkatchenko

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# Conclusion

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Uni.lu HPC Team and Experts



Dr. S. Varrette



H. Cartiaux



T. Valette



A. Ollou



S. Peter



Dr. E. Kieffer



Dr. E. Krishnasamy



Dr. X. Besson



Dr. A. Ginolhac

Research Computing and HPC Operations

HPC Research

HPC Experts

and all Aion beta-testers (~15 researchers) !

SIU



D. Constant



S. Lassere



M. De Souza



M. Christophe



J. Lorang



M. Reiter

Datacenter Engineers

Uni.lu Network and IT specialists

Procurement



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S. Peter



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Dr. E. Krishnasamy



Dr. X. Besseron



Dr. A. Ginolhac

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and all Aion beta-testers (~15 researchers) !

and all the ULHPC users ! (~ 650 active users)

SIU



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and all the ULHPC users ! (~ 650 active users)

SIU



D. Constant



S. Lassere



M. De Souza



M. Christophe



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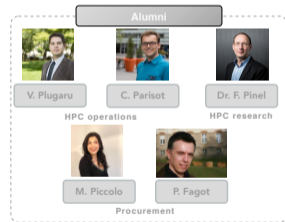
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- 1 Introduction
- 2 RFP 190027 Technical Characteristics
- 3 Performance Evaluation
- 4 Conclusion

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