



THE CYPRUS
INSTITUTE

RESEARCH • TECHNOLOGY • INNOVATION



EURO

HPC National Competence Center

Overview of HPC Systems - Dr. S. Bacchio

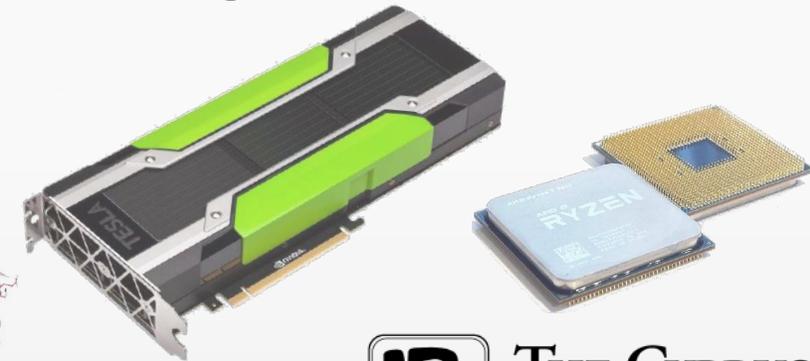
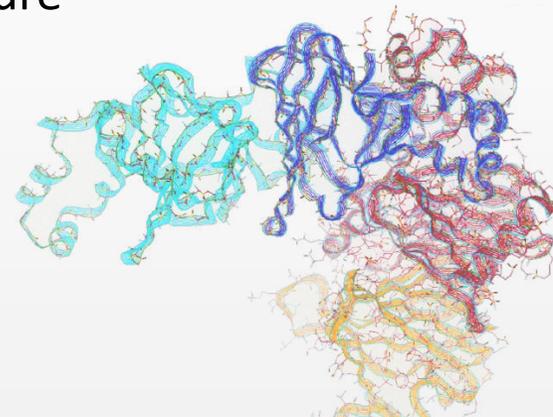


Overview of HPC Systems

- Supercomputers in Europe, present and future
- The TOP500 list, analysis of the trends
- Co-processors: CPU vs GPU architecture
- The mission of the HPC NCC

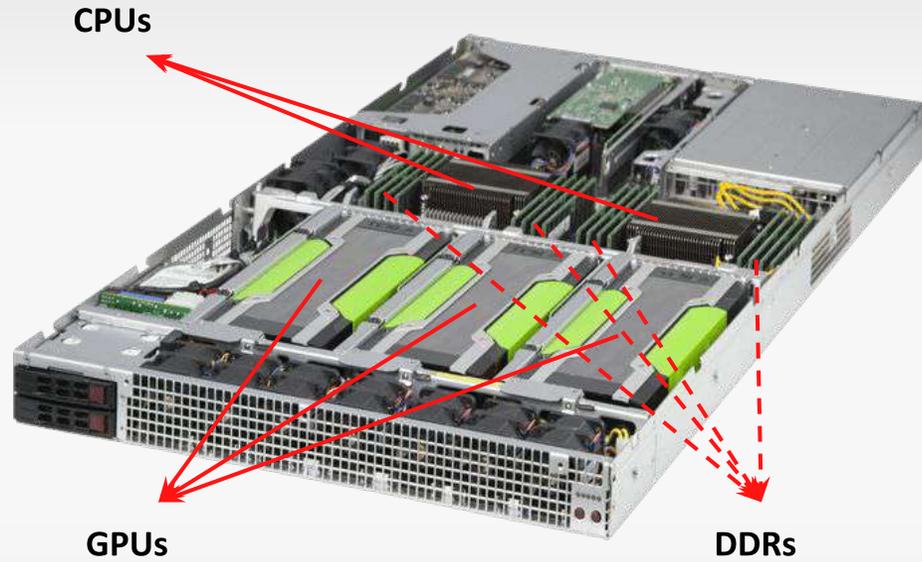


EuroHPC
Joint Undertaking





Computing Node



X no hard-drive and **X** no voltage convertor
Centralized long-term storage and power supply

VS

A node is
5x faster than
a desktop

Desktop



Inside a supercomputers

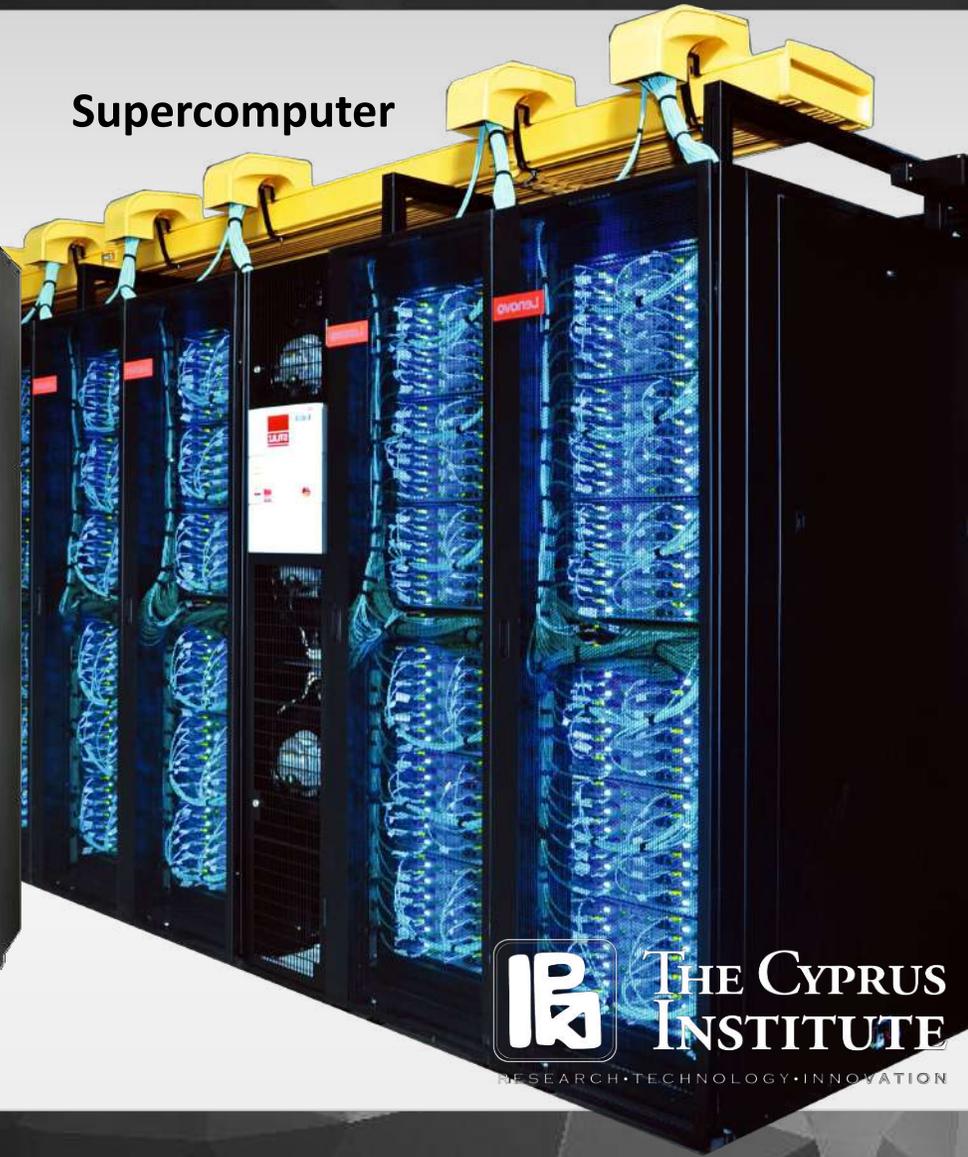
HPC NCC - CaSToRC



Computing Node

Rack

Supercomputer



- + Network
- + Storage
- + Power supply
- + Cooling



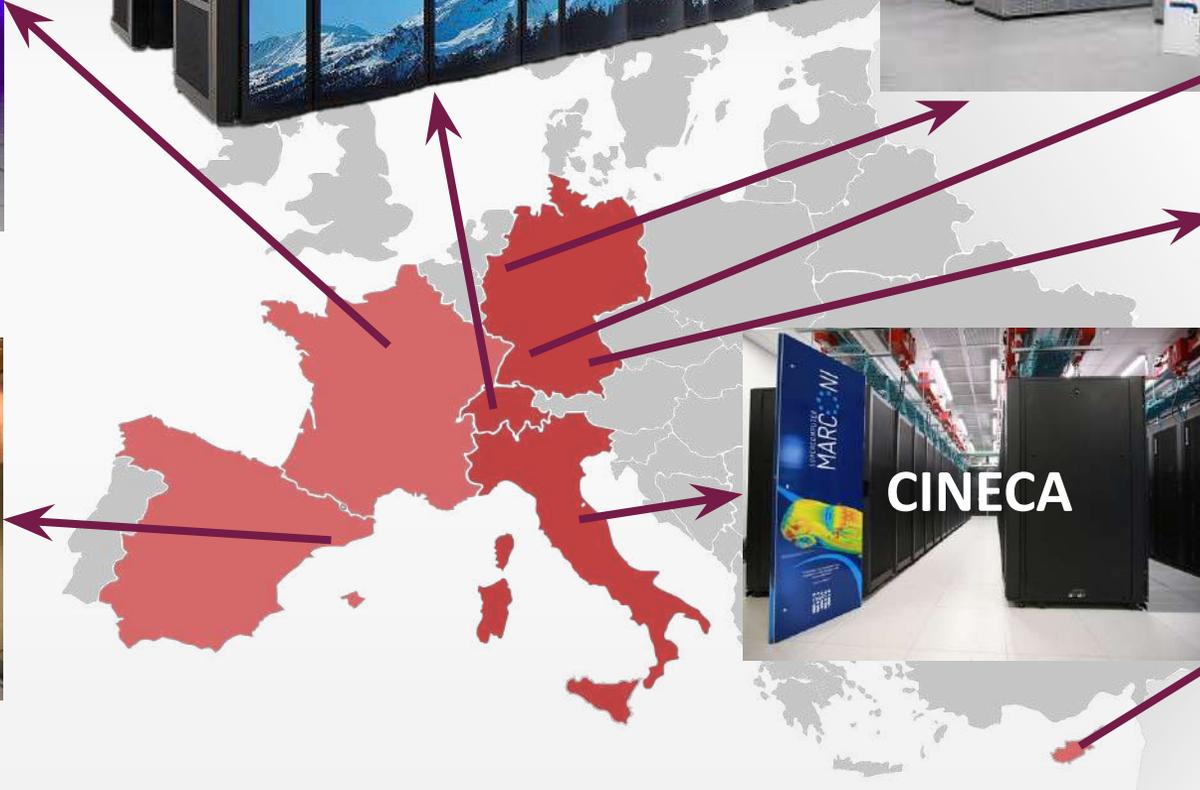
Supercomputers in Europe

HPC NCC - CaSToRC



Supercomputers in Europe

HPC NCC - CaSToRC

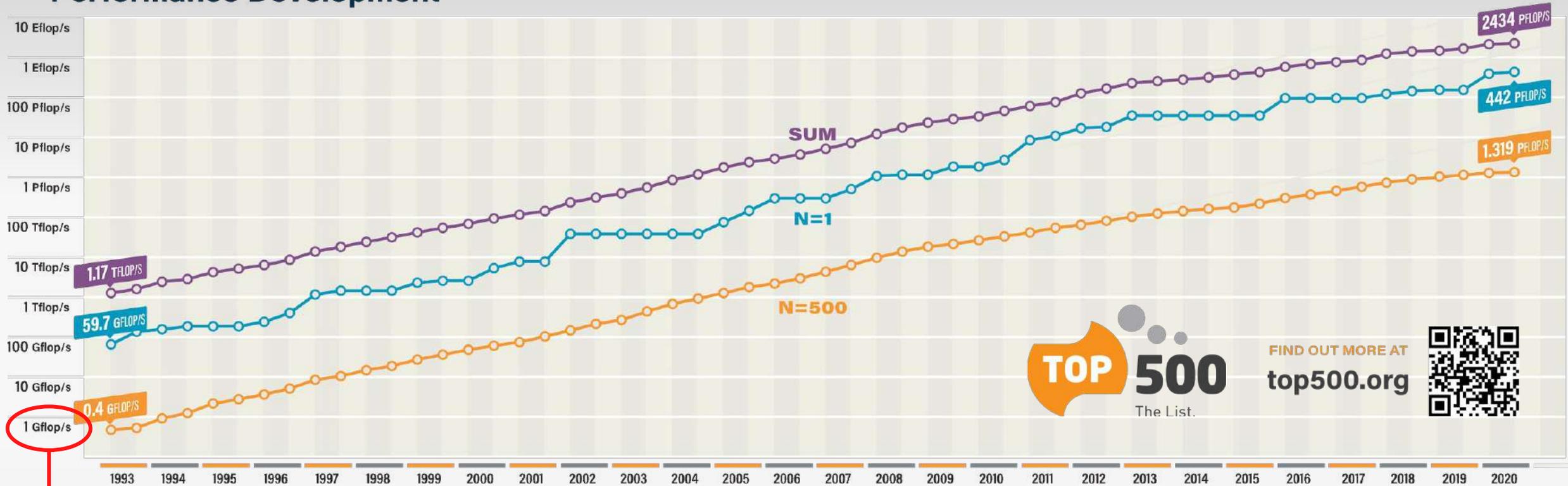


TOP 500 - The List.

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Performance Development



FIND OUT MORE AT
top500.org



FLOP/s = Floating Point Operations per Second
(in double precision)

A Standard PC does about 50 Gflops (CPU) and
1 Tflops (GPU).

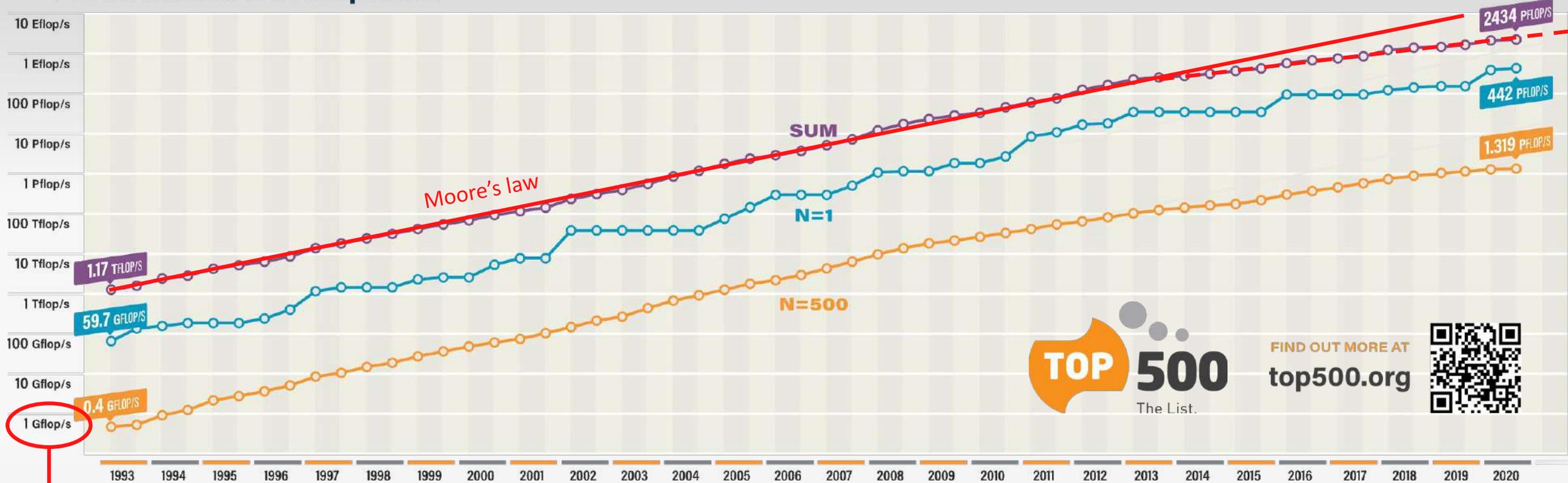


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TOP 500 - The List.



Performance Development



FLOP/s = Floating Point Operations per Second
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TOP HPC systems

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NOVEMBER 2020 SYSTEM

	SYSTEM	SPECS	SITE	COUNTRY	CORES	R _{MAX} PFLOP/S	POWER MW
1	Fugaku	Fujitsu A64FX (48C, 2.2GHz), Tofu Interconnect D	RIKEN R-CCS	Japan	7,630,848	442.0	29.9
2	Summit	IBM POWER9 (22C, 3.07GHz), NVIDIA Volta GV100 (80C), Dual-Rail Mellanox EDR Infiniband	DOE/SC/ORNL	USA	2,414,592	148.6	10.1
3	Sierra	IBM POWER9 (22C, 3.1GHz), NVIDIA Tesla V100 (80C), Dual-Rail Mellanox EDR Infiniband	DOE/NNSA/LLNL	USA	1,572,480	94.6	7.44
4	Sunway TaihuLight	Shenwei SW26010 (260C, 1.45 GHz) Custom Interconnect	NSCC in Wuxi	China	10,649,600	93.0	15.4
5	Selene	NVIDIA DGX A100, AMD EPYC 7742 (64C, 2.25GHz), NVIDIA A100, Mellanox HDR Infiniband	NVIDIA Corporation	USA	555,520	63.4	2.65

Top European systems:

	SYSTEM	SPECS	SITE	COUNTRY	CORES	R _{max}	POWER
7	JUWELS Booster	AMD EPYC 7402 (24C 2.8GHZ), NVIDIA A100, Mellanox HDR Infiniband	Juelich	Germany	449,280	44.1	1.8
8	HPC5	Xeon Gold 6252 (24C 2.1GHz), NVIDIA V100, Mellanox HDR Infiniband	Eni S.p.A.	Italy	669,760	35.5	2.3
11	Marconi-100	IBM POWER9 (16C, 3GHz), NVIDIA V100, Mellanox EDR Infiniband	Cineca	Italy	347,776	21.6	1.4
12	Piz-daint	Xeon E5-2690v3 (12C 2.6GHz), NVIDIA P100, Cray/HPE	CSCS	Switz	387,872	21.2	2.4



TOP HPC systems



NOVEMBER 2020 SYSTEM

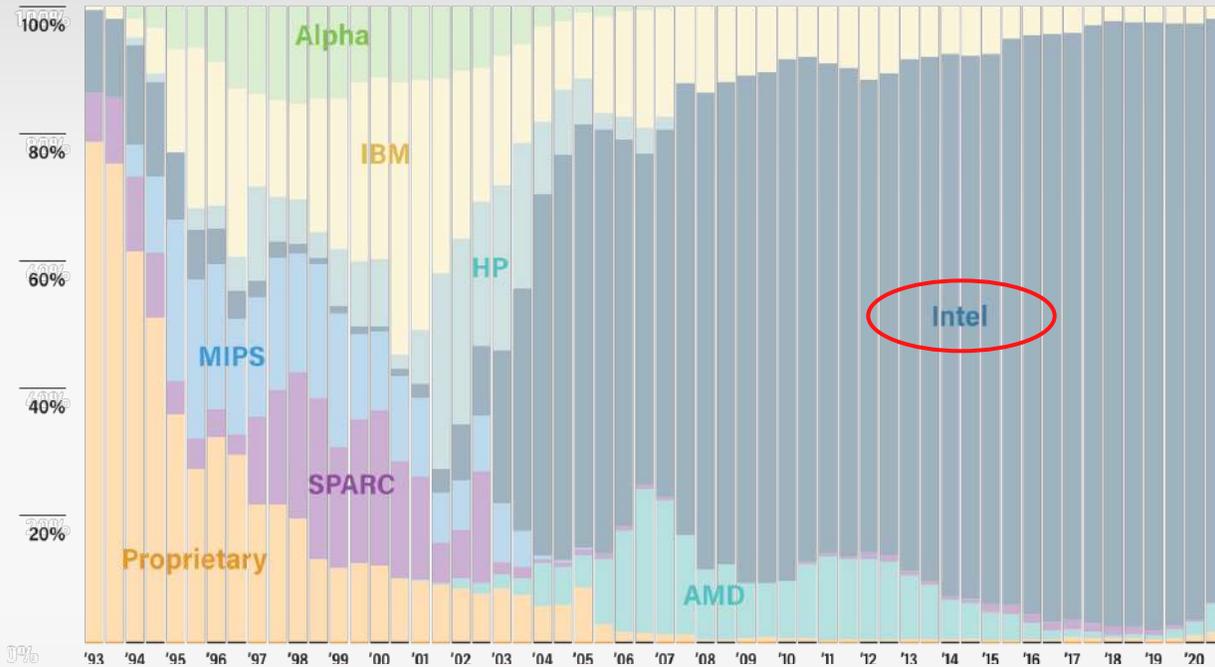
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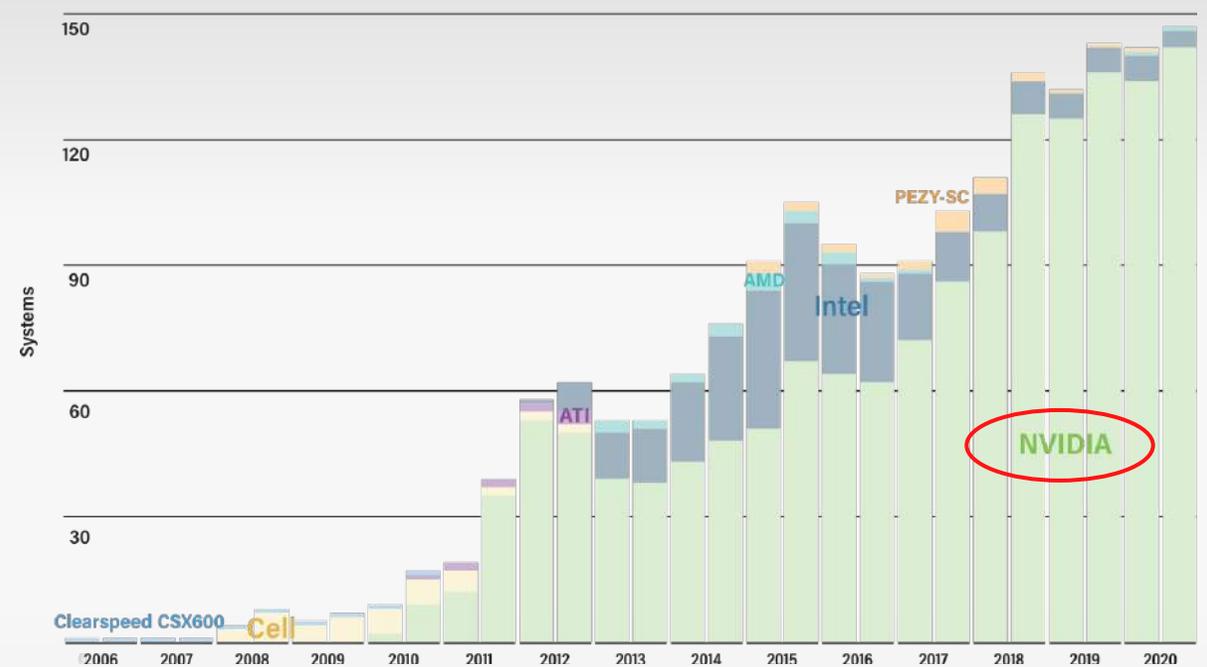
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Chip Technology



Accelerators/Co-processors

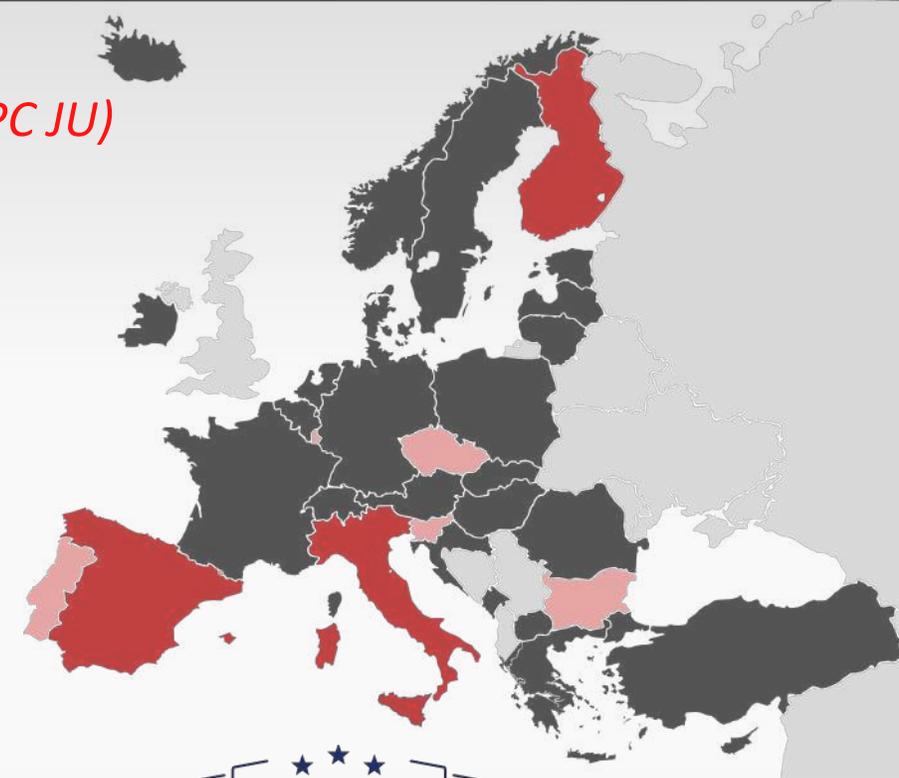


The European High Performance Computing Joint Undertaking (EuroHPC JU) is pooling European resources to buy and deploy top-of-the-range supercomputers and develop innovative exascale supercomputing technologies and applications.

The JU is currently supporting two main activities:

- Developing a pan-European supercomputing infrastructure:
 - **5 PetaFlop machines** in Bulgaria, Czech, Luxembourg, Slovenia, Portugal
 - **3 Pre-Exascale machines** with over 200 PetaFlops: Lumi in Finland, Leonardo in Italy and Marenostrum 5 in Spain
 - **2 Exascale machines** in an upcoming call

Upcoming Budget (2021 - 2033): 8 billion Euro



EuroHPC
Joint Undertaking



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Future European systems:

			SITE	COUNTRY	PFLOP/S
2021	LUMI	AMD Epyc CPUs, AMD Instinct GPUs	CSC	Finland	500
2021	Leonardo	Intel Xeon CPUs, NVIDIA Ampere A100	Cineca	Italy	250
2021	MareNostrum5	N/A (<i>probably</i> an heterogeneous system)	BSC	Spain	200

Future USA systems:

			SITE	COUNTRY	PFLOP/S
2023	El Capitan	AMD Epyc CPUs, AMD Instinct GPUs	NNSA	USA	2000
2021	Frontier	AMD Epyc CPUs, AMD Instinct GPUs	OLCF	USA	1500
2022	Aurora	Intel Xeon CPUs, Intel Xe GPUs	ALCF	USA	1000

Exascale!
Expected
also in EU
for 2023.



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NOTE: AMD and Intel are new enters in the list of GPUs vendors for top HPC systems

CPU vs GPUs

CPU



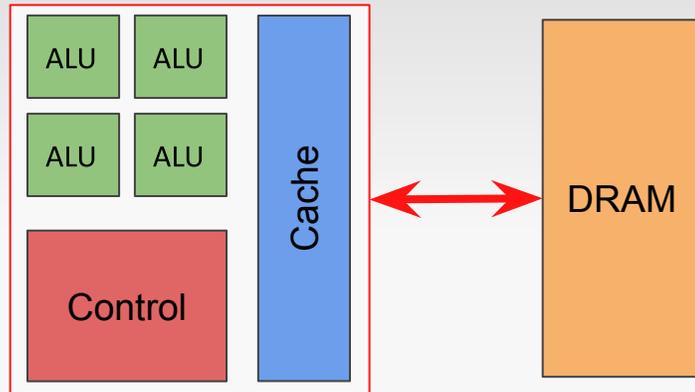
GPU



Low latency or High-throughput?

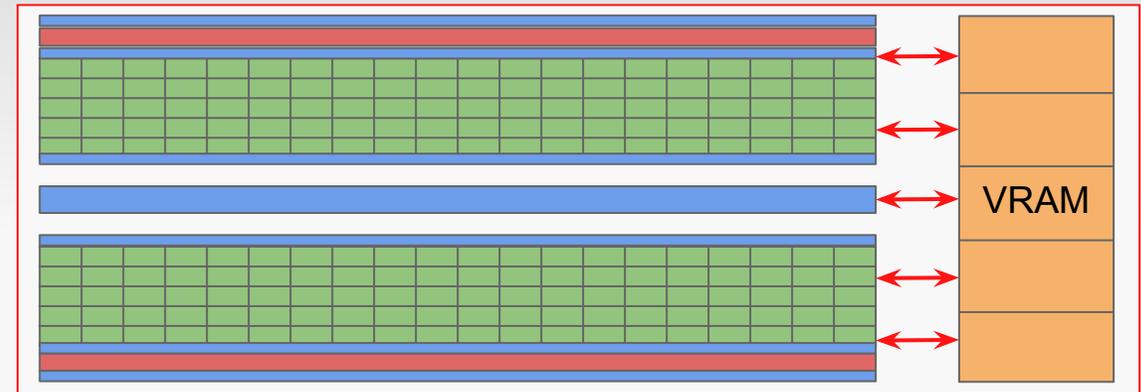


CPU



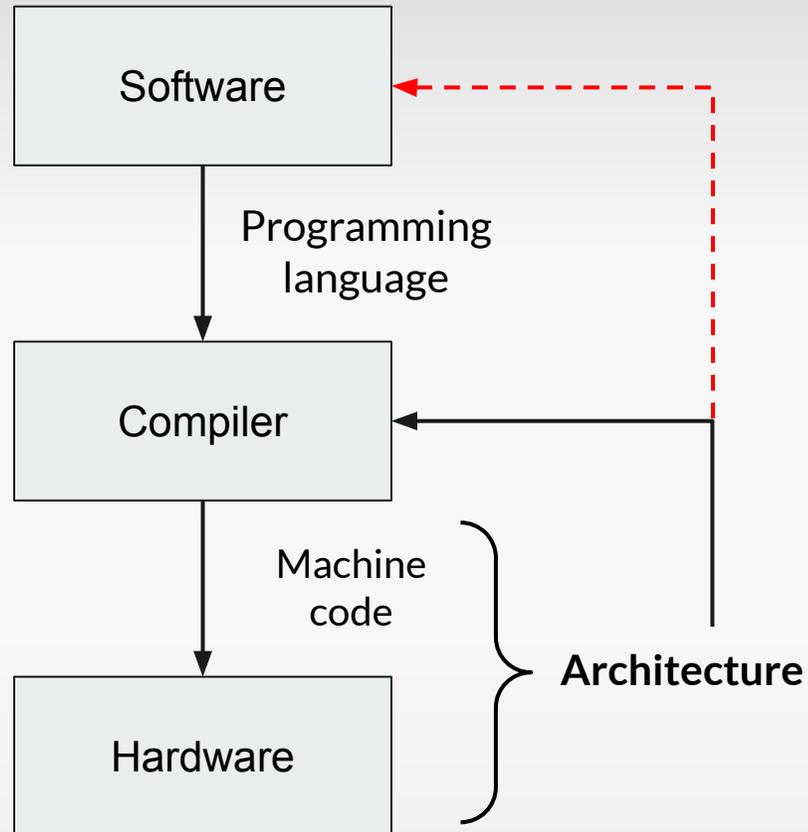
- **Optimized for low-latency access** to cached data
- Complex control logic (thousands of instructions available)
- Large caches (L1, L2, etc.)
- Optimized for serial operations
- Shallow pipelines (< 30 stages)
- Newer CPUs have more parallelism (becoming more GPU-like)

GPU



- **Optimized for data-parallel** throughput computation
- High latency tolerance
- High compute density per memory access
- High throughput
- Deep pipelines (hundreds of stages)
- Newer GPUs have better control logic (becoming more CPU-like)

Why is the architecture important?



The architecture affects the design of **HPC** software:

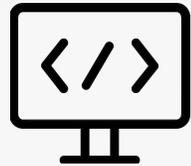
- Memory bandwidth
- Cache memory size
- Frequency
- Number of cores
- Instruction set:
 - Floating point operations (e.g. $y = a x + b$)
 - Single Instruction Multiple Data (SIMD)
- Architecture-specific features

How to research using HPC

HPC NCC - CaSToRC



- ❖ **Scientific problem**
 - Numerical approach
 - Computationally intensive
 - Parallelizable (task or data)



- ❖ **Software**
 - Optimized for HPC
 - Scalable



- ❖ **Access to a Supercomputer**
 - Preparatory access
 - Software test and benchmark
 - Competitive proposal for computing time



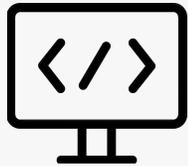
- ❖ **Production of results and analysis**
 - About 1 year long or more
 - Tera-/Peta-bytes of data produced
 - Various publications



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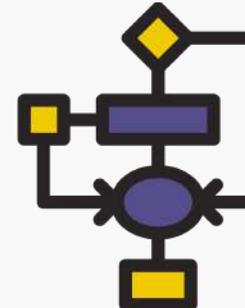
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- **Extra activities:**
 - Algorithmic research
 - Numerical improvements
 - Software development
 - New methodologies
 - Machine Learning

Our competences at the NCC

HPC NCC - CaSToRC



About us:

- Years of experience in HPC
- Access to the largest machines in Europe and USA
- Software development and optimization
- Cutting-edge research in various fields
- Numerical algorithms and large-scale simulations
- Data analysis and machine learning

Targets of NCC:

- Academic research
- Industrial applications
- Governmental support

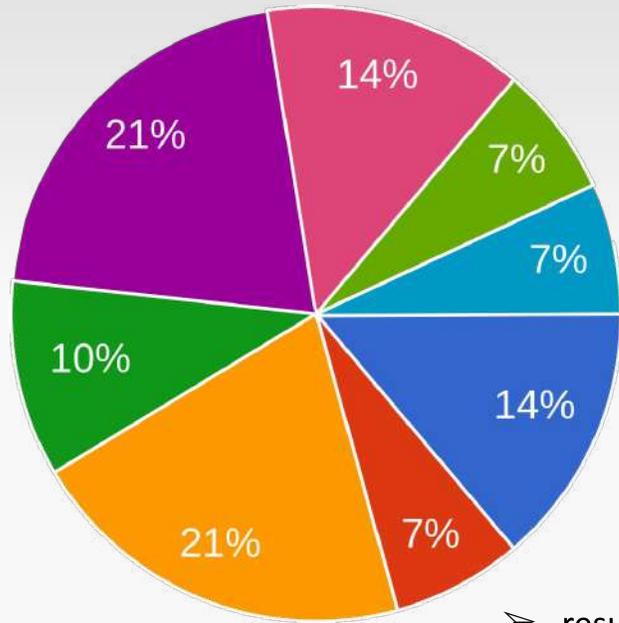
Activities:

- Training
- Seminars and Events
- Consulting



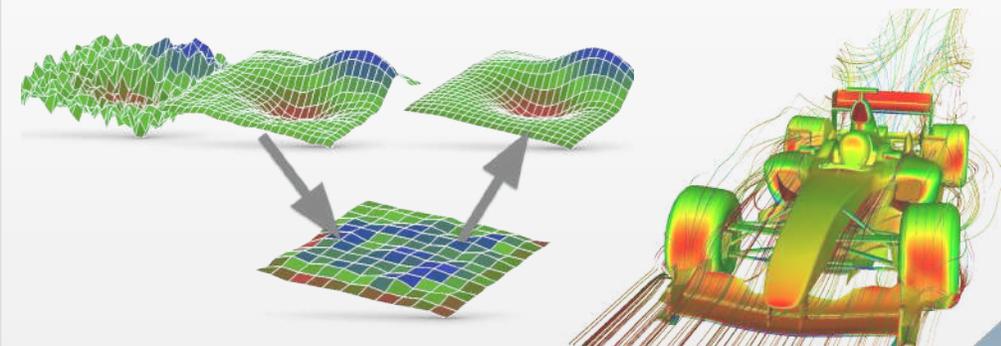
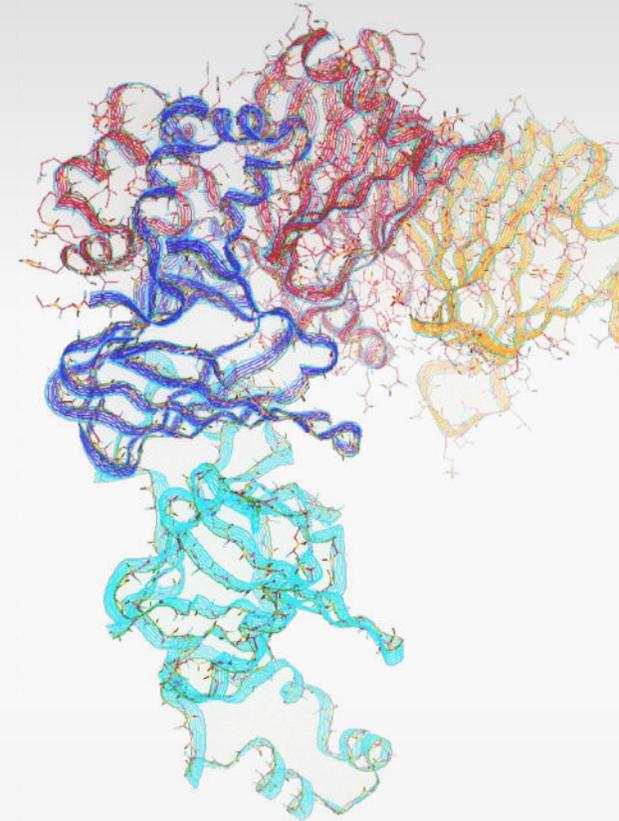
HPC research in Cyprus

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- Biochemistry, Bioinformatics
- Chemical Sciences
- Earth System Sciences
- Engineering
- Physics
- Mathematics and Computer Sc.
- Economics, Finance
- Others

➤ results from our survey on the scientific community in Cyprus



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2020 programme:



+ Internship programme (up to 6 months, paid)

Beginner Event:

15th-17th February

- 3-days event
- Introduction to HPC
- Hands-on on our systems
- Introduction to Parallel Computing
- Scripting and remote access
- Tips for writing proposals

Our HPC systems

HPC NCC - CaSToRC



- **Cy-Tera** (2012 - Legacy):
 - 98 nodes, 12-cores Intel Xeon CPU
 - ~300 TFlops
 - served > 480 projects
- **Cyclone** (2020 - Active):
 - 33 nodes, 2 x 20-cores Intel Xeon CPUs
 - 16 nodes with 4 x NVIDIA V100 GPUs
 - ~600 TFlops
 - Applications for access at <https://hpcf.cyi.ac.cy/apply/>
- **Upcoming** a new system for industrial applications with latest NVIDIA or AMD GPUs
- **Prototype systems:**
 - **Cyclamen** (2018): 8 nodes, 2 x 16-cores Intel Xeon CPU, 2 x NVIDIA P100 GPUs
 - **Phi** (2011): 4 nodes, 16-cores Intel Xeon CPU, 16 Xeon Phi accelerators

For more details, see <https://castorc.cyi.ac.cy/infrastructure>



Thank you!

HPC NCC - CaSToRC



Cultivate the use of HPC, Simulation and Data Science and to serve the needs for compute- and data-intensive applications for academia, government and industry.

Thank you for your attention!

We are recruiting and seeking for

- Team members for High-level Support Team
- Internships and post-graduates in HPC

News and Events will be announced via

- Our Email list: <https://castorc.cyi.ac.cy/subscribe-to-castorc>
- Our social media channels, webpage, etc.





- Regularly updated webpage: <https://castorc.cyi.ac.cy/national-hpc-competence-centre>
- Open positions for NCC via <https://jobboard.cyi.ac.cy>
- Infos and contact for Internships
see <https://castorc.cyi.ac.cy/training-user-support/internships> or contact t.biberian@cyi.ac.cy with subject "CaSToRC Internship"
- Inauguration of the Cypriot NCC on the 10th September 2020
<https://castorc.cyi.ac.cy/inauguration-of-the-national-hpc-competence-centre>
<https://www.youtube.com/watch?v=s1bKebGFIWQ&feature=youtu.be&t=10s>
- Contact: castorc.support@cyi.ac.cy or questions regarding academic sector of NCC j.finkenrath@cyi.ac.cy



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