



UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA

Dipartimento di Scienze e Metodi
dell'Ingegneria

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High Performance Computing for Advanced Physical Analysis

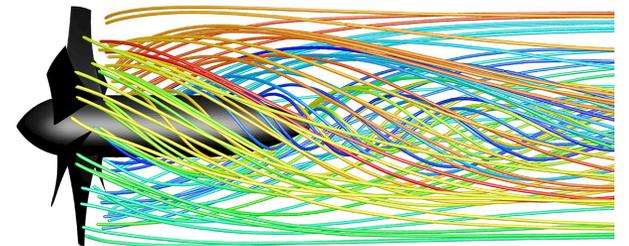
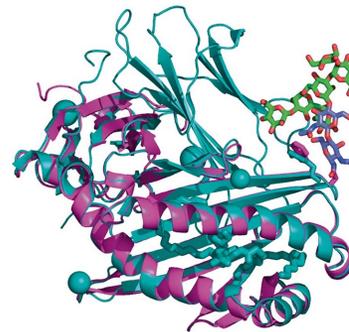
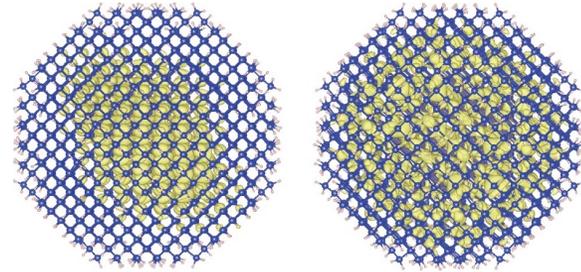
Master Degree in Digital Automation Engineering

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HPC (High Performance Computing) refers to a complex set of technologies, but the most important are (i) a **supercomputer**, which is a cluster formed by hundreds of thousands of processors with a high level of performance as compared with traditional workstations, and (ii) specific **parallel programming languages** that allow for distributing the workload on a large number of single units that communicate with each other.

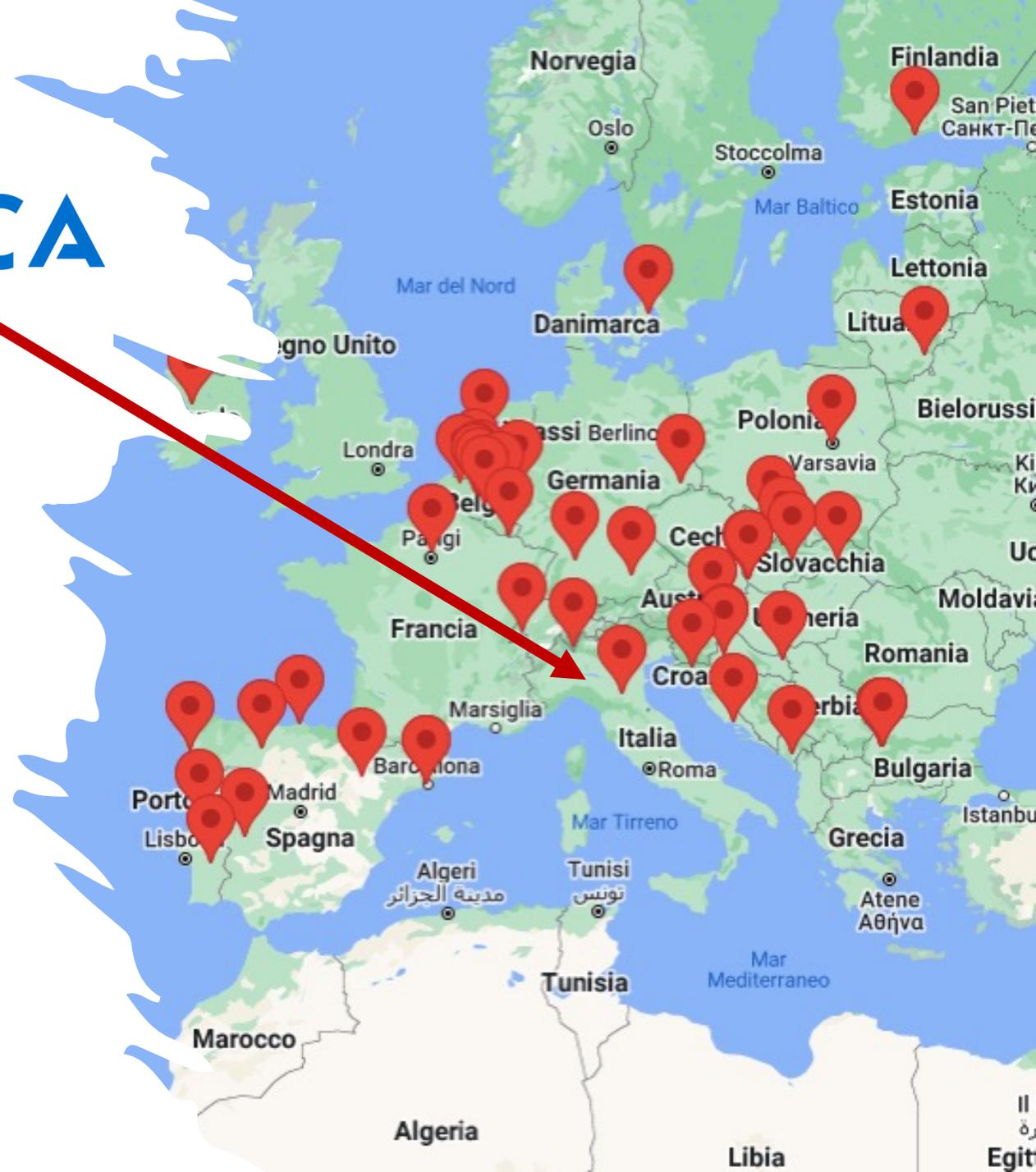
What are the HPC applications? HPC applications are specifically designed to take advantage of high-performance computing systems' ability to process massive amounts of data and perform complex calculations at high speeds. The use of HPC platforms therefore can (i) lead to a reduction of the computational time and (ii) open the possibility of simulating large systems or of reproducing complex dynamics. They include use cases as:

- **Scientific simulations**
- **Engineering simulations**
- **Genomic Sequencing and Medical Research**
- **Weather forecast**
- **Manufacturing operations, logistics and process optimization...**



The Cineca host the pre-exascale supercomputer Leonardo that is classified in n 4° position among the most powerful supercomputers in the Top500 list.

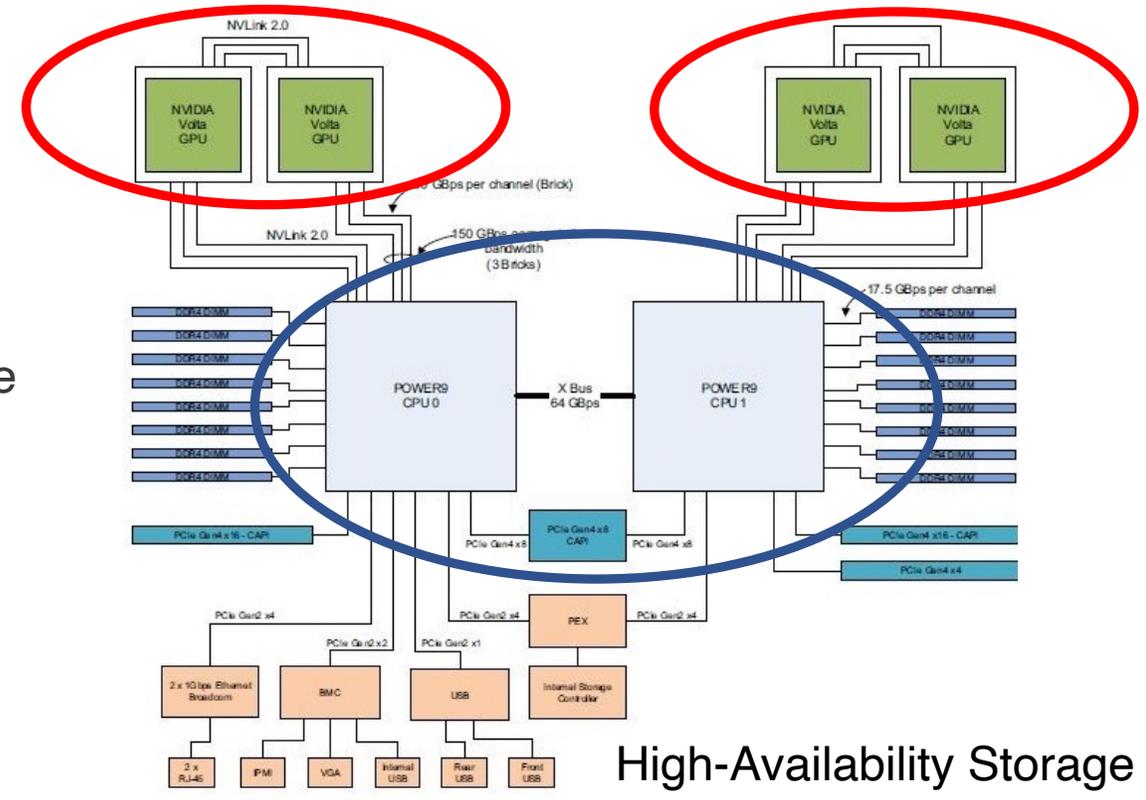
CINECA



- Have an understanding of HPC architectures.
- From a sequential algorithm (operations are executed sequentially) to a parallel algorithm (multiple operations are executed in a given time).

MPI communicator protocol
(Message Passing Interface)

- synchronize the actions of each parallel node
- manage the exchange data between nodes
- provide command and control over the entire parallel cluster.

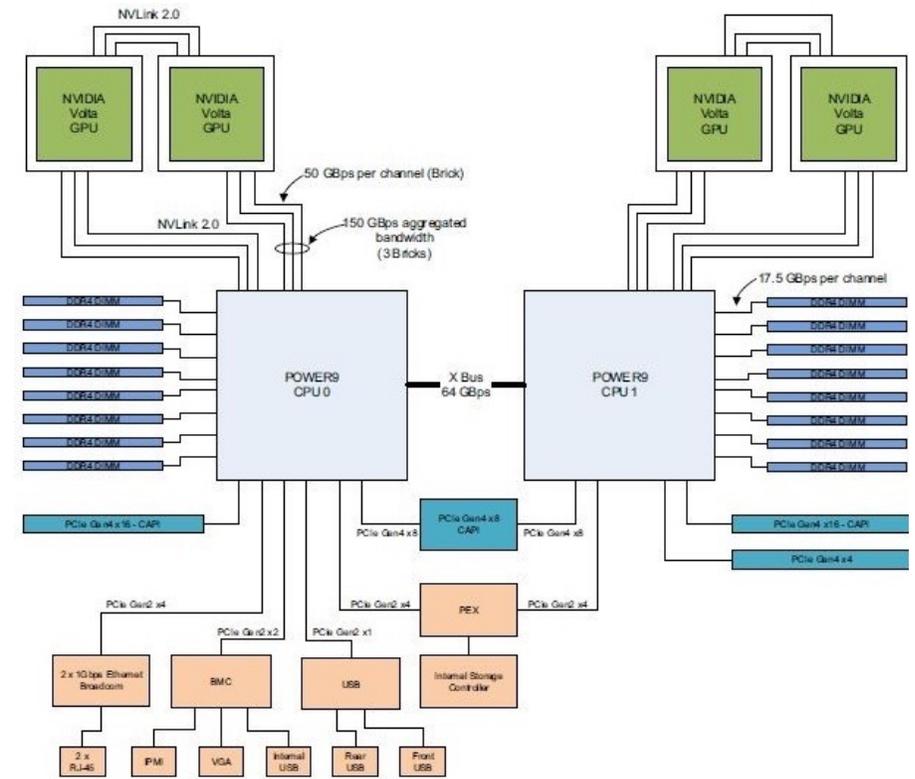


High-Availability Storage
High-Capacity Networking

shared memory paradigm, **OpenMP**

enable the code to utilize multiple threads on the same node

- Have an understanding of HPC architectures.
- From a sequential algorithm (operations are executed sequentially) to a parallel algorithm (multiple operations are executed in a given time).
- MPI, OpenMP
- Write programs with Hybrid programming MPI+OpenMP
- Porting on GPUs



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