Techniques de calcul hautes performances

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Problems with PIC simulations

- 3D simulation
- 1000^3 cells
- 8 particles per cell
- 10^6 iterations
- 25 ns per particle per iteration on a single modern processor
- More than 6 years to make this simulation on a desktop computer.
- We need a HPC cluster for this.

Smilei & miniPIC

Smilei Objective: develop the first open-source PIC code harnessing the latest high-performance computing capabilities.

- Open-source & Community-Oriented.
- Multi-Physics & Multi-Purpose : advanced physics modules and numerical methods.
- High-performance
  C++/Python • MPI/OpenMP/OpenACC/CUDA/HIP

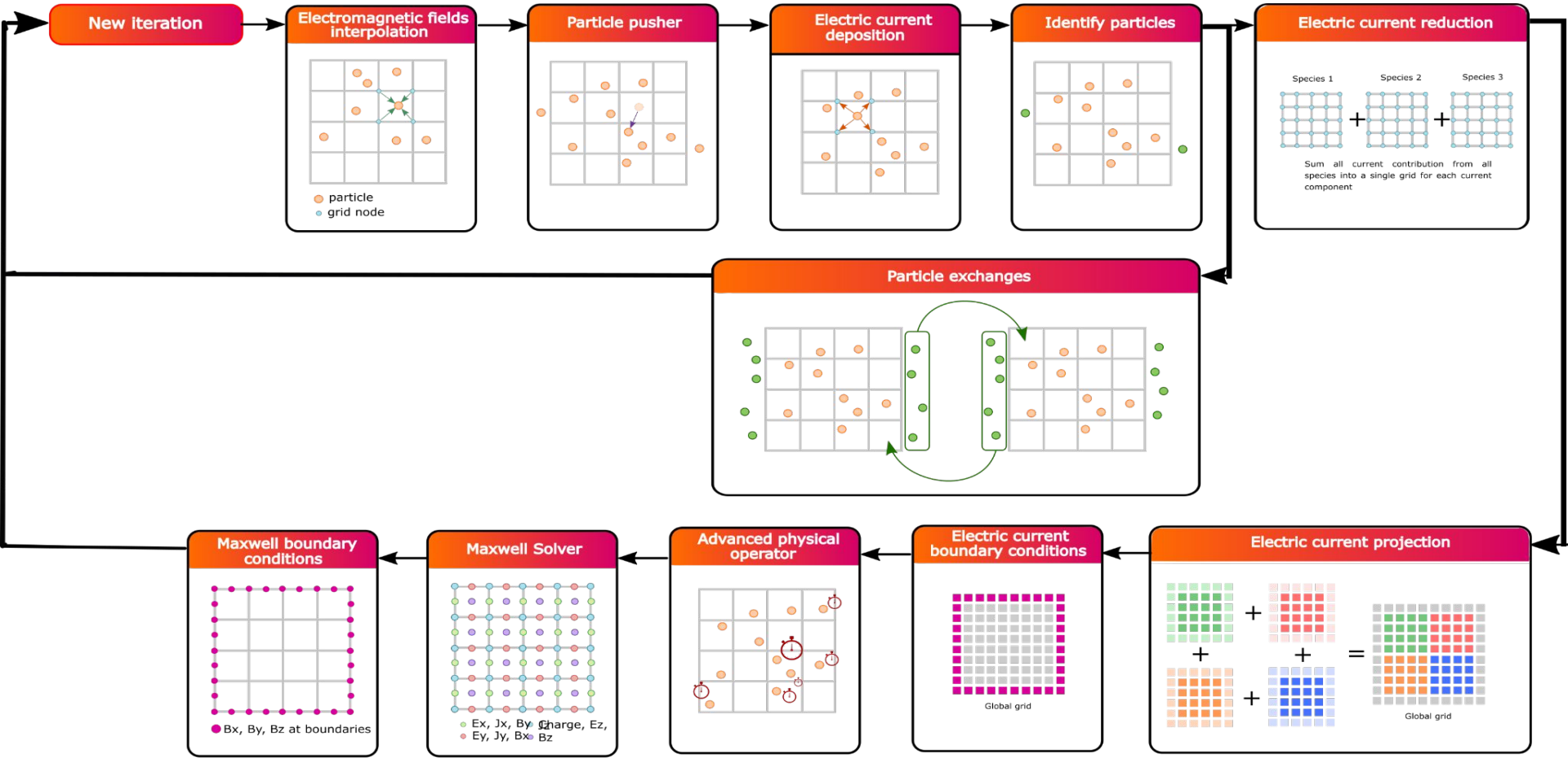
smileipic.github.io/Smilei/

miniPIC Objective: designed to explore high-performance paradigms and technologies in Particle-In-Cell algorithms.

- Strategic focus aimed at extracting the optimal performance from supercomputers.
- Not suitable for modeling of complex plasma phenomena.
- High-performance
  C++/Python • OpenMP-For/OpenMP-Task/OpenACC/CUDA/HIP/ Kokkos/ SYCL/THRUST/STDPAR/OpenACC/OpenMP-Target

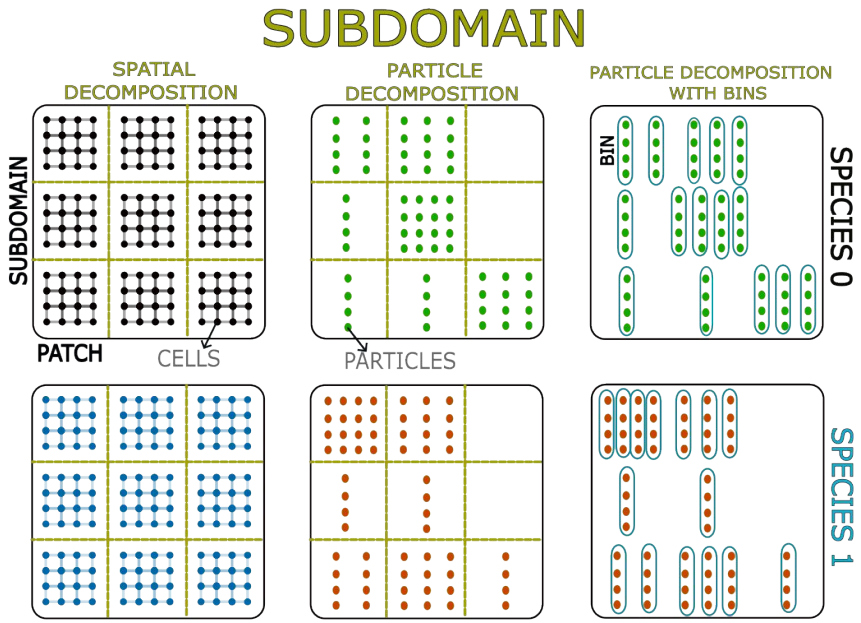
github.com/Maison-de-la-Simulation/miniPIC

miniPIC/Smilei PIC

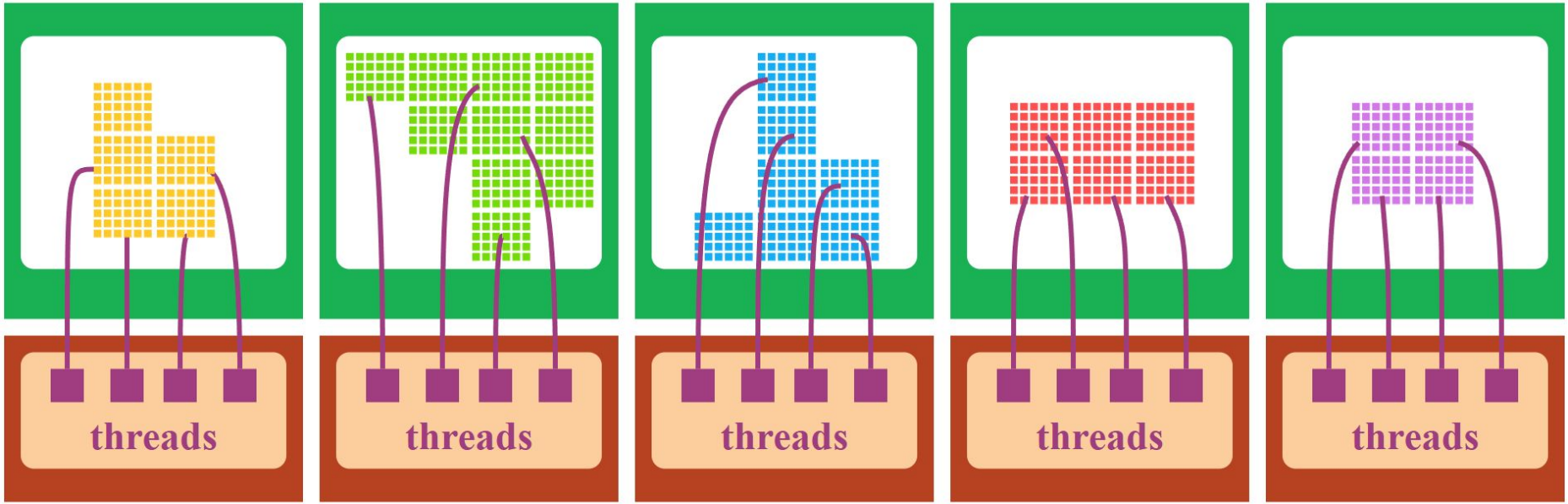


Data parallelism

- Patch domain decomposition.
- Different levels of parallelisation.
- Domain comprises species and patches.
- Patch is composed of cells and bins.
- In decomposition with bins, the notion of patches has been substituted by the bins.

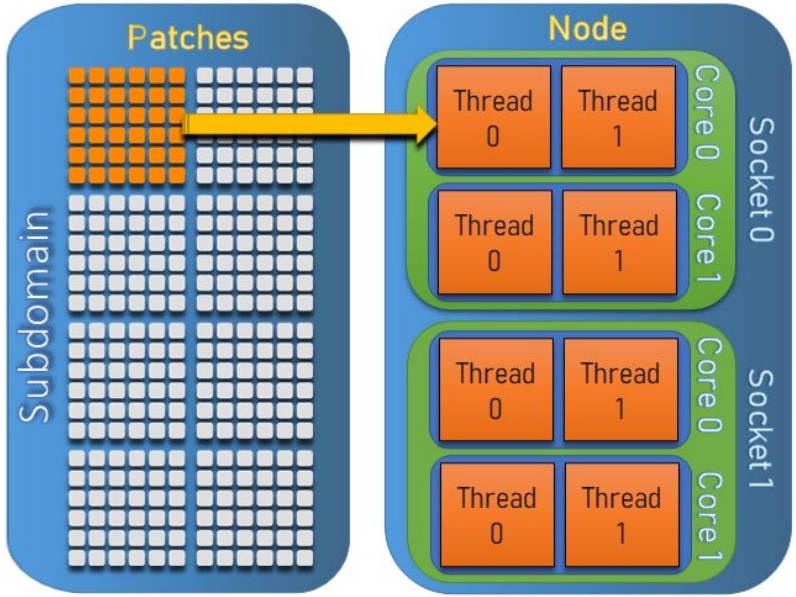


Multi-node parallelism

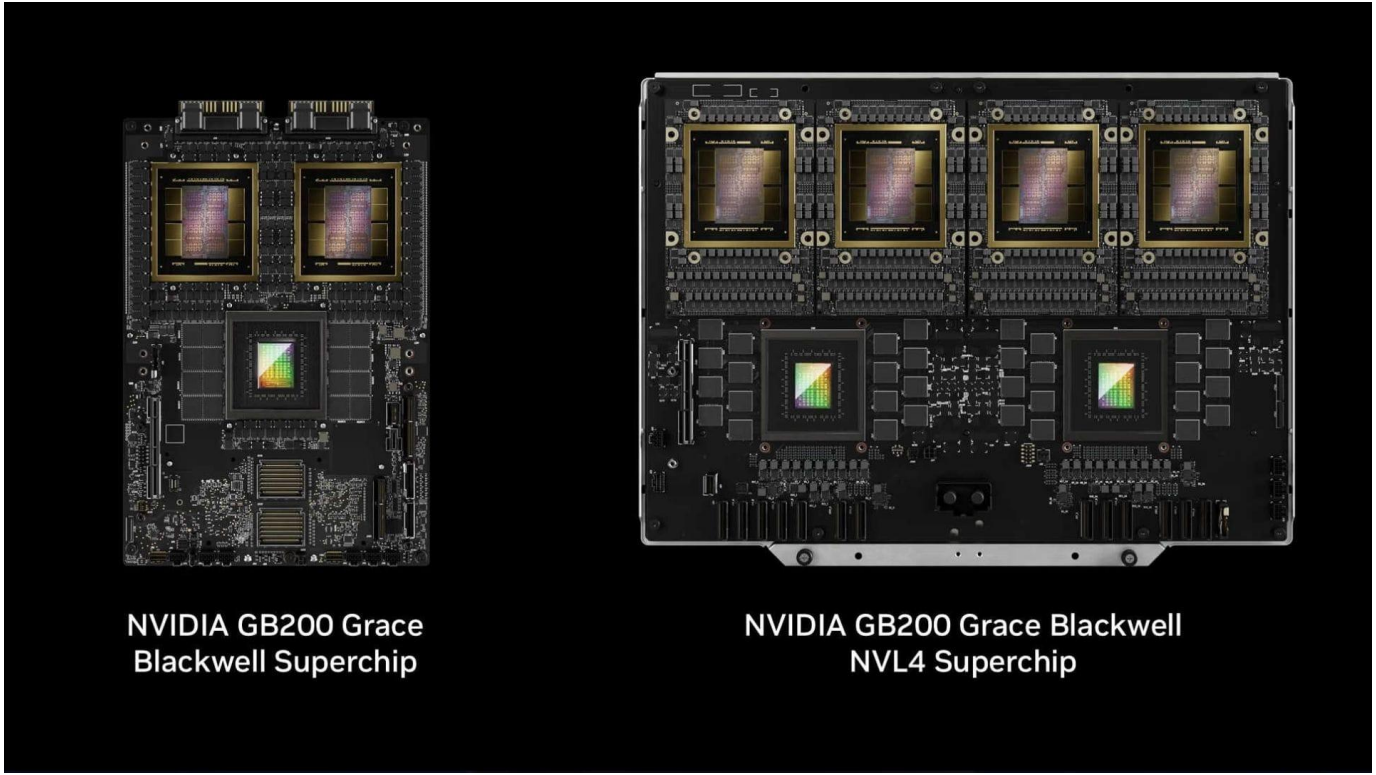


Shared Memory Parallelism

- Mapping of subdomain decomposition to computer node architecture.
- Individual patch assigned to a particular computation thread.
- This parallelization strategy enables efficient use of L2 cache reuse.



New node architectures



Thank you !