Development of an Eigen-Supercomputing Engine using a Post-Petascale Hierarchical Model
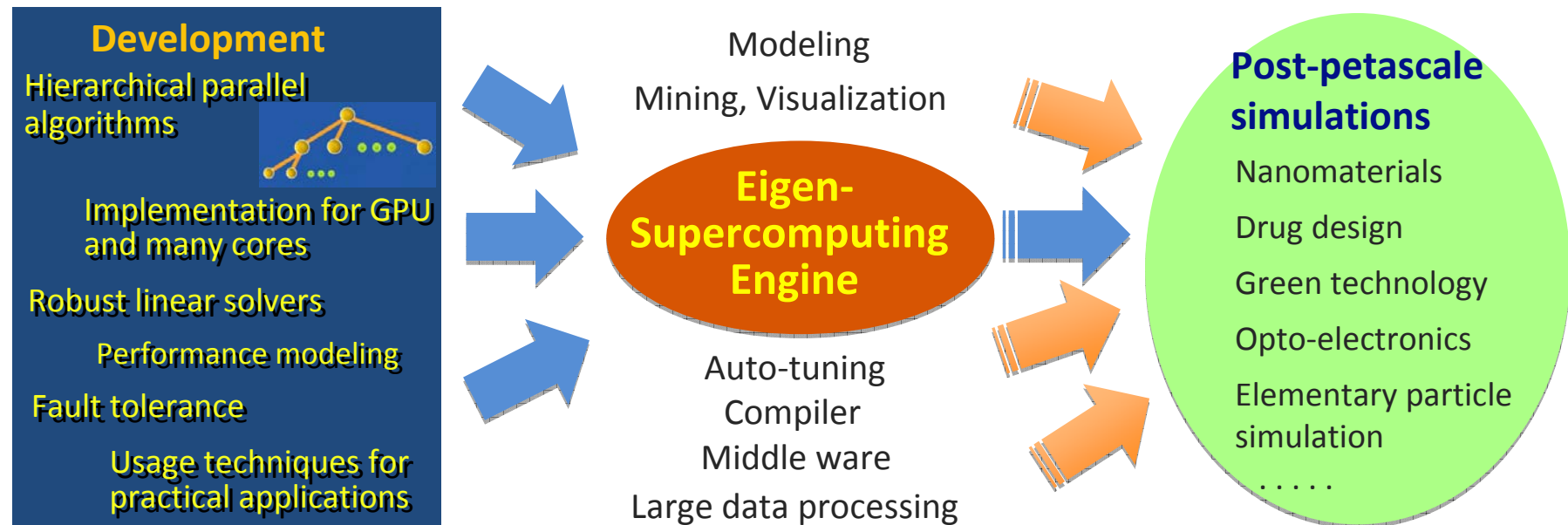
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The aim of this research is to develop a massively parallel eigenvalue analysis engine taking advantage of a hierarchical computer structure which is a defining characteristic of a post-petascale machine.
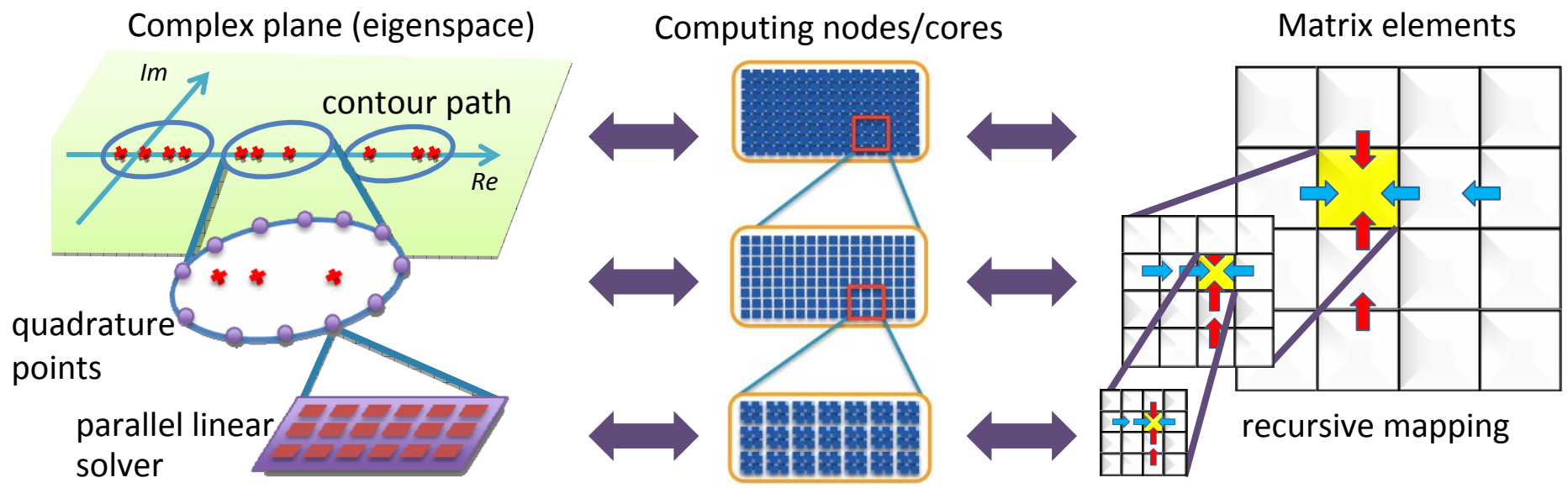
Development
- Hierarchical parallel algorithms
- Implementation for GPU and many cores
- Robust linear solvers
- Performance modeling
- Fault tolerance
- Usage techniques for practical applications

Modeling
Mining, Visualization

Eigen-Supercomputing Engine

Auto-tuning
Compiler
Middle ware
Large data processing

Post-petascale simulations
- Nanomaterials
- Drug design
- Green technology
- Opto-electronics
- Elementary particle simulation
- . . . . .

Hierarchical Parallel Algorithms for Eigenvalue

- ➢ Design hierarchical parallel algorithms which fully leverage performance of post-petascale architectures.
- ➢ Develop software with high performance/scalability/portability/reliability.
- ➢ Construct performance models to predict performance on post-petascale machines.
- ➢ In collaboration with researchers in fundamental sciences and nano-material science.

Sparse matrix: Localization of fine-grained communication by using filtering of eigenspaces based on contour integration

Dense matrix: Recursive formulation of the tridiagonalization algorithm based on matrix-matrix multiplication

Complex plane (eigenspace)   Computing nodes/cores   Matrix elements

Im

contour path

Re

quadrature points

parallel linear solver

recursive mapping

Cluster computing nodes and cores according to hierarchical structures of the