FP7 Support Action - European Exascale Software Initiative

DG Information Society and the unit e-Infrastructures

Addressing the Challenge of Exascale

European Exascale Software Initiative EESI

Towards Exascale roadmap implementation

EESI2 – Recommendations

Towards flexible and efficient Exascale software couplers

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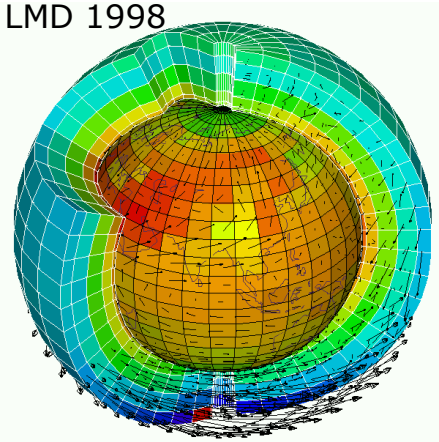
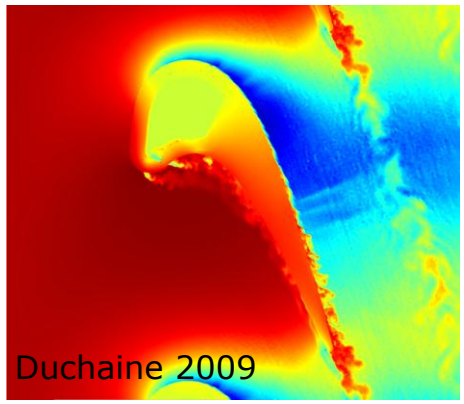
Toward flexible and efficient exascale software couplers

new

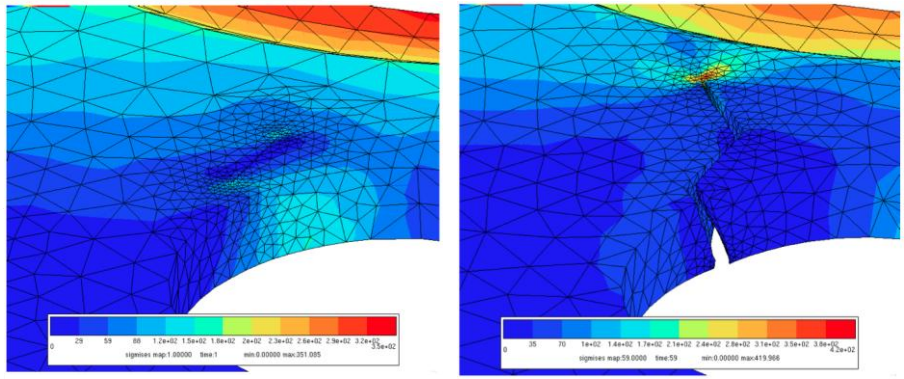
Motivations: treat global systems

- Multi-physic

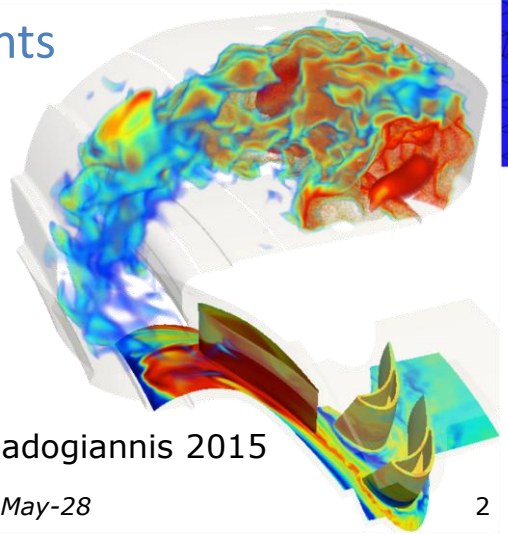




- Multi-scale



- Multi-components



Applications in climate, aerospace, aeronautics, electronics …

Highly CPU Consuming

Toward flexible and efficient exascale software couplers

Motivations

- Development of complex coupled models based on independently developed components
- Constraints:
  - Independently developed model components,
  - Scientific and technical heterogeneities,
  - Highly loaded models that exchange data with a high frequency on large number of cores
- Targets:
  - Coordinate execution of components (informatics + algorithms),
  - Ensure usability,
  - Maintain scalability of HPC components,

  ➔ Scalability of state-of-the-art libraries used today on exascale platforms?

  ➔ More parallelism, less memory and less communications

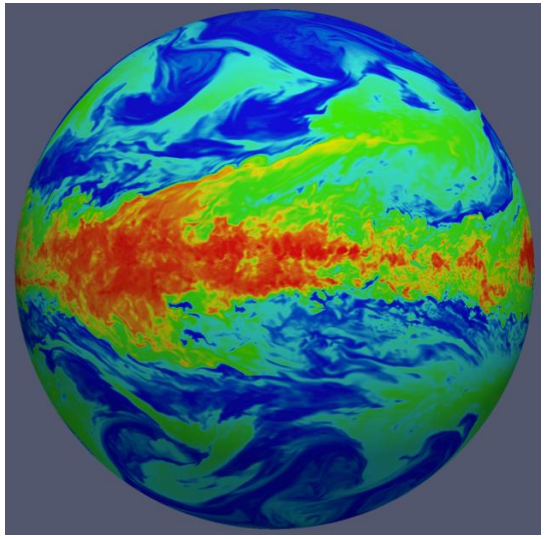
Toward flexible and efficient exascale software couplers

new

Motivations

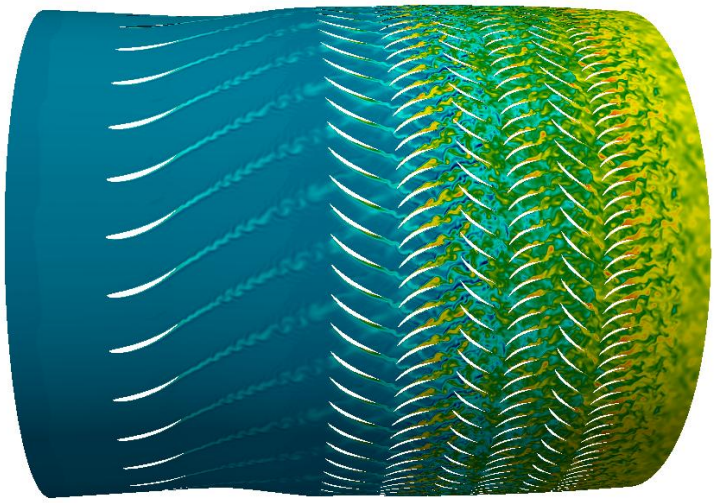
MCT (Model Coupling Toolkit)
ANL – USA

Tested until 256K cores
(Craig et al 2011)



OpenPALM
CERFACS/ONERA – France

Tested until 130K cores
(Duchaine et al 2015)



Tools exist, it is not clear which type will survive to exascale computing

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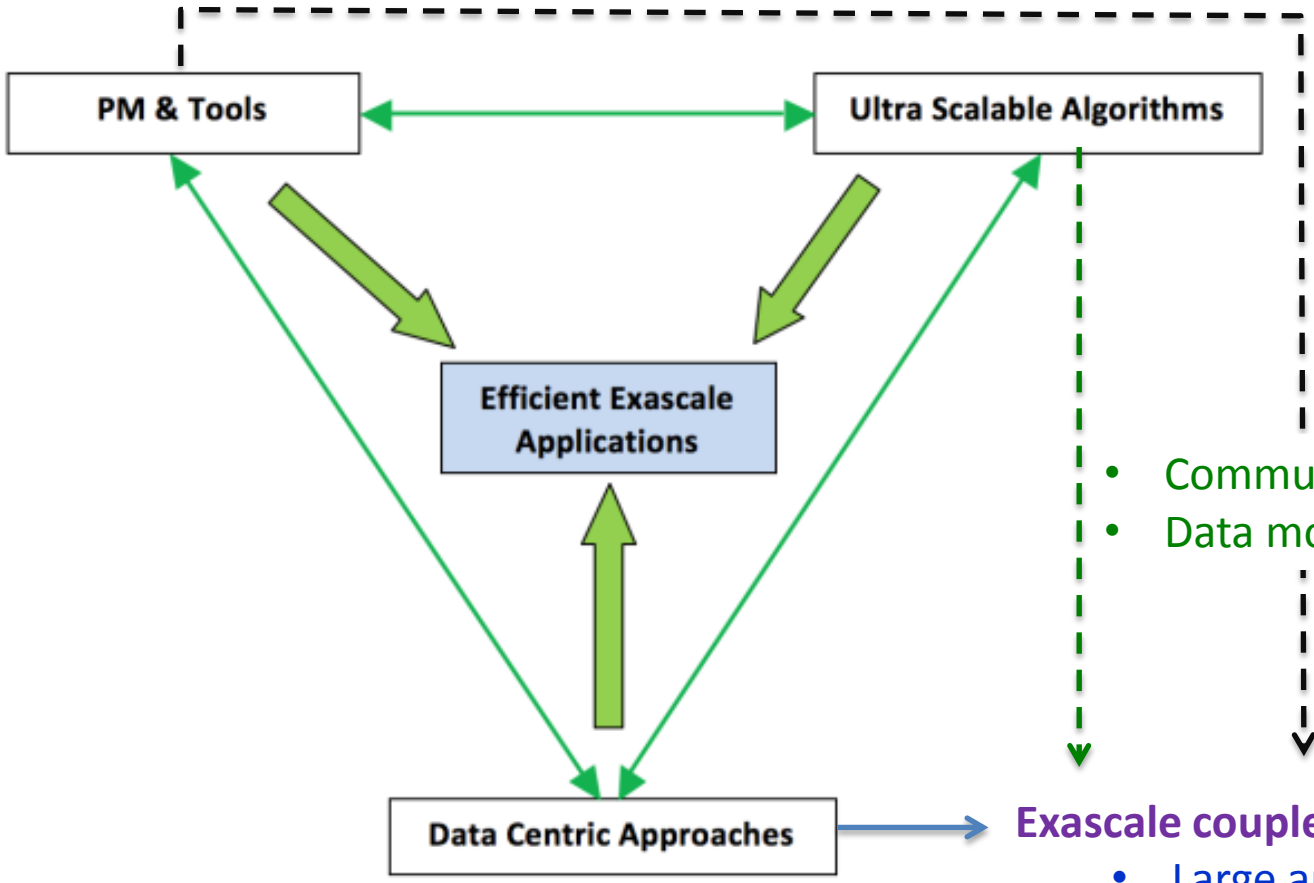

- Programing models,
- Software engineering

- Communications,
- Data movement avoidance

Exascale couplers

- Large amount of data (“Big data”),
- Data treatment,
- Data exchange

Toward flexible and efficient exascale software couplers

Proposal : Fund R&D programs in order to explore

- **Coupler improvements**
  - Define a standard coupling API to ease integration, interoperability, and cross disciplinary exchange,
  - Improve localization methods,
  - Improve data exchange protocols,

  ➔ Avoid data centralization, reduce memory movement, use asynchronous processes, investigate new programming models
- **Coupled model improvements**
  - Perform advanced comparisons between single and multiple executable approaches in terms of usability and scalability
  - Improve coupling algorithms to reduce data exchange foot-print,
  - Introduce coupling overload in code partitioning constraints,
  - Optimize communication patterns between model components (co-partitioning)
- **Software environment**
  - Develop tools to ease pre and post processing of coupled computations

Toward flexible and efficient exascale software couplers

Proposal : Fund R&D programs

- **European projects**
  - in different communities: Climate, aerospace, aeronautic, automotive, chemistry, biology, combustion …
  - and trans-disciplinary projects

- **Center of Excellence**
  - ESiWACE: Center of Excellence in Simulation of Weather and Climate in Europe
    - ➔ Benchmark of existing couplers
    - ➔ Algorithmic tests (concurrency and accuracy)
    - ➔ Unified API

- **Timing:** now, to prevent bottlenecks on coming applications

- **Budget: ~25 people and 8 - 12 M€**