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

Motivations: treat global systems

- Multi-physic

- Multi-scale

- Multi-components

Applications in climate, aerospace, aeronautics, electronics ...

Highly CPU Consuming
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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**
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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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- Large amount of data ("Big data"),
- Data treatment,
- Data exchange

Programing models,
Software engineering

Communications,
Data movement avoidance

Exascale couplers
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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
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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€