BEinGRID
BUSINESS EXPERIMENTS IN GRID

European Commission

Information Society Technologies

BE01 Demo
Computational Fluid Dynamics and Virtual Design

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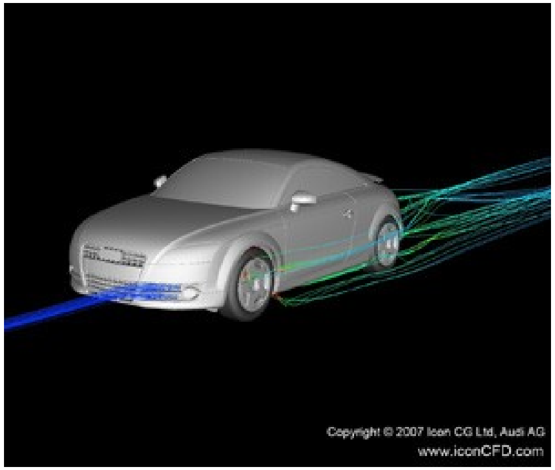
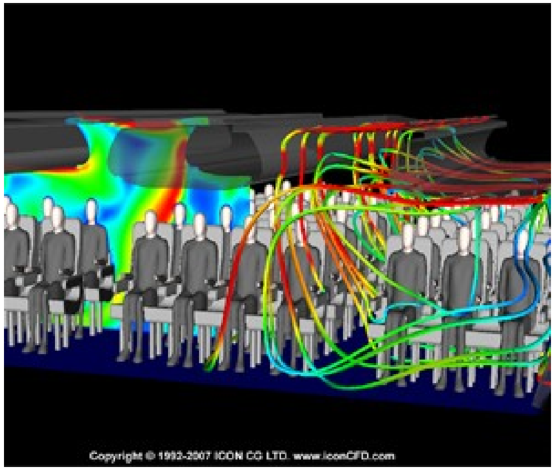
BE01 Context

- The objective of BE01 is to provide the end user with, an effective, stable and flexible Grid-based solution for CFD execution.
- This solution follows the conventional CFD execution workflow, but instead of using local resources, it exploits Grid services and distributed resources.
- The introduction of Grid technology within the CFD process can provide a valuable resource in meeting the ever-increasing CFD-driven design demands of the automobile and aerospace industry.
- GRID can enable SME's to enter markets where previously, CFD infrastructure was a barrier to entry

Computational Fluid Dynamics
CFD





A branch of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows

Performs complex calculations required to simulate the interaction of fluids and gases with the complex surfaces used in engineering

Validation of CFD simulations can be performed using experimental facilities (e.g. a wind tunnel)

Sufficient Resources

- CFD execution is a performance-oriented service with great computational demands

- Resource requirements vary depending on :
  - Simulation
  - Complexity

  - An organization may suffer from having :

– Too few resources

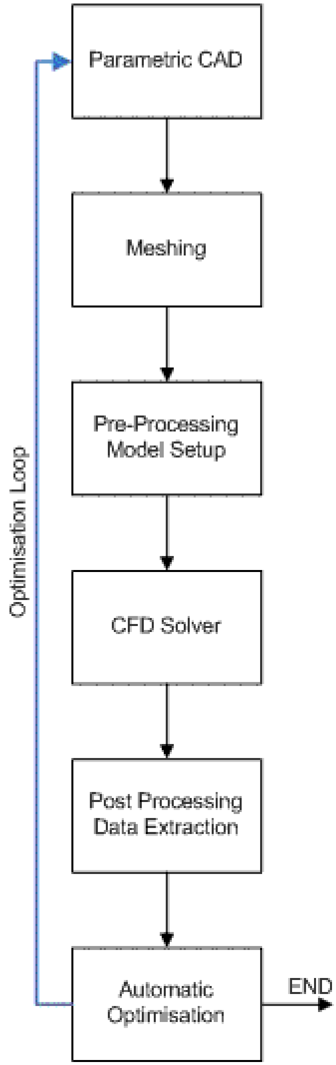
– Too many under-utilised resources

Why Grid?

- Increased speed
  - Solutions in hours, not weeks
- Increased flexibility
  - Dynamic resource allocation
- Reduced cost
  - Lower hardware costs
  - Effective labor deployment
  - Reduced IT systems administration
- Environment friendly
  - Reduction in un-used hardware resources

CFD Execution Scenario

- **The different steps in the process of CFD simulation include:**
  - ❑ **CAD (*Computer Aided Design*) geometry**
  - ❑ **Mesh generation**
  - ❑ **Solver setup and calculation**
  - ❑ **Post-processing**
- **This linear step-wise process in the traditional CFD methodology can be made into a fully automated sequence of events with a parametric CFD methodology.**
- **Automatic Optimisation is achieved through a loop using appropriate optimisation algorithms. (eg Genetic, Simplex)**

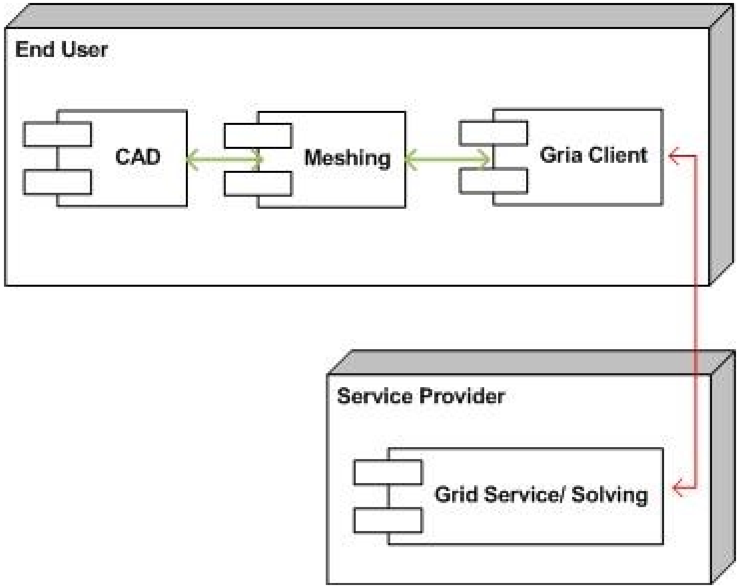


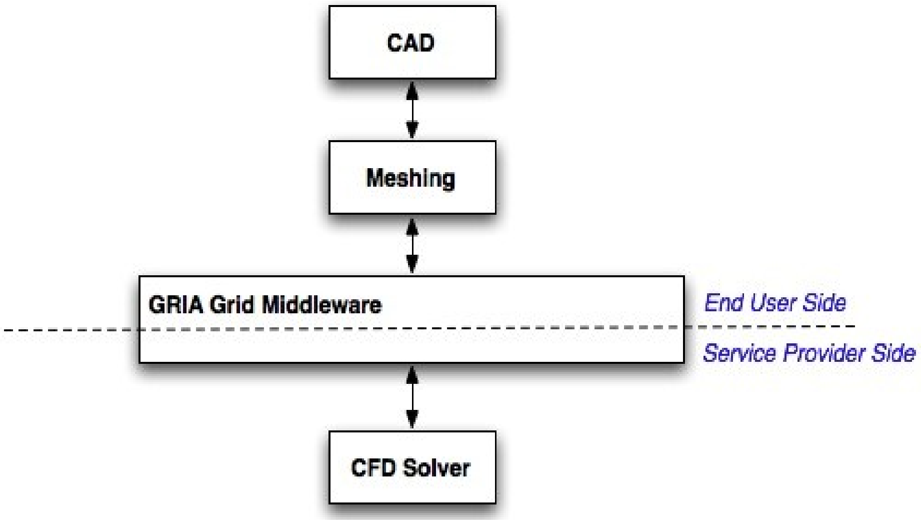
CFD in GRID

The linear step-wise process in the traditional CFD methodology can be 'gridified' by separating the process into two levels or roles:

- **the <u>End User</u>**
- **the <u>Service Provider</u>**

The interaction between levels is achieved through GRIA, the selected Grid middleware



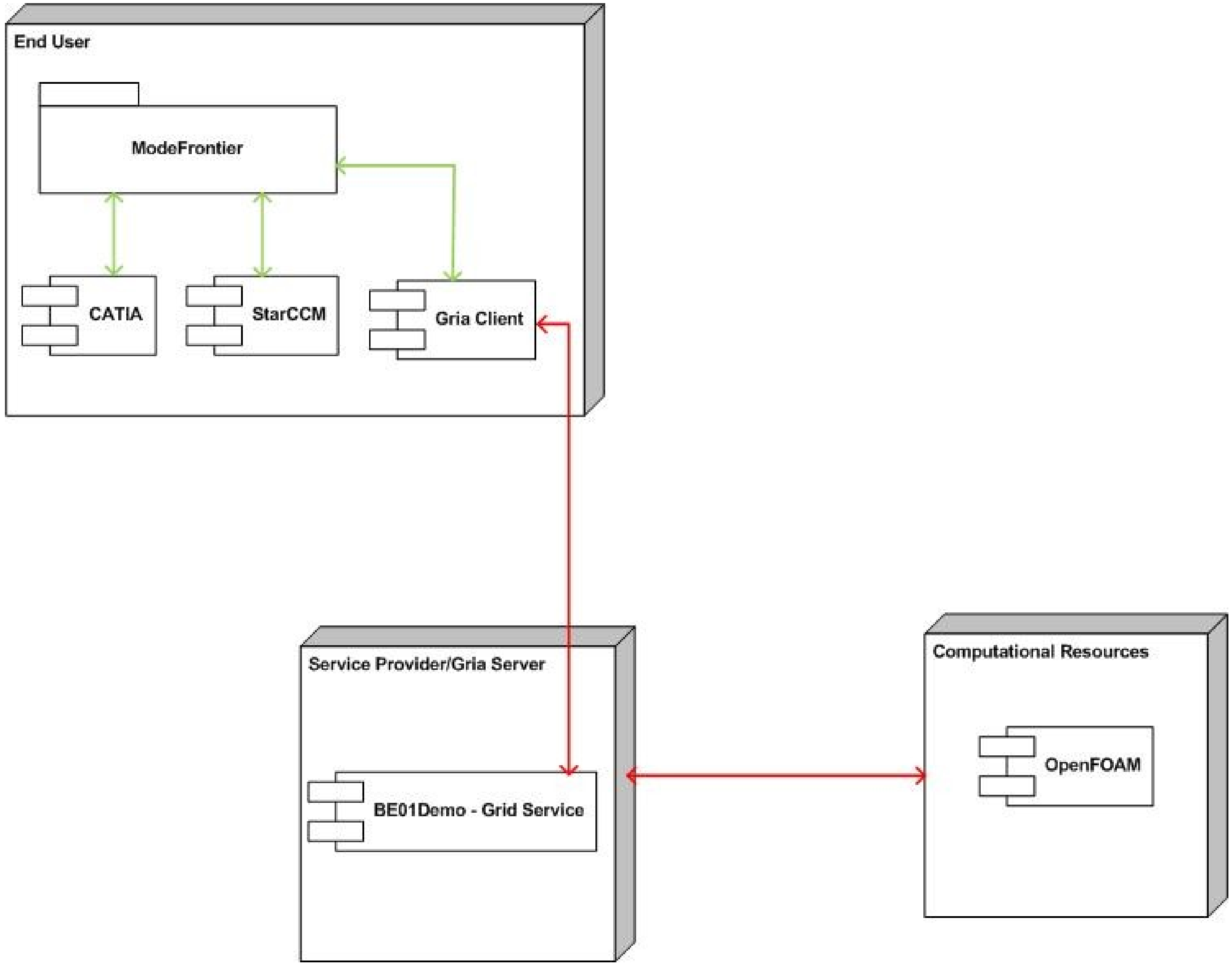


BE01 Demo - Audi case

- **The potential of GRID Computing to solve CFD optimisation problems involving industrial applications.**
- **The geometry is a cooling duct located in the under-bonnet region of a vehicle.**
  - **Air flows through the left side grill highlighted, into the cooling duct, towards the transmission.**
- **Optimisation Objectives of Duct design**
  - **Minimise Pressure Loss**
  - **Maximise Discharge Velocity**

(Courtesy of AUDI AG)

BE01 Demo - Audi case



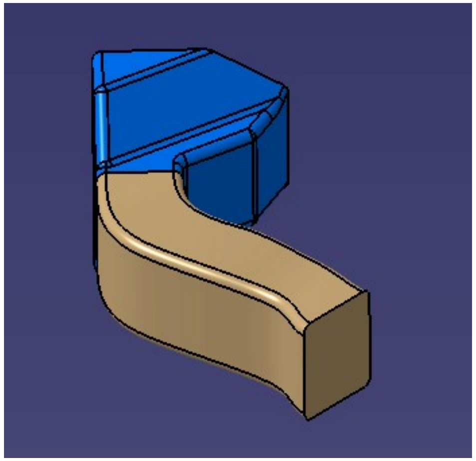
BE01 Demo - Audi case

Demo Video

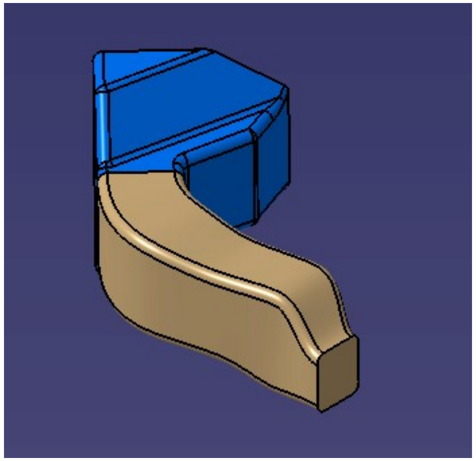
Results

- Total evaluation of 450 design variations, over 15 generations.
- 340 successful designs, 86 failed due to CAD, mesh or CFD convergence problems. The remaining 24 were repeated and therefore not considered.

- The entire execution was performed over 8 hours and 15 minutes.
- Twice as fast as the times recorded for the standard (non-Grid) execution.



Baseline Design
Discharge Velocity = 41.5 m/s
Total Pressure Drop = 661 Pa



Optimised Design (ID=397)
Discharge Velocity = 110 m/s
Total Pressure Drop = 387 Pa

Conclusions

- **Technical Benefits**
  - Faster results
  - Solve larger problems in a efficient time-frame
  - Increase insight into the physics
  - Perform Automatic Optimisation

- **Business Impact**
  - Reduced Risk
  - Improved Productivity
  - Increased Flexibility
  - Reduced Cost
  - Improved Quality
  - Environmental Impact
  - Competitive Advantage

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THANK YOU