FORTISSIMO

SOUTH Cloud

Shape Optimization under Uncertainty through HPC Cloud

Partners:

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I4MS

OPTIMAD

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Scenario

- *Simulation based product analysis is a standard, but optimization not…*
- *"In-house" optimization → cost-inefficient*
  - *specialized personnel*
    - *proficiency CAE & optimization software + HPC*
    - *problem-specific knowledge (methods, parameters, constraints…)*
    - *Integration between CAD, CAE, IT*
    - *Water-proof fully-automated workflow (geometry → CAE simulations)*
  - *simulation cost*
    - *computing ~ $O(10^2\text{-}10^3)$ x Cost(simulation)*
    - *computing resources sized for analysis (optimization peak requirement)*
    - *licensing of optimization & simulation SW*
- *ROI can be guaranteed only for standard (analysis) tasks*
  - *high amortization costs (computing infrastructure, etc.)*
  - *lack of confidence towards "new workflows"*
  - *<10% of regular CAE users (mainly LIs) → does not justify investments*

Potential Market

- *Man-in-the-loop (pseudo-optimization) is performed by >70% of regular CAE users*
  - *product improvement standard task in CAE*
  - *time & cost constraints don't allow ASO*

- *Market*
  - *experts in simulation, but "not-so-strong" background in optimization*
    - *R&D department of SMEs*
    - *engineering department of LIs*
    - *consultancy firms*

250 MEuro < market size < 500 MEuro

Benefits

- end-user: integrated, flexible and sustainable solution
  - **no amortization costs** of any type
  - **ca 75% of time savings** and **30% cost savings** wrt to man-in-the-loop (Lamborghini)
  - **No competition with on-premise resources**
- ISV: scalable business opportunity
  - from consultancy to product
- competing ISVs
  - (opt) modeFrontier, Optimus, iChrome, (CFD) Star-CCM+, FLUENT, HyperStudio, (geom) CATIA, SolidWorks, (cloud-based integrated solution) none (back then…)
- SOUTH competitive advantages
  - holistic view (provides **all necessary resources**)
  - **open and accessible** (open API, to integrate end-user CAE tools)
  - **cost effective**: pay-as-you-go (no upfront costs), no maintenance (HW/SW)
- SOUTH weaknesses
  - **no complete control** (experts)
  - **no deployment on hybrid clouds**
  - **cash-flow**

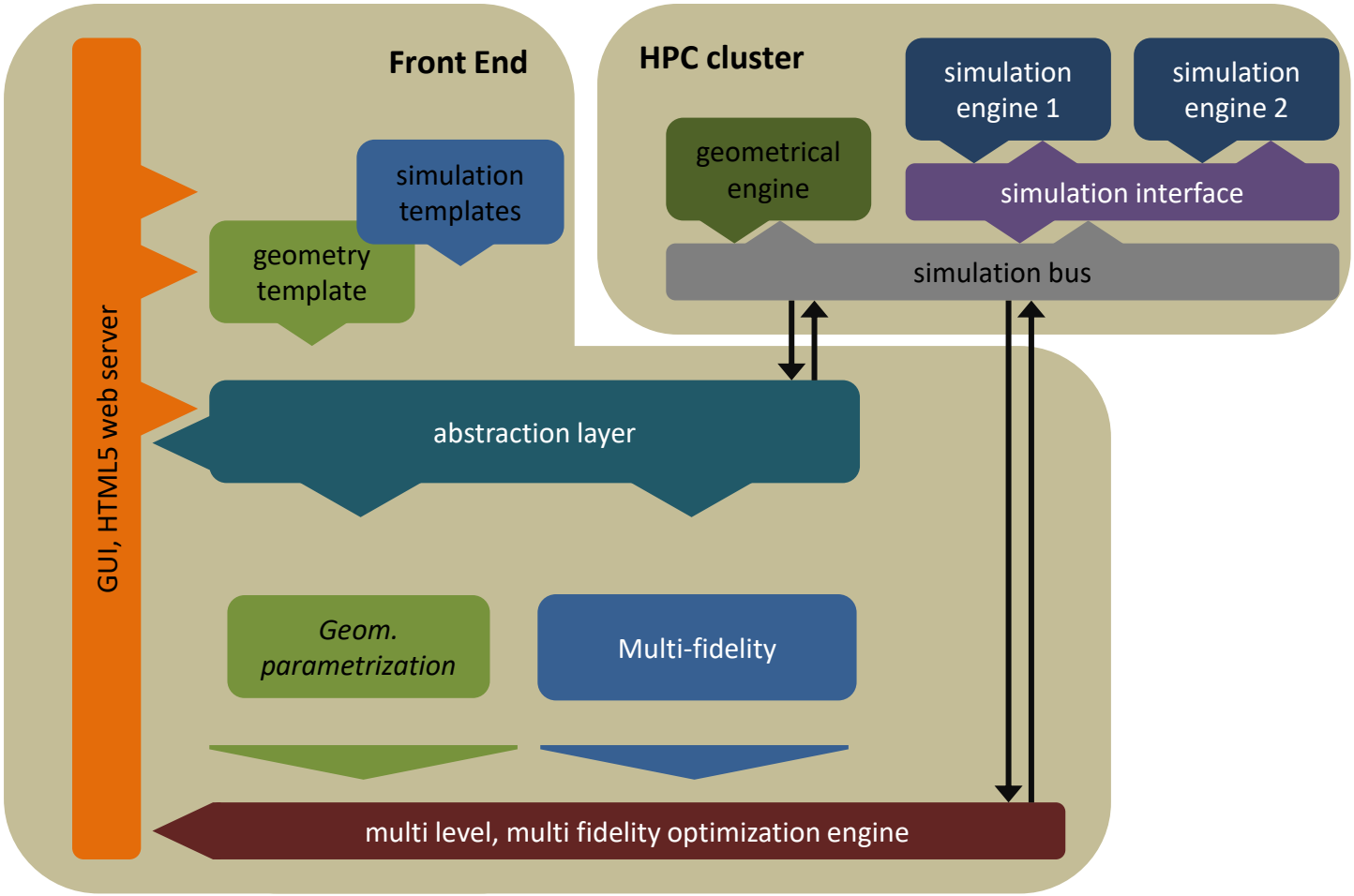
Main idea

- Tackle all burdens which have been identified
  - specialized personnel
  - software integration
  - HPC resources
  - license (as far as possible…)

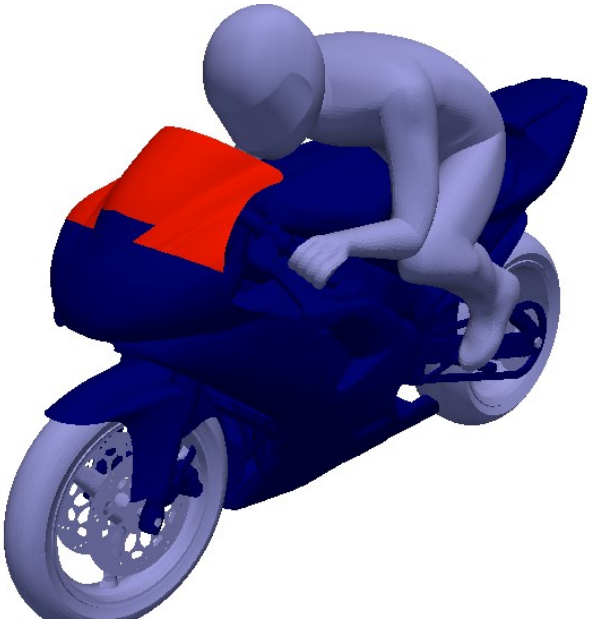
- leitmotif: user should set only intuitive parameters
  - opaque interface towards HPC structure
  - integrated solution with little process specific know-how
  - optimizer & geometrical parameterization already integrated
    - **geometrical constraints**
    - **time & cost**
  - user is responsible for the interface with CAE software
    - easy API towards simulation software
    - simulation template

- HPC → upscaling & setup for “Machine Learning” models
  - create large dataset by using simulation templates
  - Automatically identify cheaper simulation models (LowFi), which predict trends correctly
  - train AI, which mimics specialized personnel for optimization setup

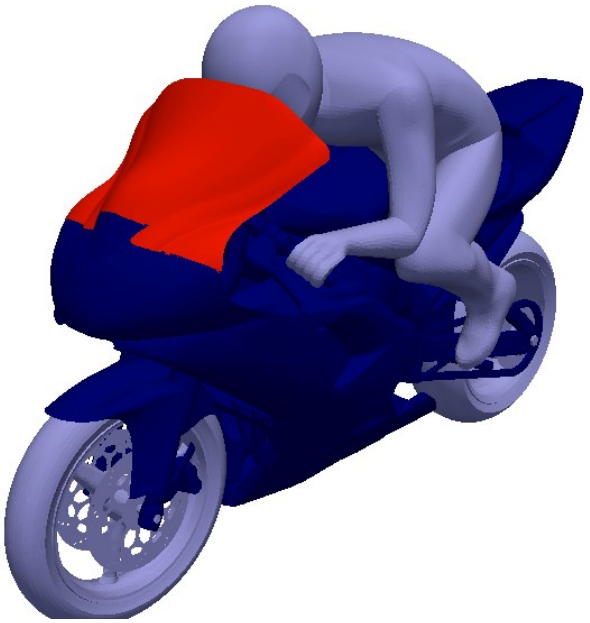
SOUTH Platform



Wind shield SO

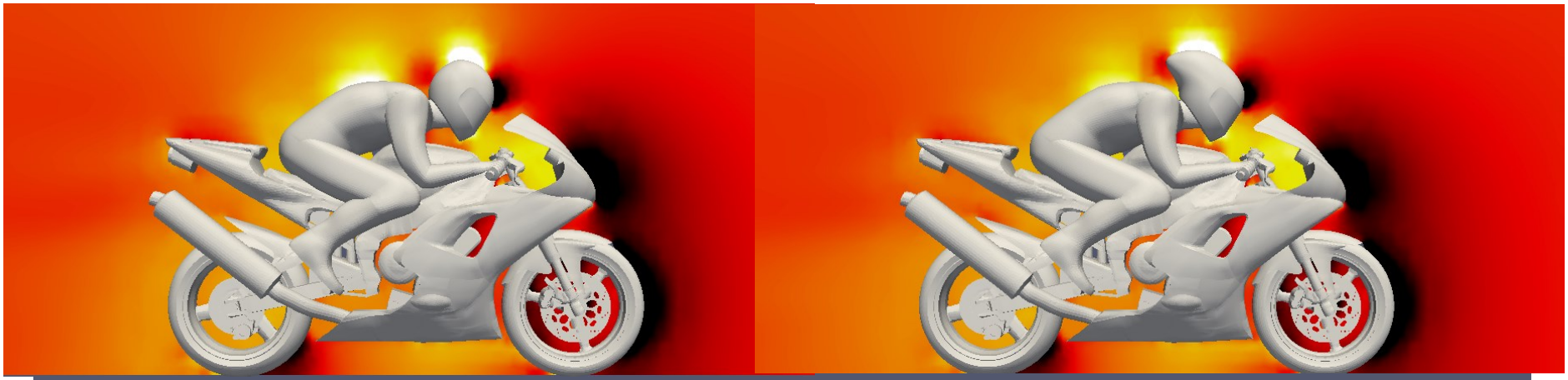


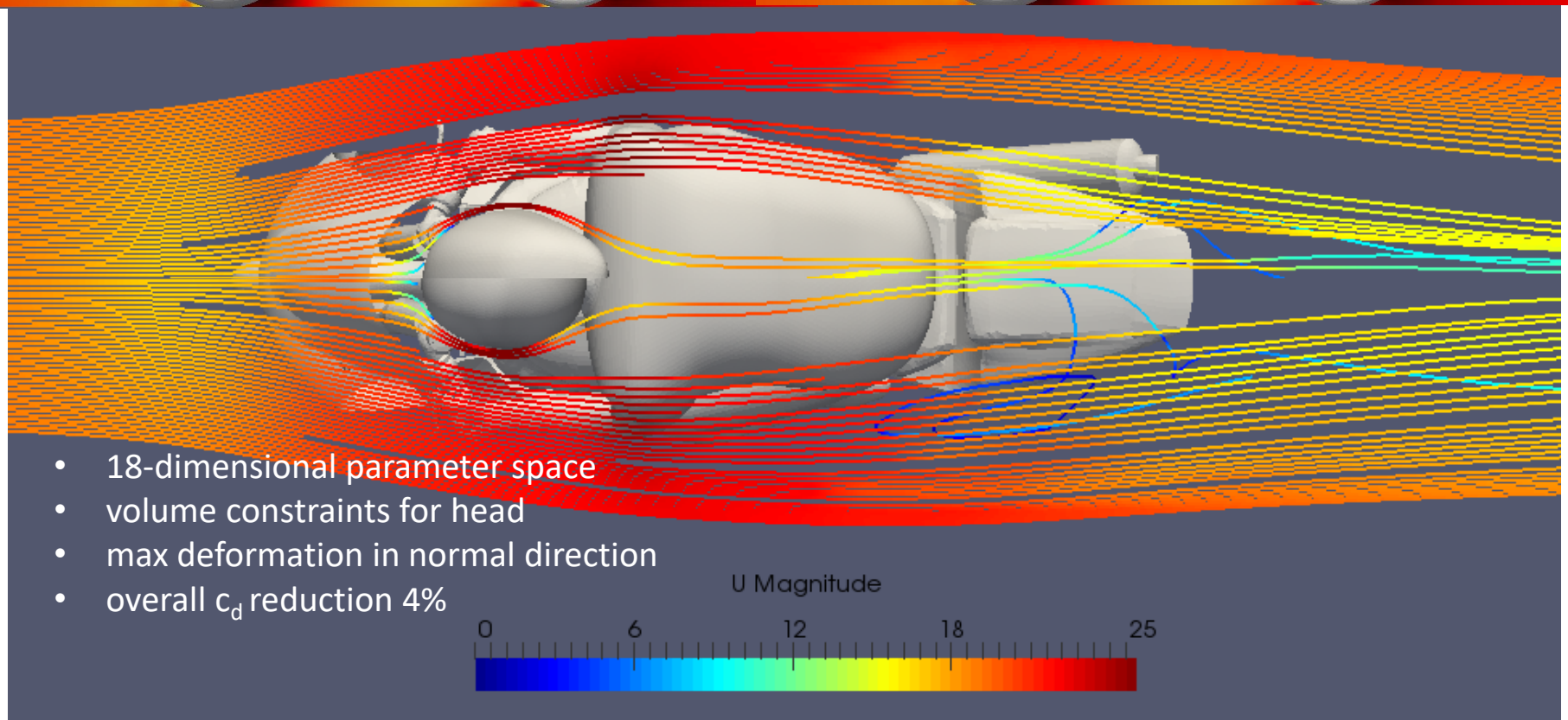
Original Geometry



Optimized Geometry

Helmet SO



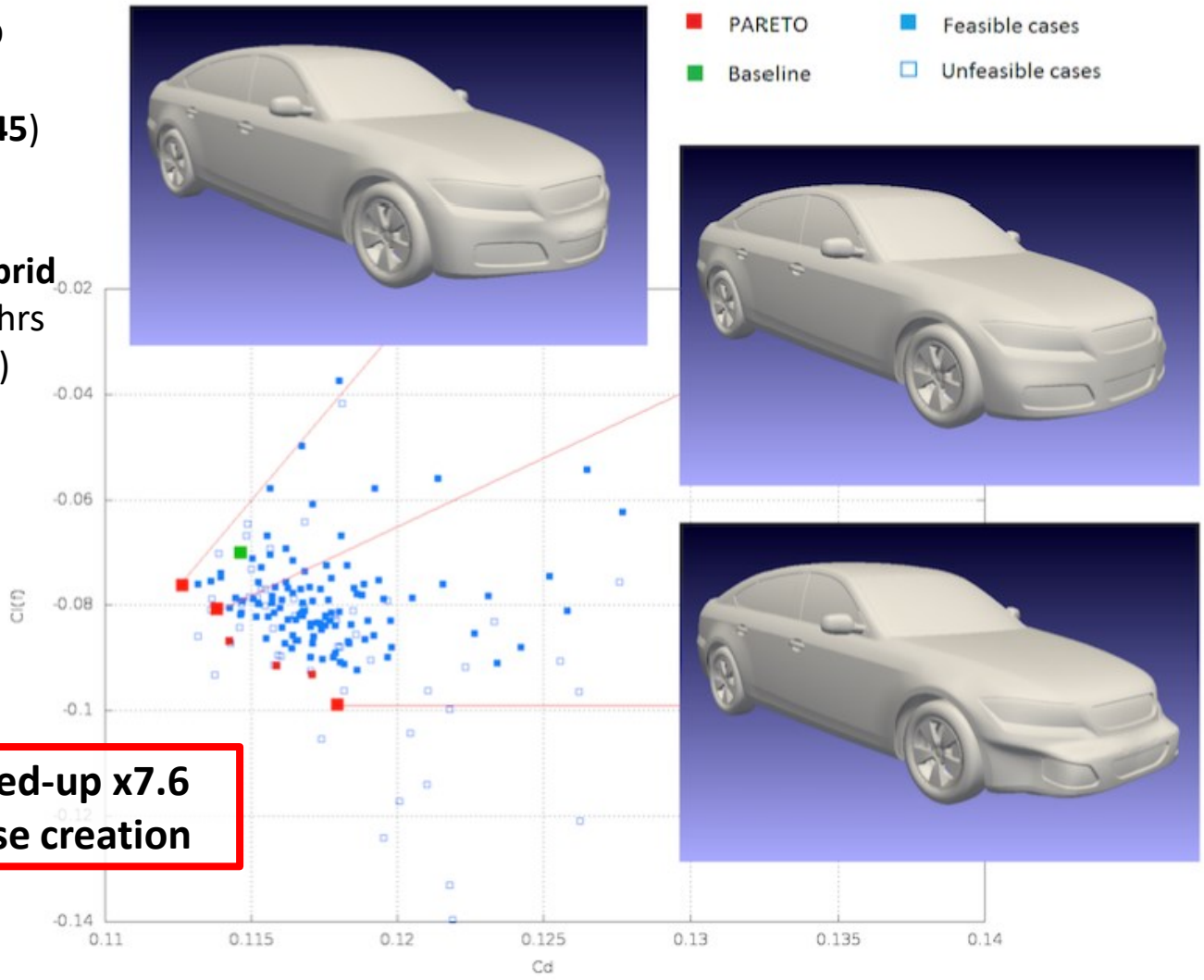


- 18-dimensional parameter space
- volume constraints for head
- max deformation in normal direction
- overall c_d reduction 4%

Front bumper Multi-objective SO

- 180 cpu-h 1 full CFD
- 4 cpu-h 1 hybrid CFD/POD (speed-up **x45**)

- ca**. 150 full CFD** simulations + **1200 hybrid** simulations = 32k CPUhrs (85% full+ 15% hybrid)
- 4.2 days on 320 cores @CINECA Galileo



optimization speed-up x7.6 including database creation

Front bumper SO – Lamborghini AVENTADOR

Rendering by Marco Cisternino (Optimad)

What happened next…

- SaaS (expected TRL: 8-9, reached TRL: 7) → not still there, yet…
  - end-user uses autonomously the platform
  - pay/optimization + consumed CPUhrs

- Obstacles:
  - Integration of end-user CAE tools
  - Licensing models
  - Fall-back on Opensource SW not always possible (lack of validation/confidence)
  - Fully automated workflow (automatic mesh generation, water-proof optimization pipeline)
  - Users "want" a fully automated workflow but "need" full control. Application-specific pipelines not sustainable from SW development point-of-view.
  - Psychological barriers
    - convince end-user to spend O(10KEuro)
    - move from on-premises to cloud (amortization vs cash flow) !!!
    - data security for LIs

What happened next…

- Service (currently ongoing)
  - provide product optimization as consultancy service using SOUTH
  - project specific costs
- Hybrid (implemented)
  - integration with customer simulation SW
  - end-user uses autonomously the platform
  - integration specific cost+ pay/optimization+ consumed CPUhours
- **Several past/ongoing projects:**
  - Nolan group (racing)
  - Lamborghini
  - Rolls Royce (aeronautic engine)
  - …
- **TRL increased → Funds secured** for further development.

Thanks. Questions?