Virtual Computing Environments

for Problem Solving on Grids

International Conference Parallel CFD 2004

Gran Canaria (SP)

Jean-Pierre ANTIKIDIS, Guillaume ALLEON, Toan NGUYEN

May 24-27th, 2004

OUTLINE

- INRIA
- MULTIDISCIPLINARY APPLICATIONS
- GRID COMPUTING
- VIRTUAL COMPUTING ENVIRONMENTS
- FUTURE TRENDS & CONCLUSION

PERSONNEL

2.700 in six Research Centers

- 900 permanent staff
  - 400 researchers
  - 500 engineers & technicians
- 500 researchers from other organizations
- 700 trainees, PhD and post-doc
- 200 external collaborators
- 400 visiting researchers
- 95 research projects
- 60 spin-offs and start-ups
- 800 active contracts

Budget 125 Meuros (tax not incl.)

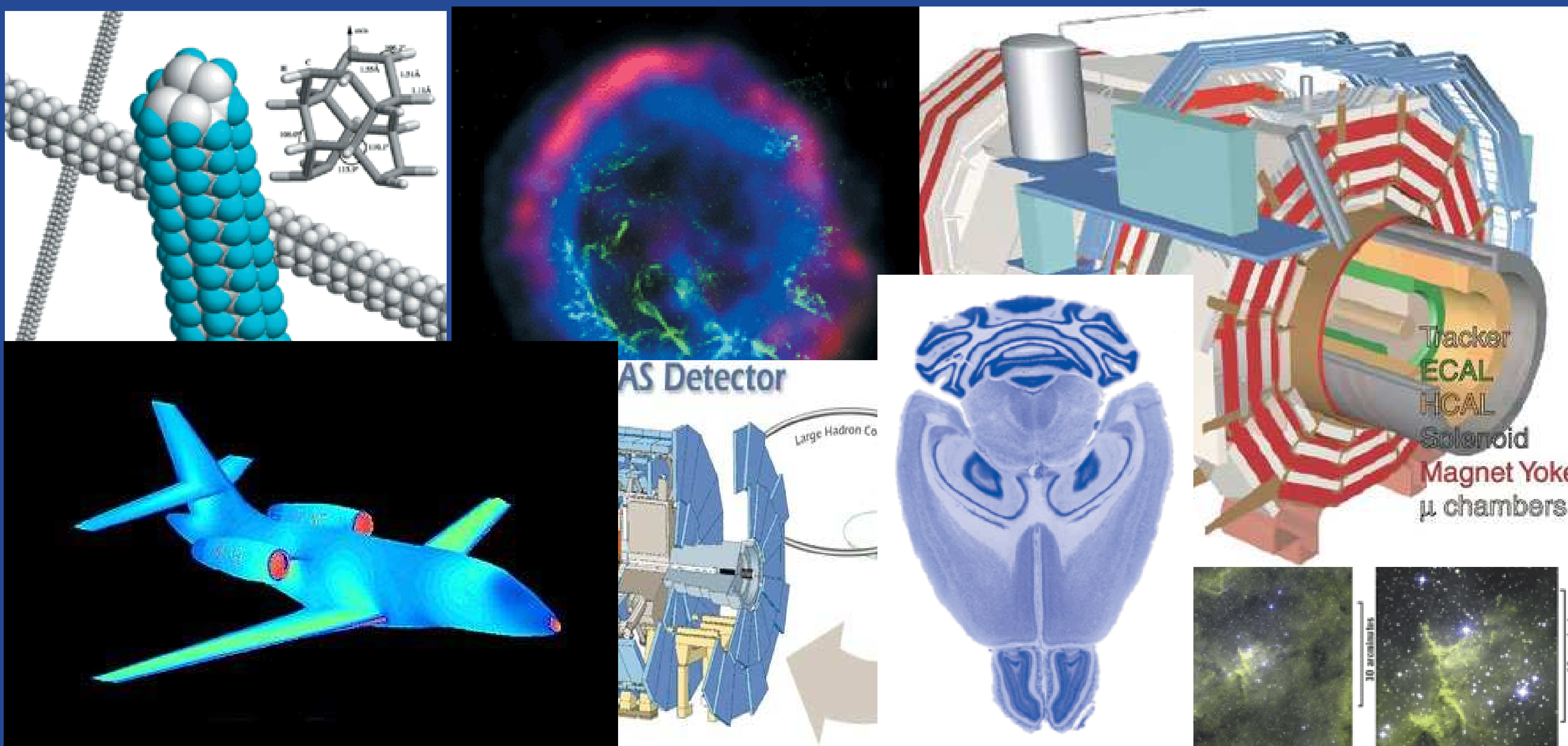
1/4 self-funding

OPALE

- INRIA project (January 2002)
- Follow-up SINUS project
- Located Sophia-Antipolis & Grenoble
- Areas

NUMERIC OPTIMISATION (genetic, hybrid, …)
MODEL REDUCTION (hierarchic, multi-grids, …)
INTEGRATION PLATFORMS
Coupling, distribution, parallelism, grids, clusters, ...
APPLICATIONS : aerospace, electromagnetics, …

MULTIDISCIPLINARY APPLICATIONS



INTEGRATING MULTIDISCIPLINARY APPLICATIONS

- INTEGRATION OF PARTNERS' EXPERTISE TO DEPLOY SEAMLESS COLLABORATIVE ENVIRONMTS
- NETWORKED PC-CLUSTERS, COMPUTERS & DATABASES TO SUPPORT MULTIDISCIPLINARY CHALLENGES
- TRANSPARENT SUPPORT FOR CONCURRENT ENGINEERING: CSCW, VR, IMMERSIVE & MULTIMODAL INTERFACES ...

KEY CHALLENGES

THE KEY WORDS ...

- KNOWLEDGE
- VIRTUAL
- COLLABORATIVE
- SEAMLESS
- MULTIDISCIPLINARY

LONG TERM EVOLUTION

- KNOWLEDGE EMPOWERING ENVIRONMENTS : KEEs
- VIRTUAL COMPUTING INFRASTRUCTURES
- SEAMLESS COLLABORATIVE ENVIRONMENTS
- ADVENT MULTIDISCIPLINARY APPLICATIONS
- ENGINEERS AND APPLICATION DEVELOPERS WANT TO BE PLAYSTATION USERS !

RESEARCH PRIORITIES
KEY TECHNOLOGIES

- COLLABORATIVE MULTIDISCIPLINARY ENVIRONMENTS
- ENABLING TECHNOLOGIES FOR VIRTUAL COMPUTING INFRASTRUCTURES
- APPLICATION DEVELOPMENT INFRASTRUCTURES

  TRANSPARENTLY GRID-ENABLED ...

  SEAMLESSLY SIMILAR TO WEB BROWSERS ...

APPLICATIONS REQUIREMENTS

- SHOULD OR COULD A GRID EMULATE A MAINFRAME ?
- HOW CAN COMPUTE MODELS BE ADAPTED TO MAKE BEST USE OF GRIDS ?
- WHERE DO GRIDS NOT MAKE SENSE ?
- WHAT IS THE REAL COST OF OWNING A GRID ?
- CAN UNUSED POWER OF DESKTOP BE HARNESSED ?
- HOW TO USE GRIDS FOR HIGH I/O APPLICATIONS ?
- HOW TO DESIGN GRIDS FOR HIGH AVAILABILITY ?

APPLICATIONS REQUIREMENTS

- **HIGH PERFORMANCE COMPUTING**

  BIOSCIENCES, ENGINEERING, ENVIRONMENTAL APPS, ...

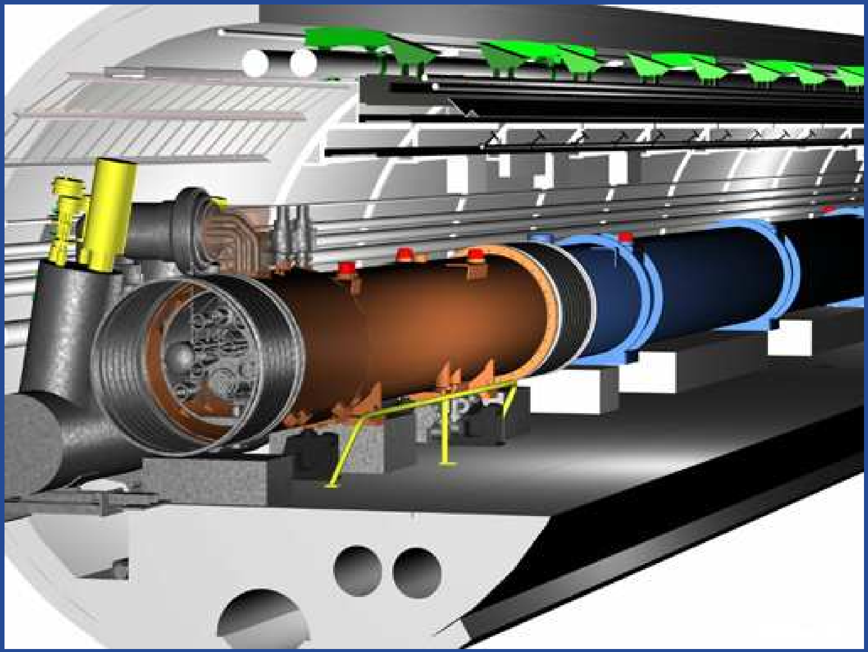
- **HIGH THROUGHPUT COMPUTING**

  HIGH ENERGY PHYSICS

  SATELLITE IMAGING

- **MULTI-LAYERED ARCHITECTURE**

  CERN LHC FACILITY



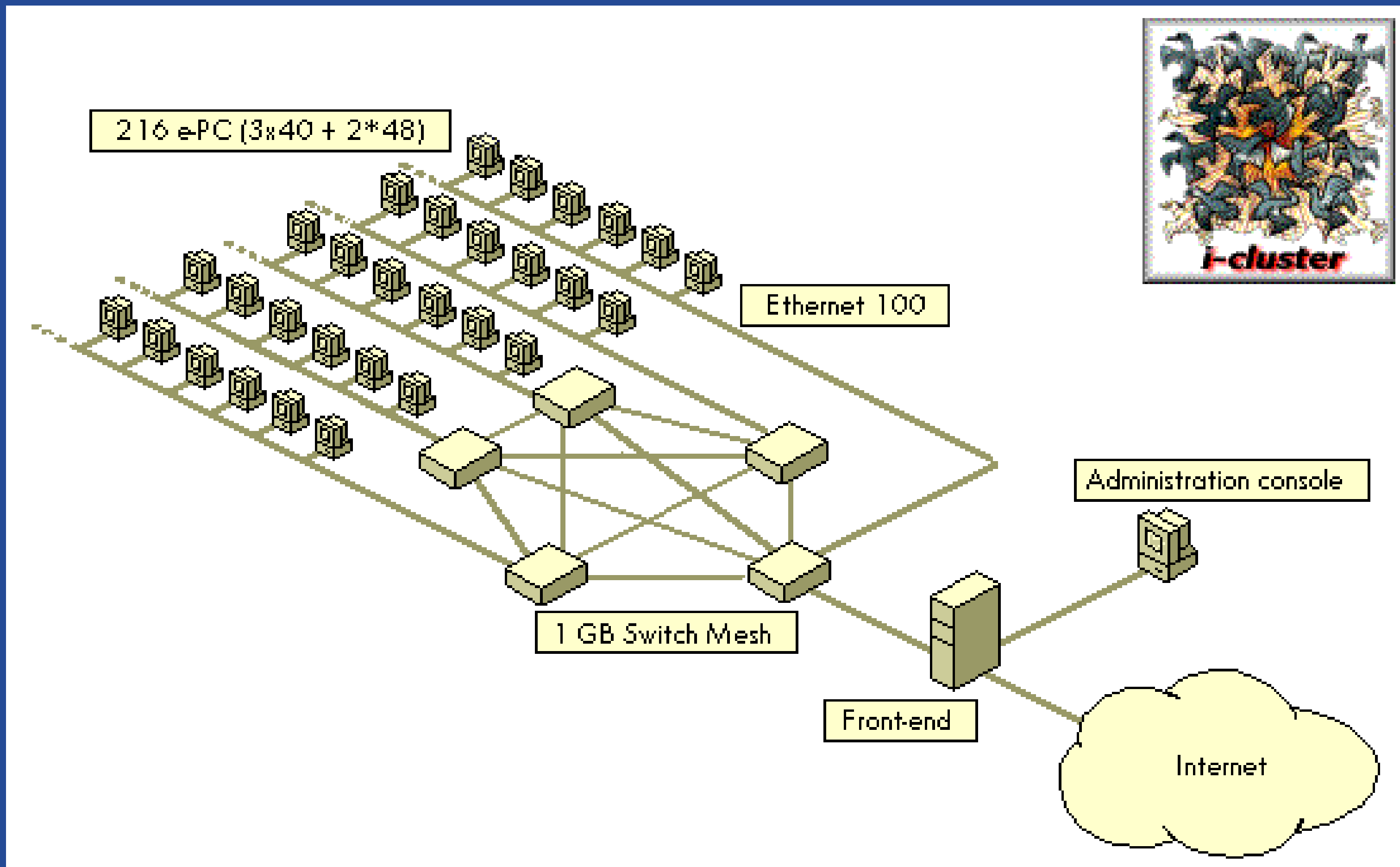
PLATFORM REQUIREMENTS

- NEED FOR VIRTUAL REALITY ENVIRONMENT ?
- NEED FOR CSCW PROCEDURES & SUPPORT ?
- NEED FOR GRID COMPUTING ?

- NEED FOR DISTRIBUTED DATABASE TECHNOLOGY ?

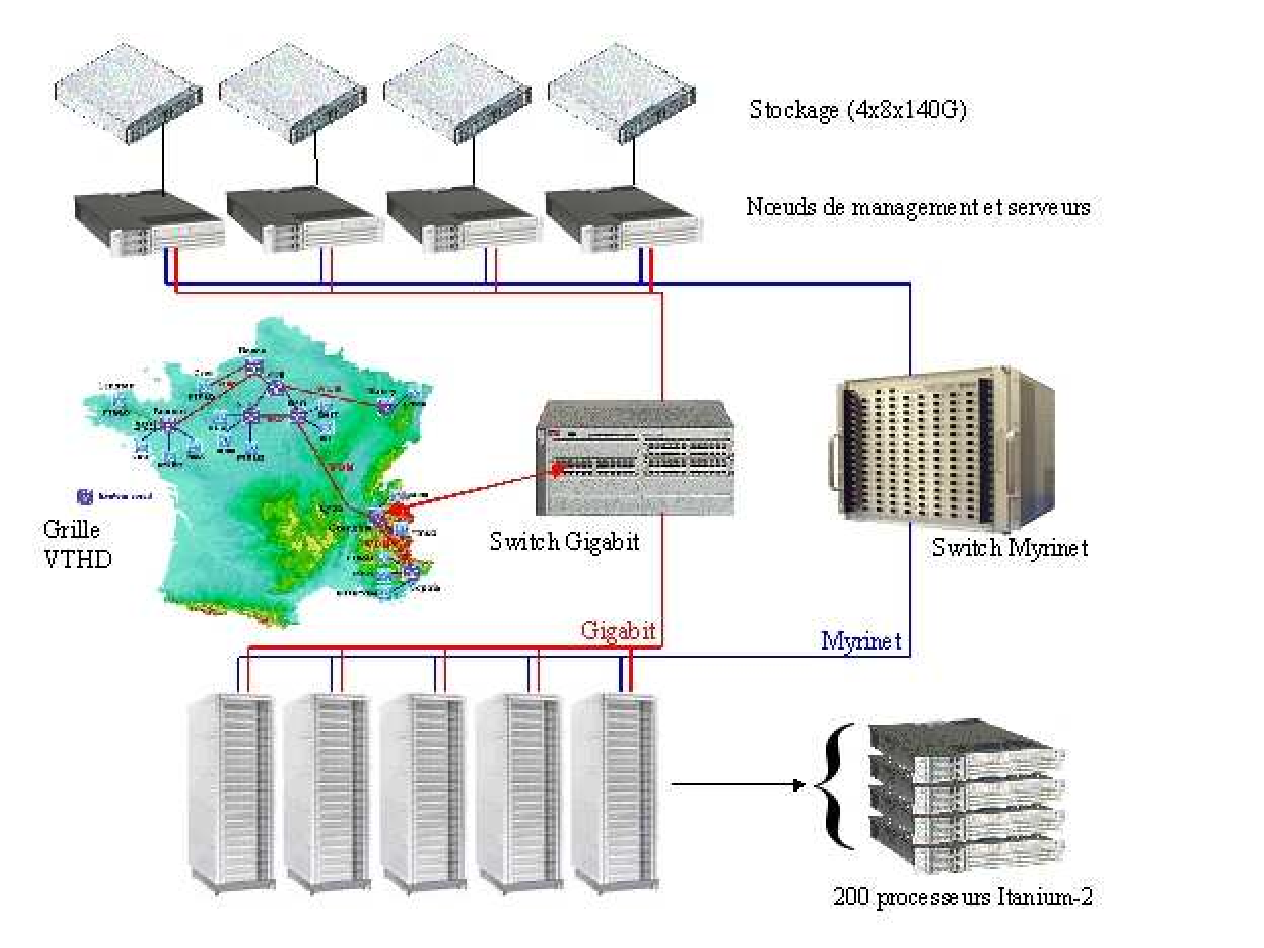
BEOWULF CLUSTERS

PC-cluster at INRIA Rhône-Alpes (216 Pentium III procs.)



CLUSTER COMPUTING

New at INRIA Rhône-Alpes : 104 Itanium-2 biprocs, 900MHz, 3Gb, 72 Gb



HEAVEN Goals

Creation of a processing structure able to host applications created by **« virtual »** descriptors.

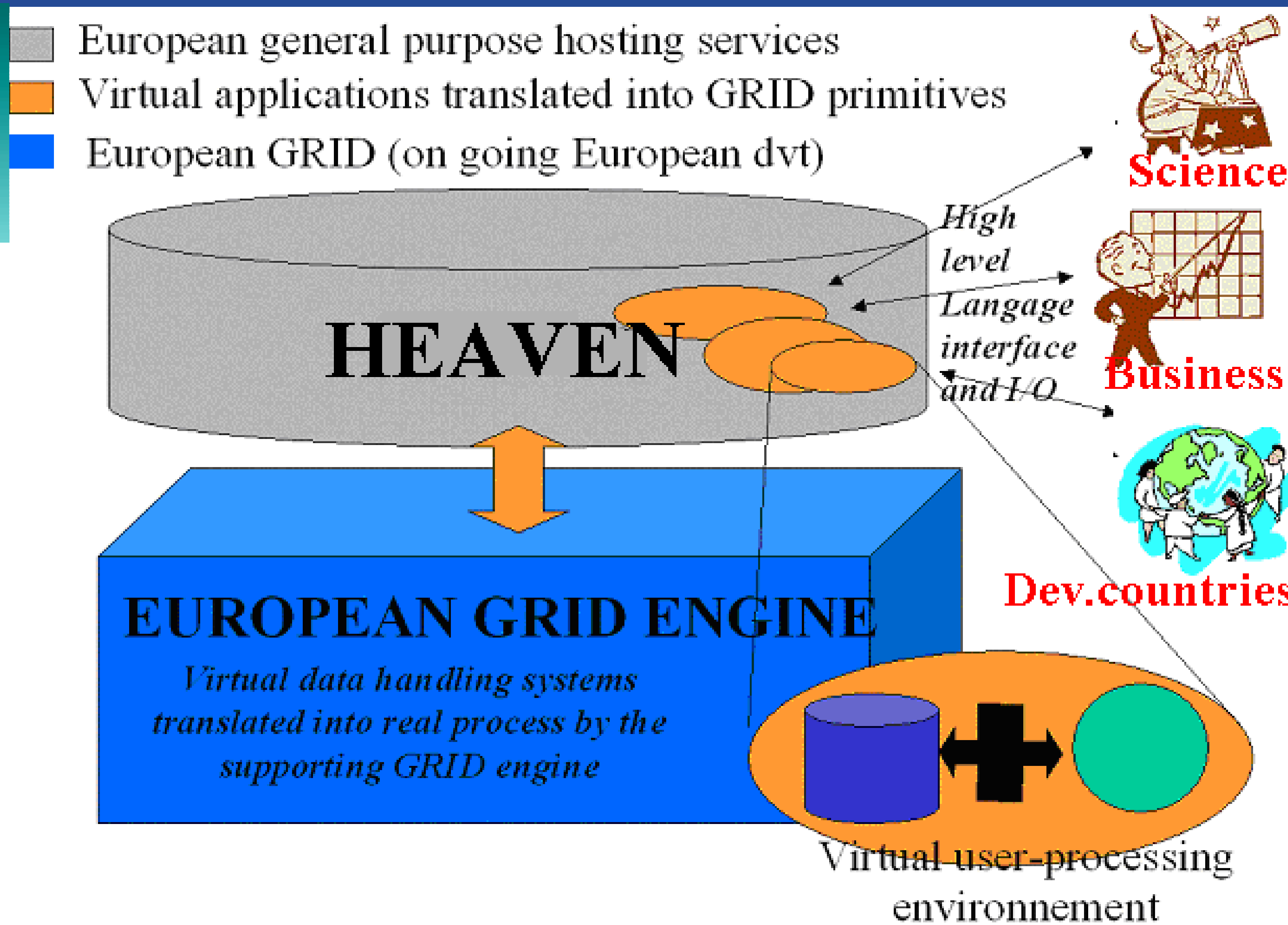
Comparable to virtual creation of objects currently in use in aerospace industry

Real implementation <=> Virtual objects

Drawback: Less efficient in term of processing resources than direct developpement

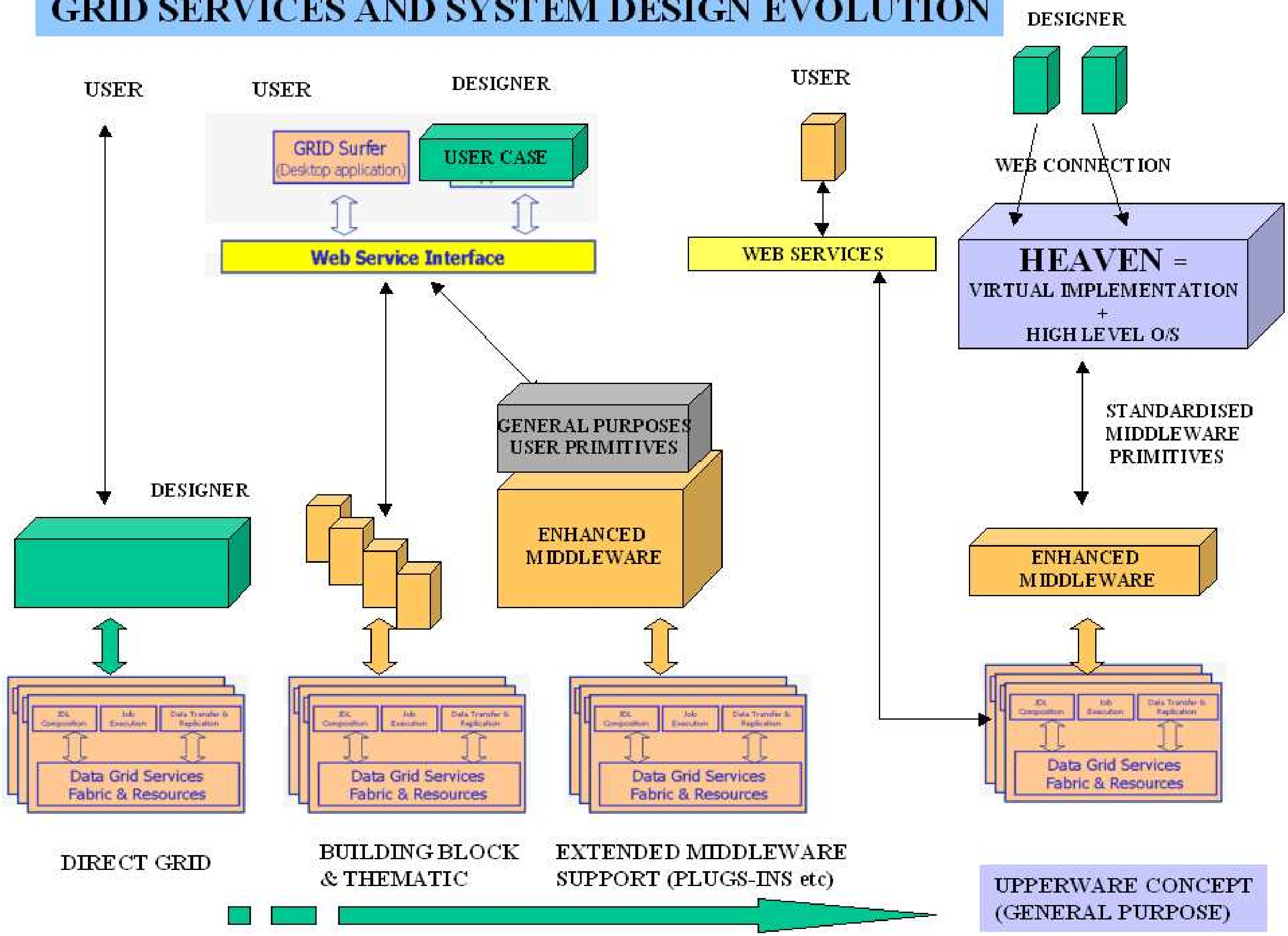
Advantages: complete flexibility, much lower cost

Why now ?: Only possible thanks to GRID properties

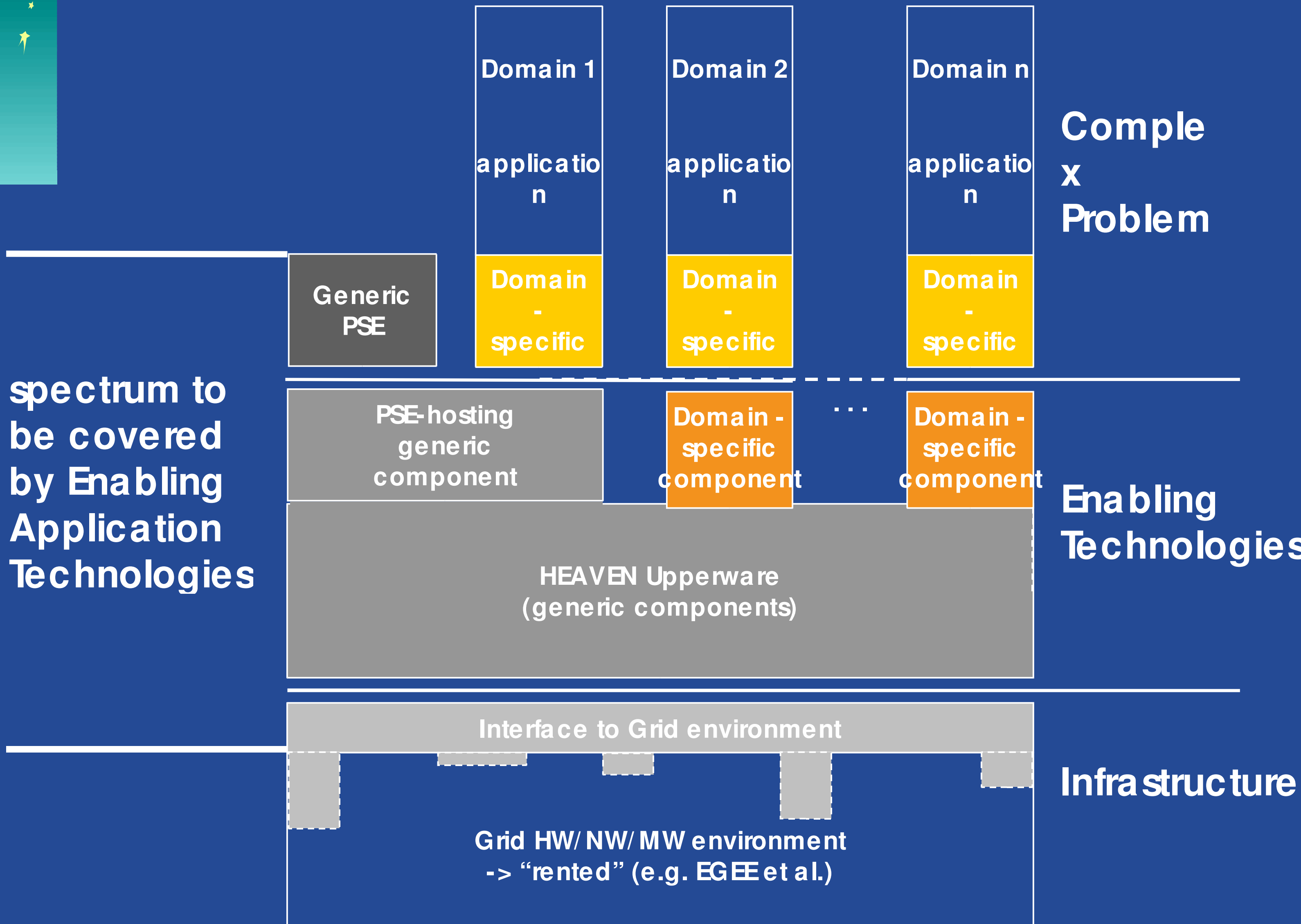


HEAVEN: a virtual space for creation of applications

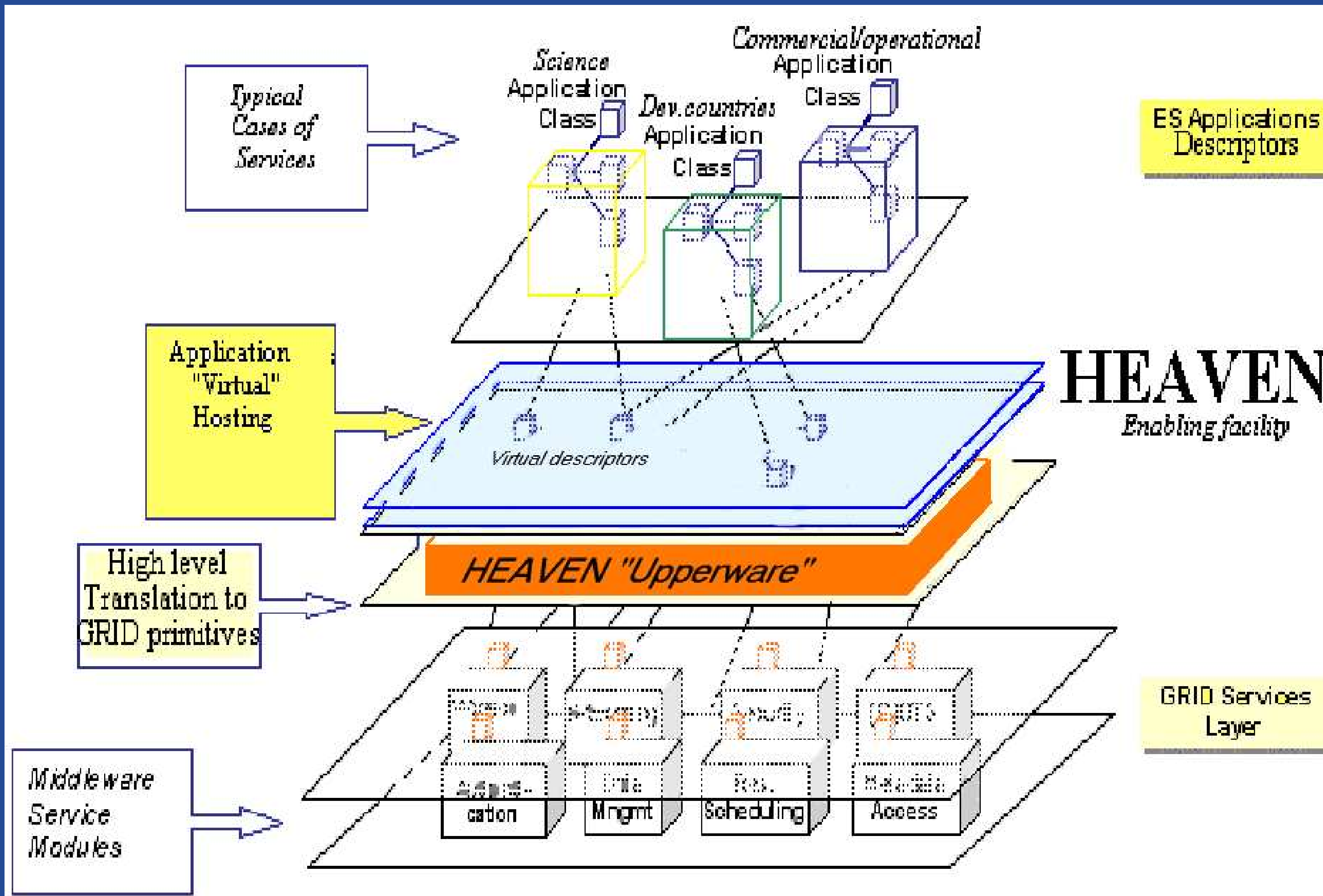
GRID SERVICES AND SYSTEM DESIGN EVOLUTION



HEAVEN

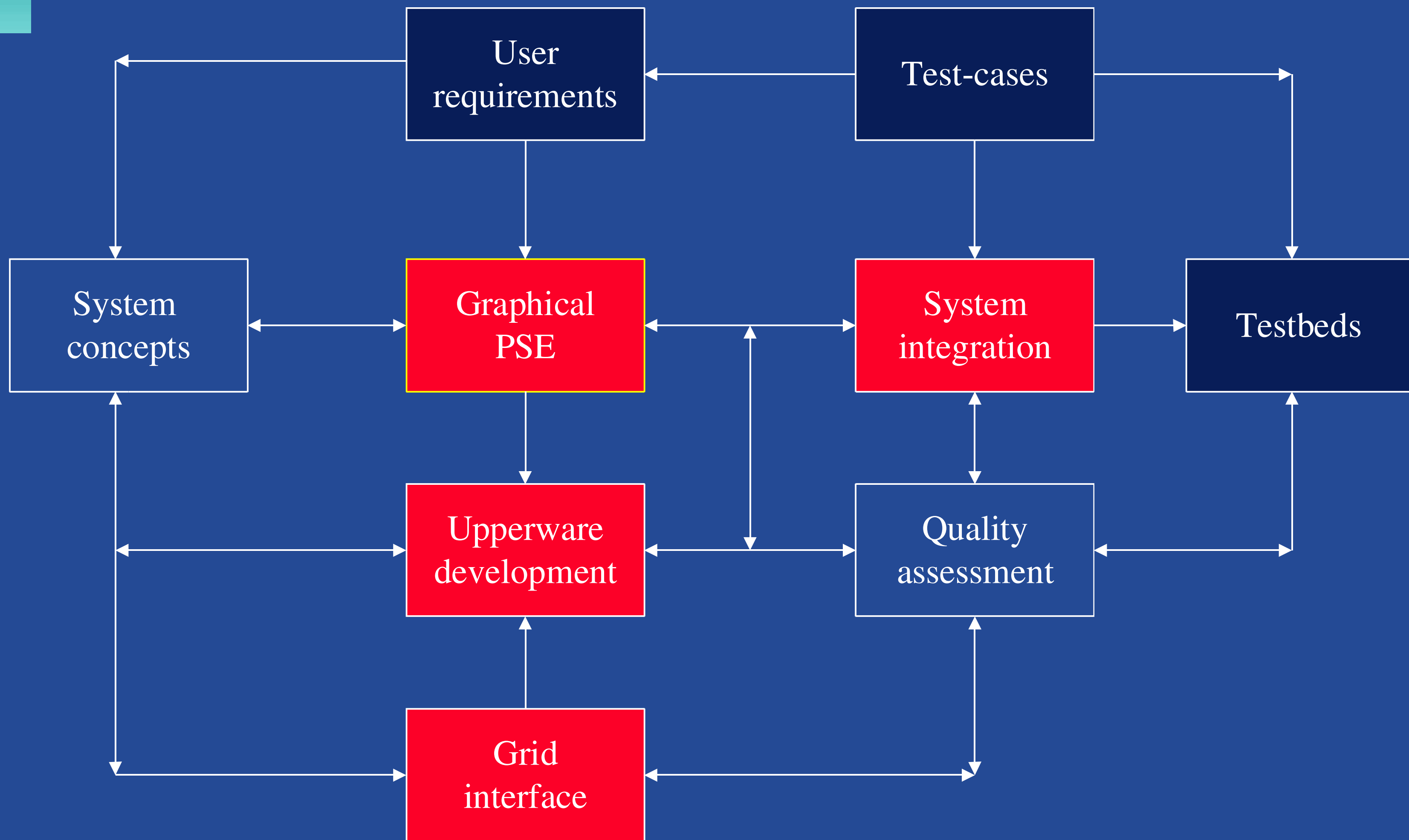


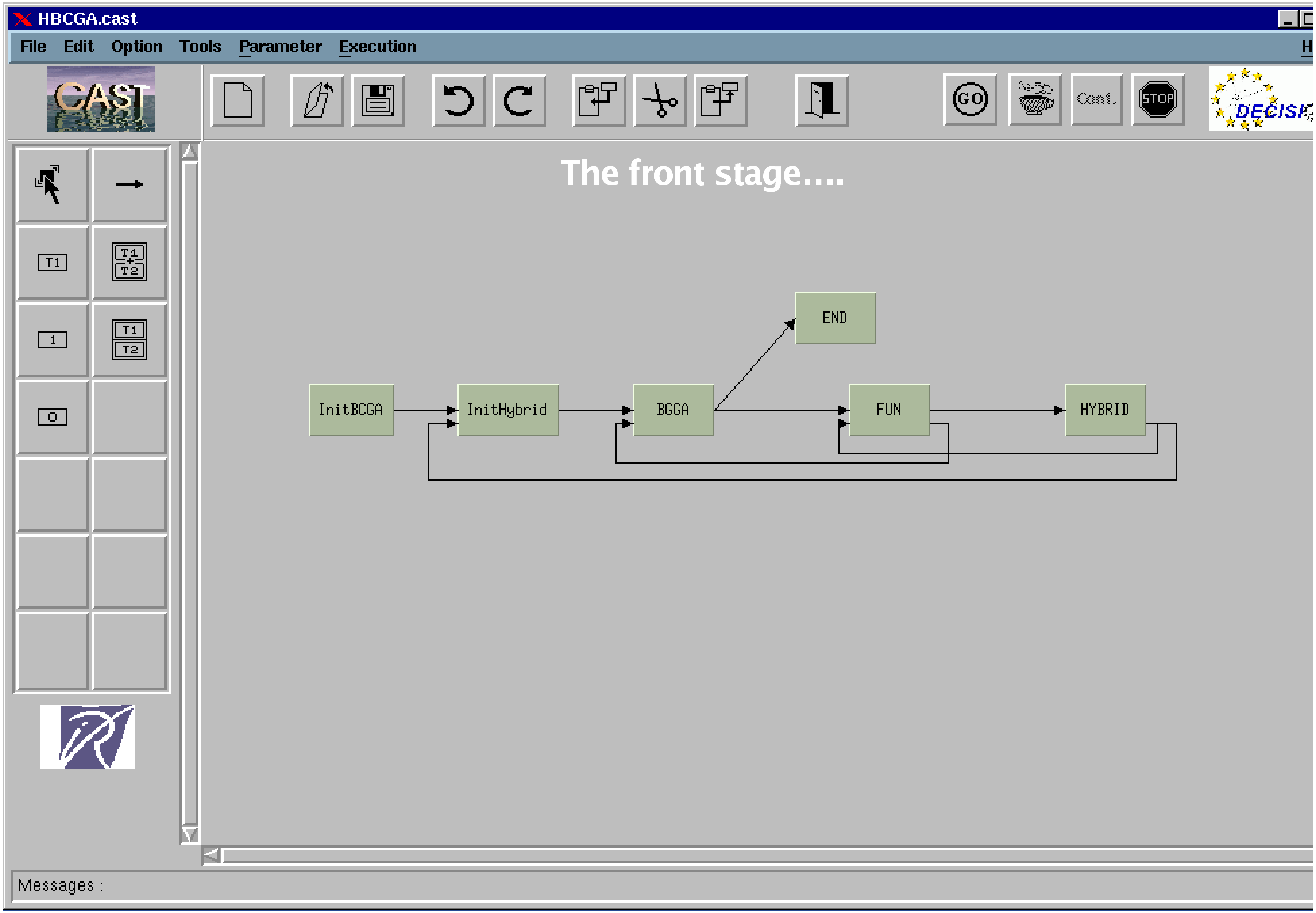
Domain 1 application
Domain 2 application
Domain n application
Complex Problem
Generic PSE
Domain - specific
Domain - specific
Domain - specific
spectrum to be covered by Enabling Application Technologies
PSE-hosting generic component
Domain - specific component
. . .
Domain - specific component
Enabling Technologies
HEAVEN Upperware (generic components)
Interface to Grid environment
Infrastructure
Grid HW/NW/MW environment
-> “rented” (e.g. EGEE et al.)


Typical Cases of Services
Science Application Class
Dev.countries Application Class
Commercial/operational Application Class
ES Applications Descriptors
Application "Virtual" Hosting
Virtual descriptors
HEAVEN
Enabling facility
High level Translation to GRID primitives
HEAVEN "Upperware"
GRID Services Layer
Middleware Service Modules
cation
Mngmt
Scheduling
Access

HEAVEN IMPLEMENTATION PLAN

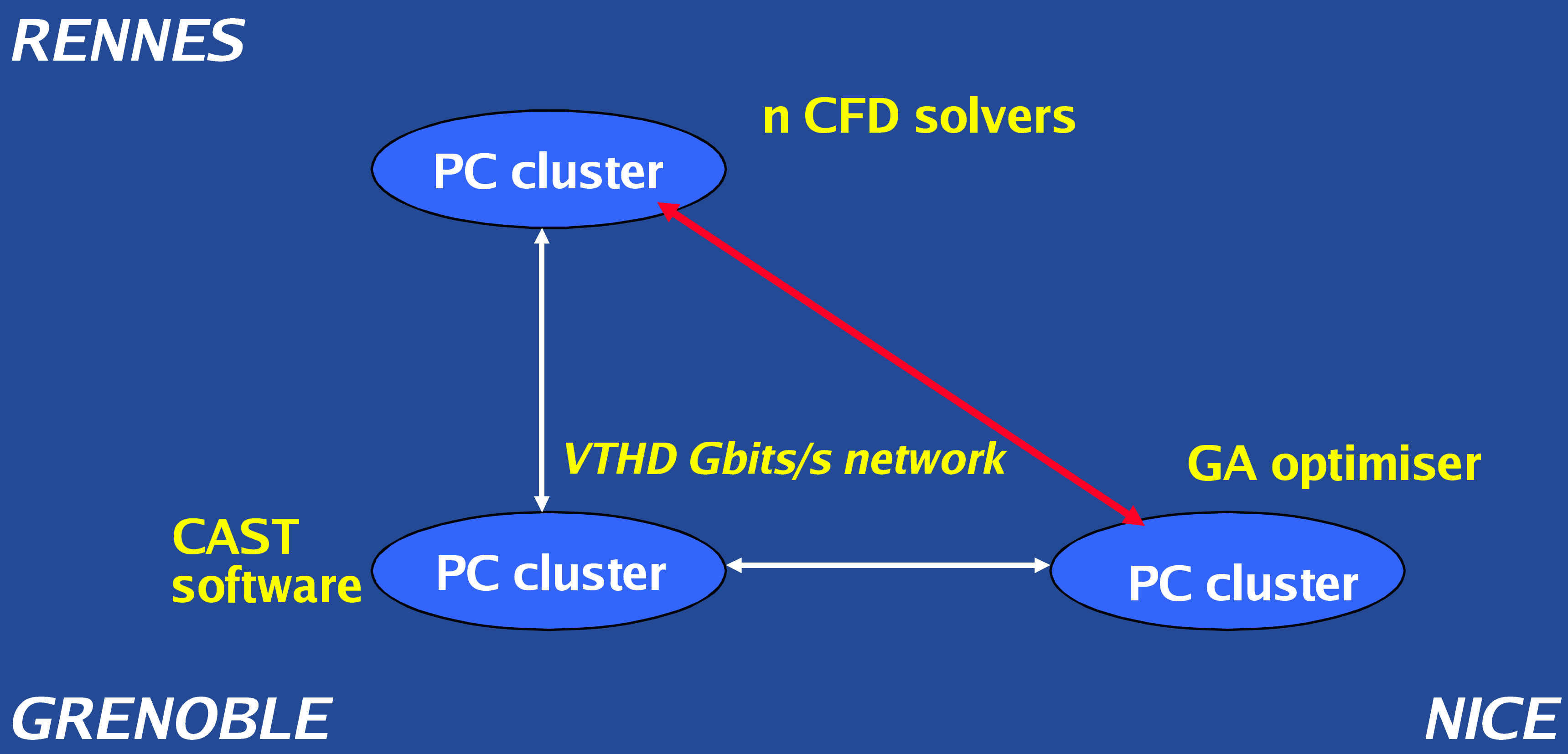
Functional breakdown



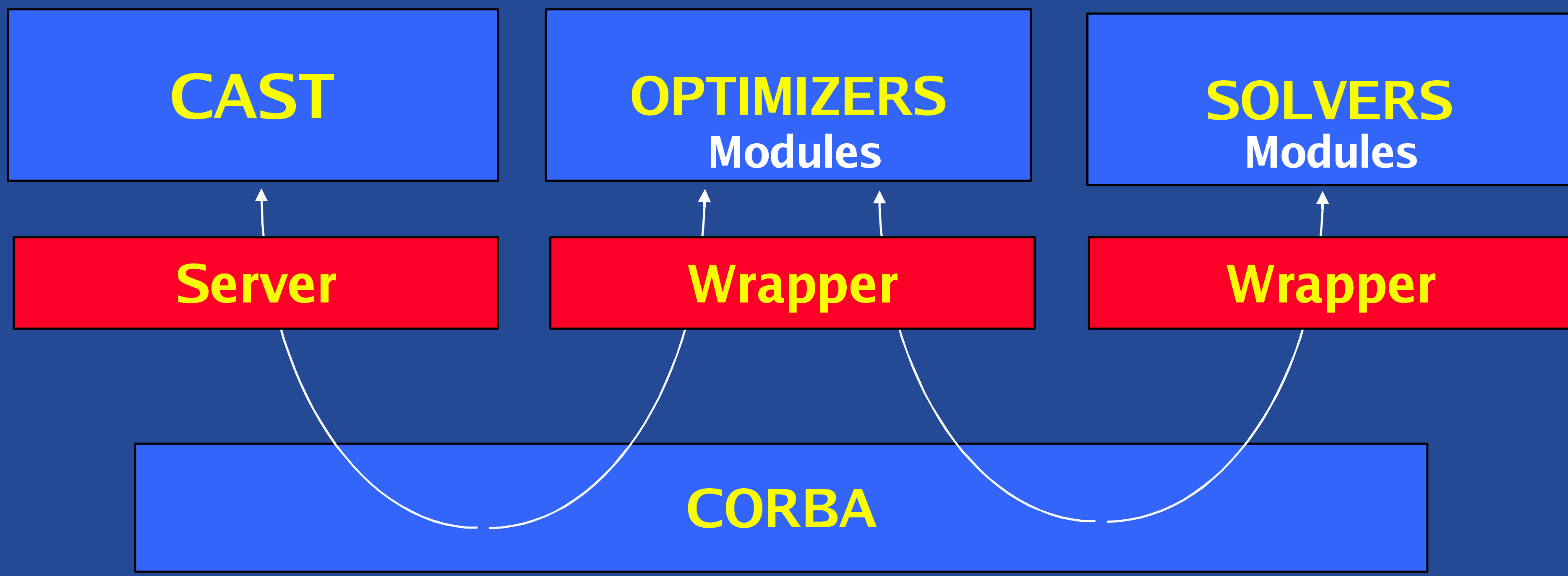

HBCGA.cast
File
Edit
Option
Tools
Parameter
Execution
CAST
DECISI
The front stage....
T1
T1
T2
1
0
END
InitBCGA
InitHybrid
BGGA
FUN
HYBRID
Messages :

CAST DISTRIBUTED INTEGRATION PLATFORM

GRID computing…



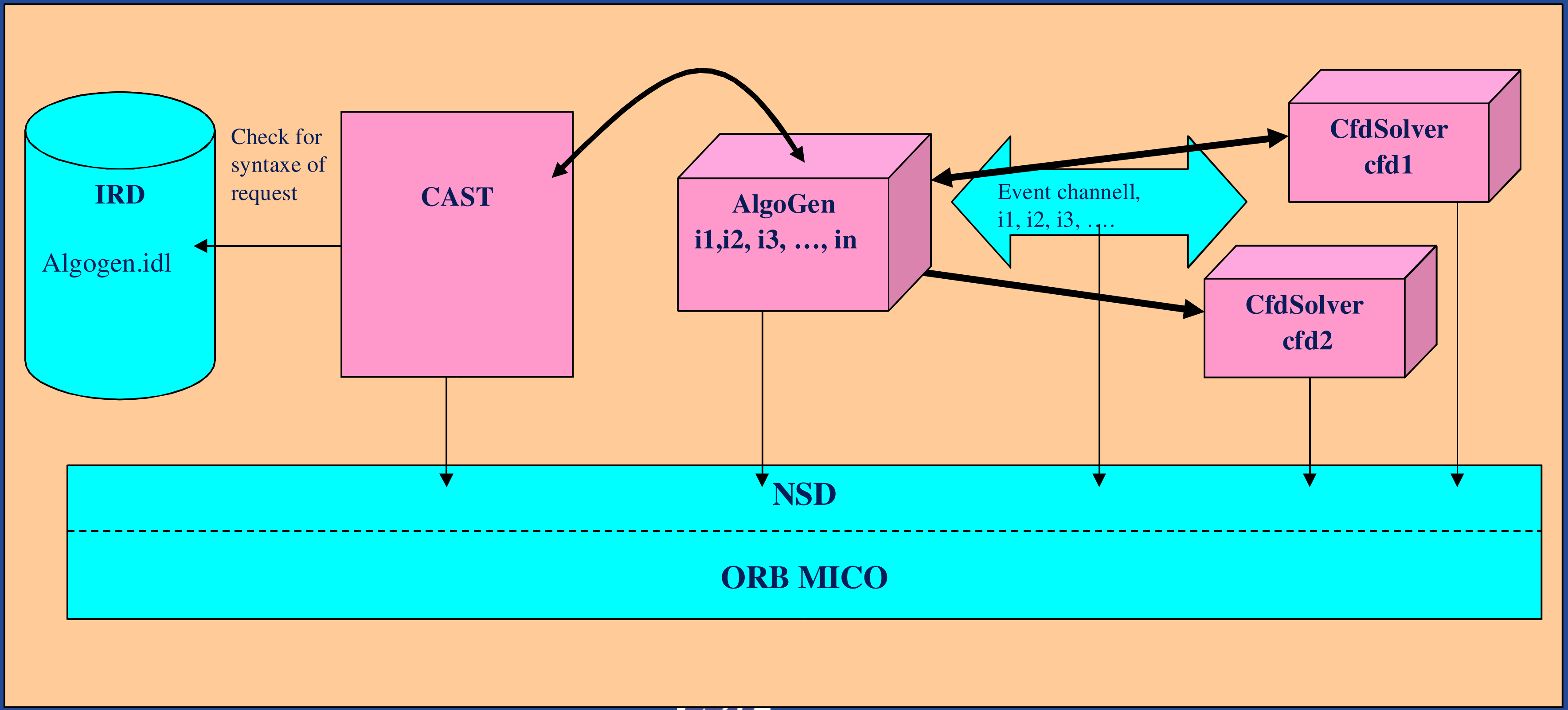
CAST PROTOTYPE



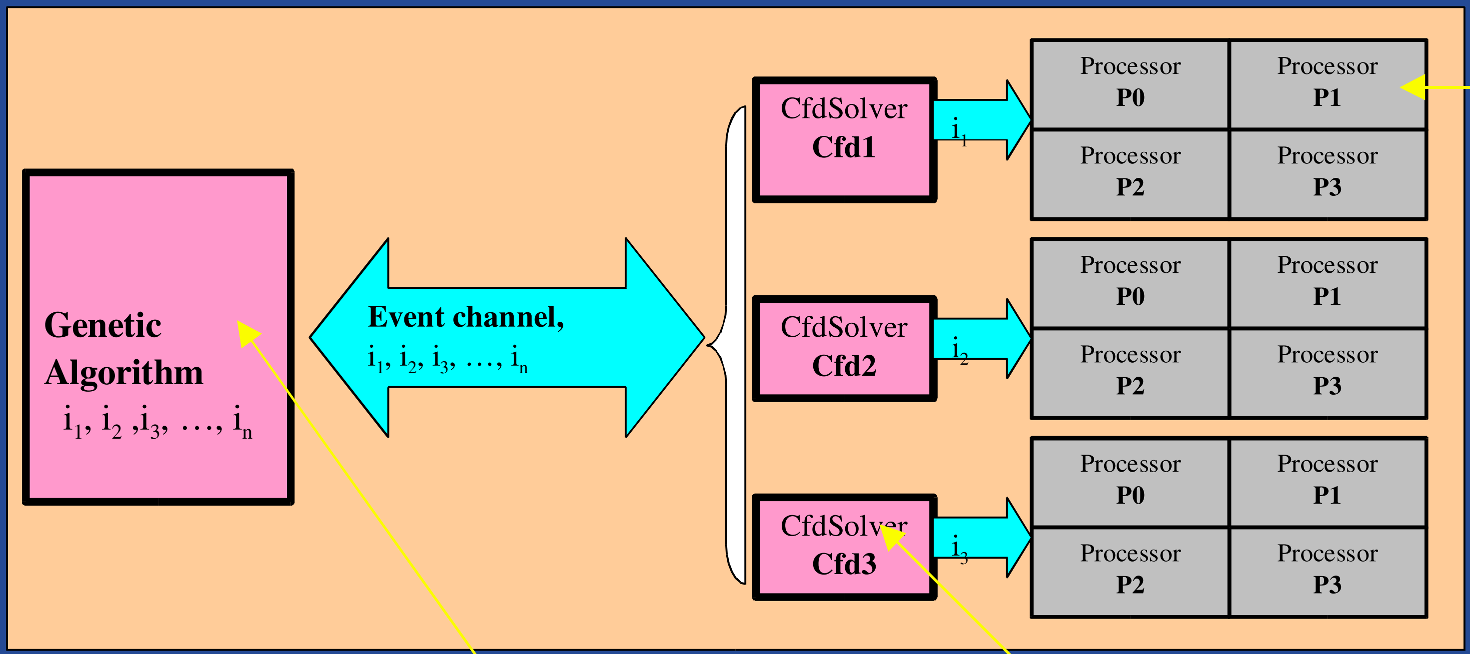
« CAST » INTEGRATION PLATFORM

Behind the stage, again…

GRID 3 PC-CLUSTERS



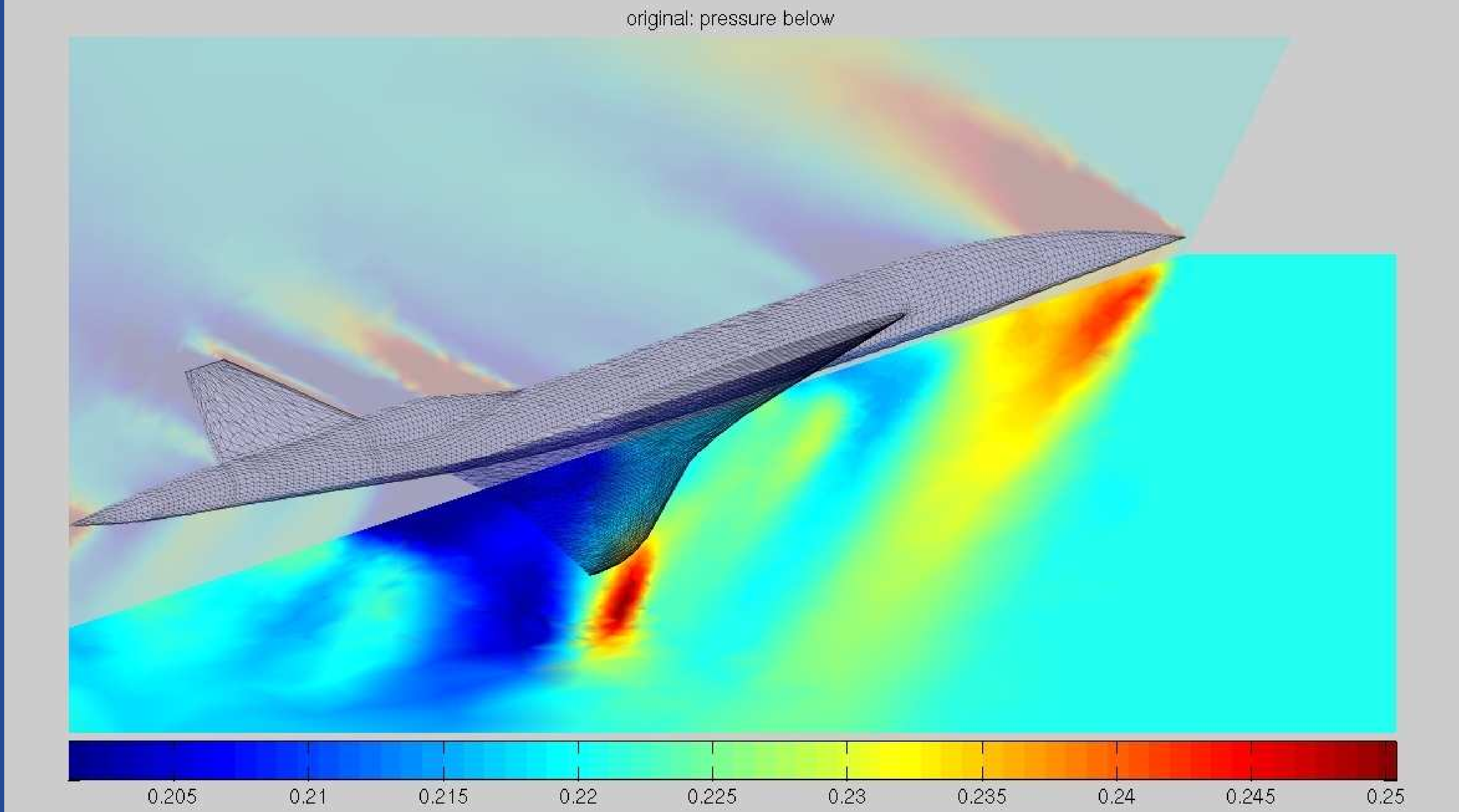
EMBEDDED PARALLELISM

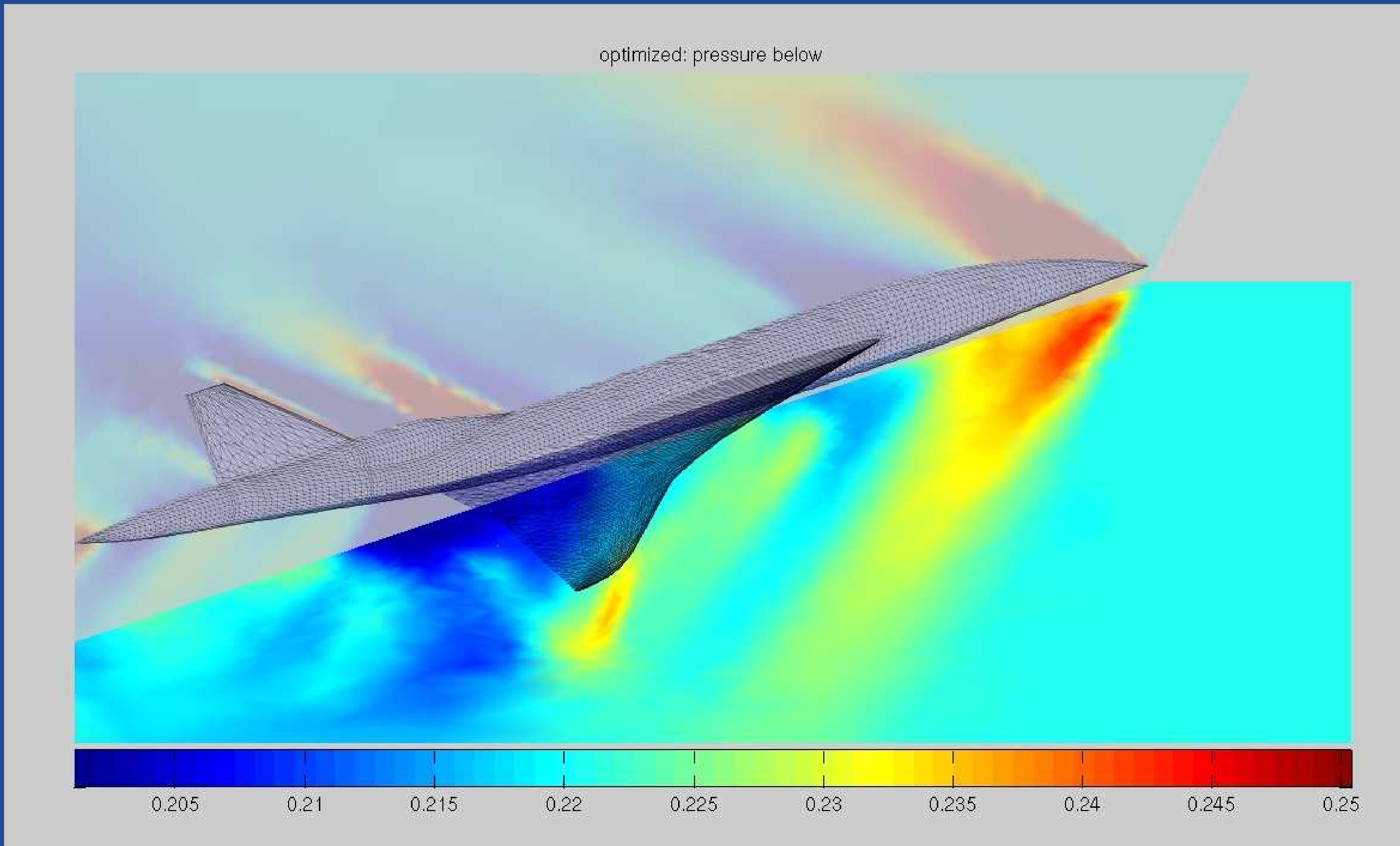


Parallelized with MPI on 4 processors

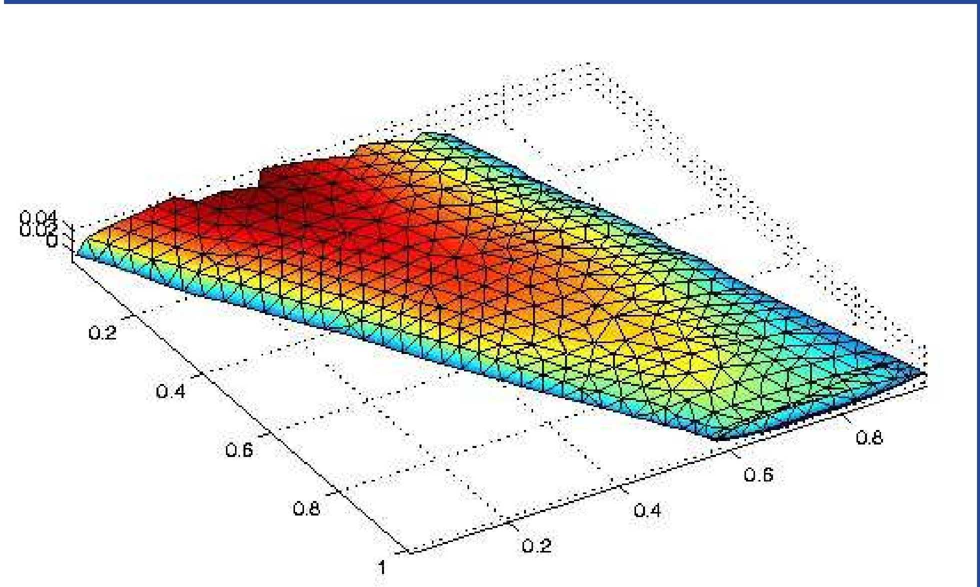
CORBA server implemented in C++

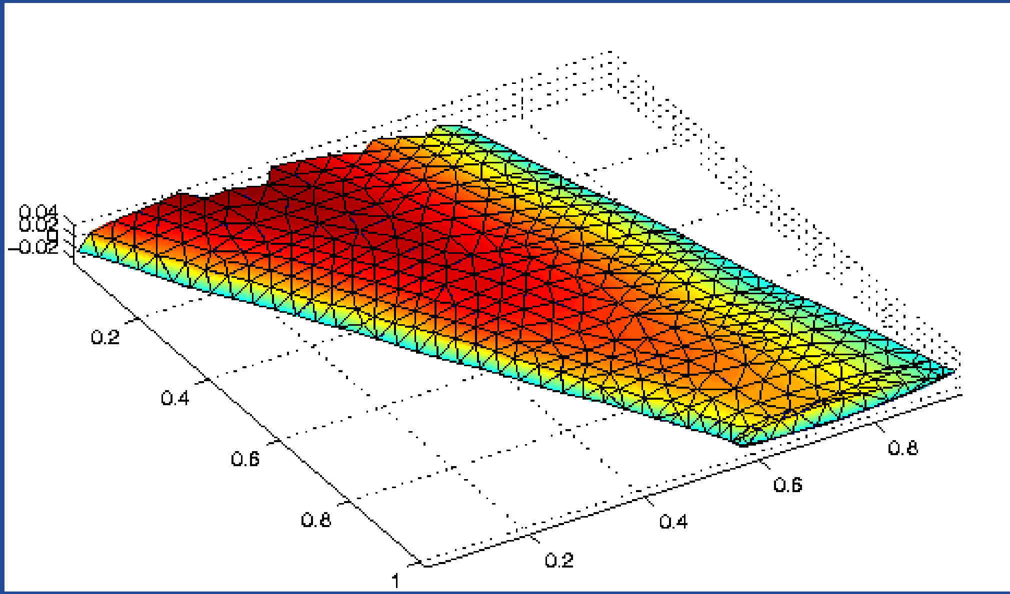
CORBA client implemented in C++


original: pressure below
0.205
0.21
0.215
0.22
0.225
0.23
0.235
0.24
0.245
0.25


optimized: pressure below
0.205
0.21
0.215
0.22
0.225
0.23
0.235
0.24
0.245
0.25

APPLICATION



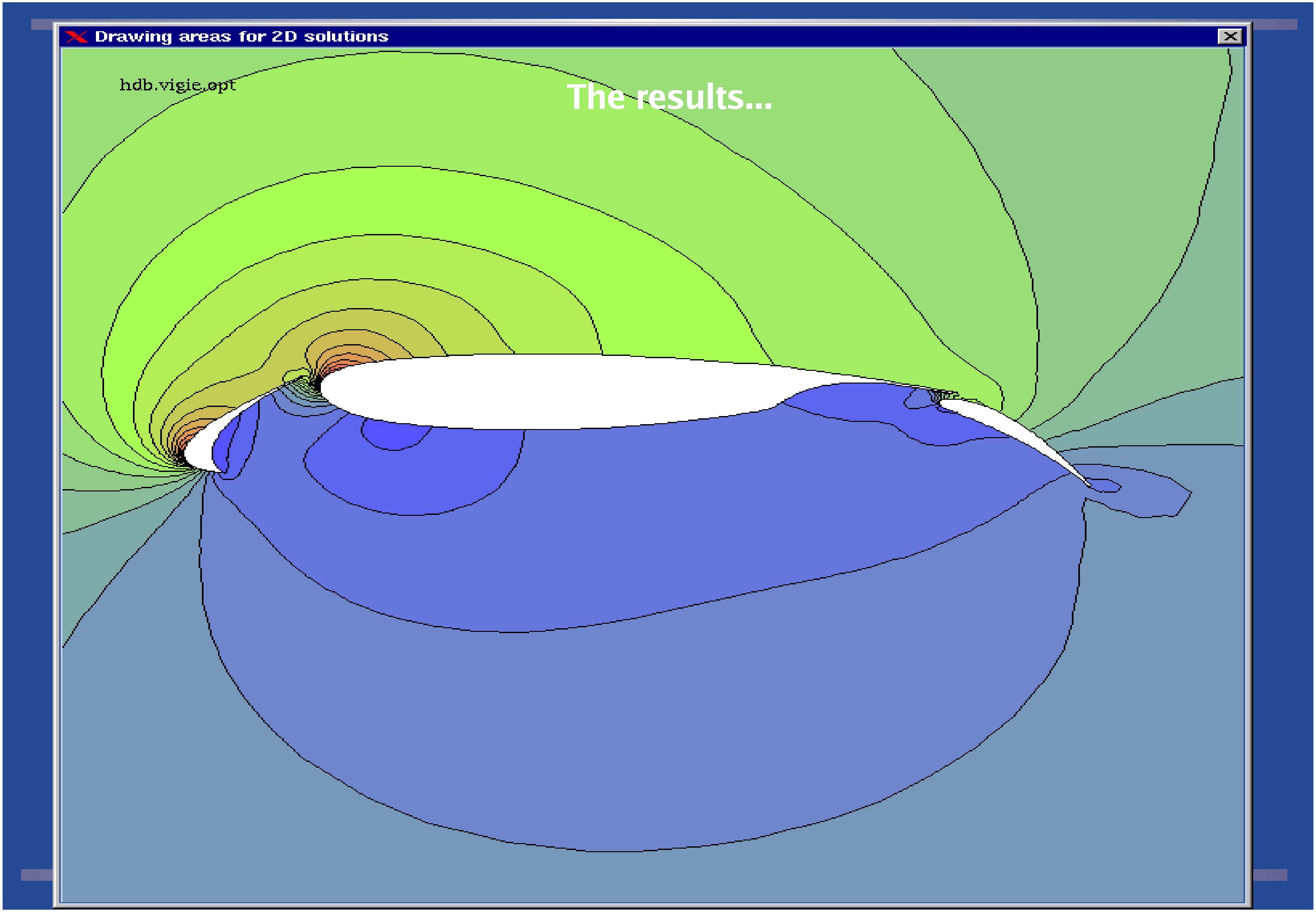


Optimized **Initial profile**

AIRFOIL OPTIMIZATION

ONERA M6 SUPERSONIC WING

AOA = 3°, MACH 1.8


Drawing areas for 2D solutions
hdb.vigie.opt
The results...

REFERENCES

- **http://www.inrialpes.fr/opale**
- **http://www.globus.org**
- **http://www.unicore.org**
- **http://www.clustercomputing.org**

Toan.Nguyen@inrialpes.fr