Virtual Computing Environments
for Problem Solving on Grids

International Conference Parallel CFD 2004
Gran Canaria (SP)

Jean-Pierre ANTIKIDIS, Guillaume ALLEON, Toan NGUYEN

EADS

May 24-27th, 2004

cnes

INRIA
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, …
INTEGRATING MULTIDISCIPLINARY APPLICATIONS

• INTEGRATION OF PARTNERS’ EXPERTISE TO DEPLOY SEAMLESS COLLABORATIVE ENVIRONMENTS

• 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, 72Gb
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
HEAVEN Upperware (generic components)

Complex Problem

Enabling Technologies

PSE-hosting generic component

Domain-specific component

Domain-specific component

Domain-specific PSE

Domain n application

Domain n specific component

Domain 2 application

Domain 2 specific component

Domain 1 application

Domain 1 specific component

Generic PSE

spectrum to be covered by Enabling Application Technologies

Interface to Grid environment

Grid HW/NW/MW environment

-> “rented” (e.g. EGEE et al.)
HEAVEN IMPLEMENTATION

Functional breakdown

- User requirements
- Test-cases
- Graphical PSE
- System integration
- Upperware development
- Quality assessment
- Grid interface
- Testbeds

Plan

- System concepts

Functional breakdown

Plan
The front stage....
CAST DISTRIBUTED INTEGRATION PLATFORM
GRID computing...

RENNES

PC cluster

n CFD solvers

VTHD Gbits/s network

GA optimiser

CAST software

PC cluster

GRENOBLE

PC cluster

NICE
Check for syntax of request

GRID 3 PC-CLUSTERS

IRM
Algogen.idl

CAST
AlgoGen
i1, i2, i3, ..., in

NSD
ORB MICO

CfdSolver
<cfdf1>

CfdSolver
<cfdf2>

Event channel, i1, i2, i3, ....
EMBEDDED PARALLELISM

Genetic Algorithm
i₁, i₂, i₃, ..., iₙ

Event channel, i₁, i₂, i₃, ..., iₙ

CfdSolver Cfd1

CfdSolver Cfd2

CfdSolver Cfd3

Processor P0
Processor P1
Processor P2
Processor P3

Parallelized with MPI on 4 processors

CORBA server implemented in C++

CORBA client implemented in C++
optimized: pressure below
APPLICATION

AIRFOIL OPTIMIZATION
ONERA M6 SUPersonic WING
AOA = 3°, MACH 1.8
REFERENCES

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

Toan.Nguyen@inrialpes.fr