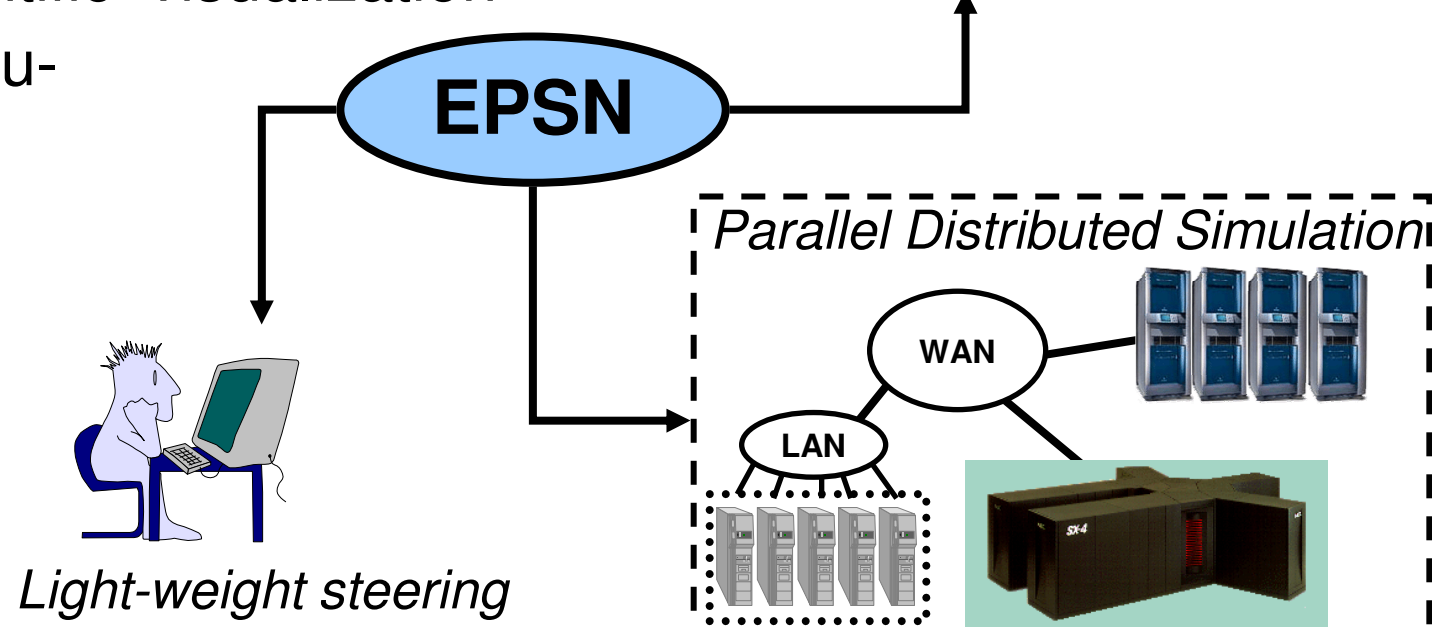


# EPSN

## A Computational Steering Environment for Numerical Distributed Simulation

Due to the emergence of Grid computing, numerical simulations are becoming more and more complex — it is not uncommon to find different models and codes coupled. Our purpose is to analyse, to design and to develop a software environment for steering distributed parallel simulations from the visualization. This computational steering environment should combine the facilities of scientific visualization with the capabilities of existing high performance simulations. The simple integration of an existing simulation should allow the end user to visualize the intermediate results and to directly interact with the simulation during its execution.



### Context and Crucial Issues

#### Parallel & distributed numerical simulations

- Aiming the most common codes (C/C++/Fortran with MPI/PVM)
- Each step of a simulation can generate very huge data

#### Parallel scientific visualization

- Complex and intensive visualization processing
- Promising evolution of the parallel visualization (clustering, tiled display)

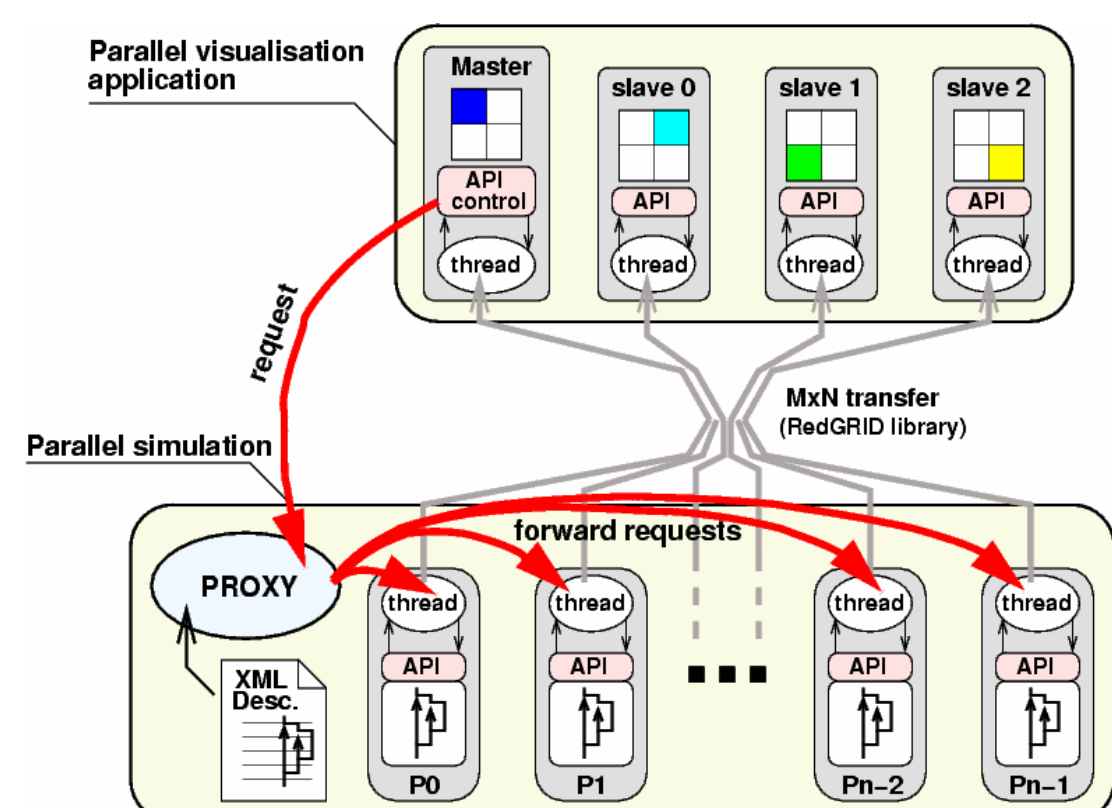
⇒ The coupling of parallel simulations and parallel visualization systems leads to several open and crucial issues.

- ✗ How to transfer data distributed on a parallel application directly to another parallel application ?
- ✓ EPSN uses a **M-by-N redistribution** library **RedGRID** (locally developed).
- ✗ How to assign precise dates in a complex simulation (e.g. nested loops) ?
- ✓ EPSN uses a **hierarchical task model** of the steerable simulations.
- ✗ How to ensure the steering treatments to occur at the same date in all the parallel processes without strongly synchronizing them ?
- ✓ EPSN **schedules** the treatments with a **weak synchronization** and the parallel processes execute them independently.

### Architecture

#### Communication infrastructure based on CORBA

- Support of heterogeneous distributed system
- CORBA server encapsulated in a thread
- Use of CORBA fully hidden to the end-user



### Simulation

#### Application fields

- Multiscale/multiphysics of solids and fluids
- Complex molecular systems: *docking, steered simulation*
- Environment: *population dynamics, epidemiology and prophylaxis*

#### Supported simulations

- Parallel SPMD applications
- Complex simulations : multiple tasks/loops, nested tasks/loops
- Distributed complex data : data fields (generic block decomposition), particles, structured grids, unstructured meshes

### User Interface

#### Visualization

- Data collection for the on-line visualization of intermediate results
- Generic client adapted to any simulation
- AVS/Express (sequential) or VTK (parallel) data source modules
- EPSN client API to develop customized user interfaces

#### Interaction

- Remote control of the simulation execution (play/stop)
- Modification of parameters and data on-the-fly
- Invocation of actions in the simulation code

### Contact

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### Web sites

**EPSN** <http://www.labri.fr/epsn>  
**RedGRID** <http://www.labri.fr/Perso/~esnard/RedGRID>  
**CoICOWS** <http://colcows.sourceforge.net>

### Publications

**ParCo 2003**, *Toward a Computational Steering Environment based on CORBA*. O. Coulaud, M. Dussere, A. Esnard.  
**EuroPar 2004**, *A Time-Coherent Model for the Steering of Parallel Simulations*. A. Esnard, M. Dussere, O. Coulaud.

### Key Points

#### Distributed and dynamic infrastructure

- Client/server relationship
- Several remote clients can connect and disconnect on-the-fly
- Concurrent client-directed requests

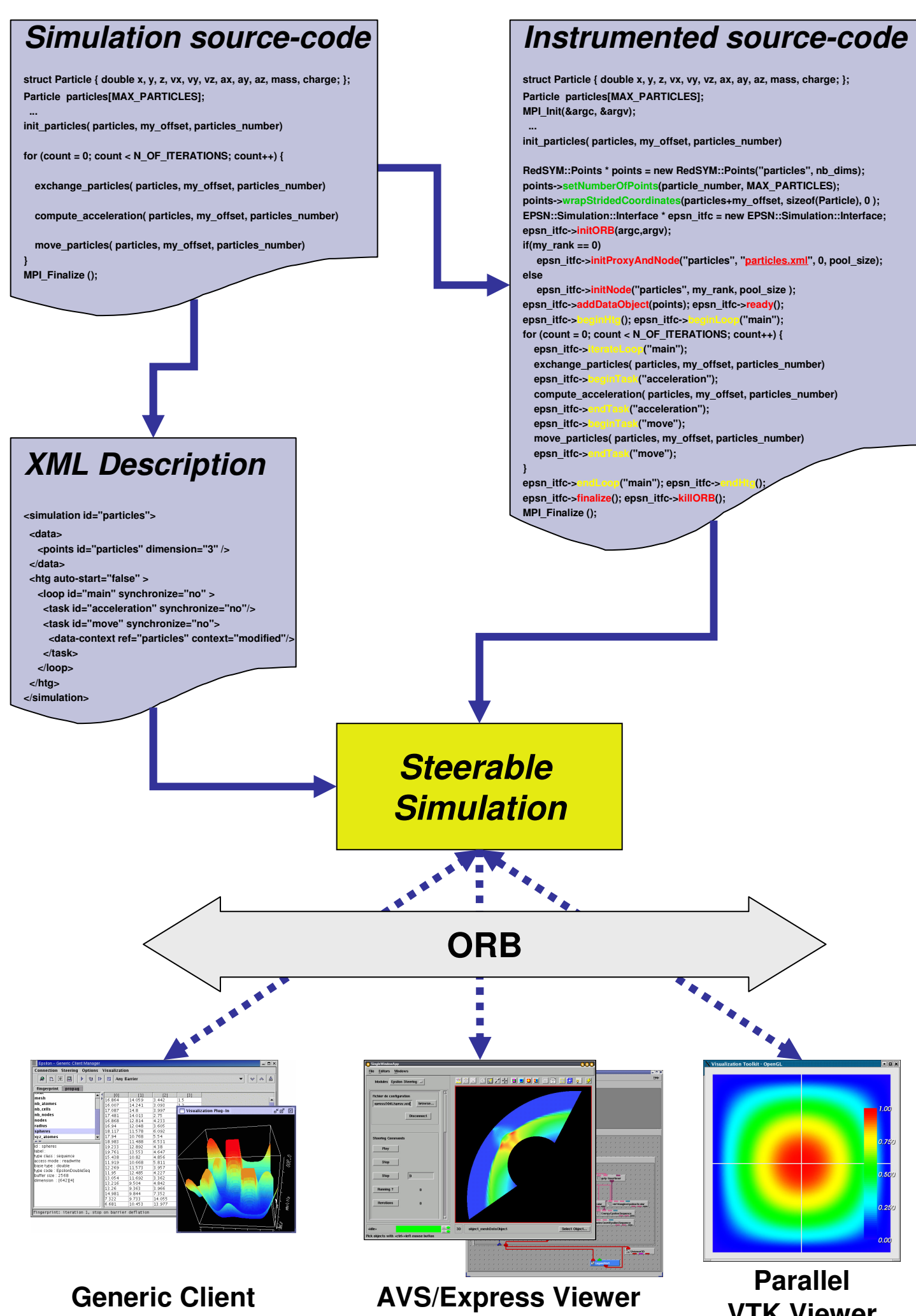
#### Instrumentation of legacy simulation

- Annotations of the sources with EPSN C++ API (C/Fortran bindings)
- Description of the simulation structure (data and tasks)

#### Performance design

- Low perturbation instrumentation (no request ⇒ no overhead)
- Communication overlapping of the and zero-copy sending
- Few synchronizations between the simulation and the steering applications

### Infrastructure



### Prospects

- Massively parallel and distributed applications
- *Grid 5000* deployment
- Evolution to parallel CORBA objects: Paco++ (PARIS project)
- Definition of high-level interaction objects and association with 3D widgets
- Virtual reality environment: haptic sensors, tiled display wall

### Partners

**INRIA-Futurs** Institut National de Recherche En Informatique et Automatique — **ScAIApplix** Project  
**LaBRI** Laboratoire Bordelais de Recherche Informatique  
**IECB** Institut Européen de Chimie et Biologie  
**SRSMC** Structure et Réactivité des Systèmes Moléculaires Complexes  
**CNRS/SMEL** Station Méditerranéenne de l'Environnement Littoral



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