Adapting ROMS to execute on GRID using a hybrid parallelization model

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RETELAB

A Virtual Laboratory for the National Network of Oceanographic Remote Sensing (RETEMAR).

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URL: http//www.retelab.org

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Keys Issues

Oceanographic research community has strong requirements for storage and satellite images processing and also for numeric simulation.

Data storage:

More data at a higher resolution every day.

Large amount of raw data.

Access to distributed data sets

Data processing:

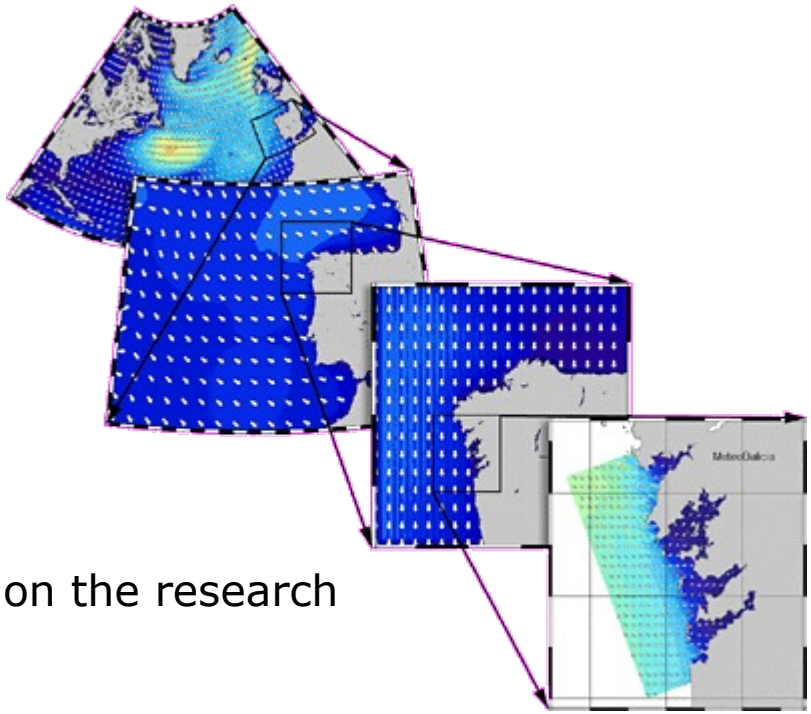
Data analysis is tedious.

Ocean study is an interdisciplinary task.

Heterogeneous data processing (it depends on the research group).

Simulation:

Currents and other oceanographic variables forecast.



Source : MeteoGalicia

Virtual laboratory

Grid technology enables oceanographic researchers to run algorithms that require high computational power and create a collaborative framework between centres, users, models and distributed data.

Main requirements:

Scientific applications used in ocean study.

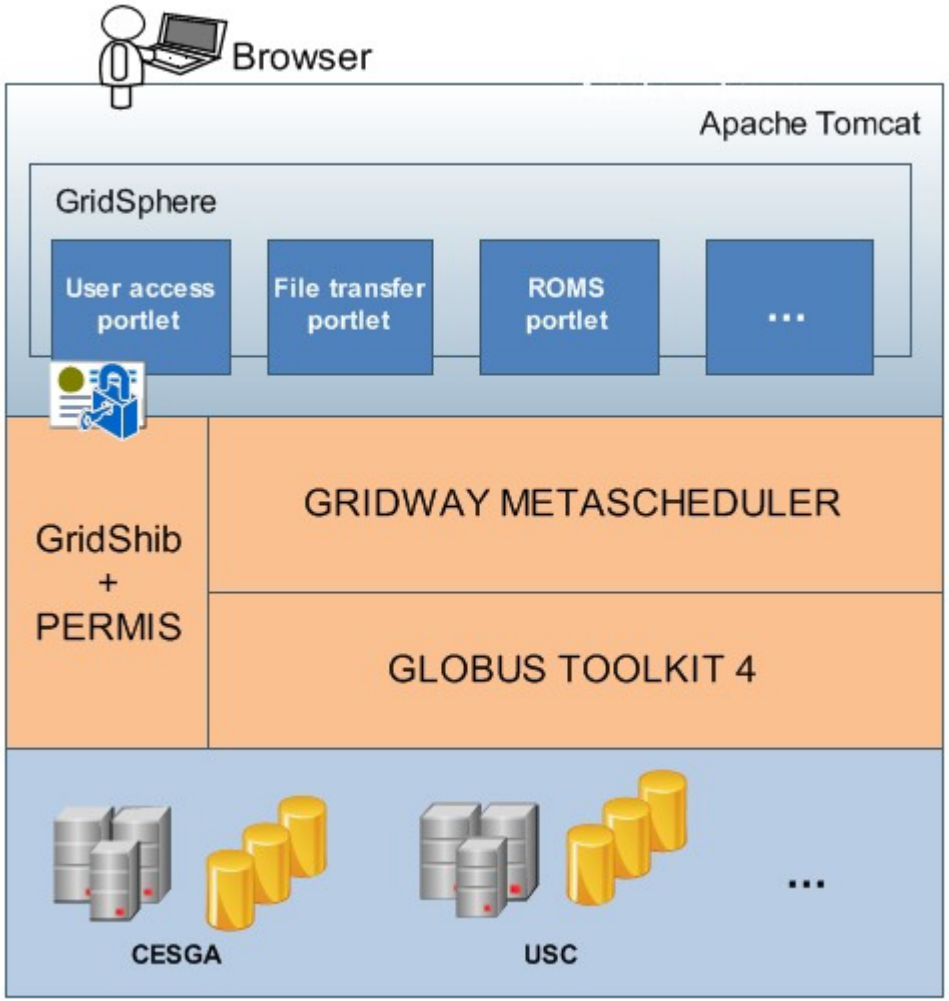
Management of security covering researchers access.

Distributed storage capacity for data exchange and management.

Processing capacity needed for data processing.

Visualisation of processed/stored data.

RETELAB Architecture



Web portal:

Developed using Java portlets (based on GridSphere Portal Framework)

Role Base Access Control using X.509 attribute certificates

GRID-enable workload management:

GridWay metascheduler

Allocates the best resources available and allows the execution of jobs.

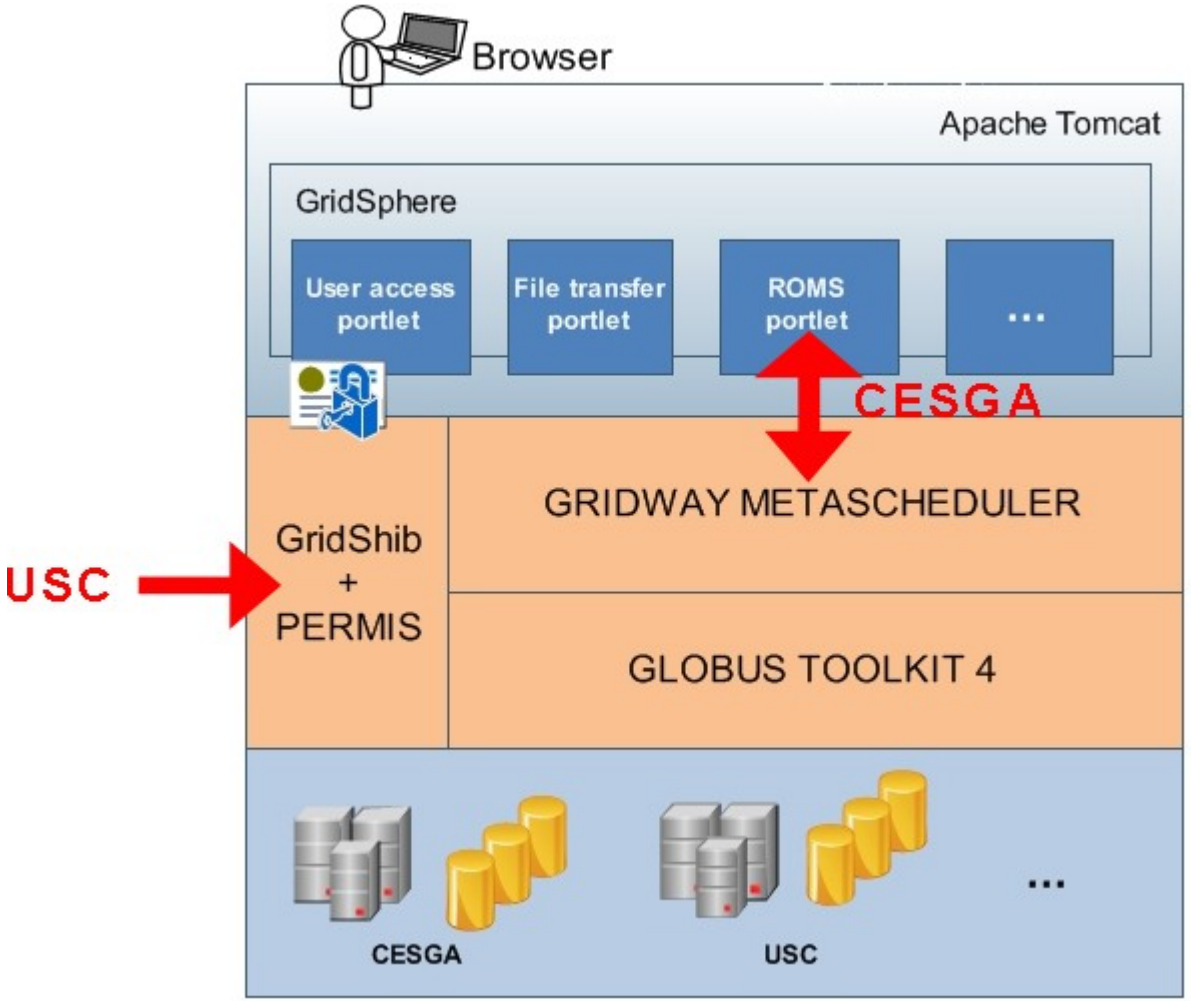
Supports Job Submission Description Language (JSDL) and DRMAA OGF standard

Grid middleware:

Globus Toolkit 4.

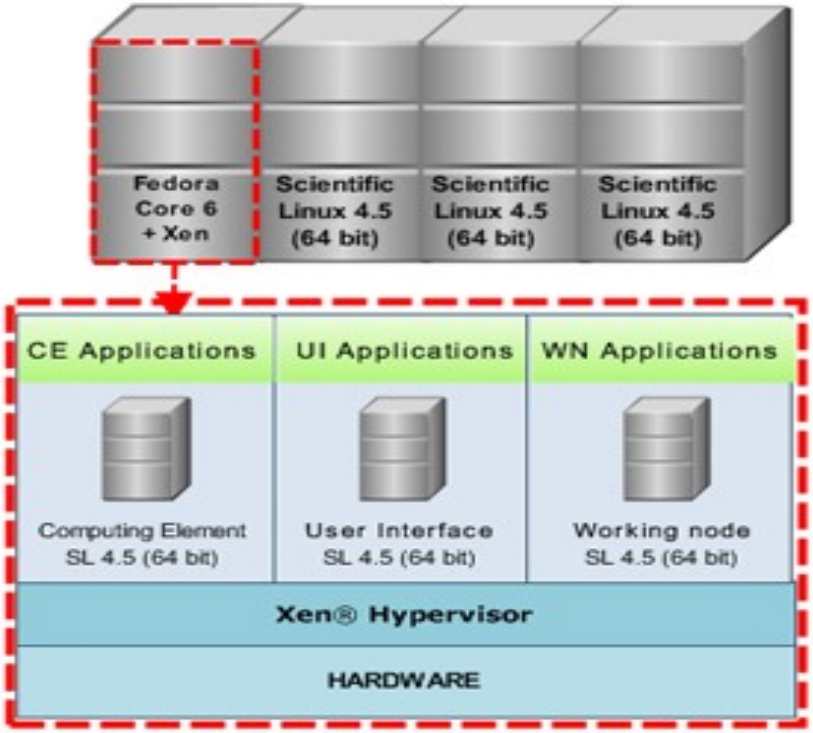
Enables the sharing of many different types of resources.

RETELAB Architecture



Computational infrastructure

Initial pilot is based on a cluster composed of 4 HP blade systems with Intel quad-core CPUs. One of the systems runs 3 Xen virtual machines.



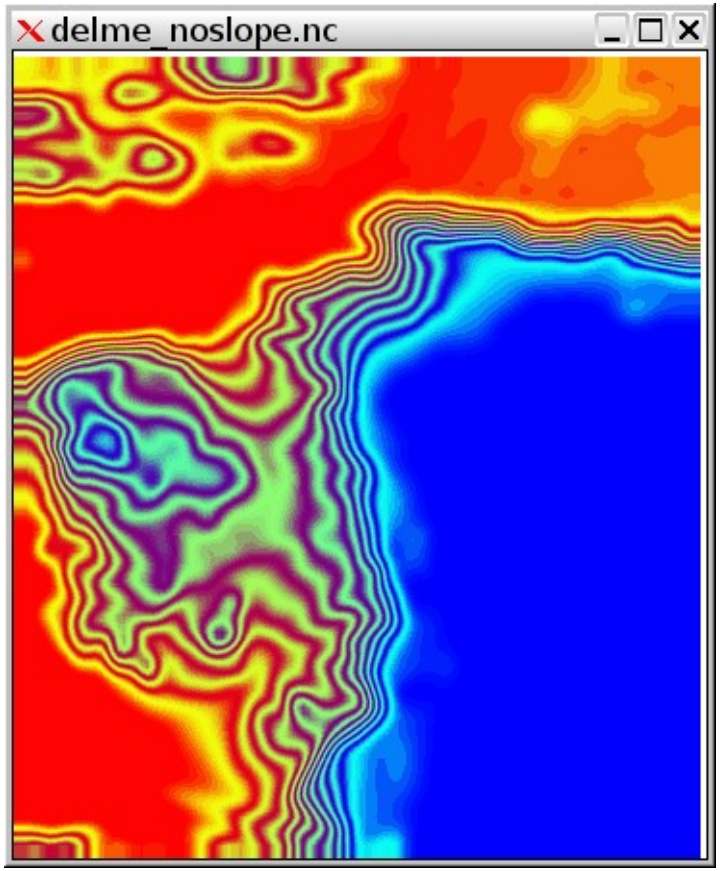
Demonstration application: ROMS

The Regional Ocean Modeling System (ROMS) is a a new-generation model for oceanic circulation:

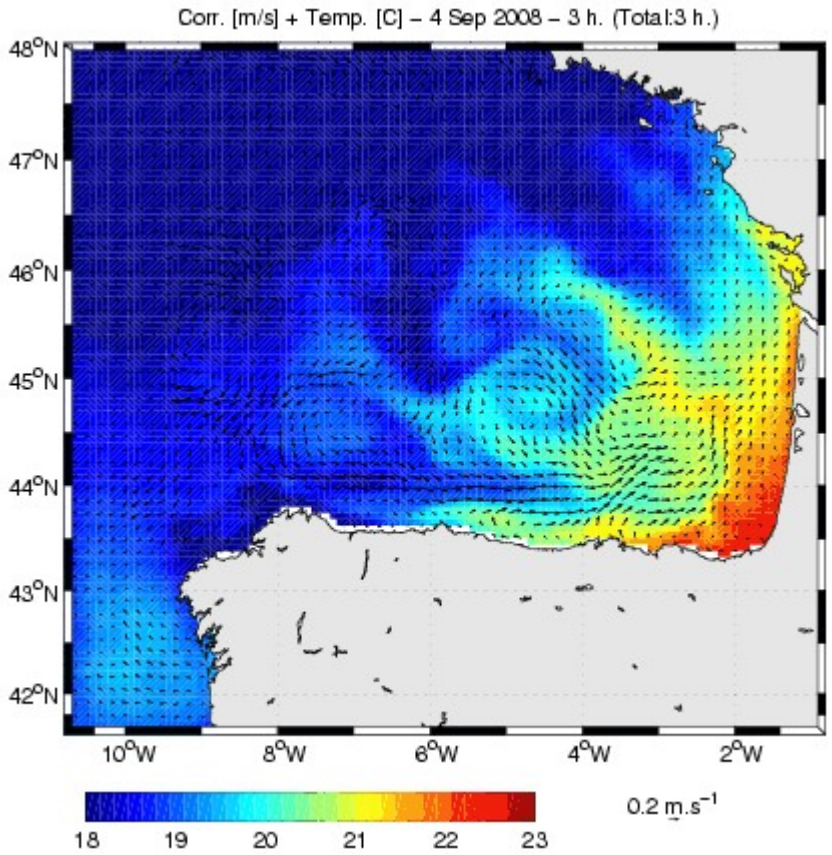
- Specially designed to simulate regional ocean systems accurately.
- Can be run in either serial or parallel computers using MPI and OpenMP programming models but not concurrently.
- Extensive pre and post-processing software for data preparation, analysis, plotting and visualization.

ROMS: http://www.myroms.org

Demonstration application: ROMS



Source: USC-TELSIG



Source: AZTI

Adapting ROMS

RETELAB architecture and the domain decomposition of ROMS MPI version will allow executing it in a hybrid model (OpenMP+MPI).

Tasks to execute ROMS using a hybrid model:

- Adapting ROMS code in order to use OpenMP and MPI simultaneously.
- Defining a new JSDL extension including multilevel parallelization features.
- Developing a specialized portlet able to translate job requirements into a JSDL document.
- Adapting Gridway components in order to use the new JSDL extension.

Adapting ROMS

Defining a new JSDL extension:

- JSDL is the Open Grid Forum standard.
- There are standard and non-standard JSDL extensions but none of them covers exactly this scenario.
- New extension includes multilevel parallelization features.
- This extension describes the aplication requiriments, not the technical details of the infrastructure.

JSDL-HTC example for NAS-MZ BT Benchmark

```
<jsdl:Application>
<jsdl:ApplicationName>NAS</jsdl:ApplicationName>
<jsdl:ApplicationVersion>3.0</jsdl:ApplicationVersion>
<jsdl-htc:HTCApplication>
   <jsdl-posix:Executable>BT.D.OpenMP</jsdl-posix:Executable>
   <jsdl-posix:Input>input.dat</jsdl-posix:Input>
   <jsdl-posix:Output>output.dat</jsdl-posix:Output>
   <jsdl-spmd:NumberOfProcesses>1</jsdl-spmd:NumberOfProcesses>
   <jsdl-htc:MinNumThreads>2</jsdl-htc:MinNumThreads>
   <jsdl-htc:MaxNumThreads>4</jsdl-htc:MaxNumThreads>
   <jsdl-htc:MemProcess>1000000</jsdl-htc:MemProcess>
   <jsdl-htc:DiskProcess>1000000</jsdl-htc:DiskProcess>
</jsdl-htc:HTCApplication>
<jsdl-htc:HTCApplication>
   <jsdl-posix:Executable>BT.D.4</jsdl-posix:Executable>
   <jsdl-posix:Input>input.dat</jsdl-posix:Input>
   <jsdl-posix:Output>output.dat</jsdl-posix:Output>
   <jsdl-spmd:NumberOfProcesses>4</jsdl-spmd:NumberOfProcesses>
   <jsdl-htc:MaxNumThreads>1</jsdl-htc:MaxNumThreads>
   <jsdl-htc:MemProcess>300000</jsdl-htc:MemProcess>
    <jsdl-htc:DiskProcess>300000</jsdl-htc:DiskProcess>
    <jsdl-spmd:SPMDVariation>
    http://www.ogf.org/jsdl/2007/02/jsd-spmd/MPI
   </jsdl-spmd:SPMDVariation>
</jsdl-htc:HTCApplication>
</jsdl:Application>
```

JSDL-HTC example for NAS-MZ BT Benchmark

Adapting ROMS

Developing a specialized portlet:

- The researcher defines the experiment details in an easy web interface.
- The portlet translates the problem into job requirements and then into a JSDL document.
- This JSDL document describes the job requirements for all the feasible ways to execute the problem (parallel and serial).
- The JSDL template is submitted to Gridway metascheduler.

Adapting ROMS

Adapting Gridway components:

- Support the new JSDL extension.
- Obtain detailed information about available resources.
- Select the best resources available and the best parallelization mode to start the asap job execution.

Questions?

THANKS!

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