A Grid programozása felhasználóbarát módon

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User concerns of Grid systems

- Fast evolution of Grid systems and middleware:
  - **EGEE, NorduGrid, TeraGrid, Grid2003, UK NGS, etc.**
  - **GT1, GT2, OGSA, OGSI, GT3, WSRF, GT4, …**
- How to cope with the variety of these Grid systems?
- How to develop/create new Grid applications?
- How to execute Grid applications?
- How to observe the application execution in the Grid?
- How to tackle performance issues?
- How to port legacy applications
  - to Grid systems
  - between Grid systems?
- How to execute Grid applications over several Grids in a transparent way?

Solution

- A high-level program development and execution environment for the Grid
- Supports the development and execution of
  - Parallel Grid applications
  - Workflow applications
- Hides the low level details of the Grid access mechanism
- Hides the variety of Grid systems, i.e., **learn once and use everywhere**
- Supports the transparent migration of applications among different Grid sites (fault-tolerance, load-balance)
- Supports the monitoring and visualization of Grid application execution
- **P-GRADE** for Grid program development
- **P-GRADE portal** for Grid program execution

P-GRADE

Parallel Grid Run-time and Application Development Environment

THE BIG ISSUE in HPC GRIDs

Sequential components (code)

C, C++
Fortran
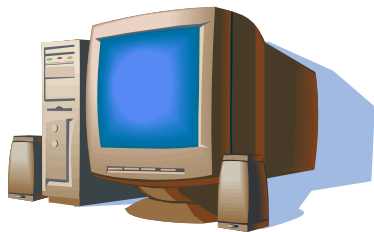
Parallelization?

Debugging?

Performance?

Execution?

Parallel components (code)
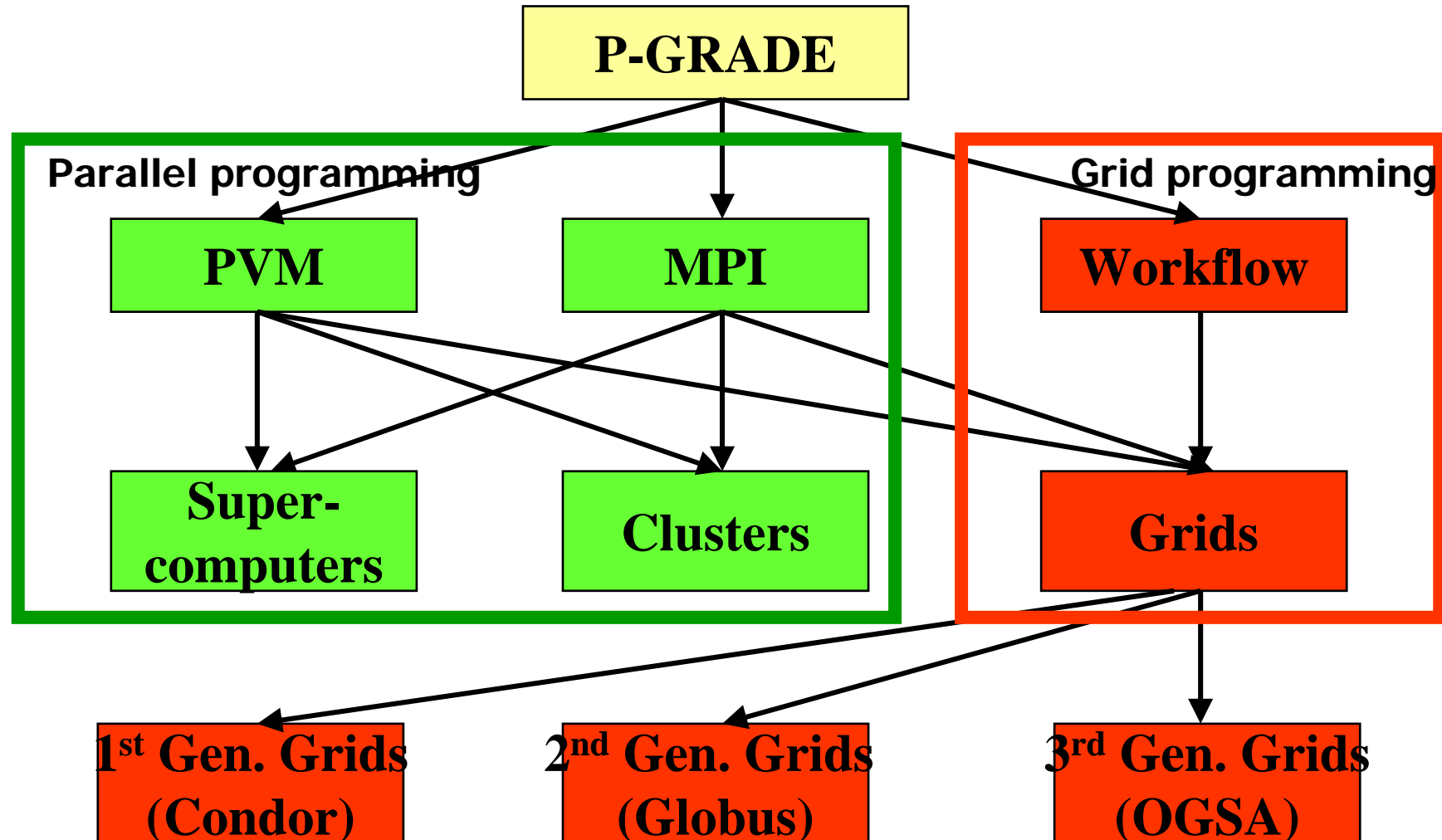
?

P-GRADE: Unified Solution for Distributed supercomputing

- **P-GRADE**

  Parallel **G**rid **R**un-time and
  Application **D**evelopment **E**nvironment

- A highly integrated parallel application development and execution system for clusters and Grids

- Provides:
  - Parallel, supercomputing, Grid programming
  - Fast and efficient development of Grid programs
  - Observation and visualization of Grid execution
  - Fault and performance analysis support for

  SUPERCOMPUTERS
  CLUSTERS
  GRIDS

Goal: Use P-GRADE for the whole range of parallel/Grid systems

P-GRADE

Parallel programming

PVM

MPI

Super-computers

Clusters

Grid programming

Workflow

Grids

1st Gen. Grids (Condor)

2nd Gen. Grids (Globus)

3rd Gen. Grids (OGSA)

Parallel programming paradigms and P-GRADE support

Paradigm

P-GRADE template

- Master/worker (parameter study)

- Processor farm

- Pipe-line programming

- Pipe

- Neighborhood-oriented, Cellular programming

- Mesh

Mesh Template
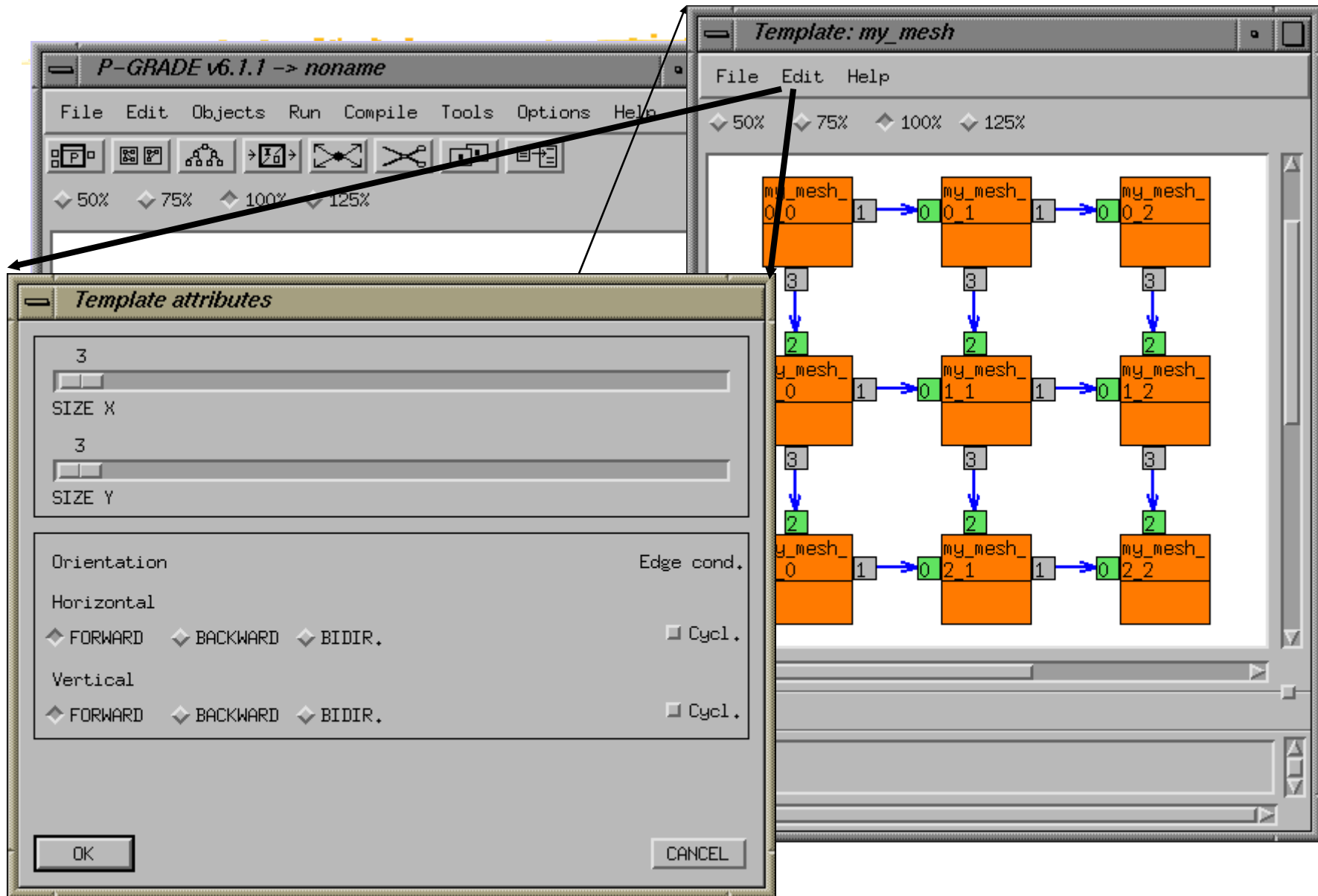
Workflow support in P-GRADE

- The workflow is a graph where
  - Nodes are jobs (or services)
  - Arcs represent file transfer between the jobs (services)
- Semantics of the workflow:
  - Job can be executed if all the necessary file transfers represented by the arcs are completed
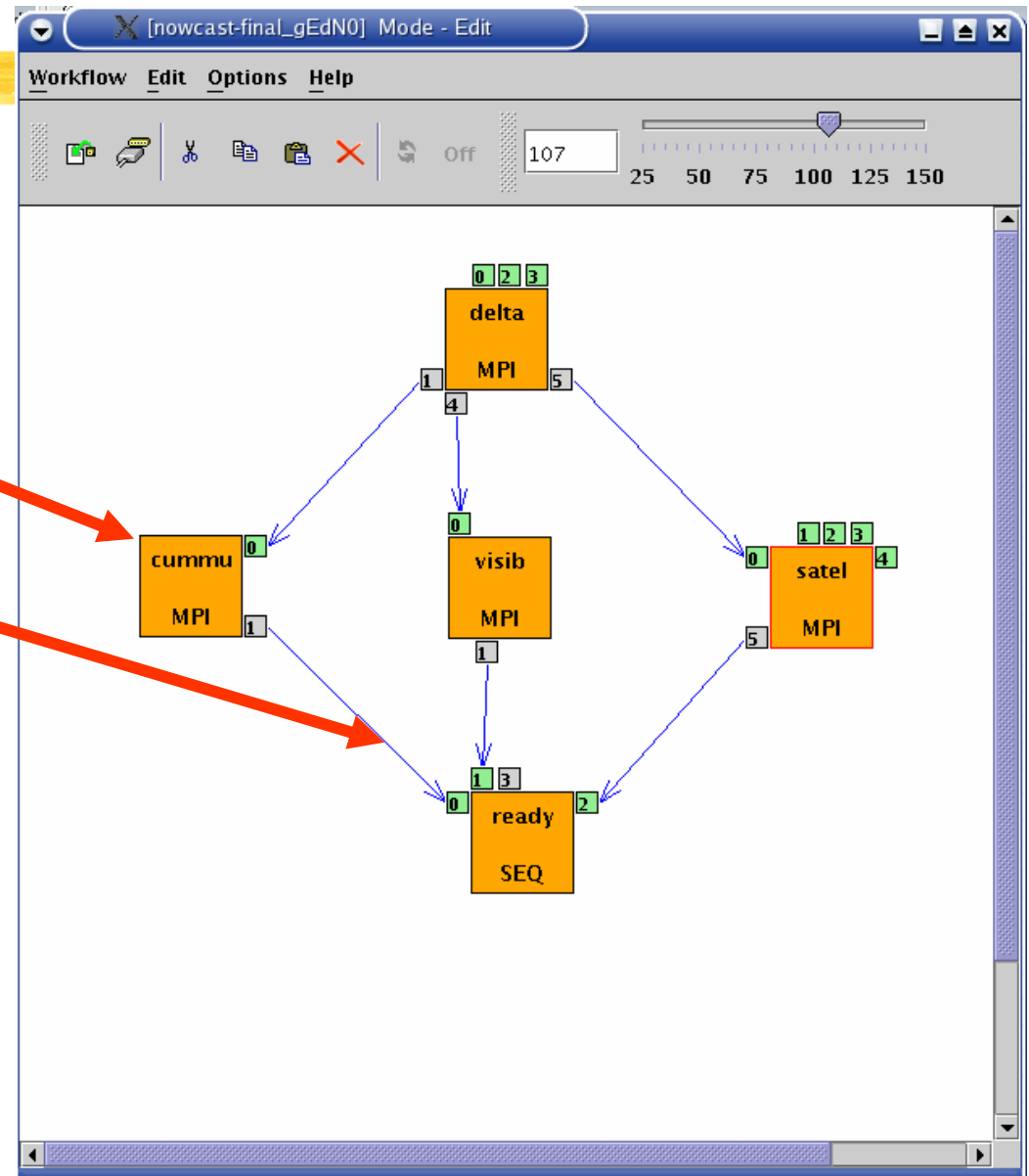
Two level parallelism by a workflow

- The workflow concept enables the efficient solution of complex problems in a distributed environment like Grid

- Semantics of the workflow enables **two levels of parallelism**:

  - Parallel execution inside a workflow node

  - Parallel execution among workflow nodes

Jobs can be parallel
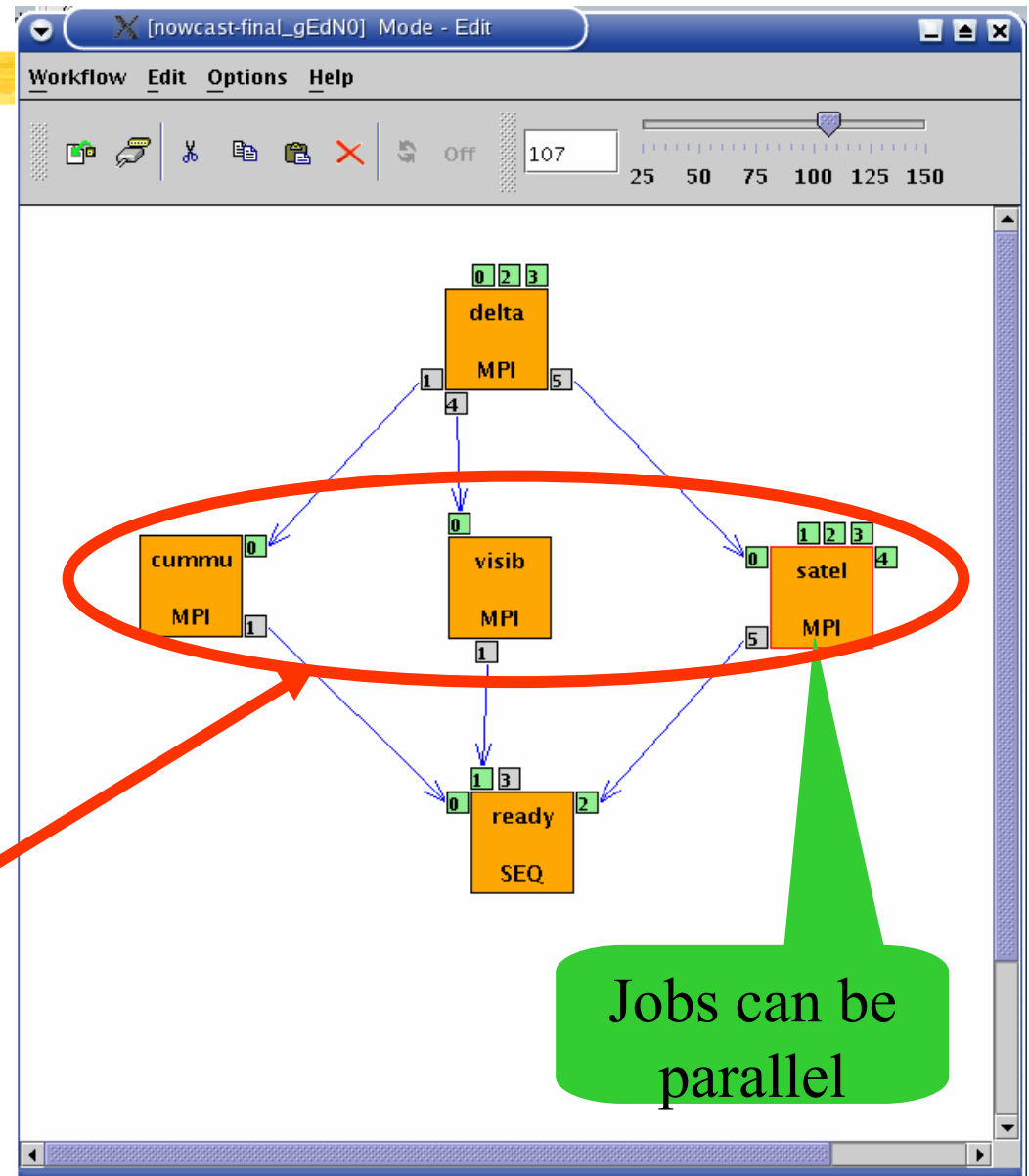
RADE in a nutshell
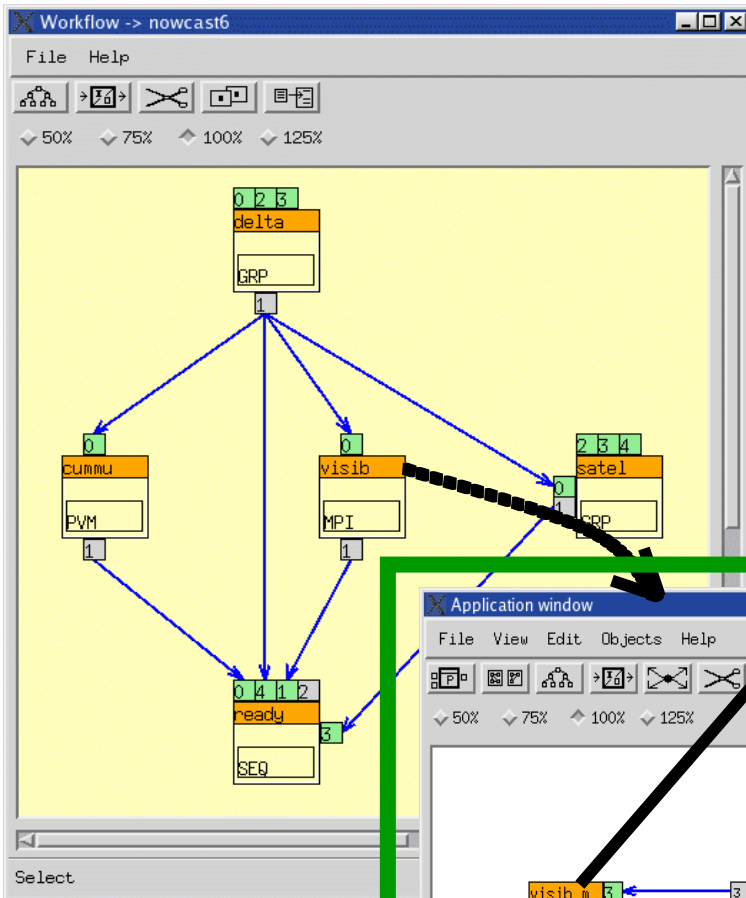
I. Workflow layer

Parallel programming support
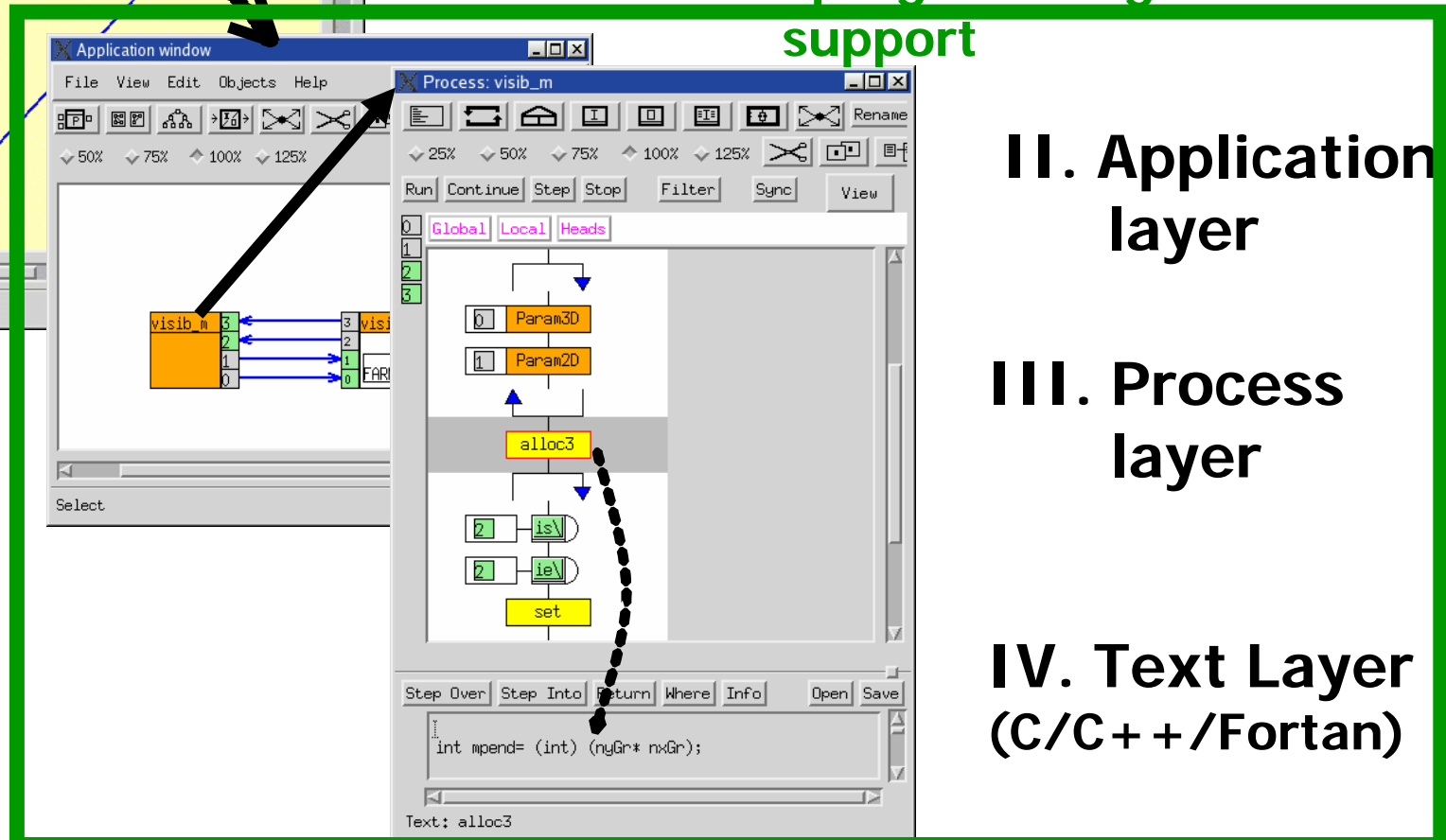
II. Application layer

III. Process layer

IV. Text Layer (C/C++/Fortan)

Levegőminőségi (LM) alkalmazás

Alapok

- Cél: reakció-diffúzió-advekció egyenletek megoldása
- Alkalmazás: passzív nyomanyagok (pl. radioaktív nuklidok) terjedésének szimulációjára
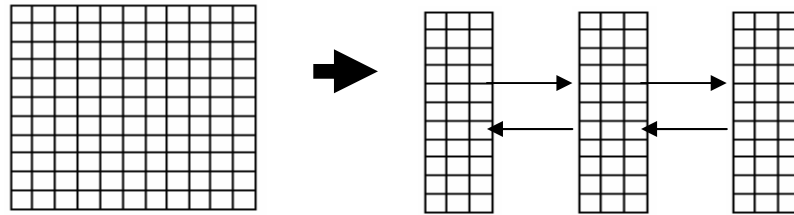
- Párhuzamosítás folyamata
  - terület felosztása az egyes processzorok között
  - szimulációs lépésenként a határfeltételek kölcsönös kicserélésével

Párhuzamos alkalmazás P-GRADE -ben

Eredmény: szennyeződés csóvák

- $h = 1000$ m (forrás magassága)
- $\Delta t = 900$s (időlépcső)
- $D = 50$ m2/s (kibocsátás)
- $u = 5$ m/s (szélmező vízszintes komponense)
- $v = 0$ m/s (szélmező függőleges komponense)
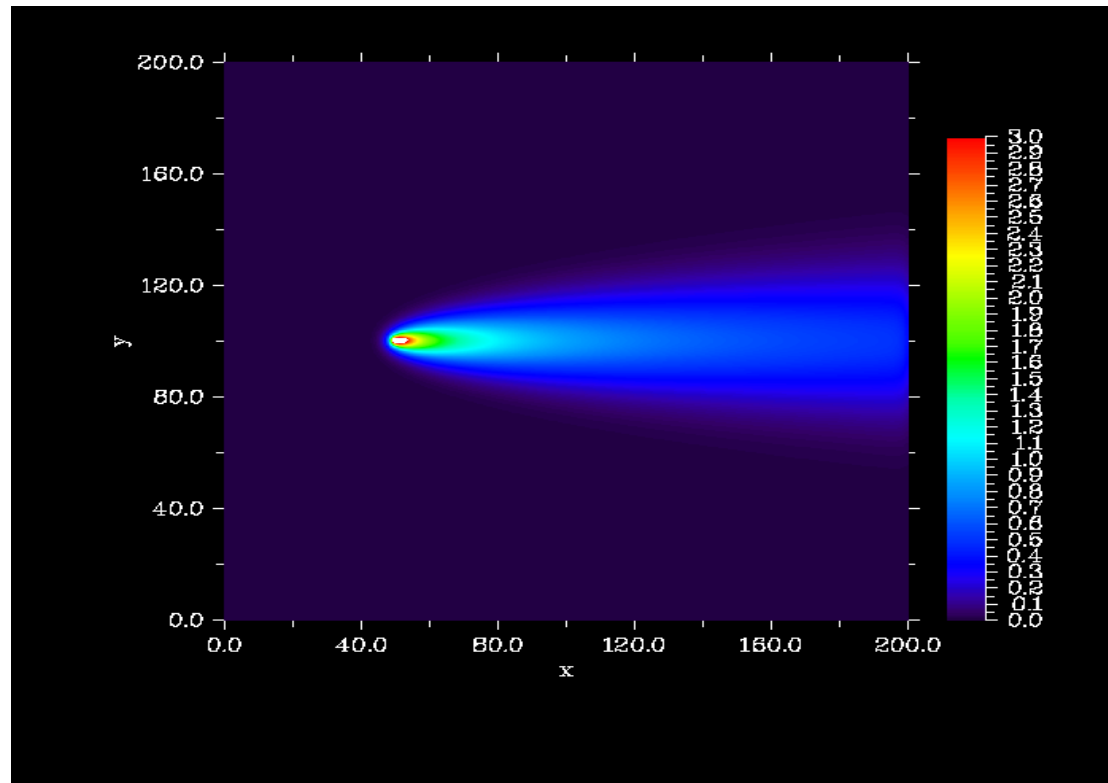
P-GRADE portal

P-GRADE portal in a nutshell

Proxy management

Definition of Grid resources

Workflow creation

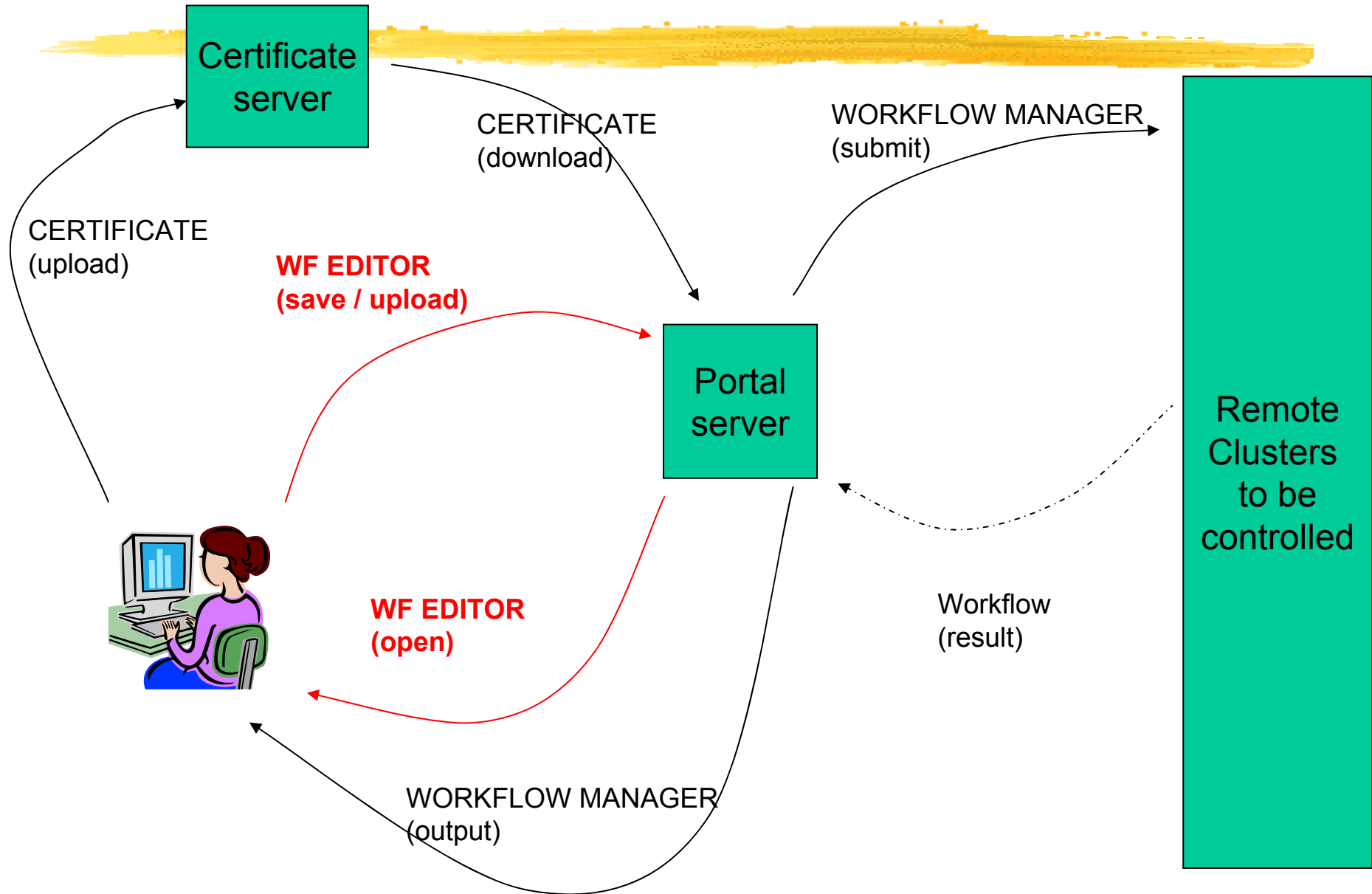**Job mapping to Grid resources**

Workflow management and execution visualization

Principles of the P-GRADE portal
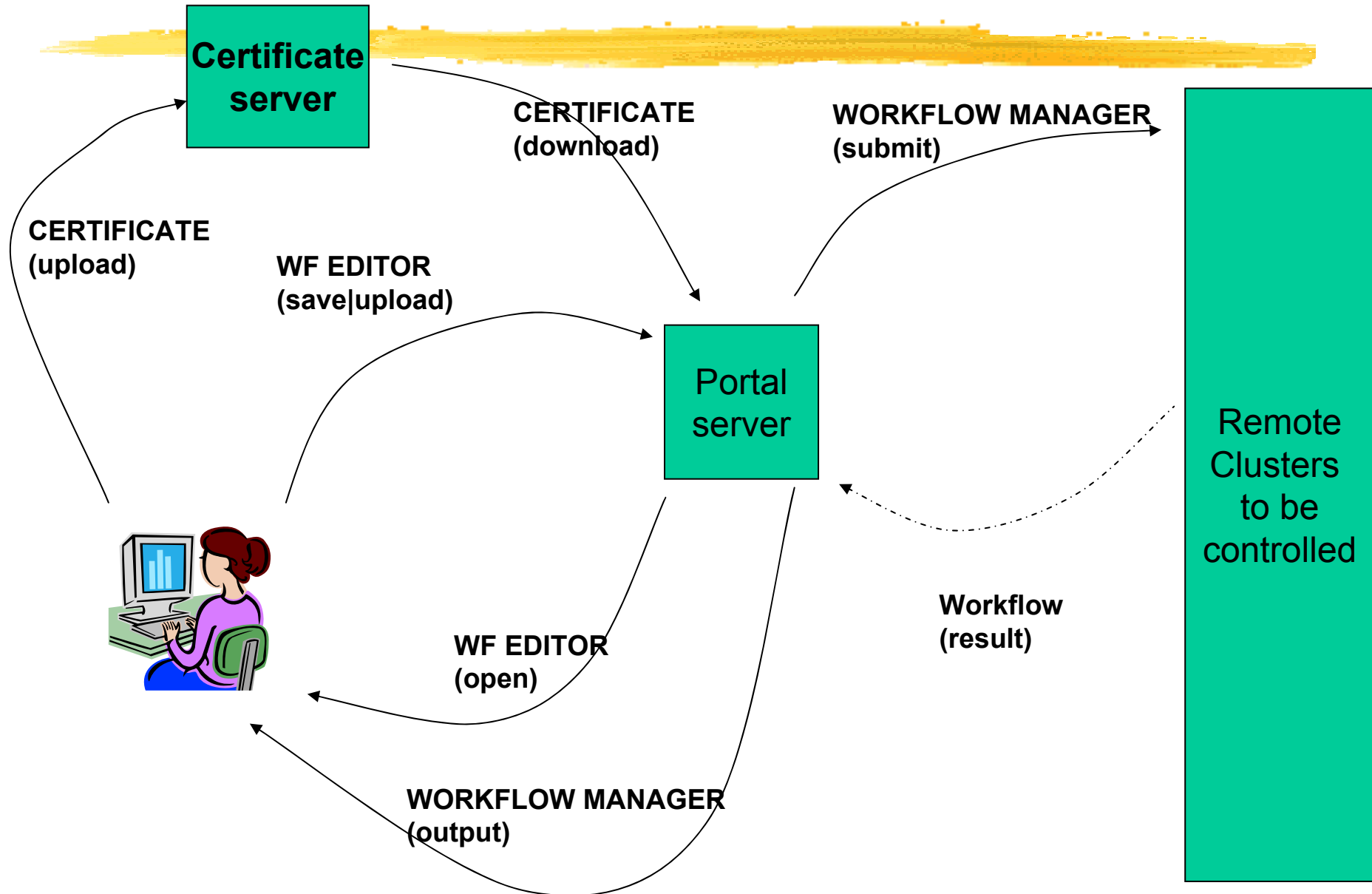
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Main interactions 2.

Certificate server

CERTIFICATE (download)

WORKFLOW MANAGER (submit)

CERTIFICATE (upload)

WF EDITOR (save / upload)

Portal server

Remote Clusters to be controlled

WF EDITOR (open)

Workflow (result)

WORKFLOW MANAGER (output)

Workflow Editor: Grid aware workflow mapping
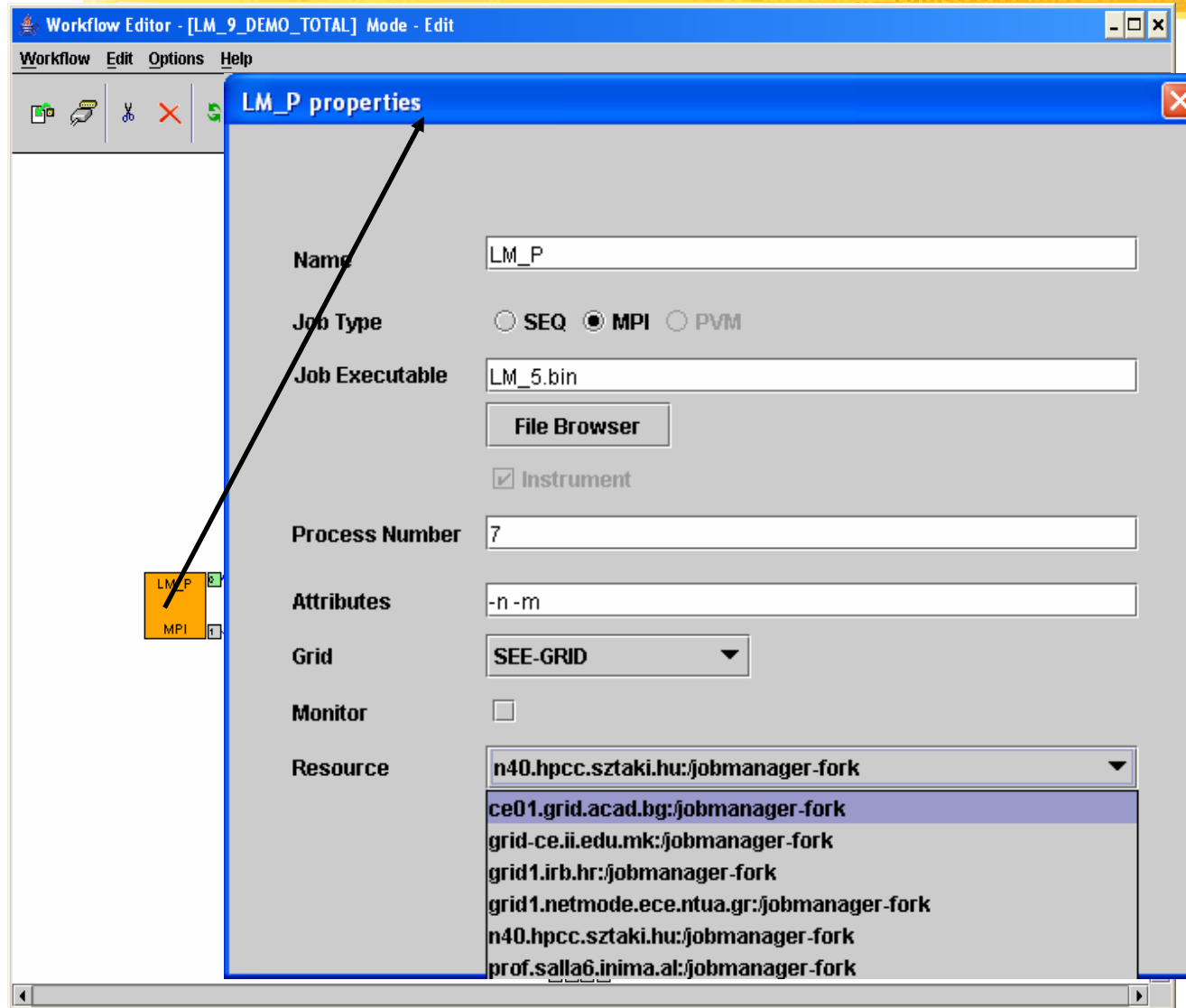
- All jobs have properties window

-This window contains the most important information about the job eg. type, name, required process number, Grid and resource name for execution

Monitoring System

- **The portal uses MDS-2 and LCG-2 information systems**

- **Users can select a Grid and a Virtual Organization to be displayed**

Workflow Editor
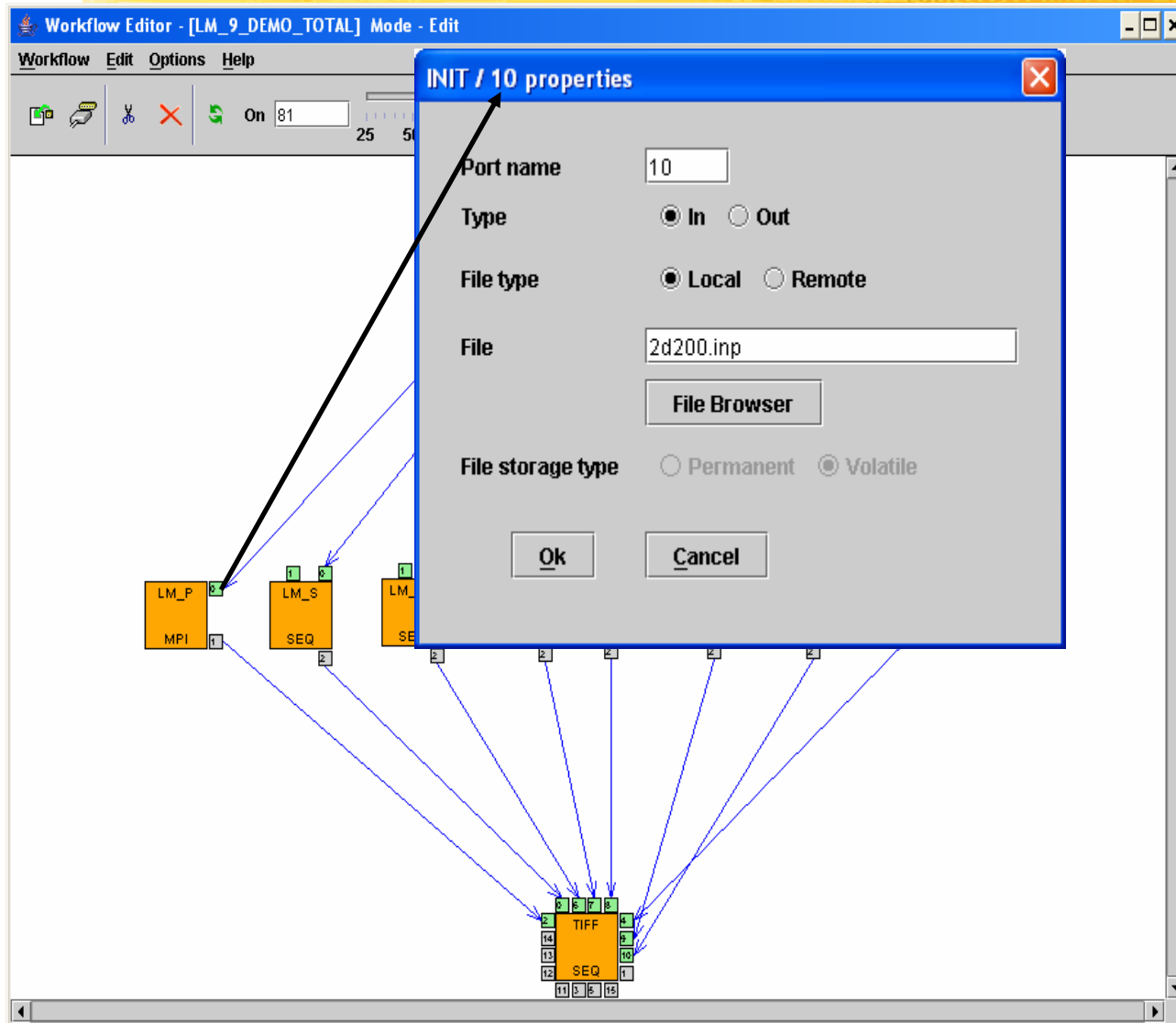
- Every job has ports

- The box in Green color represents the input port

- Every port has a Properties window to define the file settings

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Main interactions 3.

Workflow Execution

- It displays the list of jobs and their status

- The current status of the jobs are represented by colors

- It also provides access to their logs and outputs, and visualizes them

White/Red/Green color means the job is initialised/running/finished

Downloading the results

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On-Line Monitoring

Job execution visualization

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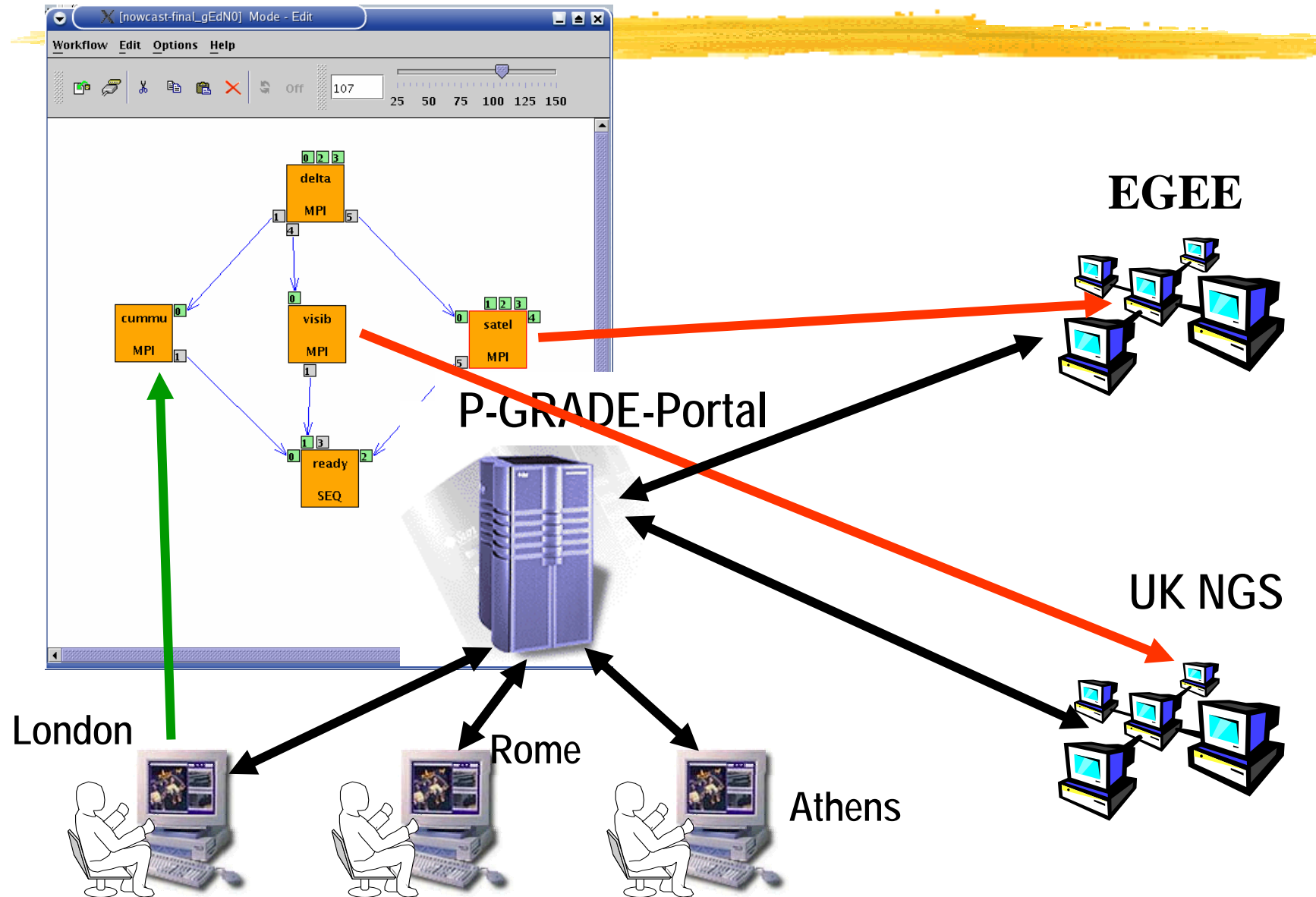- How to develop new Grid applications?
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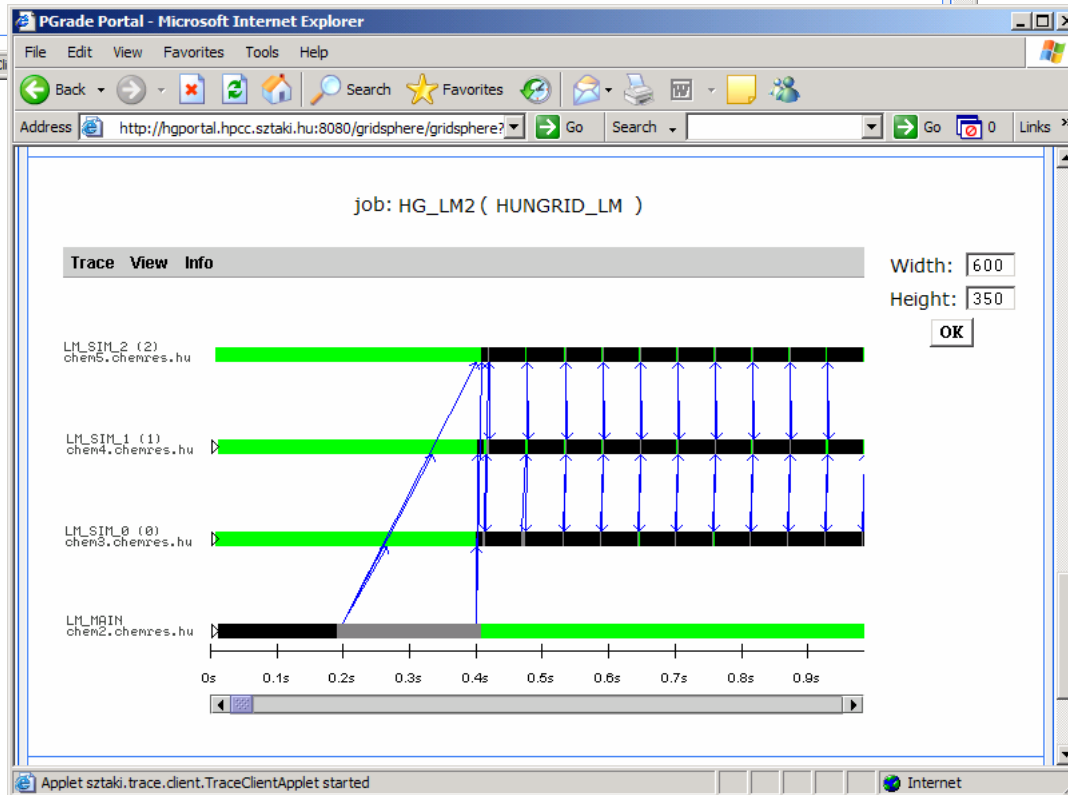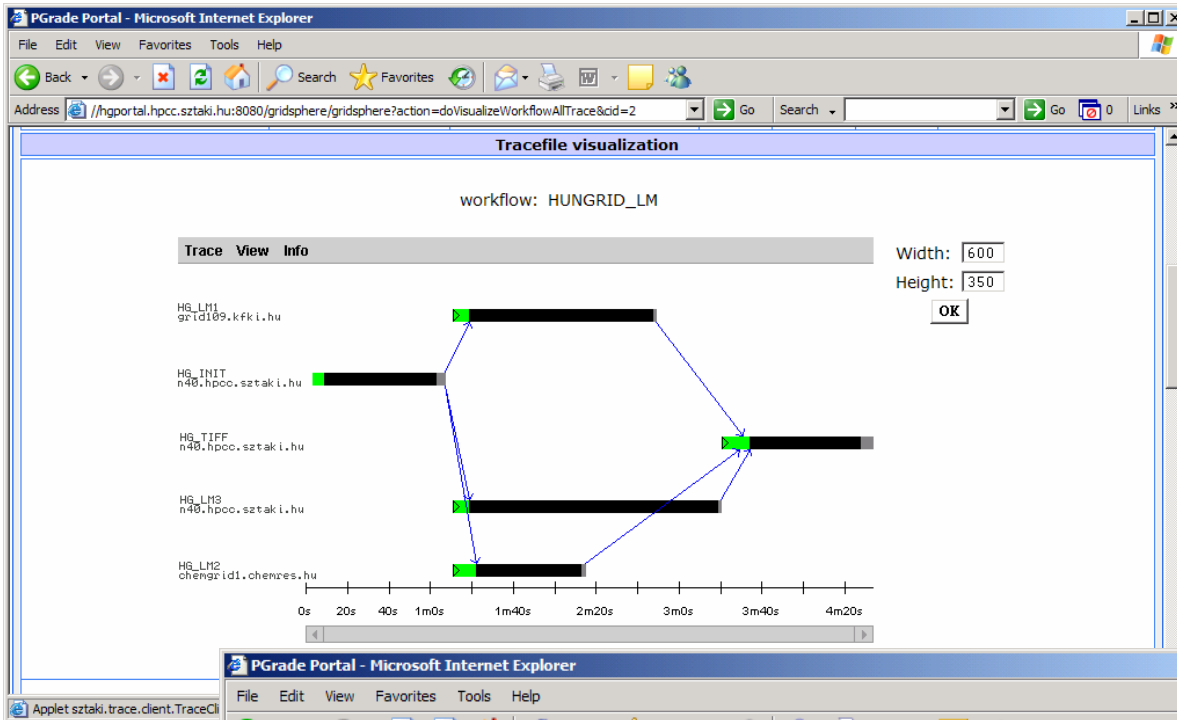- How to execute Grid applications over several Grids in a transparent way?
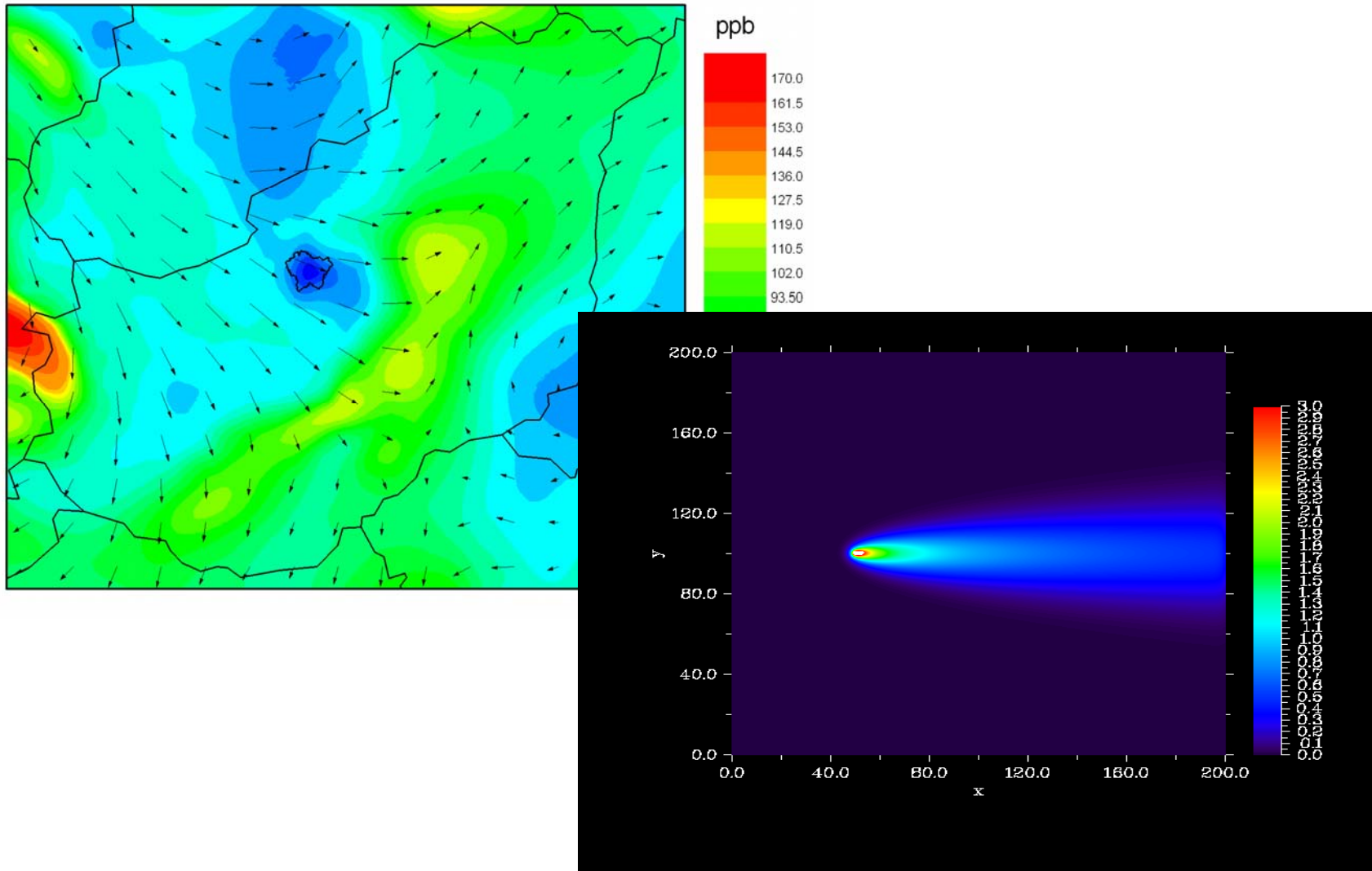
Multi-Grid portal

Levegőminőségi (LM) alkalmazás

Workflow alkalmazás P-GRADE Portál alatt

Futás- és teljesítmény vizualizáció a HUNGRID-en

Results: Air pollution forecast

# Relationship between P-GRADE and P-GRADE Portal

- The workflow editor of the portal is compatible with the P-GRADE workflow editor

- MPI programs and workflows developed in P-GRADE can be executed in various Grids by the P-GRADE portal
- They can be
  - Submitted to the Grid by the portal
  - Workflows can be modified by the workflow editor of the portal
- P-GRADE is the **development environment** and the portal is the Grid **execution environment**
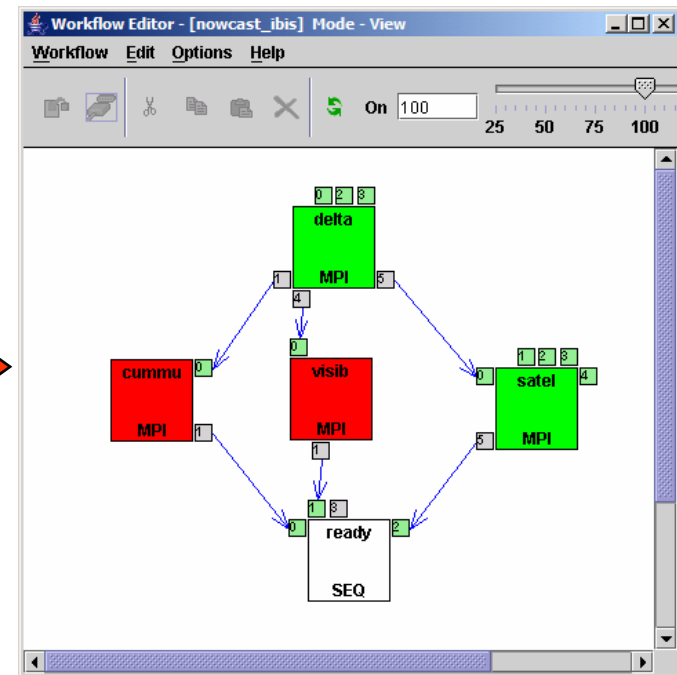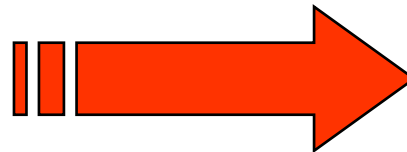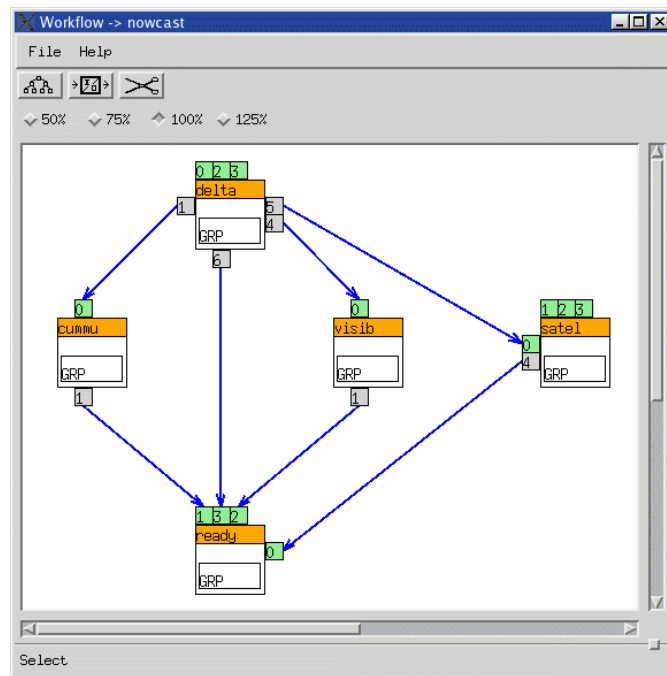
P-GRADE → EGEE

Application → MPI Job of a workflow & P-GRADE portal
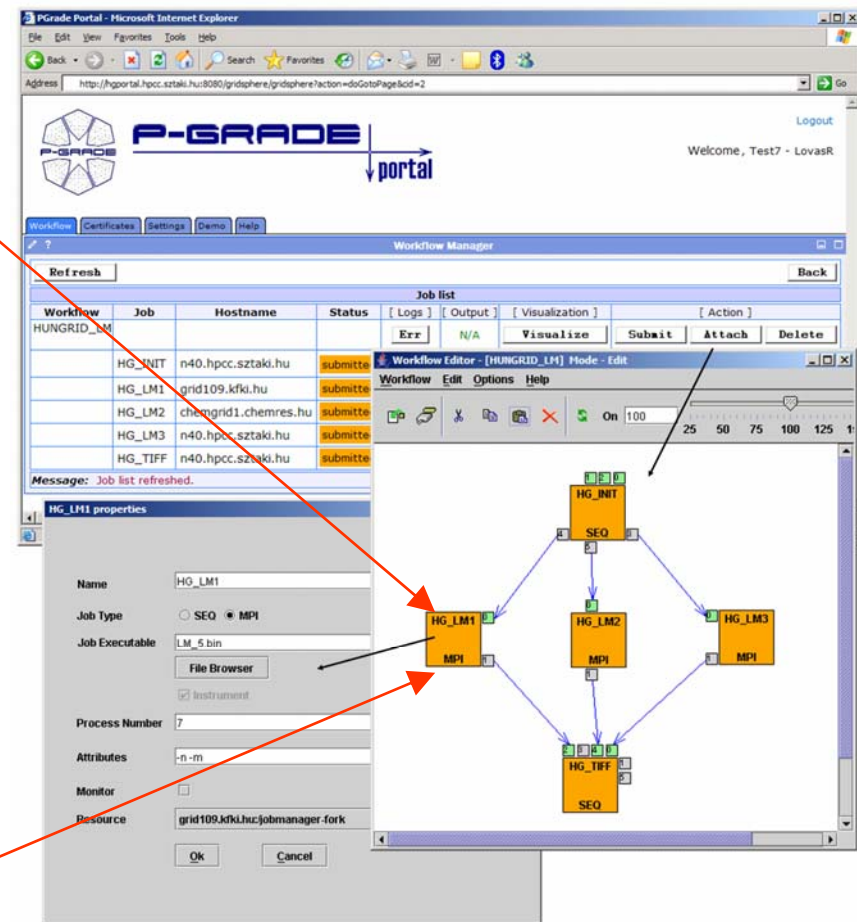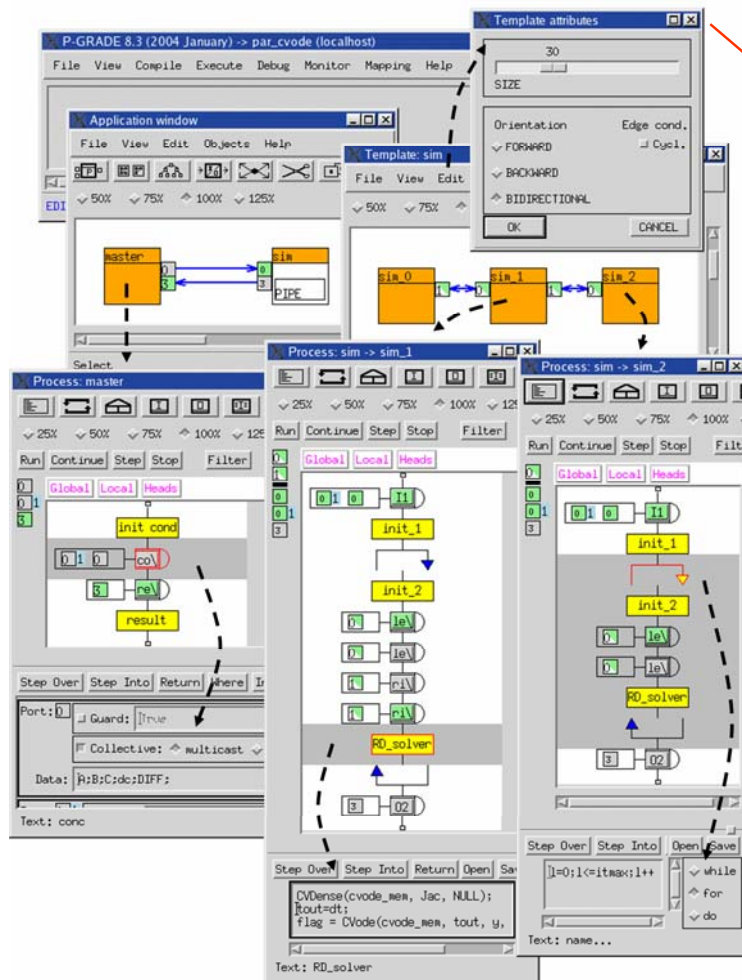
P-GRADE → EGEE

P-GRADE workflow → "Export" function → P-GRADE portal

Final conclusions

- **P-GRADE and P-GRADE portal** provide a user-friendly, high-level Grid programming and execution environment
- **Portal technology like the P-GRADE portal helps the end-users in many ways:**
  - Easy-to-use workflow concept for solving complex problems
  - Execution visualization support to observe Grid execution
  - Switching between Grid technologies will be transparent to the end-user
  - Interoperability between different Grid systems can be solved
  - Simultaneous use of different Grid systems can be solved

Learn once, use everywhere
Develop once, run everywhere

- More information at:

www.lpds.sztaki.hu/pgrade/
www.lpds.sztaki.hu/pgportal/