

***P-GRADE Portal:
Towards a User-friendly
Grid Environment***

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Technology concerns of Grid systems

- Fast evolution of Grid systems and middleware:
 - GT1, GT2, OGSA, OGSI, GT3, WSRF, GT4, ...
- Different Grid systems are using different technologies
 - EGEE (**LCG-2, g-Lite**), NorduGrid, UK NGS, Grid2003, etc.
 - Different technologies means:
 - Different usage scenarios
 - Different commands
- It's too difficult for a normal user!



The problem of current portals

- They tightly connected and tailored to only one particular Grid (eg. NGS portal, NorduGrid portal)
- If the user wants to move to another Grid
 - She has to obtain certificate for the new Grid
 - She has to get an account for its portal
 - She has to learn the new environment
 - She has to copy the files into the new system
- **Even in this case the application will use only one of those Grids!**



Grid systems for HPC – User concerns

- How to cope with the variety of 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 connect legacy applications into Grid systems?
- How to execute Grid applications over several Grids in a transparent way?



Workflow-oriented grid portals are the answer!



Properties of the P-GRADE Portal

- **General purpose, graphical, workflow-oriented Grid portal.** Supports the development and execution of workflow-based Grid applications.
- Grid services supported by the portal:
 - **MyProxy** – proxy credential management
 - **GridFTP** – file transfer
 - **GT2/GT3 GRAM** – job execution
 - **Mercury** – job monitoring
 - **PROVE** – workflow & job execution visualization
 - **BDII and MDS-2** – obtain information about resources
 - **LCG-2 broker** – resource selection
 - **GEMLCA** – invoke legacy codes
- Support for **multi-grid** workflows
- **GridSphere** based
 - Easy to expand with new portlets, easy to customize for end-users
- One common interface for all the different Grid infrastructures



*Migration scenarios with vs. without **P-Grade Portal***

- Migration from LCG-2 → G.Lite

Without P-GRADE Portal: user works ☹️

- Users should learn the new technology
- Users should modify the Grid enabled applications

With P-GRADE Portal: Portal developer works 😊

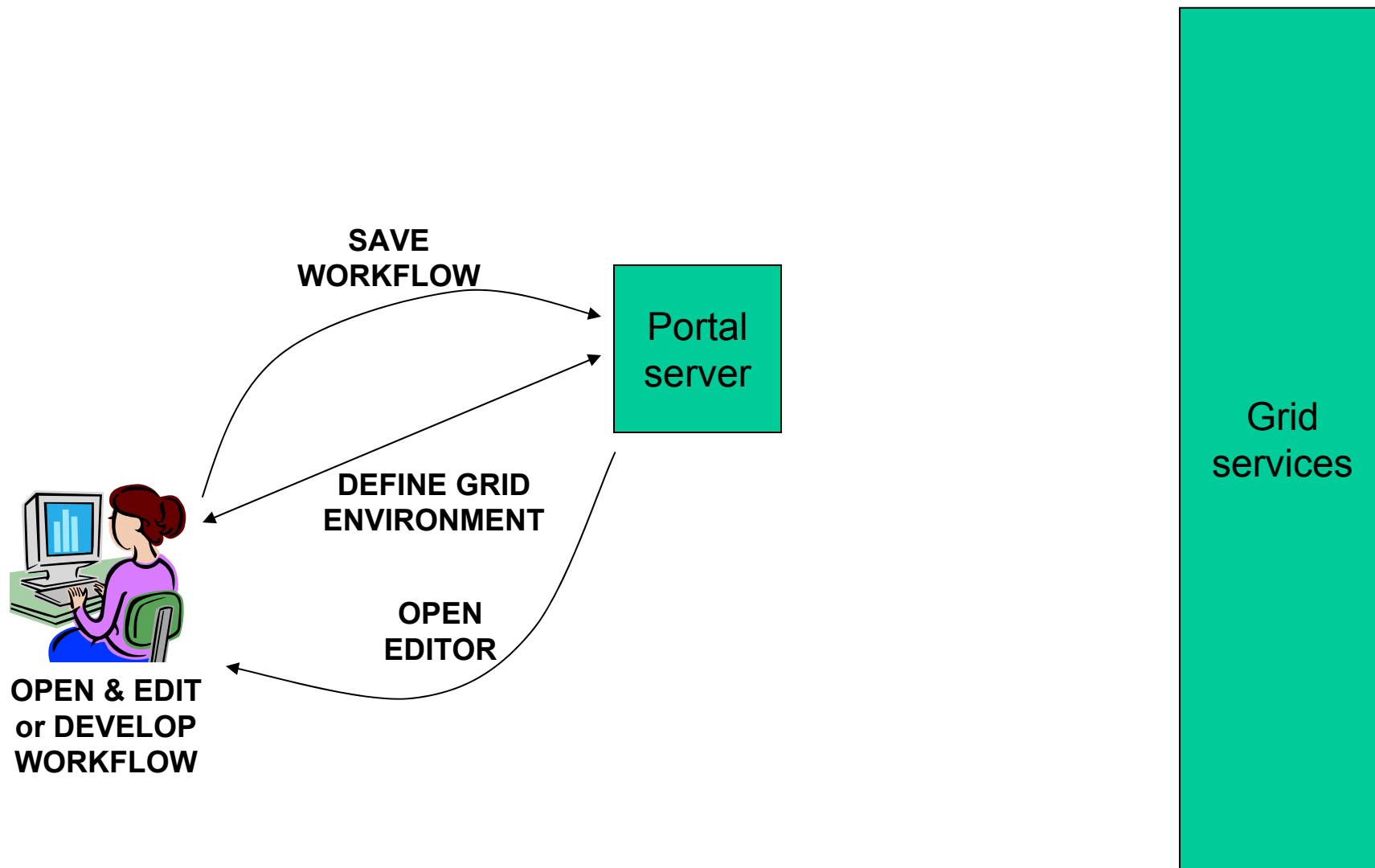
- Users can use the same, already known user interface
- Users can use the same, already used applications
- P-GRADE Portal developers should work to solve the migration problems (with customized back-end interfaces)

(It's coming soon in our new version!)



The typical P-GRADE Portal scenario

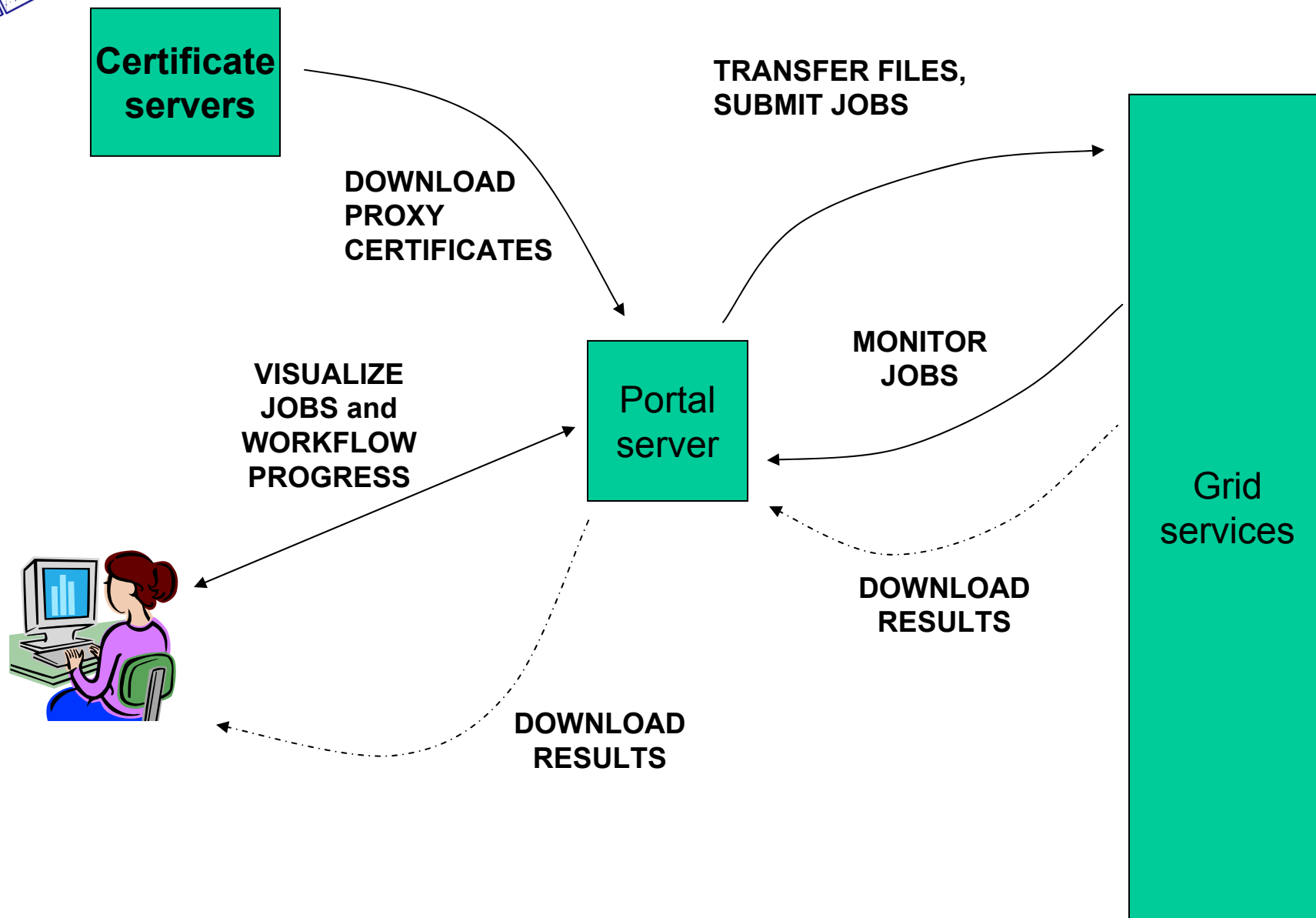
Part 1 - development phase





The typical P-GRADE Portal scenario

Part 2 - execution phase





Developing workflows with the P-GRADE Portal

Main steps

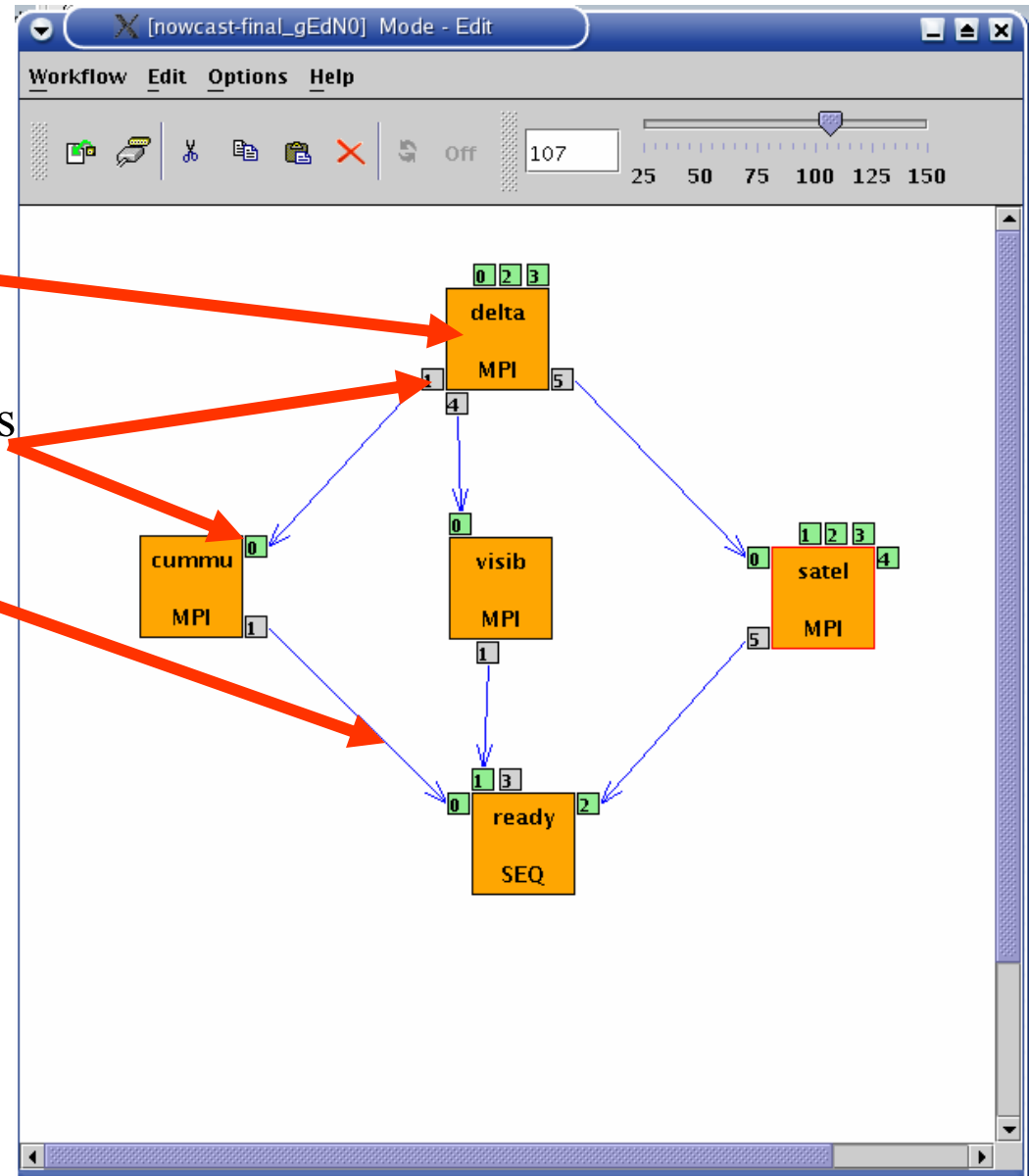
- 1. Define the Grid environment**
- 2. Define the workflow**

But first, let's see what a P-GRADE Portal workflow is!



What is a P-Grade Portal workflow?

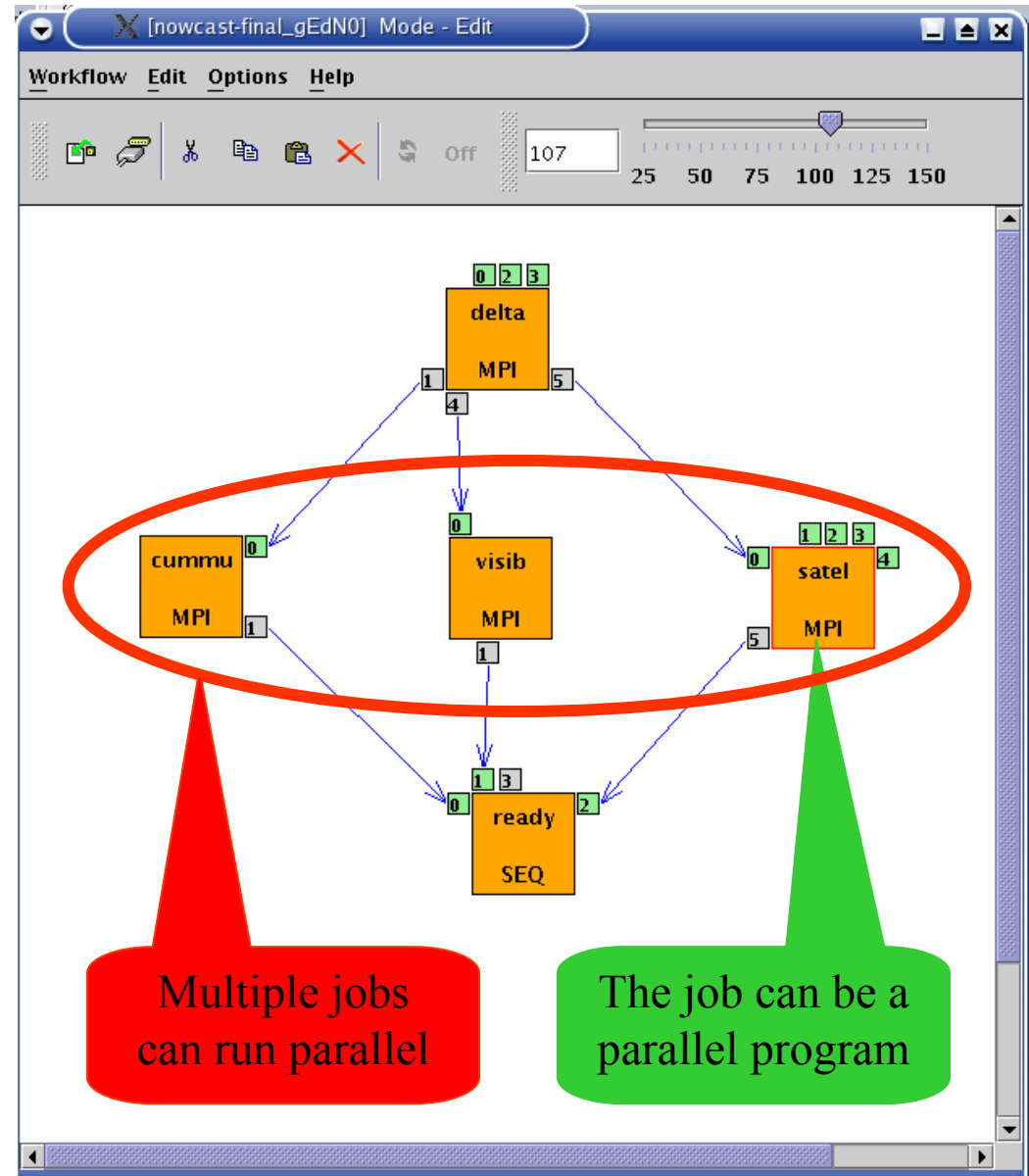
- **A directed acyclic graph where**
 - Nodes represent jobs (executable batch programs)
 - Sequential, parallel, legacy codes
 - Ports represent input/output files the jobs expect/produce
 - Arcs represent file transfer between the jobs
- **Semantics of the workflow:**
 - A job can be executed if all of its input files are available
- **Information handling:**
 - **Local input files:** on the portal server
 - **Remote input files:** at Grid storage service providers





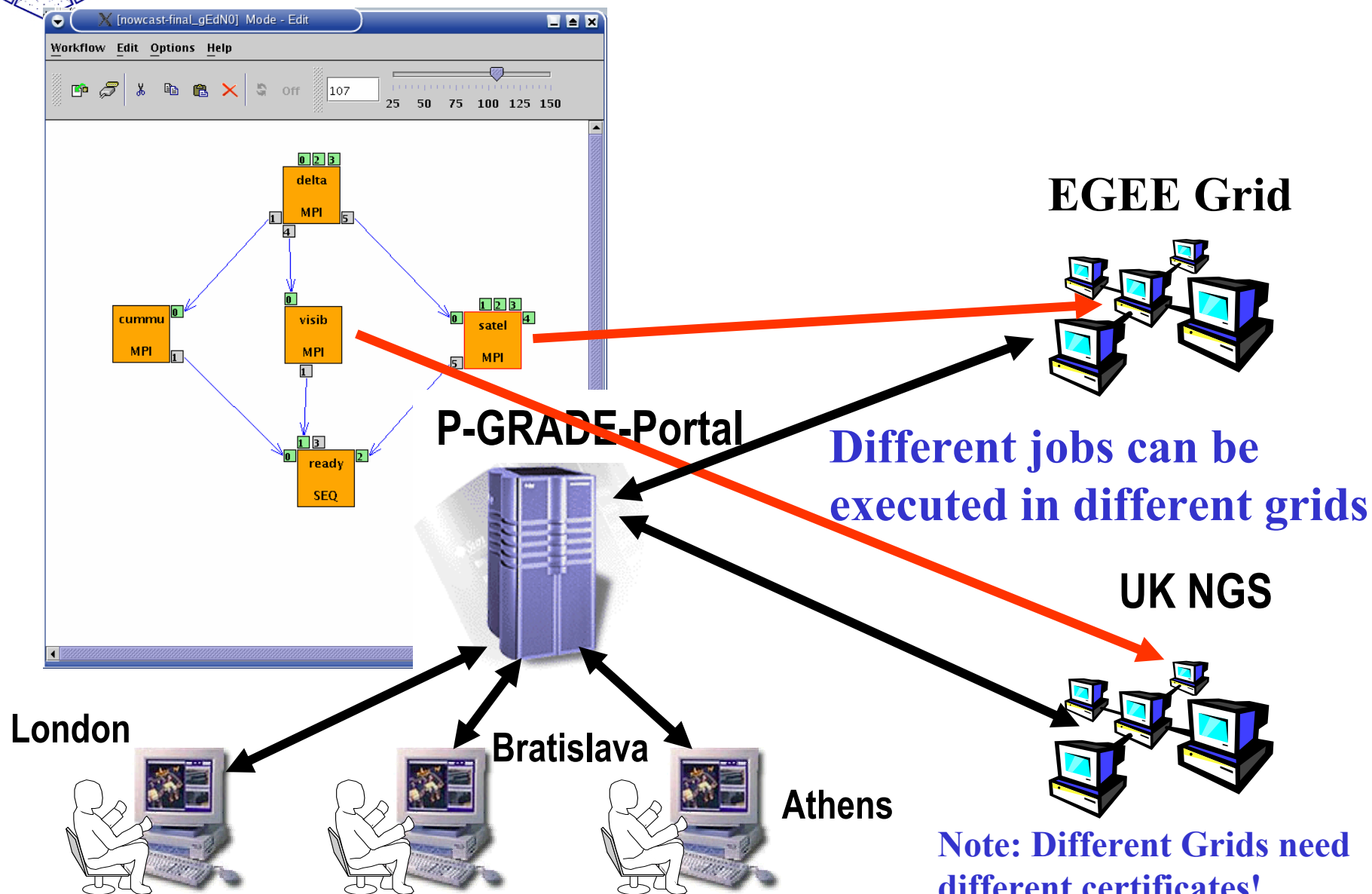
Two levels of parallelism by a workflow

- The P-GRADE Portal workflow concept enables the efficient parallelization of complex problems
- Semantics of the workflow enables two levels of parallelism:
 - Parallel execution inside a workflow node
 - Parallel execution among workflow nodes



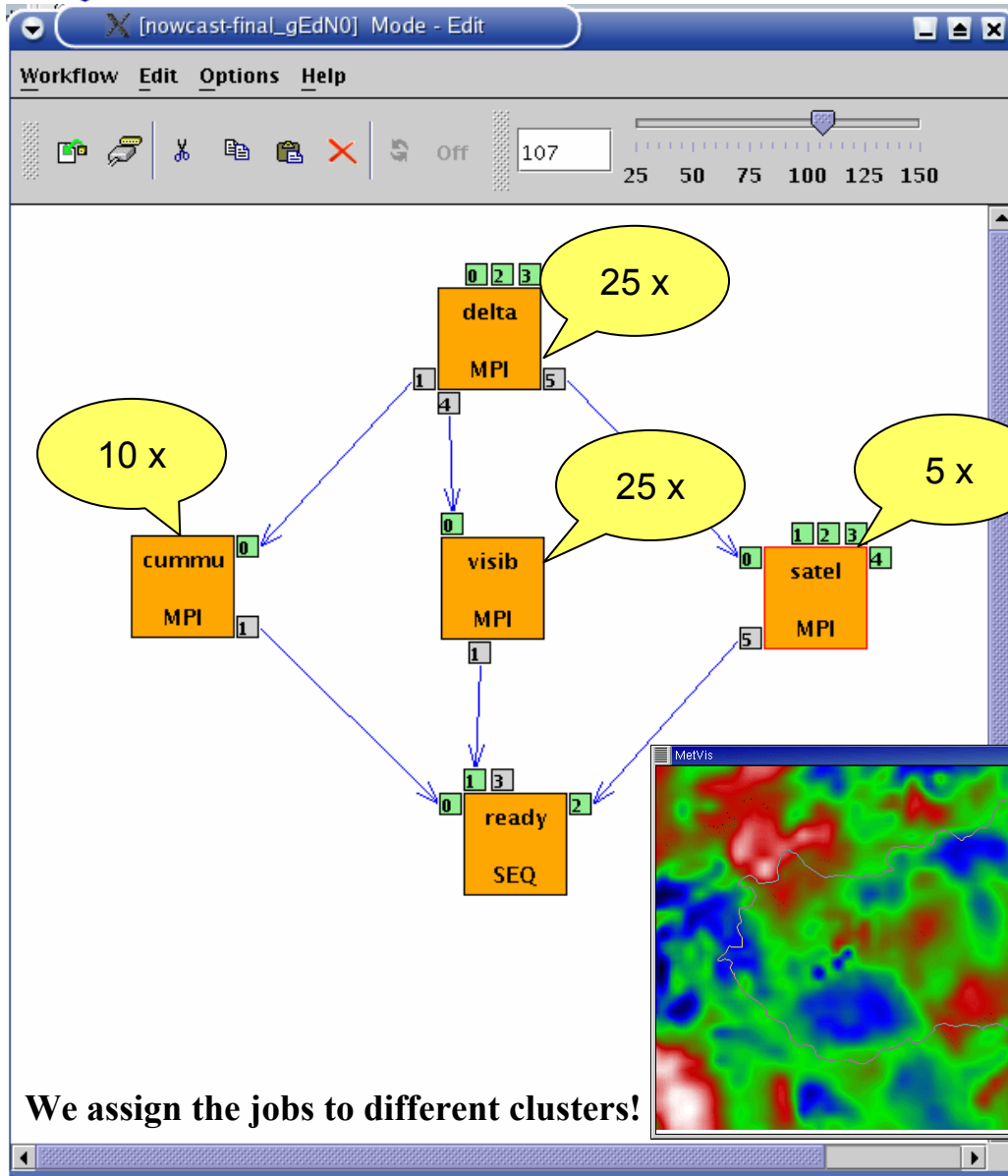


Multi-Grid P-GRADE Portal





Ultra-short range weather forecast (Hungarian Meteorology Service)



Forecasting dangerous weather situations (storms, fog, etc.), crucial task in the protection of life and property

Processed information:
surface level measurements, high-altitude measurements, radar, satellite, lightning, results of previous computed models

- Requirements:
- Execution time < 10 min
 - High resolution (1km)

We assign the jobs to different clusters!



The typical P-GRADE Portal scenario

Development phase – step 1:

Certificate servers

DOWNLOAD
PROXY
CERTIFICATES

Portal server

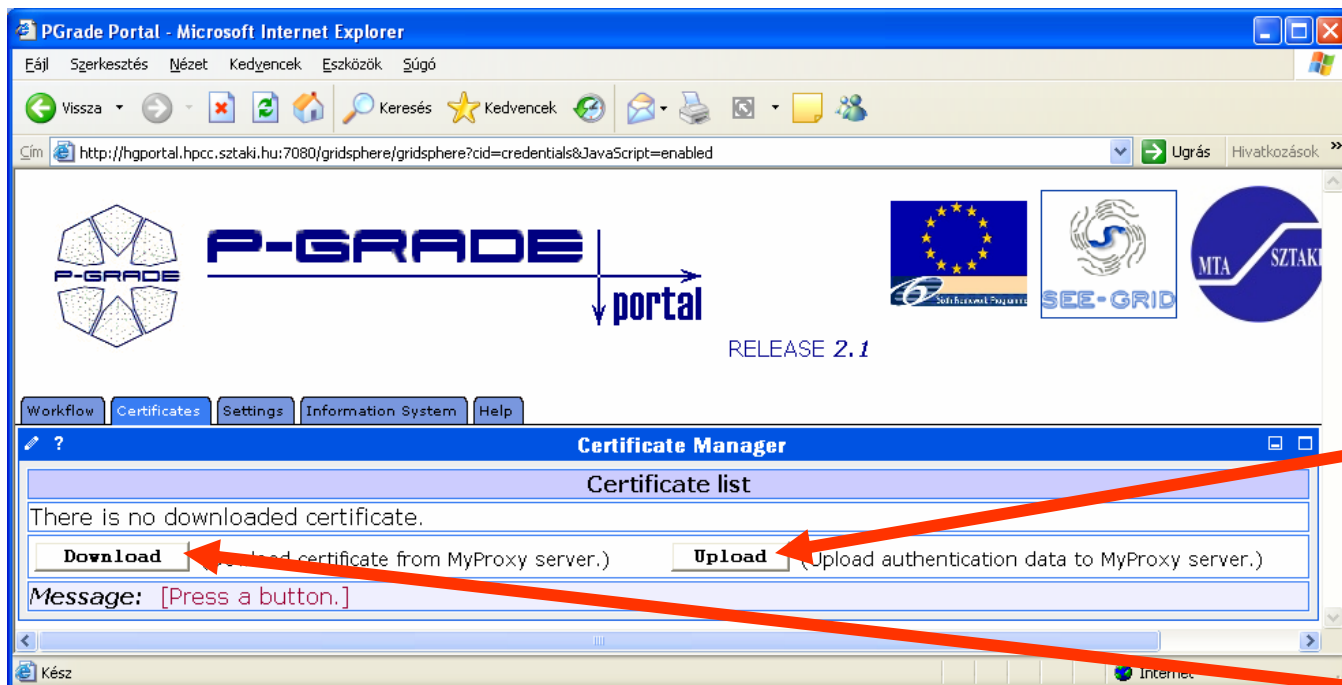
Grid services





Certificate Manager

certificates portlet



- To access Globus Grid services the portal server application needs proxy certificates
- “Certificates” portlet:
 - to upload long-term certificates to MyProxy servers
 - to download short-term proxy certificates into the portal server application



Certificate Manager

associating the proxy with a grid

Workflow Certificates Settings Information System Help

Certificate Manager

Setting certificate for GRID

Certificate details	
Downloaded from:	cvs.lpds.sztaki.hu
Issued by:	DC=ORG,DC=SEE-GRID,O=People,O=SZTAKI,CN=Jozsef Patvarczki,CN=proxy
Subject:	DC=ORG,DC=SEE-GRID,O=People,O=SZTAKI,CN=Jozsef Patvarczki,CN=proxy,CN=proxy
Timeleft:	99:56:46
Proxy type:	full legacy globus proxy
Strength [bits]:	512
Description:	

Select GRID

Select from the list:

HUNGRID	OK
HUNGRID	
SEE-GRID	
SZTAKI-GRID	Cancel

Message: Map proxy for any of the grids.

This operation displays the **details of the certificate** and the **list of available Grids**



Certificate Manager

browsing proxies

Multiple proxies can be downloaded in the portal server application at the same time!

Globus sites of SEE-GRID

Globus sites of HUNGRID



The typical P-GRADE Portal scenario

Development phase – step 2:

Certificate servers

DEFINE THE
GRID
ENVIRONMENT

Portal server



Grid services



Resource Manager

(settings portlet)

- **To define which grid resources my workflows will use**
- **Two levels:**
 - 1. Define grids** → administrator
 - 1. Name** (*e.g. SEE-GRID*)
 - 2. Information system** (*e.g. bdi.phy.bg.ac.yu:2170*)
 - 2. Define Globus GRAM sites for each grid:**
 - 1. Automatically from information system**
 - 2. Manually by the administrator**
 - 3. Manually by the user**



Resource Manager

(settings portlet)

PGrade Portal - Microsoft Internet Explorer

http://hgportal.hpcc.sztaki.hu:7080/gridsphere/gridsphere?cid=pgradeSettings&JavaScript=enabled

mywebsearch

Workflow Certificates Settings System Help

Settings

GRID configurations

Name	Information System				[Actions]
	Type	Host	Port	BaseDn	
HUNGRID	LCG2	grid152.kfki.hu	2170	mds-vo-name=local,o=grid	Resources
SEE-GRID	LCG2	bdii.phy.bg.ac.yu	2170	mds-vo-name=local,o=grid	Resources
SZTAKI-GRID	MDS2	n0.hpcc.sztaki.hu	2135	Mds-Vo-name=SzuperGRID,o=Grid	Resources

Default visualization size

Width:

Height:

(Accept values between 150-1000.)

Message: Press a button.

Kész Internet

List of available grids

To define Globus GRAM sites for such a grid



Resource Manager

(settings portlet)

Each GRAM site is identified by a

- host name
- port number (or use default)
- local jobmanager

URL	Job manager	[Actions]
ce01.grid.acad.bg	jobmanager-fork	Delete
grid-ce.ii.edu.mk	jobmanager-fork	Delete
grid1.irb.hr	jobmanager-fork	Delete
grid1.netmode.ece.ntua.gr	jobmanager-fork	Delete
n40.hpcc.sztaki.hu	jobmanager-fork	Delete
prof.salla6.inima.al	jobmanager-fork	Delete
testbed001.grid.idi.ro	jobmanager-fork	Delete

URL: Job manager: Add

Load default Back

Default visualization size

Width:



The typical P-GRADE Portal scenario

Development phase – step 3:

Certificate servers



OPEN & EDIT
or DEVELOP
or IMPORT
WORKFLOW

SAVE
WORKFLOW

Portal
server

OPEN
EDITOR

Grid
services



Workflow development

opening the workflow editor

The editor is a Java Webstart application



the download and installation is only one click!

The screenshot shows a web browser window with the URL `http://hgportal.hpc.../widsphere?action=doSubmitReallyWorkflow&id=2`. The page features the P-Grade logo, a 'portal' link, and logos for the European Union, SEE-GRID, and VIKI. Below the browser, a Java Webstart application window titled 'Workflow Manager' is displayed. It has a 'Workflow Editor' tab and a 'Refresh' button. The main content is a 'Workflow list' table:

Workflow	Status	Size	Quota (100 Mb)	[Output]	[View]	[Action]
LM_9_DEMO_TQ_TAL	submitted	26,848 MB	26%	N/A	Details	Abort Attach Delete
		26,848 MB	26%			

At the bottom of the application window, a message reads: **Message: Workflow successfully submitted.**

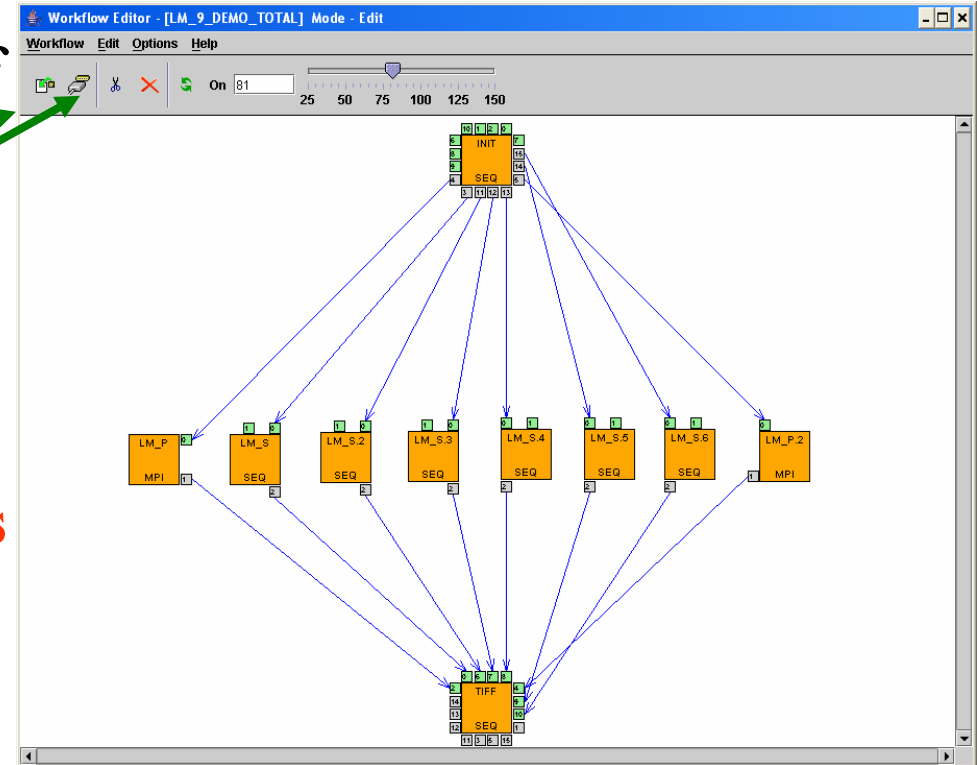


Workflow Editor

defining the graph

The aim is to define a DAG of computational jobs:

- 1. Drag & drop components:**
jobs and ports
- 2. Define their properties**
- 3. Connect ports by channels**
(no cycles, no loops, no conditions)





Workflow Editor

defining the jobs

Workflow Editor - [LM_9_DEMO_TOTAL] Mode - Edit

Workflow Edit Options Help

LM_P properties

Name: LM_P

Job Type: SEQ MPI PVM

Job Executable: LM_5.bin

File Browser

Instrument

Process Number: 7

Attributes: -n -m

Grid: SEE-GRID

Monitor:

Resource:

- n40.hpcc.sztaki.hu:jobmanager-fork
- ce01.grid.acad.bg:jobmanager-fork
- grid-ce.ii.edu.mk:jobmanager-fork
- grid1.irb.hr:jobmanager-fork
- grid1.netmode.ece.ntua.gr:jobmanager-fork
- n40.hpcc.sztaki.hu:jobmanager-fork
- prof.salla6.inima.al:jobmanager-fork

Which site to use?

Define the job:

- Executable file
- Executable type
- Number of required processors
- command line params
- The resource to be used for the execution:
 - Grid
 - Grid site



Which Grid site to use?

I still don't know which resource to use!

The information system portlet helps characterize resources!

PGrade Portal - Microsoft Internet Explorer

http://hgportal.hpc.sztaki.hu:7080/gridsphere/gridsphere?action=doCh

Grid: SEE-GRID VO: seegrid

	Computing Element						Storage Element		
	CPU		Job			Space			
	Free	Usage	Running	Waiting	Load	Total	Available	Usage	
	112	80	29%	7	0	0%	226.793 GB	216.34 GB	5%
AEGIS02-RCUB	20	20	0%	0	0	0%	398.466 GB	396.58 GB	0%
BG01-IPP	54	18	67%	4	0	0%	609.554 GB	473.543 GB	22%
BG02-IM	20	16	20%	1	0	0%	131.775 GB	79.957 GB	39%
BG03-IPP-N	3	3	0%	0	0	0%	566.608 GB	566.376 GB	0%
BG04-ACAD	48	32	33%	2	5	71%	554.647 GB	475.767 GB	14%
HR-01-RBI	60	12	80%	4	0	0%	78.317 GB	6.271 GB	92%
MK-01-UKIM_II	28	28	0%	0	0	0%	69.709 GB	69.075 GB	1%
RO-01-ICI	54	24	56%	5	36	88%	849.666 GB	828.387 GB	3%
ROGRID-NIPNE-01	24	24	0%	0	0	0%	862.807 GB	848.676 GB	2%
SZTAKI	4	4	0%	0	0	0%	4.566 GB	2.871 GB	37%
tubitakcg2	35	28	20%	1	0	0%	1.335 TB	1.335 TB	0%





Automatic resource selection

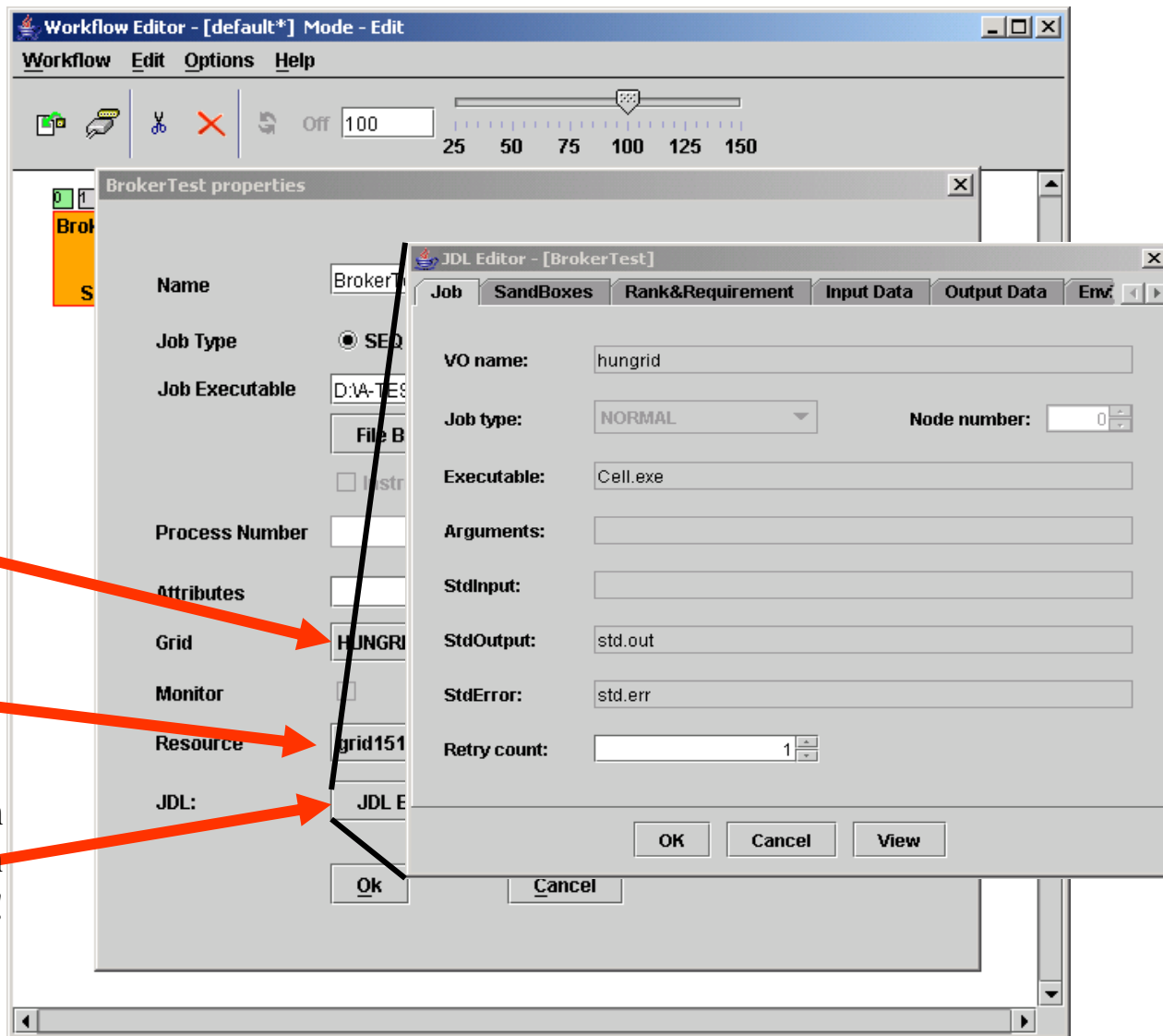
Since P-GRADE Portal v2.2

- Very useful feature
- Broker has always the latest information about resources
- Can handle all the resource selection issues
- Main steps
 1. Describe the requirements of the job
 2. Select a LCG-2 middleware based Grid for it
 3. The workflow manager will use the broker of that Grid during the execution to find the best resource for your job



Workflow Editor

defining jobs in v2.2



Select an LCG-2 based Grid!

Don't select any resource!

Define job requirements with the "Job Description Language"!

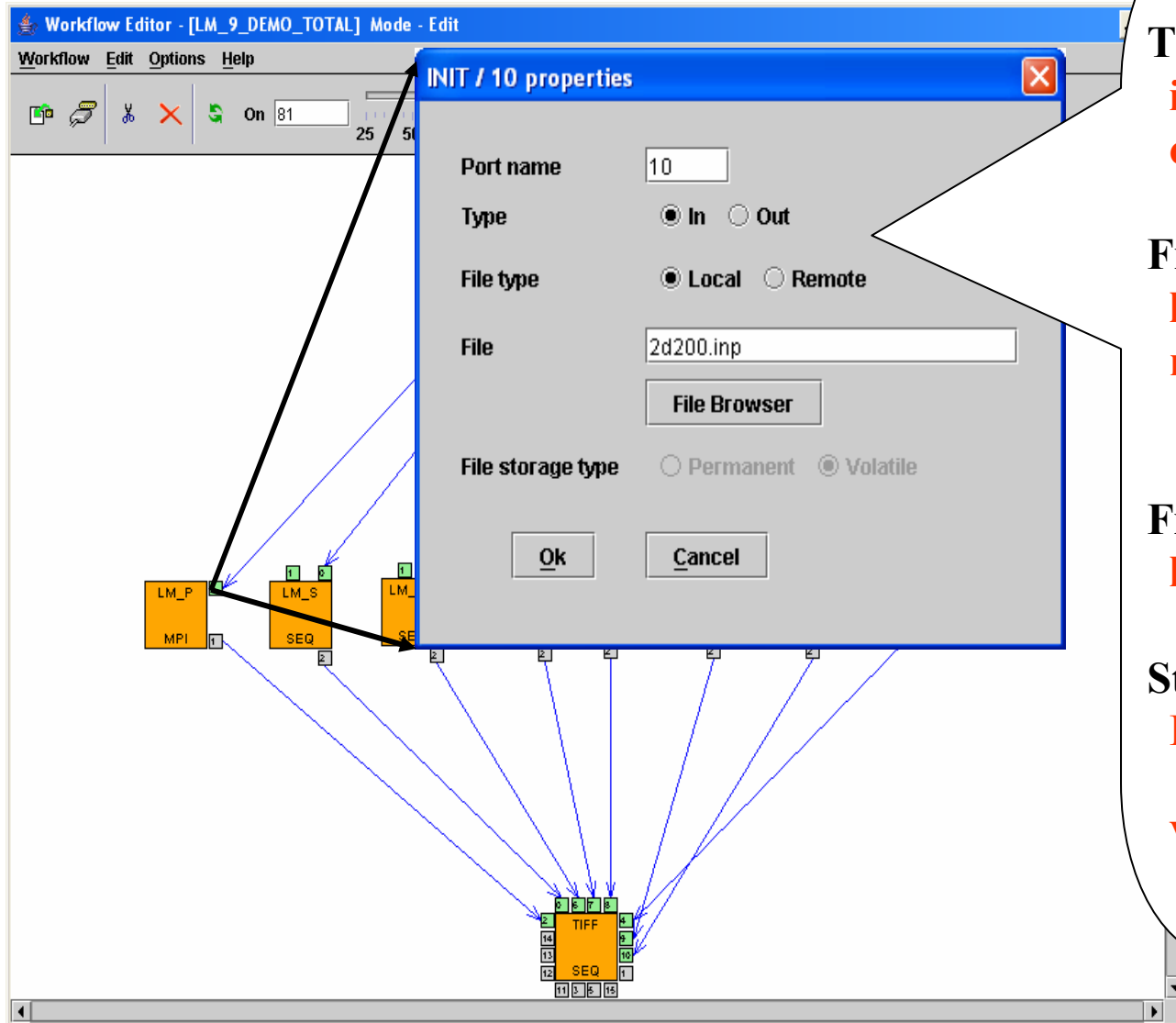
Two options:

- Automatically generated JDL
- Manually configured JDL



Workflow Editor

defining the ports



Type:

input: the job requires

output: the job produces

File type:

local: from/to my desktop

remote: from/to a

GridFTP site

File:

location or URL of the file

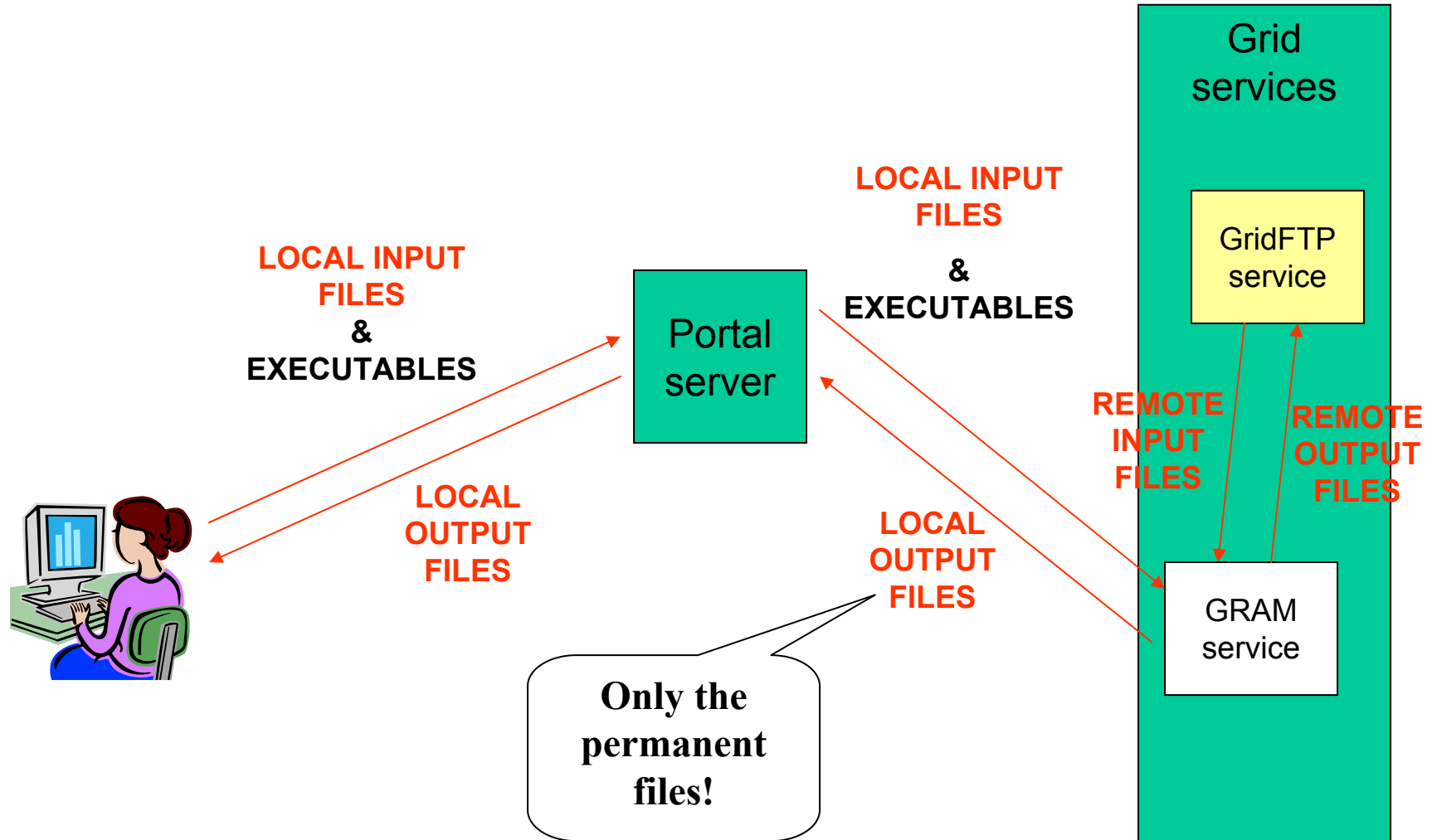
Storage type:

Permanent: final result of the WF

Volatile: just inter-job data transfer



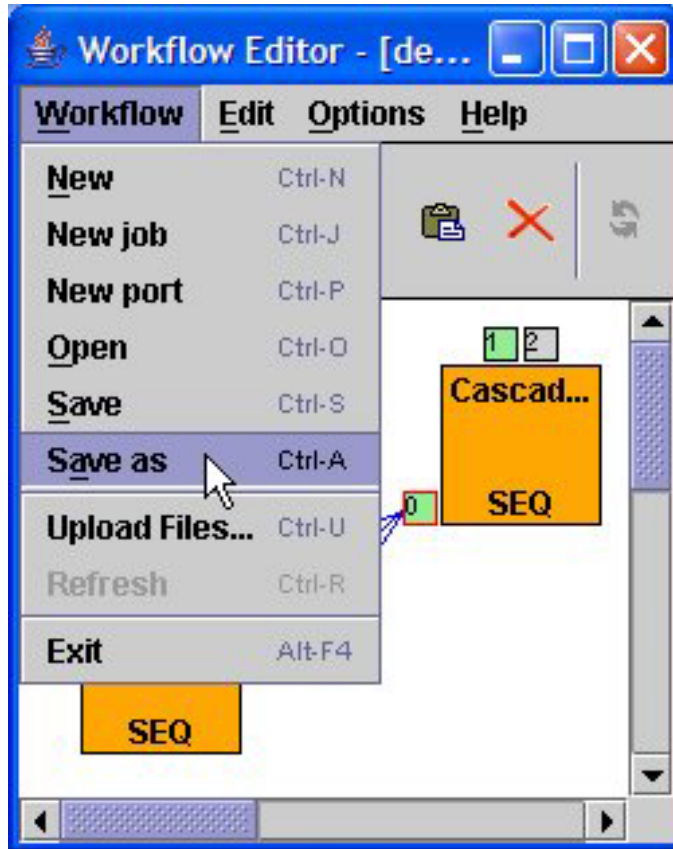
Local vs. remote files





Workflow Editor

saving the workflow



Workflow has been defined!

Let's execute it!



Executing workflows with the P-GRADE Portal

Main steps

- 1. Download Certificate**
- 2. Submit workflow**
- 3. Observe workflow progress**
- 4. If some error occurs correct the graph**
- 5. Download result**



Workflow Management

(workflow portlet)

- The portlet presents the status, size and output of the available workflow in the “**Workflow**” list
- It has a Quota manager to control the users’ storage space on the server
- The portlet also contains the “**Abort**”, “**Attach**”, “**Details**”, “**Delete**” and “**Delete all**” buttons to handle execution of workflows
- The “**Attach**” button opens the workflow in the Workflow Editor
- The “**Details**” button gives an overview about the selected workflow

The screenshot shows a Microsoft Internet Explorer browser window displaying the P-Grade Portal. The address bar shows the URL: <http://hpportal.hpcc.sztek4.hu/7080/gridsphere/gridsphere?action=doSubmitReallyWorkflow&id=2>. The page header includes the P-Grade logo, the text "P-GRADE portal", and logos for the European Union, SEE-GRID, and VIKI. Below the header, there are navigation tabs: Certificates, Settings, Information System, and Help. The main content area is titled "Workflow Manager" and contains a "Workflow Editor" button and a "Refresh" button. A "Workflow list" table is displayed with the following data:

Workflow	Status	Size	Quota (100 Mb)	[Output]	[View]	[Action]
LM_9_DEMO_TOTAL	submitted	26.848 MB	26%	N/A	Details	Abort Attach Delete
		26.848 MB	26%			

At the bottom of the portlet, there is a "Delete all" button and a message: "Message: Workflow successfully submitted."



Workflow Execution

(observation by the workflow portlet)

The screenshot shows the PGrade Portal interface in Microsoft Internet Explorer. The browser window title is "PGrade Portal - Microsoft Internet Explorer". The address bar shows the URL: <http://hgportal.hpcc.sztaki.hu:7080/gridsphere/gridsphere?action=doGotoPage&cid=2>. The page content includes a navigation menu with "Workflow", "Certificates", "Settings", "Information System", and "Help". Below the menu is the "Workflow Manager" section, which contains a "Refresh" button and a "Back" button. The main content is a "Job list" table with columns for Workflow, Job, Gridname, Hostname, Status, Logs, Output, and Visualization. The table contains 11 rows of job data. The status of each job is color-coded: "running" (red), "finished" (green), and "init" (white). The "Visualization" column contains buttons for "Visualize", "All", and "Abort". A message at the bottom of the table reads "Message: Job list refreshed."

Workflow	Job	Gridname	Hostname	Status	[Logs]	[Output]	[Visualization]
LM_9_DEMO_TOTAL				running	-	N/A	Visualize All Abort
	INIT	SEE-GRID	ce01.grid.acad.bg	finished	--		-
	LM_P	SEE-GRID	n40.hpcc.sztaki.hu	init	--		-
	LM_P.2	SEE-GRID	n40.hpcc.sztaki.hu	init	--		-
	LM_S	SEE-GRID	grid-ce.ii.edu.mk	running	--		-
	LM_S.2	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S.3	SEE-GRID	grid1.netmode.ece.ntua.gr	running	Out	-	-
	LM_S.4	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S.5	SEE-GRID	testbed001.grid.ici.ro	running	Out	-	-
	LM_S.6	HUNGRID	chemgrid3.chemres.hu	finished	Out	-	-
	TIFF	HUNGRID	grid109.kfki.hu	init	--		-

- The portal displays the list of jobs and their status

- The current status of the jobs are represented by colors

- It also provides access to their output and error streams

White/Red/Green color means the job is initial/running/finished state



Workflow Execution

(observation by the workflow portlet)

The screenshot shows the PGrade Portal interface in Microsoft Internet Explorer. The browser address bar displays the URL: `http://hgportal.hpcc.sztaki.hu:7080/gridsphere/gridsphere?action=doGotoPage&cid=2`. The page title is "PGrade Portal - Microsoft Internet Explorer". The main content area is titled "Workflow Manager" and includes a "Job list" table. The table has columns for Workflow, Job, Gridname, Hostname, Status, [Logs], [Output], and [Visualization]. The Status column contains the word "finished" in green text. The Output column shows "Being zipped.." for the first row and "Out" for subsequent rows. The Visualization column contains "Visualize" buttons. A message at the bottom of the table reads "Message: Job list refreshed."

Workflow	Job	Gridname	Hostname	Status	[Logs]	[Output]	[Visualization]
LM_9_DEMO_TOTAL				finished	Err	Being zipped..	Visualize All S
	INIT	SEE-GRID	ce01.grid.acad.bg	finished	-	-	-
	LM_P	SEE-GRID	n40.hpcc.sztaki.hu	finished	Out	-	Visualize
	LM_P.2	SEE-GRID	n40.hpcc.sztaki.hu	finished	Out	-	Visualize
	LM_S	SEE-GRID	grid-ce.ii.edu.mk	finished	Out	-	-
	LM_S.2	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S.3	SEE-GRID	grid1.netmode.ece.ntua.gr	finished	Out	-	-
	LM_S.4	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S.5	SEE-GRID	testbed001.grid.id.ro	finished	Out	-	-
	LM_S.6	HUNGRID	chemgrid3.chemres.hu	finished	Out	-	-
	TIFF	HUNGRID	grid109.kfki.hu	finished	Out	-	-

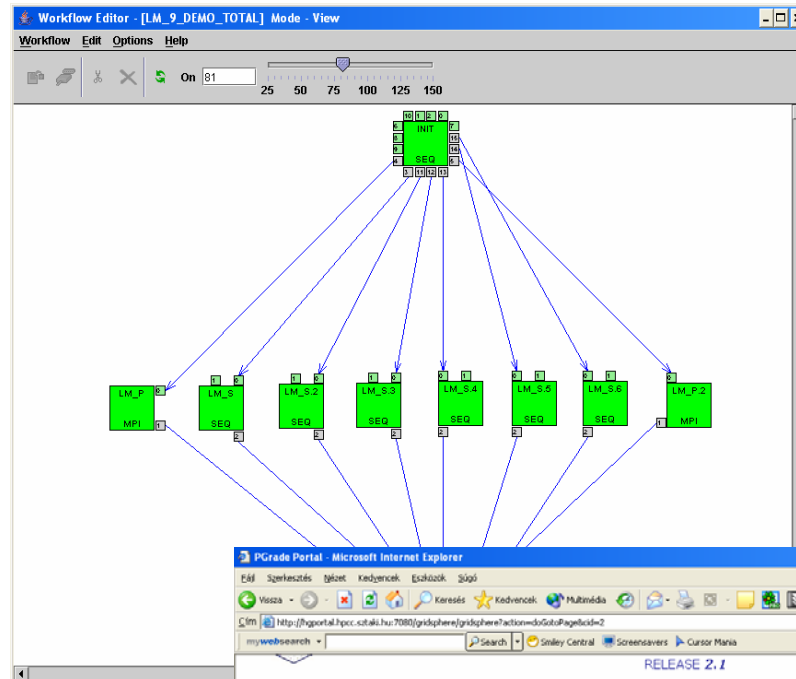
- When the jobs are finished the results could be downloaded in zip format
- The “Output” button displays the output of each job

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



Workflow Execution

I still don't know what's happening inside my workflow!



PGrade Portal - Microsoft Internet Explorer

RELEASE 2.1

Workflow Manager

Workflow	Job	Gridname	Hostname	Status	Logs	Output	[Visualization]
LM_9_DEMO_TOTAL	INIT	SEE-GRID	ce01.grid.acad.bg	finished	-	N/A	Visualize All Abort
	LM_P	SEE-GRID	n40.hpcc.sztaki.hu	running	Out	-	Visualize
	LM_P_2	SEE-GRID	n40.hpcc.sztaki.hu	running	Out	-	Visualize
	LM_S	SEE-GRID	grid-ce.ii.edu.mk	finished	Out	-	-
	LM_S_2	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S_3	SEE-GRID	grid1.netmode.ece.ntua.gr	finished	Out	-	-
	LM_S_4	SEE-GRID	grid1.irb.hr	finished	Out	-	-
	LM_S_5	SEE-GRID	testbed001.grid.id.ro	finished	Out	-	-
	LM_S_6	HUNGRID	chemgrid3.chemres.hu	finished	Out	-	-
	TIFF	HUNGRID	grid109.kfki.hu	init	-	-	-

Message: Job list refreshed.



Workflow Monitoring in P-GRADE Portal environment

- Main Monitoring levels
 - First (basic) level: Color coded information about the running workflow (Attach button)

The screenshot shows the P-Grade Portal interface in Microsoft Internet Explorer. The browser title is "PGrade Portal - Microsoft Internet Explorer". The address bar shows the URL: <http://hgportal.hpcc.sztekl.hui2080.gridisphere/gridisphere?action=doSubmitReallyWorkflow&id=2>. The page features the P-Grade logo, the text "P-GRADE portal", and logos for the European Union, IEEE-GRID, and VERA. Below the logos is a navigation menu with "Certificates", "Settings", "Information System", and "Help". The main content area is titled "Workflow Manager" and contains a "Workflow Editor" and a "Refresh" button. A table titled "Workflow list" displays the following data:

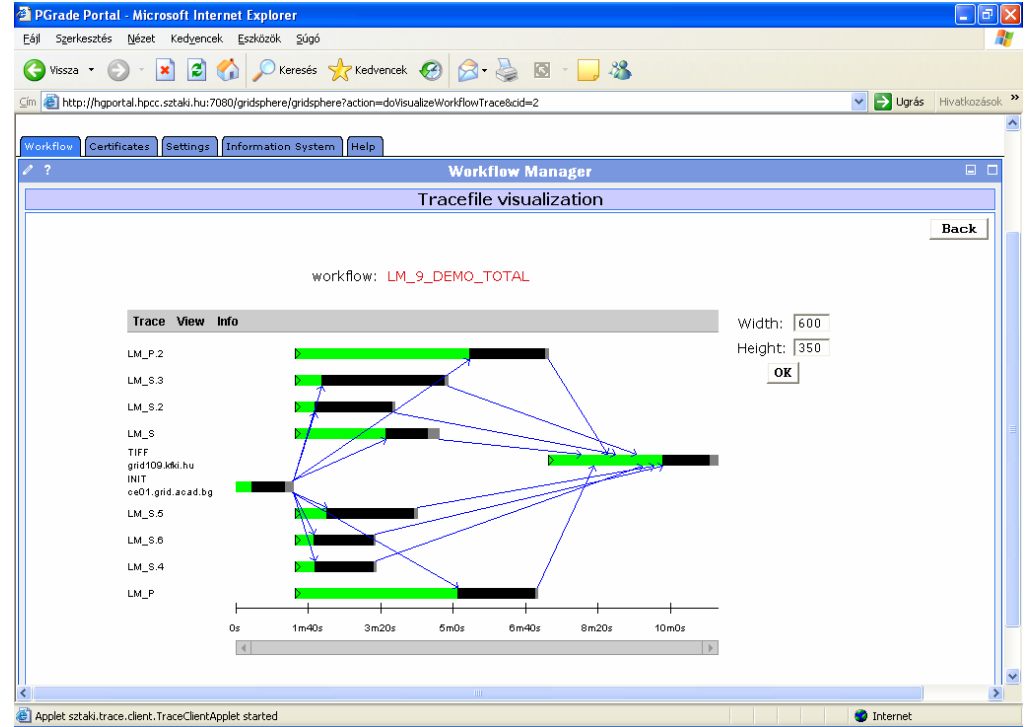
Workflow	Status	Size	Quota (100 Mb)	[Output]	[View]	Action
LM_9_DEMO_TOTAL	submitted	26.848 MB	26%	N/A	Details	Abort Attach Delete
		26.848 MB	26%			

At the bottom of the page, there is a message: "Message: Workflow successfully submitted." A red arrow points from the text "Attach button" in the list above to the "Attach" button in the table.

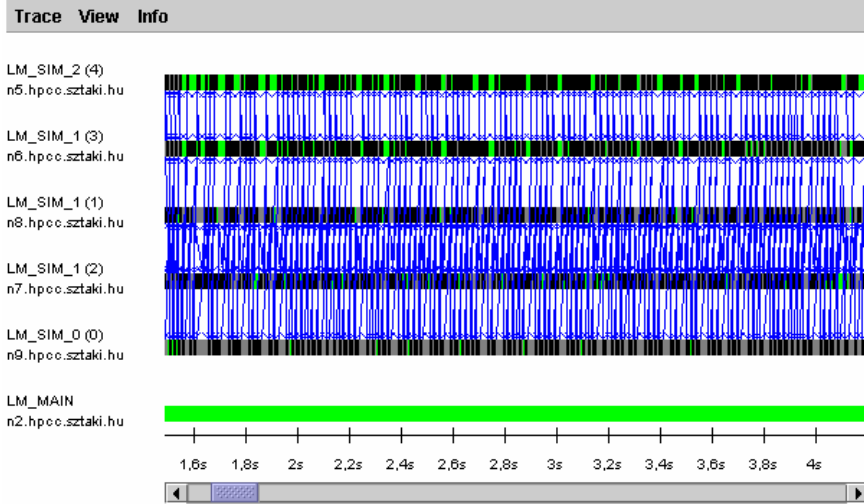


Workflow Monitoring in P-Grade Portal environment

- 2nd level:
 - Job status
 - Communication between jobs
 - Good for workflow optimization



workflow / job: LM_9_DEMO_TOTAL / LM_P



3rd level:

- Visualize MPI communication within jobs
- Good for mpi optimization



Rescuing a failed workflow 1.

(from P-PGRADE Portal v2.2)

The screenshot shows the GridSphere Portal interface in Microsoft Internet Explorer. The browser address bar shows `http://hgportal.hpcc.sztaki.hu`. The page title is "GridSphere Portal - Microsoft Internet Explorer". The main content area displays a "Job list" table with the following data:

Workflow	Job	Gridname	Hostname	Status	Log	Output	View	Action
demo-RESCUE	Count1	SZTAKI-GRID	n0 .hpcc.sztaki.hu	finished	Out	-	-	-
	Count2	SZTAKI-GRID	n0 .hpcc.sztaki.hu	finished	Out	-	-	-
	Count3	HUNGRID	chemgrid3 .chemres.hu	error	- Err	-	-	-
	Count4	SZTAKI-GRID	n0 .hpcc.sztaki.hu	submitted	--	-	-	-

Below the table, a message box displays: `Message: Workflow details successfully displayed.`

At the bottom of the page, the date "July 29, 2005" is shown. The browser status bar at the bottom indicates "Done" and "Internet".

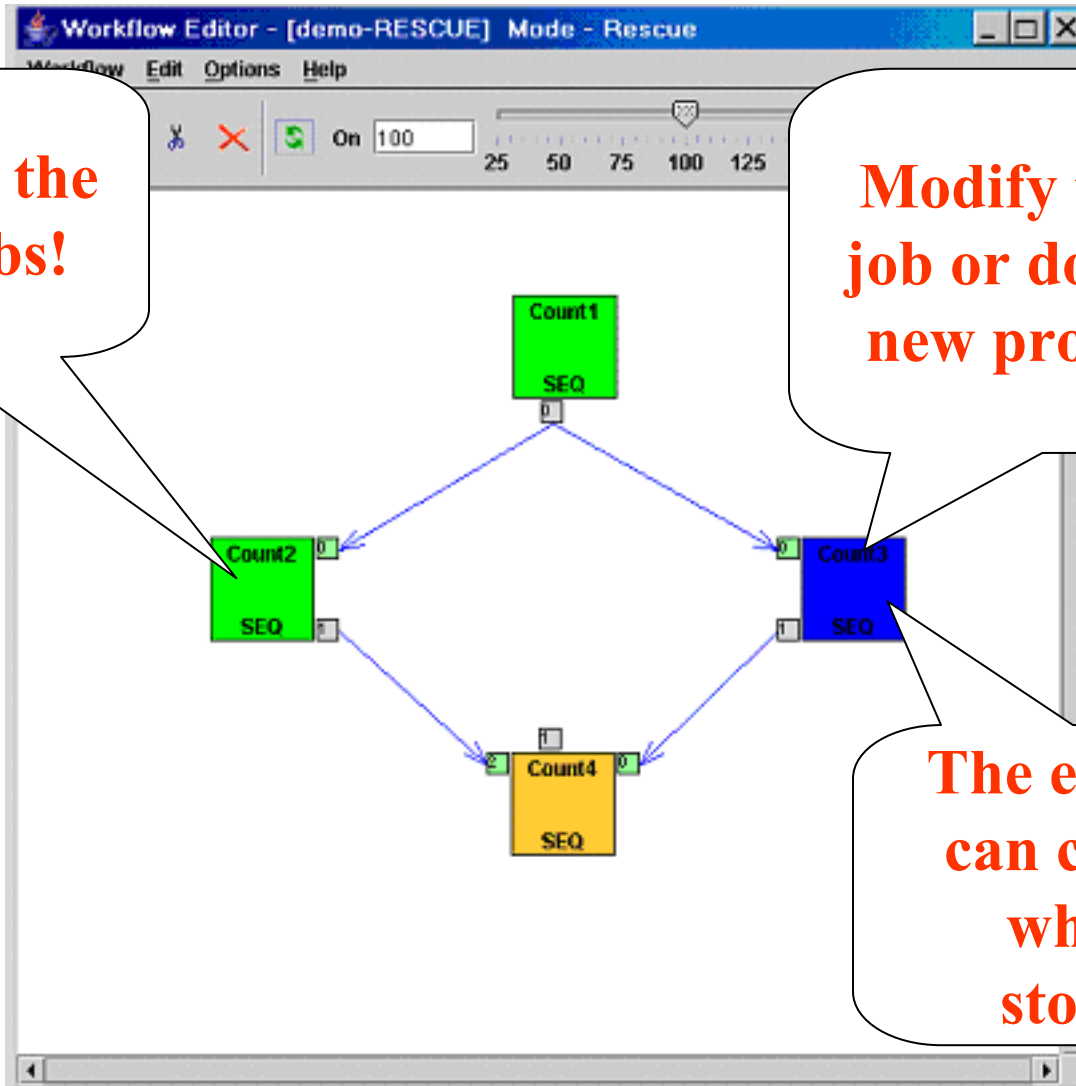
Two callout boxes are overlaid on the screenshot:

- A callout box pointing to the "error" status of Count3 contains the text: **A job failed during workflow execution**
- A callout box pointing to the "Err" link for Count3 contains the text: **Read the error log to know why**



Rescuing a failed workflow 2.

(from P-GRADE Portal v2.2)



Don't touch the finished jobs!

Modify the failed job or download a new proxy for it.

The execution can continue where it stopped!



Downloading the results...

PGrade Portal - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://fn2.hpcc.sztaki.hu:9080/gridsphere/gridsphere?action=doGotoPage&cid=2

Home Bookmarks The Mozilla Or... Latest Builds

P-GRADE portal

Logout

Welcome, Nemeth Csaba

Workflow Credentials Settings Demo Help

Workflow Manager

Refresh Back

Workflow	Job	Hostname	Status	[Logs]	[Output]	[Visualization]	[Action]
nowcast-final-g_SGE			finished		<input checked="" type="checkbox"/>	Visualize All	Subm Attach Delete
	cummu	n0.hpcc.sztaki.hu	finished	--		Visualize	
	delta	n0.hpcc.sztaki.hu	finished	--		Visualize	
	ready	n0.hpcc.sztaki.hu	finished	--		Visualize	
	satel	n0.hpcc.sztaki.hu	finished	--		Visualize	
	visib	n0.hpcc.sztaki.hu	finished	--		Visualize	

Message: Job list refreshed.

Transferring data from fn2.hpcc.sztaki.hu...

Opening nowcast_final_g.zip

The file "nowcast_final_g.zip" is of type application/x-zip-compressed, and Mozilla does not know how to handle this file type. This file is located at:
e:\pri\mc04

What should Mozilla do with this file?

Open it with the default application

Open it with Choose...

Save it to disk

Always perform this action when handling files of this type

OK Cancel



References

- Official portal of
 - SEE-GRID infrastructure
 - HUNGRID infrastructure
- P-GRADE portal is available as service for:
 - VOCE
 - UK National Grid Service
 - Croatian Grid
 - EGrid (Italy)





How to access P-GRADE portal?

- If you are interested in using P-GRADE Portal:
 - Take a look at www.lpds.szteki.hu/pgportal
 - **If you are a user**
 - **Ask an account for one of available portal services:**
 - SEEGRID portal – SZTAKI
 - HUNGrid portal – SZTAKI
 - NGS portal – University of Westminster

(Obtain a grid certificate if you don't have yet)
 - **If you are Grid application developer**
 - Contact SZTAKI to initiate collaboration
 - **If you are Grid administrator**
 - **Ask SZTAKI to install the P-GRADE Portal for you!**
 - SZTAKI is able to give support
 - SZTAKI is able to give trainings and knowledge transfer



Final conclusions

- **P-GRADE portal provides:**

- User friendly interface to wide range of Grid infrastructures
- Easy-to-use workflow concept for solving complex problems
- Fast development of Grid applications
- Integrating various components into large Grid applications:
 - Sequential codes
 - MPI codes
 - Legacy codes
- Application monitoring, performance visualization, guarantee correctness
- Interoperability between many different Grid systems
- Simultaneous execution of application components in different Grids
- Easy to port applications among Grids (Switching between Grid technologies will be transparent to the end-user)

Key motto of the P-GRADE Portal is

Learn once, use everywhere.

Develop once, execute anywhere !



Thank you.