



Enabling Grids for E-science

# Porting applications to the Grid

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Information Society



- Introduction
- **Practical:** Preparing and submitting a job based on a simple non-grid application.
- *Some theory.* Discussing common problems and obstacles of porting applications to a Grid while awaiting the job results.
- **Practical:** Retrieving and inspecting the job results.
- Final remarks.

**The main goal:**

**❖ To port and execute an existing non-grid application to the Grid.**

(In particular, this is GILDA Grid for training purpose.)

Some sources define this process commonly as “**gridifying**”. There are many useful and “single-processor” or “single-machine” applications which need gridifying.

- 1. Developing a non-grid application (or inheriting and updating an ancient one);**
- 2. Executing, Testing and Debugging the application;**
- 3. Constructing the job suite – JDL (Job Description Language) files, executables, auxiliary scripts and input/output data files;**
- 4. Submitting the job to the Grid;**
- 5. Executing, Testing and Debugging the application;**
- 6. *IF* something goes wrong  
*THEN GOTO 2*;**

- **Goal:** The application called *MatrixDemo* will be ported and executed in GILDA grid environment. (The program is borrowed from the “EGEE summer school” at MTA SZTAKI institute, Budapest, 2006.)

***MatrixDemo* is written in C programming language.**

Many Grids, especially GILDA and EGEE Grid middleware (gLite) are based on Globus Toolkit, (<http://www.globus.org/>).

**The Globus Toolkit (the fundament of gLite) is written in C, so porting the C or C++ programs is easy ... probably.**

- **MatrixDemo** program performs some matrix operations – inverting, multiplying, etc.
- **Usage:**
- **MatrixDemo** has command line interface which accepts several arguments. Starting the program without any argument will display a short help.

– Example:

**MatrixDemo I V**

This will Invert (**I**) the matrix defined in the file named INPUT1 and will store the result in the file OUTPUT with verbose details (**V**).

- **Prerequisites:**

- ✓ **File *MatrixDemo.c*** – the source code of the program.
- ✓ **Files *INPUT1* and *INPUT2*** – they contain matrix data in the following text format:

*rows, columns, cell1, cell2, cell3 ...*

Where *rows* is an integer representing the number of rows. *columns* represents number of columns, and *cell1*, *cell2* etc. are the cells of the matrix, floating point numbers separated by commas (,).

- ✓ **A standard C compiler and linker.**  
In this case we will use GNU C (gcc) already installed.
- ✓ **File *MatrixDemo.jdl*** – a prepared JDL (Job Description Language) file.

- Step:
  1. Log on to the GILDA user interface using *PuTTY* SSH (Secure shell) client located on your Windows Desktop. (The user input is given in red color.)

Hostname: **ui.grid.acad.bg**

login as: **sofiaXX**

(where XX must be 01, 02 etc.)

Password: **GridSOFXX**

(where XX is the same number as above)

*For example: the password for user **sofia15** is **GridSOF15**.*



- Step:
- 2. Download the prerequisites stored in a zipped file *MatrixDemo.zip* with the following command:

```
globus-url-copy gsiftp://se-edu.grid.acad.bg\
/pnfs/grid.acad.bg/data/gilda/MatrixDemo.zip \
file:/home/sofia15/MatrixDemo.zip
```

( This is a **Globus toolkit** command, for a change.  
Replace *sofia15* with your home directory. )

Unzip the archive in your current directory with the command:

```
unzip MatrixDemo.zip
```

(This will create a subdirectory *matrix* with all of the prerequisite files inside.)

Change the current directory:

```
cd matrix
```

- Step:
3. Compile and link the program using GNU C compiler / linker:

```
gcc -o MatrixDemo MatrixDemo.c
```

This will create an executable file *MatrixDemo*.

Look at the directory contents:

```
ls -l
```

- Step:
4. Invert the matrix stored in *INPUT1* file with the following command:

```
./MatrixDemo I V
```

Look at the content of the input file *INPUT1*:

```
more INPUT1
```

Look at the content of the output file *OUTPUT*:

```
more OUTPUT
```

And you may examine the source code:

```
more MatrixDemo.c
```

- Step:
5. **Authenticate yourself as a Grid user with gilda VO membership:**

```
voms-proxy-init --voms gilda
```

This will ask for the passphrase which is **SOFIA** for all users.

**Check the proxy status with:**

```
voms-proxy-info
```

- Step:
6. Investigate the abilities to run the job among the Grid-sites with gilda VO support:

```
glite-wms-job-list-match -a MatrixDemo.jdl
```

This command will produce a listing with all of the Grid Computing elements together with jobmanager queues that fulfill the requirements of our job.

- Steps:

7. Execute the following command:

```
glite-wms-job-submit -a -o matrix.id MatrixDemo.jdl
```

This will submit the job and will store its unique identifier in a file called *matrix.id*. You may look at that file.

8. Monitor the job status with:




```
glite-wms-job-status -i matrix.id
```

Execute this command several times until “**Done (Success)**” status.

- **The candidate-applications for porting usually are huge and complex.**
- **Some of them use low-level network functions and/or parallel execution features of a specific non-grid environment.**
- **Usage of non-standard or proprietary communication protocols.**
- **The complete source code might not be available, might not be well documented or its “out-of-host” usage is restricted by a license agreement.**

- The application might be written in many different programming languages – C, C++, C#, Java, FORTRAN etc. or even mixture of them.
- Applications may depend on third-party libraries or executables which are not available by default on some Grid worker nodes.
- Some application features could cause unintentional violation of Grid Acceptable Use Policies (Grid AUP).
- Furthermore, the application can have hidden security weakness which will be very dangerous in case of remote Grid job execution.



- Some applications are pre-compiled or optimized for using on a machine with particular processor(s) only – Intel, AMD, in 32-bit or 64-bit mode, etc. But the Grid is heterogeneous!
- The application may contain serious  bugs  which have never been  detected while running in a non-grid environment.
- Finally, the formal procedure for accepting a new application to be ported to a Grid for production or even experimental purpose is not simple.

**Therefore, the porting of an arbitrary application to Grid could be very long, difficult and expensive process!**

- Step:

9. Execute the following command:

```
glite-wms-job-output -i matrix.id --dir ./out
```

This will retrieve the Output sandbox files and will store them into a local directory named **out**.

Enter the output directory and look at the files named *OUTPUT*, *std.out* and *std.err*

```
more OUTPUT
```

```
more std.out
```

```
more std.err
```

- Step:  
10. Look to the supplied *MatrixDemo.jdl* file:

**more MatrixDemo.jdl**

The *MatrixDemo.jdl* contents:

```
[
    VirtualOrganisation = "gilda";
    Executable = "MatrixDemo";
    JobType = "Normal";
    Arguments = "I V";
    StdOutput = "std.out";
    StdError = "std.err";
    InputSandbox = {
        "MatrixDemo",
        "INPUT1"
    };
    OutputSandbox = {
        "std.out",
        "std.err",
        "OUTPUT"
    }
]
```

- **Short explanation of some important JDL-attributes:**
  - **VirtualOrganisation** – this points to our training VO (gilda);
  - **Executable** – sets the name of the executable file;
  - **Arguments** – command line arguments of the program;
  - **StdOutput, StdError** - files for storing the standard output and error messages output;
  - **InputSandbox** – input files needed by the program, including the executable;
  - **OutputSandbox** – output files which will be written during the execution, including standard output and standard error output;

- **Modify and submit the job in a way that it will produce multiplication of the two matrices stored in *INPUT1* and *INPUT2* files. Check up the result by hand. ;-)**

## Questions?