IDGF
International Desktop Grid Federation

Porting Applications to SG/DG Infrastructures

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ISGC 2011, Taipei, Taiwan

Which applications are suitable for SG/DG infrastructures?

- **Applications should run on both SGs and DGs**
  - SGs support a much wider scale of applications than DGs
  - We should assure that the application runs on DGs
- **Requirements towards an application to be executable on DGs:**
  - **Parallelization:**
    - Only **master/worker** or **parameter sweep** parallelisation
      - **No MPI** or internal communication between worker nodes
      - Nodes can only use the results of other nodes **through the server**
  - **Data handling:**
    - small or medium-sized (max. 100 MB per worker) inputs and outputs (especially for public DGs, could be larger in local DGs)
    - No shared data storage (in public DGs)
    - No confidential data (sent down to potentially un-trusted worker in public DG)

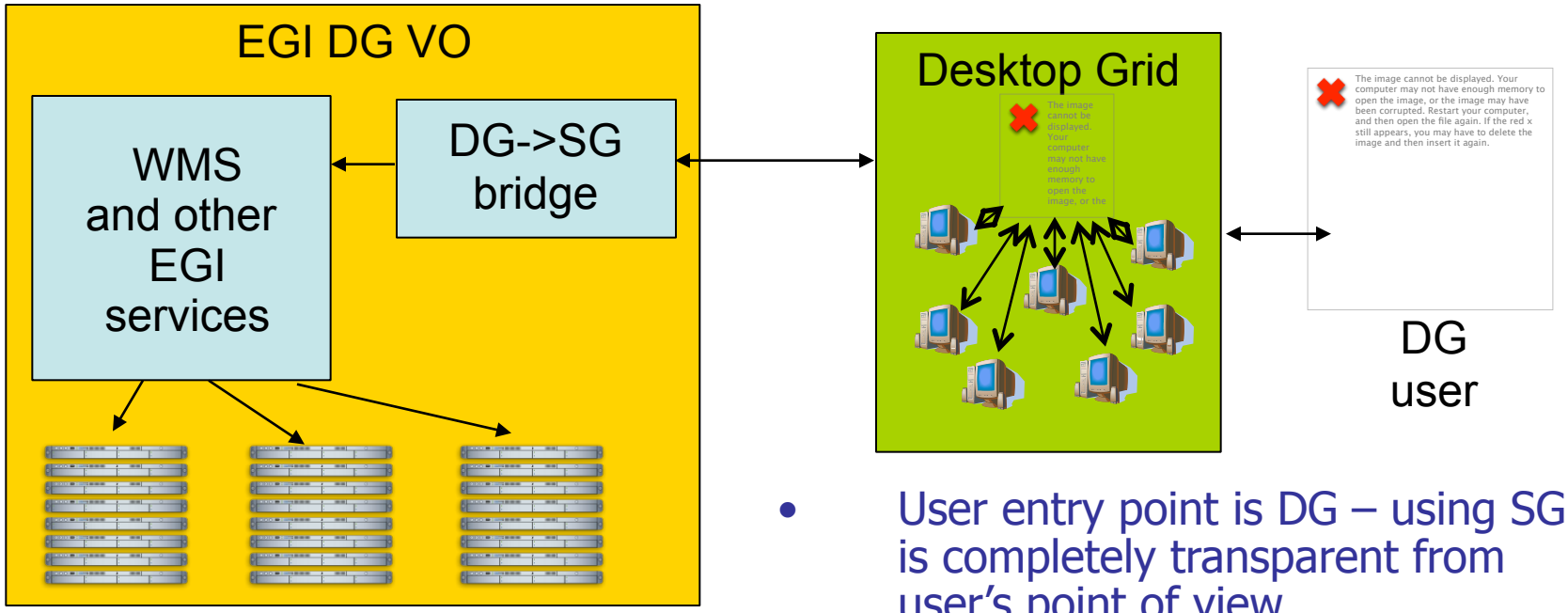
Which applications are suitable for SG/DG infrastructures?

- To achieve good performance
  - the execution time of individual jobs should be
    - **Minimum:**
      - over 10 minutes (otherwise the overhead caused by the DG will reduce the performance)
    - **Maximum:**
      - less than 2-3 hours (if longer, application level check-pointing is required to avoid loss of computation caused by user interventions)
  - the execution of individual jobs should take around the same amount of time (better scheduling, less load on the server)
- Operating systems
  - Depends on the DGs where the application will run
    - windows version may be required to utilise larger number of resources

SG/DG application scenarios

1. Application runs on DG and uses SG resources via the DG to SG bridge
2. Application submitted to SG and uses DG resources via the SG to DG bridge
3. Application uses both SG and DG resources via an external scheduling and job submission system

Scenario 1 – DG to SG via bridge



- User entry point is DG – using SG is completely transparent from user's point of view

Scenario – DG to SG via bridge

Porting to DG to SG infrastructure:

1. Develop and test DG version of application
2. Develop **Linux version** of your client application to run on SG
3. Test **client application** on SG
4. Test application via the **DG->SG bridge**
5. Write **Test report and documentation**
6. Deploy application on **production infrastructure**
   - Send test report to EGI DG VO Admin for approval
   - Deploy your application in production
     - On a DG already connected to EGI DG VO
     - Connect your DG to EGI DG VO

Which DG applications are suitable for EGI DG VO?

- **If an application is capable to run on a heterogeneous DG then it is typically capable to run in EGI too.**
  - **Public DG** applications are almost certain to run on EGI resources too.
  - **Local DG** applications may require more thorough testing and some potential fine-tuning (may suppose less heterogeneous infrastructure).
    - **E.g.:** may require large amount of memory available on local machines but not on every EGI site.

DG to SG Application Example

ViSAGE - Video Stream Analysis in a Grid Environment
By Correlation Systems Ltd. - Israel

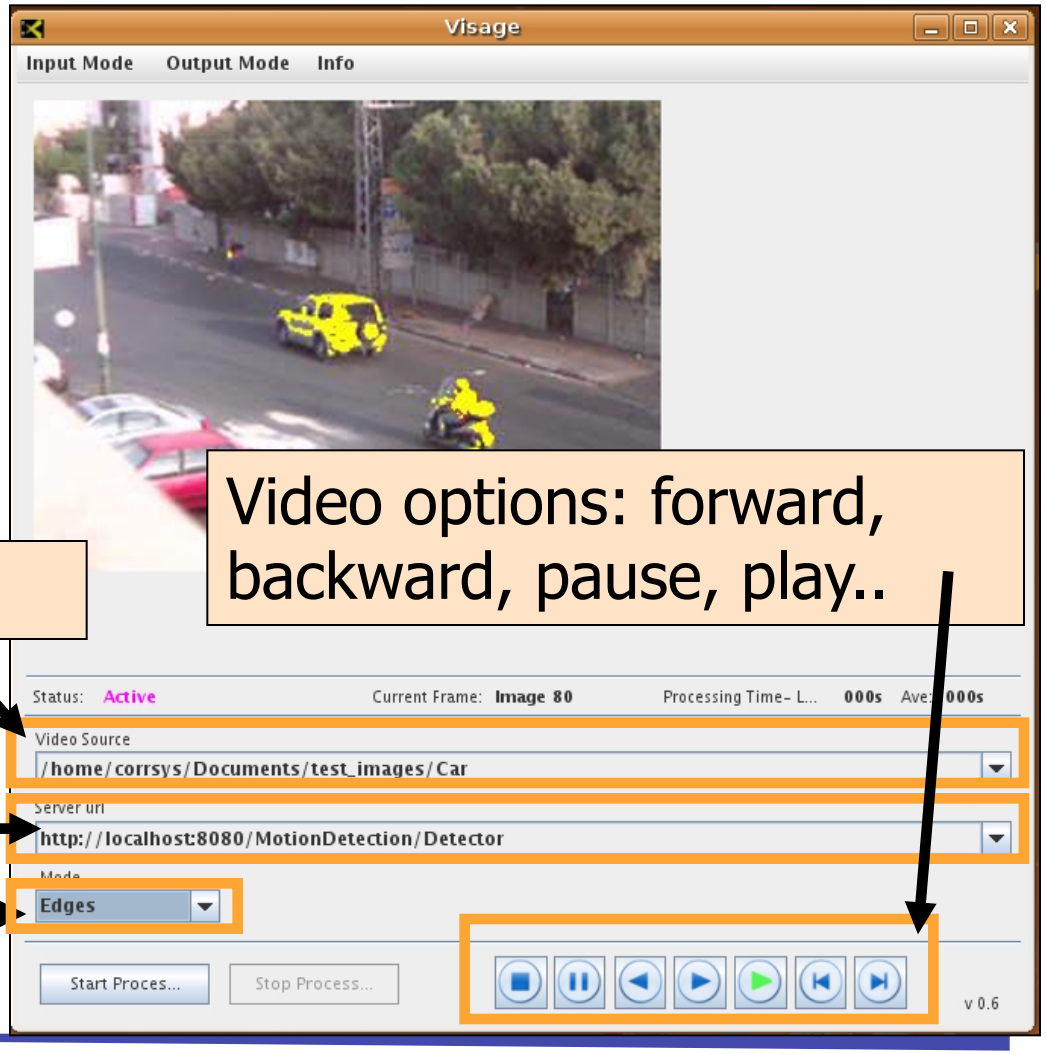
Video Analysis is a general term used to describe the use of advanced algorithms to process video data.

ViSAGE is a technology for processing of video streams using a GRID of computational nodes.

ViSAGE was developed by ***Correlation Systems Ltd.*** as EDGeS subcontractor

ViSAGE - Video Stream Analysis in a Grid Environment By Correlation Systems Ltd. - Israel

Visage processes Image pairs over the BOINC/EDGeS grid and paints movement in yellow.



Insert video source:

Video options: forward, backward, pause, play..

Insert Url of Server:

Set mode to EDGeS

e-infrastructure

ViSAGE - Video Stream Analysis in a Grid Environment By Correlation Systems Ltd. - Israel

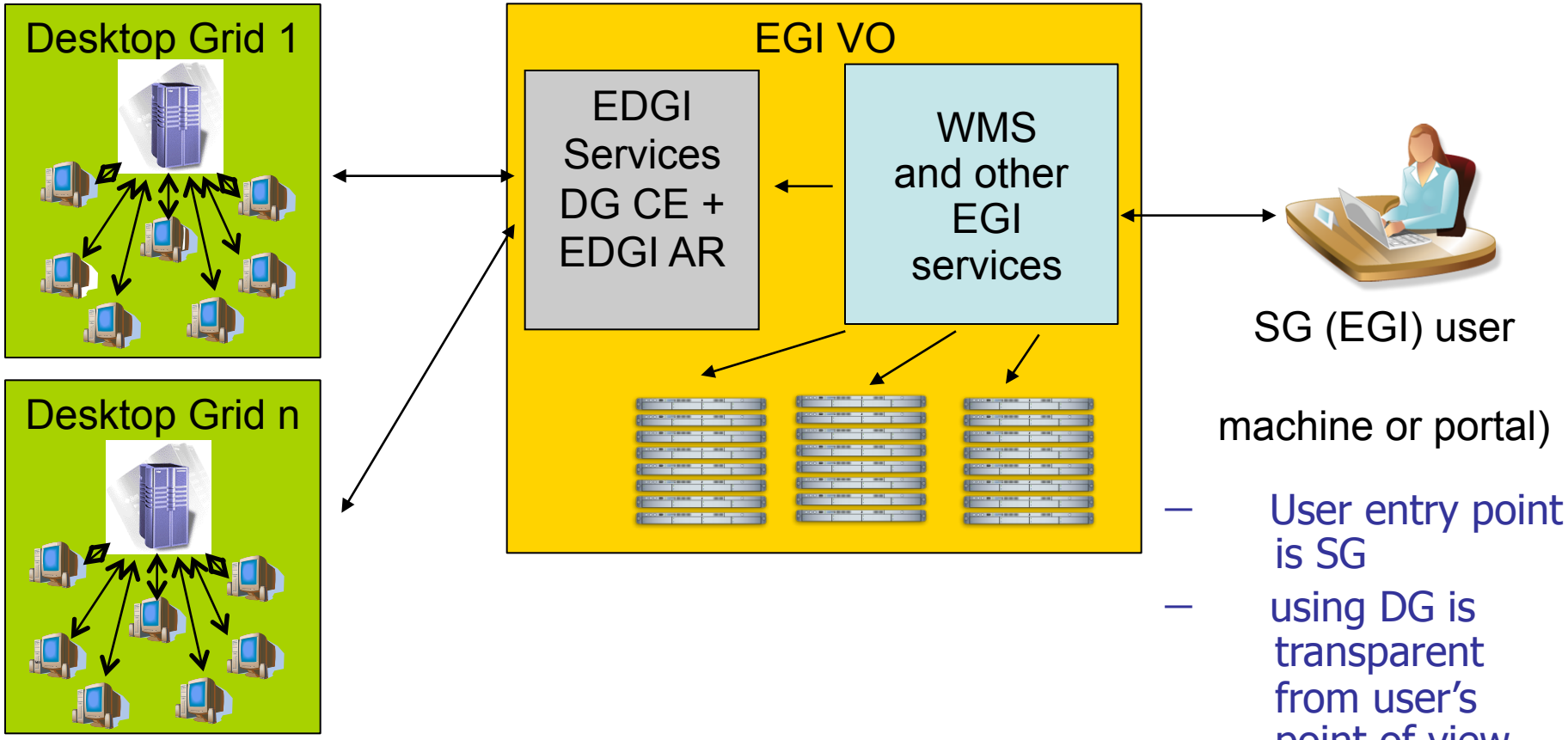
ViSAGE

Small local DG at Israel

DG to SG bridge

EGI DG VO

Scenario 2 – SG to DG via bridge



- User entry point is SG
- using DG is transparent from user's point of view

Scenario 2 – SG to DG via bridge

Porting to SG to DG infrastructure (SG version available):

1. Develop and test DG version of application
2. Test application via the SG to DG bridge and write test report
3. Have your application validated
   - Validation is done by EDGI/DEGISCO Validation Team
   - Outcome: validation document
4. Publish your application in the EDGI Application Repository
   - DG Admins can download your application from the AR if they are ready to support it
   - EGI users can also find your application in the AR
   - Bridge uses the AR for checking the validity of the application at submission time

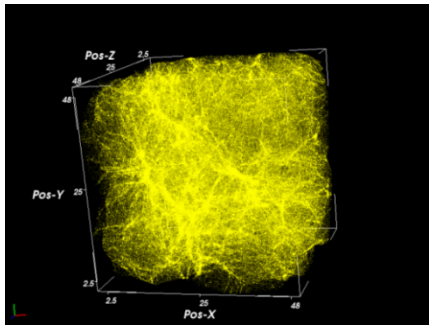
Benefits of using DGs for SG (EGI) users

- Large additional computing power can be utilized
  - Desktop Grids are easy-to-scale systems and able to collect 1-2 orders of magnitude more compute power than Service Grids
  - By interconnecting SG and DG systems SG users can transparently execute applications on any arbitrary platform involved in the new infrastructure
- As a consequence we get:
  - reduced turnover time
  - improved fault-tolerance (redundant computing)
  - higher throughput

SG to DG Application Example

VisIVO - Visualisation Interface to the Virtual Observatory

- a suite of software tools for creating customized views of 3D renderings from astrophysical data tables
- **User community**: INAF Catania (Osservatorio Astrofisico di Catania) + University of Porthmouth



- **Grid enabled version:**
  - For g-Lite based grids
    - Runs on the Cometa Consortium Grid – Catania, Messina, Palermo
  - Ported to the EDGeS platform to utilize Desktop Grid resources
  - Subcontractor in EDGI to further develop ported application

SG to DG Application Example

VisIVO - Visualisation Interface to the Virtual Observatory

Application porting

- Desktop Grid version is deployed and running on UoW Local DG and EDGeS@home
- Application is validated and published in Production Application Repository
- Application runs from EGEE to DG (UoW Local DG and EDGeS@home)

Data distribution

- Medium sized input files (up to 100 Mbytes) are currently feasible

Work in EDGI:

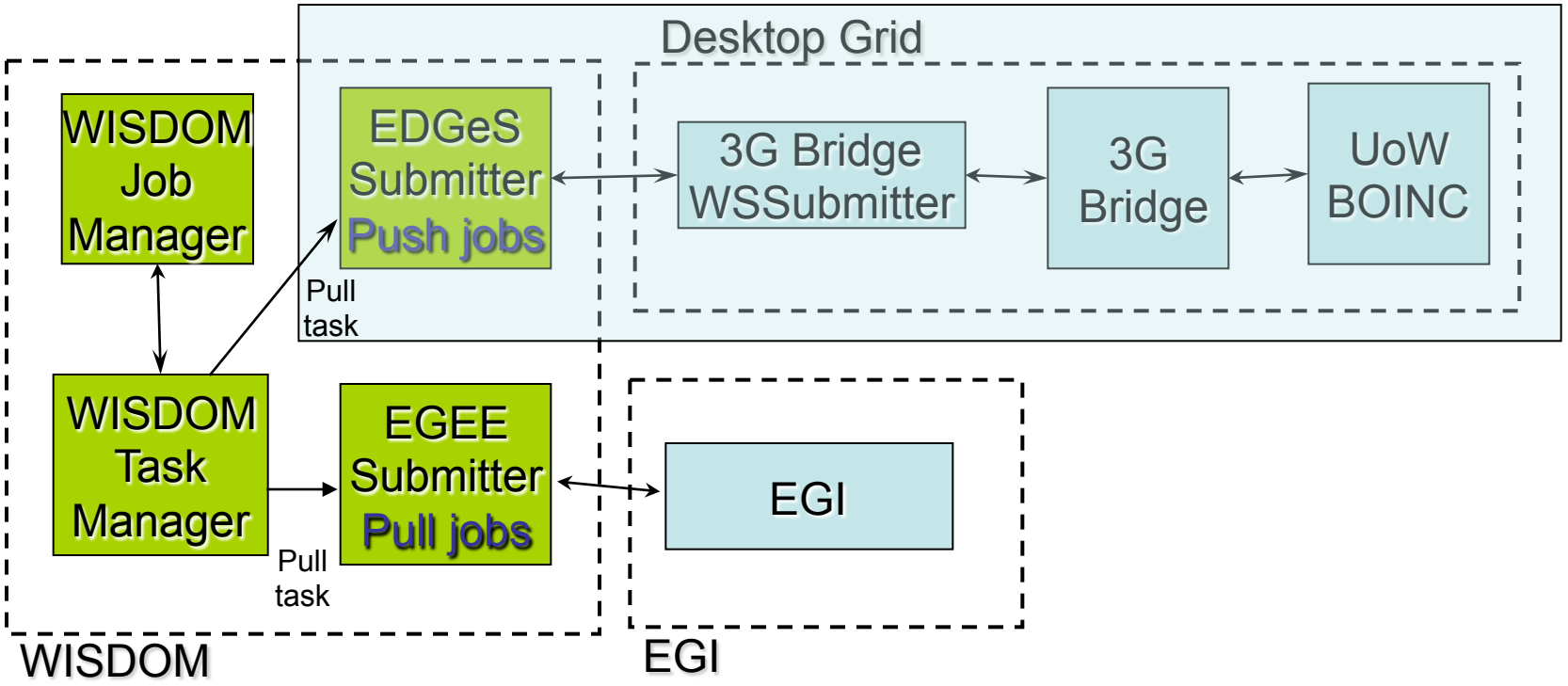
- Division of input file (potentially GBytes) and better data distribution using ADICS will be investigated
- VisIVO Web portal will be connected to DG infrastructure – potential access by the general public in museums

Scenario 3 – SG/DG resources but not through EDGeS/EDGI bridges

- Using external job submission and scheduling system to submit jobs to both SG and DG resources
  - P-GRADE/WS P-GRADE portal supports this scenario by default
    - E.g.:
      - CancerGrid application uses EGI and DG resources via the WS P-GRADE portal
  - Could be justified with specific user requirements
    - E.g.:
      - WISDOM project uses only pull jobs on EGI that are unsuitable to be bridged to DG
  - Both solutions use EDGeS/EDGI technology: 3GBridge

Scenario 3 – DG submitter for WISDOM

- WISDOM: Meta middleware to submit pull (pilot) jobs to EGI
- The DG submitter:
  - Submit push (direct) jobs to the DG when EGI resources are overloaded



Application Development to SG/DG platforms
Challenges before the EDGeS/EDGI /DEGISCO projects

For the Developer

- **DG version of the application has to be developed**
  - Only low level APIs (e.g. BOINC API)
  - Specific expertise is required
  - Platform dependent solutions (different BOINC/XtremWeb version)
- **Application composition**
  - Creation of workflows is not supported

For the user

- **Transparency for the user**
  - User would require the same or similar user interface for DG and SG applications
  - Total lack of UI for DG systems (e.g. only BOINC Admin can run the application)
- **Only validated applications can be run on a DG**
  - Requires an application repository
  - Publish, select, download, parameterize and execute applications

Tools supporting application development and execution on SG/DG platforms

API level support – for the developer

DC-API:

- Provides a uniform interface for different Grid systems (BOINC, Condor, XtremWeb)

GenWrapper:

- Generic wrapper to port legacy applications to a BOINC platform without "Boincification"

High level graphical user interface – for the developer and the user

WS-PGRADE portal:

- to support the transparent exploitation of SG/DG systems at workflow level

EDGeS Application Repository:

- Publish, select, download, parameterise and execute validated applications

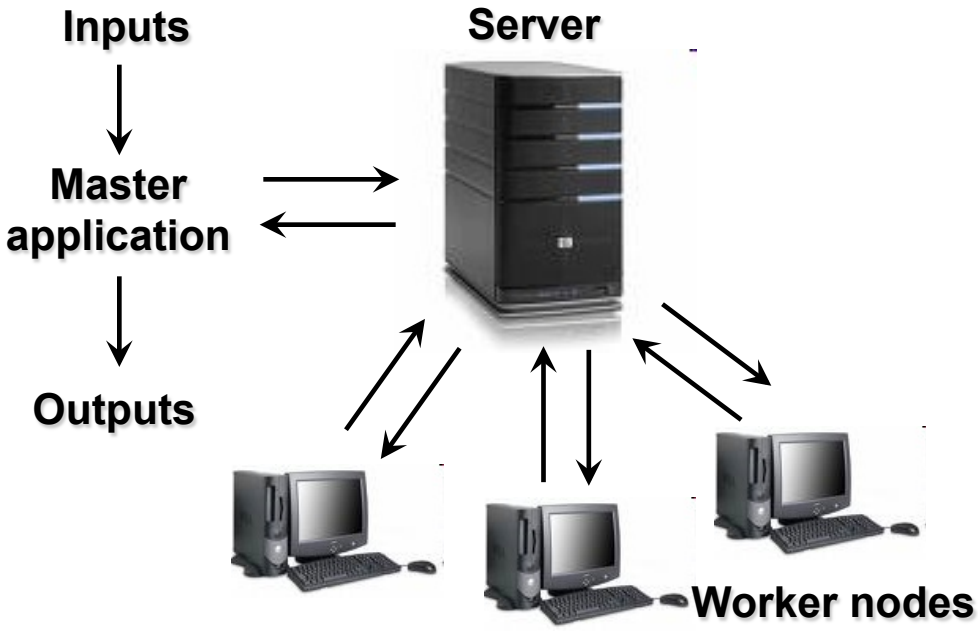
Porting applications to a DG platform

What we have…

Sequential application

What we want…

Parallel application



How does a BOINC application work?

- Based on the master-worker concept
- The sequential application is divided into two parts
  - Master application
  - Worker application
- The master imitates the running of a single-threaded application for the user
  - The application behaves similarly to the sequential version from the user's point of view
- The worker applications work on independent subtasks (work units) that can be done in parallel by different worker nodes

BOINC master and client sides

Master side

- The user starts the master
- Reads or creates inputs
- Generates and submits work units
- Waits for results
- Validates the results
- Assimilates the results
- Returns the outputs

Client side

- The BOINC client fetches work units from the server
- The client downloads the inputs and the executables
- The BOINC client starts the worker application
- The worker application runs
- The client uploads the results

What needs to be implemented?

Master side

- The user starts the master
- Reads or creates inputs
- Generates and submits work units
- Waits for results
- Validates the results
- Assimilates the results
- Returns the outputs

Client side

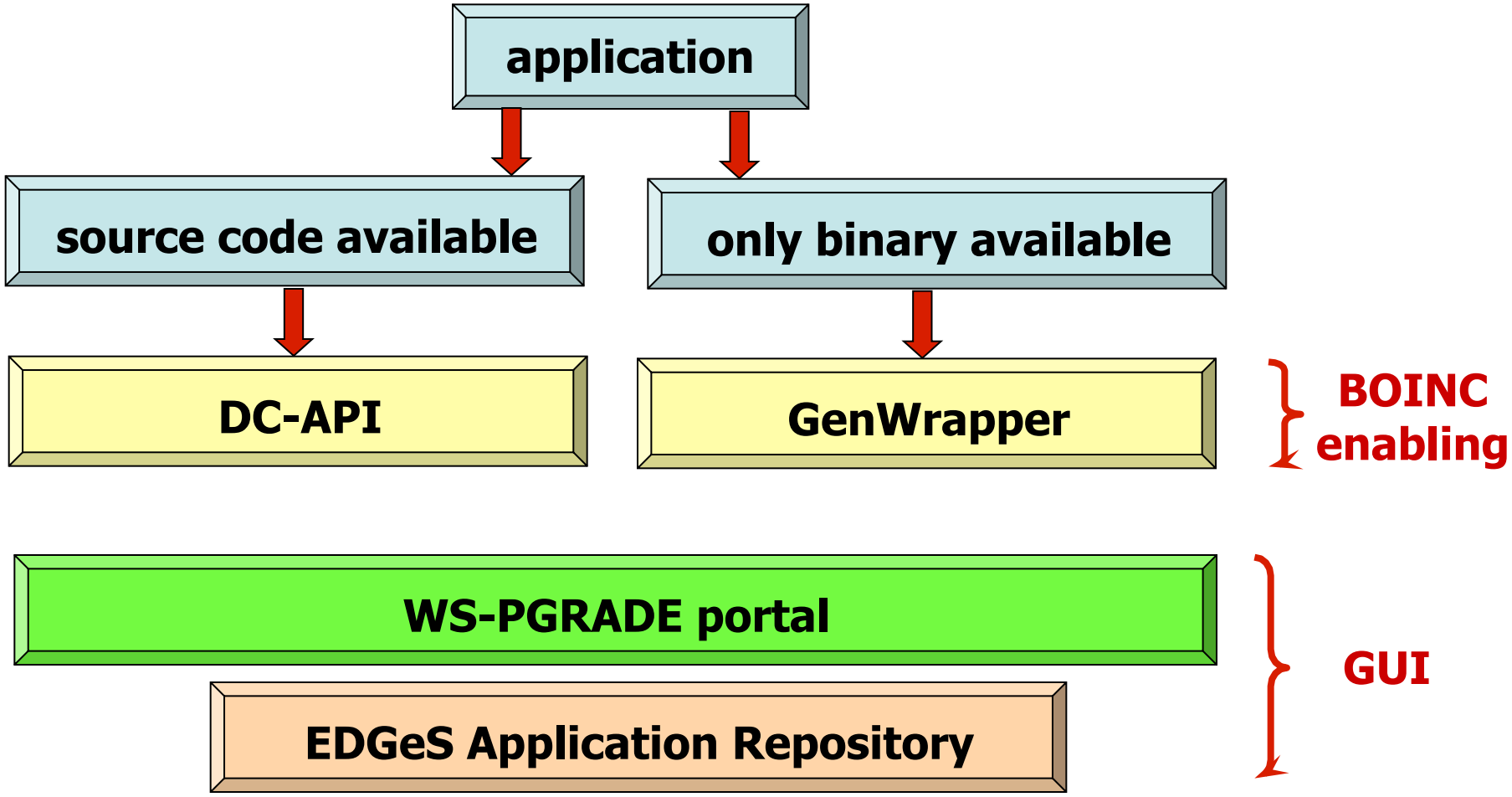
- The BOINC client fetches work units from the server
- The client downloads the inputs and the executables
- The BOINC client starts the worker application
- The worker application runs
- The client uploads the results

Needs implementation

Done by the user

Done automatically

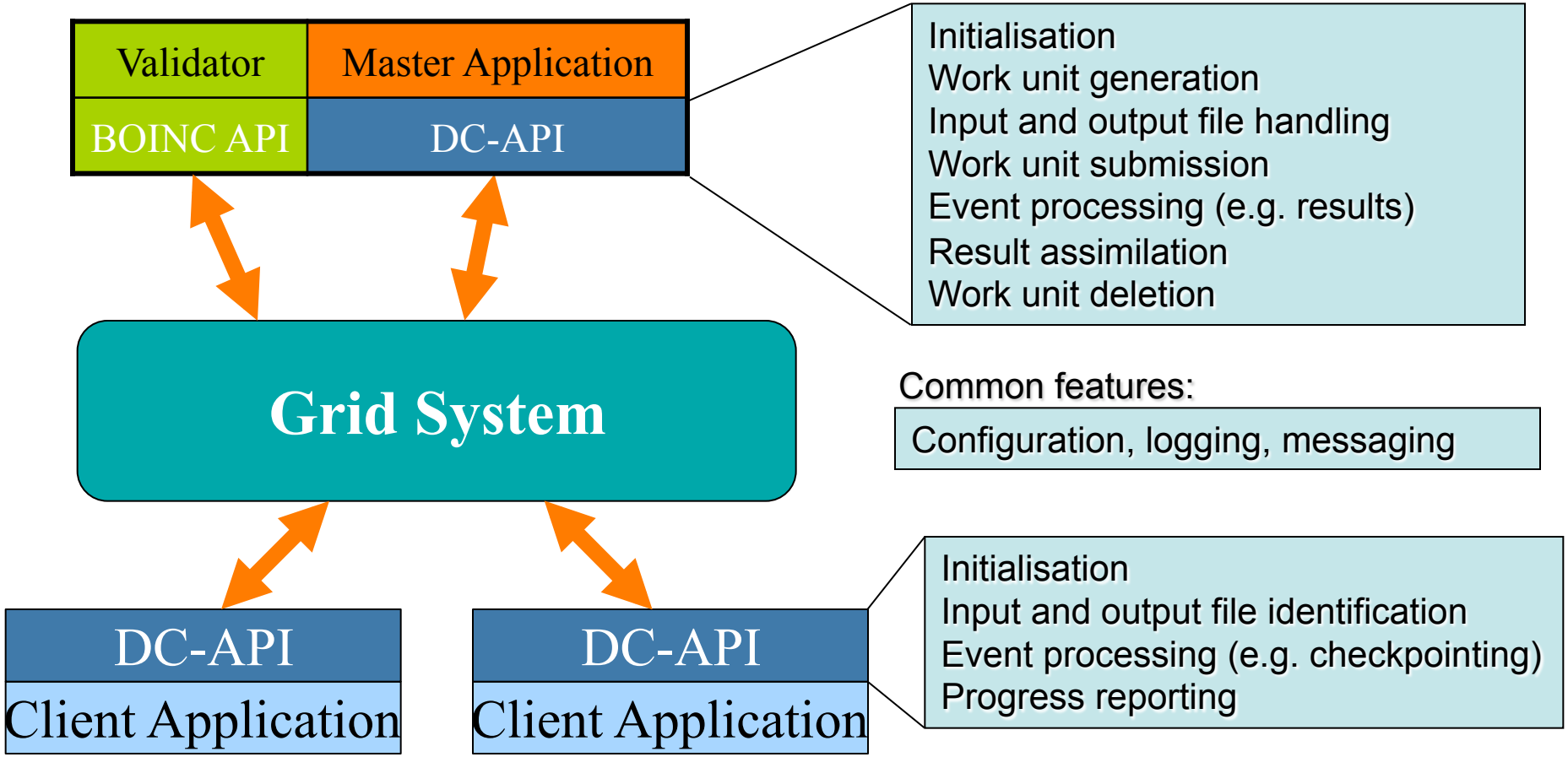
Developing a DG application



Application porting with DC-API

- **D**istributed **C**omputing **A**pplication **P**rogramming **I**nterface
- Allows **easy** implementation and deployment of distributed applications on **multiple Grid** environments
  - Back-end currently available for: BOINC, Condor, XtremWeb
  - Simplifies the development process when compared to native (e.g. BOINC, XtremWeb) APIs
  - Application can run on other Grid middleware without any modification
- **Features, properties of a DC-API application:**
  - Master-worker concept
  - Work units are sequential applications
  - Support for limited messaging between the master and the clients (status, control messages)
  - No direct communication between clients

DC-API Functionality



Develop client application (with DC-API)

- Initialisation of the DC-API
- Identification of input/output files (resolves physical/logical file names)
- Implementation of the concrete computation (one independent subtask)
- Processing incoming events (checkpointing, abort and messaging)
- Saving the state periodically (for client side checkpointing)
- Reporting fraction of the work completed
- Notifying the core client of the completion

Develop master application (with DC-API)

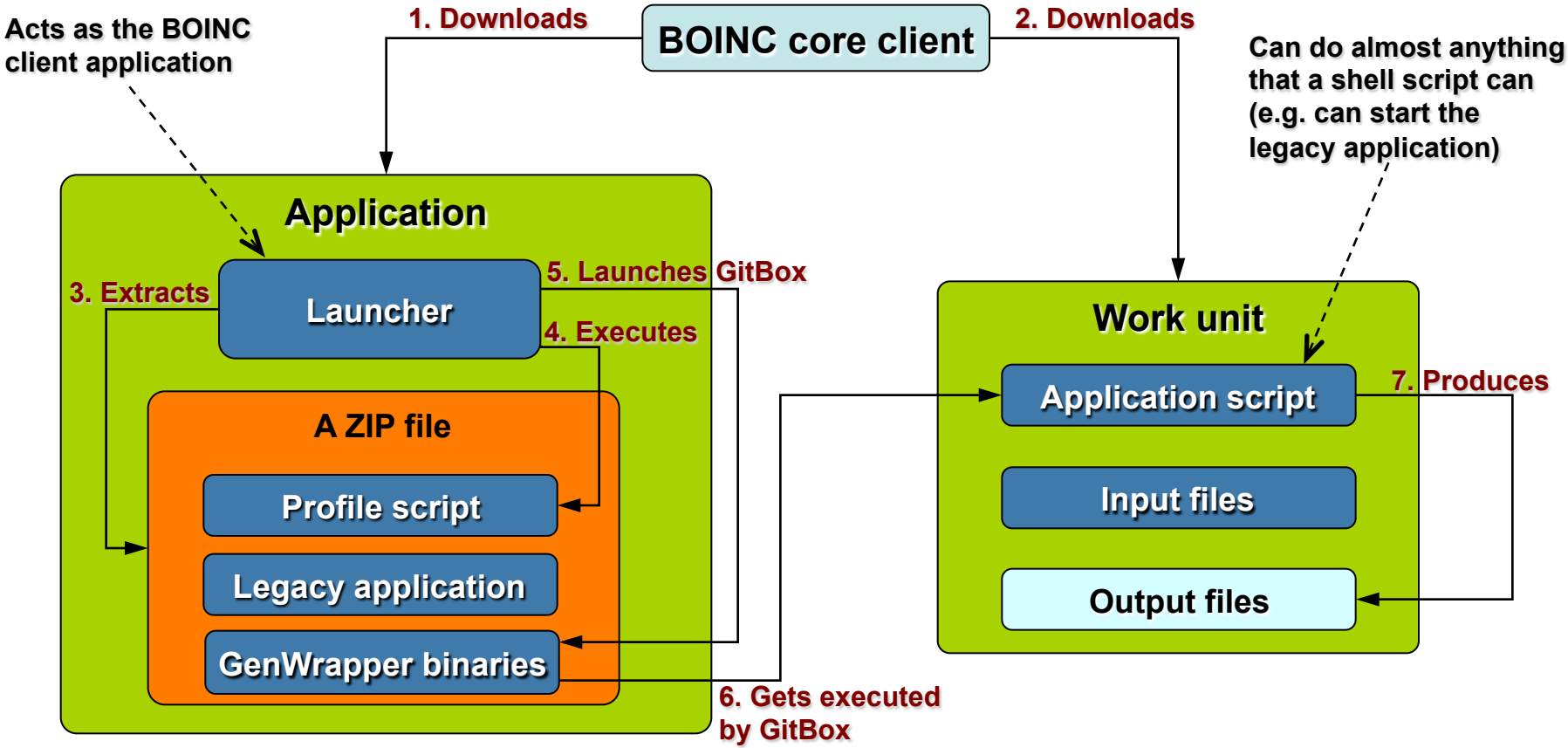
- Initialisation of the DC-API – master configuration
- Setting up callbacks (result, sub-result and message processing)
- Work unit generation and submission
- Processing events (invoke callback functions)
- Processing results (via a call-back function)
- Creating the final result (assimilation) - optional
- *Validation (compares redundant results, grants credits) – not part of DC-API – use BOINC validation framework*

GenWrapper technology

Generic wrapper

- Runs legacy applications without BOINCification
- Makes the BOINC API / DC-API available in POSIX shell scripting
- A shell interpreter is started instead of the real application that executes an application script
- The script
  - realizes BOINCification through script commands
  - may run legacy applications in any way
  - may perform any preparation on input/output files, environment, etc.
  - may do whatever you can do by a script

GenWrapper Structure



High level graphical user interface

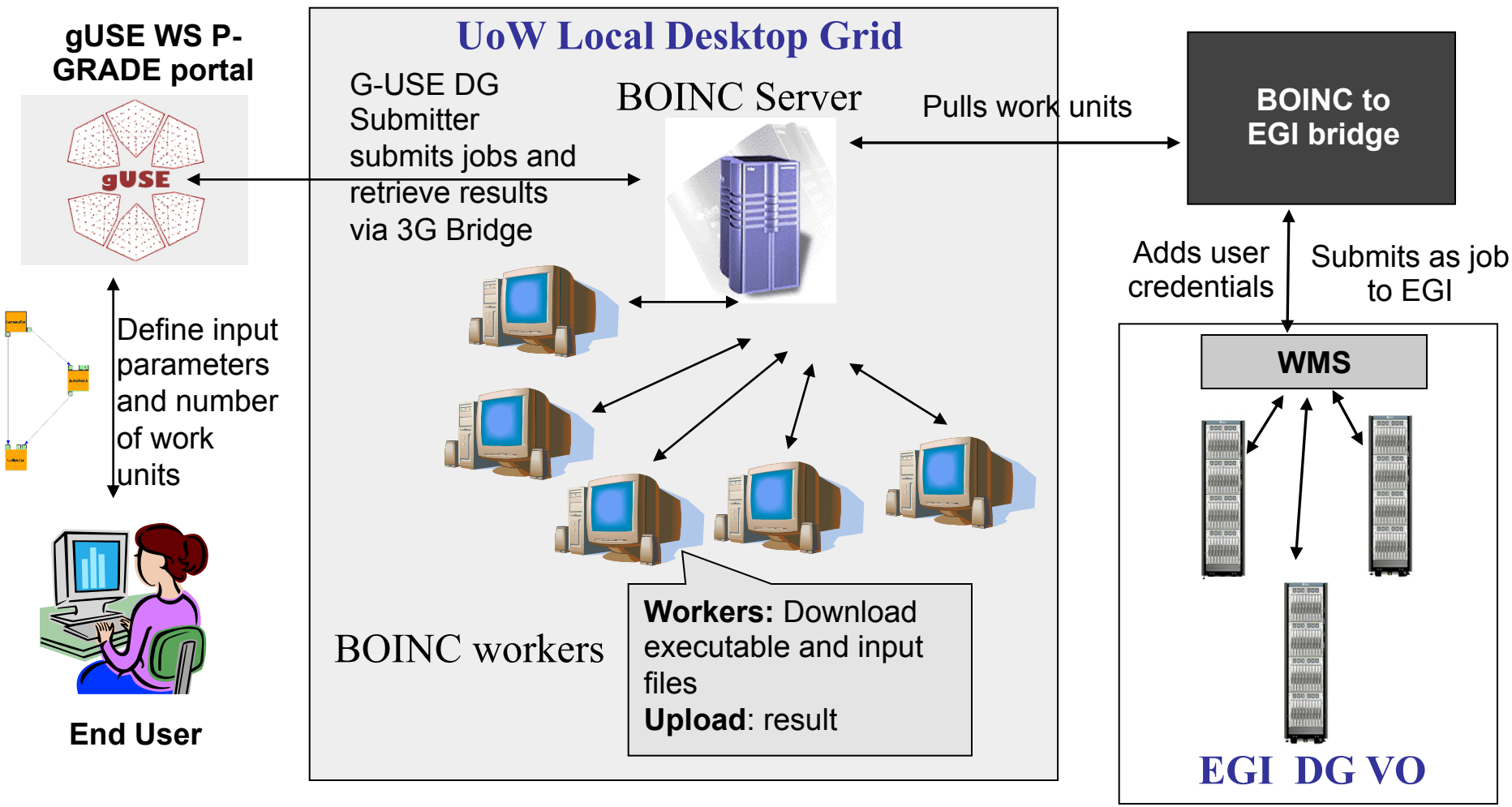
WS-PGRADE portal:

- provides high level GUI to the EDGI/DEGISCO infrastructure
- Can submit workflows to various Grid middleware: g-Lite, GT2, GT4 and BOINC
- supports the transparent exploitation of the EDGI/ DEGISCO infrastructure at application and workflow level

WS-PGRADE scenarios:

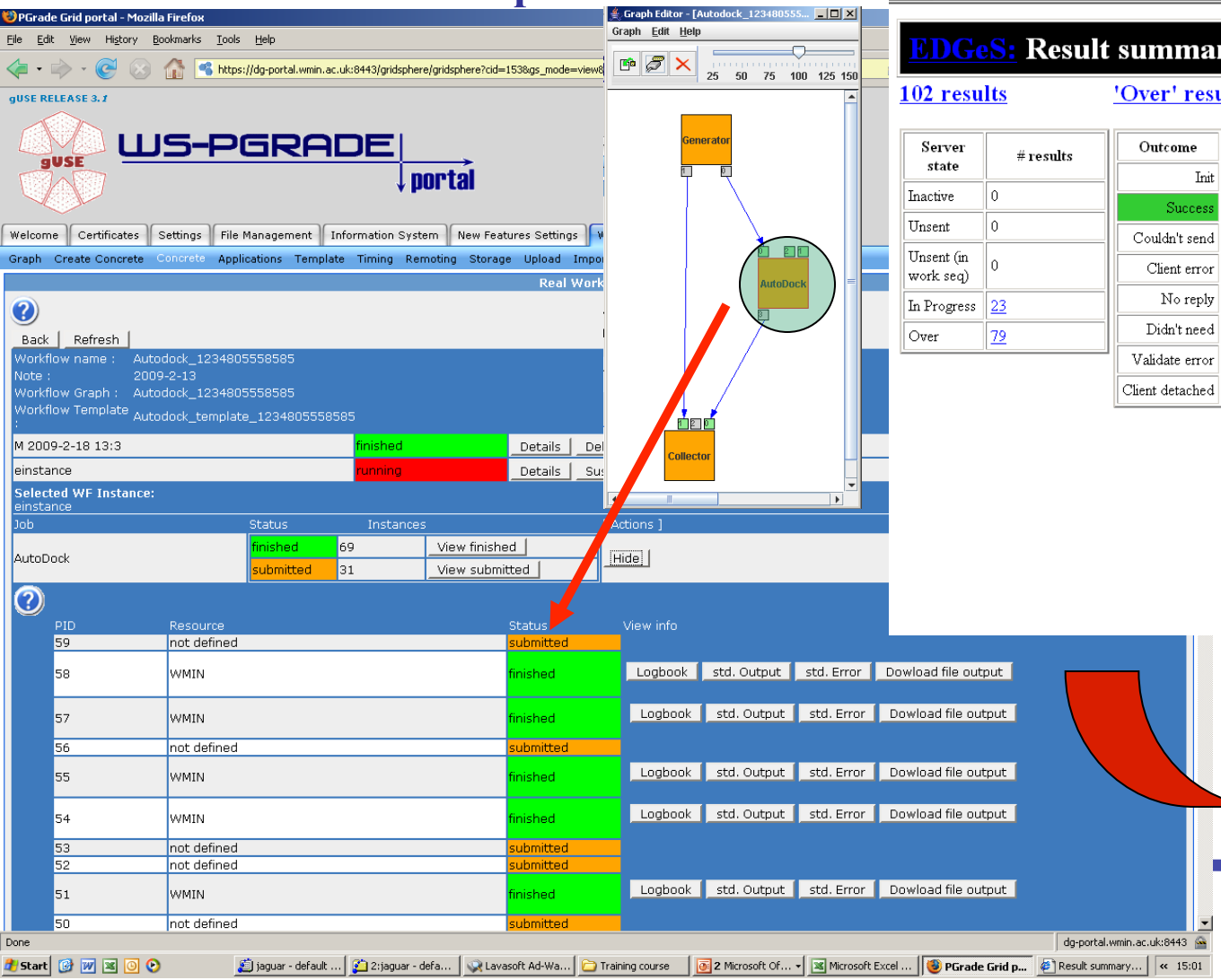
1. Connect to any DG and use the DG to SG bridge
2. Connect to SG (EGI VO) and use the SG to DG bridge to
3. Connect to DGs and EGI VOs at the same time

Scenario 1: Executing workflows on BOINC DGs and through the DG->SG Bridge



Scenario 1: Executing workflows on BOINC DGs and through the DG->SG Bridge

WS-PGRADE portal



UoW Local DG

Address http://dg-server.wmin.ac.uk/EDGeS/ops/result_summary.php?appid=2&nsecs=86400

EDGeS: Result summary

102 results | 'Over' results | 'Success' results | 'Client error' results

Server state	# results
Inactive	0
Unsent	0
Unsent (in work seq)	0
In Progress	23
Over	79

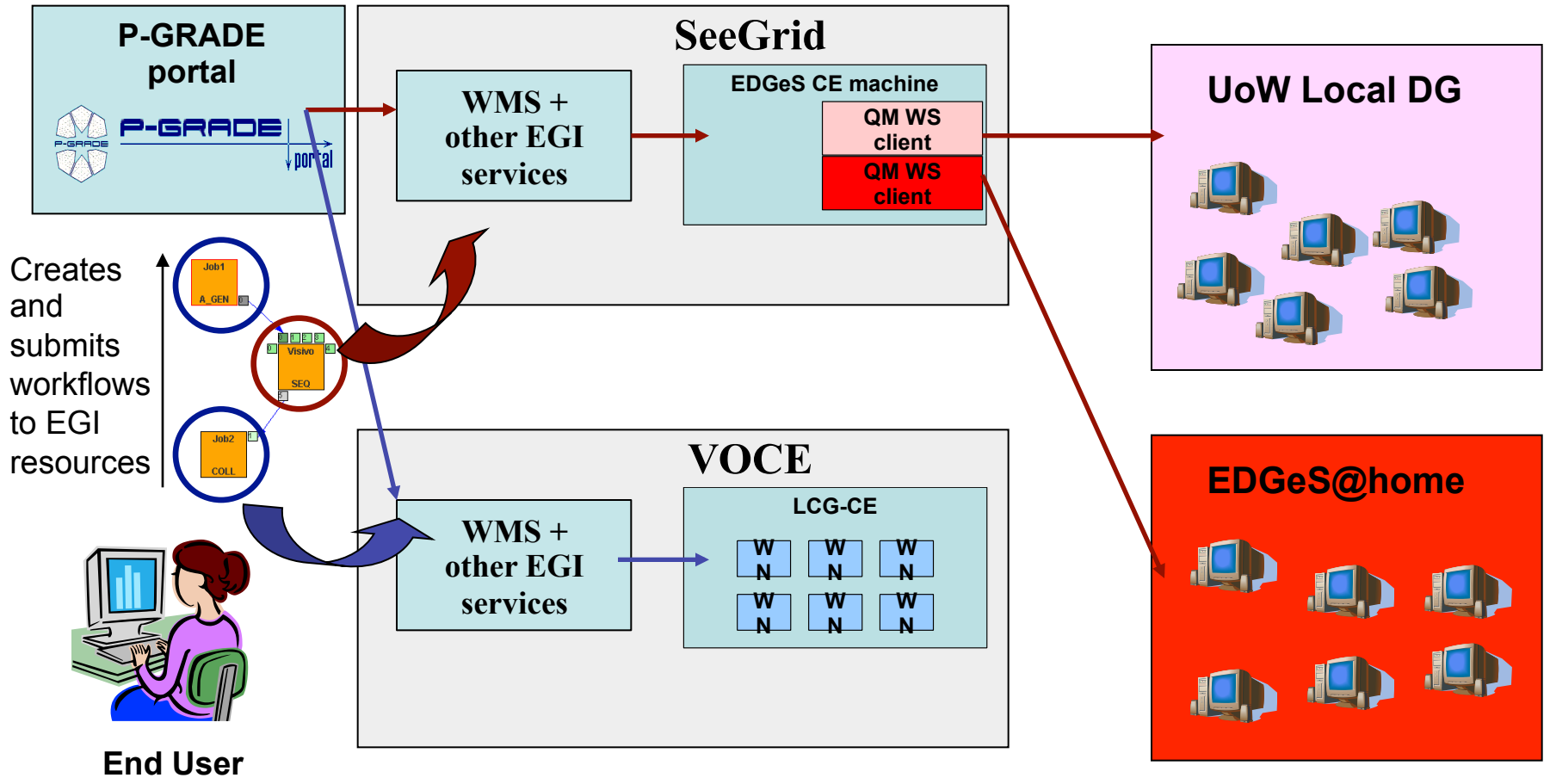
Outcome	# results
Init	0
Success	79
Couldn't send	0
Client error	0
No reply	0
Didn't need	0
Validate error	0
Client detached	0

Validate state	# results
Initial	2
Valid	77
Invalid	0
Skipped	0
Inconclusive	0
Too late	0

File Delete state	# results
Initial	2
Ready to delete	0
Deleted	77
Delete Error	0
Total files deleted	77

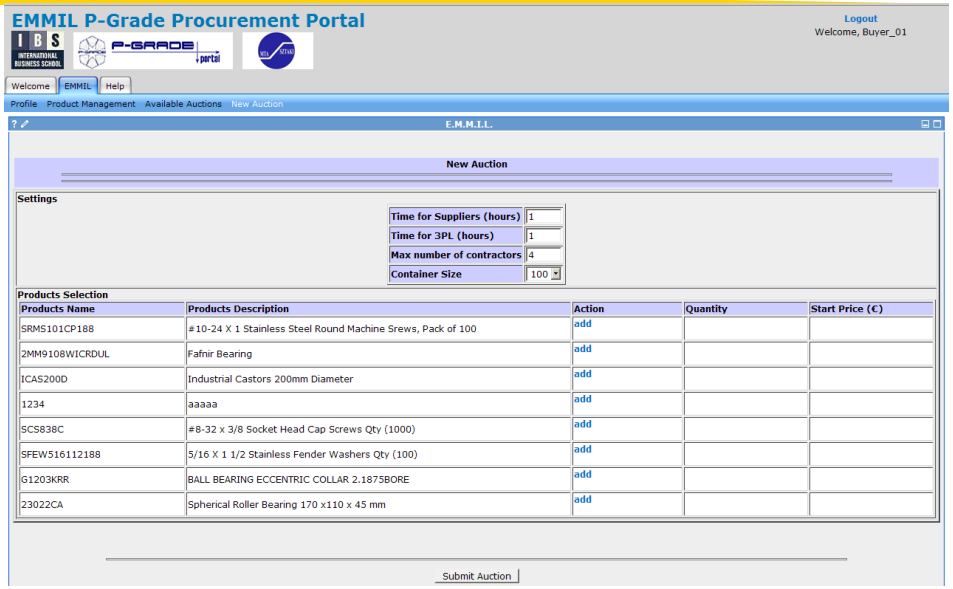
Client state	# results
Downloading	0
Downloaded	0
Compute error	0
Uploading	0
Uploaded	0
Aborted	0

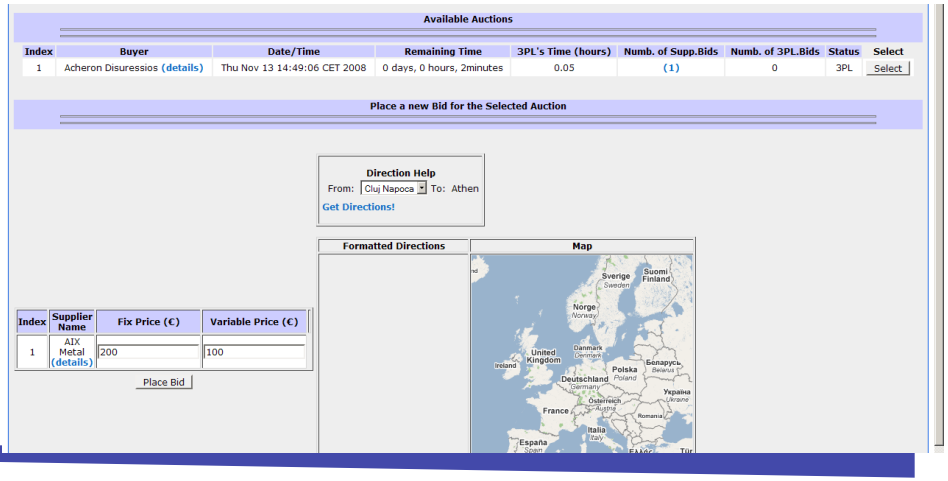
Scenario 2: Executing workflows through the SG->DG Bridge from P-GRADE portal



Scenario 2 example - EMMIL – E-Marketplace Model Integrated with Logistics

- three sided negotiation between buyers, sellers and third party logistics providers
- Aims to optimise the total coast
- Ported to EGEE as a parameter sweep application in the SEE Grid project
- Large matrix solving – matrix can be separated and solution parallelised
- Ported to EDGeS using GenWrapper





Supporting application developers and end-users
The Application Support Service

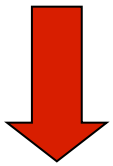
- **Aims and objectives:**
  - facilitate the porting of applications to the combined SG/DG infrastructure by targeting
    - user communities already associated with EGI or DGs
    - new user communities
- **Activities:**
  - develop a generic methodology for application porting
  - identify user communities that require the power of the SG/DG infrastructure
  - provide a service in order to aid the migration to and running of applications on the SG/DG infrastructure
    - **European users:** EDGI Application Support Service / IDGF European Chapter
    - **Non-European users:** DEGISCO Application Support Service / IDGF International Chapter

EADM
EDGeS Application Development Methodology

- **Aims and objectives:**
  - develop a generic methodology that addresses the problem of application porting and defines how the recommended software tools, developed by EDGeS, can aid this process.
- **EADM – an iterative approach**
  - EADM identifies well defined stages that have a suggested logical order. However, the overall process in most cases is non-linear allowing revisiting and revising the results of previous phases at any point.

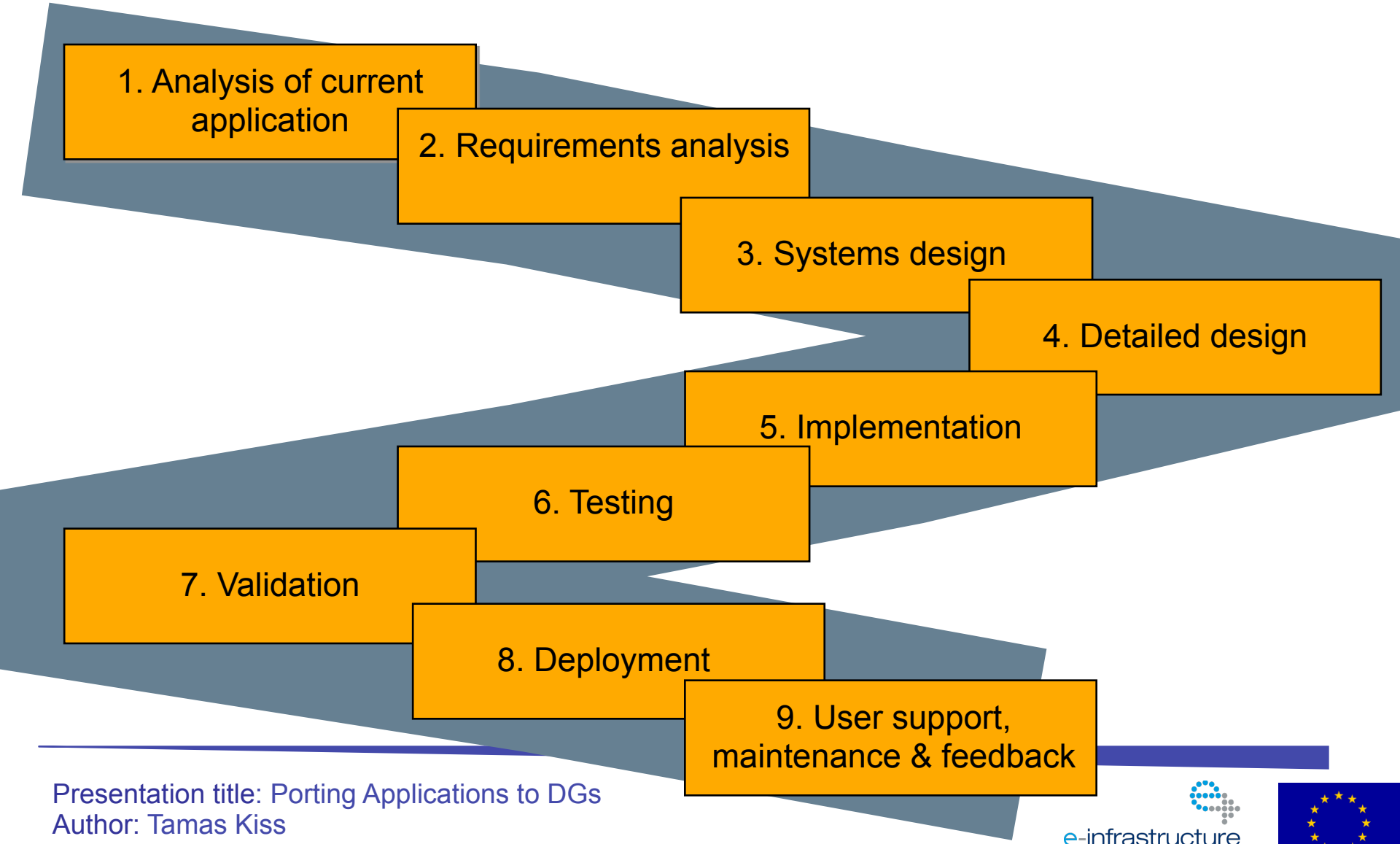
Why do we need a methodology? Motivations

- Grid application development is very often ad-hoc
  - Developers do not follow any methodology
  - Poorly documented systems
  - User expectations not fulfilled
- Systems design and development methodologies are too generic
  - Special focus is required when porting/developing an application to a SG/DG platform



EADM: EDGeS Application Development Methodology

IDGF EADM – EDGeS Application Development Methodology



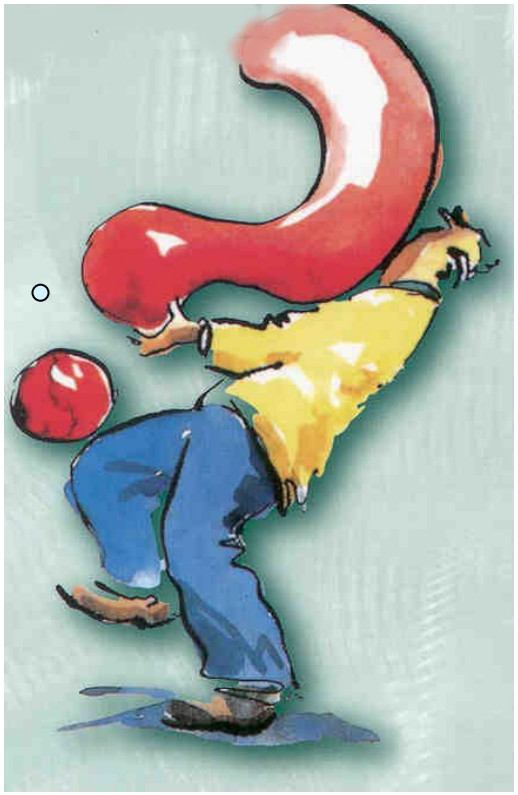
e-infrastructure

SG/DG Applications on Production infrastructure (ported by EDGeS and DEGISCO)

community	number of applications	academic	industry
Bioscience	9	8	1
Healthcare	2	1	1
Physics	8	8	
Audio and video processing	4	3	1
Business	2	2	
Applied mathematics	2	2	
Engineering	4	4	
Total	**31**	**28**	**3**

Thank you for your attention …

Any questions?



Please contact us if you need support in porting your application!

Email: kisst@wmin.ac.uk

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http://desktopgridfederation.eu