The Java CoG Kit

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Updated slides will be available on the CoG Kit web site
Funding sources & Acknowledgement

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  - DOE MICS
  - NSF NMI
- Previous versions of the CoG Kit also received funding from
  - NCSA Alliance
- Please, contact gregor@mcs.anl.gov in case you like to work with us more closely.
- Acknowledgement:
  - CoG Team, Globus Team, Globus Alliance, many others as listed on www.cogkit.org
Community

- Call on the community to help us with extending and improving the CoG Kit
Outline

- **What is the CoG Kit?**
  - Basic definitions
  - History of the CoG Kit
  - CoG Kit in action
  - Relationship to GT versions

- **Selected Project Components**
  - Design: Abstractions
  - Programming with Abstractions (Task Graphs)
  - Visual components: Portals & Applications

- **Conclusion**
Introduction
Observation

● **Problem**
  ◆ Many application developers desire to program the Grid in familiar higher level frameworks that allow rapid prototyping.

● **Solution**
  ◆ We propose to reuse a variety of commodity tools, protocols, approaches, methodologies, while integrating Grid software based on the Globus Toolkit
    ● Easier development of advanced Grid services
    ● Easier and more rapid application development
    ● Easier deployment of Grid services
    ● Code reuse and use of component repositories
    ● Use of Web services as part of the Grids
    ● Widespread use of the Grid
    ● Use of commodity technology is not limited to the client!
Abstractions

- **Hypothesis:**
  - With rapidly changing technologies it may be beneficial to have an abstraction that can be assisting in this technical challenge.

- **Solution:**
  - CoG Kit abstractions are defined for precisely that reason.
Result: CoG Kits

- CoG Kits make Grid programming simple and new technologies are easy to integrate
- We focus on a CoG Kit for Java
  - Others are possible Python, ...
  - Availability: Java CoG Kit since 1997
- Our designs are based on experience reaching back to the beginnings of Meta-computing and Grid-computing
Relationship towards GT

- Since GT3 CoG Kit is an essential part of GT
- CoG Kit protects from an evolving standard
- CoG Kit provides simple programming model
- CoG Kit supports portal and GUI developers
- CoG Kit is a bridge between application and Grid middleware developers.
- CoG Kit has known to be working with
  - GT1.0, GT2.4, GT3.0.2, GT3.2, GT3.21, SSH
  - (under dev.) GT3.9.x, GT4, Condor
  - (community) Unicore
Relationship to WS-RF

- Because ...
  - (Quote: Steve Tuecke, at a GGF meeting): “WS-RF is still under development. The OASIS standards process has just begun.”

- COG Kit
  - Provides investment protection while standards are developed.
  - Provides a more sophisticated programming model than just services
  - Focus on what many high end-users need
  - You can influence the direction of the CoG Kit by partnering with us
  - Will work with future versions of GT, SSH, Condor (planned), ...
  - We intend to support and integrate with upcoming new standards
History
<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>Term Metacomputer is introduced</td>
</tr>
<tr>
<td>1994</td>
<td>von Laszowski: <strong>Graphical Meta-computing environment</strong></td>
</tr>
<tr>
<td>1995</td>
<td>I-Way</td>
</tr>
<tr>
<td>Nov. 1996</td>
<td>von Laszewski joins Argonne</td>
</tr>
<tr>
<td>1997</td>
<td>Globus version 1 / <strong>first release of jglobus based on concepts of protocols and services includes a high throughput fault tolerant workflow prototype</strong></td>
</tr>
<tr>
<td>1998</td>
<td>CoG Team: LDAP browser wins Novel developers award</td>
</tr>
<tr>
<td>1998</td>
<td>Term Grid is introduced</td>
</tr>
<tr>
<td>1999</td>
<td><strong>Term Java CoG Kit is introduced to include jglobus and other components in a single toolkit</strong></td>
</tr>
<tr>
<td>2000</td>
<td>CoG Team: The experimental personal gatekeeper of the Java CoG Kit was been able to be installed in less than 30 seconds on a PC including Windows, a similar Globus service installed by an experienced administrator required one to multiple days.</td>
</tr>
<tr>
<td>2001</td>
<td>Cog Team: The Java CoG Kit experimental Infogram Service architecture was defined combining execution and information Services as a single Grid service.</td>
</tr>
<tr>
<td>2001</td>
<td>CoG Kit was selected by IBM to demonstrate Grid computing in Boards of Directors meeting</td>
</tr>
<tr>
<td>2002</td>
<td>Globus Team defines OGSI / <strong>Java CoG Kit for GT2.x and GT3.0/OGSI based, includes visual components such as the CoG Kit Desktop, GridFTP interface, GRAM interface</strong></td>
</tr>
</tbody>
</table>
## History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>WSRF is defined</td>
</tr>
<tr>
<td>2002 and 2003</td>
<td>CoG team rewrites the workflow component and introduces GridAnt and a new workflow engine called Karajan that contains flow and structural control (DAGs, conditions, loops). The workflow concept is expandable. Check pointing and minimal features for fault tolerance are available. Result caching is possible based on method signatures.</td>
</tr>
<tr>
<td>2004</td>
<td>CoG team introduces the concept of Grid providers making it possible that the CoG Kit can in principal submit to GT2, GT3, GT4, or SSH. Community demonstrates also UNICORE provider.</td>
</tr>
<tr>
<td>2004</td>
<td>A class project shows it is possible to define PBS and LSF providers (not distributed with the CoG Kit)</td>
</tr>
<tr>
<td>2004</td>
<td>CoG Kit receives best research poster award at SC 2004</td>
</tr>
</tbody>
</table>
| 2005 | Major new Java CoG Kit release.  
* GT2, GT3, GT4, SSH providers  
* Workflow  
* Graphical components  
* New manual |
Design

- Based on layered model
- Flexible
- Expandable
- Based on Java interfaces
- Abstracts protocols
- Abstracts services
- Provides workflow
CoG Kit is more than jglobus

Java CoG Kit v4

Documentation

Source

Community

Web Page

Wiki

Static pages

Manual

jglobus

abstractions (core)

gridfaces

Swing

portlets

Task management

CoG Workflow/gridant

CoGtop / GridDesktop

CoGShell / Grid Shell

Certificate Authority

Unicore provider

Gssh/term

Cert management

Matlab

Essential part of
GT3.02
GT3.2, GT3.2.1
GT3.9.x, GT4.0
CoG Abstraction Layers

- CoG Abstraction Layer
- CoG Data and Task Management Layer
- CoG Gridfaces Layer
- Applications
- Nano materials
- Bio-Informatics
- Disaster Management
- Portals

Development Support

CoG GridIDE

CoG GT2
- GT3 OGSi classic
- GT4 WS-RF
- Condor
- Unicore
- SSH
- Others
- Avaki
- SETI

Nano materials
Bio-Informatics
Disaster Management
Portals

Applications
Selected Project Components
Focus on Reusable APIs & Components

- **Abstractions**
  - Provide a simple programming model
- **Workflow**
  - Workflow abstraction
- **Portals**
  - Supporting APIs, abstractions and implementations for portals.
- **jglobus1.2**
  - GSI security in Java
  - GRAM protocol & client
  - gridFTP protocol & client
  - Myproxy client
- Not just API’s but also their implementation
Focus on Abstractions and Patterns

- Abstraction above Grid Toolkits
  - Task Model
    - Jobs, information query, file transfer, authentication, others
  - Gridfaces model
    - Abstract views of GUIs to the Grid in different implementations (SWING, JSP, Portlets, ...)
  - Data Types
    - Queues, Sets, Brokers, Schedulers. Based on Task model
Java CoG Kit abstractions

- A programming model based on a **task model** that simplifies elementary Grid patterns such as job execution, file transfer, and file operations.
- A programming model that includes **execution flows** in the form of directed acyclic graphs (DAG).
- The programming model is **decoupling the definition from the implementation**, thus providing independence from current and future Grid versions.
- Only elementary Grid patterns are considered.
- It makes programming the Grid simple
- It makes developing Grid portals more easy
- Focus is selected functionality
Design

- ExecutableObject
- Task
- TaskGraph
- Handlers
- Events
- Service
Design

ExecutableObject

SecurityContext

Identity

Status

Service

ServiceContact

Specification

JobSpecification

FileTransferSpecification

FileOperationSpecification

Task

TaskGraph

Dependency

Set

Queue

TaskHandler

TaskGraphHandler
Programming with Abstractions
A simple Programming Pattern

```java
public class COG implements StatusListener{
    public void create() { ... }
    public void submit() { ... }
    public void statusChanged(StatusEvent e) { ... }
    public static void main(String[] arg[]){
        try {
            COG cog = new COG();
            cog.create();
            cog.submit();
            catch (Exception e) {
                logger.error("Something went wrong:", e);
            }
        }
    }
}
```
Executing a Simple TaskGraph

```java
TaskGraph tg = new TaskGraphImpl();

public void create() {
    // define tasks
    ....
    /* Add the tasks to the TaskGraph */
    tg.add(task1);
    tg.add(task2);
    tg.add(task3);
    tg.add(task4);
    tg.addDependency(task1, task2);
    tg.addDependency(task1, task3);
    tg.addDependency(task2, task4);
    tg.addDependency(task3, task4);
}

public void submit() {
    TaskGraphHandler handler = new TaskGraphHandlerImpl();
    try {
        handler.submit(tg);
    } catch (Exception e) {
        logger.error(`Some Error occurred', e);
        System.exit(1);
    }
}
```
Create a task

Task task1 = new Task();

JobSpecification spec = new JobSpecificationImpl();
spec.setExecutable("/bin/ls");
spec.addArguments("-la");
spec.setStdOutput("output.txt");

task1.setSpecification(spec);

// bind the task (late binding)
public void statusChanged (StatusEvent event) {

    Status status = event.getStatus( );
    logger.debug(``Status changed to '' + status.getStatusCode());

    if (status.getStatusCode( ) == Status.COMPLETED) {
        logger.info(``Task Done'');
    }
    elseif (status.getStatusCode( ) == Status.FAILED) {
        logger.info(``Task Failed'');
        System.exit(1);
    }
}

Users can design their own Event handling logic based on status changes.
Using the Handler

try {
    handler.submit (cog);
} catch (InvalidSecurityContextException ise) {
    logger.error(‘`Security Exception‘’, ise);
    System.exit(1);
} catch (TaskSubmissionException tse) {
    logger.error(‘`TaskSubmission Exception‘’, tse);
    System.exit(1);
} catch (IllegalSpecException ispe) {
    logger.error(‘`Specification Exception‘’, ispe);
    System.exit(1);
} catch (InvalidServiceContactException isce){
    logger.error(‘`Service Contact Exception‘’, isce);
    System.exit(1);
}
Bind a Task to a Service

```java
Service service = new ServiceImpl(Service.JOB_SUBMISSION);
service.setProvider("GT3_2_1");

// Set Security Context – e.g. certificates and such
SecurityContext securityContext =
    CoreFactory.newSecurityContext("GT3_2_1");
securityContext.setCredentials(null); // e.g. set it to default in ./globus
service.setSecurityContext(securityContext);

// Set Contact – e.g. where to go to
ServiceContact serviceContact =
    new ServiceContactImpl("http://127.0.0.1:8080/ogsa/services/base/gram/
                           MasterForkManagedJobFactoryService");
service.setServiceContact(serviceContact);

task.setService(Service.JOB_SUBMISSION_SERVICE, service);
```
CoG Kit Desktop

Job Icons

Machine Icons

File Transfer GUI

Native Icons

Grid Shell

Grid Log

Native Icons
Contributing

- You can contribute
- We have a module concept allowing components to be integrated in the distribution easily
Conclusion

- Programming with CoG abstractions is simple
- We envision multiple programming models in CoG
- We envision multiple backend services
- We can support multiple protocols

- We like to engage the community
- Contributions:
  - CA management, Unicore provider, gsissh
  - These contributions are being integrated.