Using UNICORE and WS-BPEL for Scientific Workflow Execution in Grid Environments

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GEFÖRDERT VOM

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BIS-Grid

- „Business Information Systems: Grid-based Integration and Orchestration“
- Project Funded by german Federal Ministry of Education and Research in the context of the German Grid initiative (D-Grid)

- Prove the feasibility of Enterprise Application Integration using Grid technologies
- Provide Grid utilization and (D-)Grid participation for SMEs
- Provide a generic Grid-compatible orchestration solution

- Focus: originally business workflows, but also regards scientific workflows
- Application scenarios: call center, machine construction, flood simulation (new, provided by GDI-Grid)

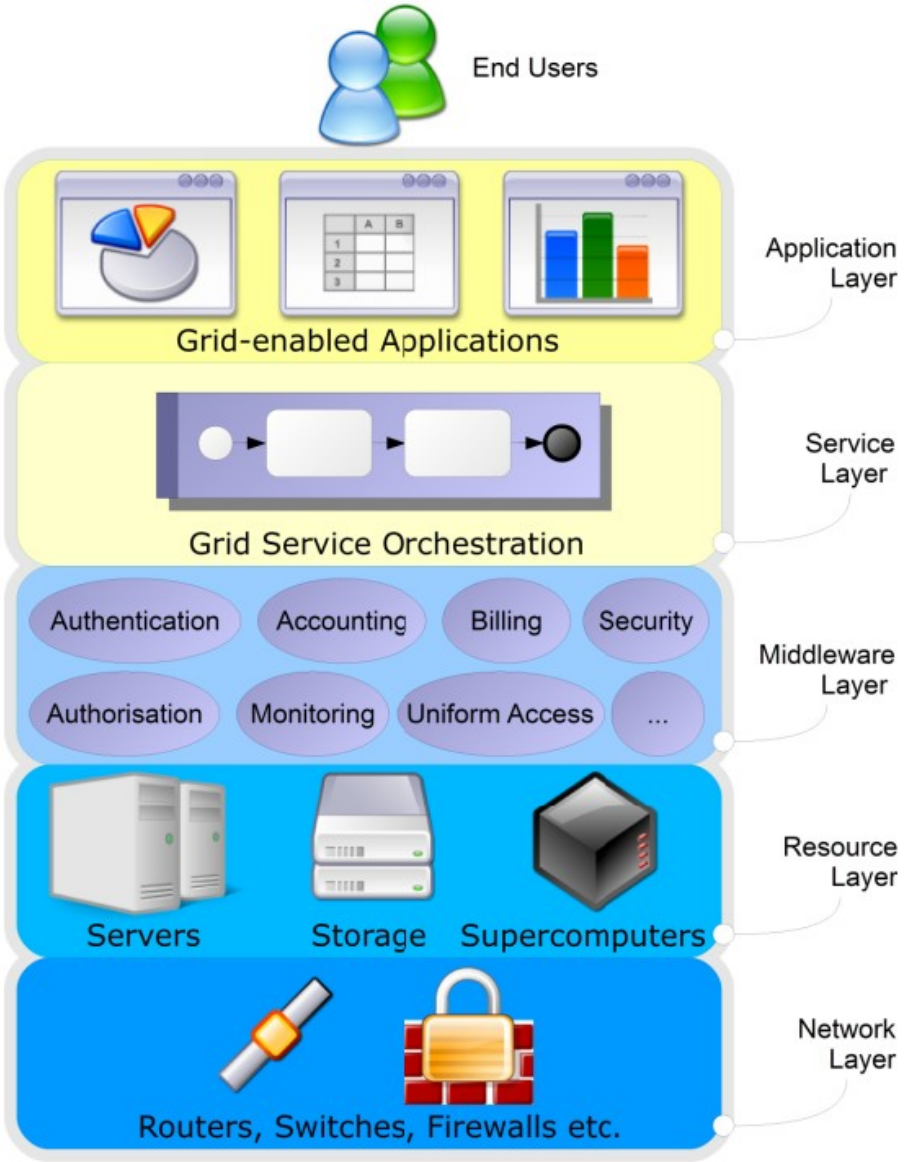
- Trustworthy collaboration and business models for Grid Providing
- Orchestration-as-a-Service (OaaS)
- Utilization of industry standards (e.g., BPMN, WS-BPEL)
- Integration with widespread technologies (e.g., ActiveBPEL)

Overview

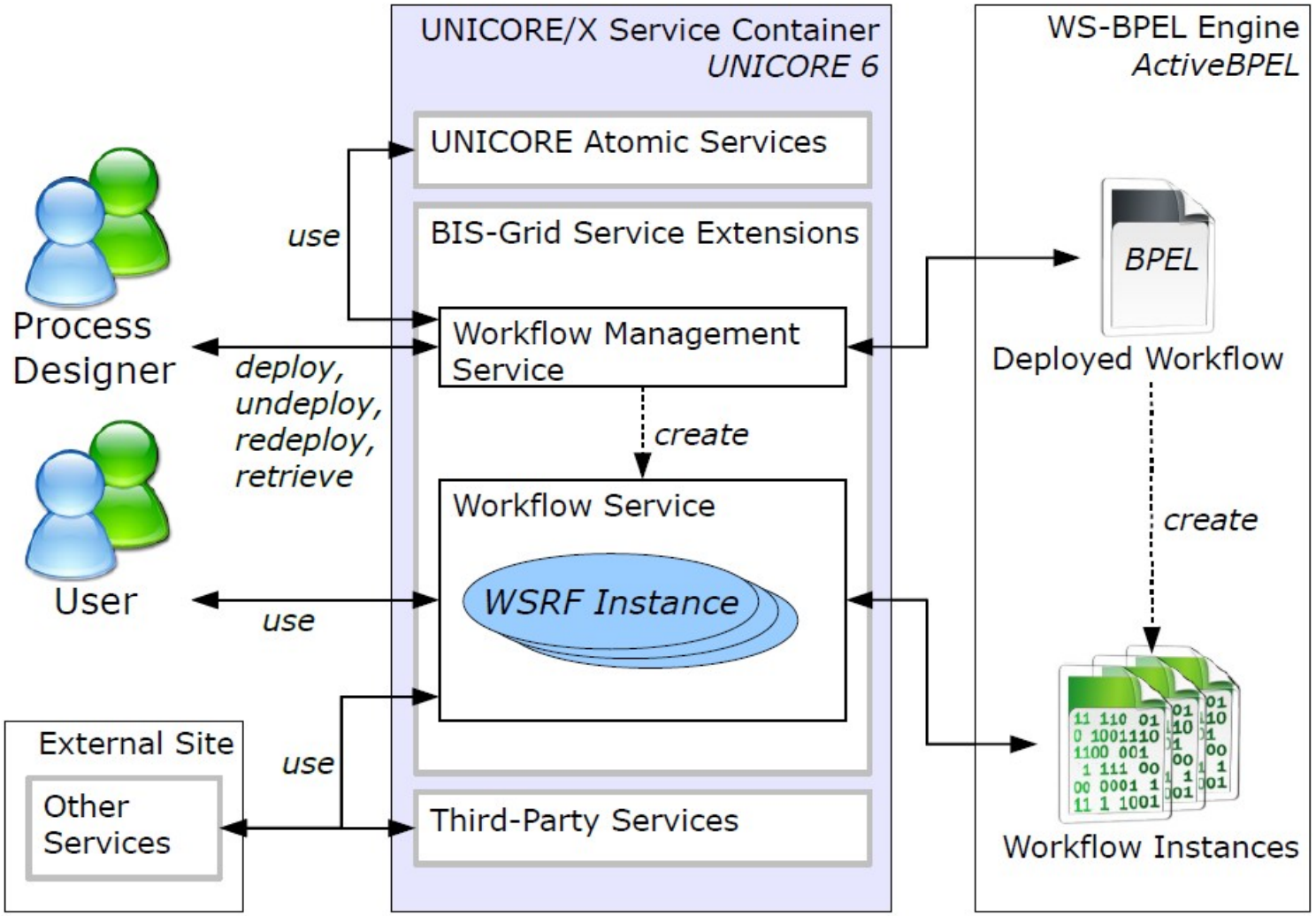
- **Grid Workflow Management**
- **BIS-Grid Engine Architecture**
- **Scientific vs. Business Workflows**
- **WS-BPEL for Scientific Grid Workflows**
- **WS-BPEL Patterns and Job Submission**
- **Future Work**

Grid Workflow Management

- Coordinate multiple job submissions over heterogeneous resources
- Provide high-level abstractions over distributed computations in the form of service orchestration
- Let users concentrate on their (scientific) application
- Abstract from technical non-domain-specific aspects
  - Resource management
  - Job scheduling
  - Details of data transfers



BIS-Grid Engine Architecture



Realized as UNICORE 6 Services, uses an arbitrary WS-BPEL engine (ActiveBPEL), provides workflows as WSRF-Grid services, supports RBAC (SAML, XACML), open source

Scientific and Business Workflows

Business workflows

- Control-driven
- Role-centric (RBAC, elaborate role models)
- Handling of information (small workflow data stored in process variables during workflow execution)
- Service provisioning (guaranteed completion, provided results as advertized)

Scientific workflows

- Data-driven (implicit control flow, activity starts when data available)
- User-centric (rights are often associated to persons directly)
- Handling of voluminous data (also third party transfers)
- Experiment implementation (importance of monitoring and workflow evolution caused by knowledge aquisition)

Similarities

- High-level view on the overall behavior of complex distributed applications
- Abstraction from technical details
- Capture and reuse domain knowledge/expertise
- Automate execution as far as possible

WS-BPEL for Scientific Workflows #1

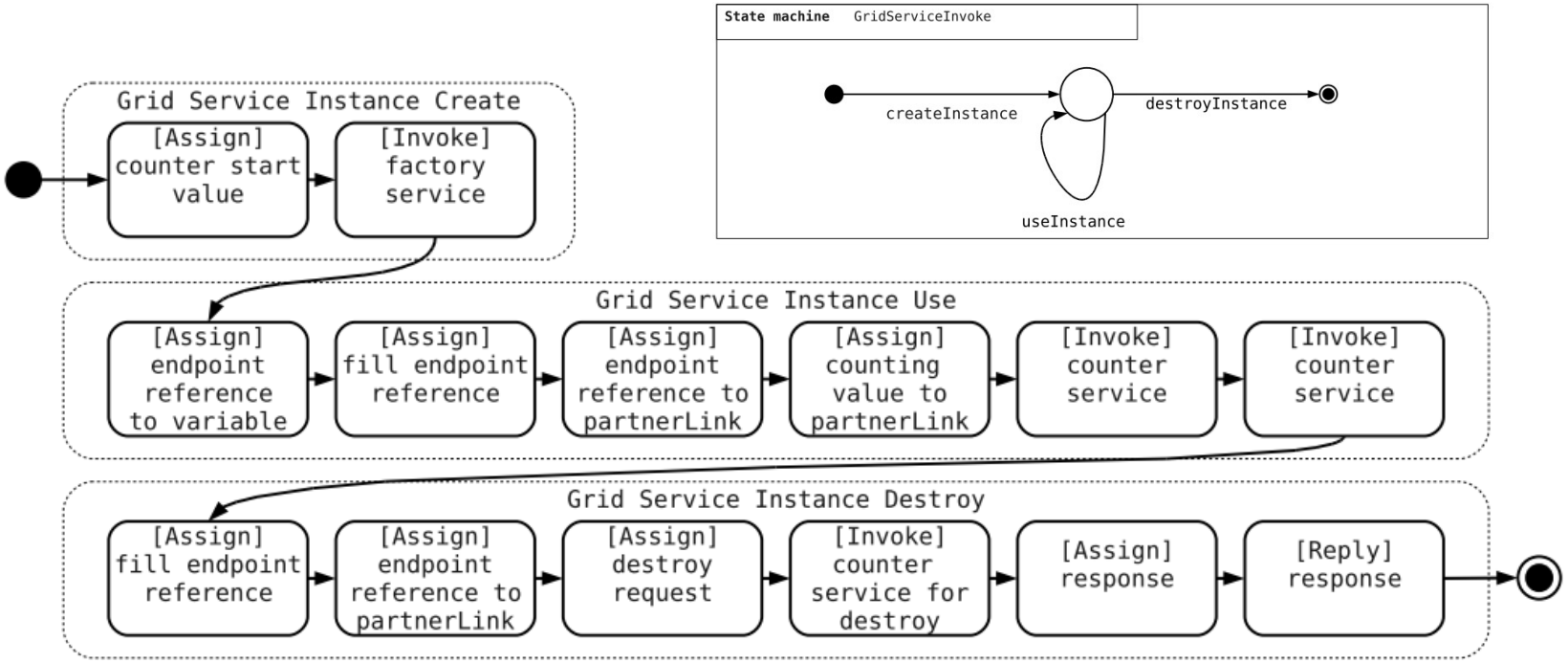
- WS-BPEL provides a single high-level abstraction for complex distributed applications in the form of reusable orchestrations of services (*programming in the large*)
- WS-BPEL descriptions represent and preserve reusable domain knowledge from a service orchestration view
- As a *de facto* industry standard WS-BPEL is well-supported by various tools for modeling and execution, and can also integrate other WS-* standards
  - Netbeans and BPMN for workflow design
  - ActiveBPEL as workflow engine
  - Possibly WS-HumanTask and BPEL4People for human interaction
- WS-BPEL addresses many of the general requirements of scientific workflow execution (next slide)

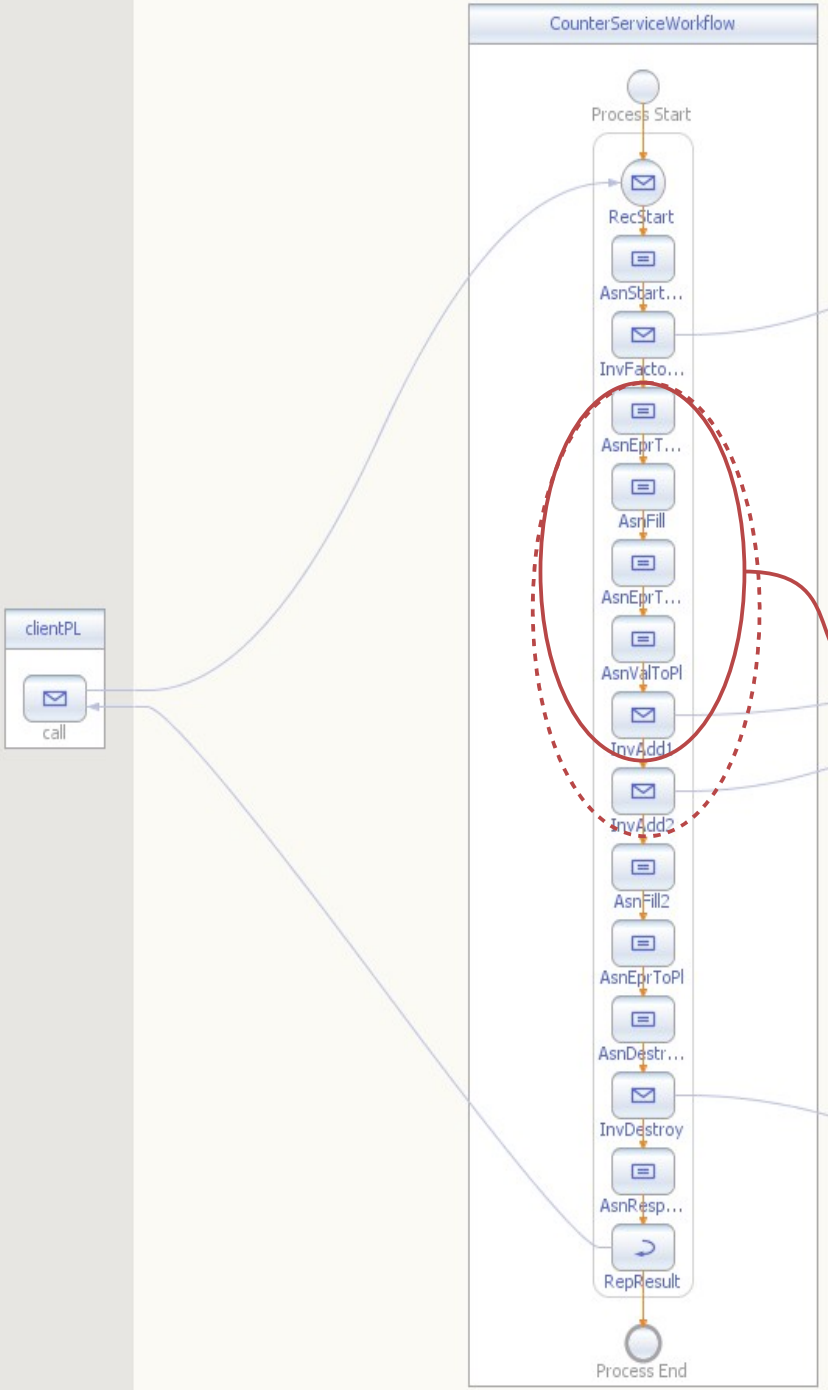
Requirements of Scientific Workflows

- *Modularity and composability* (e.g., to provide sub-workflows as standard activities on a higher level of abstraction) — *WS-BPEL*
- *Monitoring* (e.g., inspection of intermediate results of long-running processes) — *Engine, WS-BPEL Event Handlers*
- *Error handling and fault tolerance at* design-time and run-time (e.g., when sub-experiments fail) — *WS-BPEL (at design-time)*
- *Adaptability* at design-time and run-time (e.g., when the underlying resource infrastructure changes) — *WS-BPEL (at design-time)*
- *Domain-specificity* (e.g., modeling must respect that users of scientific workflows often are also their designers) — *Modeling Tools*
- *Voluminous data transfers* (e.g., large amounts of data should not be passed through the workflow engine in order to transfer it between two sites) — *WS-BPEL + JSDL-compliant Grid Middleware*

WS-BPEL for Scientific Workflows #2

- It is bothersome to write WS-BPEL code without proper modeling support
  - Adequate modeling abstractions needed
- WS-BPEL does not support the use of complex stateful services natively, for example, regarding WSRF-based Grid services
- Grid Services can be orchstrated by standard WS-BPEL, resulting in a complex service invocation pattern to be reused as a simple service in higher-level orchestrations



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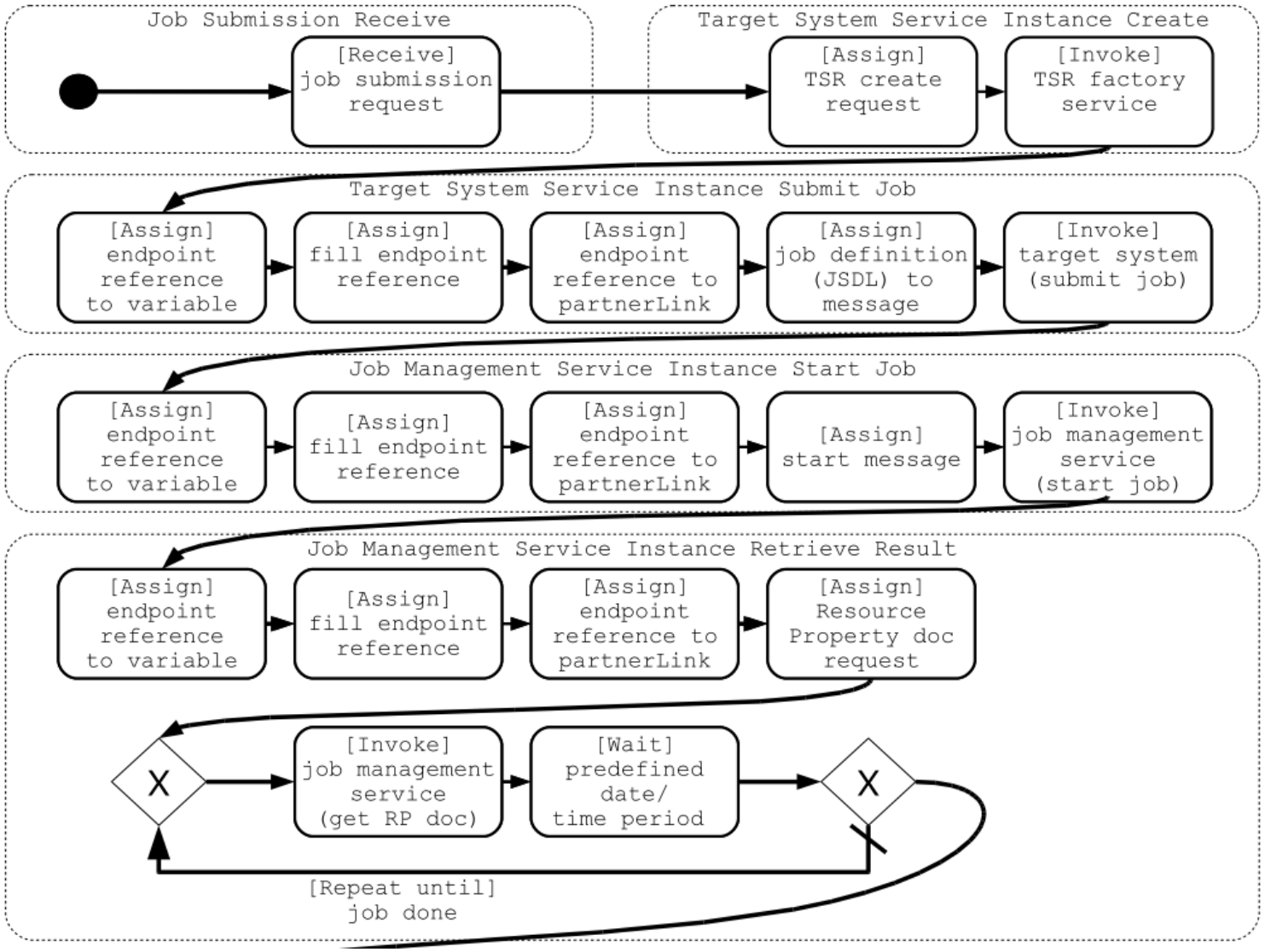
Job Submission



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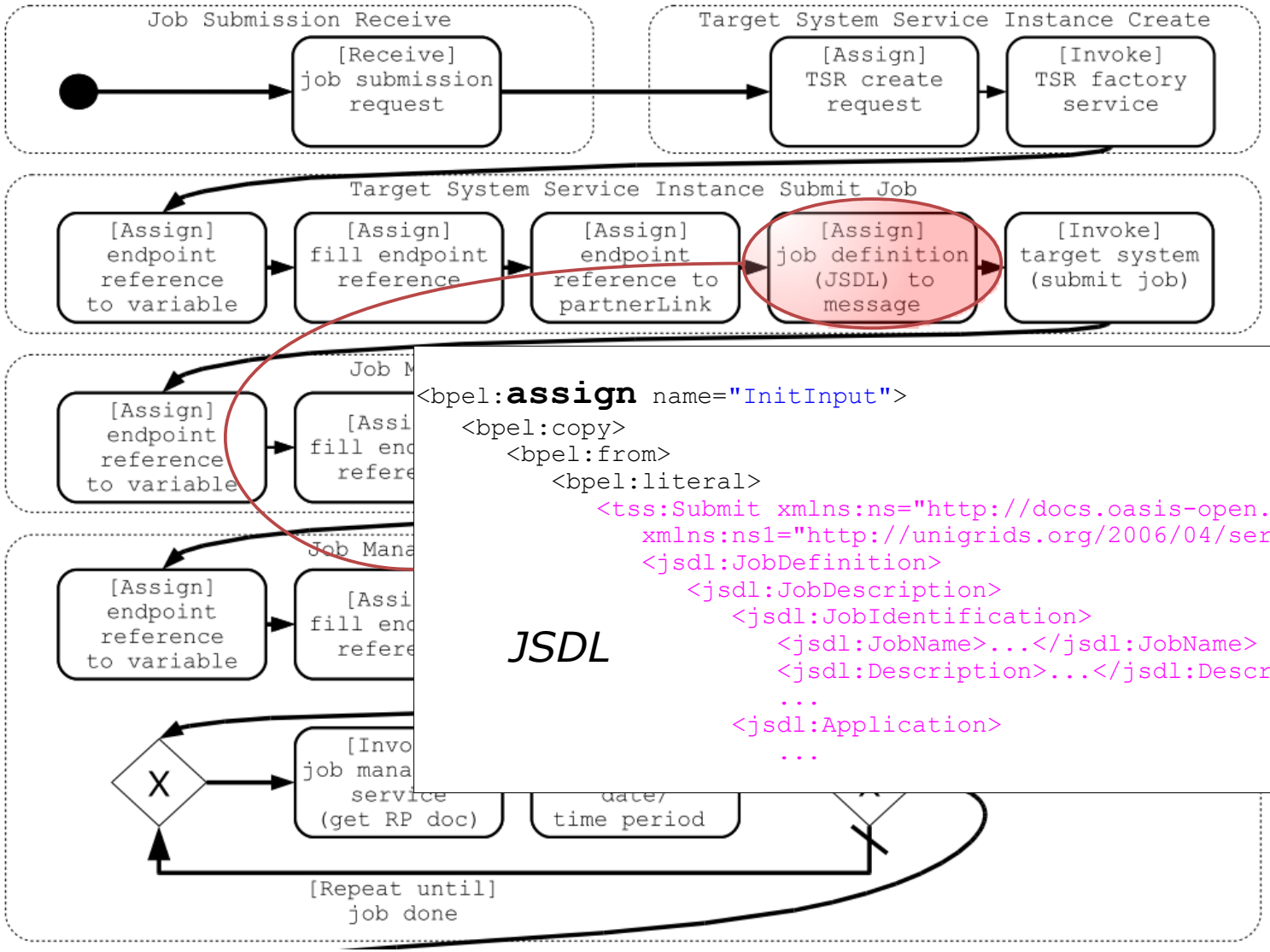
Job Submission

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                        ...
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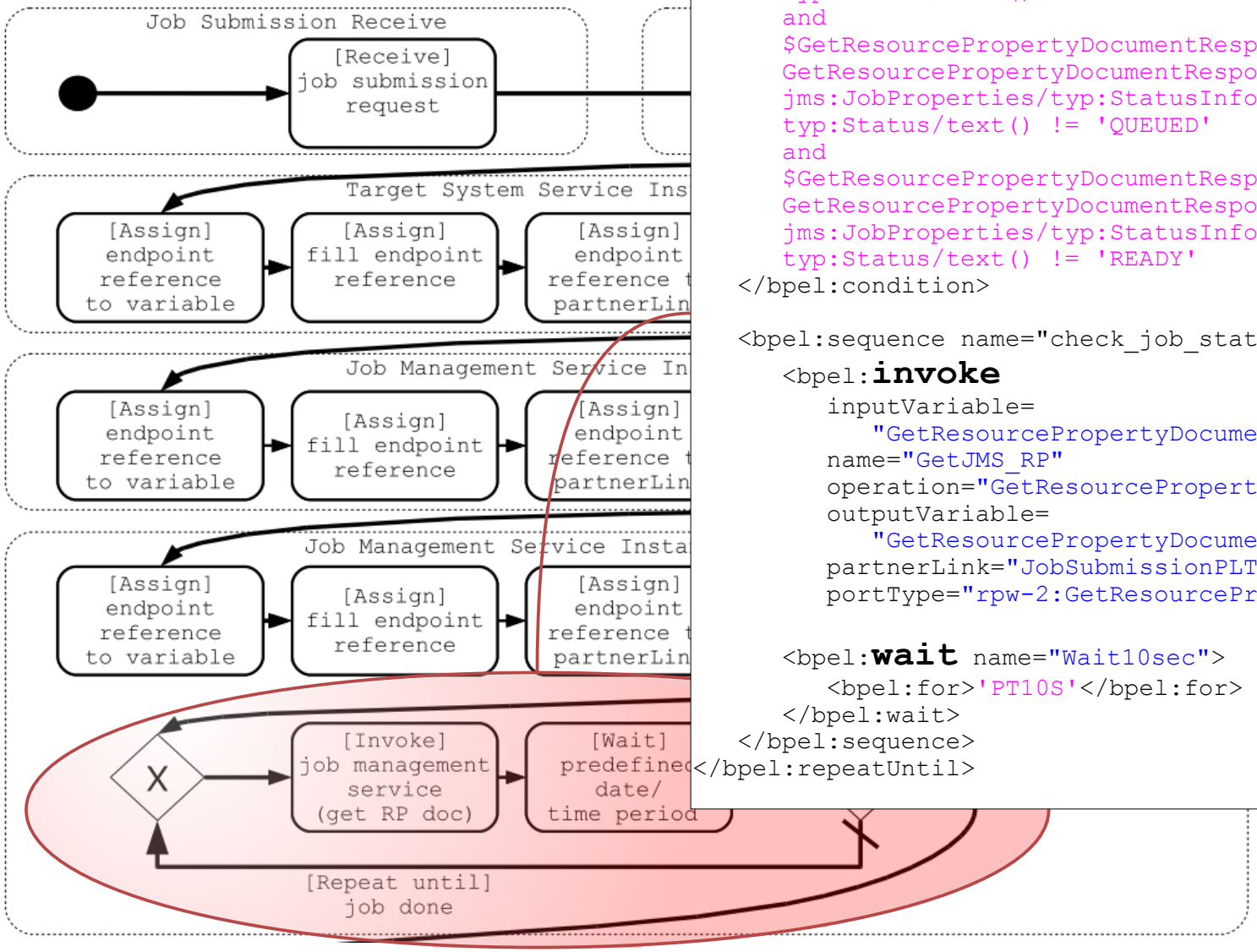
                        ...
```

JSDL

to be cont'd ...

Job Submission

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      and
      $GetResourcePropertyDocumentResponse.
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      jms:JobProperties/typ:StatusInfo/
      typ:Status/text() != 'QUEUED'
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</bpel:repeatUntil>
```

to be cont'd ...

Job Submission

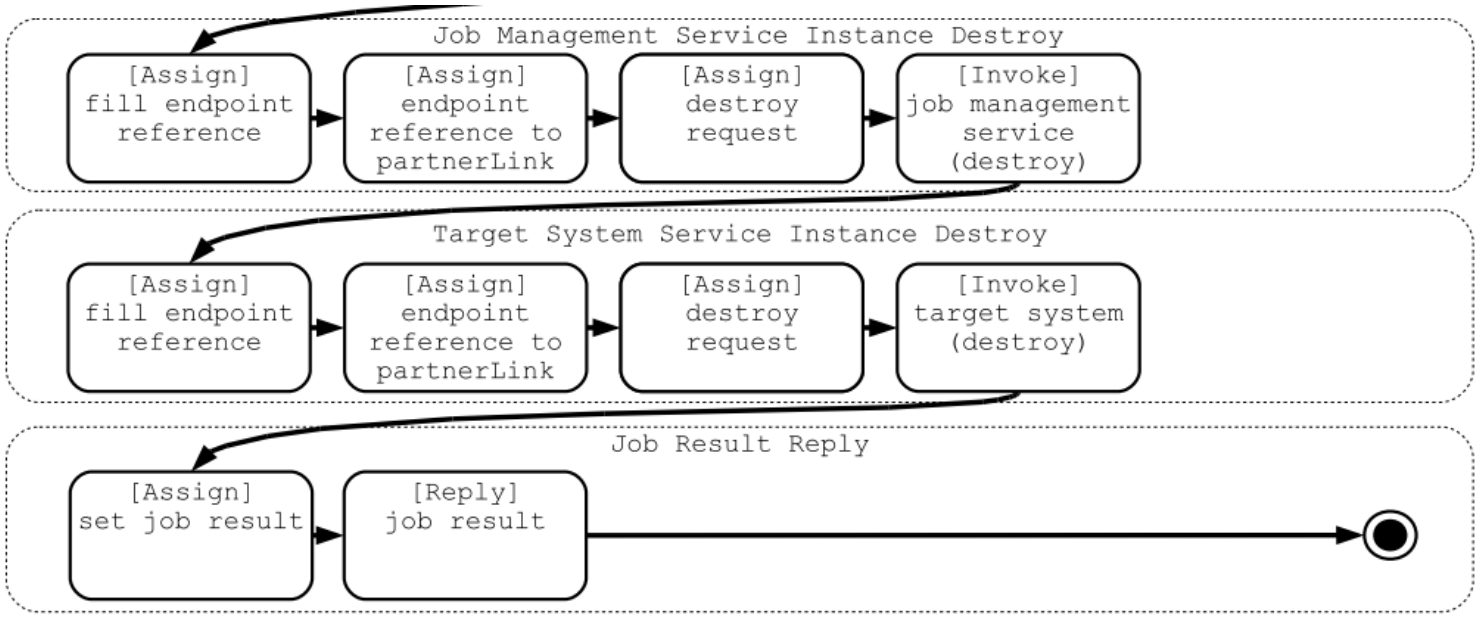
Current signature of the Job submission workflow

- *Input parameters*
  - Target System (`wsa: EndpointReferenceType`) *mandatory*
  - JSDL (`jsdl:JobDefinition_Type`) *mandatory*
  - LifetimeIntervall (`xsd:duration`) *optional*
  - WaitIntervall (`xsd:duration`) *optional*
- *Output parameters*
  - Result (`xsd:string`, *failed* or *successful*)

to be cont'd ...

Job Submission

... cont'd



- Job submission planned to be tested and evaluated in more detail in September
- Job submission workflow can be used in higher-level workflows in which, for example, a resource broker is invoked previously to choose a target system

Future Work

File transfers

- By using JSDL, the job submission pattern supports *simple* file transfers for *single* job executions
- However, the execution of *several* jobs using the *same* (voluminous) data and so-called *third party transfers* require special workflows
  - WS-BPEL engines are not designed for these purposes
  - File transfer as a single reusable domain-specific workflow activity to be configured properly

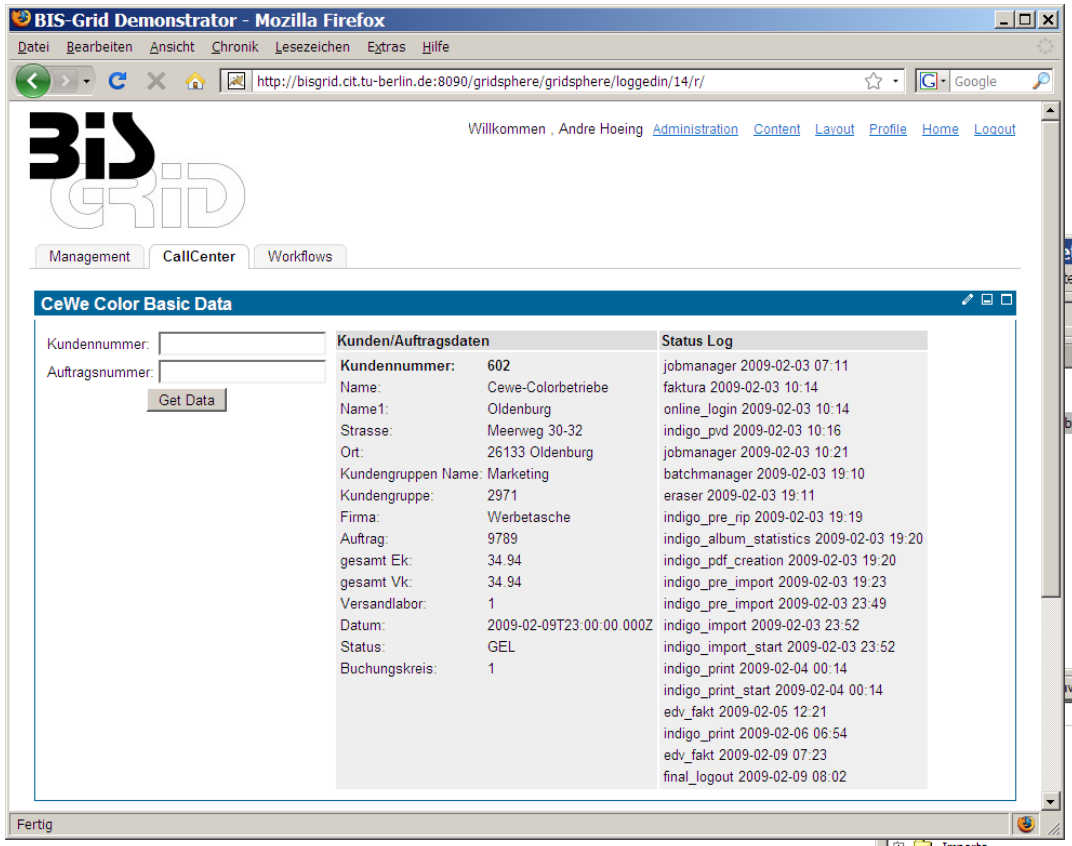
Globus Toolkit 4 interoperability

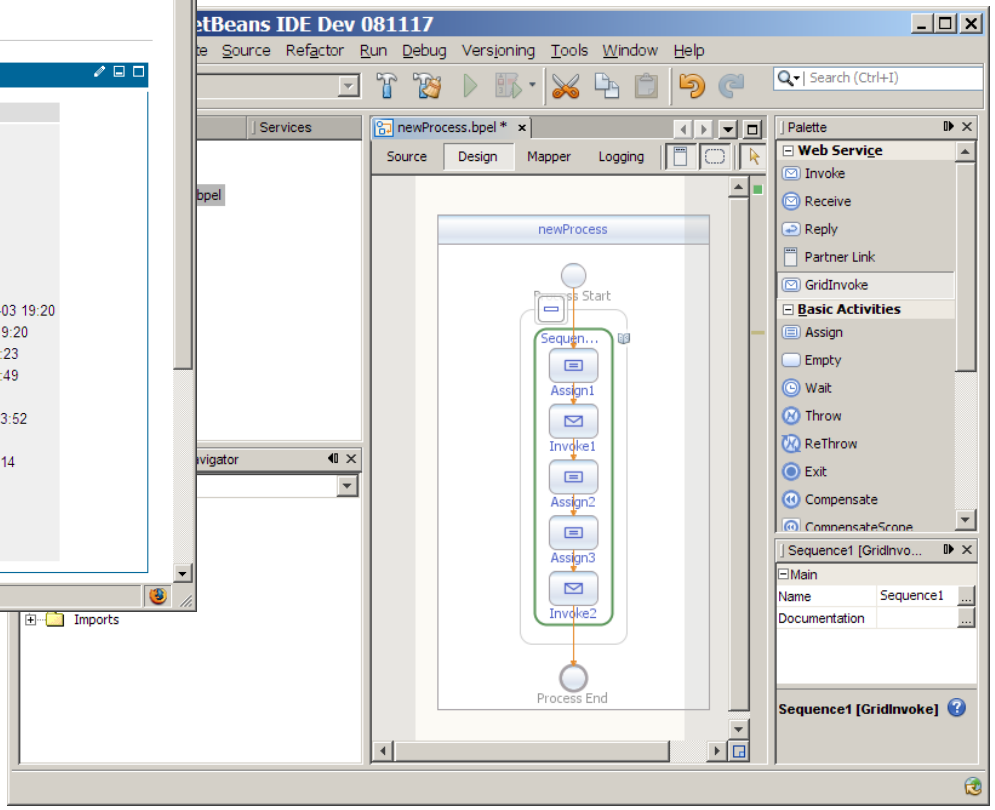
- We already developed a WS-BPEL pattern to invoke GT4 Grid services
- Open: support for GT4 Grid Security Infrastructure (GSI)
  - Evaluation in an appropriate GT4 service orchestration scenario planned (flood simulation)

Performance tests

- Application Scenario Workflows, Job Submission Workflow as basic wf-activity, bottleneck identification & load balancing

Future Work – User Clients





- End user client prototype currently based on GridSphere Portlets, business application scenarios shall integrate with existing tooling
- Extensions for Netbeans workflow designer (especially for deployment, but also for WS-BPEL pattern support)

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(„Dokumente")

http://bis-grid.sourceforge.net/

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