Employing WS-BPEL Design Patterns for Grid Service Orchestration using a Standard WS-BPEL Engine and a Grid Middleware

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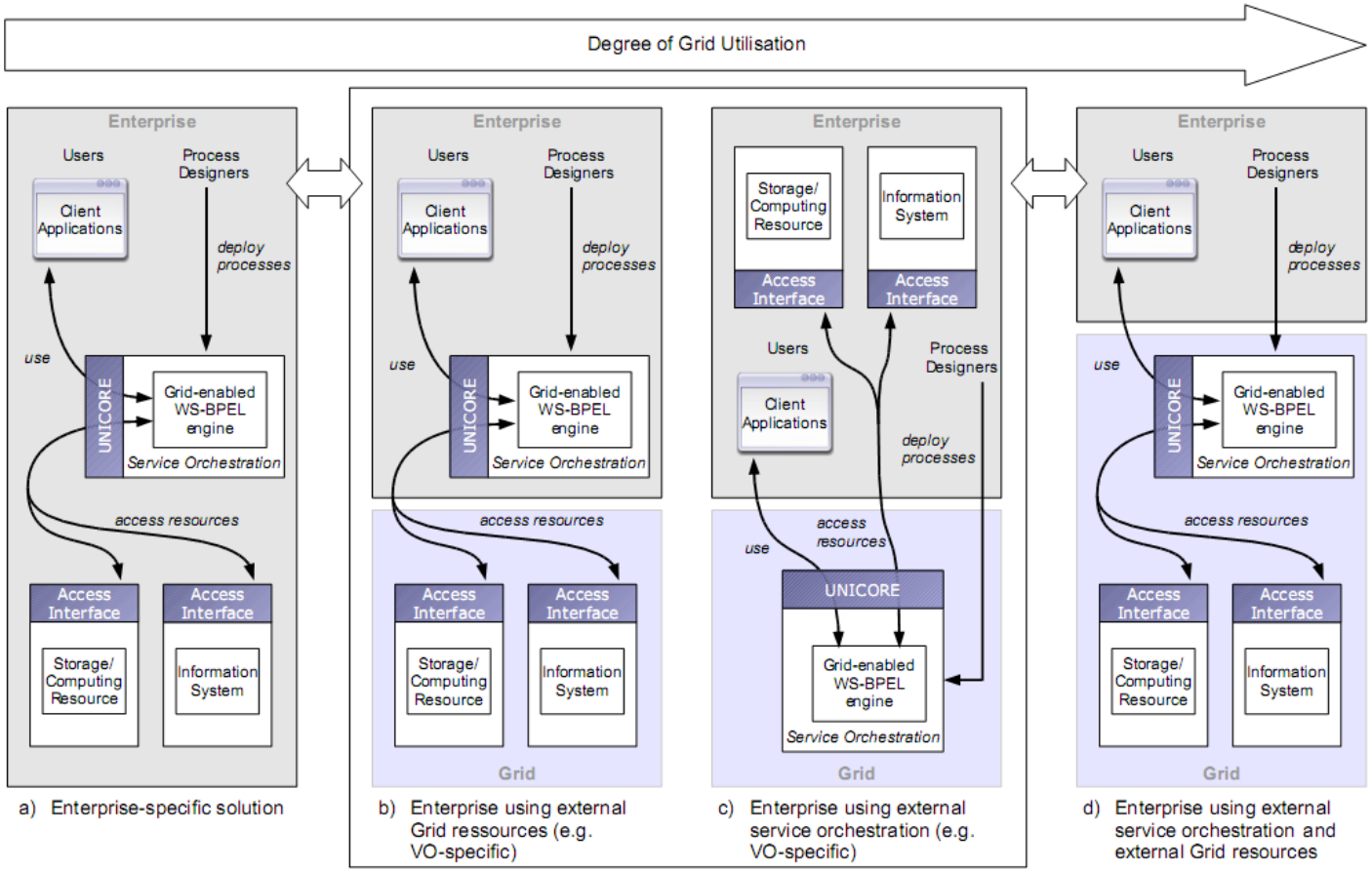
Context

BIS-Grid

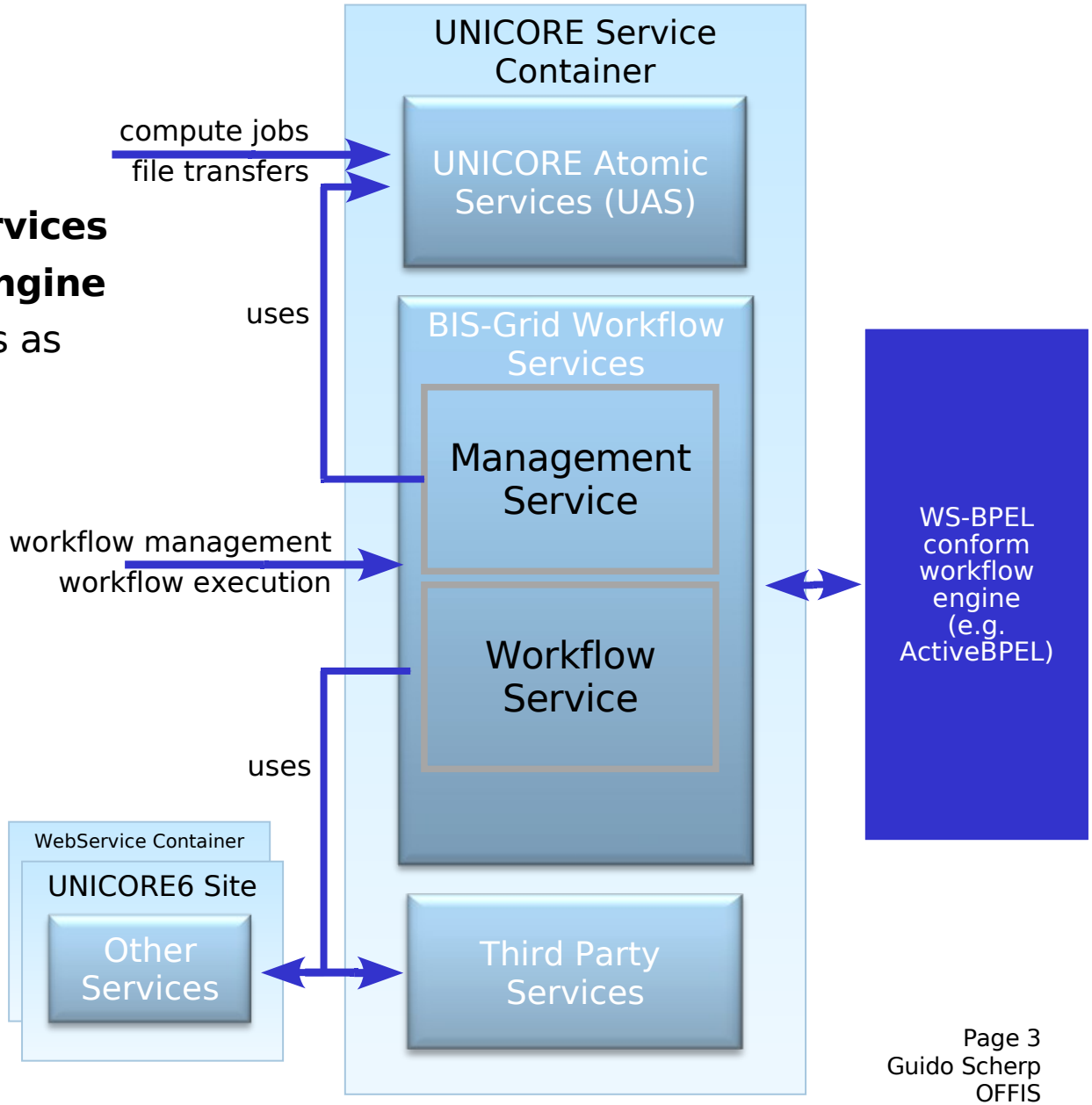
- Case study to examine the feasibility of EAI with Grid technologies
- Focus on business workflows
- Exemplary evaluation within two application scenarios with SMEs
- D-Grid project funded by the BMBF



BIS-Grid engine

Workflow Engine for Grid Service Orchestration

- Realised as **UNICORE 6 services**
- Using arbitrary **WS-BPEL engine**
- Provides WS-BPEL workflows as **WSRF Grid Services**
- **Open Source**



Motivation for WS-BPEL design pattern

Design decisions in BIS-Grid...

- Do not modify WS-BPEL
- Do not modify a WS-BPEL engine

... led to the identification of WS-BPEL design pattern

- Invoking a Grid Service is more complex than invoking a Web Service

  -> Grid utilisation pattern

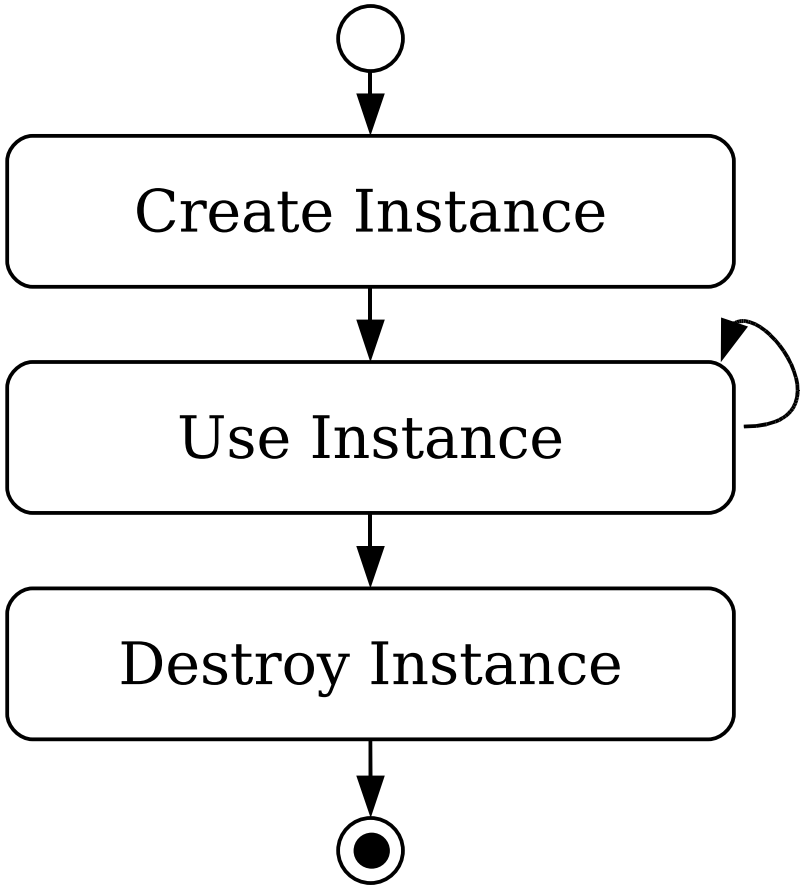
- The engine architecture requires to exchange additional information between UNICORE 6 and the WS-BPEL engine

  -> Implementation specific pattern

Grid Utilisation Patterns

Invocation of WSRF Grid Services has at least three phases

- Create, Use and Destroy
- Encapsulated by pattern **Grid-Service-Invoke**
- Includes one primitive pattern for each phase
- Specific for each Grid middleware
  - Tested with **UNICORE 6** and **GT4**[1]
- Applied within Workflow Design Tool
  - Extension of **Netbeans 6**



[1] Onyeka Ezenwoye, S. Masoud Sadjadi, Ariel Cary, Michael Robinson: *Orchestrating WSRF-based Grid* Services Technical report, School of Computing and Information Sciences, Florida International University, April 2007

Grid-Service-Invoke in WS-BPEL (1/4)

```
<sequence
    <!-- Grid-Service-Instance-Create  -->
    <invoke inputVariable="GridServiceFactoryRequest" operation="create"
          outputVariable="GridServiceFactoryResponse"
          partnerLink="GridServiceFactoryPL"
          portType="gsf:GridServiceFactoryPT"/>

    <!-- Grid-Service-Instance-Use     -->
    <assign>
      <!-- Fill the input variable GridServiceRequest -->
      ...
      <copy>
        <from>
          <literal>
            <wsa:EndpointReference xmlns:wsa="http://www.w3.org/2005/08/addressing" >
              <wsa:Address/>
              <wsa:ReferenceProperties>
                <wsa:To/>
                <wsa:Action/>
              </wsa:ReferenceProperties>
            </wsa:EndpointReference>
          </literal>
        </from>
        <to variable="DynamicEndpointReference"/>
      </copy>
```

Grid-Service-Invoke in WS-BPEL (2/4)

```
<copy>
  <from part="response" variable="GridServiceFactoryResponse">
    <query>wsa:EndpointReference/wsa:Address</query>
  </from>
  <to variable="DynamicGridServiceEndpoint">
    <query>wsa:Address</query>
  </to>
</copy>
<copy>
  <from part="response" variable="GridServiceFactoryResponse">
    <query>wsa:EndpointReference/wsa:Address</query>
  </from>
  <to variable="DynamicGridServiceEndpoint">
    <query>wsa:ReferenceProperties/wsa:To</query>
  </to>
</copy>
<copy>
  <from>
    <literal>
      <wsa:Action xmlns:wsa="http://www.w3.org/2005/08/addressing">
        ... <!-- insert soapAction attribute for target method from WSDL-Interface -->
      </wsa:Action>
    </literal>
  </from>
  <to variable="DynamicGridServiceEndpoint">
    <query>wsa:ReferenceProperties/wsa:Action</query>
  </to>
</copy>
```

Grid-Service-Invoke in WS-BPEL (3/4)

```
  <copy>
    <from variable="DynamicGridServiceEndpoint"/>
    <to partnerLink="GridServicePL"/>
  </copy>
</assign>
<invoke inputVariable="GridServiceRequest" operation="use"
          outputVariable="GridServiceResponse"
          partnerLink="GridServicePL"
          portType="gsr:GridServicePT"/>

<!-- Grid-Service-Instance-Destroy -->
<assign>
  <copy>
    <from>
      <literal>
        <wsa:Action xmlns:wsa="http://www.w3.org/2005/08/addressing">
          http://docs.oasis-open.org/wsrf/rlw-2/ImmediateResourceTermination/DestroyRequest
        </wsa:Action>
      </literal>
    </from>
    <to variable="DynamicGridServiceEndpoint">
      <query>wsa:ReferenceProperties/wsa:Action</query>
    </to>
  </copy>
  <copy>
    <from variable="DynamicGridServiceEndpoint"/>
    <to partnerLink="GridServicePL"/>
  </copy>
```

Grid-Service-Invoke in WS-BPEL (4/4)

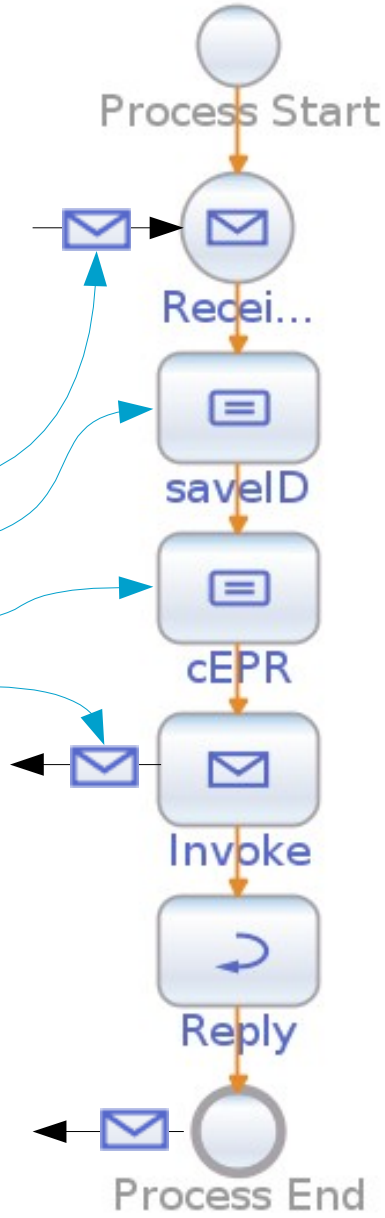
```
    <copy>
      <from>
        <literal/>
      </from>
      <to part="Destroy" variable="GridServiceDestroyRequest"/>
    </copy>
  </assign>

  <invoke inputVariable="GridServiceDestroyRequest" operation="Destroy"
          outputVariable="GridServiceDestroyResponse"
          partnerLink="GridServicePL"
          portType="gsr:GridServicePT"/>
</sequence>
```

Implementation specific patterns (1/2)

ID mapping problem: Two instances per workflow execution

- UNICORE 6 (resource ID) and WS-BPEL engine (process ID)
- Mapping needed to identify outgoing process messages
- Encapsulated by pattern **On-Receive-ID-Retrieve(1)** and **Pre-Invoke-ID-Assign(2)**
  - Ingoing message body is extended by resource ID**(1)**
  - Store resource ID after instance-creating receive**(1)**
  - Create EPR with resource ID as resource property**(2)**
  - Outgoing invoke message header contains resource ID**(2)**
- Pattern applied within our **UNICORE 6 services**
  - Deployment: Extension of WS-BPEL and WSDL definitions
  - Execution: Addition and Mapping of resource IDs



Implementation specific pattern (2/2)

Monitoring problem: WS-BPEL engine-specific process-ID is needed

- Assumption: WS-BPEL engine offers a monitoring interface

- Solution 1: **Extension of** pattern **Pre-Invoke-ID-Assign**
  - Engine-specific process ID is added to EPR's resource properties
    - e.g. ActiveBPEL offers WS-BPEL extension operation *getProcessID*
  - Invoke the monitoring interface with the process ID
  - Each WS-BPEL engine adapter must apply own WS-BPEL design pattern

- Solution 2: **Reuse of** pattern **Pre-Invoke-ID-Assign**
  - Invoke the monitoring interface to get all active processes
  - Search for resource ID value in process variables
  - Effective filter, caching and polling mechanism are needed

- Applied within our **UNICORE 6 services** and within the **WS-BPEL engine adapter**

Outlook

- **Human interactions**
  - Create own solution or use existing solutions as BPEL4People, WS-HT, ...
- **Support flow-based WS-BPEL processes with links**
  - Currently only sequence-based processes are supported with link-less flows
- **Extension of Netbeans 6**
  - Grid-Service-Invoke pattern
  - Deployment
- **In principle possible**
  - BIS-Grid engine architecture including WS-BPEL design patterns can also be implemented based on Grid middlewares as GT4

To get more information

http://www.bisgrid.de -> „Dokumente“

- Deliverable 2.1 „*Catalogue of WS-BPEL Design Patterns*“ *(DRAFT)*
- Deliverable 3.1 „*WS-BPEL Engine Specification*“
- Deliverable 3.2 „*WS-BPEL Engine Documentation*“ *(DRAFT)*
- BIS-Grid engine prototype will be available soon