Virtual Execution Environments and the Negotiation of SLAs in Grid Systems

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Grid Computing Today

- How do Grids look like today?
  - Grids are in use, but…
    - … commercial usage is rare and limited
      - only isolated applications
    - … mostly used as a prototypic solution in research
      - testbeds within research projects

- Important problem
  - No contractually fixed QoS levels
    - Deadline bounded business critical jobs
What is a Service Level Agreement

- Service Level Agreement (SLA)
  - Contract between provider and customer
    - Describes all obligations and expectations
  - Flexible formulation for each use case

<table>
<thead>
<tr>
<th>Name</th>
<th>ID or Description of SLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Context</td>
<td>Contract Parties, Responsible Persons</td>
</tr>
<tr>
<td>Terms</td>
<td>R-Type: HW, OS, Compiler, Software Packages, …</td>
</tr>
<tr>
<td></td>
<td>R-Quantity: Number CPUs, main memory, …</td>
</tr>
<tr>
<td></td>
<td>R-Quality: CPU&gt;2GHz, Network Bandwidth, …</td>
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<tr>
<td></td>
<td>Deadline: Date, Time,…</td>
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<tr>
<td></td>
<td>Policies: Demands on Security and Privacy, …</td>
</tr>
<tr>
<td></td>
<td>Price for Resource Consumption (fulfilled SLA)</td>
</tr>
<tr>
<td></td>
<td>Penalty Fee in case of SLA violation</td>
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</tbody>
</table>
The Gap between RMS and the Grid

- User asks for Service Level Agreement
- Grid Middleware realizes job by means of local RMS systems
- BUT: These RMS only offer best effort!
- Goal: SLA-aware RMS
  - Runtime responsibility
  - Reliability
  - Fault tolerance
SLA-aware RMS

- Central component
  - Interface to Grid middleware for SLA-Negotiation
  - Interfaces to Subsystems for provision of FT

- Tasks
  - SLA Negotiation
  - Policies
    - security, ...
  - Monitoring
  - FT
    - checkpoints
    - migration

- Open interfaces
Grid Migration

- **Resource Outage at Site A**
  - Cannot be compensated locally

- **Compatibility**
  - Kernel-level checkpointing
    - Demands on target resource
  - Grid are heterogeneous

- **Compatibility profile**
  - Fine-grained requirements of job
  - Part of SLA-negotiation
  - High chance of successful restart
  - But: small number of matching resources
Virtual Environments

- **Status quo:**
  Execution of application on compute node

- **Idea:**
  Establishment of VMM on node
  - Startup of application within VMM

- **VMM to match all requirements**
  - Compatibility with job
  - Compatibility with migration dataset
  - Isolation of compute node from application
Provision of Execution Environments

- Image repository with set of default system images
- SLA refers to system image as execution environment
- RMS initializes compute node
- Compute node establishes virtual environment
Impact on Compatibility

- Source RMS provided execution environment according to SLA
- ID of system image is part of the SLA at migration time
- Remote RMS establishes same execution environment
- Compatibility at restart time
Standard Negotiation Sequence

1. getTemplate
2. Fill in Template
3. createAgreement
   - Call is binding for the user
   - Check Availability
   - return SLA

4. return Template
Enhanced Negotiation Sequence

- **getTemplate**
  - return Template

- **Fill in Template**

- **getQuote**
  - Quotes are not binding
  - Return quotes array

- **Select best offer**
  - Call is binding for the user

- **create Agreement**
  - return SLA
Next Step: Execution of Virtual Systems

- User provides virtual system
  - Ready configured to execute the user’s application

- Virtual system is transferred to RMS

- RMS uses image for node initialization
  - Compute node establishes virtual system
  - Application starts in user-defined and user-provided environment
Conclusion

- SLA-awareness in Resource Management Systems
  - Fault Tolerance for handling resource outages
  - Kernel-level checkpointing
  - Job Migration: Transfer of checkpoints to remote systems

- Virtual Execution Environments
  - Migration puts low-level demands on target system
  - Ensuring compatible environments on target system
  - Increasing number of potential migration targets

- Enhancement of SLA-Negotiation process

- Feel free to download the software stack: