



# Workflow Scheduling in the ASKALON Grid Environment

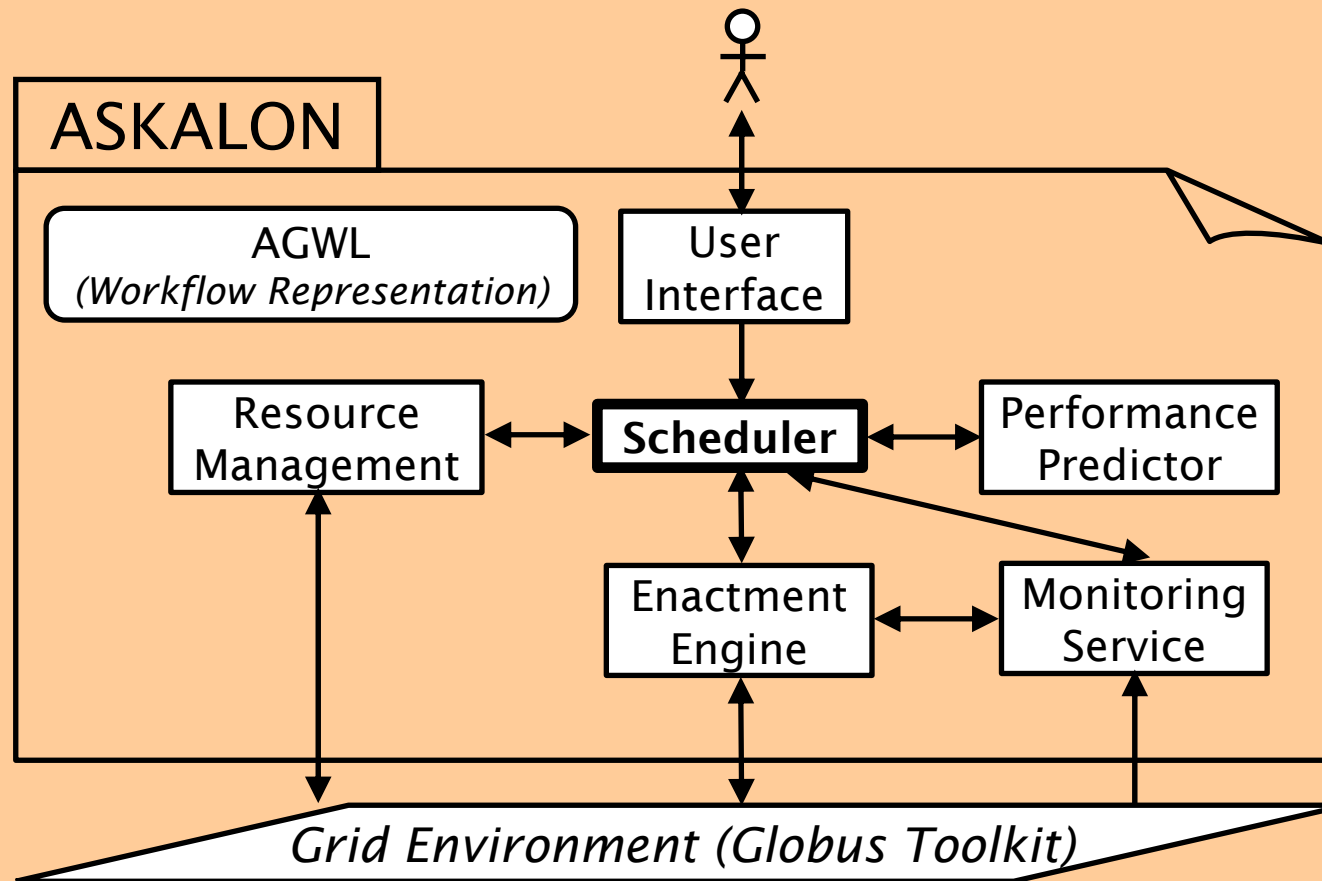
Marek Wieczorek, University of Innsbruck  
GGF16 Athens, February 14th



# Agenda

- ASKALON Grid environment
- Main characteristics of the ASKALON scheduler
- Implemented functionalities
- Research results
- Future work

# ASKALON Grid Environment



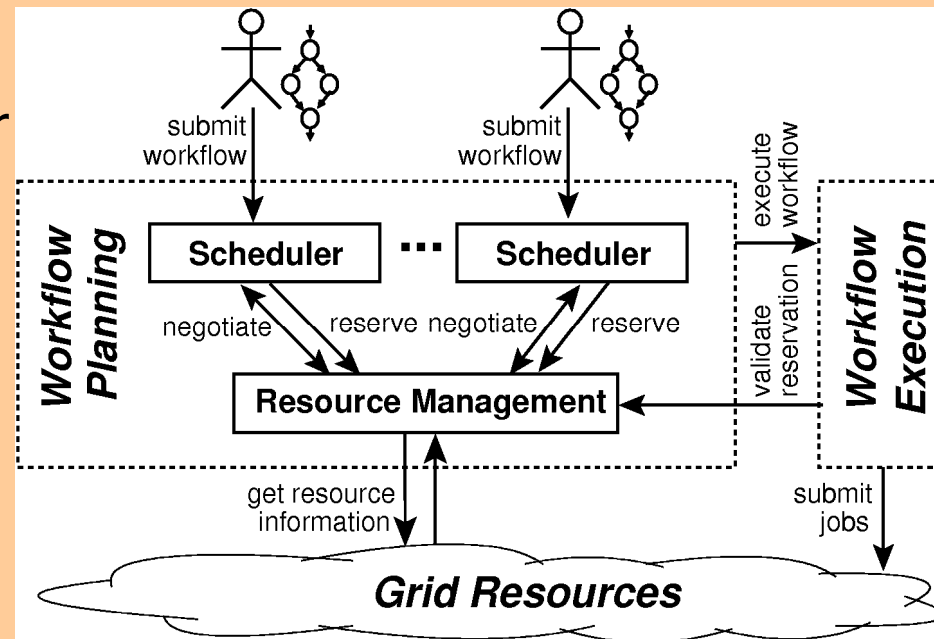


# What the Scheduler is Responsible for

- Resource pre- selection
- Advance reservation/agreement negotiation
- Dynamic workflow (re)scheduling

# Scheduling Model

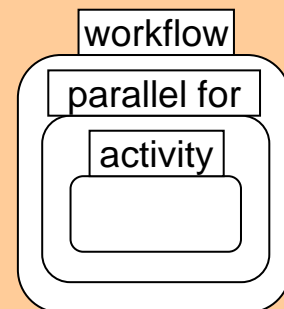
- Scientific workflow scheduler.
- Separate instance for each workflow submission
- Interacts with other ASKALON services
- Dynamic scheduling (rescheduling enabled)



# Workflow Model

```
<parallelFor name="pfor">
  <dataIns>
    <dataIn name="in" source="A1/out" >
  </dataIns>
  <loopCounter from="0" to="3" step="1"/>
  <loopBody>
    <activity name="A2">
      <dataIn name="in" source=... />
      ...
      <dataOut name="out" />
    </activity>
  </loopBody>
  <dataOuts ... />
</parallelFor>
```

XML representation

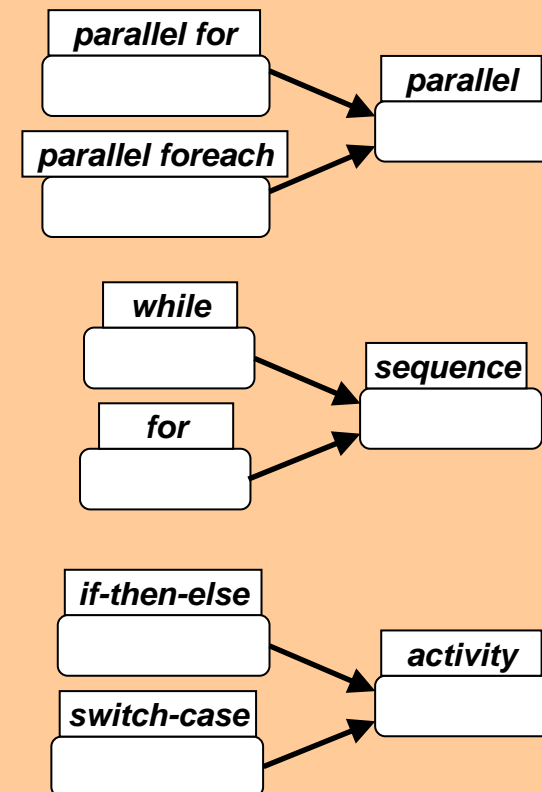


workflow graph

- AGWL – an XML Schema language
- Hierarchical workflow representation
- Advanced loop constructs (loops, parallel constructs, conditionals)
- Implementation independent
- Not ready for execution
- Conversion to a platform-dependent representation is needed

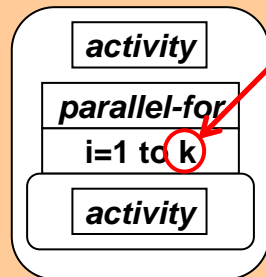
# Workflow Conversion

- Conversion to the **execution-ready** representation.
- A **speculative** conversion approach
- Expressions (i.e., loop conditions) are **evaluated**, whenever it is possible
- If we cannot evaluate, an **assumption** is made
- Assumptions are checked during the execution; **rescheduling** can be invoked
- The execution status is stored with the workflow (**statefulness**)



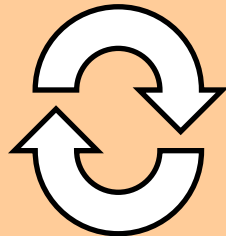
# Complex Workflow Conversion - example

## Scheduler



expression not evaluated

assumption:  
·  $k=2$



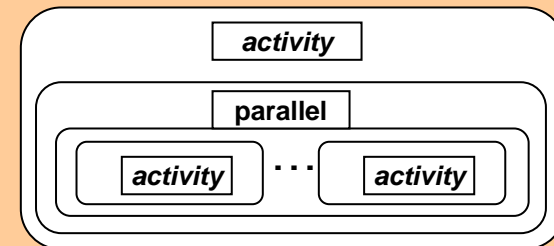
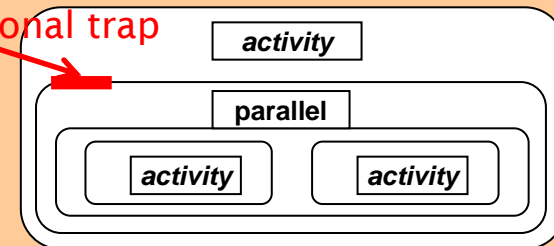
rescheduling

conditional trap failed  
an assumption

rescheduled workflow  
( $k=20$ )

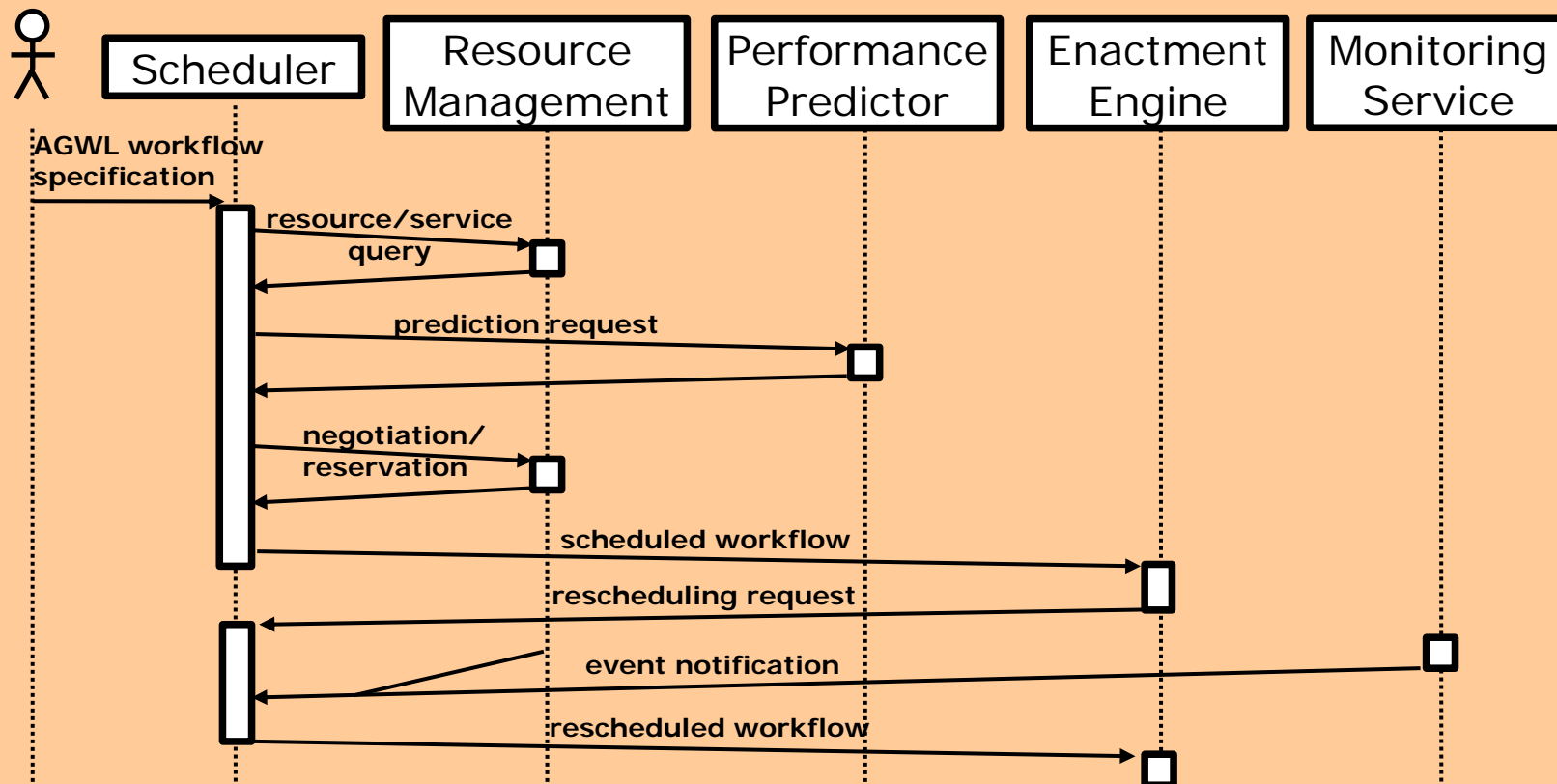
## Enactment Engine

conditional trap





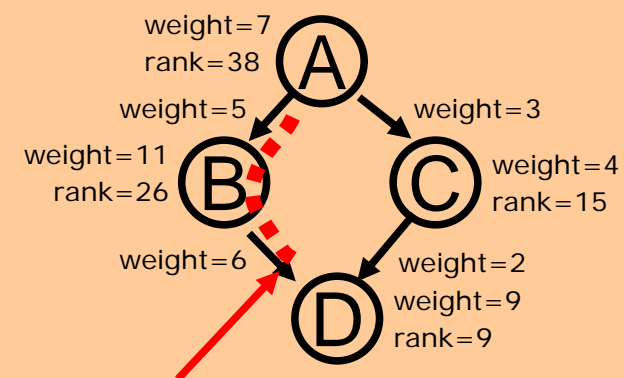
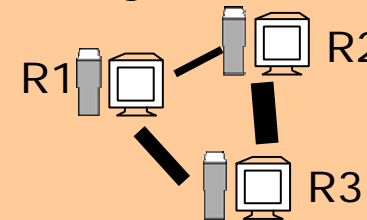
# Workflow Processing Lifecycle



# HEFT Algorithm

- Extension of the classical list scheduling algorithm
- Consists of 3 phases:
  - weighting,
  - ranking,
  - mapping
- Useful for our system:
  - fits well to the problem,
  - easy to extend (e.g., for reservations)

heterogeneous Grid



**critical path**

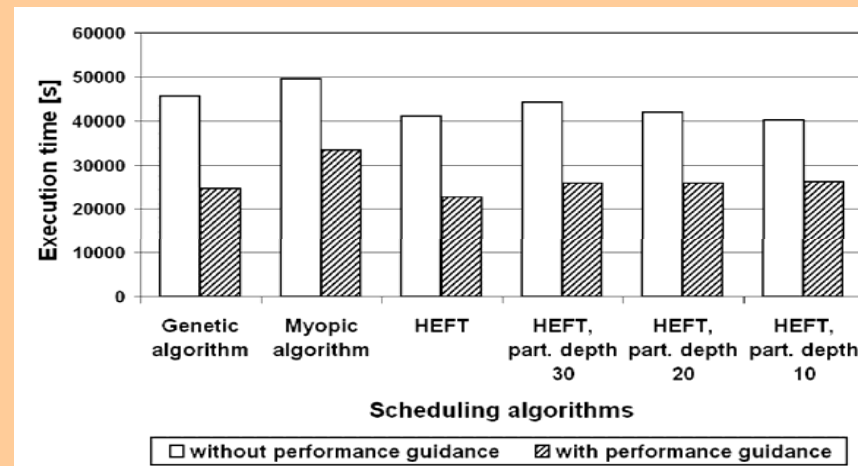
ordered list: A, B, C, D

# Advance Reservation

- Reservation- aware version of HEFT
- *Weighting* and *ranking* phases remain intact
- Ordered lists of resources *mapped* to tasks
  - first task has the shortest execution time,
  - lists ordered by decreasing fitness values
- Additional *reservation* phase
  - for each task negotiation with the Resource Management is performed,
  - reservation with the earliest finish time is confirmed

# Comparison of Scheduling Strategies

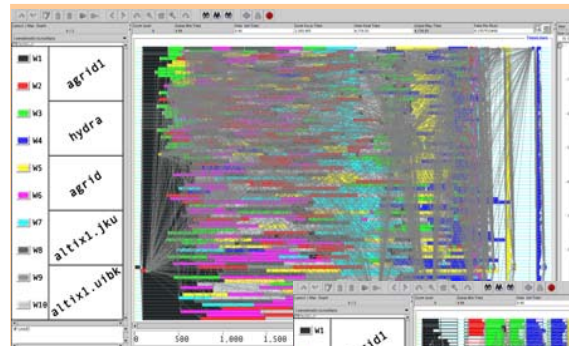
- HEFT algorithm better than other investigated approaches
- Full- ahead approach better than workflow partitioning
- Performance predictions crucial for performance-driven scheduling



different scheduling - execution times

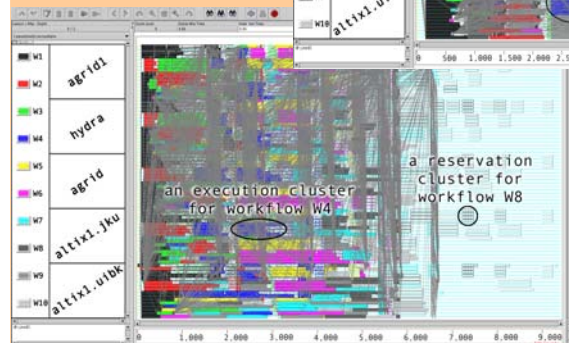
M. Wiecek, R. Prodan, T. Fahringer,  
*Comparison of Workflow Scheduling Strategies on the Grid*,  
PPAM05 Conference, September 11- 14, 2005, Poznan, Poland

# Advance Reservation Simulations



no reservations

attentive  
reservations



progressive  
reservations

- Reservation considered optionally
- 2 reservation policies investigated
- Execution time, predictability, resource usage, and fairness applied as metrics
- The progressive reservation policy better than the attentive one



# Multi- criteria Optimization

- Execution time, economic cost, quality of results, etc.
- User- defined order of criteria
- Trade- offs between few contradicting criteria resolved (bi- criteria optimization)
- Price models stored in the Resource Management
- Resource usage conditions negotiated by the scheduler form SLAs

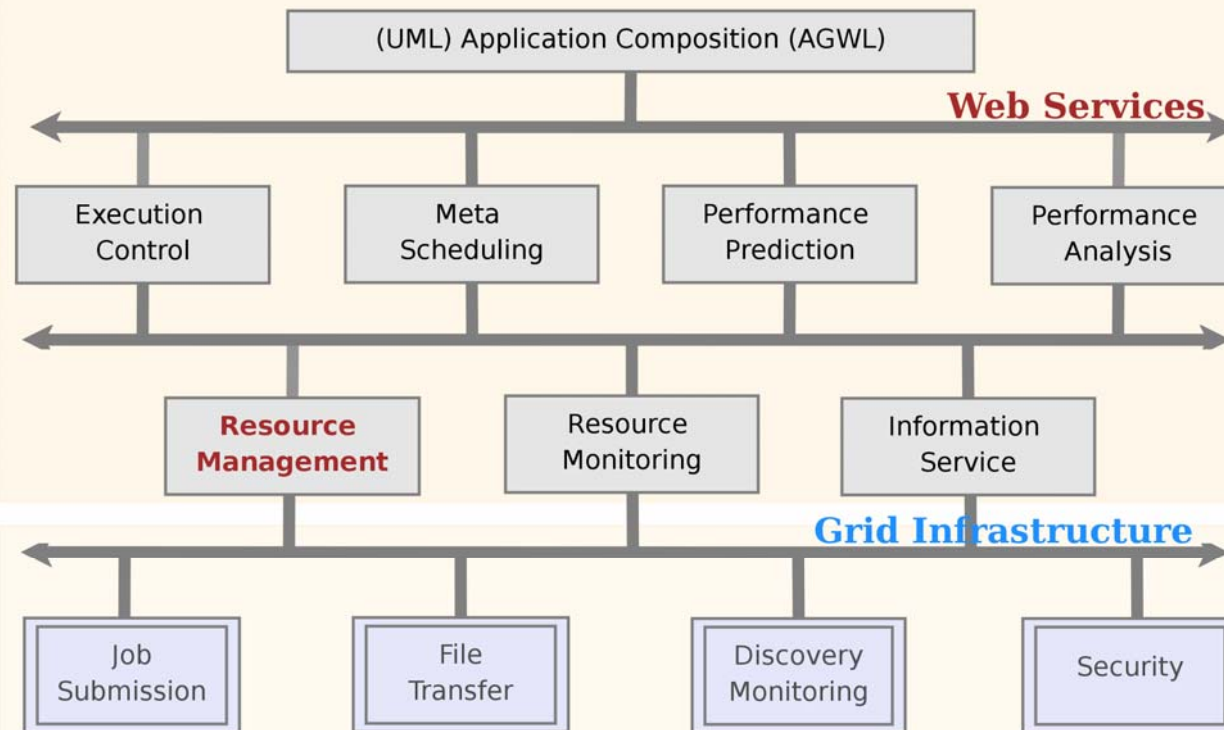


# Summary

- The ASKALON scheduler as a Grid scheduler
- The scheduler as a part of the ASKALON environment
- Implemented and not implemented functionalities
- Research studies



# ASKALON



<http://dps.uibk.ac.at/projects/askalon/>