Grid Scheduling Architecture RG

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OGF 19, January 29, 2007

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Agenda

- Session #1 and #2
  - Progress of the research group
  - Scheduler interoperation
    - Scenario
    - Required services & protocols
    - Basic set of JSDL parameters
    - Negotiation & agreement management
    - Execution management
  - Scheduling description language
  - Open issues & discussion

Milestones

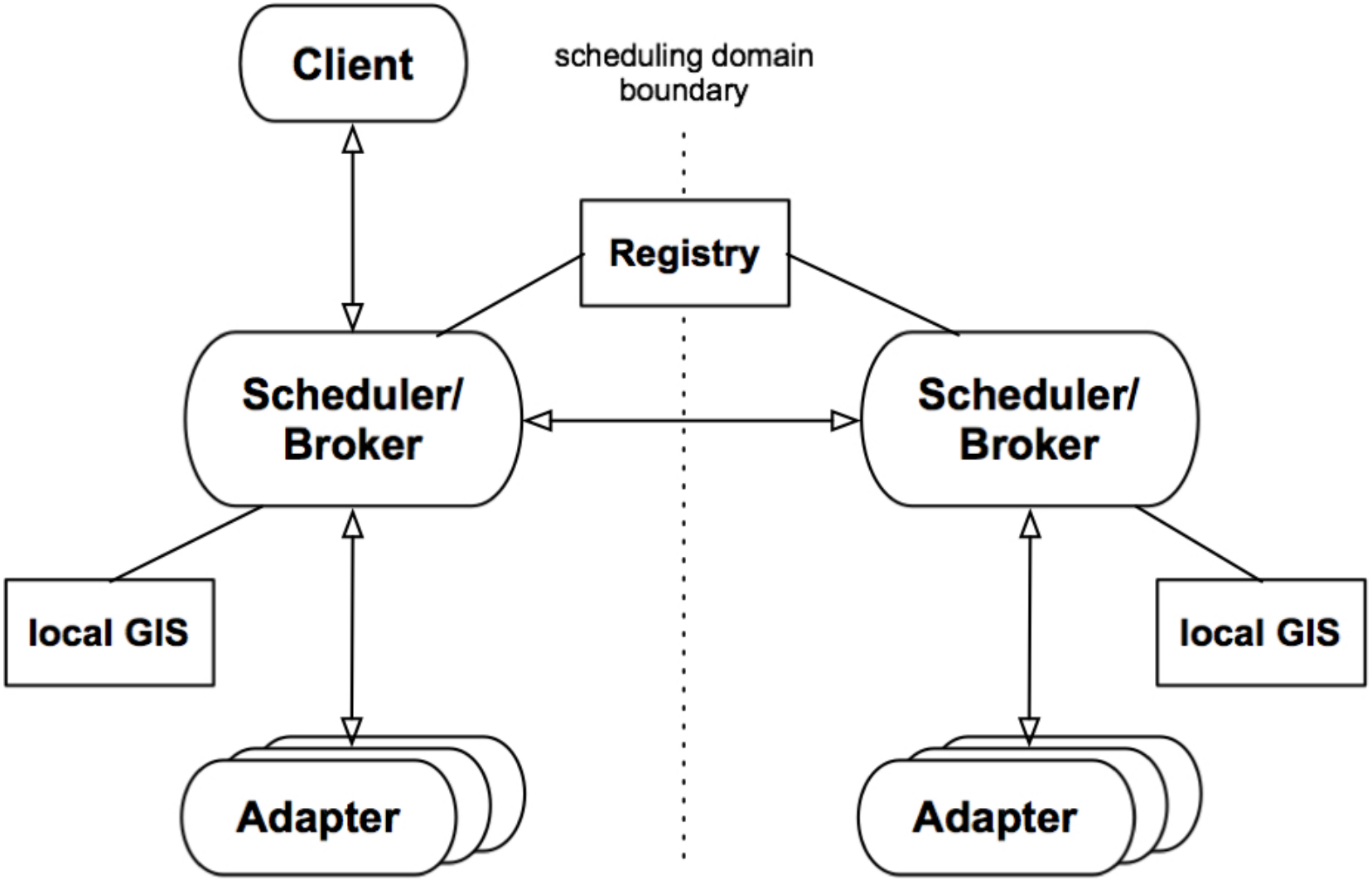
- Short term
  - Scheduler interoperation feasibility study
  - Practical show-case
  - Within 12 months from now
- Long term
  - Definition of a generic Grid scheduling architecture

Progress of the Research Group

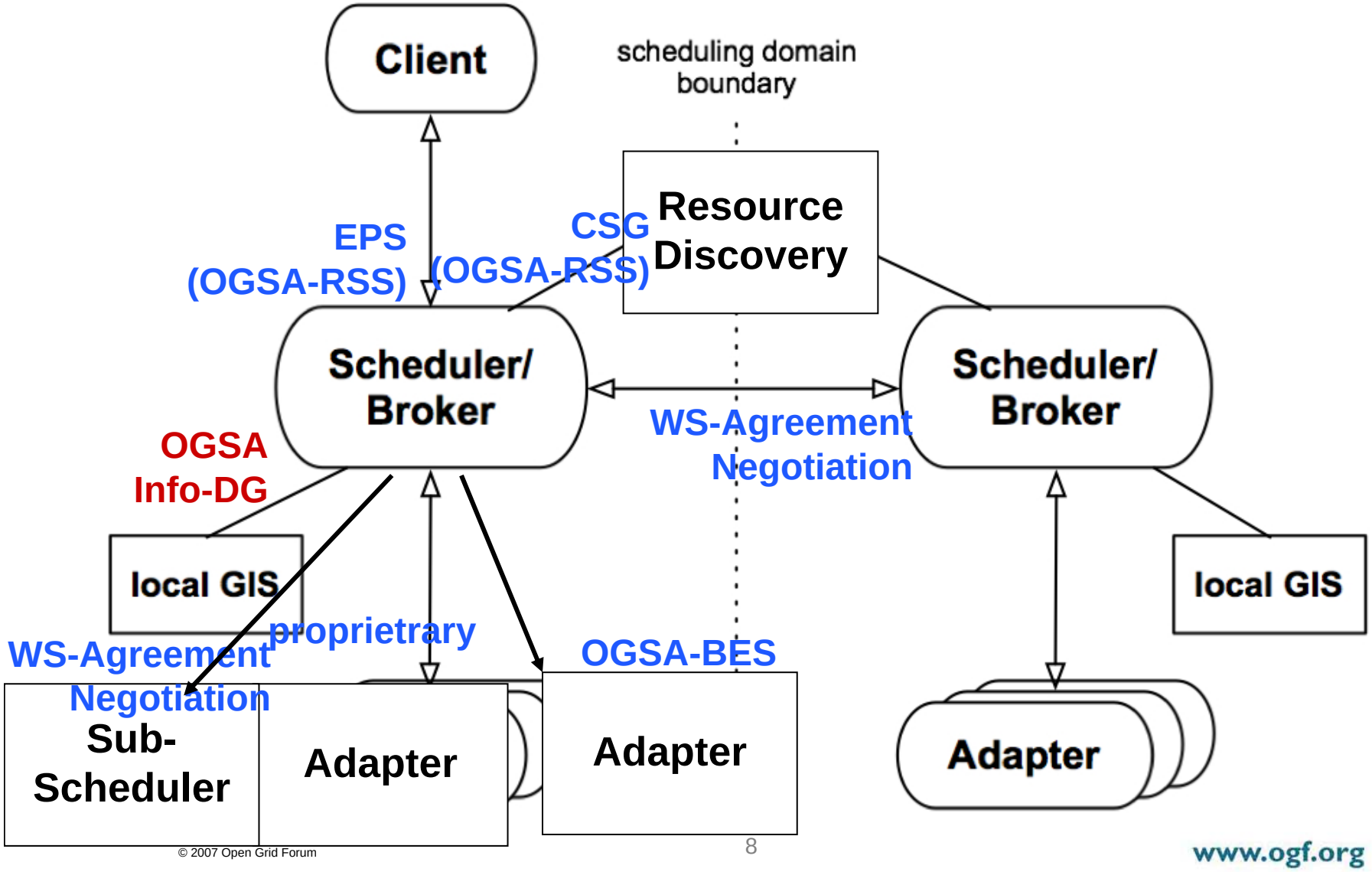
- Between OGF 18 and OGF 19
  - F2F discussion about scheduling interop in October
  - First outline of process at GSA-RG Wiki
  - First version of JSDL parameter document
  - First version of scheduler attributes document
- Grid Scheduling Architecture – Requirements document
  - Ongoing discussions about function and form
  - Status: still immature

Scheduler interoperation

Scenario – picture it!

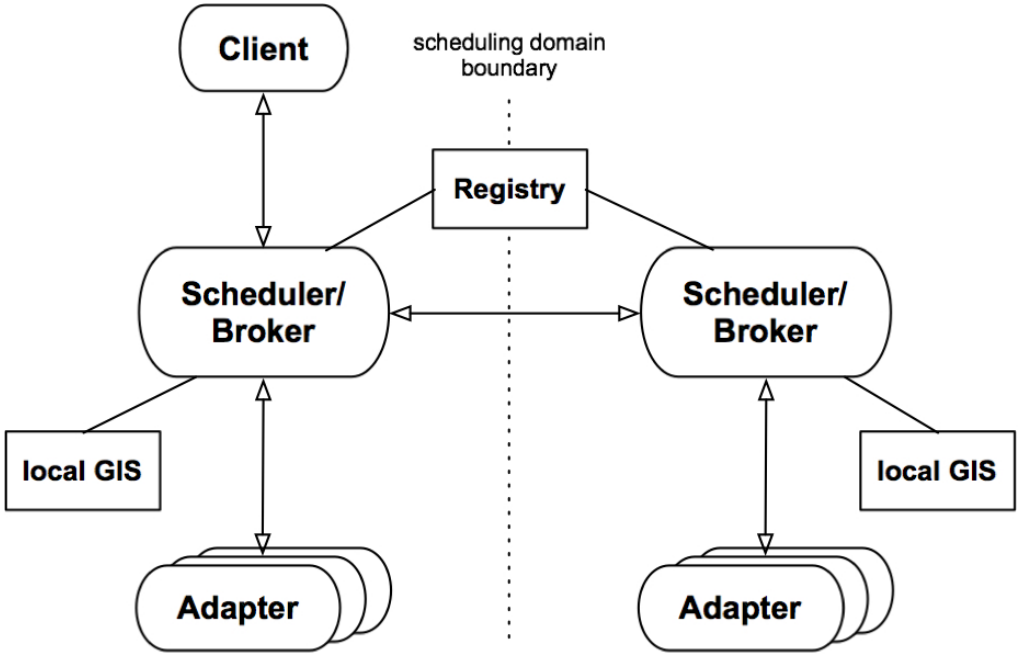


Scenario – picture it!

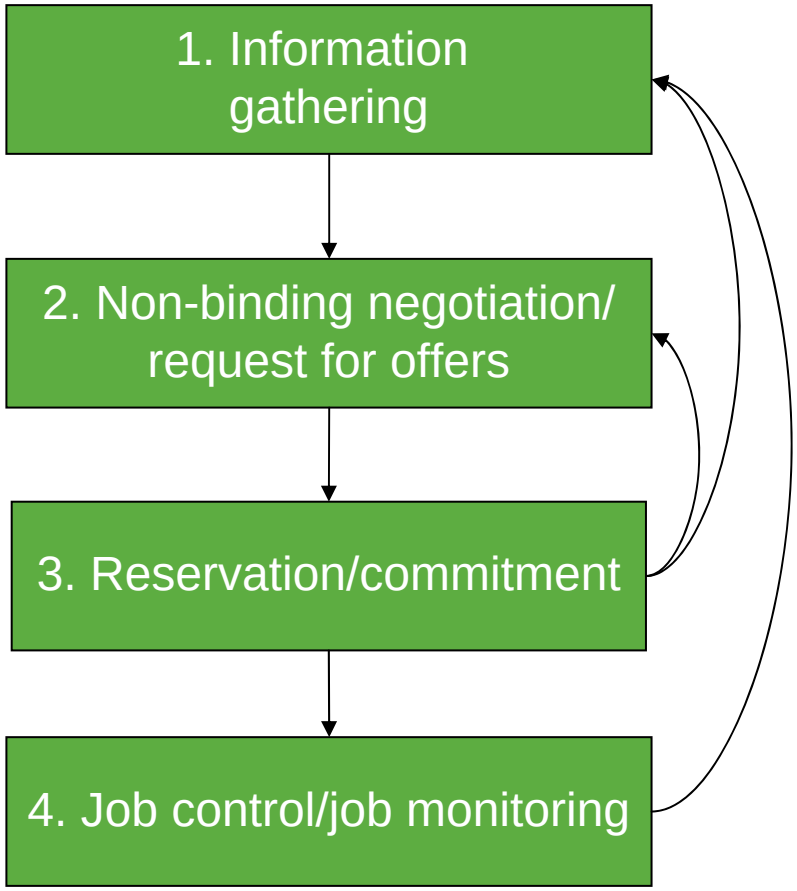


Entities involved

- Main entities
  - Client
  - Scheduler
  - Adapter
- Utility entities
  - Registry
  - Local GIS (Grid Information Service)



Communication Stages



1. Information gathering about available remote Grid schedulers
2. Non-binding negotiation may end up with several possible agreement alternatives (possibly in parallel)
3. Agreement creation and commitment; may fail and require return to previous stages
4. Handing over job control to remote Grid scheduler (responsibility remains at initiator)

Feasibility study

Goal & Interactions

- Simple use case: Two schedulers interoperate with each other
- Goal: Show feasibility through implementation
- Concrete interactions to reach agreement on delegation of scheduling decision:
  1. Scheduler A cannot fulfil a scheduling request
  2. Request is passed to Scheduler B
  3. Scheduler B checks its capabilities
  4. Scheduler A & B agree/disagree on conditions to fulfil the request
  5. [Potentially it is possible to re-negotiate the conditions]
  6. Scheduler B fulfils the scheduling request

Candidate “standards”

“Standard” descriptions:

- Common job description: JSDL
- Common resource model: OGSA Info model?
  - OR semantic translation services between different models
- Add. scheduling parameters: JSDL extensions?

“Standard” protocols

- Agreement creation: WS-Agreement
- Negotiation: WS-Negotiation?

Participating projects

Confirmed

- Grid Resource Management System (GRMS)
- MetaScheduling Service (MSS)
- D-Grid

Interested

- GridWay
- … your project?

JSDL Profile

Goal

- Agree on a basic set of attributes to be referenced in an SLAs during negotiation between Grid schedulers
- JSDL profile attributes …
  - … needed for scheduling (e.g. info about data, required number of CPUs, bandwidth etc.),
  - … referenced in service description terms in SLA negotiations (e.g. amount of memory etc.),
  - … essential for proper job execution by LRMS (e.g. job arguments, environmental variables etc.)
  - … are defined in GFD.56
- Question: What is the minimal set of attributes a scheduler MUST support?

Minimal attribute set

- Intersection of attributes supported by different systems is small
  - Comparison of GRMS and MSS resulted in only a hand of common attributes
- Full JSDL support not in focus
- Start with traditional resources: compute & files
- … Discussion needed

JSDL Profile Candidate Attributes

- JobIdentification
  - JobName
  - JobProject
- Resources
  - CandidateHosts (HostName)
  - FileSystem (name)
  - OperatingSystem
  - CPUArchitecture
  - IndividualCPUSpeed
  - IndividualCPUTime
  - IndividualCPUCount
  - IndividualNetworkBandwidth
  - IndividualPhysicalMemory
  - IndividualVirtualMemory
  - IndividualDiskSpace
- DataStaging
  - FileName
  - Source (URI)
  - Target (URI)
  - Executable
- Application
  - ApplicationName
  - ApplicationVersion
- POSIX Application
  - Executable
  - Argument
  - Input
  - Output
  - Error
  - Environment

Attributes Supported

- JobIdentification
  - **JobName**
  - JobProject
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  - **CandidateHosts (HostName)**
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Summary of JSDL Profile

- So far only GRMS and VIOLA examined
  - Other schedulers should be included to have a broader view
- Only 4 attributes common for Grid schedulers!
- However some of attributes needed only by LRMS so they can be just passed if LRMS supports JSDL
- Some of attributes are essential but not available in VIOLA. Will they be implemented?

Scheduling Description language

Scheduling Attributes

- The goal: information needed by Grid schedulers to schedule a job(s) according to user's requirements and preferences
- In general these requirements and preferences may concern time constraints, job dependencies, job priorities, scheduling objectives, data-dependent scheduling information, and other
- An initial set of attributes proposed
- From this wide set of attributes those supported by available Grid schedulers selected

Argumentation

- Attributes exist which are
  - … out of scope of JSDL (sic!), but …
  - … within the scheduling scope
- Approach
  - a) Extend JSDL
  - b) Create a Grid Scheduling Language
  - c) Steel something out there
- Note: b) could be a showstopper aiming for fast progress

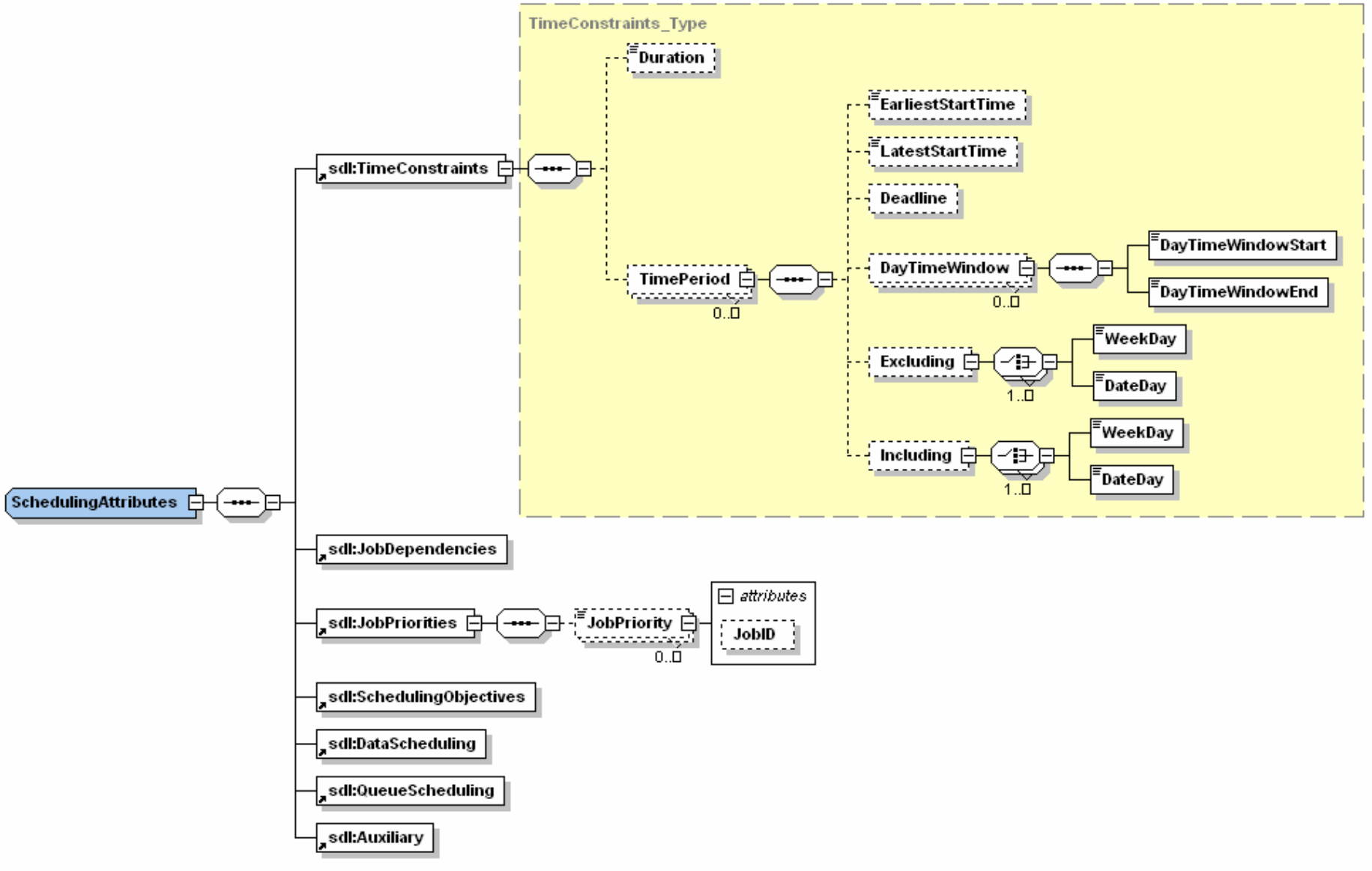
Attributes Supported

- **Duration** (required)
  - Maximal job execution time
- **EarliestStartTime**
  - Specifies the earliest start time of a job (e.g. 31st January 2007 10:00AM)
- **LatestStartTime**
  - Specifies the latest start time of job (e.g. 12th February 2007 16:00PM)
- **NoCoallocation**
  - Defines whether resources required for a given job can be allocated at more that one site

Scheduling Description Language (SDL)

- In general, specification of scheduling attributes is missing
- Not available even for local resource management systems (e.g. to specify requirements concerning advance reservation)
- Categories of scheduling attributes considered
  - time constraints,
  - job dependencies,
  - job priorities,
  - scheduling objectives/preferences,
  - data-dependent scheduling information,
  - queue-based scheduling information,
  - miscellaneous.

Preliminary Proposal of SDL



SDL Open Issues

- How to define SDL?
  - JSDL extension ?
    - But in the JSDL spec is said that SDL is out of scope
  - WS-Agreement ?
    - But concrete terms are needed
  - Separate specification?
    - Design group within GSA?
    - Another group ?
- Should be the same for LRMS?
- Which attributes should be selected?
- What else is out there?

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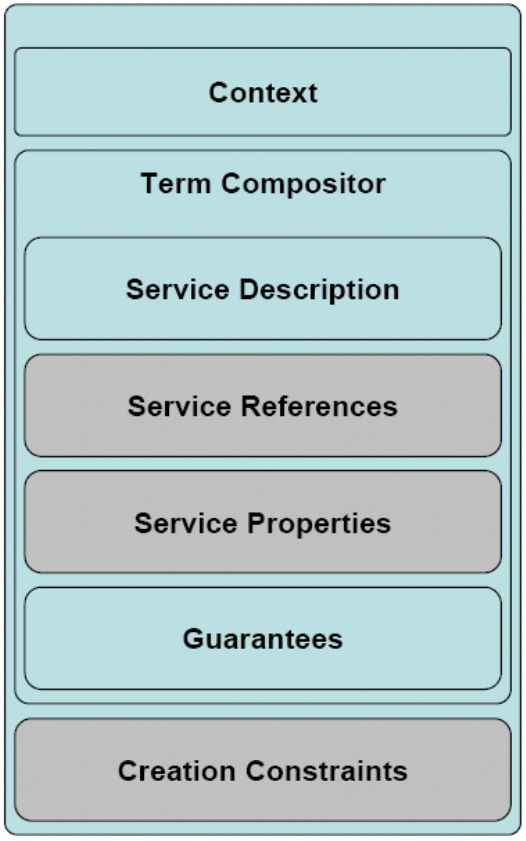
More information

- JSDL profile draft document
  - https://forge.gridforum.org/sf/go/doc14009?nav=1
- Scheduling attributes (SDL) draft document
  - https://forge.gridforum.org/sf/go/doc14026?nav=1

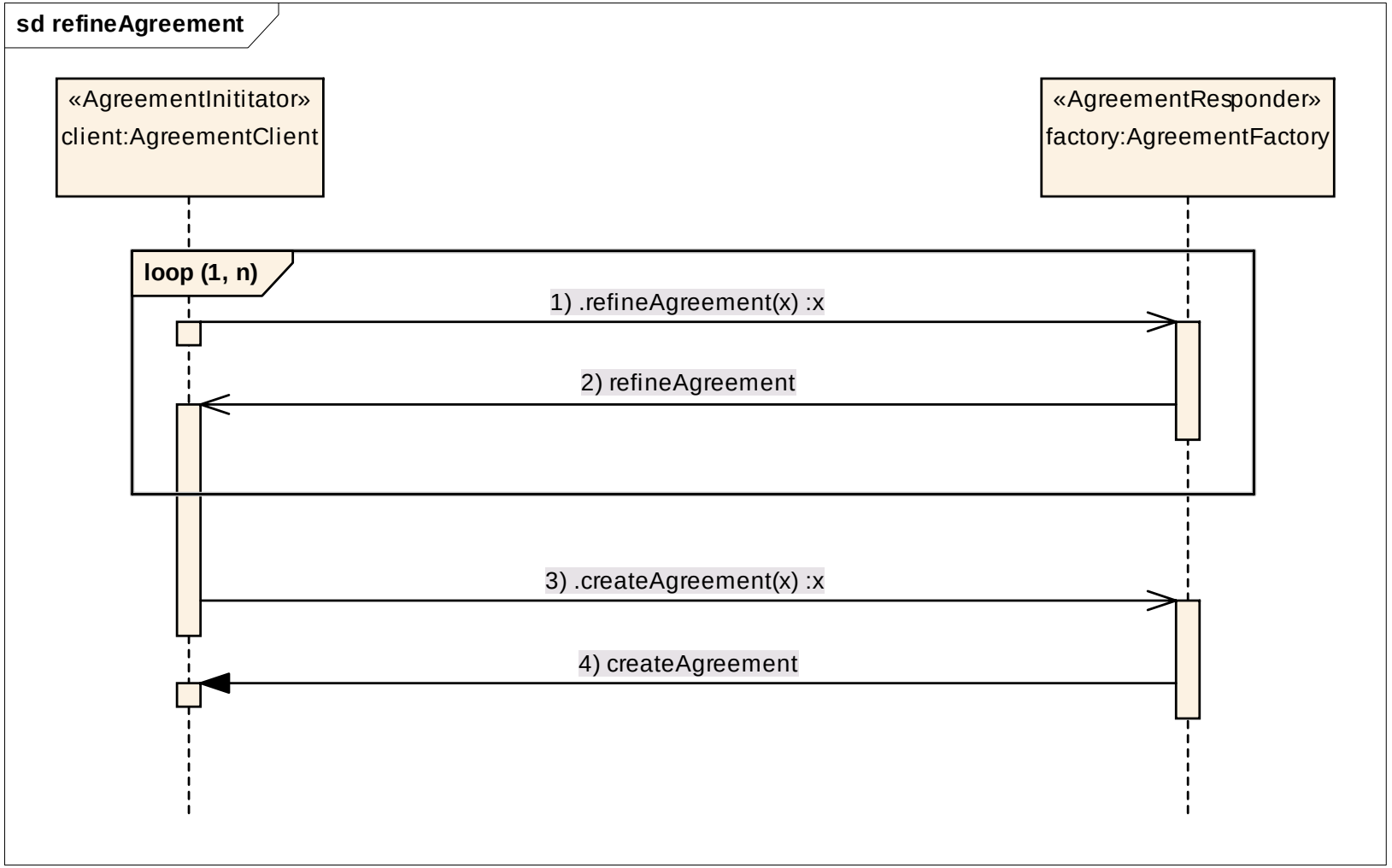
Negotiation Protocol

“Extend” WS-Agreement

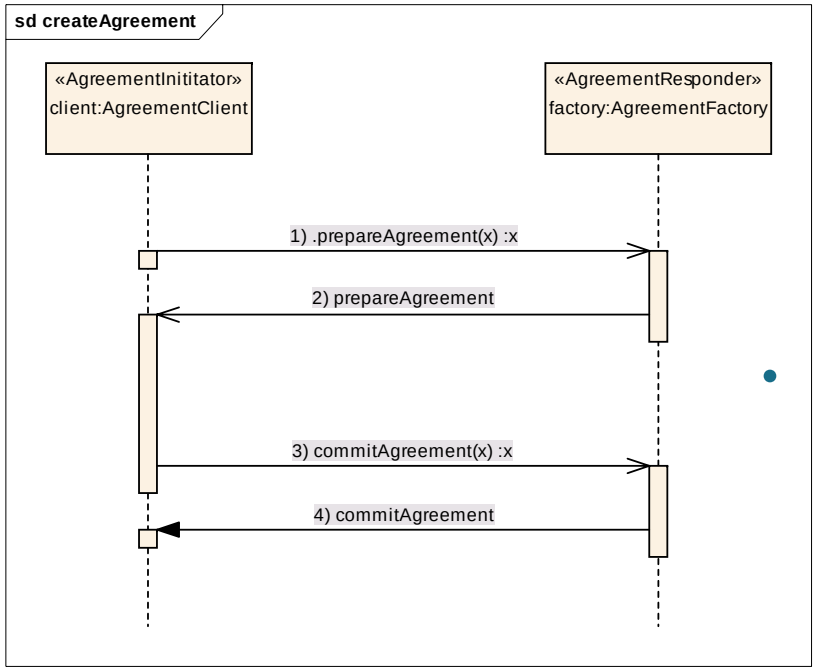


- New method refineAgreement()
- Input is a normal agreement offer
- No agreement created / no EPR sent back
- Response is (possibly refined) counter offer
- Content may change
  - e.g. ranges (CPU, memory, …) may be refined
- refineAgreement() can be called multiple times in the negotiation phase
  - Negotiating start times, resources, …
- Only valid counter offers are returned
  - Counter offer can be created in principle
- Counter offer is only a hint (no guarantee)
  - No pre-reservation implied here
- Grey terms may be skipped in a first step (needed?)

Refine & create agreement



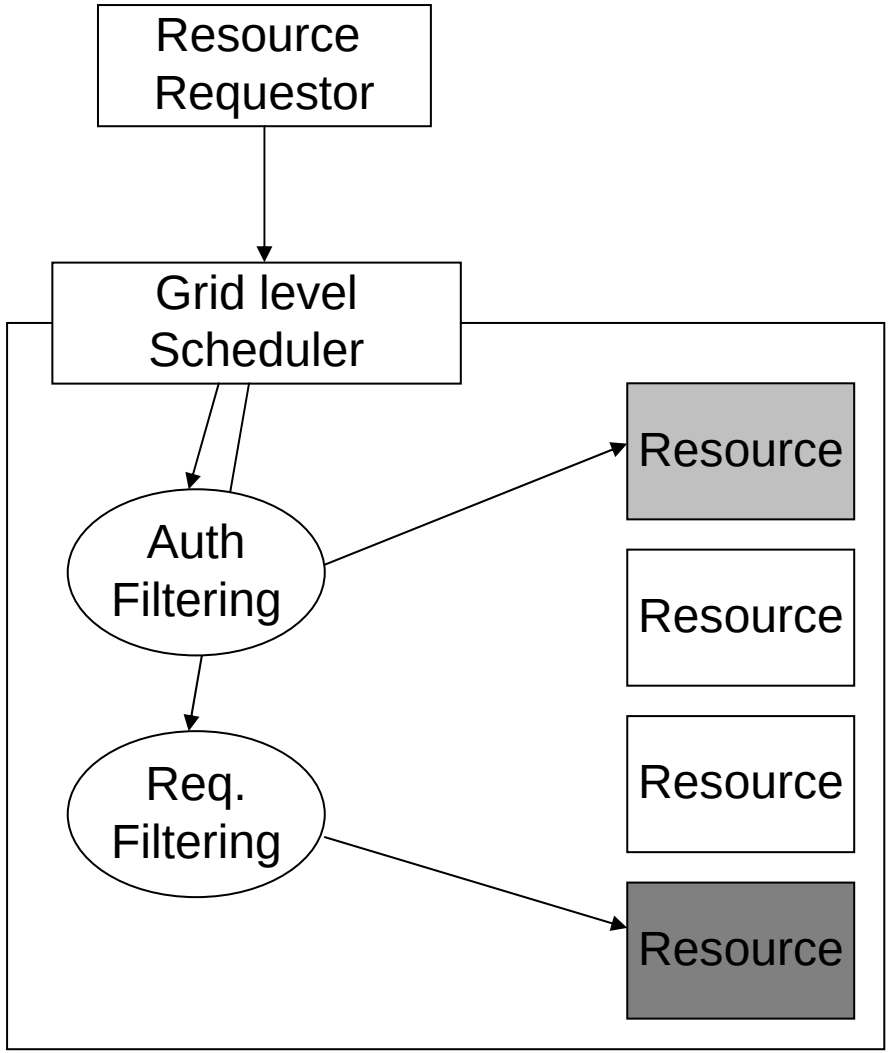
createAgreement (2PCP)



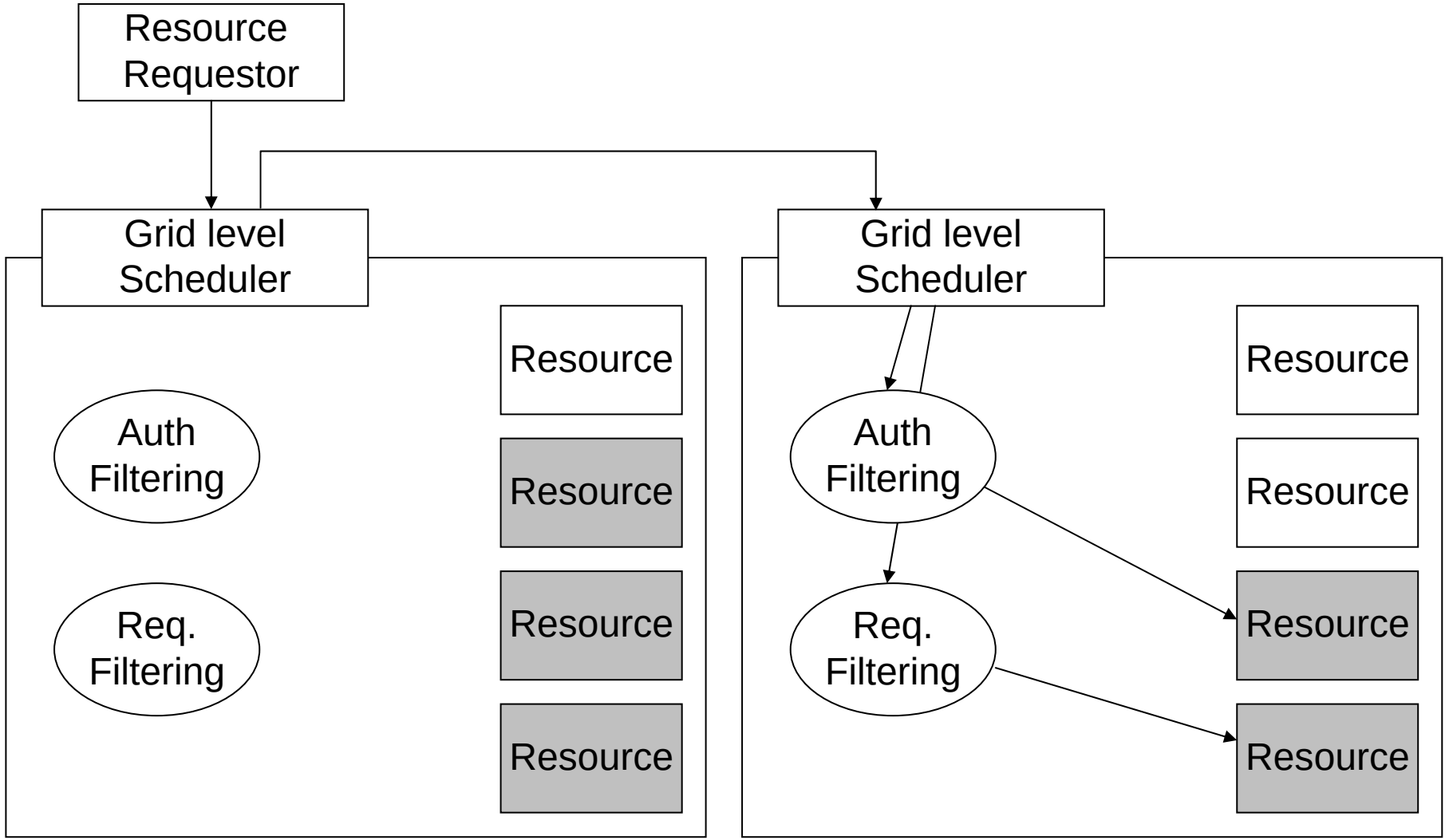
- EPR prepareAgreement(offer)
  - Same signature as createAgreement()
  - Creates a new Agreement with new state *prepared*
  - Short lifetime (e.g. one minute)
  - Includes resource pre-reservation
  - No or reduced Penalties?
- void commitAgreement(EPR)
  - Commits the prepared agreement referenced by the EPR
  - Changes the state to *observed*
  - Regular lifetime
  - Agreement costs/rewards/penalties become active
  - No errors are thrown, since resources are pre-reserved

Grid scheduling process

- Resource Discovery
  - Authorization Filtering
  - Minimal requirement filtering
- System Selection
  - Information gathering (caching)
- Reservation
  - Advance reservation
  - Task Submission
- Monitoring
- Cleanup



Multi domain negotiation



Execution Management

Execution Management after the Agreement Commitment

Prior to job execution	• Job-Transfer • Data-Transfer • Provisioning
During execution	• Monitoring/Reporting • Failure-Detection/Management
After execution	• Access to results • Clean-Up

Execution Management – Prior to Job Execution

- How is the job description transferred by whom?
- What about additional data?

Long-term:

- Data management as separate activity that is scheduled managed by initiating scheduling instance.

Short-term:

- JSDL job description is attached to agreement.
- Data management is not supported

Execution Management – Job Control

- Who initiates the job execution?
- Does it need to be triggered?
  - How is the agreement referenced to be considered?
- Or is it done automatically based on the agreement?

Long-term:

- OGSA-BES?
- OGSA-HPC-P?

Short-term:

- The job execution is initiated automatically by the agreement provider based on the JSDL description.

Execution Management – During Job Execution

- How is the job monitored?
- Who recognizes failures?
- Who manages failures?

Long-term:

- If possible, failures should be handled at the resource provider; if not possible to recover locally, it is reported to and handled by the initiator.

Short-term:

- Failures are automatically handled.
- Monitoring?

Execution Management – After Job Execution

- How are results accessed?
- How long are job information available?

Long-term:

Short-term:

Security Context – Authentication

- How do we manage access control and authentication?

Long-term:

- VOMS?

Short-term:

- ?

Issues, questions, …

Issues to discuss

- Is the current extension to WS-Agreement feasible?
- Schedulers remain automonous. All information needed has to be passed via one scheduler interoperation interface. Do we cover all aspects
- There is no common information model shared between the schedulers. Solution?
- ….

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