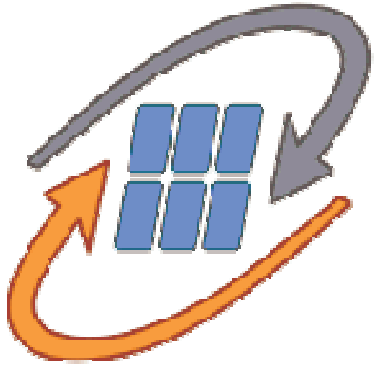

K-Wf Grid

Information Society Technologies

Knowledge Assimilation for Performance Prediction of Grid Services for optimal Workflow Execution

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Presentation Outline

- Problem Definition
- Our solution using IBL
- Monitoring and getting relevant data
- Refinement of Case Retrieval
- Using historical data of one WS to predict run-time of another WS
- Future Enhancements

Initial Assumptions

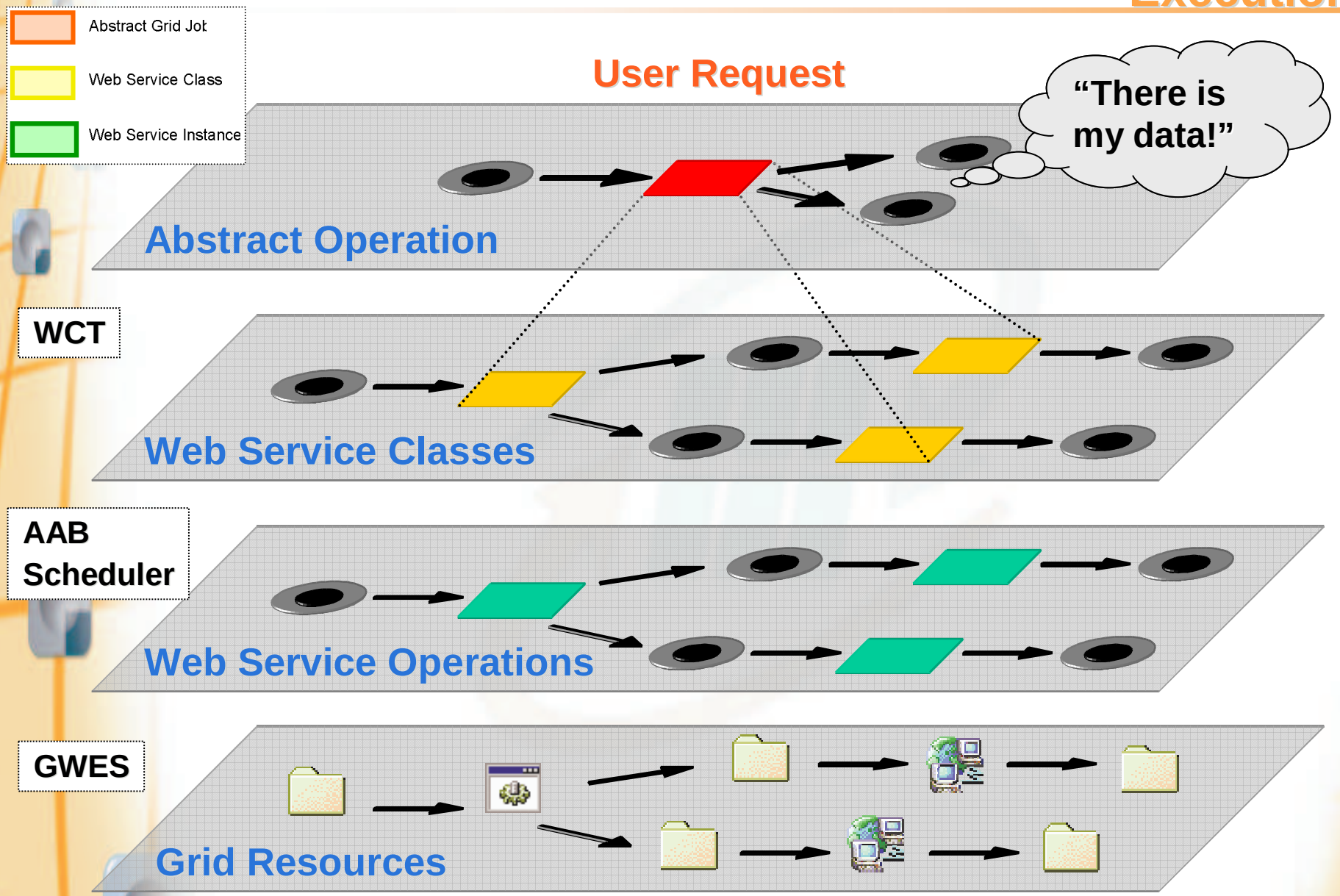
Complex Applications are being created as workflows of Web/Grid Services

- as opposite to “traditional Grid applications”: input + script submission/execution + output
- **SOA – Service Oriented Architectures**

We assume:

- Dedicated Grid Resource Environment

Workflow Orchestration and Execution



Problem Definition

The problem can be defined for two components:

1. **Scheduler's Requirement**
   To execute "the best" WS deployment (resp. one of it's operations) as a part of a workflow.
2. **WCT's Requirement**
   To use "the best" WS Class from several alternatives.

"The best" is meant in terms of predefined utility.

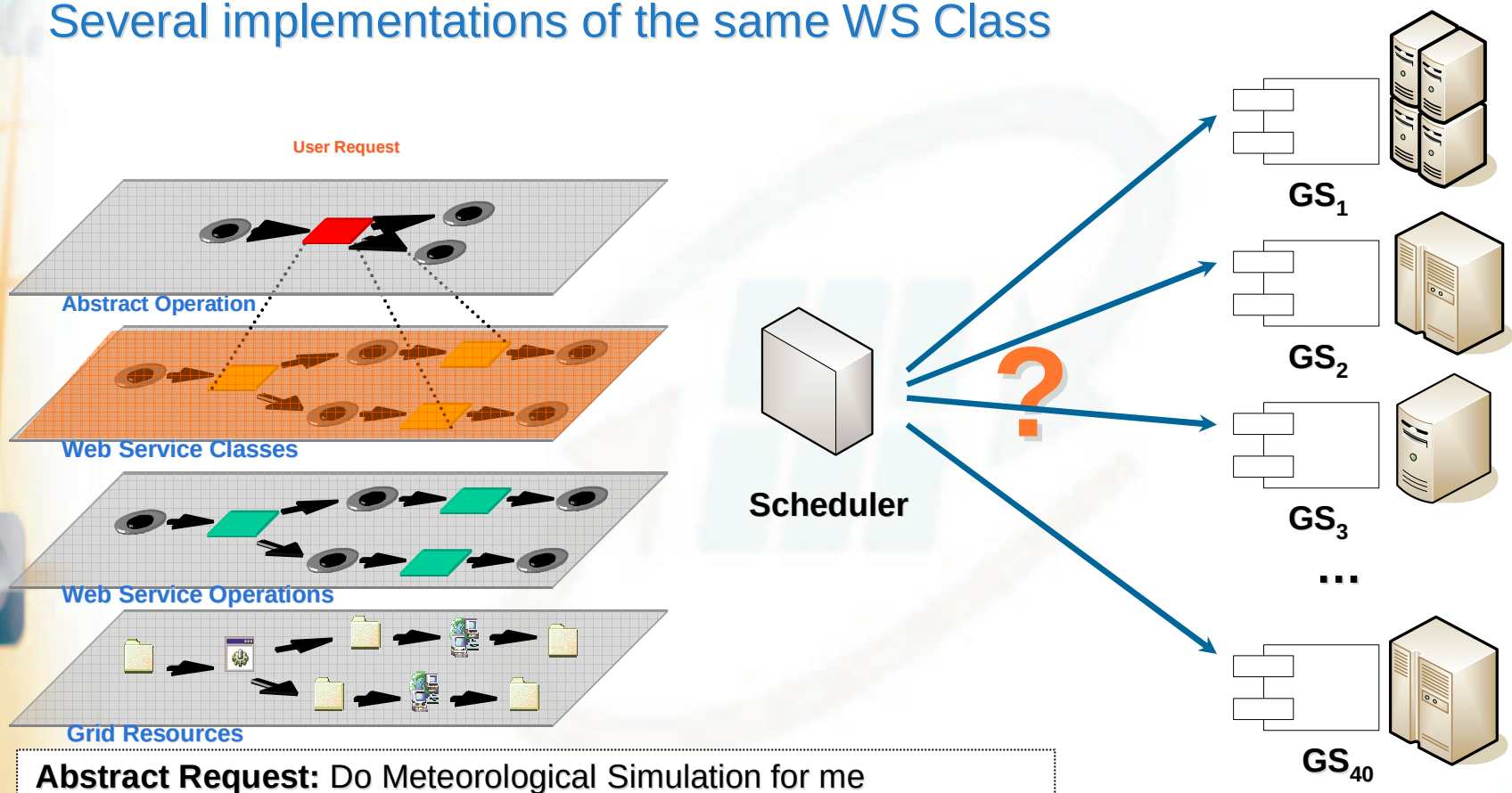
Utility Function

- minimize run time,
- minimize cost,
- ensure availability (that the WS will be maximally available),
- ensure robustness (that WS will not be interrupted, so it would need to start again),
- and others

Supporting Scheduler

Example Scenario: There are 40 deployments of the same WS deployed on different Grid Resources.

Several implementations of the same WS Class



Abstract Request: Do Meteorological Simulation for me
Service Class: Meteorological Model
Service Instance: MM5
Service Deployment: http://cluster.somewhere.com/wsrf/mm5

Instance Based Learning

Case Based Reasoning applied

1. Case Representation
2. Case Indexing
3. Case Retrieval
   - Nearest-neighbor retrieval (euclidean or other)
   - Locally (linear or polynomial) Weighted Regression
4. Case Adaptation
5. Case-Base Maintenance

Instance-based learning deficiencies

- Its major disadvantage is that it requires a large amount of historical data.
- Problem with qualitative features, where exact match of feature values must be made.

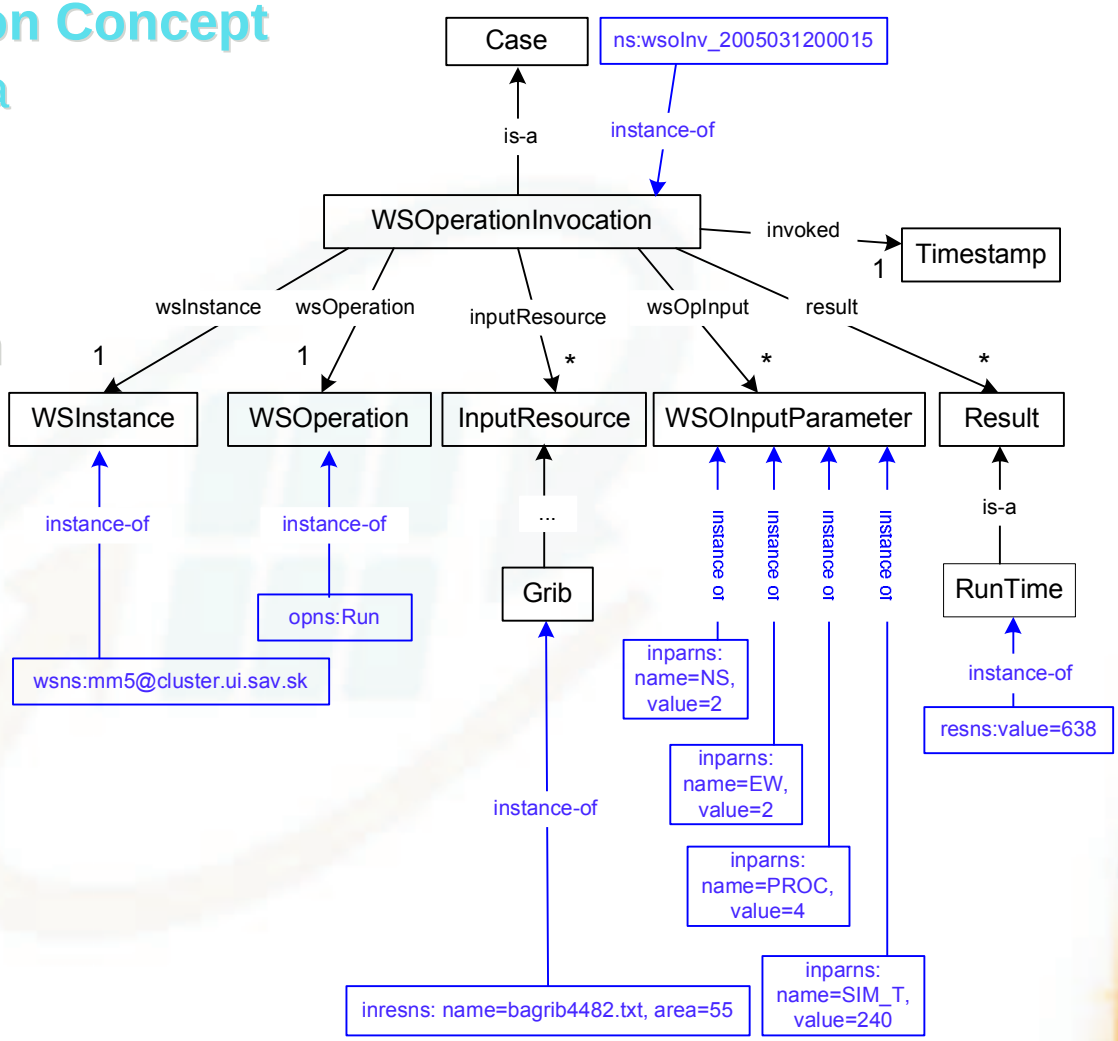
We need to know in **advance** about each Grid Service Class's:

- **It's feature vector**
- **Results we want to predict for the Grid Service Class**

Case Representation

WSOperationInvocation Concept

- used to assimilate data from several sources
- represents a single invocation of a WS Instance operation
- Data assimilated from:
  - Events,
  - Generic Ontology,
  - Domain Specific Ontology,
  - OWL-S Service Descriptions



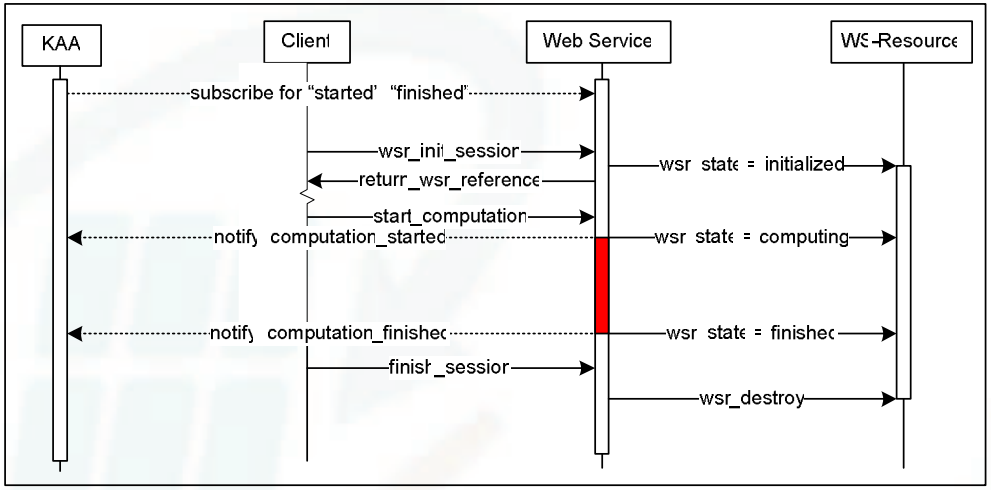
Monitoring

Monitoring can be enacted by:

- Monitoring WS Operations
- Code Instrumentation
- WS-Notification

Statefull vs. Stateless WS

- Statefull maintain state, stateless do not
- WSRF (Web Service Resource Framework)
  - WS-Resource, WS-Life Time, WS-Notification and others

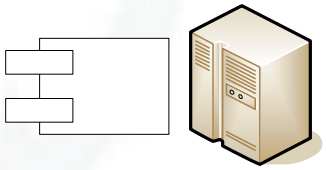


Challenge 1

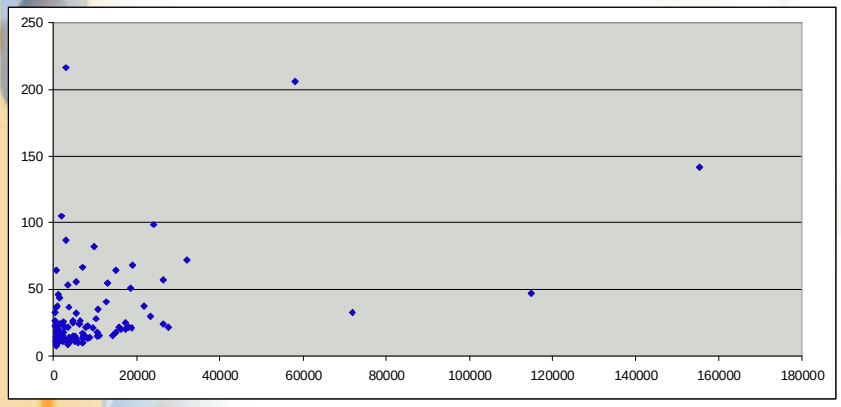
Case Retrieval must be improved – especially when we do not have well populated Case Base

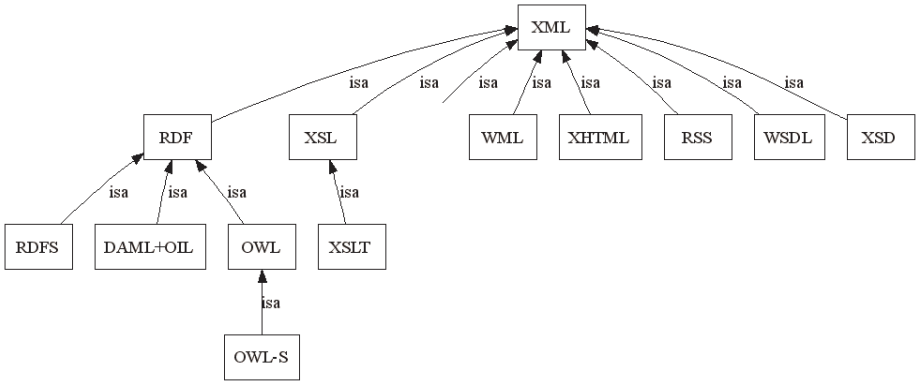
We propose refinement of case retrieval for instance-based learning through semantic description of input data

- Input parameter are ontologicaly modeled.
- Ontology allows us to build semantic structures where concepts are derived from general to more specific.
- This allows to deduce more general concepts of ontology, thus enlarging the number of cases retrieved for reasoning, thus providing more suitable base for prediction of WS behavior.



A XML-XSD validation Web Service
- One of it's features is file type

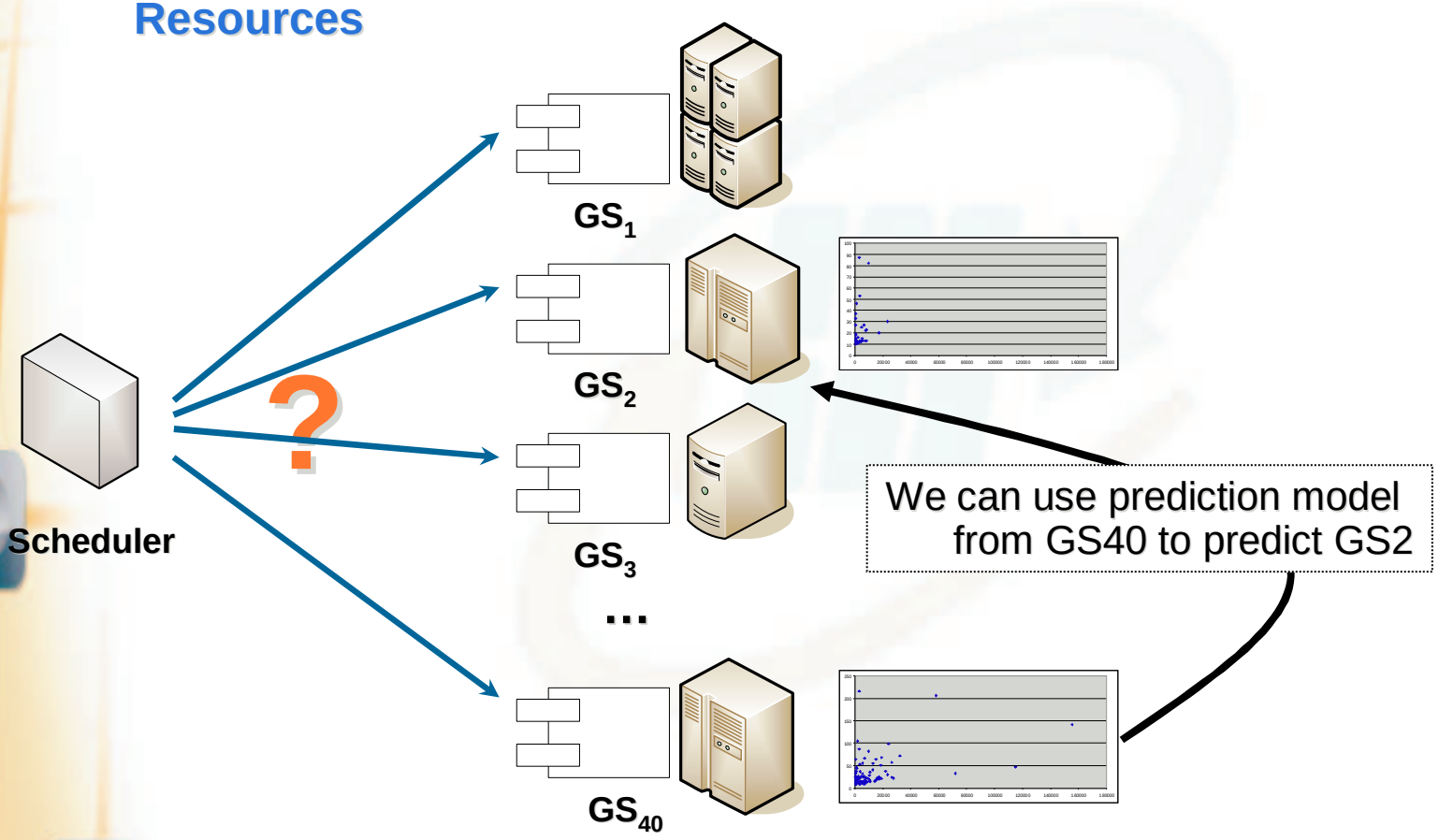




Challenge 2

We do not have historical information about GS2, but have a lot of historical information about GS40

GS2 and GS40 have deployed Grid Service and run on very similar Grid Resources



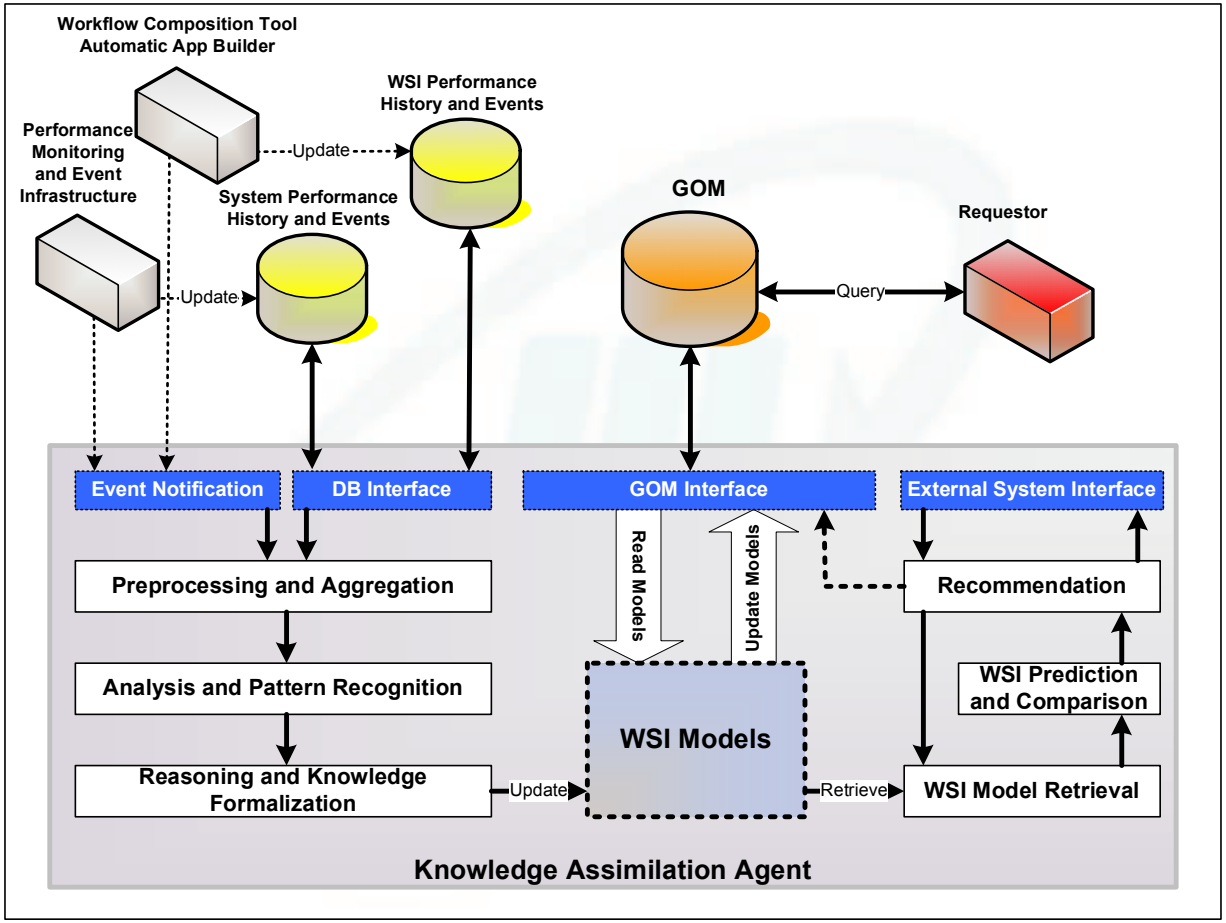
KAA - Objective

- **Main Objective**
  - to develop an agent for the maintenance of K-Wf Grid knowledge base, extraction of knowledge from the monitoring results, workflow execution reports, user input and other sources.
- **Extracts knowledge**
  - Extracted knowledge used to predict WS instance behavior patterns
    - WS runtime prediction,
    - others: WS operation latency, WS reliability prediction, WS availability prediction, WS accessibility prediction
  - Usable during scheduling of workflow executions
- **Consumes**
  - Historical (monitored) information and
  - Semantical description of web services and data

KAA – Current Implementation Status

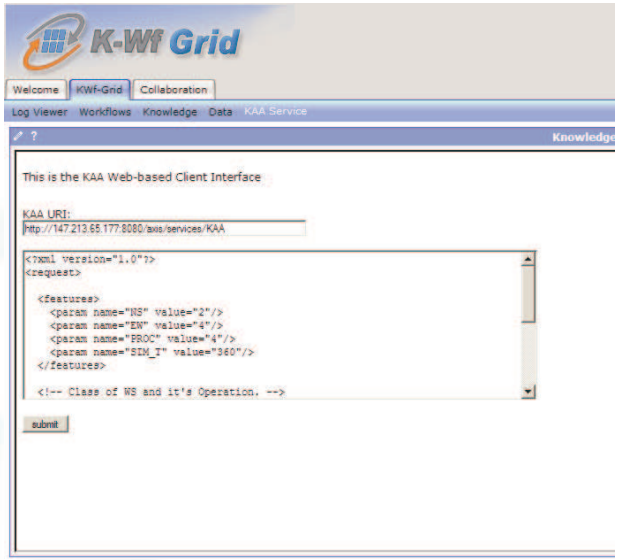
- **EventStore**
  - a stateless WS (Axis)
  - Stores XML Events into RDBMS (MySQL)
  - DB must be first initialized using XSD (using Torque)
  - When EventStore receives a new Event, it should initialize the update of the model for a WS in GOM (CONTEXT >> RESULT)
- **WS Behavior Predictor**
  - Takes cases from a DB (CASE = CONTEXT + RESULT)
  - Predicts RESULT for the given CONTEXT
  - Uses instance based learning and CBR to predict the run time
  - Can be adopted to predict WS performance measures (recently predicts runtime of WS depending on input parameters)
- **KAA**
  - Retrieves RESULT for a given CONTEXT
  - Visualization of KAA operation is visualized through the Logger portlet

KAA Architecture



KAA: Sample Request

```
<?xml version="1.0"?>
<request>
  <features>
    <param name="NS" value="2"/>
    <param name="EW" value="4"/>
    <param name="PROC" value="4"/>
    <param name="SIM_T" value="360"/>
  </features>

  <!-- Class of WS and it's Operation. -->
  <wscontext class="MM5" operation="run"/>

  <!-- WS Deployment Alternatives. One of them must be chosen.
    -->
  <wsalt>
    <ws uri="http://cluster.ui.sav.sk/mm5"/>
    <ws uri="http://cluster.cyfronet.pl/service/mm5"/>
    <ws uri="http://cluster.softeco.it/service/mm5"/>
  </wsalt>
</request>
```



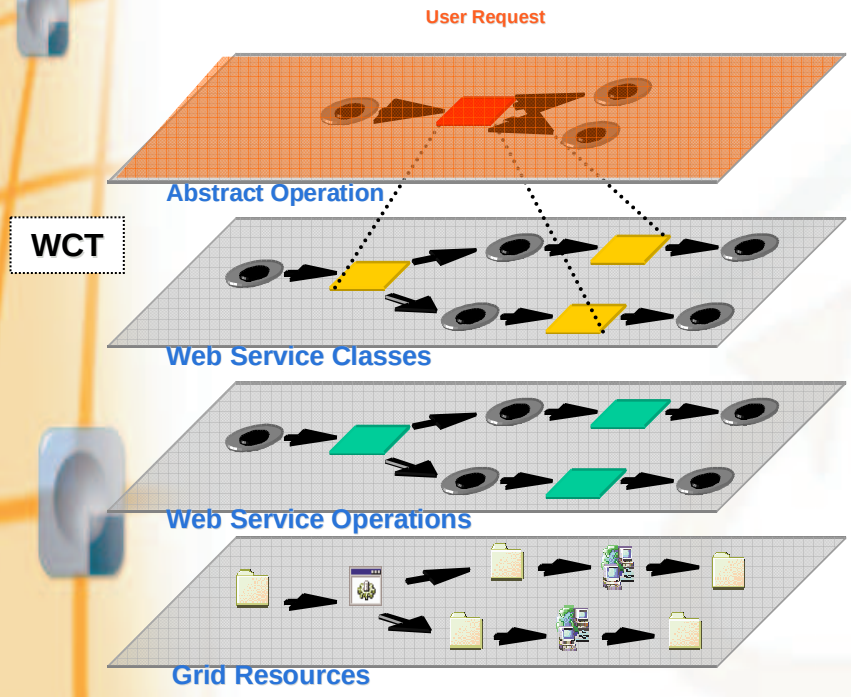
KAA: Sample Response

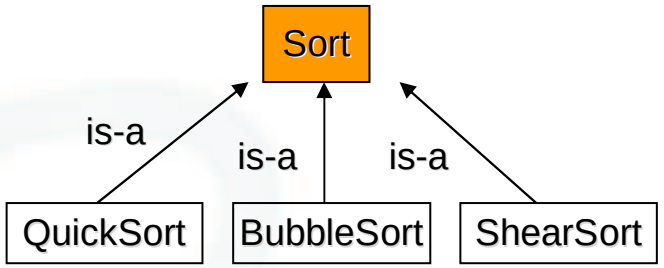
```
<?xml version="1.0"?>
<result>
  <runTime wsuri="http://cluster.ui.sav.sk/mm5">
    <value>125</value>
    <status>OK</status>
    <message>159 cases used to predict the result.</message>
  </runTime>

  <runTime wsuri="http://cluster.cyfronet.pl/service/mm5“>
    <value></value>
    <status>NORESULT</status>
    <message>Do not have enough cases to predict the runTime for
   this WS.</message>
  </runTime>

  <runTime wsuri="http://cluster.softeco.it/service/mm5">
    <value></value>
    <status>NORESULT</status>
    <message>Do not have enough cases to predict the runTime for
   this WS.</message>
  </runTime>
</result>
```

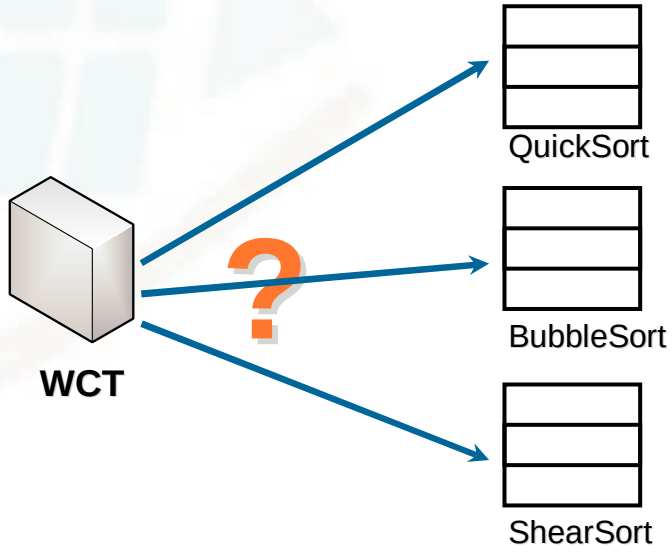
Future Plan: Supporting WCT

Same Interface implemented in several WS Class.

Example Scenario: There are 3 WS Classes of the same Interface.







Thank You

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