A Web Registry for Publishing and Discovering Mathematical Services
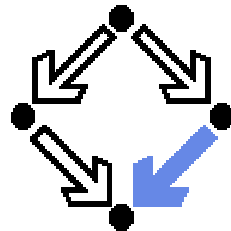
Rebhi Baraka

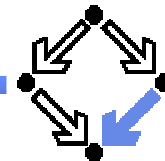Coauthors: Olga Caprotti and Wolfgang Schreiner

{rbaraka,ocaprott,schreine}@risc.uni-linz.ac.at

Research Institute for Symbolic Computation (RISC-Linz)
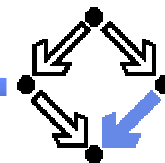
Johannes Kepler University, Linz, Austria

Outline

- Key Idea.

- What is a Mathematical Web Service?

- A Mathematical Service Description Model.

- The MathBroker Registry

- Publishing and Querying Service Descriptions.

- Achievements

- Next Step.

Key Idea

- Use and extend existing Web technologies to offer mathematical problem solutions on the Web as Web services.

- Use a Web registry to broker these services (between developer and user) :
  - Describe them using a mathematical description language (devised for this purpose).
  - Advertise them in the Web by publishing their descriptions in a Web registry.
  - User discovers them by browsing and searching the registry.
  - User accesses them from their locations.
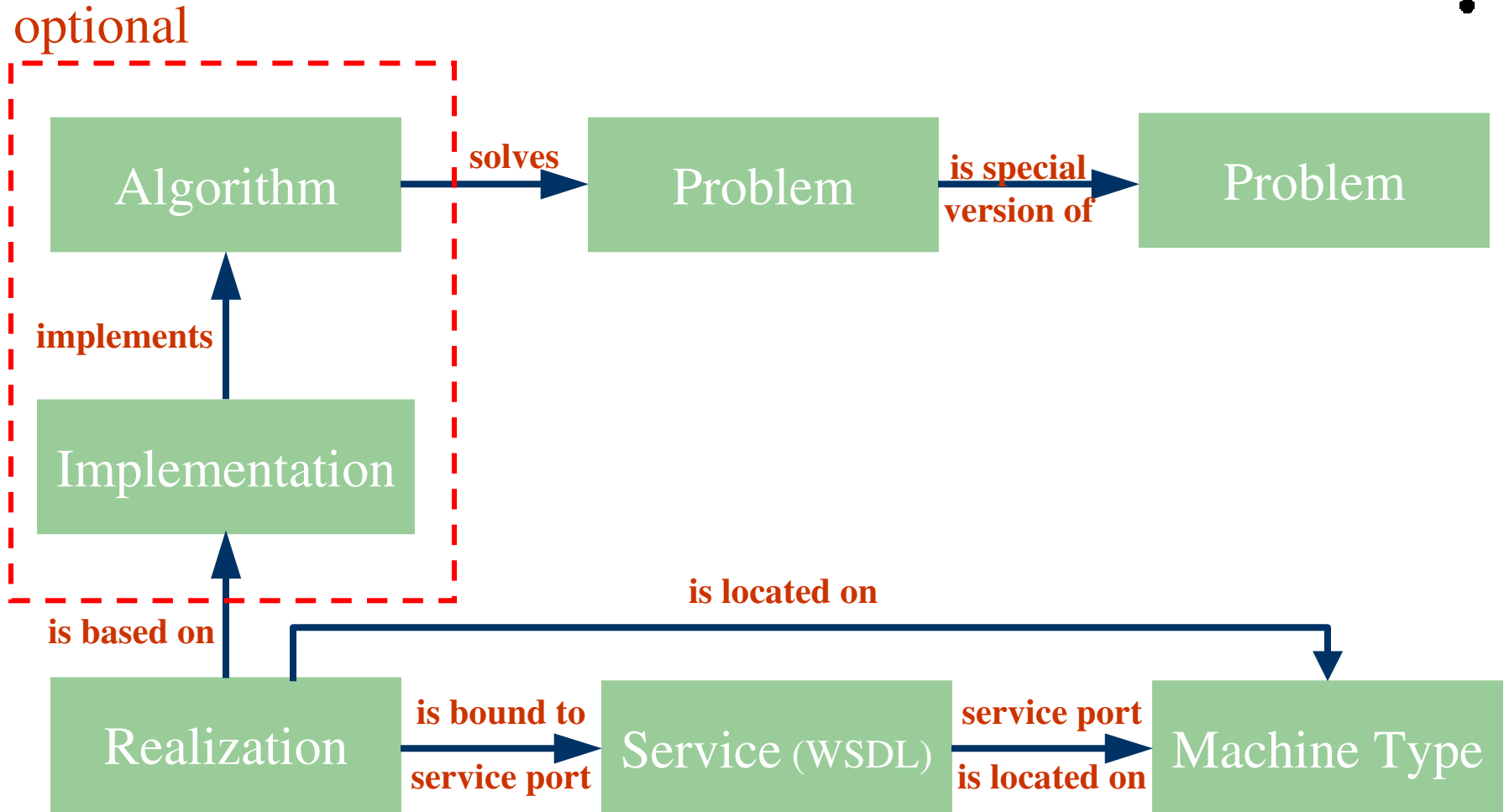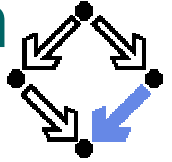
What is a Mathematical Web Service?
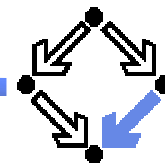
- A Web service is a problem solution that can be described, published, located, and invoked over the Web.

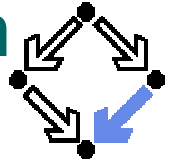- A mathematical Web service is a Web service that offers the solution to a mathematical problem.

MathBroker Sample Services:

http://perseus.risc.uni-linz.ac.at:8080/openmath/index.html

A Model for Mathematical Service Description

optional

```
┌─────────────────────────────┐
│  Algorithm ──solves──> Problem ──is special version of──> Problem
│     ↑
│  implements
│     │
│  Implementation
│     ↑
│  is based on
└─────────────────────────────┘
        │                              is located on
  Realization ──is bound to service port──> Service (WSDL) ──service port / is located on──> Machine Type
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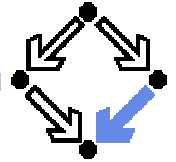
A Model for Mathematical Service Description

- Implemented as a highly structured language (MSDL).
- MSDL allows the sharing of descriptions among entities.
- Provides for reusable library of descriptions.
- A Web registry is used to publish and discover descriptions in MSDL.

MSDL:

http://poseidon.risc.uni-linz.ac.at:8080/results/xsd.html

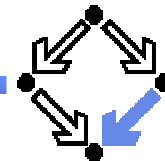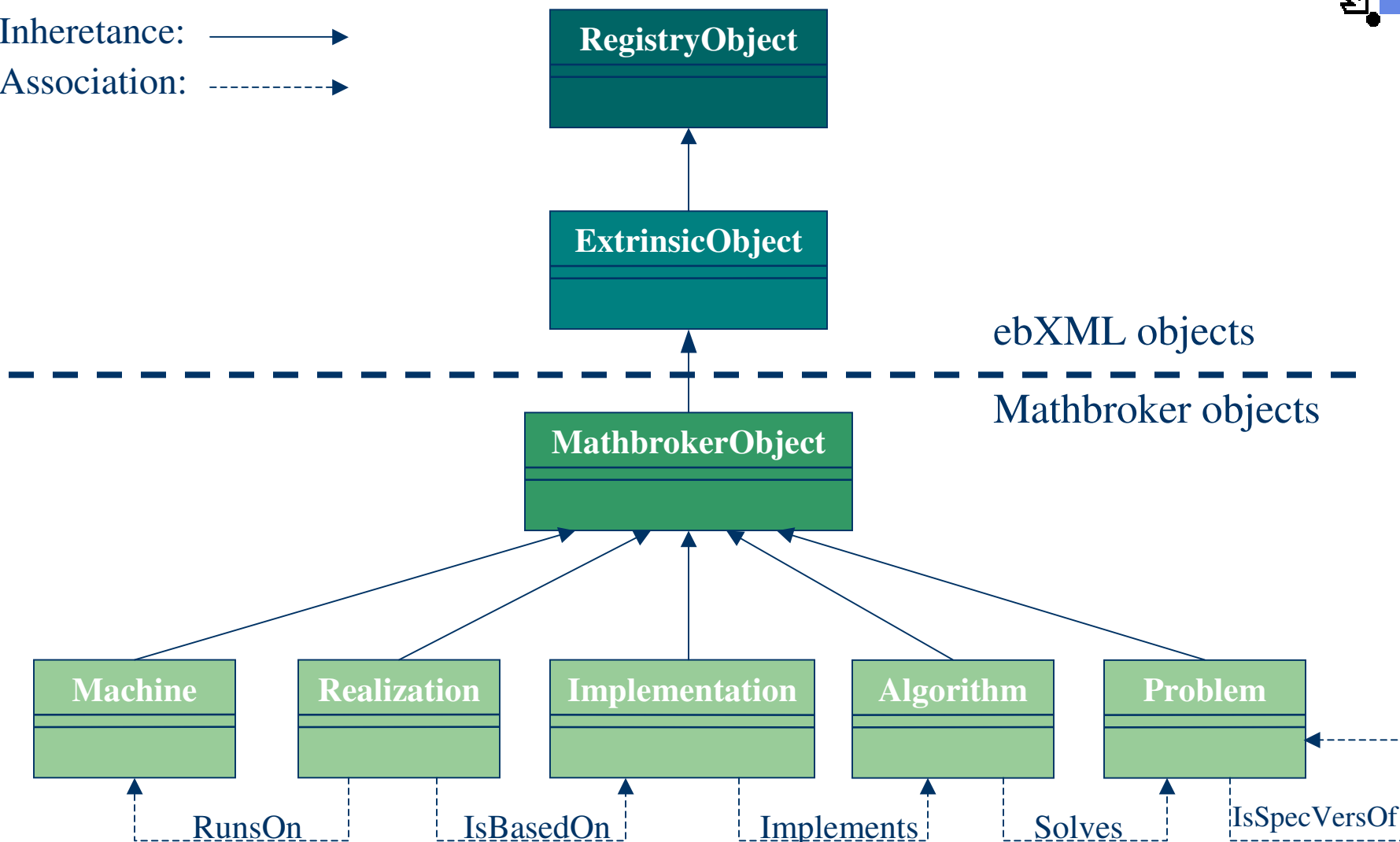# The MathBroker Registry

- A web-based shared resource that enables publishing, and discovery of Web services.

- Examples: UDDI and ebXML registry standards.

- A (mathematical) registry provides a set of functionalities to facilitate the sharing and exchange of (mathematical) service descriptions.

- Based on OASIS ebXML registry standard.

- Extends ebXML Registry Reference Implementation (ebXMLrr).
  - Registry service.
  - Registry client.

- Particularly, we extended the information model.
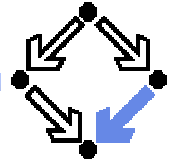
Extending the ebXML Registry

Inheretance: ⟶

Association: ⤏

RegistryObject

ExtrinsicObject

ebXML objects

Mathbroker objects

MathbrokerObject

| Machine | Realization | Implementation | Algorithm | Problem |

RunsOn   IsBasedOn   Implements   Solves   IsSpecVersOf

# The MathBroker Registry

- Handles mathematical service descriptions in the form of MSDL.

- MSDL entities can be manipulated, registered, associated, classified, and discovered via the registry.

- Mathematical taxonomies, e.g., GAMS are imported into the registry.
  - Mathematical entities can be classified.
  - Easier search/browse capabilities.

GAMS (Guide to Available Mathematical Software)

Publishing and Querying Service Descriptions
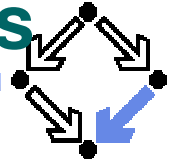
Publishing

- Client side
  - Establishes a connection with the registry,
  - Gets authenticated, and
  - Submits an MSDL description.
- Server side
  - Registry life cycle manager invokes the proper components to:
  - Extract individual entities and creates registry object for each.
  - Makes the required classification(s), and associations.
  - Saves each entity description as a repository item.

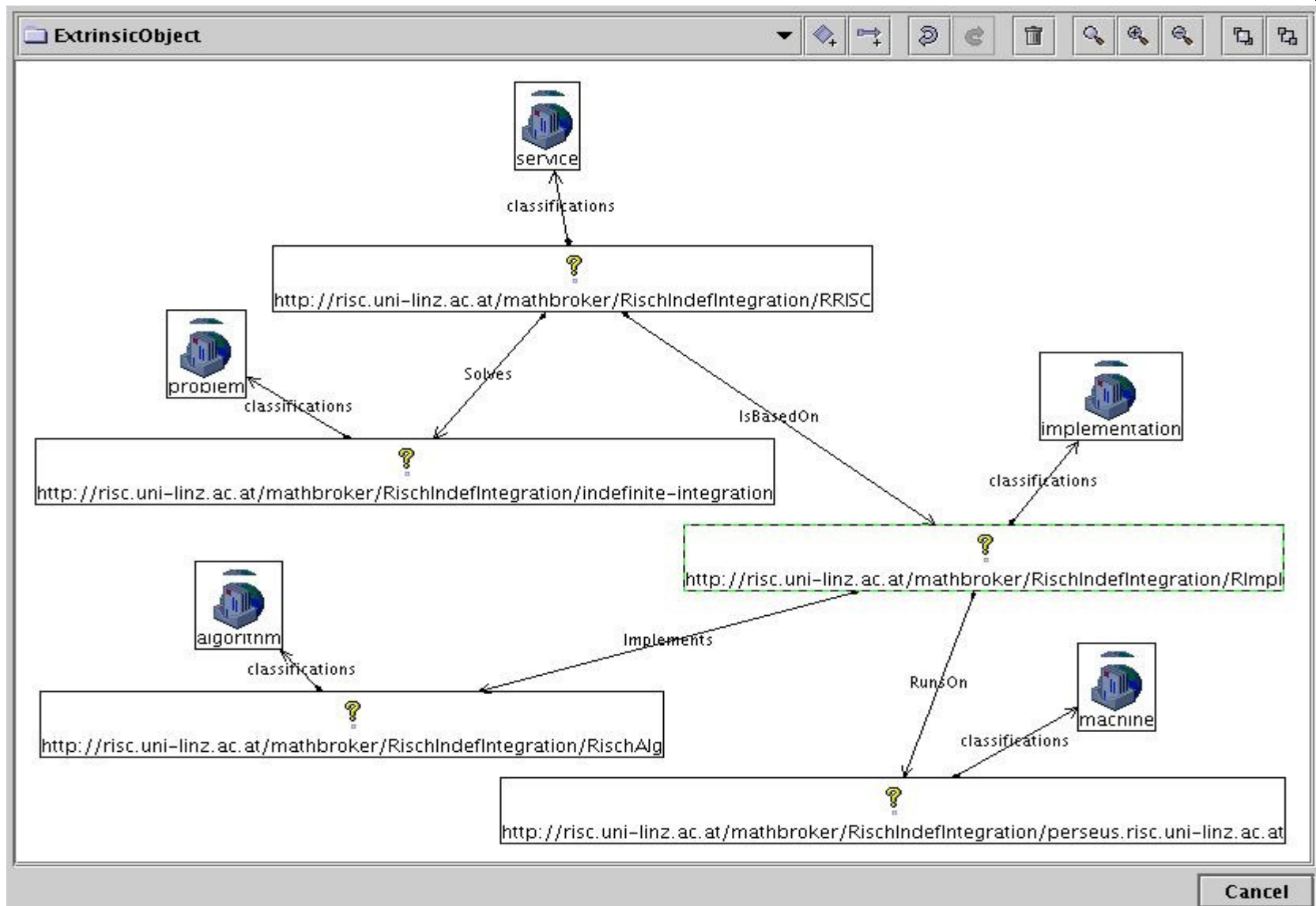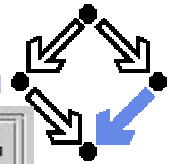# Publishing and Querying Service Descriptions
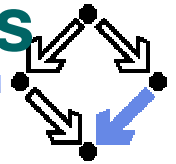
Querying

- A client establishes a connection with the registry.
- Submits a query: by name, by ID. or by classification.
- The registry query manager invokes the proper component to perform the query and return the resulting entities.

Registry:

http://koyote.risc.uni-linz.ac.at:8080/omar/registry/thin/browser.jsp

http://poseidon.risc.uni-linz.ac.at:8080/results/Registry.html
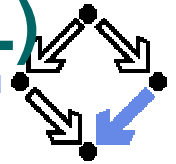
MathBroker Objects in the Registry Browser

Mathematical Services Query Language (MSQL)

- Design and implement an expressive query language MSQL. Example:

  Find all algorithms in GAMS that solve problem *myP* and have deterministc polynomial time complexity.
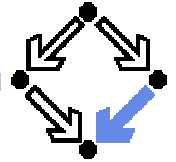
```
select every algorithm from
   /urn:uuid:56e73807-5d2f-43c8-925a-ec6341b29dcc
where
   //problem[contains(@name, "myP")] and
   //element[@class = "P"]
return algorithm
```
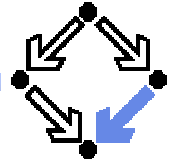
Achievements
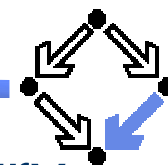
- Import mathematical taxonomies into the registry, e.g., GAMS.
  - Mathematical entities can be classified.
  - Easier search/browse capabilities.
- MSDL entities can be manipulated, registered, and discovered via the registry.
- Dependencies among MSDL objects are modeled as Associations.
- A client to publish and query MSDL descriptions.
- An ebXML-based MSDL registry API.
- A Mathematical Services Query Language (MSQL).

Next Step

- Extend MSQL to handle semantic content of registered MSDL descriptions. Example:

  Given a problem P with precondition p and postcondition q, find any service S that solves a problem with precondition p' and *postcondition* q' such that $p \Rightarrow p'$ and $q' \Rightarrow q$ (then S can also solve P).

MathBroker Project:

http://www.risc.uni-linz.ac.at /research/parallel/projects/mathbroker2

Thank You.