

# The OO jDREW Engine of Rule Responder: Naf Hornlog RuleML Query Answering

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**Wednesday, February 27, 2007**

# Outline

- Rule Responder Overview
- Agents
  - Personal
  - Organizational
  - External
- Rule Engines
  - Prova
  - OO jDREW
- Communication Middleware
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# Overview of Rule Responder

- Rule Responder is an intelligent multi-agent system for collaborative teams and virtual communities
- Supports rule-based collaboration between the distributed members of such a virtual organization
- Members of a virtual organization are represented as semi-automated rule-based agents which use rules to describe the behavioral and decision logic
- Uses RuleML subset as its Rule Markup Language, based on logic and XML
  - The member of the RuleML family employed here is Naf (Negation as failure) Hornlog
- Implemented as a Web-based service architecture

# Personal Agents

- „ A personal agent assists a single person of an organization, (semi-autonomously) acting on his/her behalf
- „ The personal agent contains a FOAF\*-like profile plus FOAF-extending rules

\* The Friend of a Friend (FOAF) project: <http://www.foaf-project.org>

# Organizational Agents

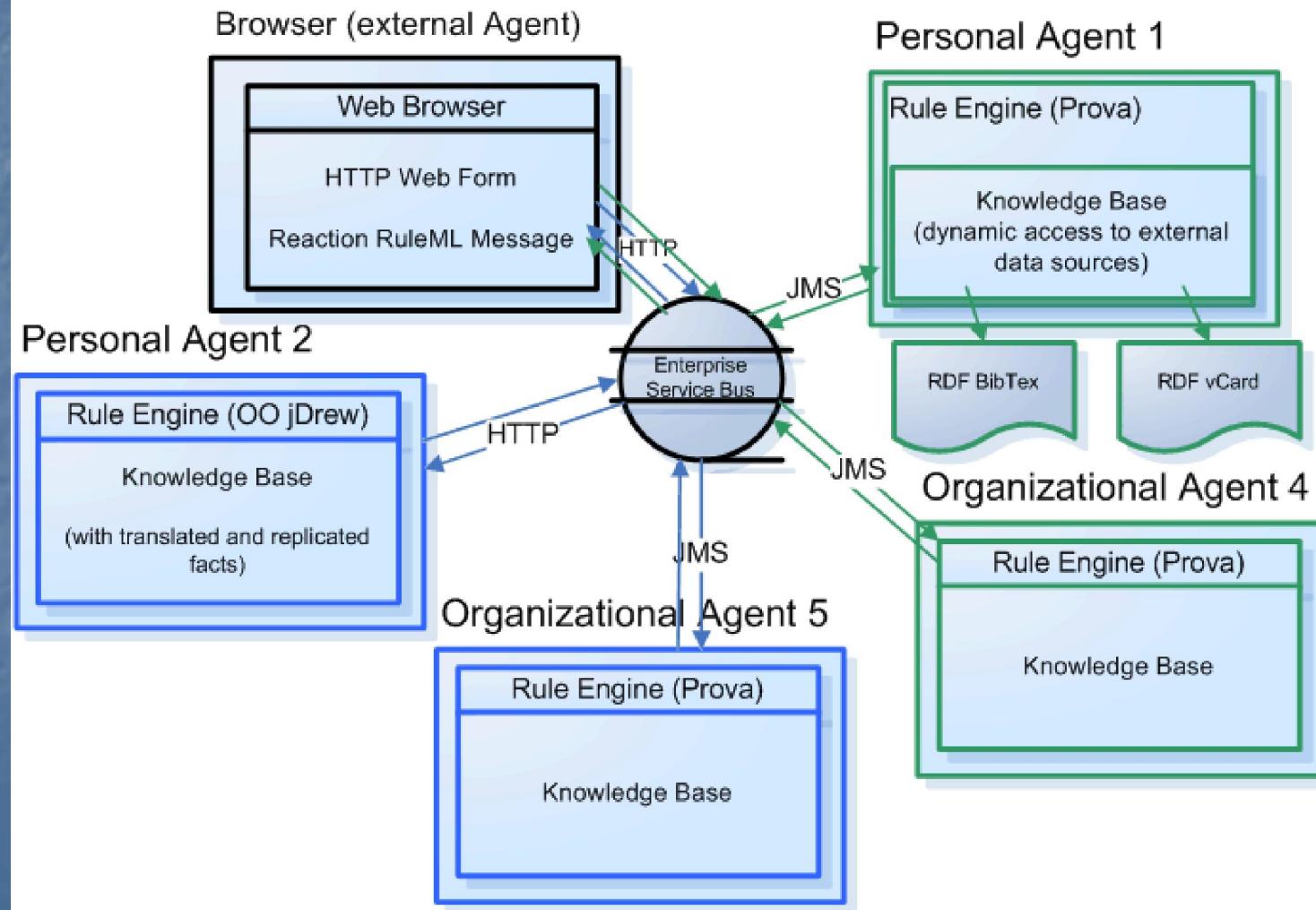
- „ Organizational agents are used to represent goals and strategies shared by each person in the organization
- „ Organizational agents contain rule sets that describe their organizations' policies, regulations, opportunities, etc.

# External Agents

- External agents communicate with the public interface of the organizational agents, exchanging messages that transport queries, answers, or complete rule sets
- End users employ a Web (HTTP) interface as an external agent of Rule Responder (currently an API-like browser interface)
- Support for multiple external agents (end users) at any time

# Architecture - Overview

Use Case 4   Use Case 5



# Rule Engines

- „ Prova (Prolog + Java)
- „ OO jDREW (Object Oriented Java  
Deductive Reasoning Engine for the Web)

# Prova

- Prova is used to implement the organizational agents of Rule Responder
- Prova is also used for some personal agents

# OO jDREW

- OO jDREW is used for implementing personal agents of Rule Responder
- Two modes of Rule Execution:
  - Bottom-up (fact-directed forward reasoning)
  - Top-down (query-directed backward reasoning)
- Rule Responder primarily uses top-down
- Supports rules in the following formats:
  - POSL (Positional Slotted presentation syntax)
  - RuleML (XML syntax, can be generated from POSL)

# Communication Middleware

- **Mule Enterprise Service Bus (ESB)**
  - Mule\* is used to create communication end points at each personal and organizational agent of Rule Responder
  - Mule supports various transport protocols (i.e. http, jms, soap)
  - Rule Responder uses http and jms as transport protocols

\* Mule – The open source SOA infrastructure:  
<http://mulesource.com>

# Reaction RuleML

- Reaction RuleML is a branch of the RuleML family that supports actions and events
- When two agents need to communicate, each others' Reaction RuleML messages are sent through the ESB

# Use Case

- RuleML-200x Symposium
  - One organizational agent acts as the single point of entry to the symposium
    - Assists with planning, preparing, and running the symposium
  - Personal agents represent Chairs of the Symposium
    - Program Chair, Publicity Chair, Panel Chair, General Chair, etc.

# Online Demo

- „ <http://responder.ruleml.org/>
- „ Use Case Demo Link:
- „ <http://ibis.in.tum.de/projects/paw/ruleml-2007/>

## Ex.: Personal Agent's Knowledge Base

% Sample OO jDREW rule in POSL syntax:

```
person(?person, ?role, ?title, ?email, ?telephone):-  
    mailphone(?person, ?email, ?telephone),  
    role(?person, ?role),  
    title(?person, ?title).
```

% Sample OO jDREW facts used by the above rule:

```
mailphone(John, john@email.com, 1-555-555-5555).  
role(John, Panel Chair).  
title(John, PHD).
```

## Ex.: Organizational Agent's Knowledge Base (Abridged)

% Sample Prova rule in POSL syntax:

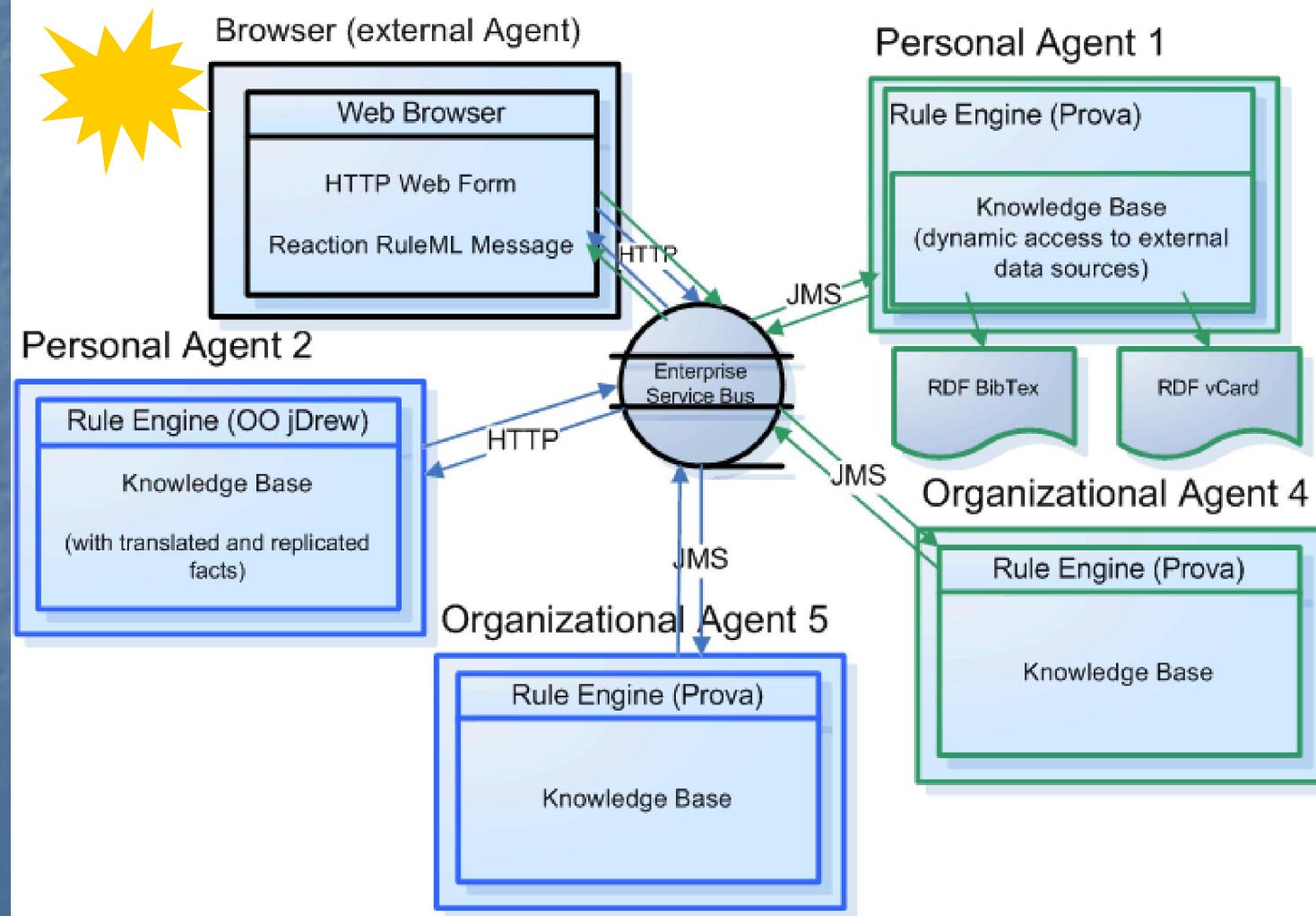
```
getContact(?conference_part, ?info, ?contact) :-  
    person(  
        ?contact, ?role, ?title, ?email, ?telephone).
```

# Example Message to the Organizational Agent

```
n <RuleML xmlns="http://www.ruleml.org/0.91/xsd"
n   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
n   xsi:schemaLocation="http://www.ruleml.org/0.91/xsd
n   http://ibis.in.tum.de/research/ReactionRuleML/0.2/rr.xsd"
n   xmlns:ruleml2007="http://ibis.in.tum.de/projects/paw#">
n
n   <Message mode="outbound" directive="query-sync">
n     <oid><Ind>RuleML-2007</Ind></oid>
n     <protocol><Ind>esb</Ind></protocol>
n     <sender><Ind>user</Ind></sender>
n     <b><content>
n       <Atom>
n         <Rel>getContact</Rel>
n         <Ind>ruleml2007_Challenge</Ind>
n         <Ind>update</Ind>
n         <Var>Contact</Var>
n       </Atom>
n     </content>
n   </Message>
n </RuleML>
```

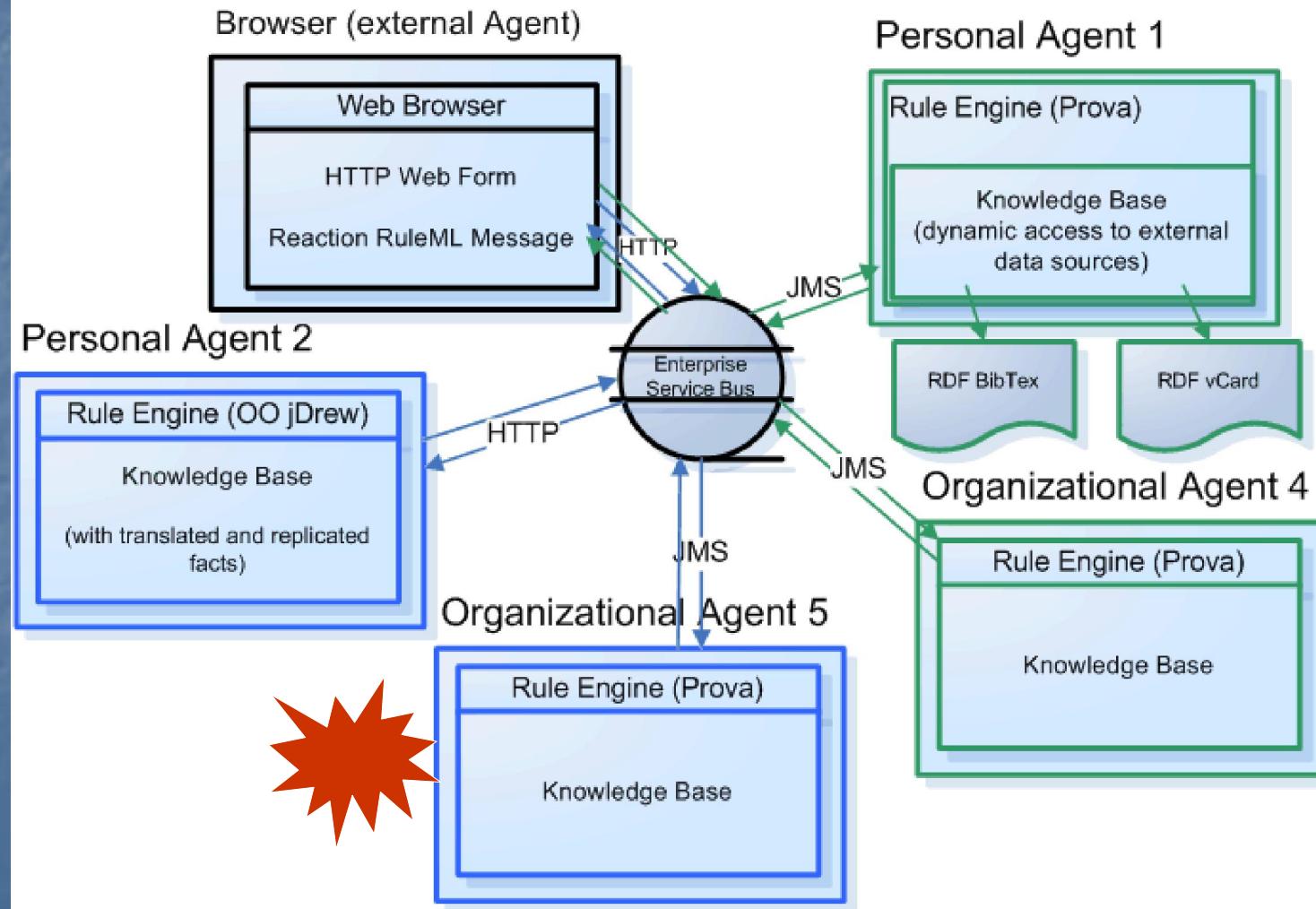
# Architecture - Overview

Use Case 4   Use Case 5



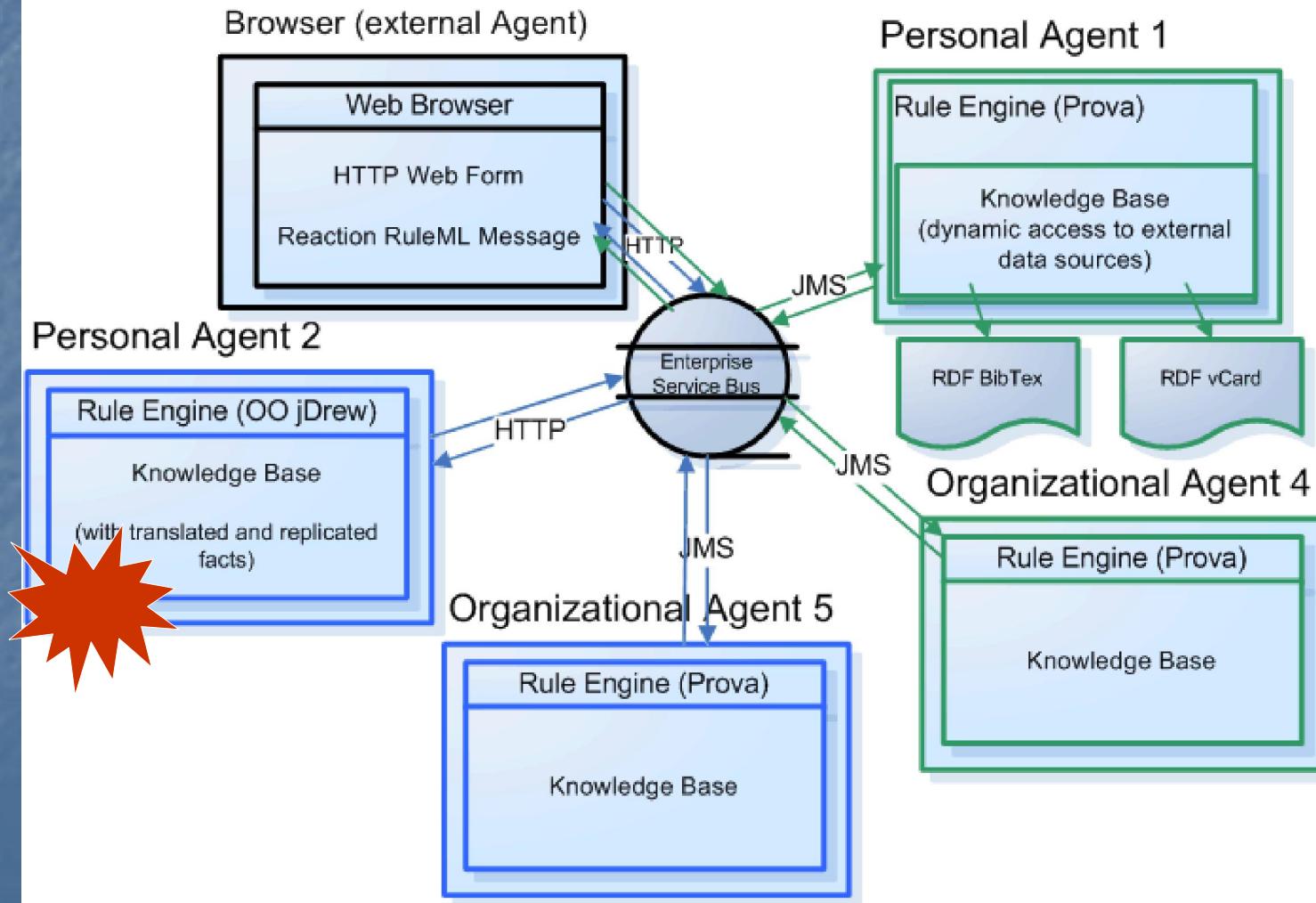
# Architecture - Overview

Use Case 4   Use Case 5



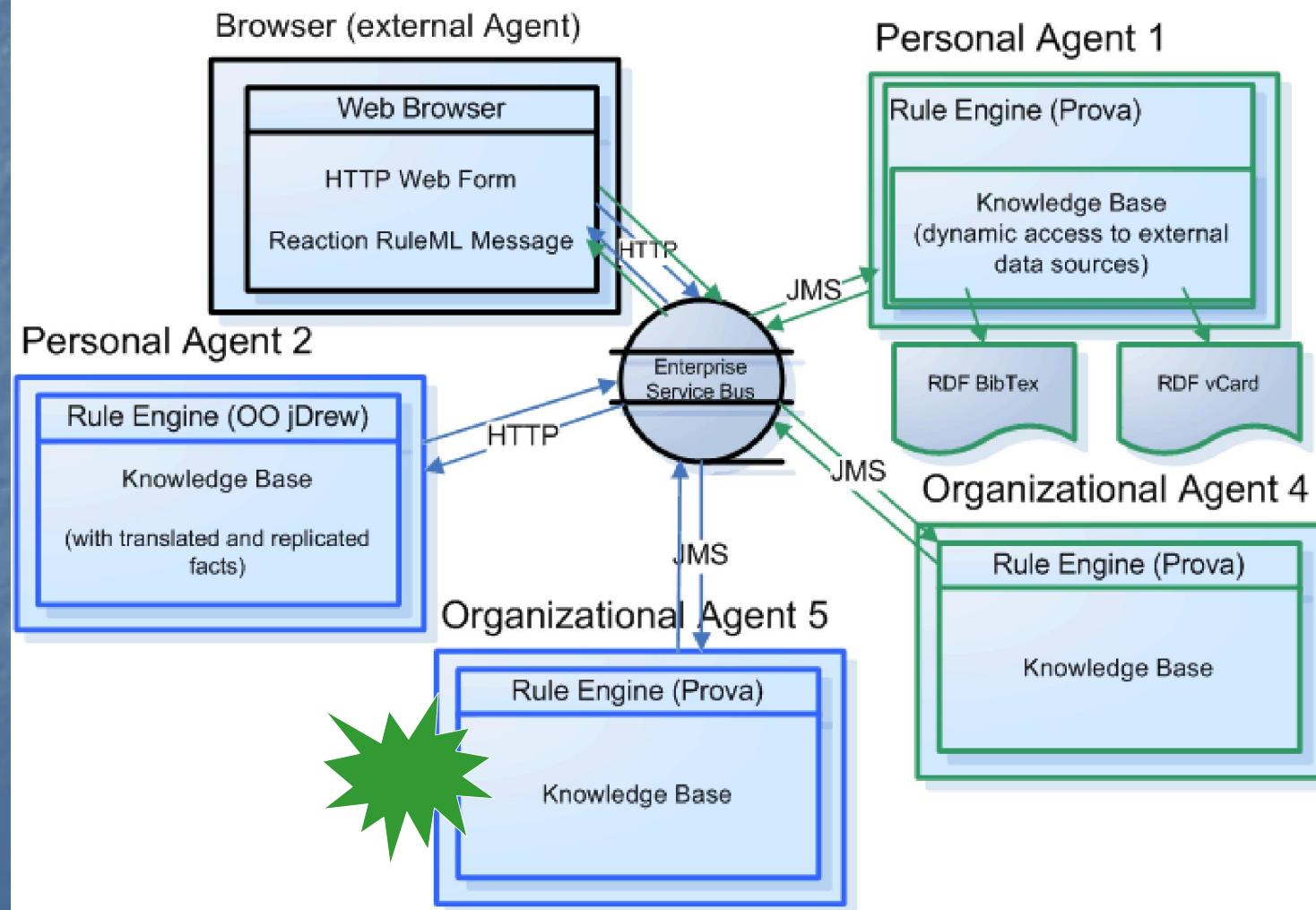
# Architecture - Overview

## Use Case 4 Use Case 5



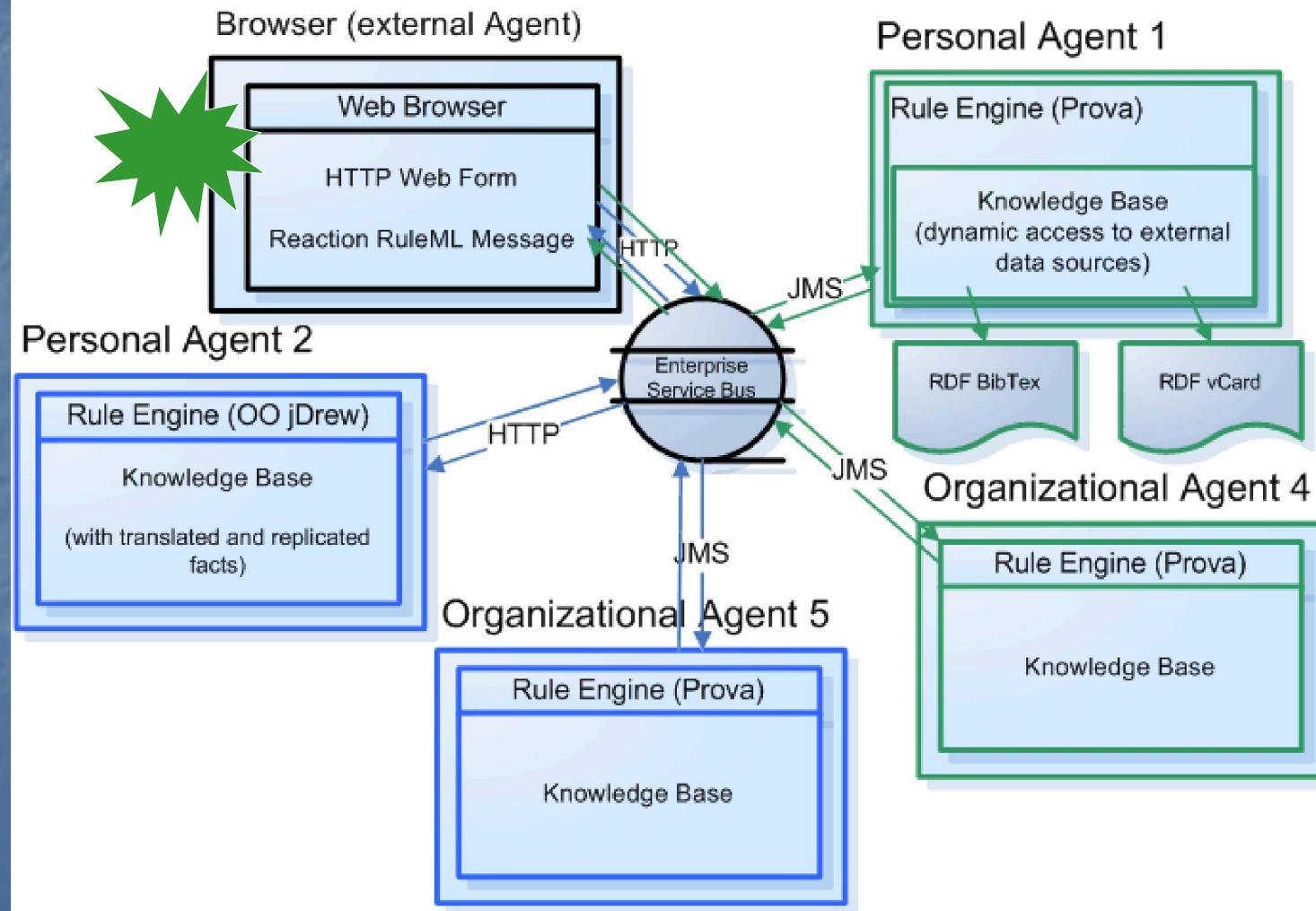
# Architecture - Overview

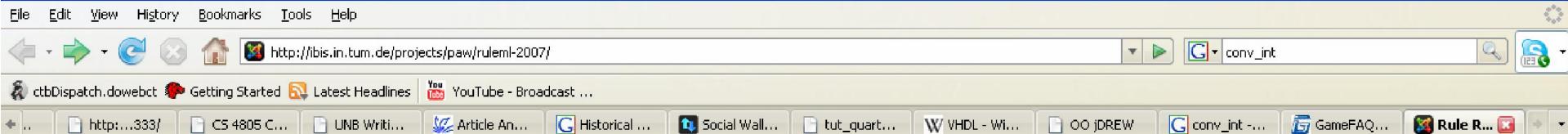
Use Case 4   Use Case 5



# Architecture - Overview

Use Case 4   Use Case 5





**MAIN MENU**

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- Publications
- News

**USER MENU**

- Use Cases
- Tools
- Download
- Project Management

**OTHER MENU**

- RuleML
- Reaction RuleML
- Prova
- OO jDrew

**USE CASES**

Written by Administrator  
Monday, 11 June 2007

## RuleML-2007 Rule Responder

Use this text form to send a query in [Reaction RuleML](#) in format to the RuleML-2007 Responder:

```
xmlns:ruleml2007="http://ibis.in.tum.de/projects/paw#"

<Message mode="outbound" directive="query">
    <oid>
        <Ind>RuleML-2007</Ind>
    </oid>
    <protocol>
        <Ind>esb</Ind>
    </protocol>
    <sender>
        <Ind>user</Ind>
    </sender>
    <content>
        <Atom>
            <Rel>getContact</Rel>
            <Ind>ruleml2007_Challenge</Ind>
            <Ind>update</Ind>
            <Var>Contact</Var>
        </Atom>
    </content>
</Message>
```

**Description:**

[RuleML-2007 Responder Use Case](#)

**Rule Interface Descriptions (Signatures)**

(you might copy and paste the examples in the Rule Responder form):

- ▶ [performative\(Performative\)](#) [example]
- ▶ [interface\(Query, Description\)](#) [example]
- ▶ [agent\(Agent\)](#) [example]
- ▶ [topic\(Topic\)](#) [example]
- ▶ [role\(Role\)](#) [example]
- ▶ [assigned\(Agent, Topic, Role\)](#) [example]
- ▶ [getContact\(Topic, Task, ContactInfo\)](#) [example]
- ▶ [permit\(Author, submit\(Author, Submission\)\)](#) [example]
- ▶ [submitted\(Submission\)](#) [example]
- ▶ [accepted\(Submission\)](#) [example]

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```
<?xml version="1.0" encoding="UTF-8"?>
<RuleML xmlns="http://www.ruleml.org/0.91/xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.ruleml.org/0.91/xsd RuleML_0.91.xsd">

<Message mode="outbound" directive="answer">
  <oid>
    <Ind>RuleResponder@iitfrdsrv0010.iit.nrc.gc.ca122</Ind>
  </oid>
  <protocol>
    <Ind>esb</Ind>
  </protocol>
  <sender>
    <Ind>RuleResponder</Ind>
  </sender>
  <content>
    <Atom>
      <Rel>getContact</Rel>
      <Ind>ruleml2007_Challenge</Ind>
      <Ind>update</Ind>
      <Expr>
        <Fun>person</Fun>
          <Ind>John</Ind>
          <Ind>john@atemailDotcom</Ind>
          <Ind>PHD</Ind>
          <Ind>PanelChair</Ind>
          <Ind>15555555555</Ind>
      </Expr>
    </Atom>
  </content>
</Message>

</RuleML>
```

## Ex.: Query to the Publicity Chair

```
n  <content>
n    <Atom>
n      <Rel>sponsor</Rel>
n      <Expr>
n        <Fun>contact</Fun>
n        <Ind>ben</Ind>
n        <Ind>nrc</Ind>
n      </Expr>
n      <Ind type="integer">500</Ind>
n      <Expr>
n        <Fun>results</Fun>
n        <Var>Level</Var>
n        <Var>Benefits</Var>
n        <Var>DeadlineResults</Var>
n      </Expr>
n      <Expr>
n        <Fun>performative</Fun>
n        <Var>Action</Var>
n      </Expr>
n    </Atom>
n  </content>
```

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```
<?xml version="1.0" encoding="UTF-8"?>
<RuleML xmlns="http://www.ruleml.org/0.91/xsd" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.ruleml.org/0.91/xsd http://www.ruleml.org/0.91/xsd">

<Message mode="outbound" directive="answer">
  <oid>
    <Ind>RuleResponder@iitfrdsrv0010.iit.nrc.gc.ca134</Ind>
  </oid>
  <protocol>
    <Ind>esb</Ind>
  </protocol>
  <sender>
    <Ind>RuleResponder</Ind>
  </sender>
  <content>
    <Atom>
      <Rel>sponsor</Rel>
      <Expr>
        <Fun>contact</Fun>
          <Ind>ben</Ind>
          <Ind>nrc</Ind>
      </Expr>
      <Ind type="integer">500</Ind>
      <Expr>
        <Fun>results</Fun>
          <Ind>bronze</Ind>
          <Expr>
            <Fun>benefits</Fun>
              <Expr>
                <Fun>logo</Fun>
                  <Expr>
                    <Fun>on</Fun>
                      <Ind>site</Ind>
                  </Expr>
                </Expr>
              </Fun>
            </Expr>
          <Fun>acknowledgement</Fun>
            <Expr>
              <Fun>in</Fun>
                <Ind>proceedings</Ind>
            </Expr>
          </Expr>
        </Fun>
      </Expr>
      <Fun>passed</Fun>
        <Ind>deadline</Ind>
      </Expr>
    </Expr>
    <Expr>
      <Fun>performative</Fun>
        <Ind>email</Ind>
      </Expr>
    </Atom>
  </content>
</Message>
```

## Ex.: Query to the Publicity Chair (ctnd)

```
n <content>
n   <Atom>
n     <Rel>sponsor</Rel>
n     <Expr>
n       <Fun>contact</Fun>
n       <Ind>ben</Ind>
n       <Ind>nrc</Ind>
n     </Expr>
n     <Ind type="integer">5000</Ind>
n     <Expr>
n       <Fun>results</Fun>
n       <Var>Level</Var>
n       <Var>Benefits</Var>
n       <Var>DeadlineResults</Var>
n     </Expr>
n     <Expr>
n       <Fun>performative</Fun>
n       <Var>Action</Var>
n     </Expr>
n   </Atom>
n </content>
```

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```
<?XML>
<Ind type="integer">5000</Ind>
<Expr>
    <Fun>results</Fun>
        <Ind>platinum</Ind>
        <Expr>
            <Fun>benefits</Fun>
                <Expr>
                    <Fun>logo</Fun>
                    <Expr>
                        <Fun>on</Fun>
                            <Ind>site</Ind>
                        </Expr>
                    </Expr>
                <Expr>
                    <Fun>acknowledgement</Fun>
                    <Expr>
                        <Fun>in</Fun>
                            <Ind>proceedings</Ind>
                        </Expr>
                    </Expr>
                <Expr>
                    <Fun>option</Fun>
                    <Expr>
                        <Fun>sponsor</Fun>
                            <Ind>student</Ind>
                        </Expr>
                    </Expr>
                <Expr>
                    <Fun>free</Fun>
                        <Var>Benefits</Var>
                        <Ind>registration</Ind>
                    <Expr>
                        <Fun>amount</Fun>
                            <Ind>2</Ind>
                        </Expr>
                    </Expr>
                <Expr>
                    <Fun>logo</Fun>
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                        <Fun>in</Fun>
                            <Ind>proceedings</Ind>
                        </Expr>
                    </Expr>
                <Expr>
                    <Fun>option</Fun>
                    <Var>Benefits</Var>
                    <Ind>demo</Ind>
                </Expr>
                <Expr>
                    <Fun>name</Fun>
```

# Conclusion

- Rule Responder can be used to implement a wide range of use cases that require an intelligent, semi-automated decision layer
- The middleware of Rule Responder allows deployment of multiple running use cases concurrently