

**Rule Responder:  
A Multi-Agent Web Platform  
for Collaborative Virtual Organizations  
Based on RuleML and OO jDREW**

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# Outline

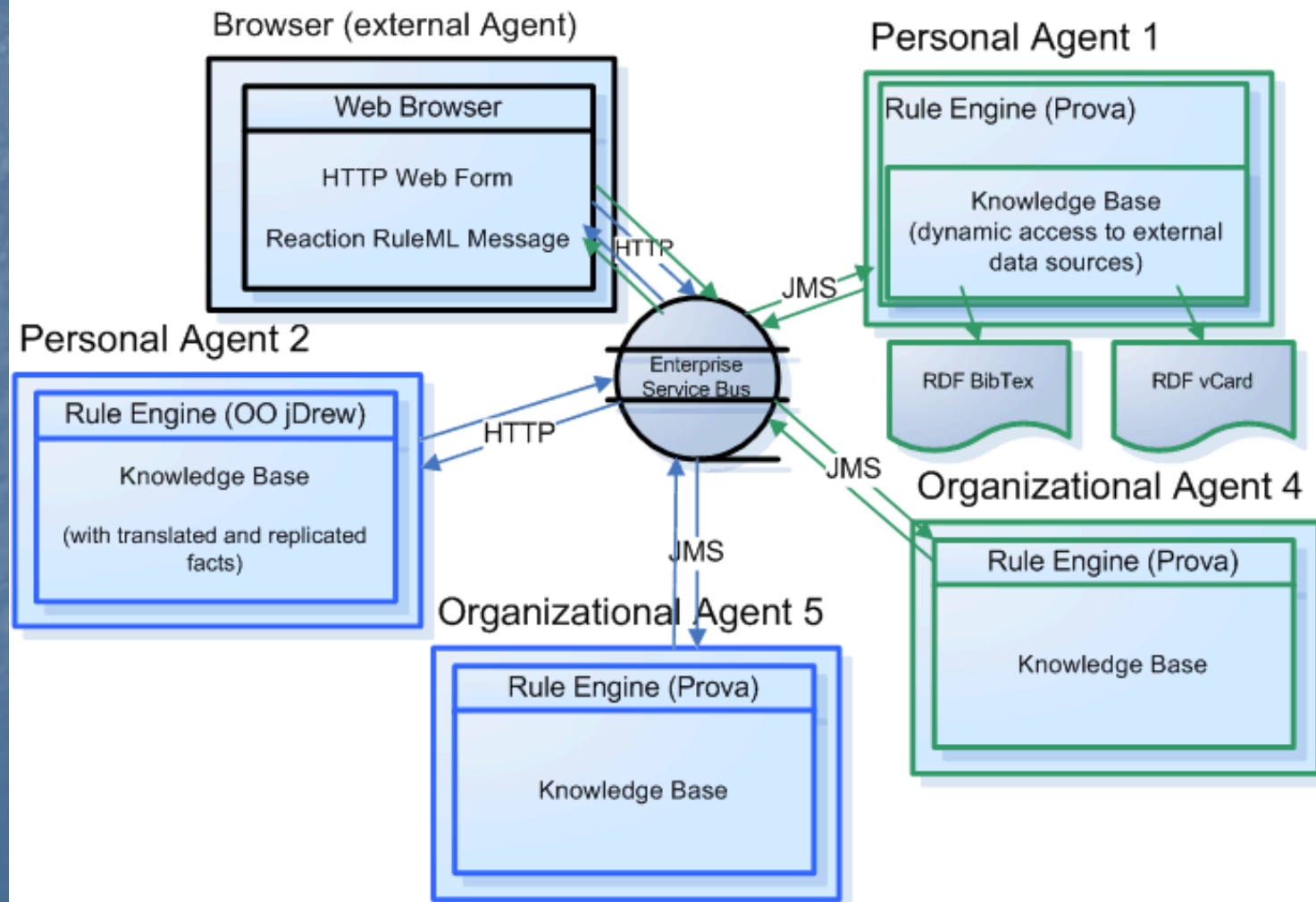
- Overview
- Agents
  - Personal
  - Organizational
  - External
- Rule Engines
  - Prova
  - OO jDREW
- Communication Middleware
  - Mule ESB
  - Reaction RuleML messages
- Demo
  - Use Cases

# Overview of Rule Responder

- Rule Responder is an intelligent multi-agent system for collaborative teams and virtual communities
- Supports rule-based collaboration between the different members of the virtual organization
- Uses RuleML as its Rule Markup Language, based on logic and XML
  - The member of the RuleML family employed here is Naf Hornlog
- Implemented as a Web-based service architecture

# Architecture - Overview

Use Case 4 Use Case 5





# Personal Agents

- A personal agent represents a single person of an organization
- The personal agent contains a FOAF\* profile with FOAF extended rules

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

# Organizational Agents

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

# External Agents

- External agents communicate with the virtual organization by sending messages that transport queries, answers, or complete rule sets to the public interface of the organizational agents
- HTTP interface to Rule Responder
- Support for multiple unique External Agents (end users) at a single time
- Users can use a web browser to communicate with Rule Responder (current test interface)



# 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 as some personal agents

# OO jDREW

- OO jDREW is used for personal agents in Rule Responder
- Two modes of Rule Execution:
  - Bottom-up (forward reasoning)
  - Top-down (backward reasoning)
- Rule Responder primarily uses top-down
- Supports rules in the following formats:
  - POSL (Positional Slotted Language)
  - RuleML

# 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



# 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 Cases

- RuleML-2007 Symposium
  - Single Organizational Agent that acts as the single point of entry to the conference
  - Assist with planning, preparing, and running the Symposium
  - Personal Agents represent Chairs of the Symposium

# Online Demo

- <http://responder.ruleml.org/>
- <http://ibis.in.tum.de/projects/paw/ruleml-2007/>



# Example Message

```

▪ <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://ibis.in.tum.de/research/ReactionRuleML/0.1/rr.xsd"
▪ 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>sponsor</Rel>
▪         <Expr>
▪           <Fun>contact</Fun>
▪           <Ind>ben</Ind>
▪           <Ind>nrc</Ind>
▪         </Expr>
▪         <Ind type="integer">500</Ind>
▪         <Expr>
▪           <Fun>results</Fun>
▪           <Var>Level</Var>
▪           <Var>Benefits</Var>
▪           <Var>DeadlineResults</Var>
▪         </Expr>
▪         <Expr>
▪           <Fun>performative</Fun>
▪           <Var>Action</Var>
▪         </Expr>
▪       </Atom>
▪     </content>
▪   </Message>

▪ </RuleML>
```

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```
■ <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://ibis.in.tum.de/research/ReactionRuleML/0.2/rr.xsd"
■ 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>
■ </RuleML>
```

# Rule Bases

- <http://www.jdrew.org/oojdrew/programChairAgent2.posl>
- <http://www.jdrew.org/oojdrew/rulesets/publicityChair.posl>