Politecnico di Milano

Self-Healing BPEL Processes with Dynamo and the JBoss Rule Engine

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Outline

- The challenge - *our goals*
- A case study - *a treasure hunt*
- The solution - *self-healing processes*
- WSCoL/WSReL
- The Dynamo Framework
  - Architecture
  - The Translation Process
  - Performance Evaluation
- Future Work

The challenge

- Composition: build intrinsically distributed and dynamic systems by leveraging remote services

Dynamism/Flexibility/Distributed Ownership/Open World

↓

pre-deployment validation is not possible!

↓

unexpected and catastrophic events can arise!

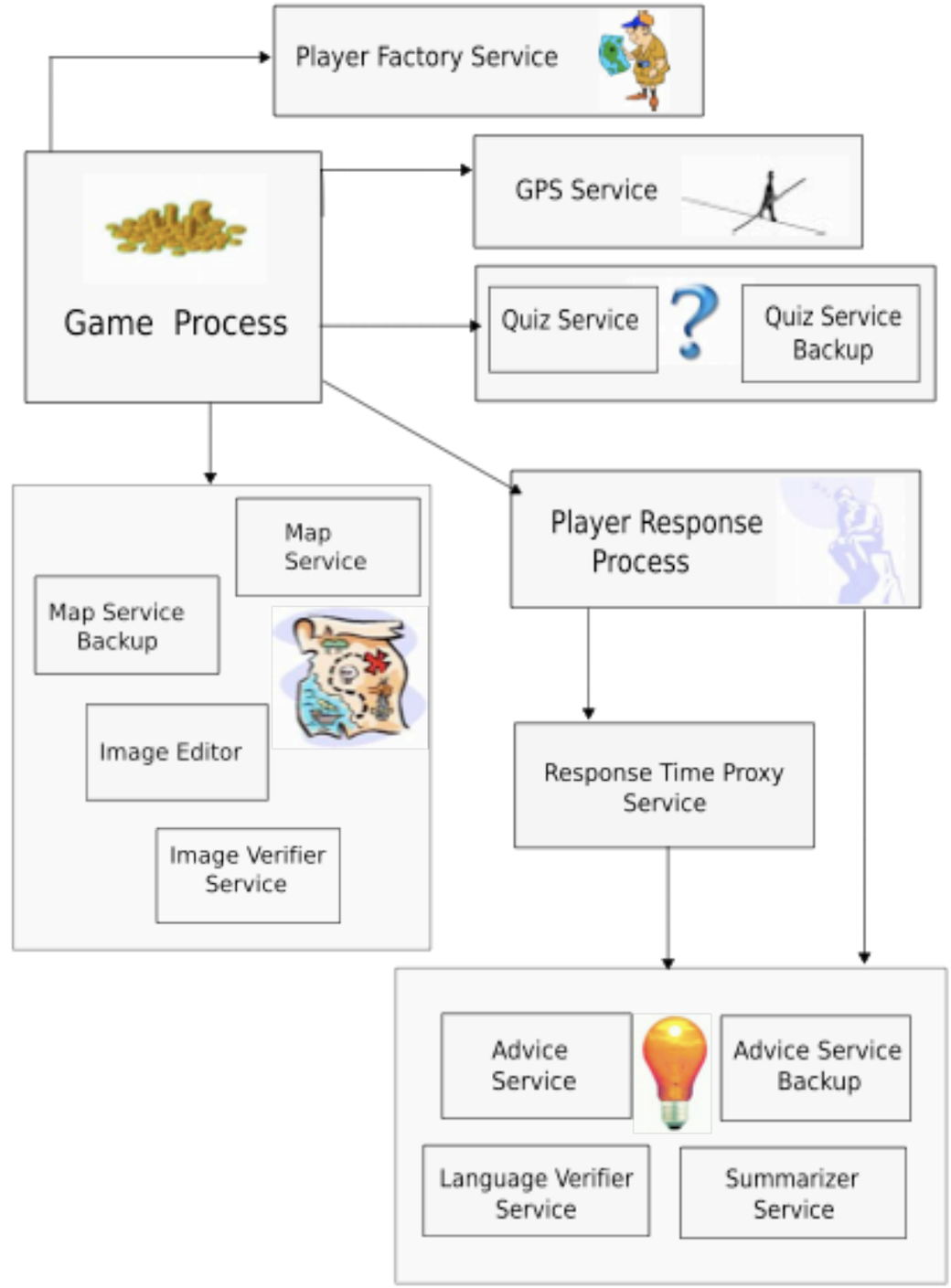
- Self-Healing Processes (monitoring/recovery) [1]
  - detect faults/errors instantly
  - contain the effects
  - recover and proceed if possible

[1] IBM Autonomic Computing Initiative. “Autonomic Computing” - http://www.-03.ibm.com/servers/autonomic

A case study - *a treasure hunt*

- Goal: find the treasure in the less time possible
- How: answer questions to obtain new maps
- Loose if you consume all your points
- Points can be used to buy suggestions

- Things that could go wrong:
  - Advice Service: does not answer within 5 seconds
  - GPS Service: the coordinates are in the wrong format
  - Quiz Service: the questions are in the wrong language
  - Advice service: the advice is too long



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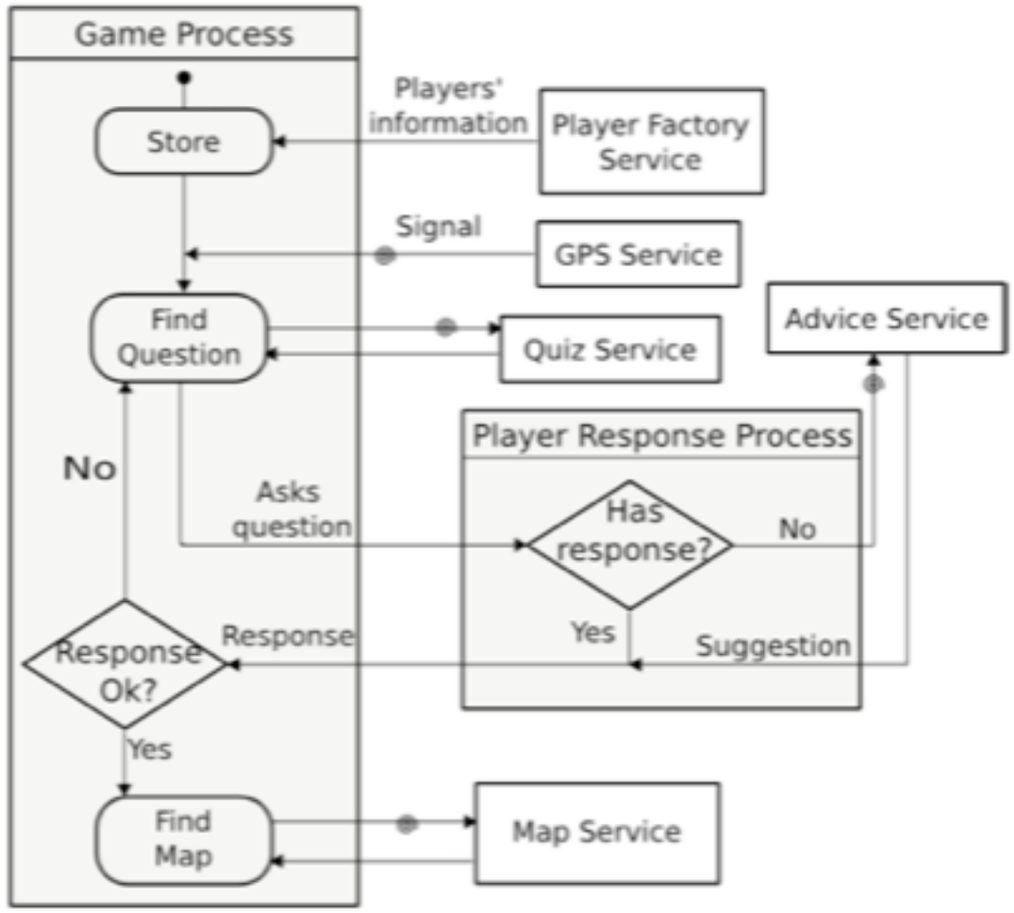

The solution

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    - pre-/post-conditions on the interactions the process has with the outside world or invariants - specified using WSCoL (*Web Service Constraint Language*)
  - an indication of the recovery strategies to be used to keep things on track
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- Implement a framework (*Dynamo*) that augments a BPEL engine with self-healing capabilities and allows for separation of concerns

WSCoL/WSReL

- WSCoL
  - Mixes JML and XML technologies
  - Characteristics:
    - internal/external/historical variables and aliasing
    - boolean/relational/mathematical operators
    - universal/existential quantifiers
    - aggregate functions
    - data type related functions

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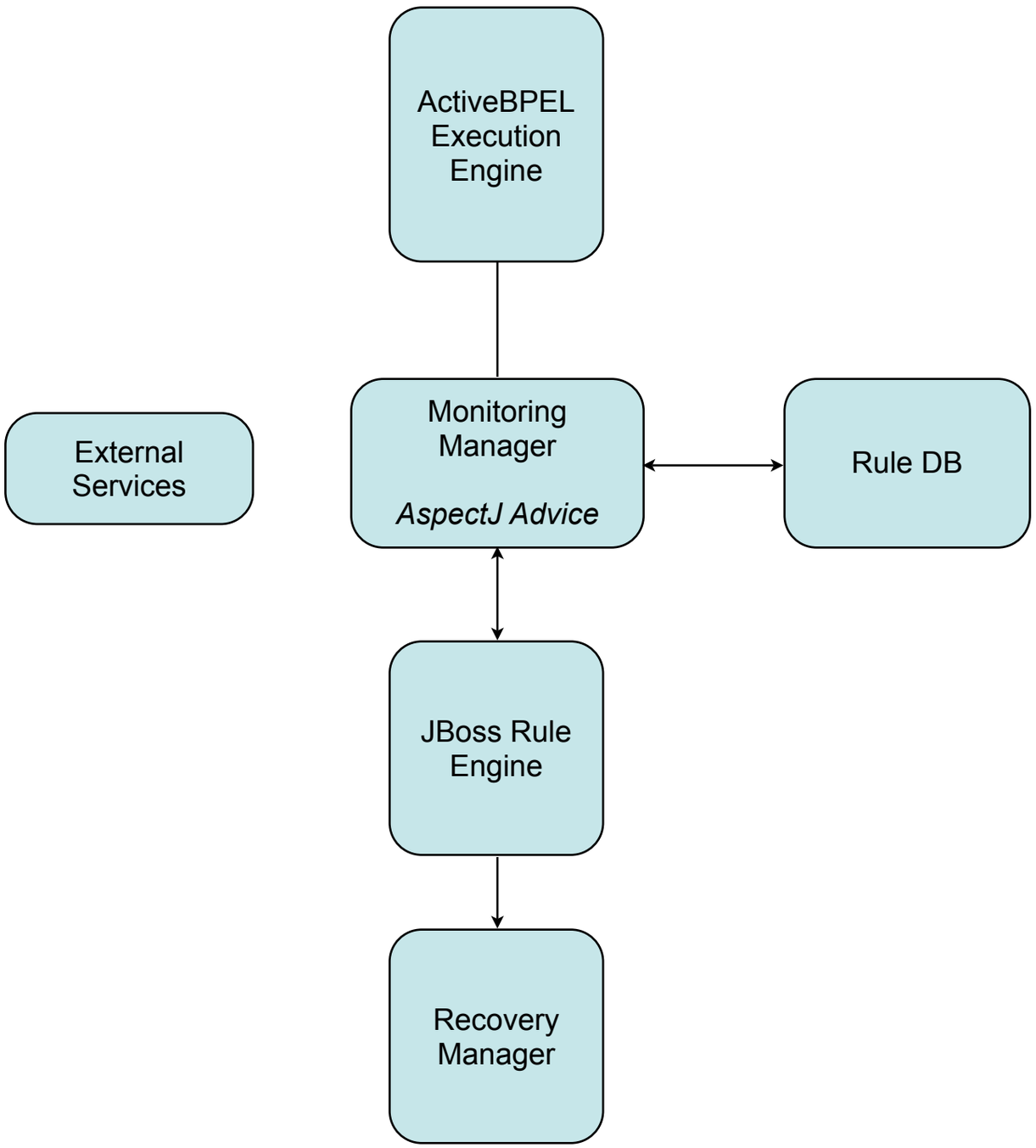
- WSReL
  - mix atomic actions into recovery steps
    - take a step and check if the problem is fixed
    - proceed to next step
  - Some actions:
    - ignore/retry/rebind/substitute/call/callback/...

Dynamo



- Self-Healing Capabilities are added to the ActiveBPEL Execution Engine using AspectJ
- Main run-time components:
  - Monitor Manager
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    - gets the properties to be checked and the strategies to be executed
  - JBoss Rule Engine
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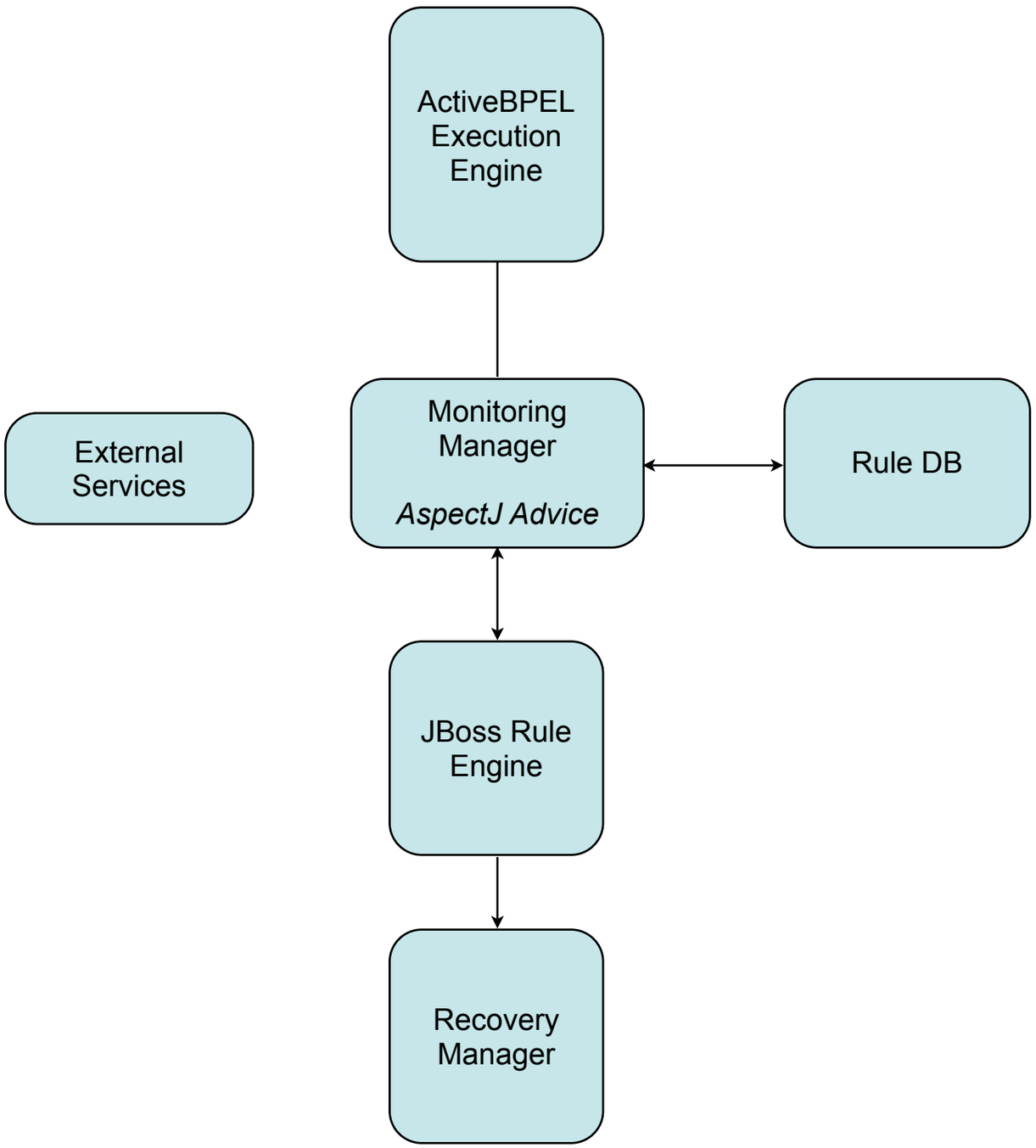

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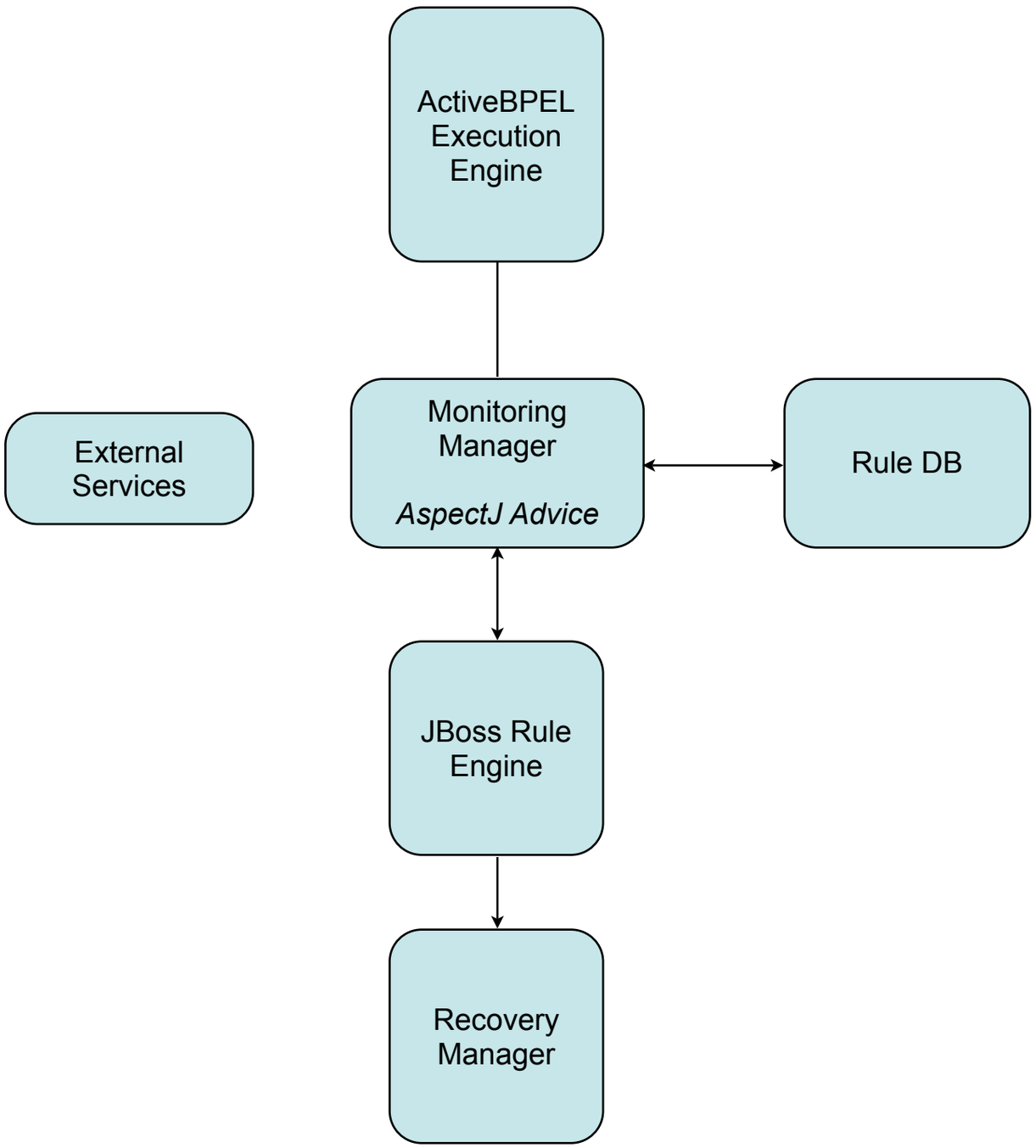

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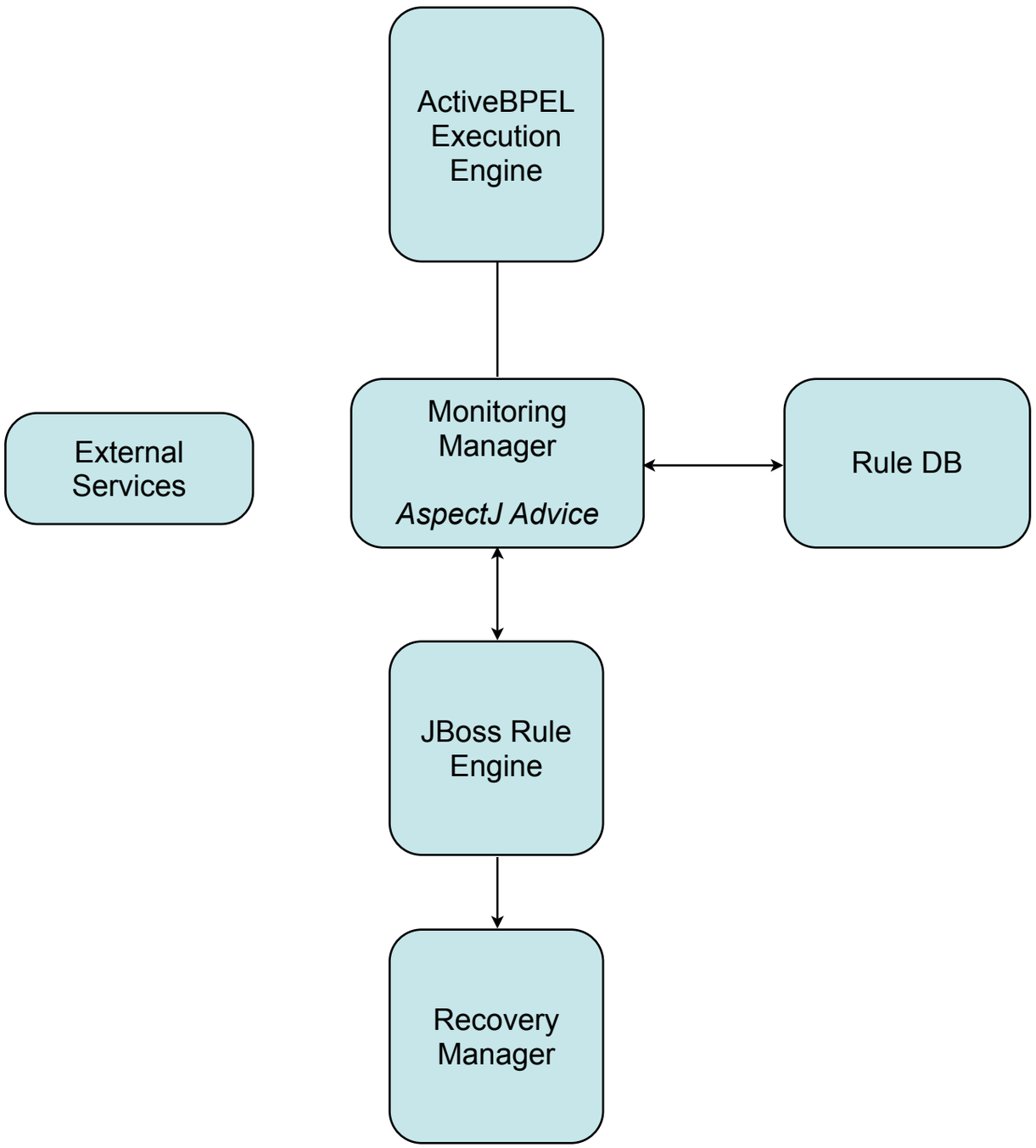

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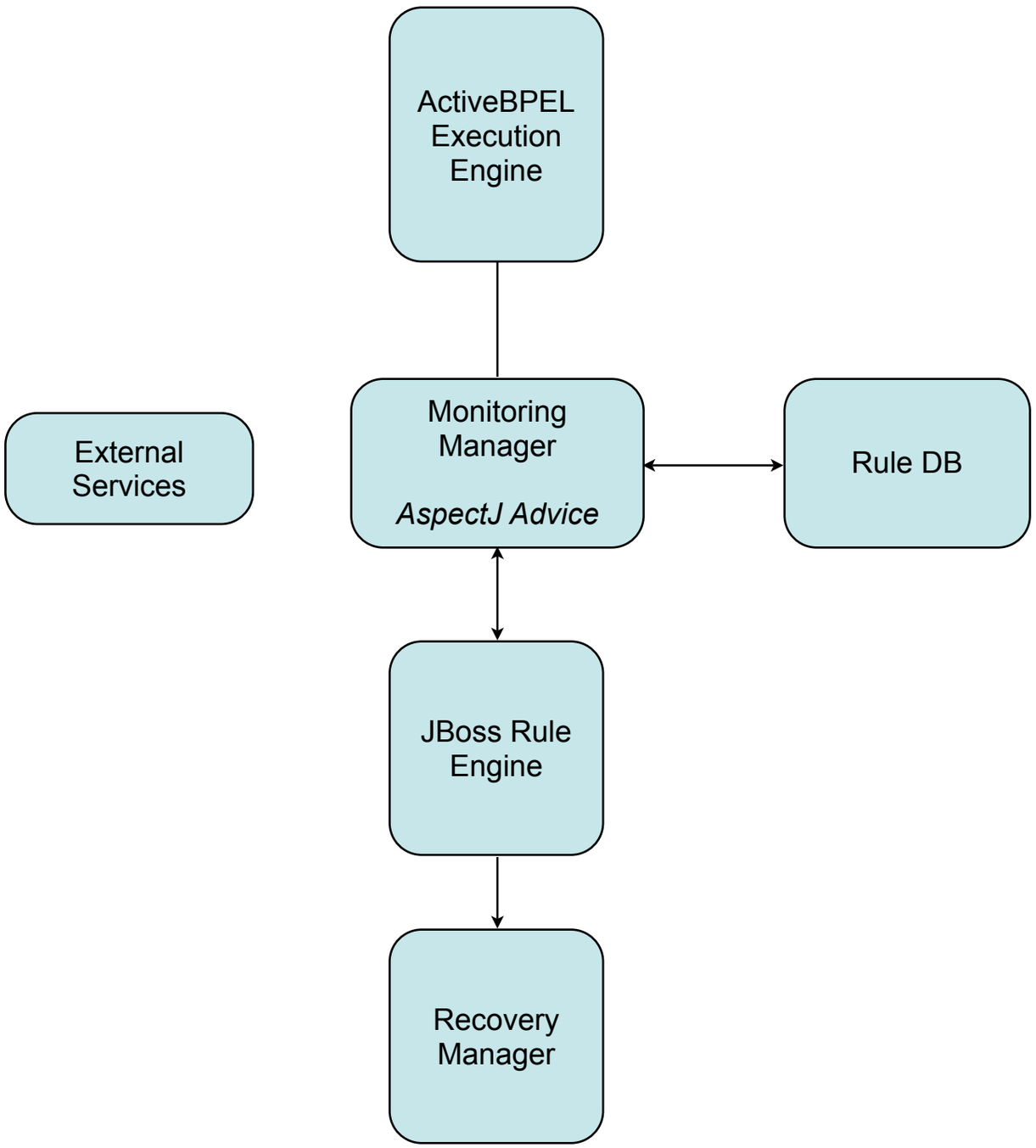

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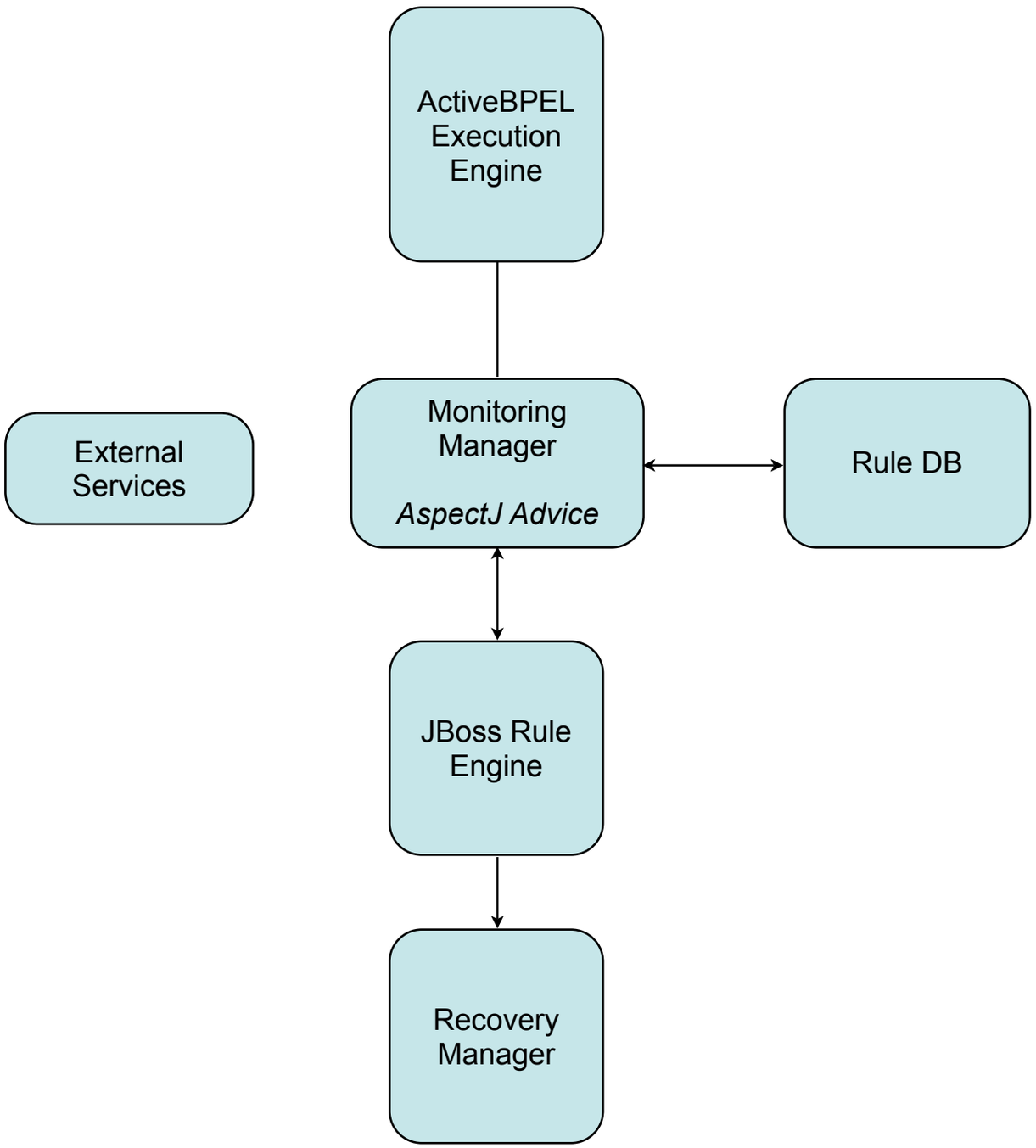

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But how do the rules get into the Rule DB? and in what format are they?

The Translation Process

- Rule:
  - 1 set of Drools rules (.drl) - *will be later translated into a rule package by JBoss*
    - use of agenda-groups, activation-groups, and salience to ensure correct semantics
  - Rule managers - *Java*
    - responsible for asserting data and/or managing aggregate functions
- Two possibilities
  - Simple Rule
    - 1 rule + 1 RuleManager

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  - Simple Rule
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```
$internalData/player/points >0;

rule “rule name”
agenda-group “manager_id”
when
   uuid : XMLWrapper(id == “uuid”) &&
   eval (uuid.getDoubleValue() >0)
then
end
```

The Translation Process

- Rule with aggregate functions
  - set of rules
  - set of managers

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- Rule with aggregate functions
  - set of rules
  - set of managers

```
forall($p2 in $internalData/player,
                $p2/points >= 0);


rule “0”
agenda-group “manager_id”
when
   forall_uuid : ForallManager
   (id==”forall_uuid”) &&
   eval(!(forall_uuid.getValue()));
then
end
```

```
rule “1”
agenda-group “forall_uuid”
when
   forall_uuid : ForallManager
   (id==”forall_uuid”) &&
   uuid : XmlWrapper(id==”uuid”) &&
   eval(uuid.getDoubleValue() >=0);
then
   forall_uuid.execute();
end

rule “2”
agenda-group “forall_uuid”
when
   forall_uuid : ForallManager
   (id==”forall_uuid”) &&
   uuid : XmlWrapper(id==”uuid”) &&
   eval(!(uuid.getDoubleValue() >=0));
then
end
```

Performance Evaluation

- Over 1000 measurements on 5 supervision rules
- Translation times
  - (WSCoL/WSReL → .drl file) + (.drl file → rule package)
  - %RE - amount due to JBoss
  - Entirely achieved off line - *una tantum*
- Execution times
  - Data collection + Data Analysis
  - %EV - amount spent collecting external/historical data
    - calling external services can lead to high variance!

Translation Times

	Average [s]	*Median [s]*	*Variance*	*%RE*
Store	0.004	0.002	~0	27.05%
Average	0.120	0.089	0.002	95.31%
Length	0.092	0.075	0.002	89.98%
Quiz	0.091	0.072	0.002	92.71%
Point	0.209	0.219	0.006	93.35%

Execution Times

	Average [s]	*Median [s]*	*Variance*	*%EV*
Store	0.100	0.079	0.004	85.01%
Average	0.245	0.237	0.005	29.64%
Length	0.049	0.039	0.001	-
Quiz	0.205	0.133	0.042	72.82%
Point	0.118	0.106	0.002	-

Future Work

- Our research
  - Take advantage of level of technical expertise to improve recovery approach
  - AOP gives us access to the run-time rep of the process
    - backward recovery vs. forward recovery
    - process re-organization
    - monitoring may also lead to changes in the process definition and to changes in other processes

- The community
  - A lot of research is not taking advantage of the intrinsic distributed nature of web services (think of BPEL) -> should we try to move to a more distributed scenario?

An example

- The game can be played by people speaking different languages
  - they will be moving throughout europe
  - the language should always be the correct one (contained in their preferences)

post-condition:

```
let $question = $internalData/quiz_service/question;
returnString(LanguageVerifierService_WSDL, "getLanguage", input + $question + input, output) ==
$internalData/player[codepoint-equal(id/text(),"playerID")]/favouriteLanguage;
```

recovery strategy:

```
retry(1) ||
rebind(QuizBackup_WSDL) && notify(messageRebind, email) ||
halt() && notify(email, messageHalt)
```