Policy analysis using a hybrid semantic reasoning engine

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Performed in the context of the “Technologies and Capabilities for Service-Enabling” project
Policy reasoning

- Policies are used in many different areas …
  - Security, quality of service, user preferences, etc.
- … and domains
  - Telecom, healthcare, etc.
Policy ontology

K. Verlaenen, B. De Win, W. Joosen, Towards simplified specification of policies in different domains, Integrated Network Management (IM2007)
“UserU” is denied access to “ResourceX”
Policies are used in many different areas …
- Security, quality of service, user preferences, etc.
- … and domains
- Telecom, healthcare, etc.

Large sets of policies
Many different actors
...

Support authors in detecting problems in large policy sets!
Policy reasoning

- Policy equivalence
- Policy inclusion or policy containment
- Policy incompatibility
- Policy conflict
- Policy incoherence
- Dominance checking
- Policy optimization
- Coverage checking
- Policy combination
- Policy deduction
- …
Hybrid reasoning

- Approach: Use the reasoning power of semantic languages (OWL, SWRL, SPARQL)
- Detect relationships between simple expressions
- Deduce more complex relationships between policies based on these simple relationships

```
<table>
<thead>
<tr>
<th>policy1</th>
<th>conflict</th>
<th>policy2</th>
</tr>
</thead>
<tbody>
<tr>
<td>when</td>
<td></td>
<td>when</td>
</tr>
<tr>
<td>X &gt; 3</td>
<td>includes</td>
<td>X &gt; 1</td>
</tr>
<tr>
<td>Y &lt;= 7</td>
<td>includes</td>
<td>Y &lt;= 9</td>
</tr>
<tr>
<td>then</td>
<td></td>
<td>then</td>
</tr>
<tr>
<td>Do something</td>
<td>conflict</td>
<td>Do something else</td>
</tr>
</tbody>
</table>
```
Hybrid reasoning

- Extend reasoning capabilities by adding support for a general-purpose rule engine
- More advanced rule constructs
  - Arbitrary functions
  - Collection management
  - Element creation
  - Not, exist, from, etc.
- Drools (aka JBoss Rules) with OWL support
Hybrid reasoning

➢ How to derive relationships?
   ➢ Rules for all expressions that can be used in conditions
     ▪ E.g. ‘x > a’ includes ‘x > b’ if a ≥ b
   ➢ Generic rules for more complex policy relationships
   ➢ Allows domain-specific analysis
   ➢ Theoretical != practical
Hybrid reasoning

Policy Repository

Drools Engine

Working Memory

Rules

Generic policy ontology

Specific Policy Language

Specific Policy Language

Application Domain

Query for problems

OWL

SPARQL

OWL Rules
Conclusion

- Preliminary results: working for basic functions
  - Equivalence, inclusion, incompatibility, conflict, incoherence
- Strong focus on extensibility
  - Complex rules are generic
  - Define semantics of specific functions / actions by policy language designers
  - Policy authors never confronted with complexity
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