Driving and Monitoring Provisional Trust Negotiation with Metapolicies

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Outline

- Motivation
- The rule language
- Metapolicies
- More applications of metapolicies
- Conclusions & Further work
Motivation (I)
The term policy refers to...

- **Security Policies**: pose constraints on the behavior of a system
- **Trust Management Policy Languages**: typically used to collect user properties in open environments
- **Business Rules**: statements about how a business is done

In addition, associated to policies one needs to execute actions. Therefore also relevant:

- **Action Languages**: used in reactive policy specification to execute actions
Motivation (& II)
Integration of policies

Although many approaches have been described to address the above points, there is no common solution, integrating them all in a single framework.
The rule language (I)

Specification

Based on normal logic program \( A \leftarrow L_1, \ldots, L_n \)

Categories of predicates are

- **Decision Predicates:**
  - **Allow()**: queried by the negotiation for access control decisions
  - **Sign()**: used to issue statements signed by the principal owning the policy

- **Abbreviation/Abstraction Predicates**

- **Constraint Predicates**: comprise usual equality and disequality predicates

- **State Predicates**: decisions according the state
  - **State Query Predicates**: read the state without modifying it
  - **Provisional Predicates**: may be made true by means of associated actions that may modify the current state
    - E.g. credential(C,K), declaration(), logged(X,logfile_name)
The rule Language (& II)
Design Assumptions ...

Provisional actions are orthogonal
- The action associated to any ground atom A cannot change the truth value of any other ground provisional atom.

Exchange of filtered set of policies between parties
- in order to avoid combinatorial explosion of requests

Negation is not applied neither to provisional predicates nor to any predicate occurring in a rule head
## Metapolicies (I)

### Current valid attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Domain</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>action</td>
<td>provisional predicates</td>
<td>commands</td>
</tr>
<tr>
<td>actor</td>
<td>provisional predicates</td>
<td>self, peer</td>
</tr>
<tr>
<td>aggregation_method</td>
<td>cost and sensitivity attributes</td>
<td>max, min, sum, adopt(Predicate)</td>
</tr>
<tr>
<td>cost</td>
<td>provisional predicates</td>
<td>number</td>
</tr>
<tr>
<td>evaluation</td>
<td>state predicates</td>
<td>immediate, delayed, concurrent</td>
</tr>
<tr>
<td>expected_outcome</td>
<td>provisional predicates</td>
<td>success, failure, undefined, unknown</td>
</tr>
<tr>
<td>explanation</td>
<td>literals and rules</td>
<td>string expression</td>
</tr>
<tr>
<td>ontology</td>
<td>abbreviation predicates, credentials, declarations, actions</td>
<td>URI</td>
</tr>
<tr>
<td>predicate</td>
<td>literals</td>
<td>predicate names</td>
</tr>
<tr>
<td>selection_method</td>
<td>negotiator</td>
<td>certain_first, order(attribute_list), adopt(Predicate)</td>
</tr>
<tr>
<td>sensitivity</td>
<td>predicates, literals, rules</td>
<td>public, private, not_applicable</td>
</tr>
<tr>
<td>type</td>
<td>predicates, literals</td>
<td>abbreviation, constraint, decision, state_predicate, provisional, state_query</td>
</tr>
</tbody>
</table>
Metapolicies
Examples

table(Key, Data).evaluation: immediate ←
ground(Key).


credential(_).ontology: URI.

abbrev(_).explanation: “this condition checks...”
Policy filtering
Semantics-preserving ...

Removing irrelevant rules
- only the relevant subset of the policies is selected

Evaluating State Predicates
- Partial evaluation

Compiling Private Policies
- Internal structure of the rules is lost

Abbreviate Predicate Renaming
- avoiding that meaningful predicate names disclose confidential information about the policy
Policy filtering
Win information loss ...

Blurring
- some rules may have to be hidden and blocked until the client is trusted enough
- sensitive state predicates may have to be blocked until their evaluation does not disclose confidential information.
- replaced with a reserved propositional symbol

allow(enter site()) ←
  declaration( usr = U; passwd = P), blurred.

Expectation
- what-if queries require the server to evaluate a request without executing immediate actions during such an evaluation

\[ \hat{\text{R}. \text{expected \_outcome}} : \text{Val} | \text{Val} \in \{\text{success, failure, undefined, unknown}\} \]
Policy Filtering (& II)
Driving filtering with metapolicies

- Filter non-applicable and irrelevant rules
  - Compile applicable, non-public rules
    - Partial evaluation of public rules
      - Execute immediate actions
        - Evaluate local provisional literals
  - Blur deferred state conditions
    - Filter irrelevant policies due to blurring
      - Replace provisional state predicates with actions
        - Anonymize abbreviation predicates
More applications of metapolicies
Credential and action selection

Candidate set: a set of credentials and actions occurring in the proof of a goal G given a set of (filtered) policies P.

A user may have different candidate sets and therefore a selection mechanism. Typical measures are:

- Number of action executions
- Distributed credential collection

But metapolicies can help on this issue according to

- sensibility of credentials disclosed
- cost of each action executed

\[
\text{action.cost.aggregation}_\text{method:sun}.
\]

\[
\text{logged.cost:} \text{Number}.
\]
More applications of metapolicies

Metalevel Constraints

Like metapolicy rules without head

\[ \leftarrow L_1, \ldots, L_n. \]

At design time
- E.g. Protecting specific combinations of credentials.
  \[ \leftarrow \text{credential}(c_1,\_), \ldots, \text{credential}(c_n,\_). \]

At runtime
- Monitor policies and metapolicies at runtime
  \[ \leftarrow \text{X.action:}A, \ A.\text{actor:}Y, \ A.\text{actor:}Z, \ Y\neq Z. \]
More applications of metapolicies
Distributed Credentials

Credential gathering distinguishes between:
- Issuer
- Credential repository
- Credential owner
- Actor responsible for fetching the credential

Issuer is encoded in the credential and ownership can be checked via challenges.

Credential.location:URI and Credential.actor:X allow encoding the repository and fetcher respectively.
More applications of metapolicies
Libraries and Language Extensions

Abbreviations and credentials can be linked to the ontologies that specify their meaning by means of a suitable metaattribute:

Obj:ontology:URI

This attribute may have multiple values because the contents of Obj may use symbols defined in different ontologies.

Metapolicy and abbreviation libraries can be exported and stored in standard formats, using RuleML and RDF/OWL.
Conclusions & Further Work

Our main contributions are...

A **trust management language** supporting general provisional-style actions

An **extendible declarative metalanguage** for driving decisions about
- Request formulation
- Information disclosure
- Distributed credential collection

A **parameterized negotiation procedure**

**Integrity constraints** for
- negotiation monitoring
- disclosure control

General **ontology-based techniques** for importing and exporting metapolicies and for smoothly integrating language extensions
Conclusions & Further Work
What we plan to do ...

Integrate event-condition-action (ECA) rules as
- some policies would be more naturally described under this paradigm
- It would extend the set of business rules directly supported

Study completeness issues, that in this context sound like: “Is negotiation always successful when the policies of the parties allow it?”

Natural language front-end to the policy domain
- Natural Language Processing (NLP)
- automatic generation of natural language explanations from proofs and filtered policies
References

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  http://www.reverse.net/I2/

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  Project deliverable D2, Working Group I2, EU NoE
  REWERSE, Mar. 2005

- Security Agent in an Applet
  http://www.l3s.de/~olmedilla/projects/trust/applet/instructions.html

- PeerTrust project
  http://sourceforge.net/projects/peertrust/
Thanks

Questions?