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A Non-Technical User-Oriented Display Notation for XACML Conditions

by Bernard Stepien, Amy Felty,
Stan Matwin

School of Information Technology and Engineering

Université d'Ottawa | University of Ottawa

www.uOttawa.ca

Motivation

- The XACML XML-based language is very precise and allows fine-grained access control policy specification with complex conditions.
- However, it is out of reach for non-technical users for the following reasons:
  - Long XML tags
  - Long and complex domain references
  - Prefix notation for operations
  - List oriented notation for conjunction and disjunction operators

Example XACML specification

Merchandise is food and DayOfTheWeek is Monday

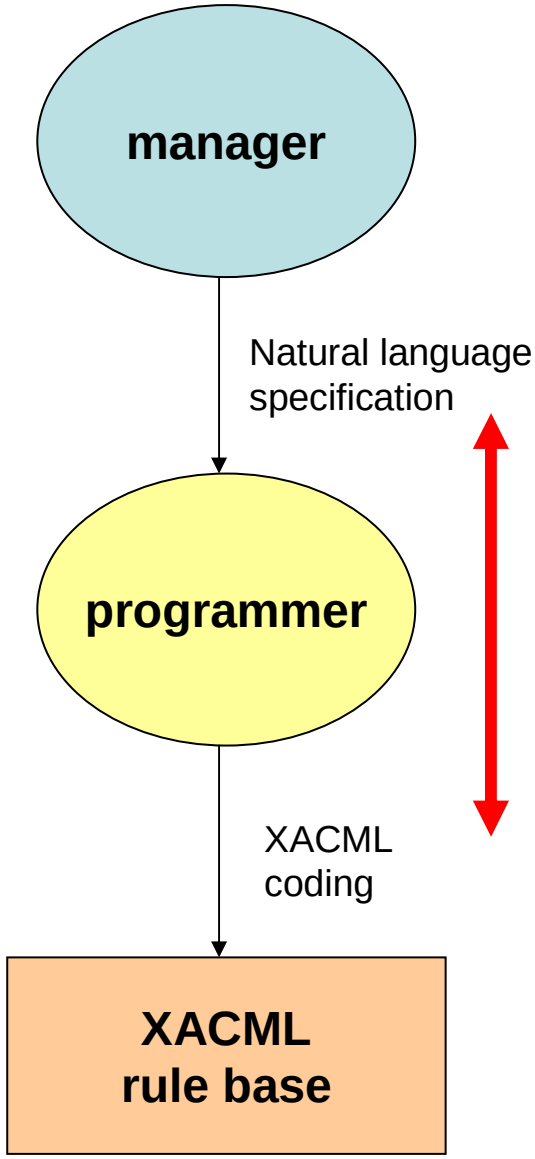
```
<Condition FunctionId="urn:oasis:names:tc:xacml:1.0:function:and">
  <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
    <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-one-and-only">
      <SubjectAttributeDesignator AttributeId="Merchandise"
                    DataType="http://www.w3.org/2001/XMLSchema#string" />
    </Apply>
    <AttributeValue
      DataType="http://www.w3.org/2001/XMLSchema#string">food</AttributeValue>
  </Apply>
  <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
    <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-one-and-only">
      <SubjectAttributeDesignator AttributeId="DayOfTheWeek"
                    DataType="http://www.w3.org/2001/XMLSchema#string" />
    </Apply>
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string"
                                                    >Monday</AttributeValue>
  </Apply>
</Condition>
```

Non-technical users application examples

- Controlled cell-phones use:
  - Restrict the phone numbers that can be called
  - Restrict the hours or days where calls can be placed
  - Restrict roaming zones
- Controlled credit-card use
  - Restrict the merchandise that can be purchased.
  - Restrict the hours and days of use
  - Restrict the stores where is can be used
  - Restrict the geographic zones of use

Access control management

traditional approach

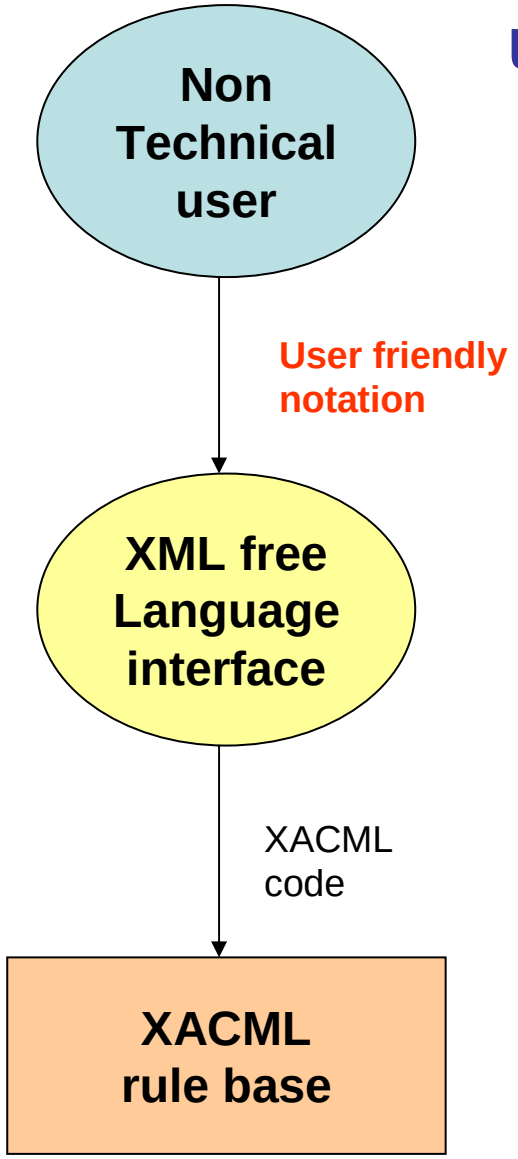


1. **Interpretation errors**
2. **Coding errors**
3. **Verification barrier**

- Who controls?
- Who implements?

Access control management

user-centric approach



- Eliminates the programmer.
- Increases user's confidence.
- Does not eliminate XACML

Viewing or editing a XACML specification

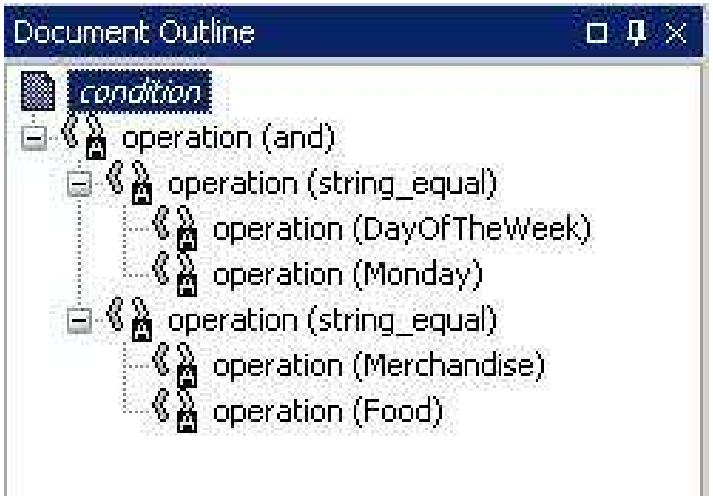
current state

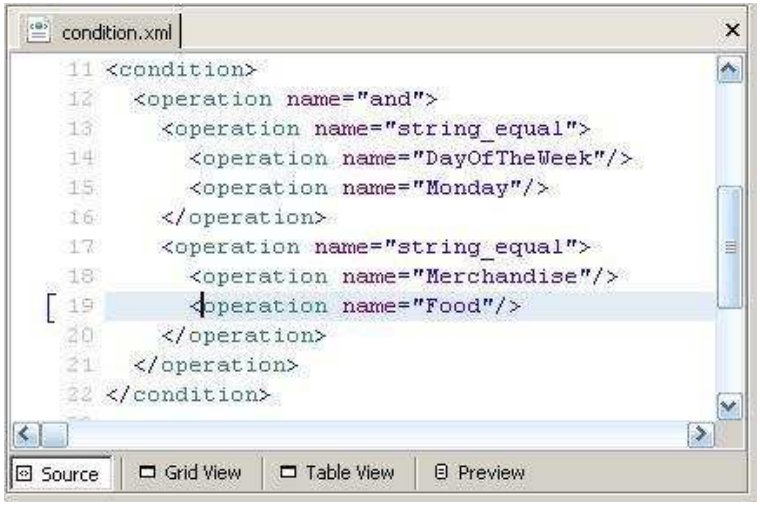
- XACML specifications can be created or edited with two classes of tools:
  - Generic XML editors
  - Specific XACML editors

Generic XML editors

basic tree notations

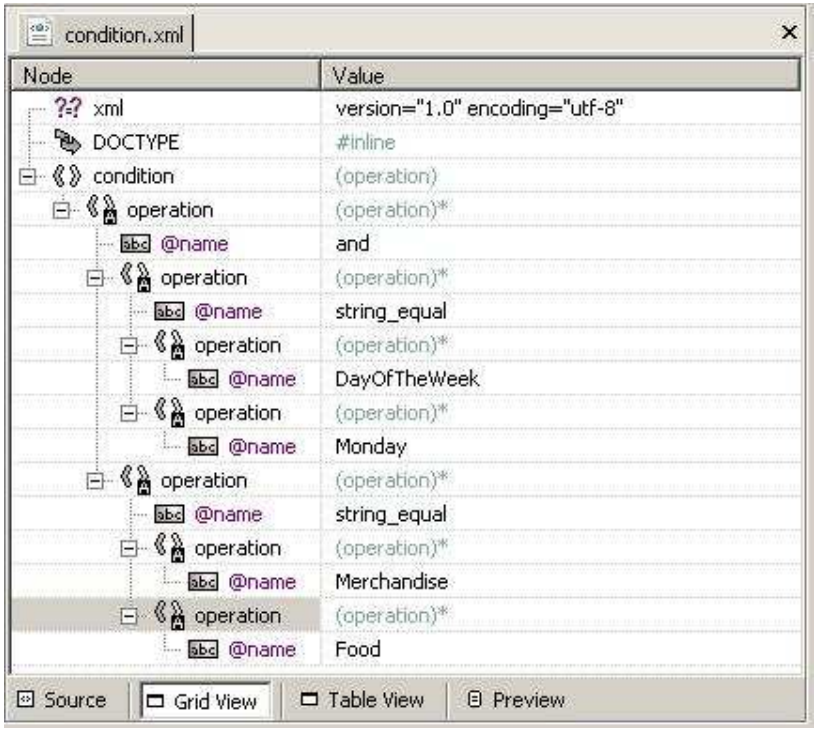
- Representing a simple logical expression in XML using XML-pad

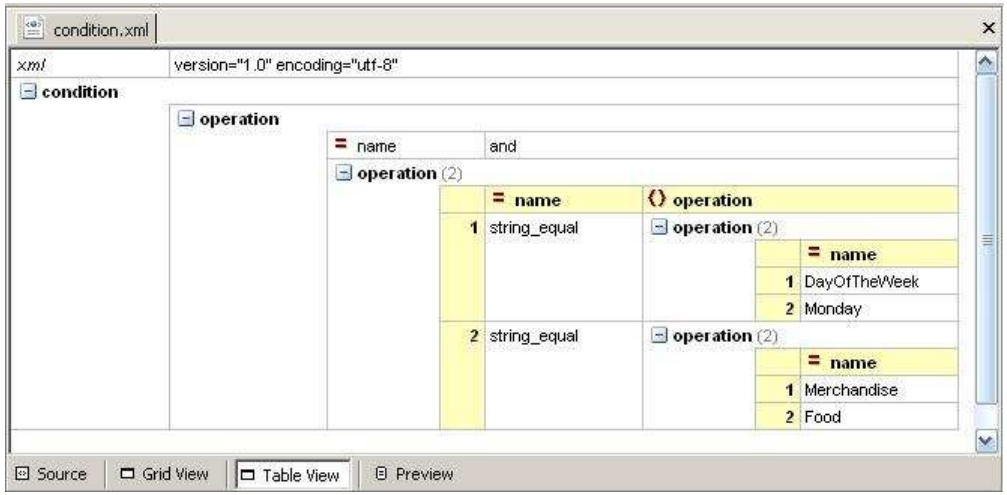




Generic XML editors

graphic tree notations

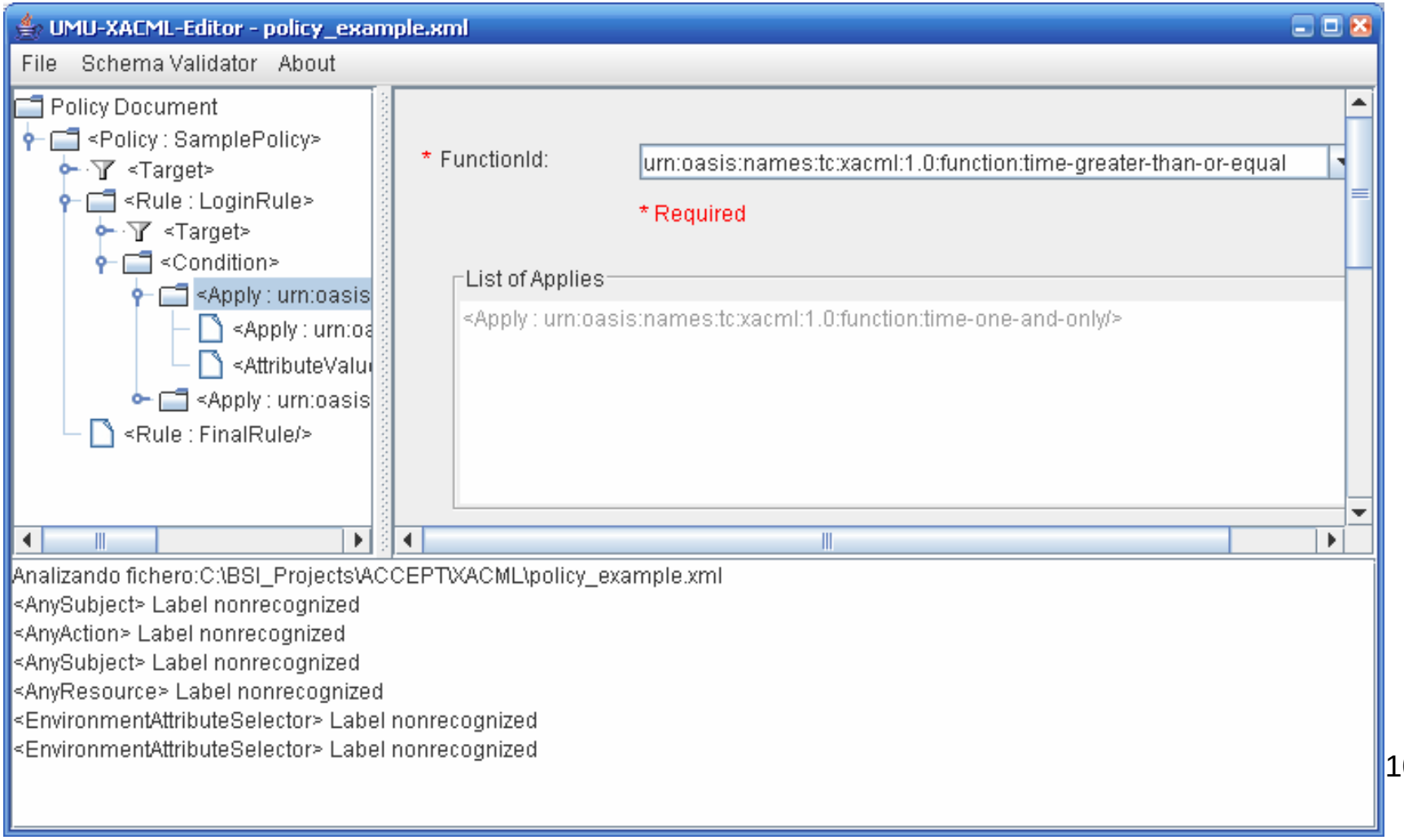




Specific XACML editors

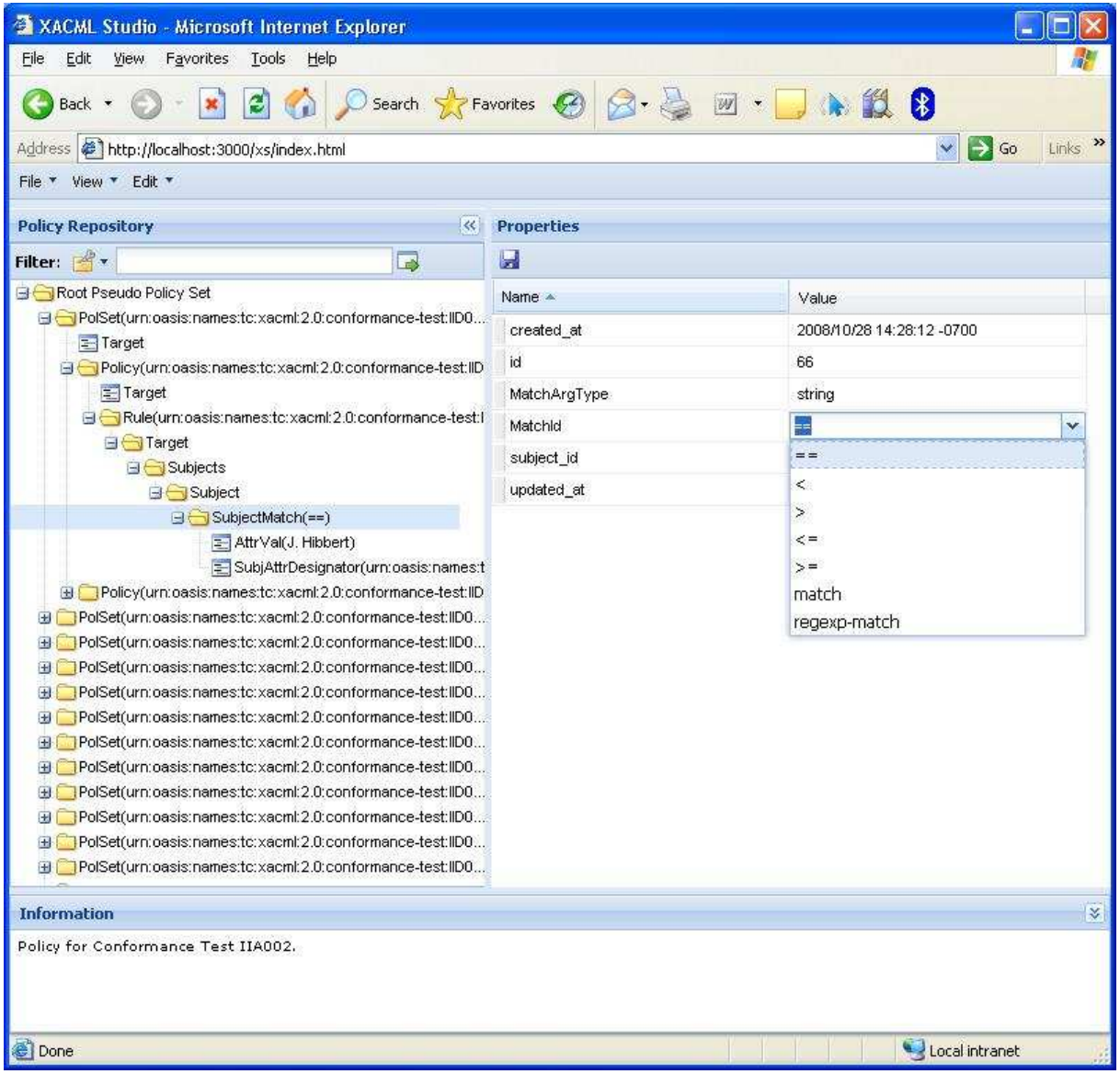
UMU XACML editor

- XML tags or domains from pull-down menus



Specific XACML editors

XACML studio



Drawbacks of XML or XACML editors

- They all require knowledge of XACML syntax and semantics.
- They all require programming skills.
- They do not reduce the amount of information a user must process.

Principles of our notation

- Stay as close as possible to the user's natural language:
  - by avoiding any technical terminology for operators
  - by maintaining the overall structure of a natural language.
- Tree representation as an implicit structuring paradigm
- Use infix representation for conjunction and disjunction operators as with natural languages.
- Maintain XACML's natural non-binary nature of conjunction and disjunction operators but eliminate its original list representation.
- Use a casual terminology for conjunction and disjunction operators depending on their position in the tree hierarchy.
- Ensure a full graphical overview of the expression being built at all times regardless of its complexity.

User-centric notation

Natural language rule:

“It is permitted to purchase food on a Monday or a Tuesday
or travel on a Friday provided that the balance of the account is over 500”.

A typical pseudo-code mathematical like translation:

((Merchandise == food and (day == Monday or day == Tuesday))
or (Merchandise == travel and day == Friday)) and balanceOfAcount > 500

Translated in our notation:

Merchandise is one of
Food
provided that DayOfTheWeek is one of Monday, Tuesday
Travel
provided that DayOfTheWeek is Friday
and
BalanceOfAccount over 500

Benefits of the notation

- The XACML rule could have been translated into straight natural language.
- But natural languages are inherently ambiguous.
- Example: it is not clear if the balance of account > $ 500 applies to food or travel purchases or even on Fridays only.
- The tree representation eliminates any ambiguity and also the need for parentheses.
- Natural language is difficult to edit and transform into formal languages (XACML or others)

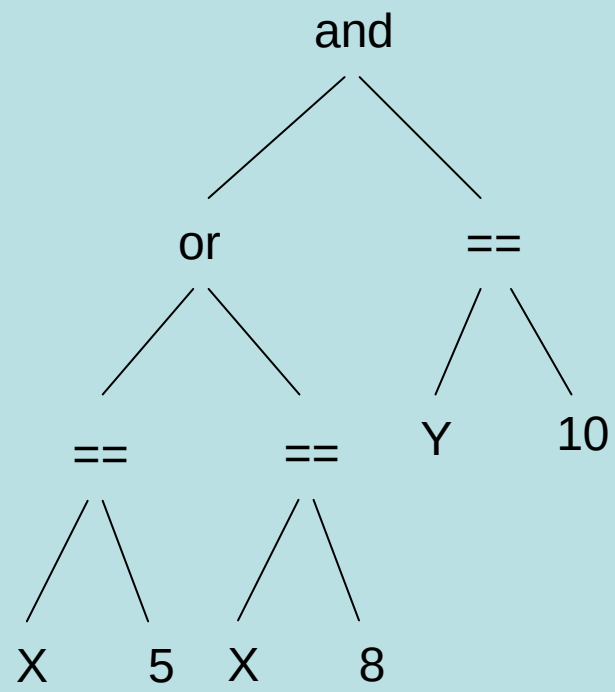
Four components of our notation

- Non binary tree representation
- horizontal tree representation
- Indentation instead of parentheses
- Variable factorization

In fact the horizontal tree representation is nothing new, it is directly derived from the structure of a XML document.

Tree concept comparison

Traditional vertical binary tree



Natural language representation

X is equal to 5 or to 8 and Y is equal to10

Our horizontal tree notation

X is one of 5, 8
and
Y is 10

List representation

- The XACML list concept for conjunction and disjunction operators is maintained but by repeating the operators between elements.

X is 3
and
Y is 15
and
Z is 34

X is 6
or
X is 45
or
X is 27

Sub-constraint terminology

- Conjunction and disjunction operators representation vary depending on their location in the hierarchy
- “and”, “or” notation at the highest level
- “Provided that”, “one of” at lower levels

```
   X is 3
      provided that K is 4
and
   Y one of 15, 24, 46
and
   Z is one of
       blue
           provided that L is 5
       red
           provided that L is 10
```

Complex rule example

Merchandise is one of
clothing
provided that BalanceOfAccount over 2000.00,
concert
provided that DistanceFromHome under 5
and
DayOfTheWeek is one of
Tuesday
provided that TimeOfTheDay between 16:00:00 and 18:00:00,
Wednesday
provided that TimeOfTheDay between 12:00:00 and 14:00:00,
Friday
provided that TimeOfTheDay before 21:00:00

Generic notation

- The notation is not limited to the representation of XACML
- Any condition expression from any Access control language can be represented.

Cisco firewall rule

```
access-list 101 deny tcp host 148.22.33.44 host 192.168.0.0 eq 3500
```

```
   protocol is tcp
and
   srcIP is 148.22.33.44
and
   dstIP is 192.168.0.0
and
   dstPort is 3500
```

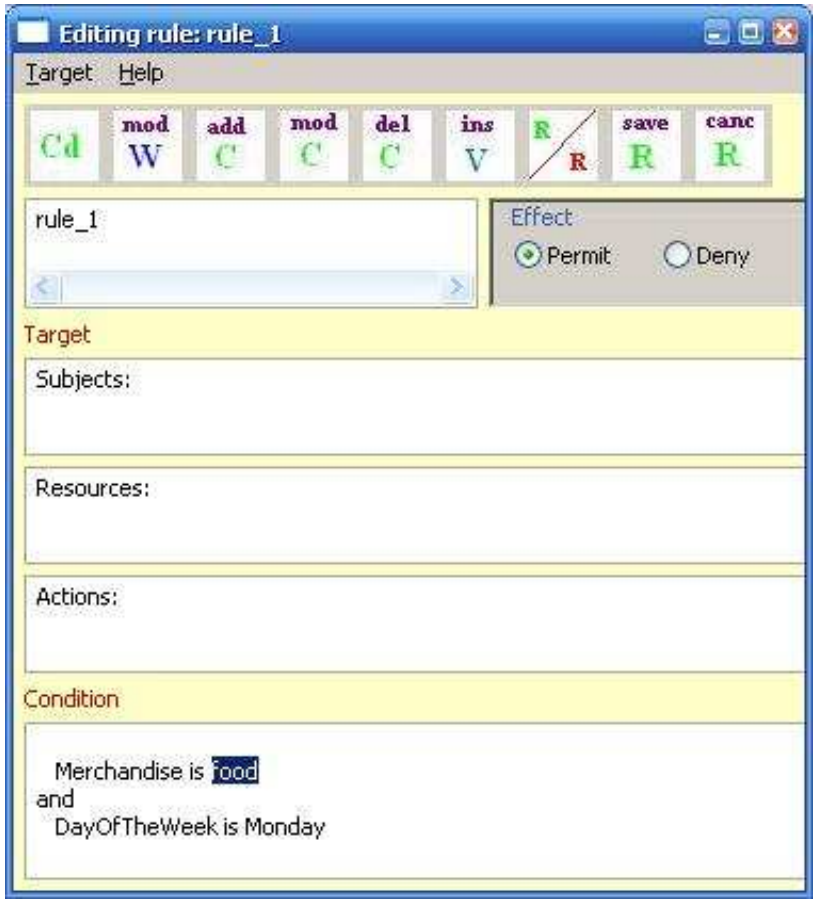
Application configuration

- The need for the programmer is not fully eliminated.
- The programmer still builds the application.
- Application provider administrates:
  - Data types
  - Enumerated values

```
<Variable name="DayOfTheWeek"
                                type="String">
  <Values>
        <Value name="Monday"/>
        <Value name="Tuesday"/>
        <Value name="Wednesday"/>
        <Value name="Thursday"/>
        <Value name="Friday"/>
        <Value name="Saturday"/>
        <Value name="Sunday"/>
  </Values>
</Variable>
```

Our notation and editors

Rule condition manipulation



Value selection

Conclusion

- With our display notation, anyone can now create and edit XACML rules
- Thus, our notation could result in a larger audience for XACML.

Contact

- Bernard Stepien – bernard@site.uottawa.ca
- Amy Felty – afelty@site.uottawa.ca
- Stan Matwin – stan@site.uottawa.ca